MORGAN AND MORECAMBE OFFSHORE WIND FARMS: TRANSMISSION ASSETS

Environmental Statement

Volume 2, Annex 2.1: Benthic subtidal and intertidal ecology technical report

September 2024
Rev: ES Issue

MOR001-FLO-CON-ENV-RPT-0033
MRCNS-J3303-RPS-10004

PINS Reference: EN020028
APFP Regulations: 5(2)(a)
Document reference: F2.2.1

Document status

Version	Purpose of document	Approved by	Date	Approved by	Date
ES	For issue	AS	September 2024	IM	September 2024

The report has been prepared for the exclusive use and benefit of the Applicants and solely for the purpose for which it is provided. Unless otherwise agreed in writing by RPS Group Plc, any of its subsidiaries, or a related entity (collectively 'RPS') no part of this report should be reproduced, distributed or communicated to any third party. RPS does not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report. The report does not account for any changes relating to the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report.

The report has been prepared using the information provided to RPS by its client, or others on behalf of its client. To the fullest extent permitted by law, RPS shall not be liable for any loss or damage suffered by the client arising from fraud, misrepresentation, withholding of information material relevant to the report or required by RPS, or other default relating to such information, whether on the client's part or that of the other information sources, unless such fraud, misrepresentation, withholding or such other default is evident to RPS without further enquiry. It is expressly stated that no independent verification of any documents or information supplied by the client or others on behalf of the client has been made. The report shall be used for general information only.

Prepared by:	Prepared for:
RPS	**Morgan Offshore Wind Limited, Morecambe Offshore Windfarm Ltd**

Contents

Tables

Figures

Appendices

Appendices Tables

Appendices Figures

Glossary

Term	Meaning
Environmental Statement	The document presenting the results of the Environmental Impact Assessment process.
Export cable corridor	The specific corridor of seabed (seaward of Mean High Water Springs and land (landward of Mean High Water Springs) from the Generation Assets to the National Grid Penwortham substation.
Generation Assets	The generation assets associated with the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm include the offshore wind turbines, inter-array cables, offshore substation platforms and platform link (interconnector) cables to connect offshore substations.
Intertidal Infrastructure Area	The temporary and permanent areas between Mean Low Water Springs and Mean High Water Springs.
Intertidal area	The area between Mean High Water Springs and Mean Low Water Springs.
Landfall	The area in which the offshore export cables make landfall (come on shore) and the transitional area between the offshore cabling and the onshore cabling. This term applies to the entire landfall area at Lytham St. Annes between Mean Low Water Springs and the transition joint bay inclusive of all construction works, including the offshore and onshore cable routes, intertidal working area and landfall compound(s).
Morecambe Offshore Windfarm: Generation Assets	The offshore generation assets and associated activities for the Morecambe Offshore Windfarm.
Morecambe Offshore Windfarm: Transmission Assets	The offshore export cables, landfall and onshore infrastructure required to connect the Morecambe Offshore Windfarm to the National Grid.
Morgan and Morecambe Offshore Wind Farms: Transmission Assets	The offshore and onshore infrastructure connecting the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm to the national grid. This includes the offshore export cables, landfall site, onshore export cables, onshore substations, 400 kV grid connection cables and associated grid connection infrastructure such as circuit breaker compounds. Also referred to in this report as the Transmission Assets, for ease of reading.
Morgan Offshore Wind Project: Generation Assets	The offshore generation assets and associated activities for the Morgan Offshore Wind Project.
Morgan Offshore Wind Project Transmission Assets	The offshore export cables, landfall and onshore infrastructure required to connect the Morgan Offshore Wind Project to the National Grid.
Offshore export cables	The cables which would bring electricity from the Generation Assets to the landfall.
Offshore export cable corridor	The corridor within which the offshore export cables will be located.
Offshore Order Limits	See Transmission Assets Order Limits: Offshore (below).
Polychaete	Marine segmented worms.

Term	Meaning
Ramsar sites	Wetlands of international importance that have been designated under the criteria of the Ramsar Convention. In combination with Special Protection Areas and Special Areas of Conservation, these sites contribute to the national site network.
Reefiness	A reefiness determination is the result of an assessment of the characteristics of a reef in order to determine if a habitat is considered a reef in the specific context of the Habitats Directive. The features that contribute to the 'reefiness' of a rocky reef include (Irving, 2009): Composition (percentage cover, including patchiness); Elevation (height of the reef above the seabed level); Extent (percentage of species composed of epifaunal species).
Special Areas of Conservation	A site designation specified in the Conservation of Habitats and Species Regulations 2017. Each site is designated for one or more of the habitats and species listed in the Regulations. The legislation requires a management plan to be prepared and implemented for each Special Area of Conservation to ensure the favourable conservation status of the habitats or species for which it was designated. In combination with Special Protection Areas and Ramsar sites, these sites contribute to the national site network.
Study area	This is an area which is defined for each environmental topic which includes the Transmission Assets Order Limits as well as potential spatial and temporal considerations of the impacts on relevant receptors. The study area for each topic is intended to cover the area within which an impact can be reasonably expected.
Survey area	The area within which each survey has been undertaken. This may differ from the Study Area as a Survey Area will be based on species or survey-specific guidance on the extent of survey required, which may be limited by, for example, habitat conditions, or be defined in terms of buffer areas around an area of potential impact.
Transmission Assets	See Morgan and Morecambe Offshore Wind Farms: Transmission Assets (above).
Transmission Assets Order Limits	The area within which all components of the Transmission Assets will be located, including areas required on a temporary basis during construction and/or decommissioning.
Transmission Assets Order Limits: Offshore	The area within which all components of the Transmission Assets seaward of Mean Low Water Springs will be located, including areas required on a temporary basis during construction and/or decommissioning. Also referred to in this report as the Offshore Order Limits, for ease of reading.

Acronyms

Acronym	Meaning
AL	Action Level
BAC	Background Assessment Concentration
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy
CCW	Countryside Council for Wales
Cefas	Centre for Environment, Fisheries and Aquaculture Science

Acronym	Meaning
CMACS	Centre for Marine and Coastal Studies
DDV	Drop-Down Video
DEFA	Department of Environment, Food and Agriculture
Defra	Department for Environment, Food and Rural Affairs
eDNA	Environmental Deoxyribonucleic Acid
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation Data Network
ERL	Effects Range Low
ERM	Effects Range Median
ES	Environmental Statement
EU	European Union
EUNIS	European Nature Information System
ICES	International Council for the Exploration of the Sea
IEF	Important Ecological Feature
ISQG	Interim marine Sediment Quality Guidelines
JNCC	Joint Nature Conservation Committee
LOD	Limit of Detection
MCZ	Marine Conservation Zone
MDS	Multi-Dimensional Scaling
MHWS	Mean High Water Springs
MNR	Marine Nature Reserve
NBN	National Biodiversity Network
NRW	Natural Resources Wales
OSPAR	Oslo-Paris convention for the protection of the marine environment of the North-Eastern Atlantic
OTU	Operational Taxonomic Unit
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PEL	Probable Effect Level
PSA	Particle Size Analysis
SAC	Special Area of Conservation
SACFOR	Super abundant, Abundant, Common, Frequent, Occasional, Rare
SIMPER	Similarity Percentages

Acronym	Meaning
SIMPROF	Similarity Profile
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TEL	Threshold Effect Level
UK	United Kingdom
ZOI	Zone of Influence

Units

Unit	Description
%	Percentage
cm	Centimetre
mg	Milligram
g	gram
kg	Kilogram
m	Metre
m^2	Square metre
km	Kilometre
km^2	Square kilometre
nm	Nautical mile

1 Benthic subtidal and intertidal ecology technical report

1.1 Introduction

1.1.1.1 This document forms Annex 2.1 of the Environmental Statement (ES) prepared for the Morgan and Morecambe Offshore Wind Farms: Transmission Assets (hereafter referred to as 'the Transmission Assets'). The ES presents the findings of the Environmental Impact Assessment (EIA) process for the Transmission Assets.

1.1.1.2 This document provides the detailed baseline characterisation of the benthic subtidal and intertidal ecology (e.g. species, communities, and habitats) associated with the Transmission Assets. Data was collected through a detailed desktop study of the existing resources available for benthic subtidal and intertidal ecology within the study area (see **section 1.2.2**), incorporating site-specific survey data and data from third party organisations.

1.1.1.3 The aim of this technical report is to provide a robust baseline characterisation of the benthic subtidal and intertidal ecology resources within the Transmission Assets Order Limits: Offshore (hereafter referred to as the Offshore Order Limits), the Intertidal Infrastructure Area, and the defined study area (see **section 1.2.2**) against which the potential impacts associated with the construction, operation, and decommissioning of the Transmission Assets can be assessed. To support this assessment of potential effects in the EIA, the ecological information presented in this technical report was used to identify a range of Important Ecological Features (IEFs). Benthic IEFs were determined based on the conservation, ecological, and commercial importance of each identified feature within the study area (see **section 1.2.2**).

1.1.1.4 This technical report is structured as follows.

- **Section 1.2**: Methodology – Overview of desktop study and site-specific surveys used to inform the baseline, study areas relevant to the report and results of consultation undertaken to date.
- **Section 1.3**: Desk study baseline characterisation – Details the results of the desk study:
  - **section 1.3.2** – Desktop data within the Transmission Assets benthic subtidal and intertidal ecology study area; and
  - **section 1.3.3** – Desktop data within the Offshore Order Limits and Intertidal Infrastructure Area.
- **Section 1.4**: Site-specific survey baseline characterisation - Details the results of the site-specific surveys:
  - **section 1.4.1**: Methodology;
  - **section 1.4.2**: Results – subtidal ecology; and
  - **section 1.4.3**: Results – intertidal ecology.

- **Section 1.5**: Summary.

1.2 Methodology

1.2.1 Sources of information – Generation Assets

1.2.1.1 This baseline characterisation has primarily been informed by site-specific benthic survey data collected for the Transmission Assets. It has also drawn on the site-specific benthic survey data collected for the Morecambe Offshore Windfarm: Generation Assets and the Morgan Offshore Wind Project: Generation Assets. The site-specific data for the Morecambe Offshore Windfarm: Generation Assets and the Morgan Offshore Wind Project: Generation Assets (hereafter referred to collectively as the Generation Assets) has been reported as desktop data in this document with the full reports presented in **Appendix A** and **Appendix B**.

1.2.2 Study area

1.2.2.1 The Transmission Assets benthic subtidal and intertidal ecology study area (hereafter referred to as the study area) encompasses the wider east Irish Sea, extending from Mean High Water Spring (MHWS) out to the furthest west extent from the Mull of Galloway in Scotland and to the west tip of Anglesey. This study area has been selected to encompass the wider Irish Sea habitats and includes the neighbouring consented offshore wind farms and designated sites (**Figure 1.1**).

1.2.2.2 The study area has been characterised by desktop data (including the site-specific benthic data for the Generation Assets, presented in **Appendix A** and **Appendix B**) and provides a wider context to the site-specific data for the Transmission Assets collected within the Offshore Order Limits (excluding the Generation Assets) and the Intertidal Infrastructure Area (i.e. the Transmission Assets survey area; see **paragraph 1.2.2.3**). The study area is large enough to incorporate all direct and indirect impacts of the Transmission Assets on benthic subtidal and intertidal receptors. The study area is the same as the regional benthic subtidal and intertidal ecology study area defined for the Morgan Offshore Wind Project: Generation Assets (Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the Environmental Statement; Morgan Offshore Wind Ltd, 2024a) and also fully encompasses the study area and Zone of Influence (ZOI) defined for the Morecambe Offshore Windfarm: Generation Assets (Volume 5, Chapter 9: Benthic ecology of the Environmental Statement; Morecambe Offshore Windfarm Ltd, 2024a).

Survey area

1.2.2.3 The Transmission Assets survey area (hereafter referred to as the survey area) encompasses the offshore export cable corridor up to the MHWS (excluding Generation Assets areas of the Offshore Order Limits for which desktop survey data was available, **section 1.2.5**). Site-specific data was collected in 2022 within the survey area which comprised the area within the offshore export cable corridor. Baseline data collected within the Morgan Offshore Wind Project: Generation Assets and the Morecambe Offshore Windfarm: Generation Assets has been incorporated as desktop data within the study area (see **section 1.3**, and **Appendix A** and **Appendix B**).

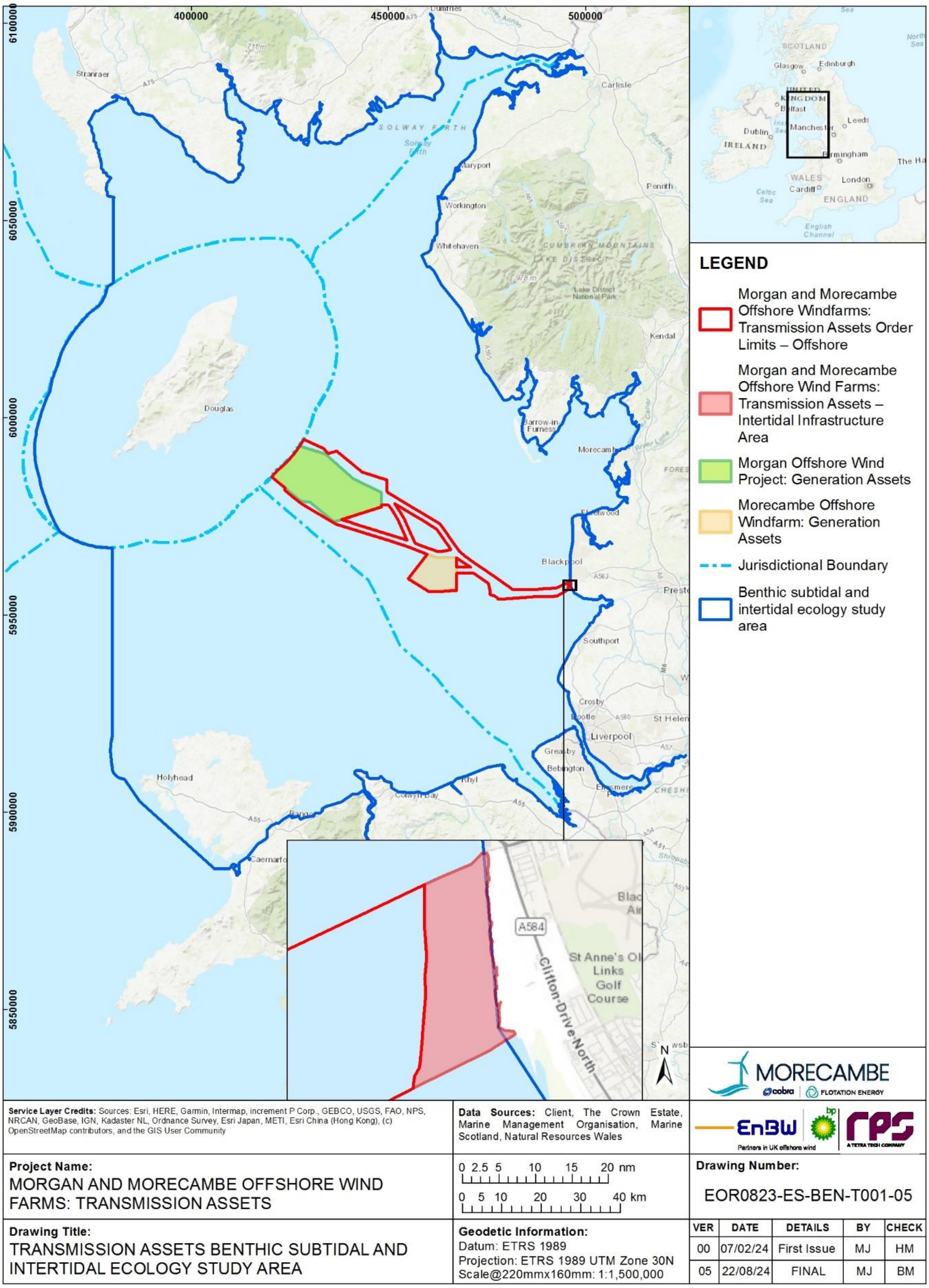


Figure 1.1: Transmission Assets benthic subtidal and intertidal ecology study area

1.2.3 Consultation

A summary of the key topics raised during consultation activities undertaken to date specific to benthic subtidal and intertidal ecology is presented in Table 2.3 of Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES.

1.2.4 Baseline methodology

1.2.4.1 A desktop review has been undertaken to inform the baseline for benthic subtidal and intertidal ecology, including a review of a number of academic publications and reports from surveys undertaken to support other project consents within the study area (including for the Morgan Offshore Wind Project: Generation Assets in **Appendix A** and the Morecambe Offshore Windfarm: Generation Assets in **Appendix B**), with many sources identified through stakeholder consultation. These provide further context to the site-specific surveys.

1.2.4.2 The benthic subtidal and intertidal ecology surveys within the survey area (i.e. the offshore export cable corridor, as defined in **paragraph 1.2.2.3**), were undertaken in 2022. The results of these surveys have been used to help characterise the wider study area, for the purposes of informing the benthic subtidal and intertidal ecology EIA chapter (Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES).

1.2.4.3 The benthic subtidal survey covered the Offshore Order Limits and consisted of grab sampling and Drop-Down Video (DDV) sampling for macrofaunal, sediment and environmental Deoxyribonucleic Acid (eDNA) analysis. Analysis of results included multivariate and univariate statistical analyses as well as descriptions of the raw data to aid in assessment of habitat and species sensitivity to potential impacts. An intertidal Phase 1 walkover survey of the Intertidal Infrastructure Area, up to MHWS, was also undertaken.

1.2.4.4 Detailed methodologies for all site-specific surveys and analyses are presented in **section 1.4**.

1.2.5 Desktop study

1.2.5.1 Information on benthic subtidal and intertidal ecology within the study area was collected through a detailed desktop review of existing studies and datasets. These sources are summarised at **Table 1.1** below.

Table 1.1: Summary of key desktop sources

Title	Source	Year	Author
Morgan Offshore Wind Project: Generation Assets. Volume 4, Annex 2.1: Benthic subtidal ecology technical report of the Environmental Statement	Morgan Offshore Wind Ltd	2024b	Morgan Offshore Wind Ltd

Title	Source	Year	Author
Morecambe Offshore Windfarm: Generation Assets. Volume 5, Appendix 9.1: Benthic Characterisation Survey Report of the Environmental Statement	Morecambe Offshore Windfarm Ltd	2024b	Morecambe Offshore Windfarm Ltd
Mona Offshore Wind Project. Volume 6, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the Environmental Statement	Mona Offshore Wind Ltd	2024	Mona Offshore Wind Ltd
Licence Area 457 Environmental Impact Assessment – Scoping Report	MarineSpace	2023	MarineSpace Ltd
Awel y Môr Environmental Impact Assessment, Volume 2, Chapter 5: Benthic Subtidal and Intertidal Ecology	RWE	2022	RWE
UK Offshore Energy Strategic Environmental Assessment (OESEA). Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil and Gas and Gas Storage and Associated Infrastructure. OESEA4 Environmental Report. Appendix 1: Environmental baseline	Department for Business, Energy and Industrial Strategy (BEIS)	2022	BEIS
The National Biodiversity Network (NBN) Gateway	NBN Atlas	2022	NBN Atlas
Lle Geo-Portal for Wales	Welsh Government	2021	Welsh Government
European Marine Observation and Data Network (EMODnet) broadscale seabed habitat map for Europe (also known as the EUSeaMap)	EMODnet-Seabed Habitats	2021	EMODnet-Seabed Habitats
Subtidal Ecology. In: Manx Marine Environmental Assessment (Second Ed)	The Government of the Isle of Man	2018a	Howe
Coastal Ecology. In: Manx Marine Environmental Assessment (Second Ed)	The Government of the Isle of Man	2018b	Howe
Burbo Bank Offshore Wind Farm Benthic and Annex I Habitat Pre-construction Survey Field Report	Burbo Bank Offshore Wind Farms (United Kingdom (UK)) Ltd/DONG Energy	2015	Centre for Marine and Coastal Studies (CMACS)

Title	Source	Year	Author
Rhiannon Offshore Wind Farm Preliminary Environmental Information Chapter 9 Benthic Ecology	Celtic Array Ltd	2014	Celtic Array Ltd
Burbo Bank Extension Offshore Wind Farm Environmental Statement Volume 2 – chapter 12: Subtidal and Intertidal Benthic Ecology	DONG Energy Ltd	2013	DONG Energy Ltd
Volume 1 Environmental Statement Walney Extension, chapter 10: Benthic Ecology	DONG Energy Ltd	2013	DONG Energy Ltd
Walney Offshore Wind Farm Year 1 post-construction benthic monitoring technical survey report (2012 survey)	Walney Offshore Wind Farms (UK) Ltd/DONG Energy	2013	CMACS
Ormonde Offshore Wind Farm Year 1 post-construction benthic monitoring technical survey report (2012 survey)	RPS Energy	2012	CMACS
A Review of the Contaminant Status of the Irish Sea	Joint Nature Conservation Committee (JNCC)	2005	Centre for Environment, Fisheries and Aquaculture Science (Cefas)
Gwynt y Môr Offshore Wind Farm Marine Benthic Characterisation Survey	Gwynt y Môr Offshore Wind Farm Ltd	2005	CMACS
Marine Phase 1 Intertidal Habitat Survey	Natural Resources Wales (NRW)	2005	NRW
Phase I- Intertidal Survey-Standard Report'	Countryside Council for Wales (CCW)	2004	CCW
North Hoyle Offshore Wind Farm Environmental Statement	Innogy NWP offshore Ltd	2002	Innogy
Broadscale seabed survey to the east of the Isle of Man	Holt *et al*.	1997	Holt *et al*.
Offshore benthic communities of the Irish Sea	Mackie	1990	Mackie

1.3 Desk study – baseline characterisation

1.3.1.1 The baseline characterisation presented in this section summarises the results of the desk study which includes the results of the site-specific baseline characterisation surveys undertaken for the Morgan Offshore Wind Project: Generation Assets (see **Appendix A**) and the Morecambe Offshore Windfarm: Generation Assets (see **Appendix B**). This desk study specifically considers sediment characteristics and contamination, subtidal and intertidal benthic ecology, and the location and characterisation of nearby designated sites.

1.3.2 Desk study data within the Transmission Assets benthic subtidal and intertidal ecology study area

Subtidal sediments

1.3.2.1 The OESEA4 (BEIS, 2022) compiled a baseline of the offshore benthic environment around the UK. It identified that the offshore seabed in the east Irish Sea, within the study area, is predominantly sedimentary, mainly of glacial origin, consisting mostly of sands and muddy sands, coarse and mixed sediments. In deeper sections tide-swept circalittoral mixed sediments were identified, in the south of the study area. In the nearshore, along the north Wales coast, the sediment is largely sandy mud or muddy sand (where it has been defined). Similar sediments are located along the west coast of England.

1.3.2.2 A large broadscale subtidal survey carried out in 1997 by the University of Liverpool, on behalf of bp (Holt *et al*., 1997), used side scan sonar and video survey methods to characterise the benthos in the region east of the Isle of Man within the study area. The survey showed the area to be relatively uniform, consisting of fine and medium sands with varying proportions of stones and shells. The surveys also identified widespread areas of fine scale sand waves or ripples. The sand waves and ripples identified consisted of much coarser sands, stones and gravel often with very large proportions of dead shell material. Muddy sediments were recorded in only a few patches in the study area, the largest of which were to the west of the Isle of Man.

1.3.2.3 The subtidal sediments of the study area, as indicated by the EMODnet (2021) data, are dominated by deep circalittoral coarse sediment, offshore circalittoral sand, circalittoral mixed sediment and offshore circalittoral mud which is characteristic of the wider Irish Sea (EMODnet, 2021). The EMODnet broad-scale habitat map predicts large areas of high energy infralittoral habitat at the mouth of the river Mersey, the river Dee and river Conwy in the south and south east of the study area, as well as the river Kent, river Leven, river Lune and the river Duddon in the east, around Morecambe Bay. High energy infralittoral habitat is also predicted in Luce Bay and Wigtown Bay in the north of the study area. There is also a large area of infralittoral sand at the entrance of the Solway Firth which is determined to be a moderate energy environment (EMODnet, 2021). Deep circalittoral coarse sediments were recorded to the south and east of the Isle of Man, while infralittoral coarse sediments were recorded to the north of the Isle of Man (EMODnet, 2021).

1.3.2.4 Broadly within the study area, seabed sediments are dominated by circalittoral coarse sediment (SS.SCS.CCS; A5.14) and circalittoral mixed sediment (SS.SMx.CMx; A5.44) in the west with sediments transitioning to offshore circalittoral sand (SS.SSa.OSa; A5.27) and offshore circalittoral mud (SS.SMu.OMu; A5.37) to the north east of the area. Seabed sediments along the English coast to the east of the

Transmission Assets are dominated by circalittoral fine sand (SS.SSa.CFiSa; A5.25) or circalittoral muddy sand (SS.SSa.CMuSa; A5.26) (**Figure 1.2**; EMODnet, 2021). **Appendix C** provides the full names for all the habitats/biotopes discussed in this section, and **Figure 1.3** is provided to facilitate understanding of the habitats presented.

1.3.2.5 A mix of circalittoral coarse sediments and infralittoral coarse sediments were present in the east and west of the Isle of Man (**Figure 1.2**, EMODnet, 2021). The EMODnet seabed map (2021) shows subtidal sediments along the north Wales coast as being dominated by circalittoral fine sand and circalittoral muddy sands in a high energy environment, with areas of coarse sediment closer to shore around the Great Orme headland, interspersed with sections of infralittoral rock close to shore on the east and west sides of the Great Orme headland. A larger area of coarse sediment is mapped north of Colwyn Bay which extends slightly east of Rhyl.

1.3.2.6 The Mona Offshore Wind Project is located in the south of the benthic subtidal ecology study area, to the south west of the Transmission Assets (**Figure 1.3**). Baseline characterisation surveys of the Mona Array Area and ZOI determined that the sediment ranged from sandy gravel to slightly gravelly muddy sand with most samples classified as gravelly muddy sand (Mona Offshore Wind Ltd, 2024). Within the Mona Offshore Cable Corridor, the sediment was predominantly classified as either gravelly muddy sand or sand, becoming finer closer to the coast (Mona Offshore Wind Ltd, 2024).

1.3.2.7 Surveys conducted by the Gwynt y Môr Offshore Wind Farm, Burbo Banks Offshore Wind Farm and Burbo Bank Extension were undertaken in the south of the study area. Pre-construction and post-construction monitoring and baseline characterisation surveys were undertaken for these projects between 2010 and 2012. These surveys characterised the sediments in the south of the study area as being dominated by circalittoral sand and coarse sediment, as well as muddy sand and sandy mud further inshore towards the north Wales coast (CMACS, 2011; SeaScape Energy, 2011; DONG Energy Ltd, 2013a). These areas of circalittoral sand in the south of the study area were interspersed with areas of circalittoral rock around the north west coast of Anglesey (**Figure 1.2**, EMODnet, 2021).

1.3.2.8 The proposed, and now dropped, Rhiannon Offshore Wind Farm was to be located in the west of the study area. Baseline characterisation surveys in 2010 and 2012 for the Rhiannon Offshore Wind Farm identified two large sandbanks, one off Lynas point on the north coast of Anglesey, and another in the east of the study area. These were composed of very well sorted mobile sand that remained submerged at all times (Celtic Array Ltd, 2014). The banks consist of medium and coarse sands with minimal mud or gravel content (Celtic Array Ltd, 2014). These banks were considered to be examples of the Annex I habitat sandbanks which are slightly covered by sea water at all times (Celtic Array Ltd, 2014).

1.3.2.9 The Walney and Ormonde offshore wind farms are located in the east of the study area. Pre-construction and post-construction monitoring, and baseline characterisation surveys were undertaken for these projects between 2009 and 2014. Surveys conducted for Ormonde Offshore Wind Farm and Walney Offshore Wind Farm found the subtidal sediments in the east of the study area were dominated by circalittoral sandy mud or circalittoral muddy sand (CMACS, 2012a; CMACS, 2012b; CMACS, 2012c; CMACS, 2013; CMACS, 2014). The 1-year post-construction surveys (2012) for the Ormonde Offshore Wind Farm recorded a higher percentage of mud further offshore and a lower percentage of mud in the south inshore areas (CMACS, 2012a). East of Morecambe Bay in the east of the study area the sediment becomes coarser than at the Ormonde Offshore Wind Farm. During the 1-year post-construction monitoring of Walney Offshore Wind Farm in 2013, the Walney array area was shown to be dominated by sandy mud with sediments transitioning to coarse sediment further offshore and inshore of the array area (CMACS, 2013).

1.3.2.10 The subtidal sediments in the south west of the study area, as determined by baseline characterisation surveys for the Rhiannon Offshore Wind Farm located to the west of the Transmission Assets, have been recorded as being dominated by sandy gravels or gravelly sand, generally coarse sediments with generally low mud content (Celtic Array Ltd, 2014). Specifically, sediments were dominated by SS.SCS.CCS and SS.SMx.CMx with patches of SS.SSa.CFiSa, with these sediments grading into mud sediments towards the Welsh coast.

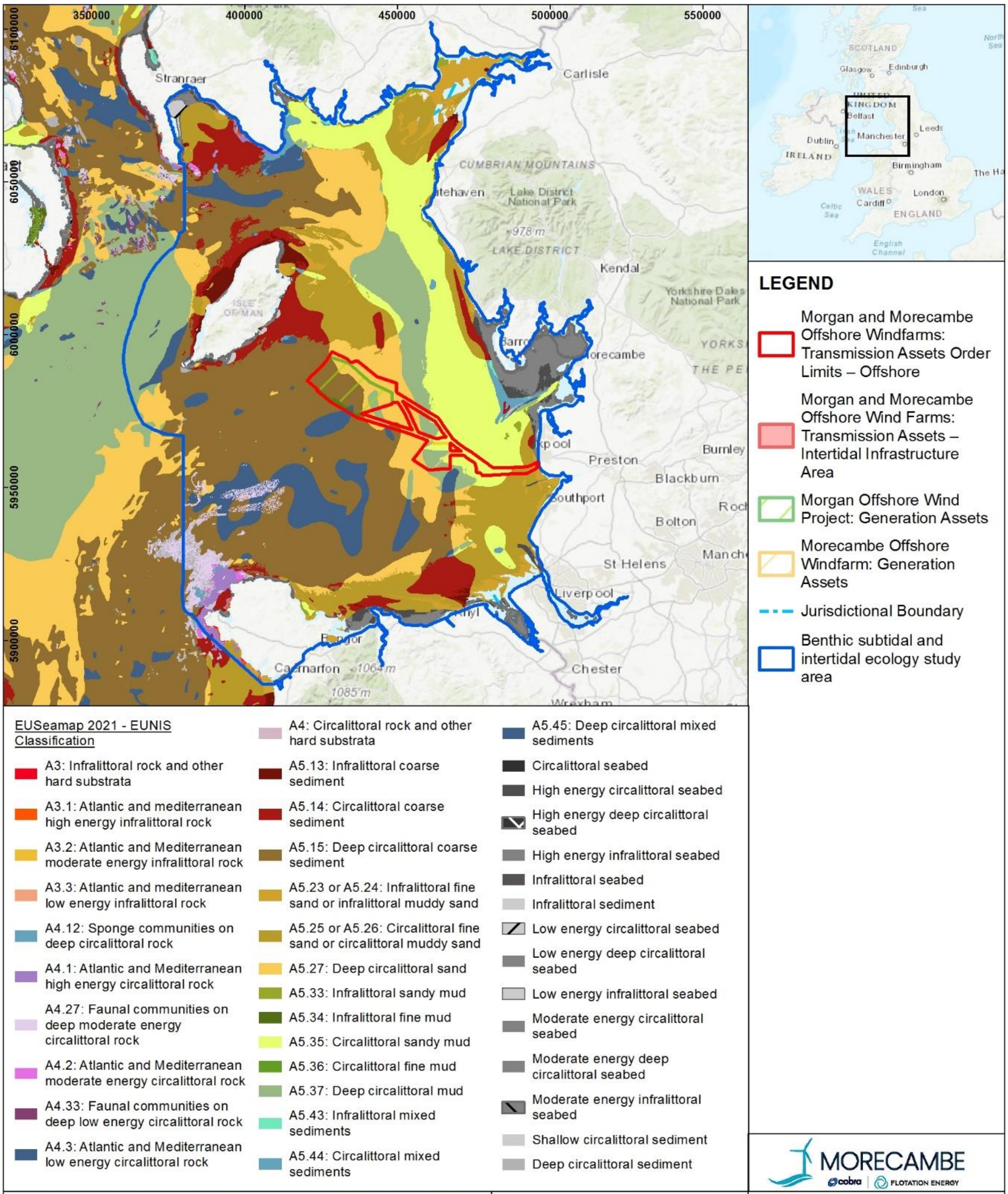
1.3.2.11 The Isle of Man territorial waters also fall within the study area. A marine environmental assessment was undertaken by Howe (2018a) to bring together subtidal surveys which have been conducted around the Isle of Man to create an extensive characterisation of the subtidal environment. The subtidal habitats to the west of the island were shown to be predominantly mixed gravel, mixed stone and mixed sand seabed which extended to the north and the south with a small area of sand/muddy sand in the south east. The seabed located to the south west of the island comprises an extensive area of mud/fine sand. Sediments within this area comprised SS.SCS.CCS, SS.SSa.CFiSa; and SS.SSa.CMuSa being recorded to the south and east of the isle (**Figure 1.2**, EMODnet, 2021). This matched with the findings of the coastal surveys in Howe (2018b), which recorded mixed stone and mixed sand seabed which extended to the north and the south with a small area of sand/muddy sand in the south east in the coastal and nearshore areas.

1.3.2.12 The consented Awel y Môr Offshore Wind Farm, also in the south of the regional benthic subtidal and intertidal ecology study area, undertook site-specific baseline characterisation surveys in 2022 (RWE, 2022). The survey identified the seafloor in the south east of the array area was characterised by numerous sandwaves and megaripples, while the west of the site was relatively flat and featureless (RWE, 2022). Sandwaves were reported to be actively mobile and migrating. In the west of the survey area sediments contained sand, gravel and a small fines fraction (RWE, 2022). In the east of the array area, sandwaves and megaripples were evident and were formed by sands with a low gravel content (RWE, 2022).

1.3.2.13 The nearshore area has been surveyed for the extension of the marine aggregate extraction licence for Area 457 in Liverpool Bay, approximately 25 km west of the English coast and 30 km north west of Wales (MarineSpace, 2023). This indicated the presence of sand and fine gravels within this area, with surrounding sediments typically being comprised of circalittoral coarse sand or gravel, with areas of coarse to medium sands, and shell gravels.

1.3.2.14 The baseline surveys informing the designation of the Fylde Marine Conservation Zone (MCZ) (Miller and Green, 2017) indicated the south and west of the MCZ, which overlaps with the Transmission Assets, were dominated by subtidal sand (SS.SSa; A5.2), with one station to the west outside the MCZ boundary being classified as subtidal mixed sediments (SS.SMx; A5.4). To the north, this grades into subtidal mud (SS.SMu; A5.3), with sediments further north of this in the Shell Flat and Lune Deep Special Area of Conservation (SAC) being comprised of a sandy substrate dune, and a cobble rock substrate further north and west (JNCC, 2017).

1.3.2.15 Near the coast there is a large proportion of circalittoral sandy mud (S.SMu.CSaMu; A5.35) in the north of the study area. Sediments characterised by SS.SSa.CFiSa or SS.SSa.CMuSa dominate the seabed nearest the coast. The EUSeaMap describes these habitats as moderate energy habitats (**Figure 1.2**, EMODnet, 2021).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, The Crown Estate, Marine Management Organisation, Marine Scotland, Natural Resources Wales, EMODnet

Project Name:
MORGAN AND MORECAMBE OFFSHORE WIND FARMS: TRANSMISSION ASSETS

0 5 10 20 30 nm
0 5 10 20 30 40 50 60 km

Drawing Number:
EOR0823-ES-BEN-T002-04

Drawing Title:
BENTHIC HABITAT TYPES WITHIN THE STUDY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@220mmx160mm: 1:2,100,000

VER	DATE	DETAILS	BY	CHECK
00	07/02/24	First Issue	MJ	HM
04	22/08/24	FINAL	MJ	TT

Figure 1.2: Benthic habitat types within the study area

Sediment contamination

1.3.2.16 Metals occur naturally in the marine environment. Generally elevated contaminant concentrations, such as metals, in the Irish Sea can originate from natural mineralisation or anthropogenic sources (Cefas, 2005). Rowlatt and Lovell (1994) recorded elevated levels of metals in the north east Irish Sea, and thus the study area, which is attributed to inputs from the industrial areas of north west England for example, Merseyside and Lancashire.

1.3.2.17 Pre-construction surveys conducted for the Burbo Bank Offshore Wind Farm (CMACS, 2005a) to the south of the Offshore Order Limits identified that seven of the nine core samples across the array area contained metals at, or above, Interim marine Sediment Quality Guidelines (ISQG) levels/Canadian Threshold Effect Levels (TELs). Additionally, two metals (lead and mercury) were present in excess of the Canadian Probable Effect Levels (PELs). The Canadian PEL establishes the concentration range within which adverse effects frequently occur (CCME, 2001). A greater proportion of surface sediment samples, especially in the top metre, contained metals above ISQG/Canadian TEL. No metals were in excess of ISQG/Canadian TEL below 1.5 m. Six of these samples were collected in the Burbo Bank Offshore Wind Farm array area (6.4 km from the Sefton coastline) and three in the offshore export cable corridor. The pre-construction site investigation survey concluded that as the contamination occurred in the upper metre of the seabed, they would be naturally mobile and therefore any additional works from offshore wind farms would not mobilise any sediment not naturally mobile.

1.3.2.18 Arsenic has regularly been recorded at elevated levels in the east Irish Sea (e.g. Camacho-Ibar *et al*., 1992) and within the study area. Arsenic was recorded above ISQG/Canadian TEL but below the Canadian PEL at four sites across the Walney Offshore Wind Farm array area as part of the benthic baseline characterisation surveys (DONG Energy Ltd, 2013b). Benthic surveys for the former Rhiannon Offshore Wind Farm site (Centrica Plc and DONG Energy Ltd, 2014), to the west of the Transmission Assets, reported sediment chemical contaminants at generally very low levels (Celtic Array Ltd, 2014a) with arsenic marginally exceeding Cefas Action Level 1 (AL1) at several sample stations.

1.3.2.19 Studies have found that arsenic levels were commonly elevated around the Liverpool Bay area (Camacho-Ibar *et al*., 1992). However, these levels typically were not attributable to anthropogenic sources, and the source was instead considered to be weathering of glaciated regions of north Wales and the Lake District (Thornton and Farago, 1997).

1.3.2.20 Benthic characterisation surveys for the Walney Extension Offshore Wind Farm Environmental Statement (DONG Energy, 2013b), to the north east of the Offshore Order Limits, identified one sample of mercury above ISQG/Canadian TEL but levels of contaminants were, overall, at levels not considered to pose a risk to the environment. Mercury levels were thought to be reducing in the years leading up to

1993 based on samples from the muscles of plaice *Pleuronectes platessa*, reducing from a mean value of the order of 0.5 mg kg^{-1} wet weight in the early 1970s, to approximately 0.2 mg kg^{-1} in 1991 (Leah *et al*., 1993). These reductions are due to reduced discharge into the Mersey estuary by the chloro-alkali chemical industry (DONG Energy, 2013b).

1.3.2.21 Surveys at Burbo Bank Extension (DONG Energy Ltd, 2013a) in the south east of the study area found no contaminants were present above Canadian PEL however the array area had elevated levels of iron, aluminium, arsenic, copper, zinc and lead above natural background levels, no contaminant was present above Canadian PEL. These results are consistent with the results from surveys for other wind farms in the area which also found elevated levels of the same metals but no exceedances of the Canadian PEL (Burbo Bank (Seascape Energy Ltd, 2002), North Hoyle (Innogy, 2002), and Gwynt y Môr (CMACS, 2005b)). The Environmental Statement for Burbo Bank Extension (DONG Energy Ltd, 2013a) found no organochlorine and organophosphorus pesticides were present at detectable levels and no sample at any depth contained Polychlorinated biphenyls (PCBs) in excess of the ISQG level. Polycyclic aromatic hydrocarbons (PAHs) were present above the Limit of Detection (LOD) in only one sample from a single depth in the south west of the Burbo Bank Offshore Wind Farm.

1.3.2.22 Site-specific surveys for Awel y Môr Offshore Wind Farm found total PAH concentrations were higher in the array area than the median concentration recorded from the Strategic Environmental Assessment 6 (SEA6) (Cefas, 2005) Irish Sea surveys (0.0237 µg/g) at six stations; however, the median value from the site-specific survey was broadly comparable to the SEA6 median value (RWE, 2022). The bioavailable metals concentrations in sediments were all below their respective Cefas ALs (RWE, 2022).

1.3.2.23 As part of the baseline characterisation surveys for the Mona Offshore Wind Project, located to the south west of the Offshore Order Limits, 40 stations were sampled for sediment chemistry (metals, organotins, PCBs and PAHs). On the whole, levels of contaminants were very low across the Mona benthic subtidal and intertidal ecology study area. Levels of the contaminants in sediment samples were below all relevant Cefas AL2, Canadian PEL, Effects Range Median (ERM) or Effects Range Low (ERL) thresholds where these exist (Mona Offshore Wind Ltd, 2024). Across the Mona Array Area and ZOI and Mona Offshore Cable Corridor, five sample stations exceeded the AL1 for arsenic but were below the Cefas AL2 threshold. All but one sample station exceeded the Canadian TEL for arsenic but were below the Canadian PEL. Furthermore, one sample station in the Mona Array Area exceeded the Cefas AL1 for cadmium but was below Cefas AL2. Levels of PCBs were typically recorded below the LOD across the Mona benthic subtidal and intertidal ecology study area with the exception of five stations. The levels of total PCBs and the total International Council for the Exploration of the Sea (ICES)-7 PCBs were however below the relevant Cefas AL1 and AL2 at these stations as well as the Canadian TEL and PEL for total PCBs (Mona Offshore Wind Ltd, 2024).

Concentrations of all PAHs in samples were below the relevant Canadian TEL (where one is specified). Concentrations of organotins were below the LOD at all stations.

1.3.2.24 Consideration of levels of contamination in sediments within the Transmission Assets survey area is detailed in **section 1.3.3**.

Subtidal benthic communities

Regional studies

1.3.2.25 Mackie (1990) describes most of the east Irish Sea as being dominated by *Venus* clam communities. Deep *Venus* communities were characterised by occurrence at depths of 40 – 100 m in coarse sand/gravel/shell sediments and for containing species such as purple heart urchin *Spatangus purpureus*, *Glycymeris* spp., *Astarte scutella* and *Venus* clams (Mackie, 1990). Deep *Venus* clam communities are present in the central and west sections of the study area (Mackie, 1990). Much of the inshore area of the study area can be characterised by shallow *Venus* clam communities on nearshore sand, tending to occur in waters 5-40 m deep, with strong currents and sand. Mackie (1990) also identified pockets of bivalve *Abra* spp. communities along the north Wales coastline as well as in the east of the study area. These communities are dominated by the bivalve species *Abra alba* and the polychaete worm *Lagis koreni* (Rees *et al*., 1977) and the biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc).

Other offshore wind farms

1.3.2.26 **Figure 1.3** displays all the mapped subtidal ecology data available from the nearby offshore wind farms within the study area and in relation to the Transmission Assets. **Appendix C.8** provides the full names for all the biotopes which are presented in **Figure 1.3** to facilitate a better understanding of the habitats presented.

1.3.2.27 The Gwynt y Môr pre-construction benthic monitoring surveys (CMACS, 2011), to the south of the Offshore Order Limits, identified the *Moerella* spp. with venerid bivalves in infralittoral gravelly sand (SS.SCS.ICS.MoeVen) biotope and the SS.SSa.CFiSa biotope as the most extensively distributed biotopes throughout the surveyed site. These biotopes are common and widespread biotopes in the local area (i.e. Liverpool Bay and north east Irish Sea). The biotope *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat) was identified at a few locations within the Gwynt y Môr site but was more dominant at the nearshore export cable route and inshore west reference sites. The *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods (SS.SSa.IMuSa.FfabMag) biotope was also described at stations on the south side of the array area, close to the Welsh coast. The Gwynt y Môr pre-construction benthic survey recorded seven *Sabellaria spinulosa* individuals across five stations out of a total of 126 stations overall, however no reefs were identified in these pre-construction site investigation surveys (CMACS, 2011).

1.3.2.28 The Burbo Bank Offshore Wind Farm is located approximately 8 km to the east of Gwynt y Môr Offshore Wind Farm. The Environmental Statement (SeaScape Energy, 2002) and three year post-construction monitoring survey both reported a variety of biotopes across the original array area and extension (SeaScape Energy, 2011). The array area was dominated by the SS.SSa.IMuSa.FfabMag with a small section of SS.SSa.CMuSa.AalbNuc identified in the east of the array area. The wider area around the array area was classified as SS.SSa.IFiSa.NcirBat. The south section of the array area was dominated by the *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit) biotope with a large proportion of the north section characterised by the SS.SCS.ICS.MoeVen biotope. The west of the array was characterised by combinations of the biotopes *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel) and SS.SSa.CMuSa.AalbNuc. The cable corridor, which extends across the mouth of the river Dee, largely consisted of the SS.SSa.IFiSa.NcirBat biotope.

1.3.2.29 The nationally scarce crab *Thia scutellata* has been recorded in the south of the study area (Rees, 2001; Moore, 2002). This small crab inhabits a specific habitat of loose, well-sorted medium sands into which it can easily burrow. This species was recorded during benthic surveys for the Burbo Bank (SeaScape Energy, 2002), Burbo Bank Extension (DONG Energy Ltd, 2013a) and the Gwynt y Môr (Npower Renewables Ltd, 2005) offshore wind farms.

1.3.2.30 Surveys conducted by CMACS (2009) at the Walney Offshore Wind Farm, in the east of the study area, found that SS.SMu.CSaMu.AfilKurAnit (in the east of the site) and *Thyasira* spp. and *Ennucula tenuis* in circalittoral sandy mud (SS.SMu.CSaMu.ThyEten) (in the west of the site where sediment has a higher gravel content) were the main biotopes in the surveyed site. Along the export cable corridor the biotopes SS.SMu.CSaMu.AfilKurAnit and SS.SSa.IMuSa.FfabMag were recorded.

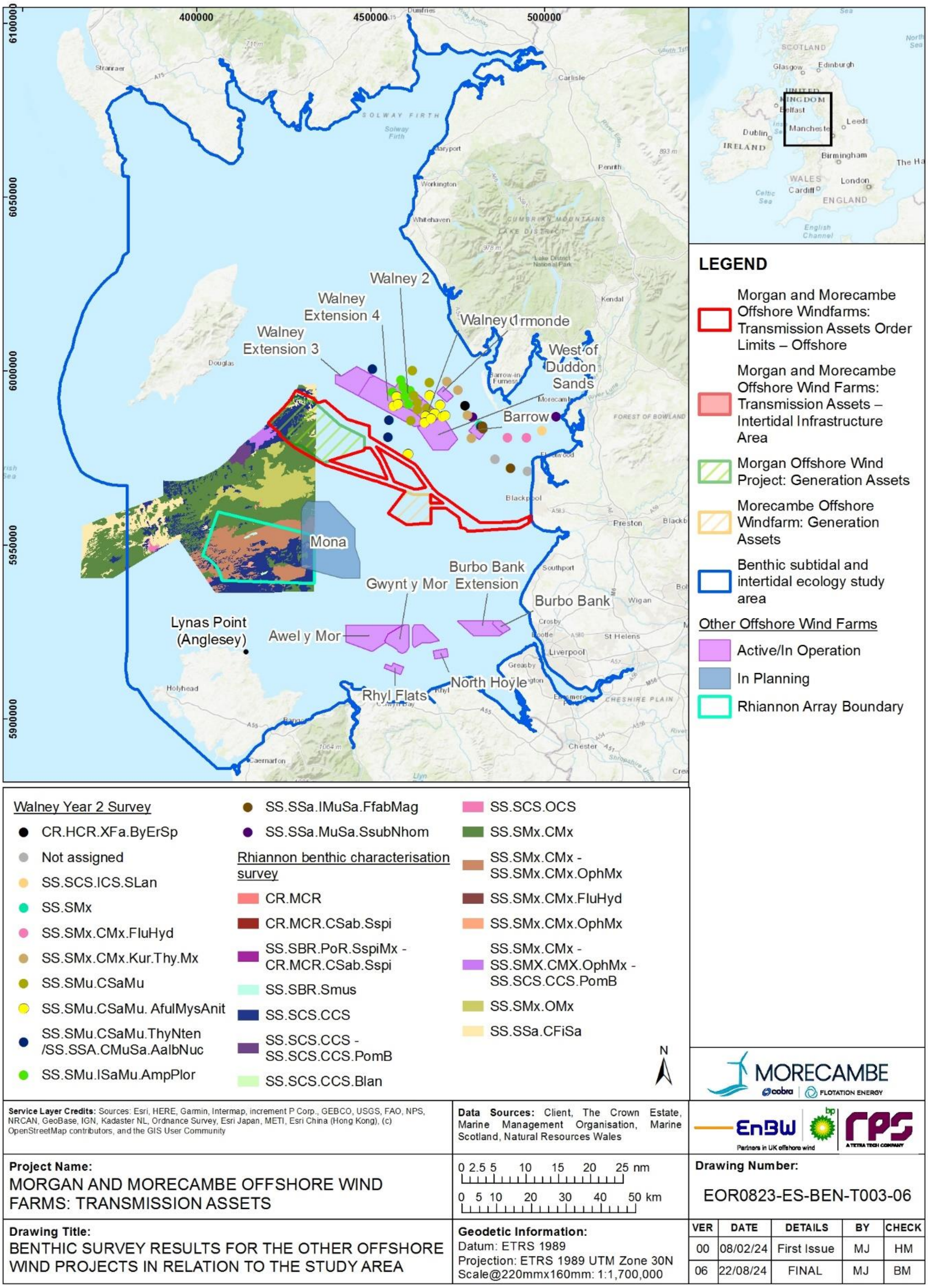


Figure 1.3: Benthic survey results for the other offshore wind projects in relation to the study area

1.3.2.31 Benthic surveys undertaken in 2013 for the Walney Year 1 post construction survey recorded sandy mud sediment communities within the Walney Offshore Wind Farm, to the north east of the Offshore Order Limits. They recorded mixed sediment communities closer to the coast and bivalve dominated communities closest to the Transmission Assets (CMACS, 2013). The main habitats recorded were *Thyasira* spp. and *Ennucula tenuis* in circalittoral sandy mud (SS.SMu.CSaMu.ThyEten), SS.SMu.CSaMu.AfilKurAnit, SS.SSa.CMuSa.AalbNuc, *Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud (SS.SMu.ISaMu.AmpPlon) and SS.SSa.IMuSa.FfabMag.

1.3.2.32 Baseline surveys for Walney Extension recorded *A. filiformis* and phoronid worms in high abundances alongside species of bivalve molluscs and polychaete worms that are adapted to mud sediments. The Walney Extension surveys recorded the presence of SS.SMx.CMx. *Kurtiella bidentata* and *Thyasira* spp. in circalittoral, muddy mixed sediments (SS.SMx.CMx.KurThyMx) and SS.SMu.CSaMu.AfilKurAnit biotopes (DONG Energy, 2013b), similar to the original array area.

1.3.2.33 The Walney Offshore Wind Farm overlaps with a number of protected species which are protected by designated areas. There is an Annex I stony reef within the Shell Flats and Lune Deep SAC (reefs are a designated feature of the SAC) which is located inshore of the Walney Offshore Wind Farm array area in the central east section of the study area (DONG Energy Ltd, 2013b). Stony reefs have also been identified at a few sample locations along the export cable corridor of Walney extension and within Morecambe Bay, all were classified as low 'reefiness' (DONG Energy Ltd., 2013b). One individual of the clam species *A. islandica,* which is on the 'Oslo-Paris convention for the protection of the marine environment of the North-Eastern Atlantic' (OSPAR) threatened species list, was recorded in a grab sample which was taken for the baseline characterisation surveys for the Walney Extension Offshore Wind Farm (DONG Energy Ltd, 2013b).

1.3.2.34 Burrowed mud habitat was also recorded in the east of the Walney Offshore Wind Farm array area and is listed as a UK Biodiversity Action Plan (BAP) habitat as well as an OSPAR habitat under 'seapens and burrowing megafauna'. The seapens and burrowing megafauna biotope has also been recorded in the Ormonde Offshore Wind Farm, West of Duddon Sands Offshore Wind Farm, and Walney Extension Offshore Wind Farm, all to the north east of the Offshore Order Limits. The sample sites where the burrowed mud biotope has been found within the Ormonde and Walney offshore wind farms are both located within the West of Walney MCZ, west of the Ormonde Offshore Wind Farm, which is designated for the protection of seapens, typically *Virgularia mirabilis* and *Pennatula phosphorea*, and burrowing megafauna among other features. Although no seapens were recorded at the sample sites within the Walney Offshore Wind Farms during the post-construction monitoring surveys, evidence of burrowing megafauna was present (CMACS, 2014).

1.3.2.35 The nearby Ormonde Offshore Wind Farm, to the north east of the Offshore Order Limits, reported very similar results in its Environmental Statement, to those described for the Walney Offshore Wind Farm, which covered an area in the east of the study area from Duddon sands to the Lune deep. The Environmental Statement found the array area itself to be mostly characterised by the SS.SMu.CSaMu.AfilKurAnit biotope with bands of the SS.SMu.CSaMu.LkorPpel and SS.SSa.CMuSa.AalbNuc biotopes with increasing proximity to the coast (Unicomarine Ltd, 2005). The 2013 year 1 post-construction benthic monitoring survey for the Ormonde Offshore Wind Farm reported that faunal taxa composition of samples was dominated by annelids, molluscs and crustaceans. Number of individuals was dominated by annelids and echinoderms which was attributable to the high number of *A. filiformis*. No Annex I reefs were recorded (CMACS, 2012).

1.3.2.36 The baseline characterisation surveys for the Awel y Môr Offshore Wind Farm showed that the majority of the array area was classified the *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (SS.SCS.CCS.PKef) biotope with some areas of higher sand content characterised by the *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel (SS.SCS.CCS.Blan) biotope and the SS.SSa.IFiSa.NcirBat biotope (RWE, 2022). No Annex I habitats or Annex II species, OSPAR threatened and/or declining species and habitats, or habitats and species listed under Section 7 of the Environment (Wales) Act 2016, were observed within the array area.

1.3.2.37 The Rhiannon Offshore Wind Farm was proposed to be located in the west of the study area. The dominant biotopes were SS.SCS.CCS, SS.SMx.CMx habitats with patches of SS.SSa.CFiSa habitats and *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx). The SS.SMx.CMx.OphMx biotope consists of circalittoral sediments dominated by brittlestars forming dense beds, living on boulder, gravel or sedimentary substrate. The *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles (SS.SCS.CCS.PomB) biotope was recorded in the west of the Rhiannon Offshore Wind Farm survey area, alongside the *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen) biotope which was reported to be widespread across the south west of the study area (Celtic Array Ltd, 2014a). Large patches of SS.SSa.CFiSa were recorded further west and to the north of the Rhiannon Offshore Wind Farm survey area in the central west of the study area (Celtic Array Ltd, 2014).

1.3.2.38 Areas of stony and rocky reefs were identified in the north west of the Rhiannon Offshore Wind Farm coinciding with the central west area of the study area. The stony and rocky reefs identified have ‘reefiness’ classifications (rocky reef criteria of Irving *et al*. (2009) and redescribed for stony reef in Limpenny *et al*. (2010)) of low to moderate. Additionally, there was an area of Annex I rocky reef composed of bedrock occurring entirely within the Rhiannon Offshore Wind Farm which was assigned a high ‘reefiness’ (Celtic Array Ltd., 2014). The rocky reef was characterised by relatively sparse epifauna dominated by starfish, with some dense patches of *O. fragilis*. Annex I stony reefs were also recorded over 10 km to the south of the Transmission Assets. However, these mostly occurred as a patchwork of boulders over areas more generally described as SS.SCS.CCS or SS.SMx.CM (Celtic Array Ltd, 2014a).

1.3.2.39 No Annex I *S. spinulosa* reefs were recorded within the former Rhiannon Offshore Wind Farm array area but a small area of low to moderate 'reefiness' *S. spinulosa* reef of 0.22 km^2 in extent was recorded within the offshore export cable corridor. *Sabellaria spinulosa* reefs were identified 20 km north west of the Rhiannon array area (in the central west part of the study area) with some small areas closer. All were deemed to be of low or low to medium 'reefiness' when assessed against the criteria for defining *S. spinulosa* reefs proposed by Gubbay (2007). Annex I rocky reefs of mostly low to moderate 'reefiness' were recorded to the west of the former Rhiannon Offshore Wind Farm, over 10 km to the south of the Transmission Assets.

1.3.2.40 Desktop baseline information from the former Rhiannon Offshore Wind Farm (Celtic Array Ltd, 2014) identified an Annex I sandbank within the study area. Side scan sonar data from Rhiannon Offshore Wind Farm also showed that in the far south west of the study area there are numerous horse mussel *Modiolus modiolus* reefs (class 2 reefs) (Celtic Array Ltd, 2014).

1.3.2.41 The baseline characterisation surveys for the Mona Offshore Wind Project, to the south west of the Offshore Order Limits, demonstrated that the Mona Array Area was primarily characterised by the polychaete-rich deep *Venus* community in offshore mixed sediments (SS.SMx.OMx.PoVen) biotope with areas of SS.SCS.CCS. Small areas of SS.SMx.CMx and SS.SMx.CMx.KurThyMx biotopes were recorded in the south east of the Mona Array Area ZOI. The SS.SMx.CMx biotope and the SS.SSa.CFiSa biotope were also identified in the south east of the surveyed Mona Array Area ZOI. In the south west of the surveyed Mona Array Area ZOI, brittlestar beds were recorded at two stations and the communities were characterised by the SS.SMx.CMx.OphMx biotope. In the Mona Offshore Cable Corridor the SS.SMx.OMx.PoVen biotope was dominant in the north, in the area adjacent to the Mona Array Area. The central section, to the north of Constable Bank, was dominated by the SS.SSa.CFiSa biotope. In the area of overlap with Constable Bank, the sediments and communities were characterised by the SS.SMx.CMx and SS.SSa.IFiSa.NcirBat biotopes. In the area of overlap with the Menai Strait and Conwy Bay SAC, and also the part of the Mona Offshore Cable Corridor to the south of the SAC, the communities were characterised by the SS.SMx.CMx.KurThyMx, SS.SSa.IFiSa.NcirBat and SS.SCS.CCS biotopes. The section of the Mona Offshore Cable Corridor approaching the coast was defined by muddy sand and mixed sediments which were characterised by communities typical of the SS.SSa.IMuSa.FfabMag biotope.

1.3.2.42 Annex I low resemblance stony reef was identified five sample stations within the Mona Array Area and ZOI (Mona Offshore Wind Ltd., 2024).

Burrows were recorded at 54 stations and, whilst no seapens were observed, the presence of burrows was classified as ‘frequent’ or above at 36 stations; therefore, it was concluded that these stations showed some similarity to the ‘seapen and burrowing megafauna communities’ habitat as defined by OSPAR. Four stations which were classified as Annex I low resemblance stony reef located in the west of the Mona Array Area and a single station in the north of the Mona Array Area ZOI. An assessment for sponge dominated habitat was also undertaken for the Mona Offshore Wind Project but no stations were found to represent the fragile sponge and anthozoan communities on subtidal rocky habitat.

Isle of Man surveys

1.3.2.43 The Isle of Man territorial waters also fall within the study area, to the north west of the Transmission Assets. A marine environmental assessment was undertaken by Howe (2018a) to bring together subtidal surveys which have been conducted around the Isle of Man to create an extensive characterisation of the subtidal environment. Howe (2018a) described the White (2011) analysis of 7,325 seabed images from a 2008 benthic survey around the Isle of Man and identified 20 different biotopes. Some of the most common included *Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud (SS.SMu.CFiMu.BlyrAchi) which was recorded over a broad area to the south west of the Isle of Man. The *Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment (SS.SMx.CMx.ClloMx.Nem) biotope was found to characterise an extensive area to the south west of the Isle of Man.

1.3.2.44 The sediments to the north of the Isle of Man were characterised by biotopes typical of mixed sediments and sand-based habitats. Intermittently around the island there were also a number of rocky biotopes recorded including the Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (CR.HCR.XFa.SpNemAdia) biotope, and faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock (CR.MCR.EcCr.FaAlCr) biotope (Howe, 2018a). Three main habitats of international conservation interest were identified during the survey, horse mussel reefs, maerl beds and Ross worm habitats *S. spinulosa*, all of which are OSPAR priority habitats (OSPAR 2008-16). Individuals of the UK BAP priority species, the sea anemone *Edwardsia timida*, were also recorded. Ocean quahog *A. islandica*, a threatened or declining species in the North Sea region as defined by the OSPAR Convention, has long been known to populate Laxey Bay to the east of the Isle of Man, as well as in Niarbyl Bay and Port Erin Bay. Eelgrass *Zostera marina* meadows are an important nursery area for many marine species (Davison and Hughes, 1998) and play an important role as a marine carbon sink. In recent years, eelgrass has only been recorded in four sites in Isle of Man waters distributed along the east coast of the island.

1.3.2.45 Bangor University conducted a benthic habitat survey of waters around the Isle of Man in 2008 and recorded *S. spinulosa* to the south of Manx waters, the habitat had not previously been formally recorded. The coast of the Isle of Man from Peel round to Maughold Head is primarily rocky, creating subtidal rocky reef habitat. The rocky reef habitats of the Isle of Man are deemed to be of high diversity. There are also extensive *Modiolus* spp. reefs around the Isle of Man with recent surveys identifying clusters of reefs at the north and south points of the island (Howe, 2018a). Other notable habitats around the Isle of Man include extensive sandbanks off the north coast. Under the European Union (EU) Habitats Directive, subtidal mobile sandbanks are included under “Sandbanks which are slightly covered by seawater at all times”. Additionally, brittlestar beds were identified as important biogenic habitats in the UK Marine SAC review in the 1990s (Hughes 1998a). The Bangor University benthic survey in 2008 indicated that seabed dominated by brittlestar beds is widespread in Manx waters.

1.3.2.46 Potential *Modiolus* spp. reefs have also been recorded by NRW in 2015 north of Anglesey, to the south of the Offshore Order Limits, with no known overlaps (Moore, 2018).

Intertidal benthic ecology

1.3.2.47 The north and north west of the study area includes the Solway Firth which is north of the potential landfall site. Reef building honeycomb worms *Sabellaria alveolata* reach the furthest north extent of their geographic range in the north of the Solway Firth, growing primarily on intertidal and subtidal rock. *S. alveolata* reefs are a protected feature of the Cumbria Coast MCZ and Allonby Bay MCZ. The Cumbria Coast MCZ is also designated for intertidal biogenic reefs, intertidal sand and muddy sand, high energy intertidal rock and intertidal under-boulder communities (Department for Environment, Food and Rural Affairs (Defra), 2019a).

1.3.2.48 The Cumbrian coast more generally can be characterised by intertidal mudflats and sandflats, saltmarshes and intertidal scars (exposed boulders and rocks), although intertidal scars are restricted to specific areas such as St Bees Head (Cumbria Biological Data Network, 2010). Further south along the west English Coast the Morecambe Bay region is protected by an Special Protection Area (SPA), which is designated for Annex I habitats including large shallow inlets and bays, reefs, *Salicornia* and other annuals colonizing mud and sand, Atlantic salt meadows *Glauco-Puccinellietalia maritimae* and mudflats and sandflats not covered by seawater at low tide (Antil and Pérez-Domínguez, 2021). Intertidal surveys undertaken in the Morecambe Bay SAC in 2015 found the most common biotopes to be blue mussel *Mytilus edulis* beds on littoral mixed substrata (LS.LBR.LMus.Myt.Mx), barnacles and *Littorina* spp. on unstable eulittoral mixed substrata (LR.FLR.Eph.BlitX) and ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata (LR.FLR.Eph.EphX).

1.3.2.49 The results of an NRW Phase 1 Intertidal habitat survey around Wales were presented in a report which characterised the full coastline (CCW, 2007). The north Wales coast includes large areas of moderately wave exposed sandy shores (CCW, 2007). The infauna has similar polychaetes and amphipods throughout the shore but varies in the abundance of certain species.

1.3.2.50 Raised and consequently drier areas of sand tend to support *Arenicola marina*, *Nephtys* spp. and amphipods *Bathyporeia* spp. Lower lying areas of sand, usually remaining wet at low water, support communities of *Macoma balthica*, *A. marina*, *E. tenuis*, *Cerastoderma edule* and the sand mason worm *Lanice conchilega*. Mud, muddy sands, sandy muds and muddy gravel dominate sheltered sediment shores. This less mobile sediment typically supports a high invertebrate biomass, particularly in the Conwy estuary in the south of the study area. Conspicuous members of muddy shore communities include *Hediste diversicolor*, *M. balthica*, *A. marina* and *Scrobicularia plana*.

1.3.2.51 At the far south west edge of the study area, the Isle of Anglesey has a large proportion of rocky coastline especially along the north coast, which has moderately wave exposed rocky shores. Fucoid algae dominate the upper and mid shore rock with zones of *Pomacea canaliculata*, *Fucus spiralis*, *Fucus vesiculosus* and *Ascophyllum nodosum*. There is a large under boulder community including *Porcellana platycheles*, tube worms, *P. triqueter*, *Asterina gibbosa* and gastropods including *Nucella lapillus* and *Littorina littorea* in areas of boulders. Across the shore there are many rockpools of differing character; green pools at the top of the shore are characterised by the green seaweeds including *Cladophora* spp. and *Enteromorpha* and *Ulva* spp.; shallow pools are characterised by coralline crustose algae and *Corallina officinalis* and deeper pools are characterised by *Fucus serratus*, *Laminaria digitata* and many other associated species.

1.3.2.52 A sanitary survey report conducted by Cefas (2014) found the intertidal zone of Colwyn Bay, Llandudno and Great Ormes Head is dominated by intertidal flats with mussel beds. Two (Rhos-on-Sea and Llandudno Pier) are more established beds with larger mussels, with another ephemeral bed at Llanddulas within the intertidal zone in the south of the study area.

1.3.2.53 More recently NRW conducted another Phase 1 Intertidal habitat survey of the intertidal zone around Wales (NRW, 2016). The results of this study show the north Wales coast, in the south of the study area, is largely composed of burrowing amphipods and polychaetes (often with *A. marina*) in clean sand shores (LG.S.AP.P). At Mean Low Tide Spring the intertidal zone as well as some small sections further landward are composed of dense *Lanice conchilega* in tide-swept lower shore sand (LGS.S.Lan). In the mid shore zone there are some large areas of burrowing amphipods and *Eurydice pulchra* in well-drained clean sand shores (LGS.S.Aeur) as well as smaller areas of *Mytilus edulis* beds on eulittoral mixed substrate (SLR.MX.MytX) and barnacles and *Littorina littorea* on unstable eulittoral mixed substrata (SLR.FX.BIlit).

1.3.2.54 Intertidal surveys of the Mona Offshore Wind Project landfall, to the south west of the Offshore Order Limits, were undertaken in 2022 and 2023, with these surveys recording that the shore was dominated by a mosaic of the *Lanice conchilega* in littoral sand (LS.LSa.MuSa.Lan) and *Macoma balthica* and *Arenicola marina* in littoral muddy sand (LS.LSa.MuSa.MacAre) biotopes in the mid-shore, with a wide band of barren shingle or gravel shores (LS.LCS.Sh.BarSh) in the upper shore, and a further mosaic dominated mostly by LS.LSa.MuSa.Lan in the lower shore. An Annex I *S. alveolata* reef was also recorded to the west of the landfall, which covered an area of 47,473 m^2 in 2022, and 41,530 m^2 in 2023. A *Mytilus edulis* bed was also identified to the west of the Mona Offshore Wind Project landfall in close proximity to the *S. alveolata* reef (Mona Offshore Wind Ltd, 2024).

1.3.2.55 The south coast of the Isle of Man is dominated by rocky shores however within this coastal section there are a number of sheltered fine sand beaches. These sandy beaches support populations of isopods, amphipods and polychaetes such as *A. marina* as well as *Arenicola defodiens*. Near the low water there are more diverse assemblages including sea urchins and bivalves. The coastline around the north of the island is composed of coarse sands and shingle with small areas of saltmarsh and estuary habitat (Howe, 2018b). A CMACS (2002) intertidal survey of the Isle of Man described by Howe (2018b) found where the shores are very coarse and mobile the communities were characterised by the biotope LS.LCS.Sh.BarSh. Where the sediments are finer and more stable the biotope LS.LGS.S.Aeur becomes dominant, characterised by *Arenicola marina*. Muddy shores are present in a few locations around the Isle of Man including outside the estuary in Derbyhaven which supports a population of the bivalve *Loripes lucinalis*, which depends upon symbiotic sulphur bacteria for its nutrition.

1.3.2.56 The north west England and Wales shoreline management plan (North West and North Wales Coastal Group, 2011) shows that in the short term (0-20 years) this shoreline is largely in net gain (shoreline is slowly moving further seaward) which will result in more intertidal saltmarsh, sandflat and mudflat habitat in the short and medium term.

1.3.2.57 The landfall for the Transmission Assets is on the north west English coast near Penwortham. The landfall encompasses the Ribble Estuary Site of Special Scientific Interest (SSSI) and the Ribble and Alt Estuaries SPA (**section 1.3.4**) which is characterised by littoral sand and muds (APEM, 2015). An APEM (2015) survey monitoring the condition of the intertidal sediments in the Ribble Estuary SSSI and Ribble and Alt SPA in 2013 also found the most frequently recorded habitat type was polychaetes in littoral fine sand (LS.LSa.FiSa.Po), followed by *Bathyporeia pilosa* and *Corophium arenarium* in littoral muddy sand (LS.LSa.MuSa.BatCare) and *Nephtys cirrosa* dominated littoral fine sand (LS.LSa.FiSa.Po.Ncir). The biotope LS.LSa.FiSa.Po was recorded at upper, mid and lower shore transect sites, and the sub-biotope LS.LSa.MuSa.BatCare was mainly recorded on the upper shore (APEM, 2015).

1.3.2.58 In the intertidal zone of the area to the north of the Intertidal Infrastructure Area, following the coastline of Morecambe Bay, *Ascophyllum nodosum* as well as *Ostrea edulis* have been identified with confirmed reports on NBN Atlas (2021), both of which are included on the UK BAP species list. Additionally, the UK nationally rare species *Acanthocardia aculeata* has been recorded in the south of the intertidal zone (NBN Atlas, 2021).

1.3.3 Desk study data within the Transmission Assets Order Limits: Offshore

1.3.3.1 The desktop information presented in **section 1.3.2** provided a broad overview of the sediment characteristics and contamination, and the benthic subtidal and intertidal ecology of the study area, utilising the data from published literature and reports within the study area.

1.3.3.2 This section focuses on desk study information relating specifically to the Offshore Order Limits and, in particular, draws on the findings of the site-specific benthic characterisation surveys undertaken for the Generation Assets. The methodologies for these site-specific surveys have been detailed below with full details provided in **Appendix A** and **Appendix B**.

Survey methodologies

Morgan Offshore Wind Project: Generation Assets

1.3.3.3 Two site-specific subtidal surveys were undertaken across the Morgan Offshore Wind Project: Generation Assets in 2021 and 2022. The 2021 site-specific subtidal survey was undertaken across the Morgan Array Area (and the Mona Array Area) within the Morgan benthic subtidal ecology study area. The site-specific subtidal survey in 2022 was undertaken to characterise the Morgan Array Area ZOI. The sampling strategies were designed to adequately sample the area to provide data for baseline characterisation. The survey designs were discussed and agreed with Natural England, JNCC and NRW.

1.3.3.4 The 2021 survey comprised 35 combined grab and DDV sample stations located in the Morgan Array Area and an additional two stations sampled with DDV only (**Figure 1.4**).

1.3.3.5 The 2022 survey comprised 11 sample stations located within the Morgan Array Area and 15 sample stations located within the Morgan Array Area ZOI. Of the stations sampled in the Morgan Array Area seven were locations previously sampled in 2021; resampling was conducted to enable comparison between years and to determine if there had been any temporal changes in the communities present. All of the stations sampled in the 2022 survey comprised combined grab and DDV sampling (**Figure 1.4**).

1.3.3.6 The full methodologies used in the Morgan Offshore Wind Project: Generation Assets site-specific surveys are detailed in Volume 4, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the Morgan Offshore Wind Project: Generation Assets Environmental Statement (Morgan Offshore Wind Ltd, 2024b), provided in full in **Appendix A**.

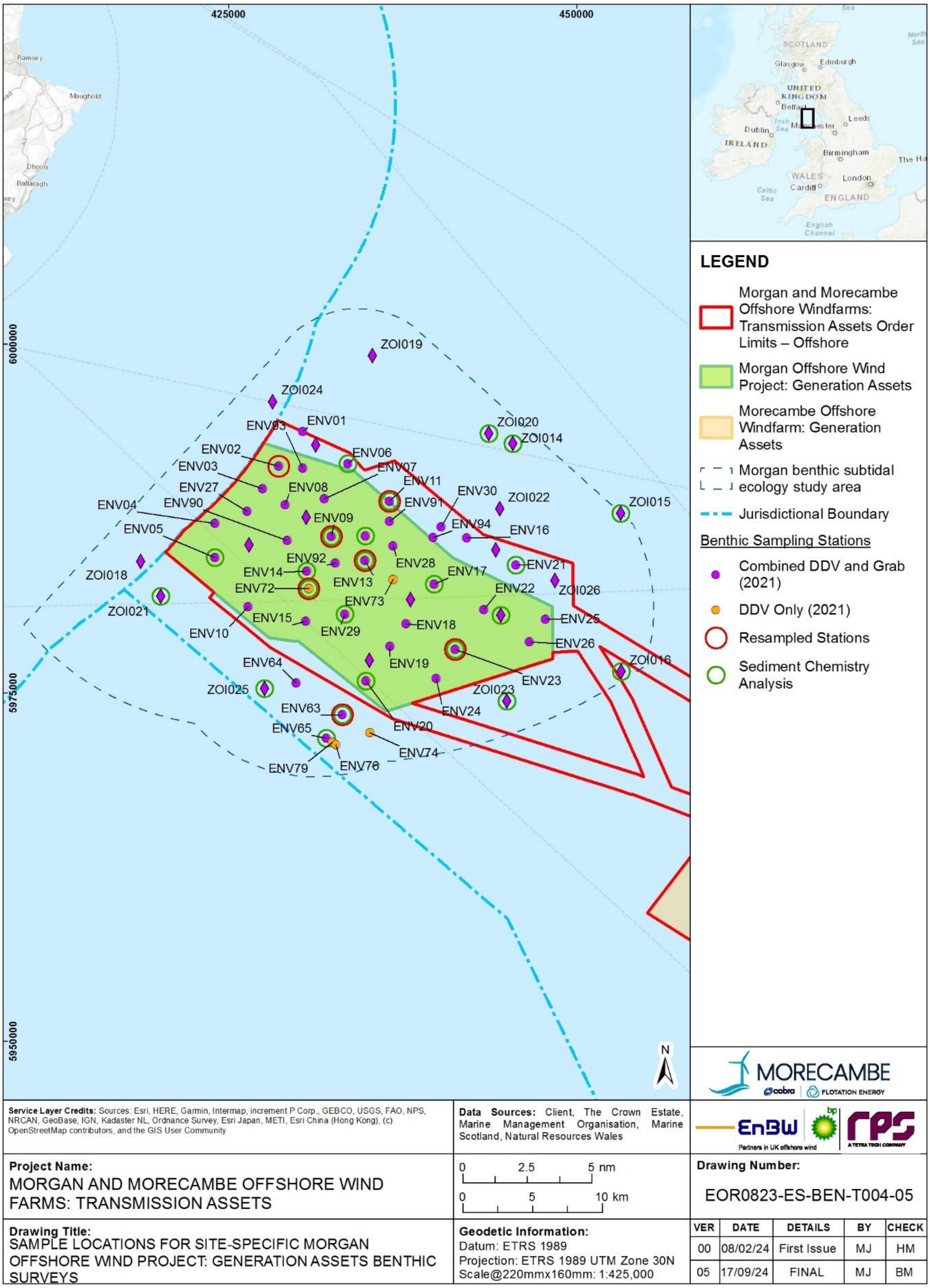


Figure 1.4: Sample locations for site-specific Morgan Offshore Wind Project: Generation Assets benthic surveys

Morecambe Offshore Windfarm: Generation Assets

1.3.3.7 The site-specific benthic characterisation survey for the Morecambe Offshore Windfarm: Generation Assets was undertaken in May/June 2022. The survey comprised 50 stations sampled via both grab and DDV for Particle Size Analysis (PSA) and macrobenthic analysis, alongside DDV transects for potential hard substrates identified during geophysical surveys, and a specific assessment of seapen and burrowing megafauna communities. The locations of the stations sampled during the 2022 survey are shown in **Figure 1.5**. Sediments for contaminant analysis were collected from a subset of 20 sampling stations.

1.3.3.8 The full methodologies used in the Morecambe Offshore Windfarm: Generation Assets site-specific survey are detailed in Volume 5, Appendix 9.1: Benthic Characterisation Survey Report of the Morecambe Offshore Windfarm: Generation Assets Environmental Statement (Morecambe Offshore Windfarm Ltd, 2024b), provided in full in **Appendix B**.

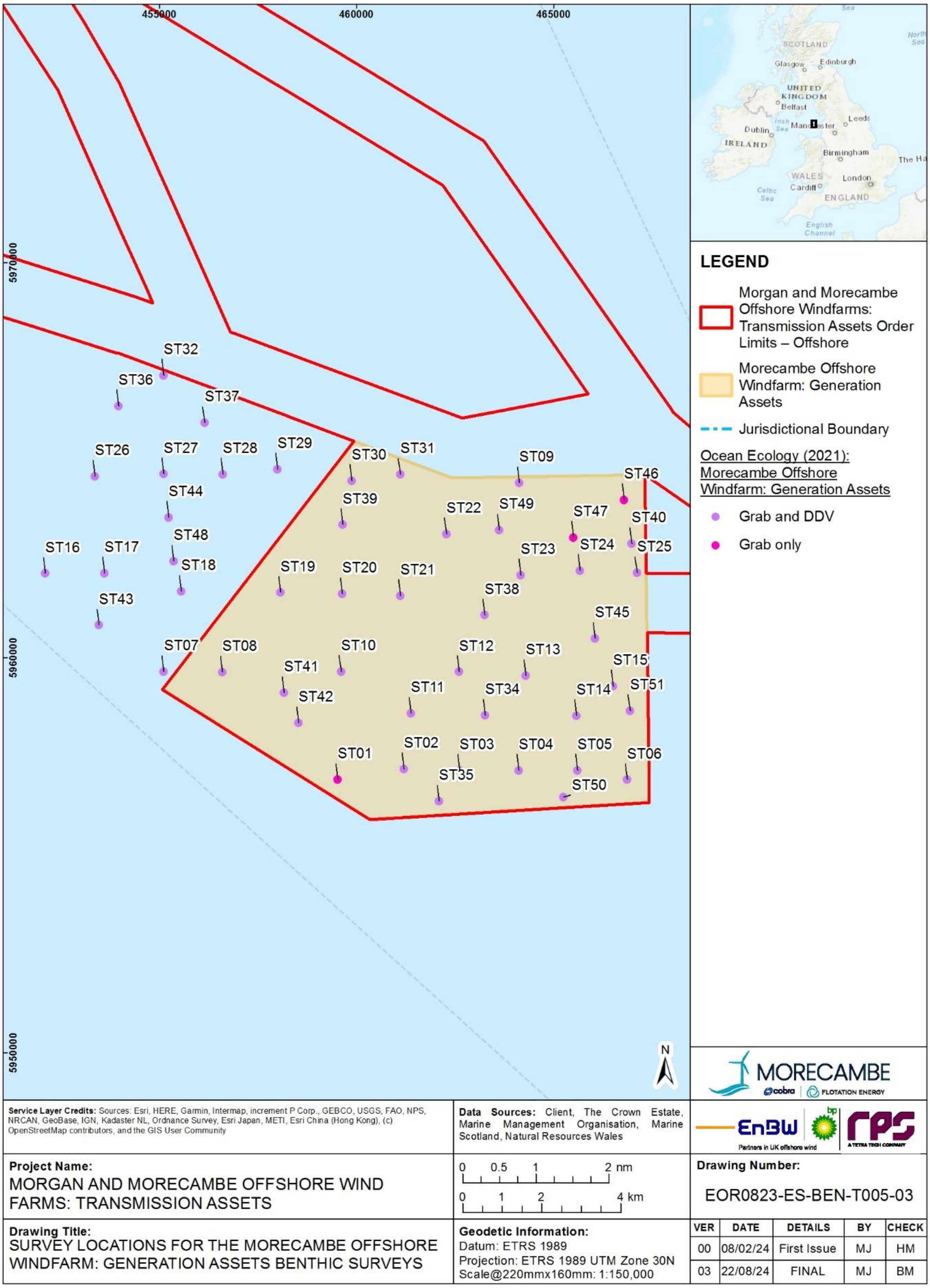


Figure 1.5: Survey locations for the Morecambe Offshore Windfarm: Generation Assets benthic surveys

Subtidal sediments

1.3.3.9 The EMODnet (2021) data for the Offshore Order Limits shows the sediments in the west are dominated by deep circalittoral coarse sediments, grading to deep circalittoral sand and muds moving east, and then circalittoral sandy mud and circalittoral muddy sand and fine sands in the nearshore area (**Figure 1.2**).

Morgan Offshore Wind Project: Generation Assets

1.3.3.10 The Morgan Offshore Wind Project: Generation Assets has been classified by EMODnet (2021) as being dominated by deep circalittoral coarse sediment in the west, deep circalittoral sand in the east, and a relatively small area of deep circalittoral mixed sediments in the south east.

1.3.3.11 The subtidal benthic sediments across the Morgan Offshore Wind Project: Generation Assets were classified into sediment types according to the Folk classification. Sediments ranged from gravelly sand to muddy sandy gravel, with the majority of the samples in the Morgan Array Area classified as gravelly muddy sand or gravelly sand. Across the Morgan Array Area ZOI sediments ranged from muddy sandy gravel to gravelly muddy sand, with the majority of samples classified as sand. Of all the samples within the Morgan benthic subtidal ecology study area, the majority were classified as gravelly sand (36.51%), gravelly muddy sand (30.16%) and sand (19.05%), representing the three most common sediment types, with the remaining samples having slight variations of these, such as stations with slightly gravelly sand or muddy sandy gravel. According to the simplified Folk Classification (Long, 2006), most stations were classified as mixed or coarse sediments with areas of mixed or coarse sediment with areas of mixed sediment and sand and muddy sand sediment (Morgan Offshore Wind Ltd, 2024b).

1.3.3.12 Across all sample stations in the Morgan benthic subtidal ecology study area, the average percentage sediment composition was 12.52% gravel, 79.53% sand and 7.95% mud. Across this area sand made up the highest proportion of the sediment composition. The sediment composition also showed a higher percentage of gravels within the central and west section of the surveyed area in comparison to the east section, and particularly in the south west of the Morgan ZOI. The sample stations with the highest percentage composition of mud were generally found along the central and west sections of the Morgan Offshore Wind Project: Generation Assets and the north east of the Morgan Array Area ZOI. These findings are consistent with the results of the geophysical surveys which also identified coarse sediments in the west and fine sediments predominantly in the east (Morgan Offshore Wind Ltd, 2024b).

1.3.3.13 Sediments across the Morgan Offshore Wind Project: Generation Assets were typically very poorly sorted or poorly sorted, and a small number of samples were classified as moderately sorted. Two sample stations were moderately well sorted, and these station were classified as sand with 0.08% gravel, 99.92% sand and 0.00% mud, and 0.23% gravel, 99.77% sand and 0.00% mud respectively. One sample in the Morgan Array Area ZOI was classified as extremely poorly sorted, with this station classified as muddy sandy gravel with 32.06% gravel, 53.55% sand and 14.39% mud.

1.3.3.14 In the 2022 site-specific surveys, seven sample stations which had been sampled in the 2021 site-specific survey were resampled. Of the resampled stations one sample station had the same Folk modified sediment classification as was assigned from the 2021 analysis, the other samples only showed minor variation in their classification from 2021 to 2022 (e.g. changing from gravelly muddy sand to gravelly sand). All the sediments were sand based, as observed in the 2021 survey. The Folk modified sediment classifications for the new sample stations in the Morgan Array Area did not result in the identification of any new sediment classifications beyond what was identified in 2021. Full results of the site-specific surveys undertaken for the Morgan Offshore Wind Project: Generation Assets are provided in **Appendix A**.

Morecambe Offshore Windfarm: Generation Assets

1.3.3.15 The EMODnet broad-scale seabed habitat map indicated that sediments within the Morecambe Offshore Windfarm: Generation Assets are dominated by the following sediment habitats including European Nature Information System (EUNIS) classifications A5.25/A5.26 Circalittoral fine sand/Circalittoral muddy sand, A5.27 Deep circalittoral sand, A5.35 Circalittoral sand mud and A5.37 Deep circalittoral mud.

1.3.3.16 Some variation in sediment type was observed between sampling stations, with stations located towards the west and south west of the Morecambe Offshore Windfarm: Generation Assets having slightly coarser sediments. Based on the proportions of gravel, sand and mud, six sediment types have been identified across the Morecambe Offshore Windfarm: Generation Assets based on the Folk (1954) classification. Specifically, 27 sediment samples consisted of muddy sand (mS), seven of sand (S) and eight of slightly gravelly sand ((g)S), six of slightly gravelly muddy sand ((g)mS), and one each of gravelly muddy sand (gmS) and sandy mud (sM). The mean (± standard error) proportion of sand across all survey stations was 81.01 ± 2.03%, mean (± standard error) gravel content was 0.51 ± 0.41% and mean (±SE) mud content was 18.46 ± 2.05% (Morecambe Offshore Windfarm Ltd, 2024b).

1.3.3.17 Most of the sediments recorded were classified as very poorly to poorly sorted (78% of stations) due to the mixed composition of different size fractions of all three principal sediment types (gravel, sand, and mud). However, 11 of the samples made of sand and slightly gravelly sand were classified as moderately to moderately well sorted. Full results of the site-specific surveys undertaken for the Morecambe Offshore Windfarm: Generation Assets are provided in **Appendix B**.

Sediment contamination

Morgan Offshore Wind Project: Generation Assets

1.3.3.18 A total of 24 sediment samples from across the Morgan Offshore Wind Project: Generation Assets were analysed for sediment chemistry (metals, organotins, PCBs and PAHs), with 11 in the Morgan Array Area and 13 in the Morgan Array Area ZOI. Levels of contamination were generally low across the Morgan Offshore Wind Project: Generation Assets.

1.3.3.19 Levels of cadmium, chromium, copper, nickel, lead, mercury and zinc did not exceed the relevant Cefas AL1 or the Canadian TEL in any of the samples. Concentrations of arsenic marginally exceeded the Cefas AL1 (20 mg/kg) at one station within the Morgan Array Area, and two stations within the Morgan Array Area ZOI, but all three were below Cefas AL2. Within the Morgan Array Area, 10 sample stations exceeded the Canadian TEL for arsenic, as did seven sample stations in the Morgan Array Area ZOI, although all stations were below the Canadian PEL for arsenic.

1.3.3.20 Concentrations of organotins were below LOD at all stations sampled.

1.3.3.21 Levels of PCBs were typically recorded below the LOD across both the Morgan Array Area and Morgan ZOI, with the exception of two stations. The levels of the total ICES-7 PCBs were however below the relevant Cefas AL1 (0.01 mg/kg) at these stations and levels of total PCBs were also below the Cefas AL1 (0.02 mg/kg) and Cefas AL2 (0.2 mg/kg).

1.3.3.22 Total PAH concentrations ranged from 60 µg/kg to 363 µg/kg across both the Morgan Array Area and ZOI. Concentrations of all PAHs in samples in the Morgan Array Area and ZOI were below the relevant Canadian TEL (where one is specified). PAH concentrations were also well below their respective ERL values, indicating toxic effects to fauna from PAHs is unlikely. Full results are available in Volume 2, Annex 2.1: Benthic subtidal ecology technical report of the Morgan Offshore Wind Project: Generation Assets Environmental Statement (Morgan Offshore Wind Ltd, 2024b), provided in full in **Appendix A**.

Morecambe Offshore Windfarm: Generation Assets

1.3.3.23 To inform the baseline for sediment quality for the Morecambe Offshore Windfarm: Generation Assets, 20 grab samples were taken for chemical analysis during benthic surveys.

1.3.3.24 Trace and heavy metal concentrations were overall low with none of the metals analysed exceeding any of the reference level. In general metal concentrations were relatively higher to the east, closer to land than stations located further offshore. Arsenic was an exception to this trend as it exceeded the Canadian TEL at three stations, one located to the west and two to the south of the Morecambe Offshore Windfarm: Generation Assets. However, arsenic concentrations never exceeded Cefas AL1 or the OSPAR Background Assessment Concentration (BAC) level.

1.3.3.25 PAH concentrations were compared to Cefas AL1 (no Cefas AL2 available for PAHs), OSPAR BAC levels and USA Environmental Protection Agency ERL, and Canadian TEL and Canadian PEL where possible. The only reference level to be exceeded was the BAC, with pyrene and naphthalene being above reference levels at six of the 20 stations sampled. However, when averaged across the wind farm site, none of the PAH concentrations exceeded any of the reference levels. In general PAHs showed higher concentrations at the nearshore stations compared to stations located further offshore, similar to what was observed for trace metals. Overall, there were no exceedances of Cefas AL1, ERL, Canadian TEL, or Canadian PEL.

1.3.3.26 The concentrations of two organotins (dibutyltin (DBT) and tributyltin (TBT)) were analysed from the sediment taken at each of the 20 stations. All stations had organotin concentrations below the detection limit of 0.005 mg/kg. To provide some context, Cefas AL1 for organotins is 0.1 mg/kg and Cefas AL2 is 1 mg/kg.

1.3.3.27 All 25 PCBs congeners were analysed from the sediments taken at each of the 20 stations. No Cefas ALs exist for each individual PCBs, however most PCBs had concentrations below the detection limit of 0.00008 mg/kg. Cefas ALs do exist for the sum of all 25 PCBs congeners. At all stations the sum of all 25 PCBs congeners was below Cefas AL1 (0.02 mg/kg), ranging from below detection limit to 0.0009 mg/kg.

Subtidal benthic ecology

Morgan Offshore Wind Project: Generation Assets

1.3.3.28 A total of 470 taxa were recorded during the 2021 and 2022 site-specific surveys within the Morgan Offshore Wind Project: Generation Assets. The data were analysed using multivariate statistics which identified 33 faunal groups, which were further refined to ten distinct biotopes across the Morgan Offshore Wind Project: Generation Assets.

1.3.3.29 As shown in **Figure 1.6**, the benthic communities in the west and south Morgan Array Area and ZOI were characterised by the SS.SMx.OMx.PoVen biotope. In the west of the Morgan Array Area ZOI, a single station was assigned to the SS.SMx.CMx.OphMx biotope. The centre of the Morgan Array Area was characterised by SS.SCS.CCS and a small area of offshore circalittoral mixed sediment (SS.SMx.OMx). The east and most of the north edge of the Morgan Array Area were characterised by muddier sediments and the SS.SMu.CSaMu.LkorPpel biotope. Further east in the Morgan Array Area ZOI a broader circalittoral muddy sand biotope was prevalent (SS.SSa.CMuSa) which graded into communities characterised by the SS.SMu.CSaMu.AfilKurAnit biotope at the east edge of the Morgan Array Area ZOI. The habitats and communities in the north of the Morgan Array Area ZOI were characterised by the *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri) biotope (**Figure 1.6**). Full results are available in Volume 2, Annex 2.1: Benthic subtidal ecology technical report of the Morgan Offshore Wind Project: Generation Assets Environmental Statement (Morgan Offshore Wind Ltd, 2024b), provided in full in **Appendix A**.

1.3.3.30 The habitats assessment indicated that small pencil burrows were observed in the site-specific surveys, with no seapens observed. An analysis of this burrow habitat was therefore undertaken by determining the density of burrows and their abundance which was then categorised using the SACFOR (Super abundant, Abundant, Common, Frequent, Occasional, Rare) classification.

1.3.3.31 At the 36 stations where burrows were observed, the maximum burrow density varied from 0.02 burrows per m^2 to 6.62 burrows per m^2, but burrow abundance was not identified as greater than 'frequent' on the SACFOR scale at any station across the surveyed area. A total of 18 stations within the Morgan Array Area and six within the Morgan Array Area ZOI had an abundance of burrows which were classified as 'frequent' although the majority of burrows were very small and in the 0 cm to 1 cm size range category. It was therefore concluded that these areas had only a negligible resemblance to the 'seapen and burrowing megafauna communities' habitat. However, in order to adopt a precautionary approach, those stations were assumed to represent the 'seapens and burrowing megafauna communities' habitat.

1.3.3.32 Seabed imagery analysis and a stony reef assessment indicated that two stations within the south of the Morgan Array Area ZOI were classified as having low resemblance to Annex I stony reef. These stations were located to the south west of the Transmission Assets and outside the Offshore Order Limits (see **Figure 1.6**).

1.3.3.33 An assessment for sponge dominated habitat was also undertaken but no stations were found to represent the fragile sponge and anthozoan communities on subtidal rocky habitat. Full results are available in Volume 2, Annex 2.1: Benthic subtidal ecology technical report of the Morgan Offshore Wind Project: Generation Assets Environmental Statement (Morgan Offshore Wind Ltd, 2024b), provided in full in **Appendix A**.

Morecambe Offshore Windfarm: Generation Assets

1.3.3.34 Analysis of macrofaunal data from the site-specific survey samples indicated the presence of four macrobenthic groupings, with two dominating biotopes being noted. Specifically, for macrobenthic group A the biotope that most closely aligned with the community observed in this group was A5.351 *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud, which is consistent with the finer sediments recorded in at these locations characterised by notable mud contributions. As shown in **Figure 1.6**, this biotope dominated the east side of the Morecambe Offshore Windfarm: Generation Assets.

1.3.3.35 Macrobenthic groups B-D were characterised by the polychaetes *N. cirrosa*, *Sthenelais limicola*, *Spiophanes bombyx* and *Scoloplos armiger*, amphipods of the genus *Bathyporeia* with variable abundances of the bivalve *A. alba*. The biotope that most closely aligned with this assemblage was A5.252 *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand, which is consistent with sediments being sandier at these locations compared the Macrobenthic Group A and representative of the textural groups Sand and Slightly Gravelly Sand. As shown in **Figure 1.6**, this biotope and these assemblages were distributed along the west side of the Morecambe Offshore Windfarm: Generation Assets.

1.3.3.36 No Annex I habitats were identified within the surveyed area, however large areas of the OSPAR/FOCI habitat ‘Seapens and burrowing megafauna’ were identified across the windfarm site within the EUNIS habitat A5.26, although no seapens were noted to be present. As there is currently no Marine Protected Area designated within this area, there is no legislative protection afforded to the observed seapen and burrowing megafauna habitats observed within this survey.

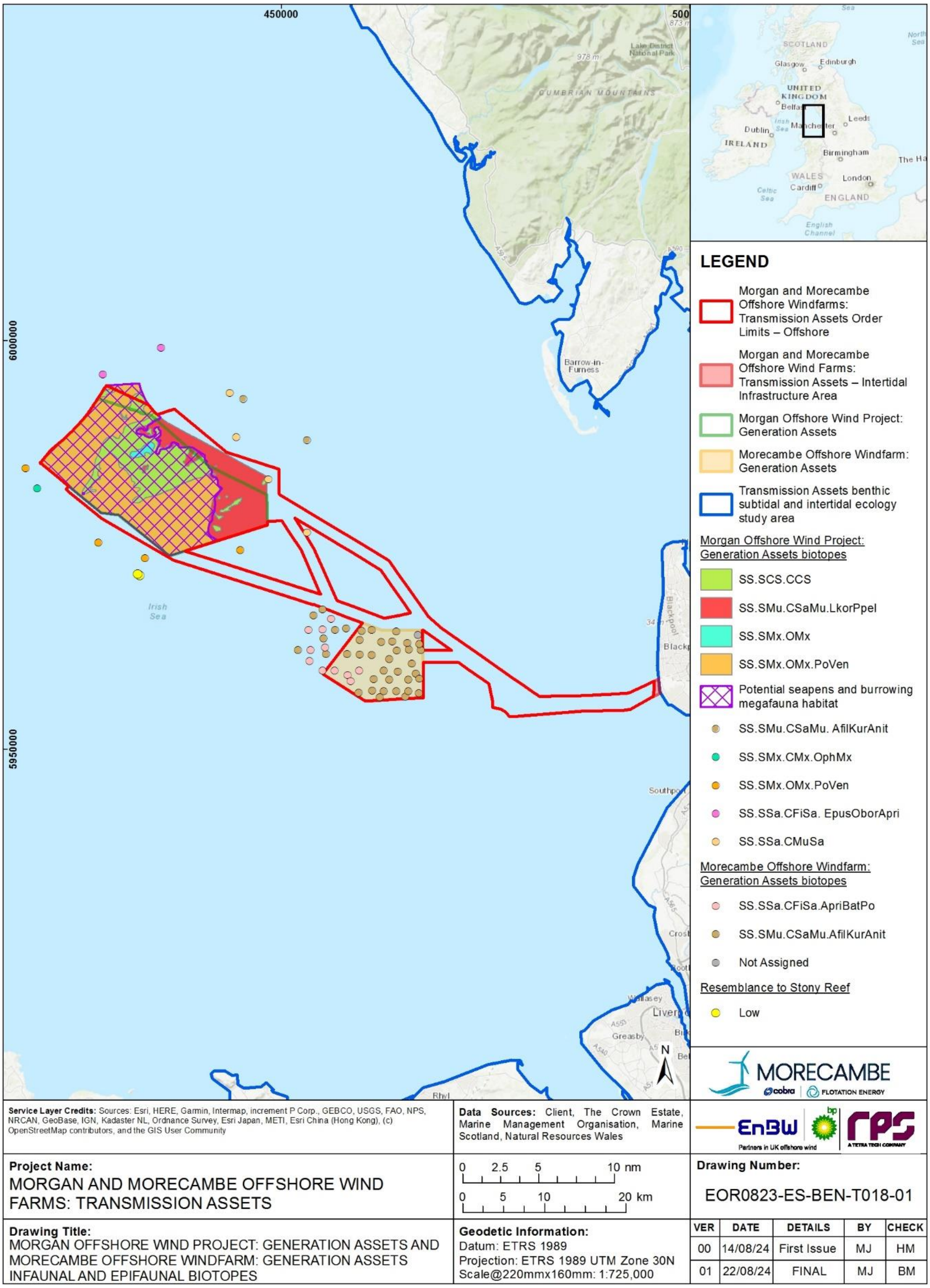


Figure 1.6: Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets infaunal and epifaunal biotopes

1.3.4 Designated sites within study area

Morgan Offshore Wind Project: Generation Assets

1.3.4.1 The relevant designated sites identified for the Morgan Offshore Wind Project: Generation Assets are the same as for the Transmission Assets as the study areas are the same. The relevant designated sites are therefore outlined in **Table 1.2** below and are not repeated here.

Morecambe Offshore Windfarm: Generation Assets

1.3.4.2 The relevant designated sites identified for the Morecambe Offshore Windfarm: Generation Assets are the same as for the Transmission Assets as the study areas are the same. The relevant designated sites are therefore outlined in **Table 1.2** below and are not repeated here.

Transmission Assets

1.3.4.3 There are a number of sites of nature conservation importance, which are designated for relevant benthic subtidal and intertidal ecology features, within the study area. The designated sites are described in **Table 1.2** and shown in **Figure 1.7**. The internationally and nationally designated sites have been detailed below.

Table 1.2: Summary of designated sites within the study area and relevant qualifying features

Designated site	Distance from Transmission Assets (km)	Relevant qualifying features
Liverpool Bay/Bae Lerpwl SPA	0	• Supporting habitat (for designated ornithological features).
Ribble and Alt Estuaries SPA	0	• Supporting habitat (for designated ornithological features).
Fylde MCZ	0	• Subtidal sand. • Subtidal mud.
Ribble Estuary SSSI	0	• Intertidal mudflats. • Intertidal sandflats.
Shell Flat and Lune Deep SAC	5.72	• Sandbanks which are slightly covered by sea water all the time. • Reefs.
West of Walney MCZ	5.85	• Subtidal sand. • Subtidal mud. • Seapen and burrowing megafauna communities.

Designated site	Distance from Transmission Assets (km)	Relevant qualifying features
West of Copeland MCZ	6.32	• Subtidal coarse sediment. • Subtidal sand. • Subtidal mixed sediment.
Morecambe Bay SAC	15.3	• Estuaries. • Mudflats and sandflats not covered by seawater at low tide. • Large shallow inlets and bays. • Sandbanks slightly covered by sea water at all times. • Large shallow inlets and bays. • Coastal lagoon. • *Salicornia* and other annuals colonising mud and sand. • Atlantic salt meadows *Glauco-Puccinellietalia maritimae*. • Reefs.
Langness Marine Nature Reserve (MNR)	16.75	• Eelgrass *Zostera marina* meadow. • Intertidal mud. • Kelp forest. • Sea caves.
Little Ness MNR	20.42	• Horse mussel reef. • Maerl.
Douglas Bay MNR	22.23	• Beaumont's nudibranch *Cumanotus beaumonti*. • Maerl beds. • Rocky reef. • Kelp forest.
Laxey Bay MNR	22.4	• Eelgrass *Zostera marina* meadow. • Rocky reef. • Sandy seabed. • Maerl. • Ocean quahog *A. islandica*. • Common whelk.
Ramsey Bay MNR	26.47	• Maerl beds. • Eelgrass meadows. • Horse mussel reefs. • Rocky shore and reef.

Designated site	Distance from Transmission Assets (km)	Relevant qualifying features
Baie y Carrickey MNR	30.22	• Rocky reef. • Sea caves. • Kelp forest. • Eelgrass meadows.
Dee Estuary/Aber Dyfrdwy SAC	32.81	• Estuaries. • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*). • Mudflats and sandflats not covered by seawater at low tide.
Calf of Man and Wart Bank MNR	35.81	• Rocky reef. • Sand banks. • Kelp forest.
Niarbyl Bay MNR	36.84	• Rocky reef. • Kelp forest. • Sea caves. • Intertidal blue mussel beds. • Ocean quahog (*A. islandica*).
Port Erin Bay MNR	36.88	• Rocky reef. • Brittlestar beds. • Kelp forest. • Stalked jellyfish. • Flame shell.
Dee Estuary Ramsar Site	38.58	• Ramsar criterion 1 – Extensive intertidal mud and sand flats with large expanses of saltmarsh towards the head of the estuary.
West Coast MNR	38.7	• Rocky reef. • Intertidal blue mussel. • Mixed soft sediment. • Kelp forest. • Burrowing anemone (*E. timida*).
Cumbria Coast MCZ	42.92	• Intertidal under boulder communities. • *S. alveolata* reefs.
Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC	43.89	• Sandbanks which are slightly covered by sea water all the time. • Mudflats and sandflats not covered by seawater at low tide. • Submerged or partially submerged sea caves. • Large shallow inlets and bays. • Reefs.

Designated site	Distance from Transmission Assets (km)	Relevant qualifying features
Creigiau Rhiwledyn/Little Ormes Head SSSI	48.27	• Caves and overhangs. • Moderately exposed rock. • Rockpools. • Soft piddock bored substrata. • Under-boulders.
Pen y Gogarth/Great Ormes Head SSSI	48.35	• Caves and overhangs. • Moderately exposed rock. • Rockpools. • Soft piddock bored substrata. • Under boulders.
Aber Afon/Conwy SSSI	49.51	• Coastal plain estuary ecology.
Traeth Pensarn SSSI	50.38	• Sandbanks. • Shingle ridge.
Luce Bay and Sands SAC	68.05	• Large shallow inlets and bays. • Sandbanks which are slightly covered by sea water all the time. • Mudflats and sandflats not covered by seawater at low tide. • Reefs.
Allonby Bay MCZ	78.49	• Blue mussel beds. • *S. alveolata* reefs.
Solway Firth SAC	84.32	• Sandbanks which are slightly covered by sea water all the time. • Reefs.

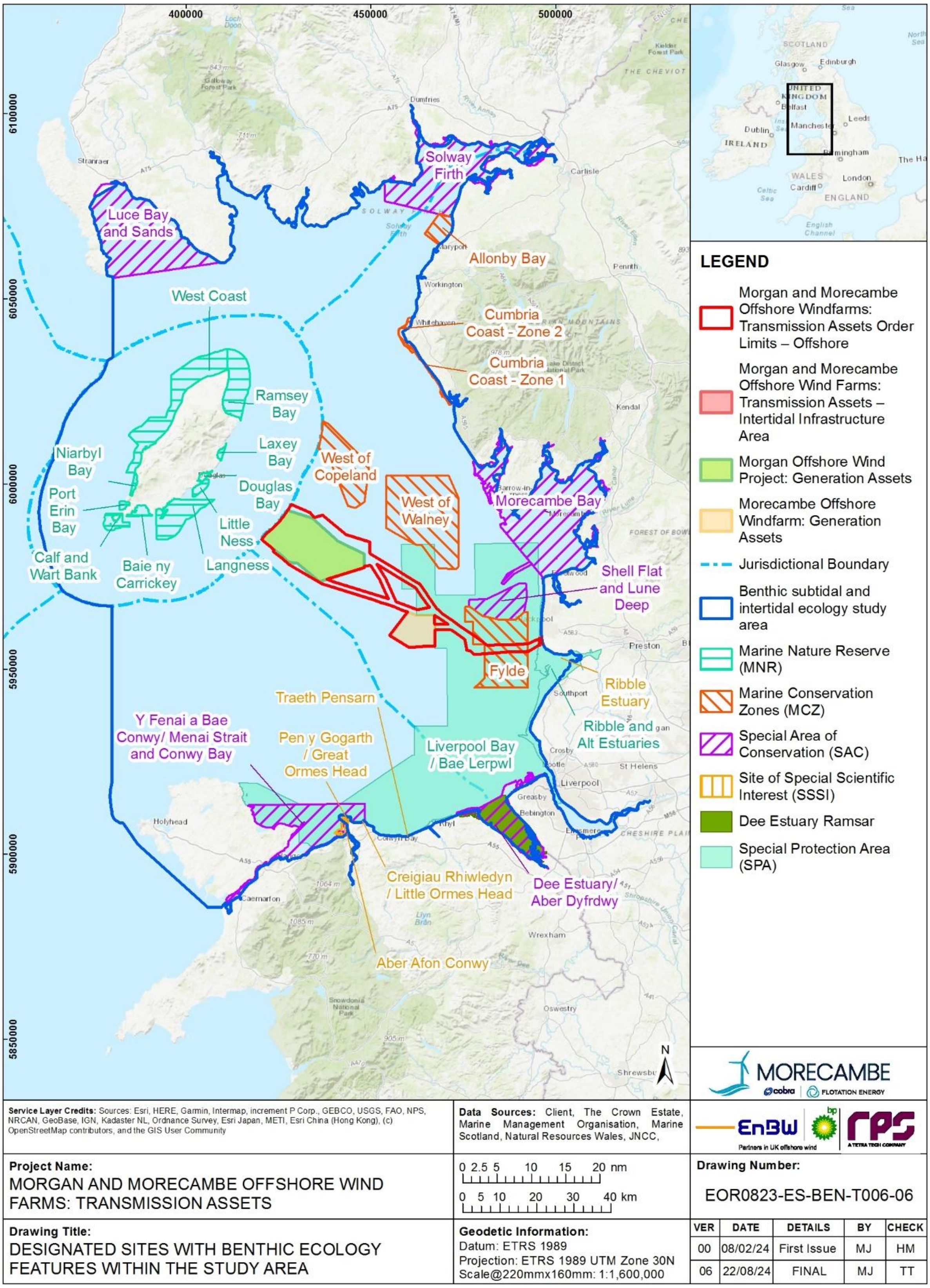


Figure 1.7: Designated sites with benthic ecology features within the study area

International designations

Liverpool Bay/Bae Lerpwl SPA

1.3.4.4 The Liverpool Bay SPA overlaps with the nearshore area of the Offshore Order Limits and borders the coastlines of north west England and north Wales. It is designated for the protection of red-throated diver *Gavia stellata*, common scoter *Melanitta nigra*, and little gull *Hydrocoloeus minutus* in the non-breeding season; common tern *Sterna hirundo* and little tern *S. albifrons* in the breeding season, and an internationally important waterbird assemblage (JNCC, 2016), all of which at least partially depend upon benthic habitats as a feeding environment.

Ribble and Alt Estuaries SPA

1.3.4.5 The Ribble and Alt Estuaries SPA overlaps with the nearshore area of the Offshore Order Limits and covers a large portion of the coast between Blackpool and Crosby, covering the landfall area. It is designated for the protection of a variety of overwintering and breeding bird species including *Philomachus pugnax* and *S. hirundo,* and internationally important seabird and waterbird assemblages (JNCC, 2015a), with supporting habitats of tidal flats, sand and shingle shores and saltmarshes (JNCC, 2005).

Shell Flats and Lune Deep SAC

1.3.4.6 The Shell Flats and Lune Deep SAC is located on the north boundary of Fylde MCZ in the east Irish Sea, 5.72 km north east of the Offshore Order Limits at its closest point.

1.3.4.7 Shell Flat sandbank runs north east from the south corner of the site. The bank is an example of a Banner Bank, which are generally only a few kilometres in length with an elongated pear/sickle-shaped form, located in water depths less than 20 m below chart datum (Natural England, 2012). This feature is designated as a sandbank which is slightly covered by seawater all the time. Lune Deep is designated for its reef habitat which represents a good example of boulder and bedrock reef (Natural England, 2012). The presence of stony reef, cobbles and small boulders supporting tide-swept fauna including hydroids, bryozoans, anemones and sponges. A more recent survey indicated the presence of SS.SSa.CMuSa.AalbNuc and *Kurtiella bidentata* and *Abra* spp. in infralittoral sandy mud (SS.SMu.ISaMu.KurAbr) across the SAC (Natural England, 2022).

Morecambe Bay SAC

1.3.4.8 The Morecambe Bay SAC is located on the west coast of England, in the county of Lancashire. The site is located 15.3 km east of the Offshore Order Limits at its nearest point. The variation in physical and environmental conditions throughout the site, including rock and soft sediment types, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.3.4.9 This SAC is designated for numerous Annex I habitats throughout the subtidal and intertidal environment. One of the key habitats being the estuaries in this area, within the SAC four rivers contribute to the estuary resulting in the largest single area of continuous intertidal mudflats and sandflats in the UK and the best example of muddy sandflats on the west coast (JNCC, 2022c). Mudflats and sandflats not covered by seawater at low tide is another Annex I habitat that this SAC is designated for. Furthermore, Morecambe Bay is the second-largest embayment in the UK, after the Wash and as such, it has also been designated for its large shallow inlets and bays habitat (JNCC, 2022c).

Aber Dyfrdwy/Dee Estuary SAC

1.3.4.10 The Aber Dyfrdwy/Dee Estuary SAC is located on the north Wales coast in the south east of the east Irish Sea, 32.81 km south east of the Offshore Order Limits at its closest point.

1.3.4.11 The Aber Dyfrdwy/Dee Estuary SAC covers an area of 158.05 km^2 (JNCC, 2022b). This site is designated for three main features: mudflats and sandflats not covered by seawater at low tide, *Salicornia* and other annuals colonising mud and sand and Atlantic salt meadows *Glauco-Puccinellietalia maritimae*. Other Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site, include estuaries and various dune habitats. The majority of these features are in good conditions and targets are currently in place to maintain this condition.

Dee Estuary Ramsar site

1.3.4.12 The Dee Estuary Ramsar site is located on the north Wales coast, almost entirely overlapping with the Dee Estuary SAC, and is located 38.58 km south east of the Offshore Order Limits at its closest point.

1.3.4.13 The Dee Estuary Ramsar site covers an area of 143.02 km^2 (Ramsar, 2012). This site is classified under criterion 1 for extensive intertidal mud and sandflats with large expanses of saltmarsh towards the head of the estuary (Ramsar, 2012). Much of the upper part of the estuary consists of muddy fine sand dominated by *Hediste diversicolor* and *Macoma balthica*. The sediment flats in the outer estuary also have fine muddy sands but here they are dominated by *Cerastoderma edule* and *Arenicola marina*. Where water movement is greater the sediments tend to be coarser and sandier, with *Nephtys* sp. and *Bathyporeia* sp. It also supports some nationally scarce biotopes including *Sabellaria alveolata* reefs around Hilbre Island and piddock beds (*Barnea candida*) on Holocene clay banks within the estuary (Ramsar 2012).

Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC

1.3.4.14 The Menai Strait and Conwy Bay SAC is located in north west Wales, between mainland Wales and the island of Anglesey. The site is located

43.89 km from the Offshore Order Limits. The variation in physical and environmental conditions throughout the site, including rock and sediment type, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.3.4.15 For the qualifying habitats (sandbanks which are slightly covered by sea water all the time, mudflats and sandflats not covered by seawater at low tide, submerged or partially submerged sea caves and reefs), the SAC is considered to be one of the best areas in the UK for mudflats and sandflats not covered by seawater at low tide, reefs, and sandbanks which are slightly covered by seawater all the time. The features are distributed throughout the SAC with no single feature occupying the entire SAC and with features overlapping in some locations. According to the most recent condition assessment (NRW, 2019), three features of the SAC are considered to be in favourable condition (sandbanks which are slightly covered by sea water all the time, mudflats and sandflats not covered by seawater at low tide, and reefs) and the large shallow inlets and bays feature is in unfavourable condition.

1.3.4.16 Within the Menai Strait SAC the sandbanks which are slightly covered by seawater all the time and reefs are notable features. The reef feature is further defined by the JNCC (2022a) as rocky reefs dominated by communities of filter feeders such as sponges. The sandbanks vary from stable muddy sands in areas with weak tidal streams to relatively clean well-sorted and rippled sand where tidal streams were stronger (JNCC, 2022a). In very shallow waters relatively species-rich sandy communities are dominated by polychaetes (JNCC, 2022a).

Luce Bay and Sands SAC

1.3.4.17 The Luce Bay and Sands SAC is located on the south west coast of Scotland. The site is located 68.05 km from the Offshore Order Limits at its nearest point. The variation in physical and environmental conditions throughout the site, including rock and soft sediment types, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.3.4.18 In the marine environment this SAC is designated for one Annex I feature, large shallow inlets and bays, of which the Luce Bay and Sands SAC is a high quality example (JNCC, 2022d). The JNCC (2002d) describe the sediments within Luce Bay as ranging from boulders to highly mobile sands, which support rich plant and animal communities typical of a large bay in south west Scotland. The shallow depths of the bay (0-10 m) contain major sandbanks along the west and north shores. Most of the intertidal area of the bay comprises small boulders on sandy sediment. Some larger boulders on the lower shores have spaces beneath and between them which provide shelter for false Irish moss *Mastocarpus stellatus* and allowing for under-boulder communities to develop, including ascidians, sponges and crustose coralline algae. In the subtidal area communities of sparse kelp *Laminaria hyperborea* and sea-oak *Halidrys siliquosa*, red algae and the dahlia anemone *Urticina* *felina* have been identified. Much of the central part of Luce Bay consists of slightly deeper water that supports a rich community of polychaete worms, bivalves, echinoderms and brittlestars, particularly *Ophiura* spp.

Solway Firth SAC

1.3.4.19 The Solway Firth SAC is located on the west coast border between England and Scotland and is formed by the river Solway. It is one of the least-industrialised and most natural large estuaries in Europe (JNCC, 2022e). The site is located 84.32 km from the Offshore Order Limits at its nearest point. The variation in physical and environmental conditions throughout the site, including rock and soft sediment types, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.3.4.20 This SAC is designated for numerous Annex I habitat including sandbanks which are slightly covered by sea water all the time, estuaries and mudflats and sandflats not covered by seawater at low tide (JNCC, 2022e). The sandbanks in the Solway Firth are mainly composed of gravelly and clean sands, due to the very dynamic nature of the estuary. The dominant species of the infaunal communities comprise different annelid worms, crustaceans, molluscs and echinoderms, depending on the nature of the substrate. As a very natural estuary with limited industrialisation highly mobile, predominantly sandy intertidal flats have been able to form on the west coast. The Solway Firth contains the third-largest area of continuous littoral mudflats and sandflats in the UK.

National designations – Marine Conservation Zones

Fylde MCZ

1.3.4.21 The Fylde MCZ overlaps the Offshore Order Limits and was originally designated in 2013 to protect 156 km^2 of subtidal sands, with this updated in 2016 to also include 104 km^2 of subtidal muds. The MCZ covers an area of approximately 260 km^2 within the Liverpool Bay area, and is located between 3 and 20 km off the west coast of the Fylde and Ribble Estuary, with a depth range of approximately 0.35-22 m. The site is located in proximity to the Shell Flat and Lune Deep SAC and is co-located within the Liverpool Bay SPA.

1.3.4.22 Both broadscale habitat features are considered to be good representatives of these habitats in the east of the Liverpool Bay area, with the general management approach recommended to maintain both habitat types in favourable condition. There are pockets of mud present in small areas across the rest of the site (Environment Agency, 2015).

1.3.4.23 The MCZ acts as a protected habitat for crabs, brittle stars, a rich community of bivalve molluscs such as the razor shell *Pharus legumen* and *A. alba* (Kaiser *et al.,* 2006), polychaetes primarily within the genera *Nephtys* and *Pholoe*, and demersal flatfish species including sole *Solea solea* and plaice *P. platessa* (Natural England, 2016).

1.3.4.24 The habitats within the Fylde MCZ were characterised in a baseline survey of the area by Natural England (Miller and Green, 2017). Specifically, this found that subtidal sand substrate (A5.2 classification) dominated approximately the south three fifths of sampled sites, largely as a result of sediment outflows from the Ribble Estuary to the south east. The benthic community is characterised by a variety of species, ranging from a low-abundance bivalve-dominated community including *Corbula gibba*, *Chamelea striatula* and *Dosinia* spp. to a mixed polychaete and bivalve community which includes *Ophelia* sp., *K. bidentata* and *Glycera tridactyla* (Environment Agency, 2015). Subtidal muds (A5.3 classification) dominated the north two fifths, with an overall trend of increasing mud percentage moving north within the MCZ.

1.3.4.25 Multivariate analysis of the 2017 grab sample data showed significantly increased biodiversity in the north of the MCZ compared to the south. The biotopes *Glycera lapidum* in impoverished infralittoral mobile gravel and sand/*Morella* spp. with venerid bivalves in infralittoral gravelly sand biotope (SS.SCS.ICS.Glap/SS.SCS.ICS.MoeVen) covered a large proportion of the south part of the MCZ in association with the sandy substrates. The number and variety of biotopes increased further north, with SS.SMu.CSaMu.AfilKurAnit (previously SS.SMu.CSaMu.AfilMysAnit) dominating the subtidal muds, with this being geographically and statistically grouped alongside SS.SSa.CMuSa.AalbNuc, with these two biotopes having been recognised as grading into one another (Envision Mapping Ltd., 2014). Occasional sites characterised as *Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand (SS.SSa.IMuSa.EcorEns) have also been noted in the north west of the MCZ.

West of Walney MCZ

1.3.4.26 West of Walney MCZ Is located in the Irish Sea, off the coast of Cumbria and to the west of Walney Island. The MCZ is 5.85 km north east of the Offshore Order Limits at its closest point. The MCZ covers an area of 388 km^2 most of which is in inshore waters, but with a small section crossing the 12 nm boundary into offshore waters (Defra, 2016). This site is notable as it is part of a network of mud-based seapen and burrowing megafaunal habitats in this region (Defra, 2016). All of the designated features (subtidal sand, subtidal mud and seapens and burrowing megafauna communities) are currently recovering to favourable condition (Defra, 2016, JNCC, 2018).

1.3.4.27 The MCZ provides important protected habitats to worms, molluscs, sea urchins, and crustaceans, and the subtidal sands support high densities of burrowing brittle stars, along with flatfish. The seapens are colonial cnidarians which thrive within the subtidal mud habitats protected within the MCZ boundary, while also providing habitats for brittle stars *A. filiformis*, horseshoe worms *Phoronid* species, polychaete worms *Scalibregma inflatum* and *Nephtys hombergii*, bivalves *K. bidentata* and *A. nitida* and the burrowing crustaceans *Callianassa subterranea* and *Goneplax rhomboides* (CMACS, 2013). The subtidal sands act as habitats for the same polychaete and echinoderm species, differing by also providing habitats to the bivalves *K. bidentata*, and *Chamelea striatula*, and crustaceans *Corystes cassivelaunus* (The Centre for Environment, 2007).

1.3.4.28 Most of the substrate is subtidal muds (A5.3), with exception of the north east corner, where a relatively small area of subtidal sands (A5.2) are present and limited to the shallowest region of the MCZ. The seapen and burrowing megafauna communities feature also covers the majority of the site with seapens *Virgularia mirabilis* found sparsely throughout the entire site, but mainly focused along the south boundaries of the designated area (Titan Environmental Surveys, 2005). Burrowing megafauna, such as *Nephrops norvegicus* and *C. subterranea,* and worms such as the echiuran, or spoon-worm *Maxmuelleria lankesteri* (Hughes, 1998b) occur almost uniformly across the entire site, except for the subtidal sands in the north east, which host burrowing brittle stars and some species of flatfish.

1.3.4.29 Site-specific infaunal grab sample surveys carried out in 2016 and 2018 (Mitchell *et al*., 2023) broadly supported these findings. Specifically, the 2018 survey found 89 sites composed of subtidal muds, and 11 composed of subtidal sand in the north east of the designated area. Infaunal analysis indicated the site to be dominated by a mix of the SS.SSa.CMuSa.AalbNuc, SS.SMu.CSaMu.AfilKurAnit, and burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud (SS.SMu.CFiMu.MegMax) biotopes. The designated habitat assessment indicated that all subtidal mud sites throughout the MCZ contained species indicative of the seapen and burrowing megafauna communities, aligning with previous surveys within this area (Titan Environmental Surveys, 2005).

West of Copeland MCZ

1.3.4.30 West of Copeland MCZ is located in the east Irish Sea, 6.32 km north of the Offshore Order Limits and it covers an area of 158 km^2. The seabed within the West of Copeland MCZ is predominantly composed of a mix of subtidal sediments from fine sand through to coarse sediment (Defra, 2019a). It is these sedimentary habitats which are the protected features of this site (subtidal sand, subtidal coarse sediment and subtidal mixed sediment). The subtidal sand habitat is in favourable condition, but the subtidal coarse and subtidal mixed sediments are recovering to favourable condition (Defra, 2019a). This range of habitats supports a wide variety of species including bivalve molluscs (such as *Venus* clams and razor clams), worms, sea urchins, anemones, starfish, crabs and sea mats (Defra, 2019a).

1.3.4.31 The majority of the MCZ is characterised by the subtidal coarse sediments (A5.1) feature, which dominates the west border and centrally, primarily at a depth of 20-30 m. This feature is surrounded and interspersed by a patchy distribution of the subtidal sands (A5.2) feature, covering most of the north west and south of the MCZ in the 20-50 m depth range, with a relatively small portion of the south being covered by the subtidal coarse sediments designated feature (Defra, 2019a, EMODnet, 2021). The north east border of the MCZ is largely characterised by subtidal mixed sediments (A5.4) interspersed with patches of the subtidal coarse sediment and subtidal sand features. This range of habitats support a variety of communities, with common species being the *Venus* clam *Chamelea gallina* and razor clams *Ensis ensis*, which are found within all designated feature habitats.

Cumbria Coast MCZ

1.3.4.32 The Coast of Cumbria MCZ is located on the west coast of England, within the county of Cumbria. The MCZ is 42.92 km north east of the Offshore Order Limits at its closest point. The MCZ is an inshore site that stretches for approximately 27 km along the coast of Cumbria and in total it covers an area of 22 km^2 (Defra, 2019b). This site is notable as it is an extensive and important example of intertidal rocky shore habitats and associated communities on the sedimentary coast of north west England (Defra, 2019b). All of the designated habitat features of this MCZ (high energy intertidal rock, *S. alveolata* reefs, intertidal biogenic reefs, intertidal sand and muddy sand, intertidal under-boulder communities, moderate energy infralittoral rock and peat and clay exposures) are currently being maintained to preserve their favourable status (Defra, 2019b).

1.3.4.33 The diverse physical habitat at this MCZ helps to support this wide variety of designated features. The extensive intertidal boulder and cobble reefs within the site support good examples of nationally important *S. alveolata* reefs (Defra, 2019b). Where this habitat extends towards and below the low water mark examples of under-boulder communities are prevalent supporting unusual algae and mobile animals such as long-clawed porcelain crabs, sea slugs and brittlestars shelter among sponges (Defra, 2019b).

Allonby Bay MCZ

1.3.4.34 The Allonby Bay MCZ is located on the west coast of England, within the county of Cumbria. The MCZ is 78.49 km north west of the Offshore Order Limits. The MCZ is a nearshore site on the English side of the Solway Firth and in total it covers an area of 40 km^2 (Defra, 2022c). This site is notable for large areas of reefs, including *S. alveolata* reefs and blue mussel beds (Defra, 2022c). All of the designated habitat features of this MCZ (intertidal rock, *S. alveolata* reefs, intertidal biogenic reefs/sand and muddy sand/coarse sediment, subtidal biogenic reefs, subtidal coarse/sand/mixed sediment, moderate energy infralittoral rock and peat and clay exposures) are currently being maintained to preserve their favourable status (Defra, 2022c).

National designations – Sites of Special Scientific Interest (SSSI)

Ribble Estuary SSSI

1.3.4.35 The Ribble Estuary SSSI is located on the Irish Sea coast of the counties of Lancashire and Merseyside. The site overlaps a small part of the east of the Offshore Order Limits. This SSSI is 92.26 km^2 in area and also contains the Ribble Marshes National Nature Reserve (NNR).

1.3.4.36 The estuary and in particular its extensive sand flats, mud flats and salt marshes, is especially important for migratory birds. The landfall overlaps with Unit 010 of the Ribble Estuary SSSI, Salter's Bank, where the habitats comprise of sheltered areas of slightly muddy sand on the mid to upper show which grade into well drained rippled sand or mobile areas of large sand waves. (Natural England, 2008). A survey in the north of the site (Natural England, 2015), near Lytham St Annes, found the upper shore to be characterised by sandy habitat with a range of polychaete species and amphipods. The fauna in sediments on the lower shore area identify high numbers of juvenile brittlestars and fragments of hydroids and bryozoans. A large number of empty razor shells *Ensis* spp. were also present scattered over the sediment surface.

1.3.4.37 The Ribble Estuary SSSI is a highly dynamic environment subject to a range of environmental influences including wave and wind action as well as flow from the Ribble River channel. The locations of channels and surface features of the sandflats can vary weekly and seasonal variation in the faunal communities occurs both within and across years.

Creigiau Rhiwledyn/Little Ormes Head SSSI

1.3.4.38 Creigiau Rhiwledyn/Little Ormes Head SSSI is located on the north Wales coastline and overlaps the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. The site is located 48.27 km from the Offshore Order Limits. Creigiau Rhiwledyn/Little Ormes Head SSSI covers an area of 0.36 km^2 (CCW, 2002). This site is notable for various marine biological features including specialised and nationally scarce cave, rockpool, overhang and rock-boring bivalve biotopes (physical habitats and their associated community of species including animals and plants) within the intertidal zone (CCW, 2002).

Pen y Gogarth/Great Ormes Head SSSI

1.3.4.39 Pen y Gogarth/Great Ormes Head SSSI is located on the north Wales coastline and overlaps the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. The site is located 48.35 km from the Offshore Order Limits. Pen y Gogarth/Great Ormes Head SSSI covers an area of 3.03 km^2 (JNCC, 2015). This site is notable for having the largest extent of moderately exposed rock, supporting a complete zonation of marine biotopes, as well as specialised and nationally scarce flora and fauna, most typically associated with rock pool, cave and limestone rock habitats found between the Great Orme and the Solway Firth (CCW, 2013).

Aber Afon/Conwy SSSI

1.3.4.40 Aber Afon/Conwy SSSI is located on the north Wales coastline, at the mouth of the river Conwy and overlapping with the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. The site is located 49.51 km from the Offshore Order Limits. Aber Afon/Conwy SSSI covers an area of 12.95 km^2 (CCW, 2003). This site is notable as a high-quality example of an intertidal estuarine community (CCW, 2003). The site supports nationally important ‘piddock’ communities on; eulittoral peat, eulittoral firm clay with *M. edulis*, lower eulittoral soft rock with *F. serratus* and sublittoral fringe soft rock with *L. digitata* (CCW, 2003). In addition, the site supports specialised communities of shallow pools on mixed substrata with hydroids, ephemeral algae and *L. littorea* (CCW, 2003).

Traeth Pensarn SSSI

1.3.4.41 Traeth Pensarn SSSI is located on the north Wales coastline and is located 50.38 km from the Offshore Order Limits. Traeth Pensarn SSSI covers an area of 51.67 km^2, of which 42.46 km^2 is within the intertidal zone (82%). This site is notable for its coastal vegetated shingle beach as well as exposed sand and littoral sediment. All designated features of this site are located above the MHWS mark.

National designations – Marine Nature Reserves (MNR)

Langness MNR

1.3.4.42 The Langness MNR is located to the south east of the Isle of Man and 16.75 km north west of the Offshore Order Limits. Langness MNR is 88.67 km^2, or 10.67% of the 0-3 nm inshore zone, and is the third largest MNR (Department of Environment, Food and Agriculture (DEFA), 2022a).

1.3.4.43 The Langness MNR is important for a variety of fauna including sea birds and seals as well as benthic species such as grooved topshell *Jujubinus striatus* and the bivalve *L. lucinalis*, (DEFA, 2022a). The site also home to seagrass meadows growing at depths between 5-12 m, as well as kelp forests (DEFA, 2022a). At the coast there is also a series of small subtidal caves which are thought to be nursery sites for lobsters.

Little Ness MNR

1.3.4.44 The Little Ness MNR is located to the east of the Isle of Man and 20.42 km north west of the Offshore Order Limits. Little Ness MNR is relatively small at 10 km^2, but one of the most important sites because of its very high species diversity (DEFA, 2022i).

1.3.4.45 The Little Ness MNR encompasses a variety of habitats including horse mussel reefs and maerl beds (DEFA, 2022i). This site also has an important population of critically endangered European eels where young eels can be found in spring before travelling up rivers (DEFA, 2022i). As a result of this rich benthic environment a variety of seabird and marine mammals can also be found in this area.

Douglas Bay MNR

1.3.4.46 The Douglas Bay MNR is located to the east of the Isle of Man and 22.23 km north west of the Offshore Order Limits. Douglas Bay MNR covers an area of 4.6 km^2 (DEFA, 2022b).

1.3.4.47 This MNR encompasses an area of maerl bed, a red coralline seaweed which creates a fine layer over the seabed. This habitat attracts a high diversity of species including shellfish and anemones, as well as being a refuge for juvenile queen scallops and whelks which are commercially important to the Isle of Man (DEFA, 2022b). Rocky reefs and kelp forests are also found in this MNR. Beaumont's nudibranch is an important species in this MNR due to its limited range only occurring between the UK and Norway (DEFA, 2022b).

Laxey Bay MNR

1.3.4.48 The Laxey Bay MNR is located to the east of the Isle of Man and 22.4 km north west of the Offshore Order Limits. Laxey Bay MNR is approximately 4 km^2 in size which equates to around 0.5% of the 0-3 nm area, or 1% of the reserves network (DEFA, 2022c).

1.3.4.49 The Laxey Bay MNR is one of the smallest MNRs around the Isle of Man however it contains a wide variety of benthic habitats such as seagrass meadows, rocky reefs, sandy seabed and maerl beds (DEFA, 2022c). This MNR supports ocean quahog *A. islandica* and common whelk *Buccinum undatum* which is one of the five commercially fished species around the Isle of Man (DEFA, 2022c).

Ramsey Bay MNR

1.3.4.50 The Ramsey Bay MNR is located to the north east of the Isle of Man and 26.47 km north west of the Offshore Order Limits. Ramsey Bay MNR covers an area of around 97 km^2, half of which is highly protected. Designated in 2011 as the island's first MNR, it is divided into five zones, four of which are highly protected for important habitats, such as horse mussel reef and eelgrass meadow (DEFA, 2022f).

1.3.4.51 Horse mussels can reach 15 cm in length and attach to the seabed with threadlike hairs. Over time the number of mussels increases, and they can form a reef structure with highly a complex three-dimensional structure which can be colonised by sponges, tube worms, soft corals and barnacles. Rocky reefs are also present in the intertidal and subtidal environment (DEFA, 2022f).

Baie y Carrickey MNR

1.3.4.52 The Baie y Carrickey MNR is located to the south of the Isle of Man and 30.22 km west of the Offshore Order Limits. Baie ny Carrickey MNR covers an area of 11.37 km^2 and was originally established as a fishery-restricted area in 2012 to reduce gear conflict between scallopers and pot fishermen and protect rocky reefs (DEFA, 2022d).

1.3.4.53 The Baie y Carrickey MNR encompasses an area of rocky reef, kelp forest and seagrass meadows as well as sea caves which all contribute to its designated status (DEFA, 2022d).

Calf of Man and Wart Bank MNR

1.3.4.54 The Calf of Man and Wart Bank MNR is located to the south west of the Isle of Man and 35.81 km west of the Offshore Order Limits. The Calf of Man and Wart Bank MNR is 20.15 km^2, or 2.4% of the 0-3 nm inshore zone (DEFA, 2022e).

1.3.4.55 The Calf of Man and Wart Bank MNR encompasses habitats such as rocky reefs and kelp forests (DEFA, 2022e). This MNR also contains sandbanks composed of sandy sediment and influenced by the waves and tide resulting in a dynamic habitat of mounds and ripples (DEFA, 2022e). This habitat is home to sandeels which are an important prey species for a number of marine mammals and seabirds.

Niarbyl Bay MNR

1.3.4.56 The Niarbyl Bay MNR is located to the west of the Isle of Man and 36.84 km north west of the Offshore Order Limits. First established as a Fisheries Closed Area for scallop reseeding trials in 2009, this MNR is 5.66 km^2 in area and makes up just over 1% of the reserves network (DEFA, 2022g).

1.3.4.57 The Niarbyl Bay MNR encompasses habitats such as rocky reefs, kelp forest and sea caves as well as intertidal blue mussel beds (DEFA, 2022g). The ocean quahog is also an important feature of this MNR due to the coarse gravel habitats found in the south of the site (DEFA, 2022g).

Port Erin Bay MNR

1.3.4.58 The Port Erin Bay MNR is located to the west of the Isle of Man and 36.88 km north west of the Offshore Order Limits. Port Erin Bay MNR is relatively small at approximately 4.5 km^2. Facing due west, the bay acts as a funnel for wind and wave from the Irish Sea and these forces have produced one of the best sandy beaches on the island (DEFA, 2022j).

1.3.4.59 The Port Erin Bay MNR encompasses habitats such as rocky reefs, kelp forest and brittlestar beds (DEFA, 2022j), all of which take advantage of the site being closed for fishing since 1989 (DEFA, 2022j). The site is also notable for having stalked jellyfish *Stauromedusae* which are rare across the British Isles as well as the flame shell *Limaria hians* which is a species of marine clam named for its fiery orange colours.

West Coast MNR

1.3.4.60 The West Coast MNR is located to the west of the Isle of Man and 38.7 km north west of the Offshore Order Limits. The West Coast MNR is the largest of the nature reserves at around 185 km^2, which equates to 43% of the protected area network (DEFA, 2022h).

1.3.4.61 The West Coast MNR has a distinctive physical environment as a result of the strong tidal currents around the Point of Ayre (DEFA, 2022h). The seabed is composed of sand deposits as well as rock fragments as a result of the glacial history of this area. These sediments have enabled the creation of rocky reefs, intertidal mussel beds and kelp beds (DEFA, 2022h). The main habitat within this MNR is mixed soft sediment which is inhabited by scallops and whelks as well as the burrowing sea anemone *E. timida* (DEFA, 2022h).

1.4 Site-specific surveys – baseline characterisation

1.4.1.0 A summary of the site-specific surveys undertaken within the survey area (i.e. the offshore export cable corridor excluding Generation Assets, as defined in **paragraph 1.2.2.3**) to inform the benthic subtidal and intertidal ecology is outlined in **Table 1.3** below.

Table 1.3: Summary of surveys undertaken to inform benthic subtidal and intertidal ecology

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Landfall intertidal survey	Intertidal Infrastructure Area	Phase I walkover survey	RPS	May 2022	**Section 1.4.2**: Transmission Assets Intertidal Survey results
Transmission Assets Geophysical Survey	Geophysical survey of proposed export cable routes	Geophysical overview of survey area, informed by XOcean bathymetry data.	Gardline	April 2022	Gardline, 2022 (summarised in **section 1.4.2**)
Transmission Assets benthic subtidal survey	Transmission Assets survey area	Grab samples and DDV sampling	Gardline	April-August 2022	**Section 1.4**: Site-specific survey results

1.4.1 Methodology

Subtidal survey

1.4.1.1 The 2022 site-specific subtidal survey was undertaken across the survey area. The sampling strategy was designed to adequately sample the area to provide data for baseline characterisation. The survey design was discussed and agreed with Natural England, JNCC and NRW (see **section 1.2.3**). The site-specific benthic subtidal survey was undertaken by Gardline Limited (Gardline) between April and August

2022, drawing on bathymetry data collected by XOcean. The survey was conducted onboard the vessels *Ocean Resolution* and *Titan Endeavour*.

1.4.1.2 The 2022 subtidal survey comprised 77 combined grab and DDV stations within the survey area (i.e. the offshore export cable corridor excluding the Generation Assets, as defined in **paragraph 1.2.2.3**) and five additional DDV only stations within the Fylde MCZ (see **Figure 1.8**). Stations were spread evenly across the survey area at approximately 1.5 to 2 km intervals and targeted different bathymetric features as per the survey strategy agreed with the SNCBs. At the completion of the survey, all 77 stations had been successfully sampled within the survey area.

Grab sampling

1.4.1.3 Grab sampling was undertaken at all 77 sample locations using a 0.1 m^2 mini-Hamon grab (**Figure 1.8**), to ensure adequate data coverage for both infaunal and epifaunal communities at each location. Macrofaunal, particle size and environmental DNA (eDNA; see **Appendix C.9**) samples were collected from all stations. Samples for chemical analysis were collected at 39 of the grab sample stations, at approximately every other station.

1.4.1.4 Initial processing of all mini Hamon grab samples was undertaken aboard the survey vessel in line with the following methodology.

- Assessment of sample size and acceptability made using strict standardised criteria.
- Photograph of sample with station details, scale bar taken and described prior to sub-sampling.
- Surficial (<2 cm depth) sediments were taken directly from the mini-Hamon grab for chemical and biological analysis.
- One sediment grab was obtained which was divided into six sub-samples; two approximately 1 litre samples for chemical analysis, and a spare, PSA with a spare taken using a plastic scoop and placed into plastic zip-lock bags. Sample emptied onto 1 mm sieve net laid over 4 mm sieve table and washed through using gentle rinsing with seawater hose.
- Two separate grab samples from each station were collected for infaunal macroinvertebrate identification. Each faunal sample was washed with seawater and transferred to a 0.5 mm sieve, finer sediment fractions were washed from the sample using an auto-sieve.
- The sieve residue was transferred to a uniquely labelled sample jar using scoops and/or funnels and fixed with formaldehyde solution (less than 20% formalin).
- eDNA samples were taken from two grabs at each sampling location. From the homogenised sample approximately 30 g was taken as small scoops from various points in the decanted sample.

These samples were then stored in an airtight bag shielded from ultraviolet light and stored at less then -18ºC prior to analysis.

1.4.1.5 Whilst replicate samples were collected at each station, only one PSA sub-sample, one chemistry sub-sample and one eDNA sub-sample from each station were sent for analysis, together with one biological sample. All other samples were retained as spares.

Drop-down video

1.4.1.6 All sample stations in the survey area were surveyed with DDV with a minimum of 22 seabed photographs and 12 minutes of footage collected at each station at appropriate intervals including stations which required multiple attempts with the DDV equipment to produce adequate footage for analysis. Environmental seabed images were taken by means of a digital stills shallow water camera system with a dedicated strobe and video lamp, mounted within a stainless-steel frame. Video footage was also acquired throughout all stations using a high definition (HD) video camera. The survey was conducted with the SubC Control Ltd 1Cam Alpha Mk5 camera system, with 5,075 photographs with adequate visibility taken using this stills camera across all surveyed stations.

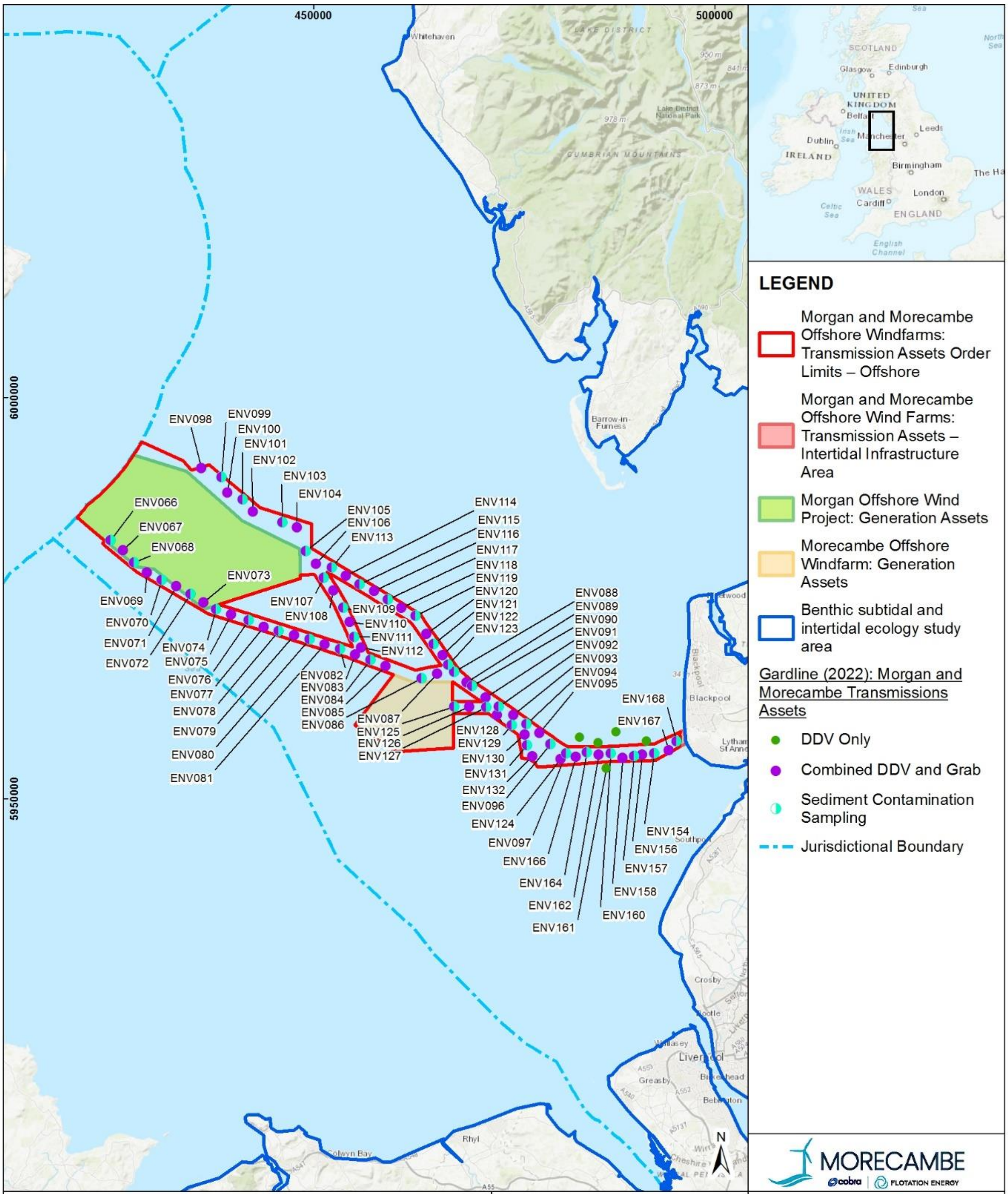
1.4.1.7 A further five DDV only sample stations (ENV155, ENV159 and ENV161, ENV163 and ENV165) were added to the original stations within the survey area to target designated habitats within the Fylde MCZ while minimising damage from sampling to ensure a robust and up to date characterisation of the areas of the MCZ which overlap the Transmission Assets for the purposes of the EIA.

1.4.1.8 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 PC hard drive. On completion, photographs were downloaded onto a computer. All hard disk drives were labelled with the relevant job details, write-protected and stored.

Survey limitations

1.4.1.9 The survey DDV component experienced few significant technical or mechanical issues, with seabed imagery transects being interrupted due to strong currents or poor visibility at only eight stations, with usable data subsequently collected on second attempt transects. Five stations experienced issues with automatic logging of coordinates, with these being manually entered instead, and four stations had at least one point where the camera was unable to take photos of the seabed, although this was deemed acceptable given the number of other images available for seabed characterisation. The lamp also failed at one station (ENV067), although this was fixed and the transect resurveyed in a second deployment.

The survey grab sampling similarly experienced few issues, with too much material retained in samples at three stations, a trigger failure at one station, and a failure to close entirely at another. All of these issues were dealt with by deploying the grab sampler again to collect other samples. Therefore, the limitations of the survey were overall relatively minor and were able to be dealt with by practical equipment adjustments on the survey vessel at the time of sampling, providing reliable data.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community	**Data Sources:** Client, The Crown Estate, Marine Management Organisation, Marine Scotland, Natural Resources Wales
Project Name: MORGAN AND MORECAMBE OFFSHORE WIND FARMS: TRANSMISSION ASSETS	0 2.5 5 10 nm; 0 5 10 20 km
Drawing Title: COMPLETED SITE-SPECIFIC SAMPLE LOCATIONS WITHIN THE SURVEY AREA	**Geodetic Information:** Datum: ETRS 1989; Projection: ETRS 1989 UTM Zone 30N; Scale@220mmx160mm: 1:800,000

Drawing Number: EOR0823-ES-BEN-T007-06

VER	DATE	DETAILS	BY	CHECK
00	08/02/24	First Issue	MJ	HM
06	22/08/24	FINAL	MJ	TT

Figure 1.8: Completed site-specific sample locations within the survey area

Sample analysis

Benthic infaunal analysis

1.4.1.10 Two separate grab samples from each station were collected for infaunal macroinvertebrate identification. For each faunal sample the entire contents of a single grab were washed into a clean plastic tray using seawater and then transferred to 1 mm and 0.5 mm sieves. Finer sediment fractions were washed from the sample using an auto-sieve, which sprayed a low-powered seawater jet onto the underside of the sieve. The sieve residue was transferred to uniquely labelled sample jars using a scoop and/or funnel, making sure that none of the sample was lost or trapped in the sieve mesh. Sieved samples were immediately fixed with a known concentration of formaldehyde solution ('formalin', less than 20%). The formalin in the sample pots was subsequently diluted to a concentration of approximately 4%. One of the faunal samples was worked up as a matter of course and a second retained as a spare.

1.4.1.11 Benthic macrofaunal identification was undertaken by Thomson Environmental Consultants Limited. In the laboratory, samples were gently washed across a 0.5 mm mesh sieve to remove any sediment fines and preservative. The retained material was sorted by hand to extract all macrofauna. The organisms were identified and counted to produce a species list for each grab sample. Sample residues were checked by a second individual to provide a degree of quality control.

Sediment characteristic analysis

1.4.1.12 PSA was carried out by Kenneth Pye Associates Ltd. and Ocean Ecology (both Marine Management Organisation validated laboratories), in accordance with North East Atlantic Marine Biological Analytical Quality Control methods for diamictons (Mason, 2016). No dispersants were used, and the sediment was not treated to remove carbonates or organic matter prior to analysis. The sieve sizes ranged from 63 mm to <1 μm and were all assigned to a Wentworth classification (Wentworth, 1922). The results present particle size distributions in terms of mean phi, fraction percentages (i.e., gravel, sand and fines), sorting (mixture of sediment sizes) and skewness (weighting of sediment fractions above and below the mean sediment size) and kurtosis (degree of peakedness of a distribution) (Folk and Ward, 1957). The sediment samples were additionally classified using the modified Folk triangle classification and the EUNIS classification. These classifications use the sand: mud ratio and the percentage of gravel (Folk, 1954; Parry, 2019).

Sediment chemistry analysis

1.4.1.13 As part of the subtidal survey, sediment samples were taken for the purpose of sediment chemistry analysis. Sediment hydrocarbon, metals, total organic carbon, organotins and PCB analyses were carried out by SOCOTEC. Samples were transferred to an appropriate sample container, labelled and sent to a suitable qualified laboratory for analysis. Samples were analysed for the following contaminants:

- metals;
- PCB;
- total organic carbon;
- organotins; and
- PAH.

eDNA analysis

1.4.1.14 eDNA samples were taken from two grabs at each sampling location where possible (see **Appendix C.9**). From the homogenised sample approximately 30 g was taken as small scoops from various points in the decanted sample. These samples were then stored in an airtight bag shielded from ultraviolet light and stored at less then -18^{o}C prior to analysis.

1.4.1.15 The eDNA analysis was carried out by NatureMetrics. In the laboratory, DNA was extracted from approximately 10 g of each sample. An extraction blank was also processed for each extraction batch. DNA were amplified in triplicate PCRs with primers targeting the V4 region of the 16S rRNA gene for bacteria and the V4-V5 region of the 18S rRNA gene for fauna. All purified index PCRs were pooled into final libraries with each sample added in equal concentrations.

1.4.1.16 Sequence data were processed for quality filtering, Operational Taxonomic Unit (OTU) clustering and taxonomic assignment. Taxonomic assignments were made for each OTU using sequence similarity searched against two reference databases appropriate for the dataset. Results for both searches were combined and assignments made to the lowest possible taxonomic level where there was consistency. Minimum similarity thresholds of 98%, 95%, and 92% were required for species-, genus-, and higher-level assignments. The OTU table was filtered to remove low abundance OTUs from each sample (<0.05% or <10 reads for bacteria and <0.035% or <10 reads for fauna, whichever was the greater threshold for the sample).

Data analysis

Sediment characteristics

1.4.1.17 The PSA data were categorised using the Folk classification which groups particles into mud, sand and gravel (mud 2 mm) and the relative proportion of each was used to ascribe the sediment to one of 15 classes (e.g. slightly gravelly sand, muddy sand etc.) (Folk, 1954; Long, 2006). These classifications were then used to describe the data in the analysis. Proportions of mud, sand and gravel, as well as the Folk and Ward sorting coefficient, were also used to describe the sediment data. The Folk and Ward sorting coefficient describes the extent of deviation from lognormality of the particle size distribution (i.e. the variation in particle size with a sample).

Sediment chemistry

1.4.1.18 The results of the sediment chemistry analysis were compared to the Cefas ALs (Cefas, 1994, reviewed by the Marine Management Organisation, 2015). Cefas AL1 and AL2 give an indication of how suitable the sediments are for disposal at sea. Contaminant levels which are below Cefas AL1 are of no concern and are unlikely to influence the marine licensing decision while those above Cefas AL2 are considered unsuitable for disposal at sea. Those between Cefas AL1 and AL2 would require further consideration before a licensing decision can be made.

1.4.1.19 Sediment chemistry data were also compared to the Canadian Sediment Quality Guidelines (CCME, 2001), which give an indication on the degree of contamination and the likely impact on marine ecology. For each contaminant, the guidelines provide Canadian TEL, which is the minimal effect range at which adverse effects rarely occur and a Canadian PEL, which is the probable effect range within which adverse effects frequently occur. For PAHs the best estimates of the potential toxicity of in marine sediments are ERL and ERM concentrations for total low molecular weight, total high molecular weight and total PAHs (Neff, 2004).

Macrofaunal analysis

1.4.1.20 Destructive sampling techniques and sieving may damage delicate benthic organisms. It is, therefore, commonplace for fragmented organisms to be found in faunal samples. The following conditions were applied to the recording of damaged specimens and fragments.

- Fragments that constituted a major component of an individual, that unequivocally represented the presence of an entire organism, and that could be identified to species level, were recorded and included with other counts of that species.
- Fragments that constituted a significant component of an individual, that unequivocally represented the presence of an entire organism, but that could not be identified to species by virtue of their incompleteness, were recorded to the lowest possible taxonomic level.
- Fragments that did not unequivocally represent the presence of an entire organism were ignored (e.g. *Ophiura* arms, *Echinocardium* shell fragments, etc).

1.4.1.21 Recorded fragments, therefore, represent discrete observations of individuals that were present at the time of sampling and were included in the analysed data set.

1.4.1.22 Macrofauna was defined as organisms that are normally larger that the mesh size of the sieve used to separate them from the sediment (Gardline, 2018). Meiofaunal organisms, such as the *Ostracoda* and

Copepoda, which would not be consistently sampled, were not recorded. Due to their generally small size (in fully marine environments), species from the *Oligochaeta*, *Tardigrada* and *Gnathostomulida* were only enumerated when a sieve with a mesh size of 0.5 mm or less was used to separate organisms from sediments; otherwise, these organisms were noted to be present, but not enumerated.

1.4.1.23 Planktonic organisms, such as *Chaetognatha* and *Mysidacea* were not recorded. The presence of nektonic species, such as fish and *Cephalopoda*, was recorded, but were not enumerated. Colonial, stoloniferous and encrusting epibenthic species were identified but not enumerated. With the exception of discrete seapen *Pennatulacea* colonies, only solitary tunicates and cnidarians were enumerated and included in statistical analyses. Colonial tunicates and cnidarians were identified but not enumerated. When found, the presence of *Porifera* sponges was recorded, but not identified to lower taxonomic levels, enumerated, or included in statistical analyses. Where *Gnathiidae* were recorded, those individuals not identified to species level were grouped as a single indeterminate *Gnathiidae* entry. In accordance with standard Gardline in-house guidelines the following organisms were not identified to species, but were enumerated and included in the data set for analyses at a higher taxonomic level.

- *Nemertea* – identified to phylum.
- *Platyhelminthes* – identified to phylum.
- *Phoronida* – identified to genus.
- *Hemichordata* – identified to phylum.

Data rationalisation

1.4.1.24 The benthic infaunal and epifaunal datasets were handled as both untransformed and transformed sets, with a square root transformation used specifically to down-weight the species with the highest abundances for multivariate community analysis. The analysis of the infaunal community was made using the enumerated taxa only dataset to avoid skewing the results with the encrusting/colonial taxa recorded as ‘present’; these taxa were combined with the DDV data and analysed separately.

1.4.1.25 Juveniles of some species were recorded in the raw infaunal data including species such as *Aphroditidae*, *Sthenelais boa*, *Decapoda* and *Pisidia longicornis*. Juveniles represented only a small proportion of the overall population, with no significant statistical difference noted between the datasets including and excluding juveniles, and they were therefore included in the analysis to best characterise the habitats present.

1.4.1.26 Colonial/encrusting taxa within the grab samples, which were recorded only as present/absent, were combined with the DDV data and given an abundance of 1 or 0 respectively to enable them to be included in a separate multivariate analysis. Epifaunal data were recorded as present/absent, and therefore removed from the infaunal grab data analysis, but were included in the epifaunal analysis.

Univariate analysis

1.4.1.27 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 sample station, the percentage contribution of each taxonomic group to the total number of taxa and the total number of individuals.

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

Multivariate community analysis

1.4.1.29 The benthic infaunal grab data and combined DDV and grab epifaunal data were analysed using the PRIMER v6 software (Clarke and Gorley, 2006).

1.4.1.30 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, although the same methodology was used for both. Specifically, the Bray Curtis similarity coefficient was calculated to assess the similarity of stations based on the taxa present. This produced a dendrogram indicating the relationships between stations graphically, based on the similarity matrix and used a Similarity Profile (SIMPROF) test (at a 5% significance level) to test whether the differences between the identified clusters were significant.

1.4.1.31 Similarity Percentages (SIMPER) analyses were subsequently undertaken on the transformed infaunal and epifaunal datasets to identify which species best explained the similarity within groups and the dissimilarity between the groups identified in the cluster analysis. The similarity matrix was also used to produce a Multi-Dimensional Scaling (MDS) ordination plot to show, using a two or three-dimensional graphical 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 and Warwick (2001).

Biotope allocation

1.4.1.32 The results of the cluster analyses and associated SIMPER outputs were reviewed alongside the raw, untransformed data and PSA outputs to assign biotopes (Connor *et al*., 2004). The identified clusters were grouped together based on similarities in sediment, taxa presence and abundance and assigned to the most appropriate biotope classification. These classifications were plotted over the results of geophysical surveys of the same survey area to visually represent the biotope distribution in relation to underlying sediments and physical conditions. Both infaunal and epifaunal results were combined to provide a full combined biotope map for the survey area.

Site-specific intertidal survey

1.4.1.33 A Phase 1 intertidal walkover survey of the Intertidal Infrastructure Area was undertaken in May 2022 during the optimal period for intertidal biotope survey mapping (namely April to October) (Wynn *et al.,* 2006).

1.4.1.34 The proposed landfall is located at North Beach at Lytham St Annes, on the Lancashire coast. The landfall covers a linear distance of approximately 2.6 km extending south from North Beach at Lytham St Annes.

1.4.1.35 A Phase 1 intertidal walkover survey was undertaken on 16 and 17 May 2022. The survey was carried out on a spring tide cycle and focussed on intertidal biotopes from MHWS to approximately mean low water springs (MLWS) within the Intertidal Infrastructure Area.

1.4.1.36 The survey was carried out by experienced marine biotope and coastal habitat surveyors and was undertaken with reference to standard intertidal survey methodologies as outlined in the JNCC Marine Monitoring Handbook (Davies *et al.,* 2001), Procedural Guidance No 3-1 In situ intertidal biotope recording (Wyn and Brazier, 2001 and Wyn *et al*., 2000), and The Handbook for Marine Intertidal Phase 1 Biotope Mapping Survey (Wyn *et al*., 2006).

1.4.1.37 During the walkover survey, notes were made on the shore type, wave exposure, sediments/substrates present and descriptions of species/biotopes present (JNCC, 2015). The spatial relationships between these features were observed and waypoints were recorded by a hand-held global positioning system (GPS) device, in conjunction with hand-written descriptions and photographs. Biotopes present were identified, and their extents mapped with the aid of aerial photographs and a hand-held GPS recorder. Biotope mosaics have been mapped where biotopes occurred intricately together. Any other features within the intertidal zone were also noted including any habitats/species of conservation importance.

1.4.1.38 On-site exploratory digging for sub-surface fauna occurred at various locations across the beach. In addition, sieving of sediments was undertaken in different biotopes at eight sieving stations. The locations of the stations were determined in the field. The procedure involved the collection of four spade-loads (approximately 0.02 m^2) of sediment dug to a depth of 20-25 cm, which were then sieved through a series of stacked sieves, the finest of which was 0.5 mm mesh. All macrofauna species present were identified to the highest taxonomic level possible in the field and also enumerated on site. Field notes were also taken on the physical characteristics including sediment type (Wentworth, 1922) and presence of anoxic layers in the sediment.

1.4.1.39 GPS readings were taken in the survey area using Garmin eTrex 10 and eTrex 20 handheld units. Both units were tested against fixed reference points prior to the survey and had an accuracy of within 5 m.

Constraints

1.4.1.40 The intertidal survey was fine-tuned around available weather windows on the 16 and 17 May 2022. The survey on the evening of the 16 May 2022 was delayed by two hours due to a thunder and lightning storm although one hour was regained by staying later on the beach until dusk. The survey on the evening of 17 May 2022 was brought forward to the morning to avoid forecasted rain. Occasional brief showers occurred during both surveys though these are not considered to have impinged on the quality of the survey or findings presented in this report.

Habitat analyses

Seapens and burrowing megafauna communities assessment

1.4.1.41 The seapens and burrowing megafauna habitat is described by OSPAR as ‘Plains of fine mud, at water depths ranging from 15-200 m or more, which are heavily bioturbated by burrowing megafauna with burrows and mounds typically forming a prominent feature of the sediment surface. The habitat may include conspicuous populations of seapens, typically *V. mirabilis* and *P. phosphorea*’.

1.4.1.42 Guidance by the JNCC (2014) clarifies how to identify this habitat and suggests that burrowed areas of mud should be deemed to be a ‘seapen and burrowing megafauna communities’ habitat regardless of the presence of seapens if multiple sightings of burrows and/or mounds attributable to the relevant species are observed. Habitats can be classed as ‘seapen and burrowing megafauna communities’ regardless of the grain size composition of the sediment (JNCC, 2014).

1.4.1.43 The clarifications (JNCC, 2014) advocate utilising seabed video imagery and/or photographs to confirm the presence of burrows or mounds and seapens, where present. The density classifications as laid out by the Marine Nature Conservation Review SACFOR scale (JNCC, 2013) were used to quantify these defining features. The overall density of burrows was assessed in order to consider whether their density was a ‘prominent’ feature of the sediment surface and potentially indicative of a sub-surface complex gallery burrow system.

1.4.1.44 The JNCC (2014) guidance also states that the habitat occurs predominantly in fine mud sediments. However, some examples of this habitat have been identified in areas of sandy muds. As such, where there is clear evidence of the relevant biological assemblages (burrowing megafauna and in some examples, seapens), such habitats can be classified as ‘Seapen and burrowing megafauna communities’ regardless of the grain size composition of the sediment (JNCC, 2014).

1.4.1.45 The overall or average burrow densities were calculated for each target using the total area covered by the seabed imagery (average image swathe width x camera transect length). It should be noted that there was no attempt to ascertain species due to the inherent complexities of detail needed (ICES, 2011) which is not available with the data acquired. As such and in line with the JNCC report (JNCC, 2013) recommendations, a degree of caution should be applied to these density results as they are not necessarily definitive of the habitats condition.

Fragile sponge and anthozoan communities on rocky habitats assessment

1.4.1.46 Recent attempts to formally quantify a threshold as to what density of sponges define a deep-sea sponge habitat have been made by the DNV (2013) and the JNCC (Henry and Roberts, 2014). The DNV approach is based upon assessment of the percentage cover of sponges in each image. Only images with >10% sponge cover (High) are thought to constitute an OSPAR deep-sea sponge aggregation (DNV, 2013). This approach is useful as a field guide as to whether an aggregation may occur though is subject to a lot of variation due to differences in camera height above and angle to the seabed.

1.4.1.47 Imagery acquired during the site-specific survey was acquired using a DDV system, therefore it was subjected to wave effects which varied the camera height above the seabed consequently which may dramatically have altered the still imagery field of view. Consequently, any determination of habitats by this approach should be considered as a coarse indication of the habitat’s presence.

1.4.1.48 Further, evidence of the species communities being present that are listed in biotopes that constitute ‘fragile sponge and anthozoan communities on rocky habitats’ (MarLIN, 2015) were also assessed to define the habitat.

1.4.2 Results – subtidal ecology

Physico-chemistry

Sediment characteristics

Geophysical survey

1.4.2.1 The site-specific 2022 Gardline geophysical survey showed seabed sediments within the survey area (i.e. the offshore export cable corridor, as defined in **paragraph 1.2.2.3**) generally compromised sand, slightly gravelly clayey sand, clayey sand and sandy clay (Gardline, 2022).

1.4.2.2 Seabed features included ripples in the offshore section of the Offshore Order Limits with wavelengths of up to 15 m and heights of 0.6 m. Seabed sediments in areas of ripples were generally clayey sand, with patches of slightly gravelly clayey sand in areas of subcrop. Stiff clays subcropping the seabed beneath a veneer of surficial sand were also observed. The seabed gently undulated with isolated dunes of wavelengths 250-450 m and heights of 6.5 m present in the shallower sections, with a greater number of boulders than elsewhere within the survey area.

1.4.2.3 In the central section of the Offshore Order Limits, the seabed shoaled and dunes were more extensive. Dune wavelengths of 150-300 m were recorded with measured heights of up to 8 m. Seabed sediments comprised slightly gravelly clayey sand with patches of clayey sand and sand, with coarser sediments generally located in local minor deeps.

1.4.2.4 In the nearshore section, the seabed was found to alternate between featureless clayey sand and rippled clayey sand. Patches of sandy clay and slightly gravelly clayey sand were more common as the seabed shoaled towards the beach (Gardline 2022).

PSA samples

1.4.2.5 The subtidal benthic sediments across the survey area were classified into sediment types according to the Folk classification. Sediments ranged from gravelly muddy sand to slightly gravelly sand, with 42% of the samples classified as muddy sand (**Figure 1.9**). Of the other samples, 26% were classified as sand and 10% were classified as gravelly muddy sand, representing the three most common sediment types across the survey area. The coarseness of sediments generally increased with increasing distance from the coast, with sediments in the west of the survey area typically comprising gravelly muddy sands and gravelly sands. Sediments in the central area of the survey area were dominated by muddy sands and sandy muds, and in proximity to the landfall sediments comprised of sands.

1.4.2.6 According to the simplified Folk Classification (Long, 2006), most stations within the survey area were classified as sand and muddy sand (46%), with areas of mud and sandy mud (36%), mixed sediment (10%) and coarse sediment (8%) in decreasing order.

1.4.2.7 The percentage sediment composition (i.e. mud ≤0.63 mm; sand <2 mm; gravel ≥2 mm) recorded from the PSA samples at each grab sample station in the survey area is presented in **Figure 1.10** and **Appendix C.1**. Across all sample stations, the average percentage sediment composition was 3.32% gravel, 76.8% sand and 19.88% fines and mud. Across the survey area, sand made up the greatest proportion of the sediment composition at almost all stations, with only ENV088, ENV091, ENV097, and ENV125 around the Morecambe Offshore Windfarm: Generation Assets having a higher percentage composed of fine materials than sands or gravels, and no stations being dominated by gravel. The sediment composition showed a general trend of increasing fines and mud concentration with increased proximity to the coast, but particularly in the centre of the survey area, to the north east and east of the Morecambe Offshore Windfarm: Generation Assets. Within the south east of the survey area, in the nearshore area directly west of the landfall, the percentage of fine materials was significantly higher, averaging 33.8% across the eight surveyed locations.

1.4.2.8 Sediments across the survey area as a whole were typically very poorly sorted (51%), or poorly sorted (26%), with a small number of moderately (7%) or moderately well (13%) sorted. A single station (ENV107) was well sorted, with this site being composed of 1.07% fines, 98.85% sands, and 0.08% gravel. This pattern of high (>90%) sands with very low fine and gravel compositions was also seen in all the moderately well sorted sites, with this pattern of high proportions of sand found throughout the survey, except for the area overlapping the area directly to the north east of the Morecambe Offshore Windfarm: Generation Assets, where a higher proportion of fines were recorded (**Figure 1.10** and **Appendix C.1**).

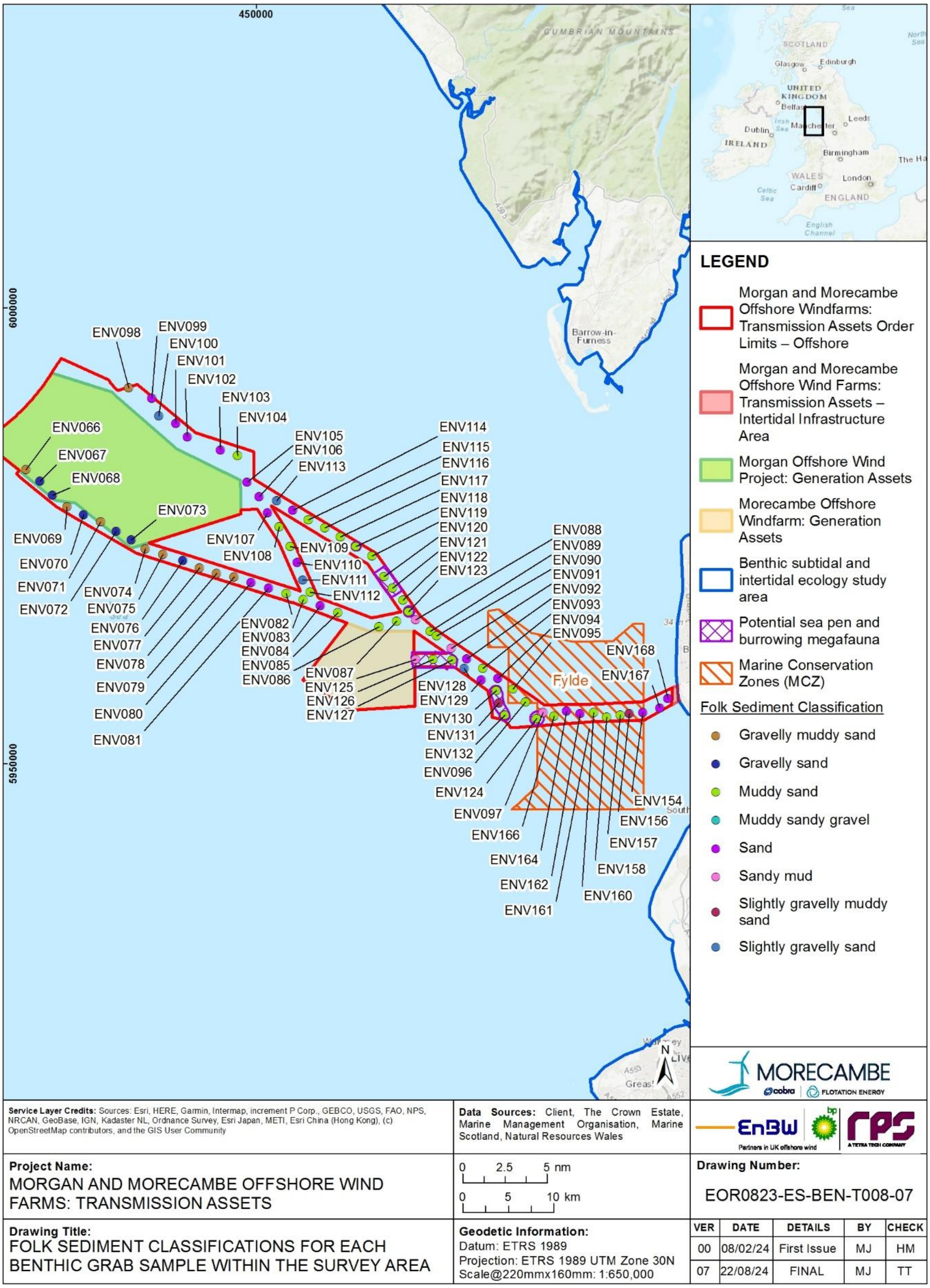


Figure 1.9: Folk sediment classifications for each benthic grab sample within the survey area

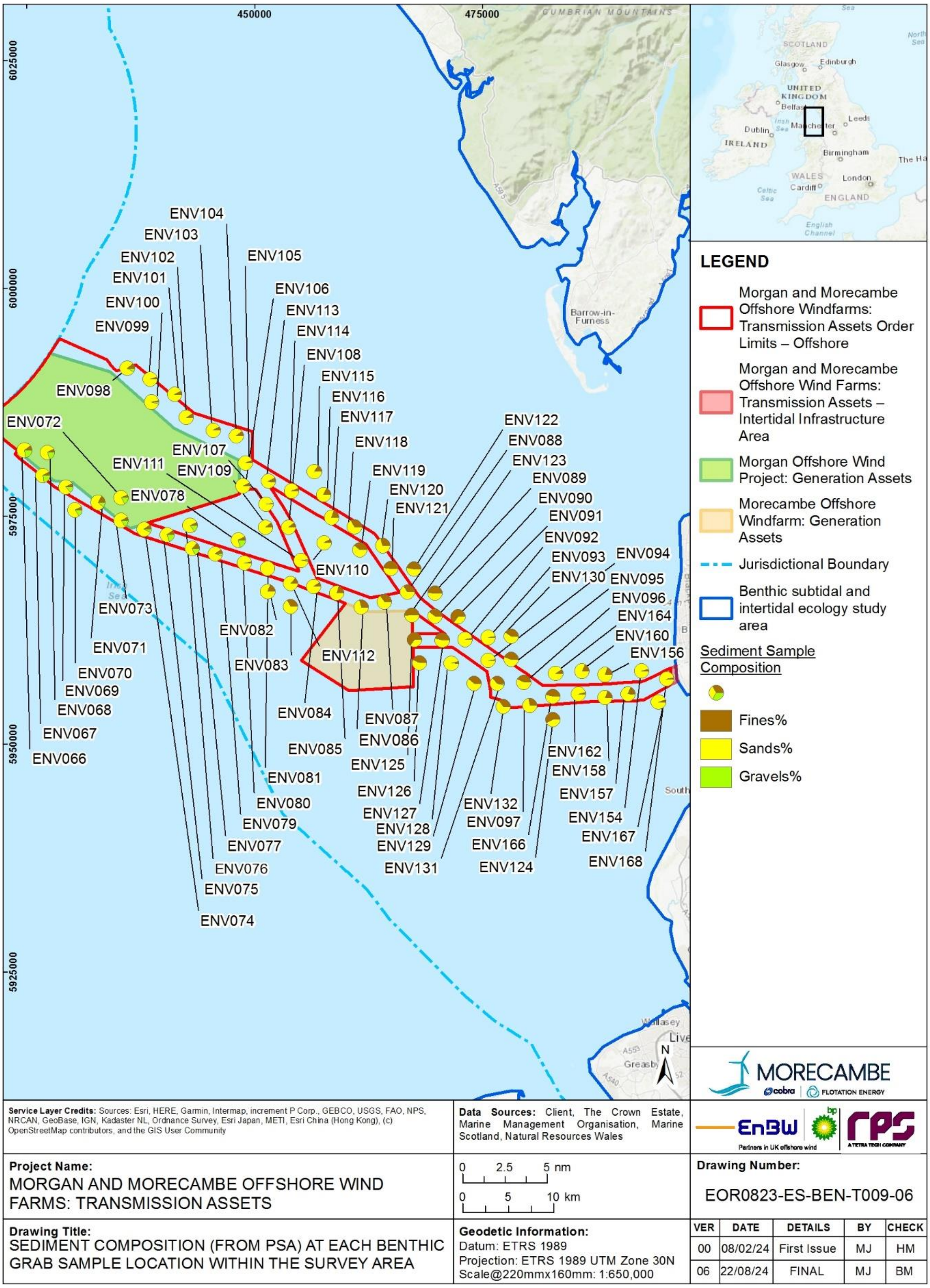


Figure 1.10: Sediment composition (from PSA) at each benthic grab sample location within the survey area

Sediment contamination

1.4.2.9 Sediment samples were analysed for contaminants, with the results of the metals, PCBs, PAHs and organotins analyses summarised below. Full results are available in **Appendix C.2**.

1.4.2.10 Broadly, most sites showed contaminant concentrations below the Cefas AL1, and the Canadian TEL, and no sites exceeding the Cefas AL2 or Canadian PEL.

Metals

1.4.2.11 Heavy metals are readily adsorbed by sediments which can lead to metals accumulating to concentrations far higher than the surrounding environment. These sediments can become re-suspended through bioturbation or through physical processes/disturbances. Metals will tend to accumulate in these fine-grained sediments and can become bioavailable to marine organisms through ingestion. The uptake of heavy metals by marine organisms can lead to bioaccumulation through trophic levels leading to apex organisms accumulating metals to adverse and toxic levels. This could result in significant adverse effects including mortality, impaired reproduction, reduced growth and alterations in metabolism as a result of oxidative stress and disruption to the food chain.

1.4.2.12 No sites exceeded the relevant Cefas AL1 or Canadian TELs and PELs for cadmium, chromium, copper, lead, or zinc. Concentrations of nickel at a single station located offshore in the north west of the Offshore Order Limits and immediately east of the Morgan Offshore Wind Project: Generation Assets (ENV105; 20.6 mg/kg) marginally exceeded the Cefas AL1 of 20 mg/kg but were well below the Cefas AL2 (**Figure 1.11**). Sediments at seven sites, mostly within the central section of the survey area, exceeded the Canadian TEL for mercury but all were below the Cefas AL1 (**Figure 1.11**). The most prevalent metal contaminant recorded in the sediments was arsenic, which was present in concentrations exceeding the Canadian TEL at 17 sites but did not exceed Cefas AL1 or Canadian PEL at any station. Results are displayed below in **Table 1.4** and **Figure 1.11**, with full analysis results for all stations provided in **Appendix C.2**.

Table 1.4: Concentrations of metals recorded in sediments within the survey area

Station	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Detection Limit	1	0.1	0.5	2	0.01	0.5	2	3
Cefas AL1 (mg/kg)	20	0.4	40	40	0.3	20	50	130

Station	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
Cefas AL2 (mg/kg)	100	5	400	400	3	200	500	800
Canadian TEL (mg/kg)	7.2	0.7	52.3	18.7	0.13	-	30.2	124
Canadian PEL (mg/kg)	41.6	4.2	160	108	0.7	-	112	271
ENV066	12.2	0.05	18.7	7.9	0.02	16.5	9.9	33.8
ENV068	13.0	<0.04	18.6	8.2	<0.01	16.0	9.8	31.2
ENV070	10.1	0.05	12.4	7.0	<0.01	12.2	10.6	35.4
ENV072	12.8	<0.04	12.8	5.6	<0.01	10.2	9.1	28.4
ENV074	12.6	<0.04	10.7	6.8	<0.01	9.6	12.3	27.8
ENV076	11.9	0.06	11.5	6.6	<0.01	12.1	12.7	38.6
ENV078	13.2	<0.04	10.0	6.1	<0.01	8.5	13.4	30.8
ENV080	9.6	<0.04	7.3	6.6	0.03	6.1	8.1	30.1
ENV082	6.2	<0.04	10.1	7.3	0.06	7.3	11.4	43.7
ENV084	4.8	<0.04	7.9	5.2	0.05	5.9	8.7	44.3
ENV086	3.4	<0.04	10.5	7.8	0.09	7.8	11.7	49.3
ENV088	4.6	<0.04	16.2	9.0	0.14	11.6	17.6	82.8
ENV090	8.3	<0.04	9.3	5.9	0.04	8.3	7.8	50.7
ENV092	7.7	<0.04	6.3	4.4	0.03	5.8	7.5	40.4
ENV094	18.4	<0.04	7.9	5.8	0.03	7.9	14.3	42.8
ENV096	6.0	<0.04	13.8	9.0	0.12	10.4	16.8	62.8
ENV097	7.7	<0.04	24.5	14.4	0.27	16.2	29.4	87.0
ENV099	8.4	<0.04	7.7	5.3	0.03	5.9	9.1	36.0
ENV101	5.9	<0.04	7.1	5.0	0.03	5.5	7.0	28.9
ENV103	4.8	<0.04	7.0	5.6	0.03	5.1	7.5	28.2
ENV105	4.5	<0.04	14.7	5.6	0.03	20.6	7.1	48.0
ENV107	5.9	<0.04	6.7	5.5	0.03	5.2	7.7	28.9
ENV109	5.8	<0.04	9.8	6.1	0.06	7.8	11.6	35.3
ENV111	5.2	<0.04	6.7	5.0	0.04	4.9	7.0	33.2
ENV113	4.8	<0.04	7.3	4.6	0.04	5.1	7.7	31.7
ENV115	4.3	<0.04	8.7	7.3	0.05	6.4	9.4	36.4
ENV117	4.2	<0.04	11.0	8.8	0.07	8.2	11.4	60.3
ENV119	4.9	<0.04	15.7	8.7	0.13	11.6	16.9	112.0

Station	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
ENV121	4.4	<0.04	17.8	10.3	0.14	12.7	18.4	99.0
ENV123	4.5	<0.04	13.4	7.8	0.11	10.0	14.9	103.0
ENV125	7.0	0.23	25.3	13.0	0.20	18.2	27.2	96.8
ENV127	6.5	0.10	19.3	9.4	0.14	14.4	20.0	76.2
ENV129	15.7	0.07	7.9	4.8	0.03	8.8	10.1	35.4
ENV131	6.0	0.06	15.2	8.1	0.13	12.9	17.2	57.5
ENV154	6.7	<0.04	11.5	4.3	0.02	8.8	6.7	26.2
ENV157	8.0	<0.04	13.1	5.0	0.05	9.6	10.7	40.2
ENV160	19.4	<0.04	13.5	5.6	0.04	10.0	14.8	45.7
ENV164	13.6	<0.04	11.6	5.1	0.06	10.1	9.8	32.8
ENV168	6.0	<0.04	12.4	4.2	0.03	8.6	6.8	24.8

Green = exceeds Canadian TEL, Blue = exceeds Canadian PEL, Yellow = exceeds Cefas AL1, Orange = exceeds Cefas AL2

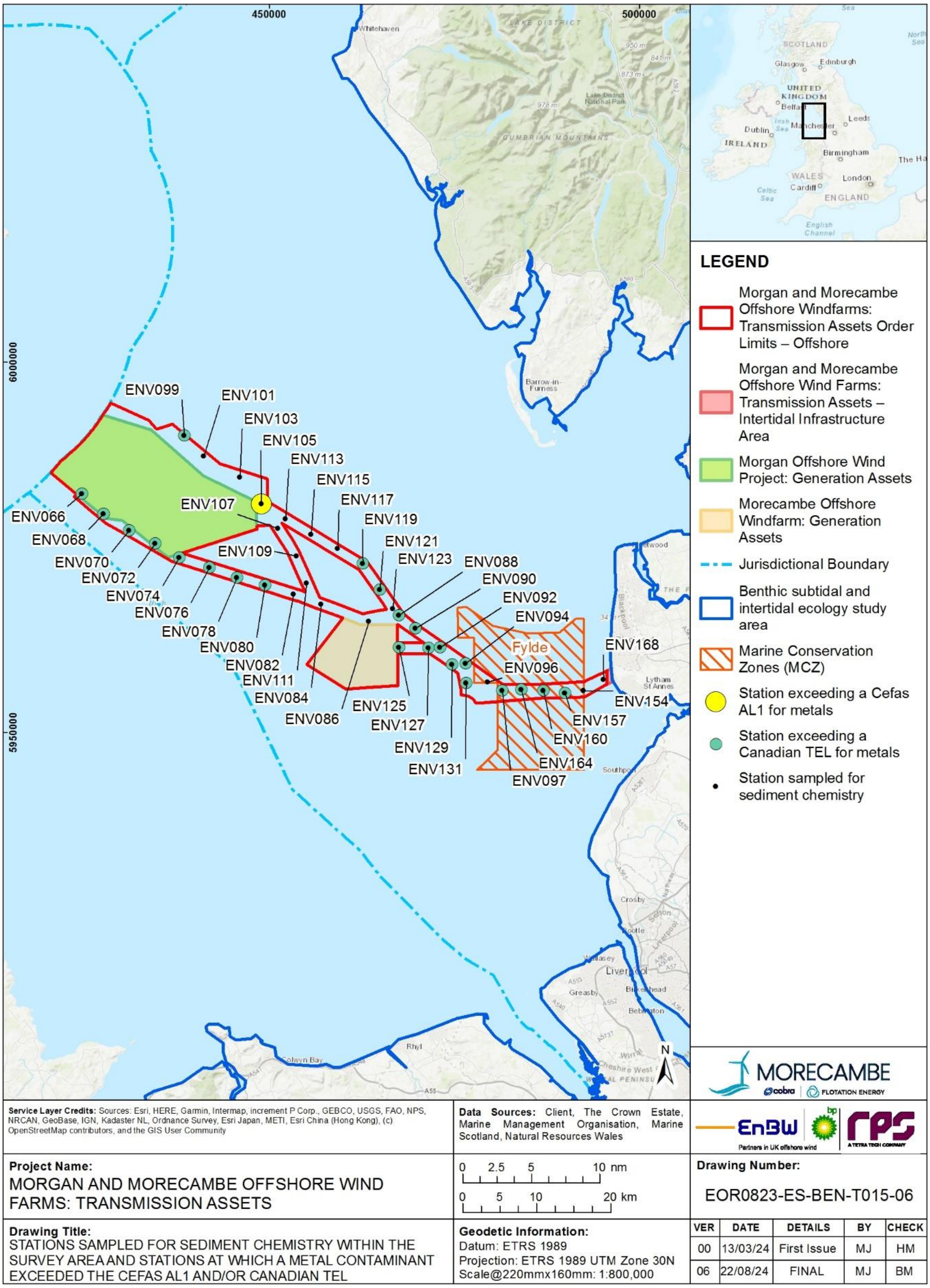


Figure 1.11: Stations sampled for sediment chemistry within the survey area and stations at which a metal contaminant exceeded the Cefas AL1 and/or Canadian TEL

Organotins

1.4.2.13 Organotin concentrations across the survey area were below the LOD at all sample stations.

Polychlorinated biphenyls

1.4.2.14 PCBs are toxic to aquatic organisms including benthic species, where contact with sediment can increase the risk of exposure. Reproductive and developmental problems have been observed in organisms 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. Due to their persistence and lipophilic nature, PCBs have the potential to bioaccumulate, particularly in lipid rich tissue. Bioaccumulation of PCBs is recorded in fish, birds and marine mammals with known to cause sublethal toxicological effects. Accumulation of PCBs in sediments therefore poses a potential hazard to sediment-dwelling organisms.

1.4.2.15 Of the 39 sites sampled (**Figure 1.8**), detectable levels of PCBs were only recorded in sediments at 13 stations, the majority of which were in the nearshore part of the survey area approaching the landfall. However, levels of PCBs, for all samples, were found to be below all available Cefas AL1s. The levels of the total ICES-7 PCBs were below the relevant Cefas AL1 threshold (0.01 mg/kg) at all stations, and total PCBs were below the Cefas AL1 (0.02 mg/kg) and Cefas AL2 (0.2 mg/kg) at all stations. The results are presented in full in **Appendix C.2**.

Polycyclic aromatic hydrocarbons

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

1.4.2.17 On the whole, levels of PAHs recorded in the sediment were low. Total PAH concentrations per station ranged from 0.024 mg/kg at ENV099 to 1.111 mg/kg at ENV125 (located within the centre of the Offshore Order Limits, directly east of the Morecambe Offshore Windfarm: Generation Assets). Within the central and nearshore parts of the survey area (i.e. to the east and south east of the Morecambe Offshore Windfarm: Generation Assets), sediment analysis at five sites (ENV088, ENV096, ENV097, ENV121 and ENV125) indicated levels of dibenzo[a,h]anthracene above the Canadian TEL (but below the Canadian PEL). The greatest concentration was recorded at ENV097 (located at the west boundary of the Fylde MCZ), with this site also displaying levels of acenaphthylene contamination above the Canadian

TEL. One site, ENV125, recorded concentrations above the Canadian TEL (but below the Canadian PEL) for acenaphthene, acenaphthylene, and dibenzo[a,h]anthracene. Levels of all individual PAHs were below the Cefas AL1 for individual PAHs (i.e. 0.1 mg/kg). The Cefas AL1 for dibenzo[ah]anthracene is lower at 0.01 mg/kg but concentrations in all samples were below this more conservative threshold with the exception of a single station ENV097 where levels of dibenzo[ah]anthracene (0.0164 mg/kg) marginally exceeded this threshold. Concentrations of individual PAHs were also well below their respective ERL values. The total PAHs per station were also below the ERL threshold for total PAHs of 4 mg/kg indicating that toxic effects to fauna by PAHs are unlikely. Full details of results are presented in **Appendix C.2**.

Infaunal analysis

Summary statistics

1.4.2.18 A total of 688 taxa were recorded during the site-specific surveys. Of these, 203 taxa were colonial or taxa whose abundance could not be enumerated, and therefore were recorded as present. These taxa were removed from the infaunal numerical and statistical analysis but were included in the epifaunal numerical analysis (**section 1.4.2**). A total of 29,085 individuals representing 485 enumerated taxa were recorded during the site-specific surveys. Of these, juveniles accounted for 685 individuals from 16 taxa representing 2.8% of the total number of individuals and 3.3% of the total number of taxa recorded. None of the enumerated taxa were bony fish.

1.4.2.19 Of the 485 total taxa enumerated from the site-specific survey data, none were observed at all stations. A total of 86 taxa (17.73%) were recorded as single individuals; these rarely recorded taxa were distributed across the survey area. A total of 253 taxa (52.17%) were represented by <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 and Warwick, 2006). The relatively high numbers of single and low abundance species recorded in this survey could suggest a reasonably diverse community that has been subjected to relatively low levels of disturbance or contamination.

1.4.2.20 Juveniles were recorded from stations across the survey area from taxa including Echinodermata, Mollusca, Arthropoda and Annelida. The five most abundant juvenile taxa were within the Echinodermata, Annelida, and Mollusca, specifically *Spatangoida* (448 individuals), *Ophiuroidea* (67 individuals), *Mytilidae* (46 individuals), *Aphroditidae* (33 individuals) and *Dendrochirotida* (19 individuals). Juveniles of these five taxa made up 89.5% of the total number of juvenile individuals.

1.4.2.21 No sites recorded all five of the most abundant juvenile taxa. Sample station ENV117 (located in the centre of the survey area) recorded the highest number of juvenile individuals (75, dominated by 72

Spatangoida, two *Aphroditidae*, and one *Ophiuroidea*), while station ENV102 (located in the offshore part of the survey area to the north east of the Morgan Offshore Wind Project: Generation Assets) had the highest number of individual taxa (five, composed of *Aphroditidae*, *Lucinoma borealis*, *Asteroidea*, *Spatangoida*, and *Ophiuroidea*, all with fewer than 10 individuals).

1.4.2.22 The survey recorded 203 taxa as being present that were either colonial or unable to be enumerated, with these dominated by Annelida (45.60%), Arthropoda (18.70%), and Bryozoa (16.30%) individual taxa. Of the present taxa, Copepoda were present across the greatest number of sample stations (37 out of 77). ENV067 recorded the highest number of individual taxa (29).

1.4.2.23 The dataset was divided into the five major taxonomic groups: Annelida (Polychaeta), Arthropoda, Mollusca, Echinodermata and 'Others'. The 'Others' category comprised of the following.

- Nine taxa of Annelida (other) including *Sipuncula*, *Golfingiidae*, *Golfingia* (*Golfingia*) *elongata*, *Golfingia* (*Golfingia*) *vulgaris vulgaris*, *Nephasoma* (*Nephasoma*) *minutum*, *Thysanocardia procera*, *Phascolion* (*Phascolion*) *strombus strombus*, *Grania* and *Naididae.*
- Five taxa of *Chordata* (*Branchiostoma lanceolatum*, *Ascidiacea*, *Polycarpa fibrosa*, *Dendrodoa grossularia* and *Molgula*).
- Three taxa of *Cnidaria* (*Actiniaria*, *Edwardsia claperedii* and *Cerianthus lloydii*).
- One taxa of Arthropod (other) (*Nymphon brevirostre*).
- One taxa of Hemichordata.
- One taxa of Nemertea.
- One taxa of Phoronida (*Phoronis*).
- One taxa of Platyhelminthes.
- One taxa of Priapulida (*Priapulus caudatus*).

1.4.2.24 The absolute and proportional contributions of the five main taxonomic groups to the overall community structure is summarised in **Table 1.5** whilst biomass values by gross taxonomic groups are presented in **Appendix A**.

Table 1.5: Contribution of gross taxonomic groups recorded in the infaunal grab samples

Group	Individuals		Taxa	
	Abundance	Proportional contribution (%)	Abundance	Proportional contribution (%)
Annelida	11,840	40.71	213	43.92
Mollusca	8,243	28.34	99	20.41
Echinodermata	4,798	16.50	32	6.60
Arthropoda	2,098	7.21	118	24.33
Other	2,106	7.24	23	4.74
Total	29,085	100.00	485	100.00

1.4.2.25 The faunal communities were generally dominated by Annelida (n=11,840) and Mollusca (n=8,243) which contributed 40.71% and 28.34% of the total number of individuals respectively. Number of taxa were also dominated by Annelida which contributed 43.92% of the total number of taxa. At individual sample stations, gross taxonomic group proportions broadly reflected these results, with Annelida and Mollusca comprising the highest proportions of the taxa at all sample stations, with 62.34% of stations being dominated by Annelida, and 37.66% being dominated by Mollusca.

1.4.2.26 The biomass data indicated a more complex distribution, with the biomass of 44.4% of stations being dominated by echinoderms, and 40.28% being dominated by molluscs, compared to 12.50% for annelids. This is likely linked to typical body size of the taxa present, with Echinodermata and Mollusca species likely to have a higher weight per individual than Annelida. At the station with the highest biomass overall (ENV166, in the nearshore part of the survey area), 88.70% of the biomass was dominated by Mollusca, with the prickly cockle *Acanthocardia echinata* representing 65.52% of the biomass recorded at this station. The stations with next three highest recorded biomass (ENV103, ENV096 and ENV132, in descending order) were similarly dominated by Mollusca, with *A. echinata* comprising a high percentage of the biomass at these stations. The highest biomass station not dominated by Mollusca was ENV098, which was dominated by Echinodermata (89.17% of all biomass recorded at this station), with the brittlestar *O. fragilis* accounting for 87.96% of the overall biomass for this station.

1.4.2.27 The most abundant individual taxa was the mollusc *K. bidentata*, with 4,467 individuals recorded in total throughout the survey area. Station

ENV117 (located in the centre of the survey area, to the north of the Morecambe Offshore Windfarm: Generation Assets) recorded the highest abundance of this species with 400 individuals. The species with the second highest abundance was the brittlestar *A. filiformis*, with a total of 3,367 individuals recorded across all stations, and occurring in highest abundance at station ENV093, with 292 individuals recorded. The third most abundant species present was the polychaete *L. koreni*, with 2,735 individuals present overall.

Multivariate community analysis

1.4.2.28 The results of the cluster analyses, SIMPROF tests and SIMPER analyses were used, together with the raw untransformed infaunal data from the grab samples, to assign infaunal biotopes to each sample station. 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 groups could be explained by differences in abundances of characterising species rather than the presence/absence of key species.

1.4.2.29 The results of the hierarchical clusters analysis of the square root transformed infaunal dataset (including juveniles) together with the SIMPROF test identified 24 faunal groups that were statistically dissimilar, based on the SIMPROF test. Of these faunal groups, six groupings were represented by a single sample station (**Figure 1.12**). The 2D MDS plot is presented in **Figure 1.13** and the low stress value (0.16) indicates that this is a good representation of the data. The 3D MDS plot has not been presented as the 2D MDS plot presents a clearer representation of the data. All faunal groupings are presented in **Table 1.6**, together with the assigned biotopes and key characterising infaunal taxa.

1.4.2.30 Faunal group A exhibited the greatest distance between itself as a distinct grouping and all other faunal groups, with an average similarity of approximately 10% between this and other groups (**Figure 1.12**). The groups containing individual stations were faunal groups C (ENV073), H (ENV100), O (ENV091), P (ENV090), Q (ENV125) and V (ENV157). Faunal group A (SIMPROF a) showed the lowest Bray-Curtis similarity of 34.48%, while faunal group W (SIMPROF w) showed the highest Bray-Curtis similarity (71.67%) of all faunal groups that contained more than one sample station (**Table 1.6**).

1.4.2.31 Faunal groups S and R showed the lowest Bray-Curtis dissimilarity (43.90%; i.e. were statistically most similar in terms of species composition), while faunal groups A and O showed the highest dissimilarity (98.2%). Six groupings showed greater similarity to each other than with other faunal groups, with Bray-Curtis dissimilarity below 50%. Specifically, these groups were faunal groups T and S (49.93% dissimilarity), faunal groups W and U (49.69%), faunal groups T and R (47.47%), faunal groups V and W (45.17%) and faunal groups S and R (43.90%). These relatively similar communities being grouped separately likely indicate transitional boundaries between biotopes, or specific local conditions.

1.4.2.32 Samples from stations located offshore within the north of the Offshore Order Limits, to the north and south east of the Morgan Offshore Wind Project: Generation Assets, typically clustered together and included faunal groups I, J, K, L, M, N, and X (**Table 1.6**). The sand and muddy sand sediments broadly characterising these stations were dominated by the polychaetes *L. koreni*, *S. inflatum* and *S. limicola* and bivalves including *P. pellucidus*, *K. bidentata* and *A. alba*. Samples associated with these faunal groups were assigned the biotope SS.SMu.CSaMu.LkorPpel. Samples associated with faunal group X were typically located closer to shore, to the east of the Morecambe Offshore Windfarm: Generation Assets, than the other faunal groups but were assigned the same biotope due to underlying sandy sediments.

1.4.2.33 Samples from stations located offshore in the north west of the Offshore Order Limits, to the south west of the Morgan Offshore Wind Project: Generation Assets, clustered together and included faunal groups B, C, D and E (**Table 1.6**). The sediments associated with samples locations in these faunal groupings were characterised by mixed and coarse sediments. The communities associated with samples in faunal group E were characterised by the presence of *Nemertea*, polychaetes including *Lysidice unicornis* and *Syllis armillaris*, alongside a diverse assemblage of other low abundance polychaete species. Samples within faunal group E were classified as the SS.SMx.OMx.PoVen biotope.

1.4.2.34 The single station associated with faunal group C had a more diverse bivalve and polychaete community, being dominated by *Anomiidae* and *S. triqueter*. However, this site was also assigned the SS.SMx.OMx.PoVen biotope based on consideration of the species list broadly matching this biotope in low abundances, and all surrounding stations within the survey area and within the Morgan Offshore Wind Project: Generation Assets also being composed of this biotope, with no distinct features allowing classification as a different biotope.

1.4.2.35 Within faunal groups B and D, within the survey area immediately to the south east of the Morgan Offshore Wind Project: Generation Assets, a range of polychaete species were also present, but the presence and abundance of the bivalve *K. bidentata* and associated amphipod community on the slightly shallower mixed to coarse muddy sediments allowed these to be classified as the SS.SMx.CMx.KurThyMx biotope.

1.4.2.36 Samples collected from stations locations distributed across the central section of the survey area, to the north east and east of the Morecambe Offshore Windfarm: Generation Assets, clustered together, including faunal groups O, P, R, S and T (**Table 1.6**). The sediments within this area comprised muds and sandy muds, with an increase in fine and mud sediment percentages moving closer to the shore. These sites were characterised by high abundances of the brittlestar *A. filiformis* and the bivalve mollusc *K. bidentata*, typically with associated bivalve taxa and the polychaete *Pholoe baltica*, and *Phoronis* spp. These communities were considered to be representative of the

SS.SMu.CSaMu.AfilKurAnit biotope. Whilst this biotope is typically found in depths greater than 50 m, and all the stations in including faunal groups O, P, R, S and T were within a depth range of only 15-32 m, the communities present were considered to be best represented by this biotope, although it is noted that this is not a perfect fit.

1.4.2.37 Samples approaching the landfall, in the east of the survey area and to the east of the Morecambe Offshore Windfarm: Generation Assets, typically clustered together and included faunal groups Q, U, V and W (**Table 1.6**). The communities associated with faunal groups F and G also demonstrated similarity with the communities associated with faunal groups Q, U, V and W. The sediments in this area varied between sands and muddy sands, and muds and sandy muds, with a higher proportion of sand associated with samples located within approximately 20 km of the landfall, as demonstrated by groups F and G. Faunal groups Q, V and W were dominated by, or had a relatively high abundance of the bivalve molluscs *A. alba, Abra* spp. and *N. nitidosa*, with associated diverse polychaete and bivalve communities. Sample stations associated with these faunal groups were therefore assigned the SS.SSa.CMuSa.AalbNuc biotope.

1.4.2.38 Faunal group U, which encompassed sample stations ENV162, ENV164 and ENV166 within approximately 15 km of the landfall, similarly had communities which included *Abra* sp. and *N. nitidosa*, but in lower proportions than in other similar groupings such as Q, V and W, and with higher abundances of *K. bidentata* and *A. filiformis*, which would match more closely with the SS.SMu.CSaMu.AfilKurAnit biotope. However, an examination of dissimilarity values indicated this faunal group was approximately evenly dissimilar to group W (49.69% dissimilar to SS.SSa.CMuSa.AalbNuc) and group T (57.4% dissimilar to SS.SMu.CSaMu.AfilKurAnit). This may indicate a transition boundary between biotopes or a change in underlying sediment. This was further analysed by site, with ENV162 and ENV164 to the west being classified as SS.SSa.CMuSa.AalbNuc due to higher abundances of *Abra* species and the presence of *Phaxas* sp., while ENV166 to the east was designated as SS.SMu.CSaMu.AfilKurAnit based on the higher abundance of *K. bidentata*, and the absence of *Phaxas* spp.

1.4.2.39 Faunal groups F (ENV167 and ENV168) and G (ENV154 and ENV156) contained samples from the most inshore stations sampled and the associated communities showed some resemblance to the SS.SSa.CMuSa.AalbNuc biotope. This was due to the presence of amphipods including *Abludomelita obtusata*, *Aora gracilis* and *Microprotopus maculatus* in the expected 10 m depth and sand and muddy sand sediments typical of this biotope. However, these stations lacked the *Abra alba* or other characterising species of this biotope. Also, overall broad diversity at all stations in these groups, and specifically the communities at ENV168 and ENV154 stations, showed a dominance of polychaete species such as *Magelona johnstoni*, *S. bombyx* with *L. conchilega* which are not characteristic of the SS.SSa.CMuSa.AalbNuc biotope. Therefore, the species were not a clear match for any other specifically identified biotopes, and both faunal groups were instead classified as the higher level infralittoral fine sand (SS.SSa.IFiSa) biotope, with this supported by the DDV at these stations.

1.4.2.40 Faunal group A comprised a pair of samples (ENV080 and ENV081) and faunal group H comprised a single sample (ENV100), which were both listed as statistically distinct faunal groupings. However, both sites had a high proportion of sand with differing levels of gravel and fines, and the associated communities were characterised by high abundances of the pea urchin *Echinocyamus pusillus*, the polychaete *N. cirrosa* and the bivalve *Asbjornsenia pygmaea*. The communities at these stations were therefore considered to be representative of the SS.SSa.CFiSa.EpusOborApri biotope. The communities associated with samples in faunal group H were characterised by *L. koreni* and *Grania* spp., which are not typically found in this biotope and are absent in group A, but not in high enough abundances for these groupings to be considered separate biotopes.

1.4.2.41 The faunal groups identified in the SIMPER analysis were used together with the raw data to assign seven infaunal biotopes (**Table 1.6** and **Table 1.7**; **Figure 1.14**).

Table 1.6: Simprof groups and biotope classifications for the infaunal dataset

Faunal group	Station	Depth range (m)	Simplified Folk classification	Characterising infaunal taxa from SIMPER analysis	Biotope	Comments
A	ENV080, ENV081	37-38	Sand and muddy sand	*Asbjornsenia pygmaea, Echinocyamus pusillus, Nephtys cirrosa*	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri)	Typical sediment and depth, presence of *Echinocyamus pusillus*, *Nephtys cirrosa* and *Asbjornsenia pygmaea* as expected. Biotope also recorded elsewhere in north Irish Sea.
B	ENV079, ENV098	37-38	Mixed sediment	*Scalibregma inflatum, Kurtiella bidentata, Echinocyamus pusillus, Sthenelais limicola, Abra*	*Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.KurThyMx)	Biotope has been noted in the study area previously, *Scalibregma inflatum* and *Kurtiella bidentata* present in higher abundances, and *Abra* found in typical abundance.
C	ENV073	40	Coarse sediment	*Anomiidae, Spirobranchus triqueter, Echinocyamus pusillus, Serpulidae, Grania, Owenia*	Polychaete-rich deep *Venus* community in offshore mixed sediments (SS.SMx.OMx.PoVen)	Typical 30-50 m depth in gravel with coarse to medium sand, with associated *Spirobranchus triqueter*, *Echinocyamus pusillus*, *Ampelisca spinipes* and *Owenia.*
D	ENV075, ENV076, ENV077, ENV078	37-39	Mixed and coarse sediment	*Echinocyamus pusillus, Paradoneis lyra, Nemertea, Kurtiella bidentata, Scalibregma inflatum, Phoronis, Ampelisca, Owenia*	*Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.KurThyMx)	Muddy sand and gravel in 30-50 m depth range, has been noted nearby previously. *Scalibregma inflatum* and *Kurtiella bidentata* present in only slightly higher abundances than typical, with associated *Ampelisca* and *Owenia* community.

Faunal group	Station	Depth range (m)	Simplified Folk classification	Characterising infaunal taxa from SIMPER analysis	Biotope	Comments
E	ENV066, ENV067, ENV068, ENV069, ENV070, ENV071, ENV072, ENV074	37-47	Mixed and coarse sediment	*Nemertea, Lysidice unicornis, Syllis armillaris, Cirrophorus branchiatus, Sphaerosyllis hystrix*	Polychaete-rich deep *Venus* community in offshore mixed sediments (SS.SMx.OMx.PoVen)	Typical depth range and gravelly sand and muddy mixed sediment, diverse assemblage of polychaetes, nemerteans, and syllidae species matching expected description.
F	ENV167, ENV168	9-10	Sand and muddy sand	*Magelona johnstoni, Glycera tridactyla, Magelona filiformis, Donax vittatus, Mytilidae*	Infralittoral fine sand (SS.SSa.IFiSa)	Diverse community in sand and muddy sand, with no distinct match to specific biotopes, therefore classified as SS.SSa.IFiSa.
G	ENV154, ENV156	8-12	Sand and muddy sand	*Nemertea, Magelona filiformis, Glycera tridactyla, Magelona johnstoni, Pseudocuma (Pseudocuma) longicorne, Mactra stultorum, Perioculodes longimanus, Kurtiella bidentata*	Infralittoral fine sand (SS.SSa.IFiSa)	Diverse community in sand and muddy sand, with no distinct match to specific biotopes, therefore classified as SS.SSa.IFiSa.
H	ENV100	40	Mixed sediment	*Echinocyamus pusillus, Sthenelais limicola, Lagis koreni, Abra, Tanaissus danica, Grania*	*Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri)	Medium to fine sand, presence *of Echinocyamus pusillus*, *Nephtys cirrosa*, and *Asbjornsenia pygmaea*, and this same biotope has been found slightly further north in similar conditions in the east Irish Sea.

Faunal group	Station	Depth range (m)	Simplified Folk classification	Characterising infaunal taxa from SIMPER analysis	Biotope	Comments
I	ENV082, ENV110, ENV111	33-36	Sand and muddy sand	*Lagis koreni, Scalibregma inflatum, Sthenelais limicola, Spatangoida, Kurtiella bidentata, Scoloplos armiger*	*Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel)	Depth range and sediment properties typical of this biotope, dominated by *Lagis koreni* with associated *Scalibregma inflatum*, *Kurtiella bidentata* and *Abra alba* in proportions typical of this biotope.
J	ENV099, ENV101, ENV102	35-49	Sand and muddy sand	*Lagis koreni, Scalibregma inflatum, Sthenelais limicola*	*Lagis koreni and Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel)	Physical conditions broadly match I, with similar biota, with notable lack of *Phaxas pellucidus*, suggesting this is a local variant of the broader biotope.
K	ENV085, ENV116	28-29	Mud and sandy mud	*Kurtiella bidentata, Sthenelais limicola, Lagis koreni, Amphiura filiformis, Scalibregma inflatum, Spatangoida*	*Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel)	Physical conditions as typical for this biotope in 20-30 m range, with sandy mud sediment. Similar biota to I and J, with lack of *Phaxas pellucidus* suggesting this is again a local variation on the biotope.
L	ENV104, ENV113, ENV114, ENV115	30-35	Sand and muddy sand	*Spatangoida, Sthenelais limicola, Lagis koreni, Phoronis, Tellimya ferruginosa, Nucula nitidosa, Cardiidae*	*Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel)	Physical and sediment conditions similar biota to nearby faunal groups, with difference of being dominated by reasonably mobile *Spatangoida*, with polychaete community typical of this biotope present here.

Faunal group	Station	Depth range (m)	Simplified Folk classification	Characterising infaunal taxa from SIMPER analysis	Biotope	Comments
M	ENV083, ENV084, ENV112	32-33	Sand and muddy sand	*Sthenelais limicola, Spatangoida, Lagis koreni, Scoloplos armiger, Poecilochaetus serpens, Bathyporeia*	*Lagis koreni and Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel)	Physical and sediment typical of this biotope in 30-50 m depth range. Dominated by polychaetes (many not on typical list, indicating potential transition to different biotope) and mobile *Spatangoida*, but species list matches many typical of for *Lagis* biotope.
N	ENV103, ENV105, ENV106, ENV107, ENV108, ENV109	31-35	Sand and muddy sand	*Bathyporeia, Sthenelais limicola, Lagis koreni, Echinocyamus pusillus, Spatangoida, Pharidae, Magelona filiformis*	*Lagis koreni and Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel)	Depth and sediment, with characterising species, and associated polychaetes and bivalves including *Kurtiella bidentata* typical of this biotope. Lack of *Phaxas pellucidus* suggests this is a local variation of this biotope.
O	ENV091	20	Mud and sandy mud	*Amphiura filiformis, Kurtiella bidentata, Pholoe baltica, Nucula nitidosa, Priapulus caudatus*	*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	Typical depth and sediment, with *Amphiura filiformis* and *Kurtiella bidentata*, and many other species typical of this biotope.
P	ENV090	19	Mud and sandy mud	*Nucula, Scalibregma inflatum, Kurtiella bidentata, Sthenelais limicola, Lumbrineris aniara*	*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	Typical depth and sediment, with *Amphiura filiformis* and *Kurtiella bidentata*, and many other species typical of this biotope.

Faunal group	Station	Depth range (m)	Simplified Folk classification	Characterising infaunal taxa from SIMPER analysis	Biotope	Comments
Q	ENV125	28	Mud and sandy mud	*Abra, Hyala vitrea, Phoronis, Magelona minuta, Nucula hanleyi*	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc)	Broadly matches sediment and depth 20-30 m, with close alignment of species for this biotope, likely listed as distinct due to high abundance of *Hyala vitrea* gastropods which are not present in any other sites.
R	ENV123, ENV127, ENV128, ENV130, ENV131, ENV132	17-20	Mud and sandy mud	*Amphiura filiformis, Kurtiella bidentata, Pholoe baltica, Phoronis, Lumbrineris aniara*	*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	*Amphiura filiformis*, *Kurtiella bidentata*, and *Pholoe baltica* all present, although in higher abundance than expected in biotope, and full species list also has multiple overlaps. Shallower than typical of this biotope but confirmed from surveys nearby.
S	ENV087, ENV089, ENV092, ENV093, ENV095, ENV096, ENV097, ENV126	15-22	Sand and muddy sand	*Amphiura filiformis, Kurtiella bidentata, Pholoe baltica*	*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	*Amphiura filiformis*, *Kurtiella bidentata*, and *Pholoe baltica* all present, although in higher abundance than expected in biotope, and full species list also has multiple overlaps. Shallower than typical of this biotope but confirmed from surveys nearby.
T	ENV086, ENV088, ENV117, ENV118, ENV119, ENV120, ENV121, ENV122	22-32	Mud and sandy mud	*Amphiura filiformis, Kurtiella bidentata, Pholoe baltica, Phoronis, Callianassa subterranea, Hyala vitrea*	*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit)	*Amphiura filiformis*, *Kurtiella bidentata*, and *Pholoe baltica* all present, although in higher abundance than expected in biotope, and full species list also has multiple overlaps. Shallower than typical of this biotope but confirmed from surveys nearby.

Faunal group	Station	Depth range (m)	Simplified Folk classification	Characterising infaunal taxa from SIMPER analysis	Biotope	Comments
U	ENV162, ENV164, ENV166	14-22	Sand and muddy sand	*Kurtiella bidentata, Varicorbula gibba, Nucula nitidosa, Amphiura filiformis, Lumbrineris aniara, Pholoe baltica, Phoronis*	*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit) and *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc)	Station-specific examination of data indicated the presence of both biotopes, with ENV162 and ENV164 communities typical of SS.SSa.CMuSa.AalbNuc and ENV166 typical of SS.SMu.CSaMu.AfilKurAnit .
V	ENV157	12-14	Mud and sandy mud	*Phoronis, Chaetozone christiei, Nemertea, Abra alba, Edwardsia claparedii, Pholoe baltica, Lagis koreni, Amphiuridae*	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc)	Typical 10-20 m depth range with muddy sands and gravel. *Abra* and *Nucula* present, with associated *Chaetozone*, *Phoronis*, amphipod, and echinoderm communities present.
W	ENV158, ENV160	17-19	Sand and muddy sand	*Kurtiella bidentata, Lagis koreni, Amphiuridae, Varicorbula gibba, Edwardsia claparedii, Nucula nitidosa, Abra alba*	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc)	Typical 10-20 m depth range with muddy sands and gravel. *Abra* and *Nucula* present, with associated *Phoronis*, amphipod, and echinoderm communities present.
X	ENV094, ENV124, ENV129	15-16	Sand and muddy sand	*Lagis koreni, Scalibregma inflatum, Abra, Kurtiella bidentata, Varicorbula gibba*	*Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel)	Present in 10-20 m range in sandy mud conditions, with diverse range of characterising biota present (*Lagis*, *Scalibregma*, Nemertea, *Pholoe baltica*).

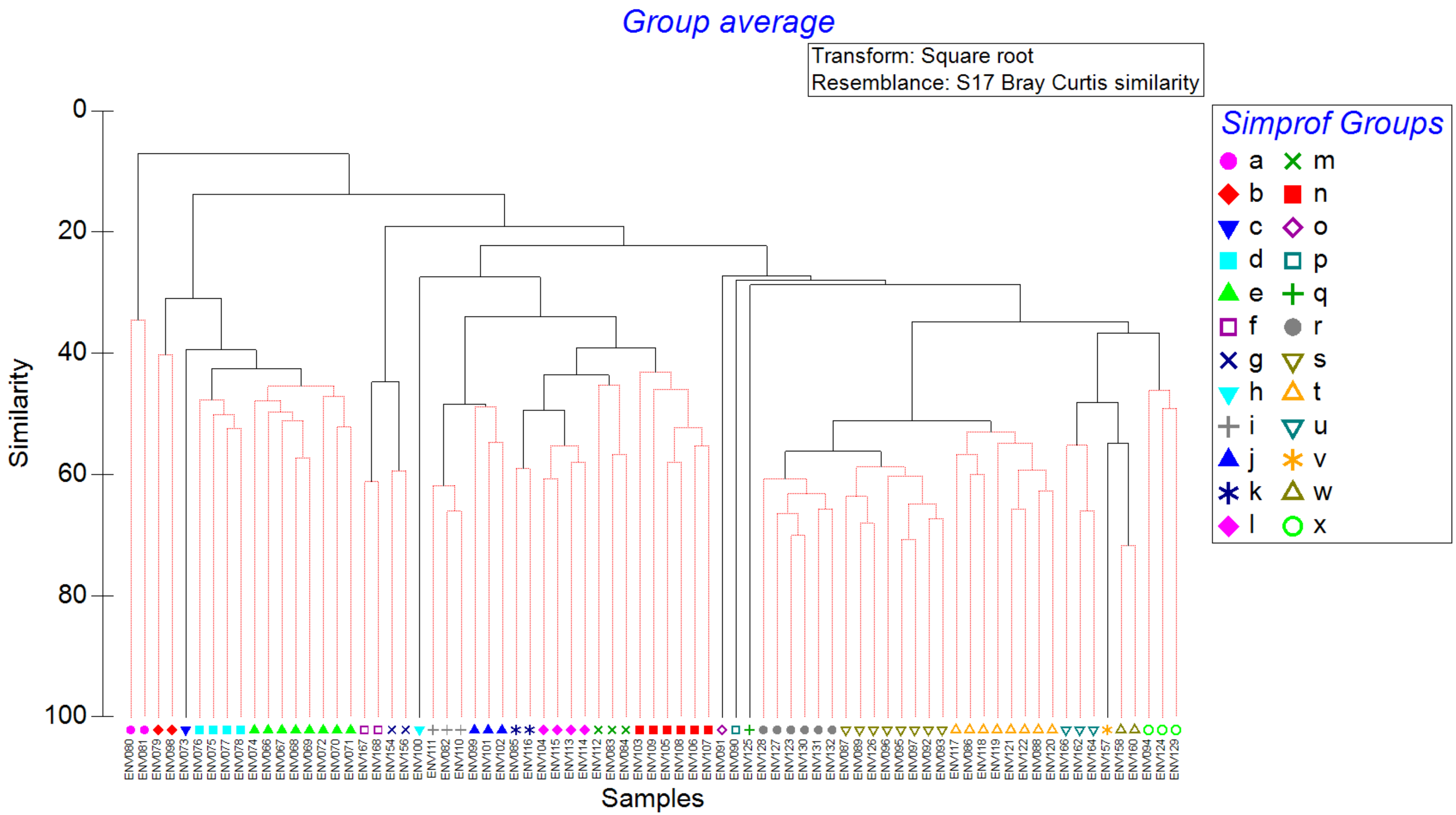


Figure 1.12: Dendrogram of infaunal communities from benthic grab samples

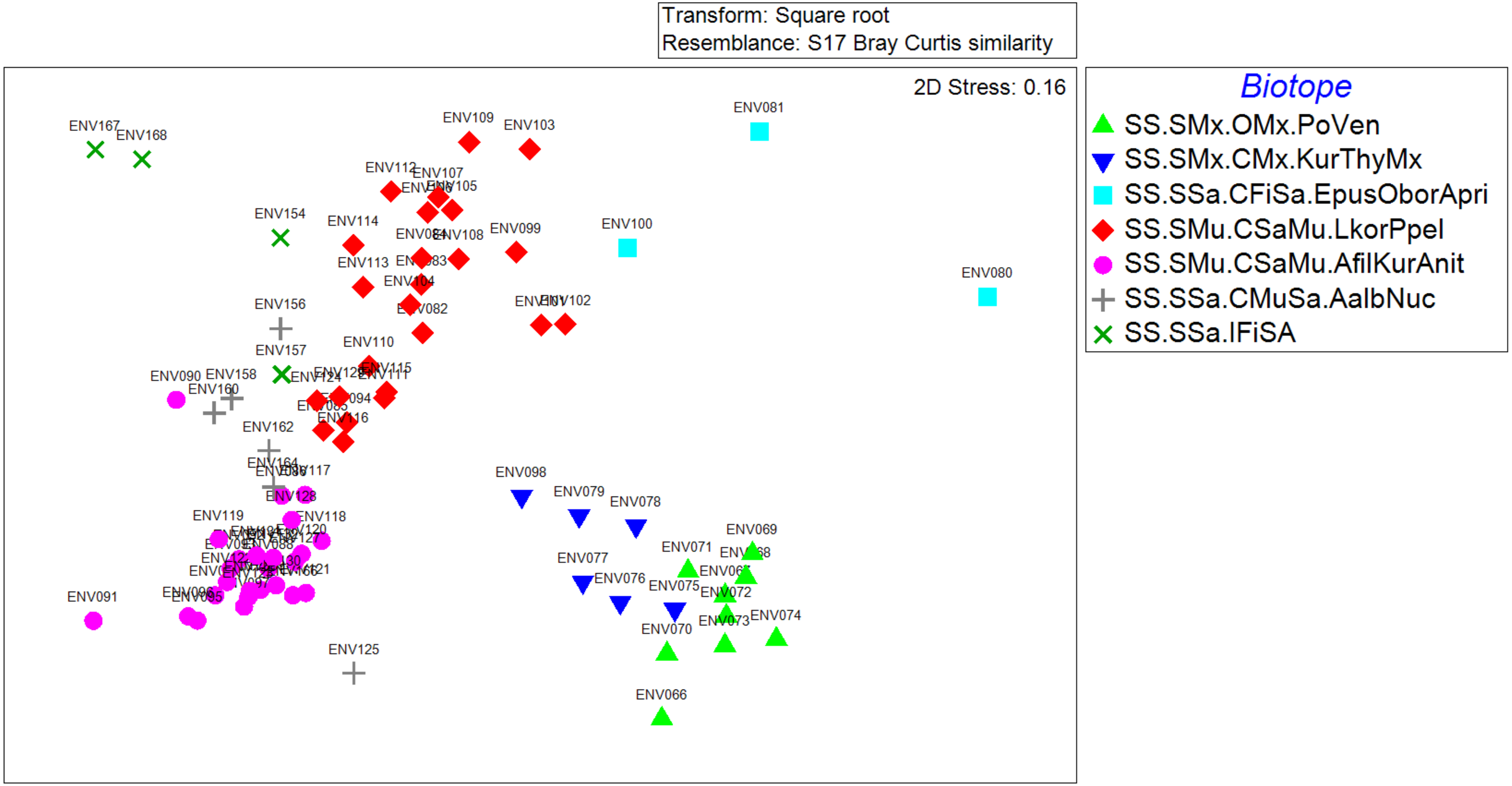


Figure 1.13: 2D MDS plot of infaunal communities from grab samples

Table 1.7: Summary of infaunal biotopes identified from grab samples

Infaunal biotope	Grab sample stations	Water depth range (m)	Sediment classification (Folk)	Characterising species	Geographic location
SS.SMu.CSaMu.AfilKurAnit	ENV086, ENV087, ENV088, ENV089, ENV090, ENV091, ENV092, ENV093 ENV095, ENV096, ENV097, ENV117, ENV118, ENV119, ENV120, ENV121, ENV122, ENV123, ENV126, ENV127, ENV128, ENV130, ENV131, ENV132, ENV166	15-32	Sand and muddy sand, and mud and sandy mud	*Amphiura filiformis, Kurtiella bidentata, Pholoe baltica, Nucula nitidosa, Scalibregma inflatum, Sthenelais limicola, Lumbrineris aniara, Phoronis*	East of the survey area, north east and east of the Morecambe Offshore Windfarm: Generation Assets.
SS.SMu.CSaMu.LkorPpel	ENV082, ENV083, ENV085, ENV094, ENV099, ENV101 ENV102, ENV103, ENV104, ENV105, ENV106, ENV107, ENV108, ENV109, ENV110, ENV111, ENV112, ENV113, ENV114, ENV115, ENV116, ENV124, ENV129	15-49	Sand and muddy sand, mud and sandy mud, and fine to medium sand	*Lagis koreni, Scalibregma inflatum, Sthenelais limicola, Spatangoida, Kurtiella bidentata, Scoloplos armiger, Amphiura filiformis, Spatangoida Phoronis, Tellimya ferruginosa, Nucula nitidosa, Cardiidae*	East and south east of Morgan Offshore Wind Project: Generation Assets, extending south to Morecambe Offshore Windfarm: Generation Assets, with separate individual stations on disturbed sediment in south of survey area.
SS.SMx.OMx.PoVen	ENV066, ENV067, ENV068, ENV069, ENV070, ENV071, ENV072, ENV073, ENV074	37-47	Sand and muddy sand to coarse and mixed sediment	*Nemertea, Lysidice unicornis, Syllis armillaris, Cirrophorus branchiatus, Sphaerosyllis hystrix*	West of the survey area along the west boundary of Morgan Offshore Wind Project: Generation Assets.

Infaunal biotope	Grab sample stations	Water depth range (m)	Sediment classification (Folk)	Characterising species	Geographic location
SS.SSa.CMuSa.AalbNuc	ENV125, ENV157, ENV158, ENV160, ENV162, ENV164,	12-28	Sand and muddy sand, and mud and sandy mud	*Abra alba, Nemertea, Hyala vitrea, Phoronis, Magelona minuta, Nucula hanleyi, Phoronis, Chaetozone christiei, Edwardsia claparedii, Lagis koreni, Amphiuridae Kurtiella bidentata, Amphiuridae, Nucula nitidosa*	Nearshore east in survey area.
SS.SMx.CMx.KurThyMx	ENV075, ENV076, ENV077, ENV078, ENV079, ENV098	37-39	Mixed to coarse sediment	*Scalibregma inflatum, Kurtiella bidentata, Echinocyamus pusillus, Sthenelais limicola, Abra, Paradoneis lyra, Nemertea, Phoronis, Ampelisca, Owenia*	South east of Morgan Offshore Wind Project: Generation Assets, with one station far north east on similar sediment.
SS.SSa.CFiSa.EpusOborApri	ENV080, ENV081, ENV100	37-40	Mixed sediment to sand and muddy sand	*Asbjornsenia pygmaea, Echinocyamus pusillus, Nephtys cirrosa, Sthenelais limicola, Lagis koreni, Abra, Tanaissus danica, Grania*	North west of Morecambe Offshore Windfarm: Generation Assets and north east of Morgan Offshore Wind Project: Generation Assets.
SS.SSa.IFiSa	ENV154, ENV156, ENV167, ENV168	8-12	Sand and muddy sand	*Magelona johnstoni, Pseudocuma (Pseudocuma) longicorne, Nemertea, Glycera tridactyla, Lanice conchilega*	Within 10 km of the landfall in the nearshore

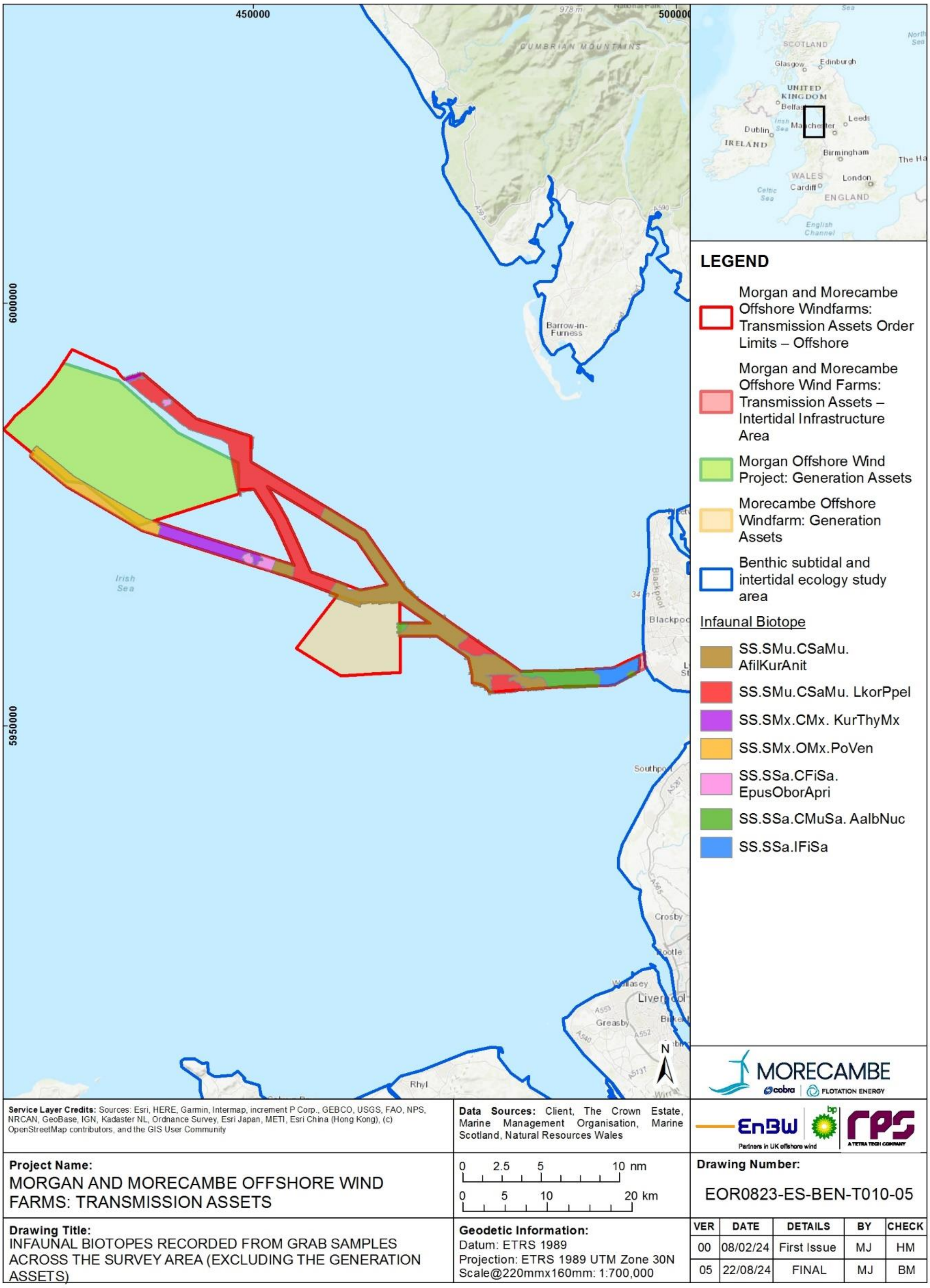


Figure 1.14: Infaunal biotopes recorded from grab samples across the survey area (excluding the Generation Assets)

Univariate analysis

1.4.2.42 The following univariate statistics were calculated for each benthic infaunal grab sample station: number of species/taxa present (S), abundance (N), wet weight 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 infaunal biotopes identified from the infaunal data and these are summarised in **Table 1.8** with univariate statistics for individual sites presented in **Appendix C.5**.

Table 1.8: Mean (± standard deviation) univariate statistics for the infaunal biotopes

Biotope	S	N	Biomass (g)	d	J'	H'	λ
SS.SMu.CSaMu.AfilKurAnit	5.34±2.9	11.11±3.76	23.93±24.65	1.72±1.01	0.78±0.24	1.28±0.62	0.66±0.25
SS.SMu.CSaMu.LkorPpel	8.78±4.2	13.39±5.53	12.09±19.67	2.93±1.19	0.94±0.06	1.95±0.55	0.89±0.11
SS.SMx.OMx.PoVen	25.11±6.01	50.56±10.55	12.61±16.41	6.13±2.14	0.94±0.01	3.01±0.26	0.96±0.01
SS.SSa.CMuSa.AalbNuc	3.33±1.63	9.17±2.04	15.14±16.75	1.02±0.64	0.59±0.3	0.78±0.48	0.45±0.25
SS.SMx.CMx.KurThyMx	20±1.79	37.17±3.87	13.36±20.19	5.27±0.51	0.95±0.01	2.84±0.1	0.96±0.01
SS.SSa.CFiSa.EpusOborApri	21±6.08	33.33±11.37	0.48±0.43	5.68±1.22	0.97±0.01	2.94±0.25	0.97±0.01
SS.SSa.IFiSa	4.25±1.5	8±2.16	7.92±9.41	1.52±0.55	0.79±0.09	1.12±0.37	0.66±0.15

1.4.2.43 The SS.SMu.CSaMu.AfilKurAnit had the highest biomass (23.93±24.65 g wet weight), while SS.SMx.OMx.PoVen had the highest number of species (25.11±6.01) and had the highest mean number of taxa (50.56±10.55). The SS.SSa.IFiSa biotope was associated with the lowest mean number of taxa (4.25±1.5). After the SS.SMx.OMx.PoVen (50.56±10.55) biotope, the next highest mean number of individuals were associated with the SS.SMx.CMx.KurThyMx (37.17±3.87) and SS.SSa.CFiSa.EpusOborApri (33.33±11.37) biotopes, which was expected due to the high number of taxa in these biotopes. The most common biotopes - SS.SMu.CSaMu.AfilKurAnit, which was assigned to 26 stations, and SS.SMu.CSaMu.LkorPpel which was assigned to 23 stations – were relatively species poor, with a mean number of taxa of 5.34±2.9 and 8.78±4.2 taxa respectively. These biotopes also recorded low mean abundances.

1.4.2.44 The highest mean diversity score of all the identified communities was associated with the biotope SS.SMx.OMx.PoVen (d=6.13±2.14, H'=3.01±0.26), which was expected as this biotope had the highest number of taxa. The SS.SSa.CFiSa.EpusOborApri biotope had the second highest mean diversity score (d=5.68±1.22, H'=2.94±0.25). The lowest diversity recorded was associated with the SS.SSa.CMuSa.AalbNuc biotope (d=1.02±0.64, H'=0.78±0.48), which is expected of a muddy environment with potentially low oxygen penetration through the sediment. Overall, the mixed sediment and sandy biotopes had higher mean diversity indices than the muddy sediments, which is expected due to the greater habitat diversity/complexity present in mixed sediments compared to mud environments, which are capable of supporting a higher number of species.

1.4.2.45 Pielou's evenness scores (J') and the Simpson's index of Dominance (λ) scores were similar across the majority of biotopes, with ranges of 0.94-0.97 for four of the identified biotopes for J', with the highest in the SS.SSa.CFiSa.EpusOborApri biotope. This indicated an even distribution of abundances among taxa and that this biotope was not dominated by a high number of individuals within a small number of species. Values of J' were lowest in the muddy and sand sediment biotopes, with SS.SMu.CSaMu.AfilKurAnit having the second lowest (0.78±0.24), and SS.SSa.CMuSa.AalbNuc (0.59±0.3) having the lowest value, suggesting slight dominance by a small number of species within these relatively low abundance biotopes. The distribution of λ values followed the same pattern, with values clustered between 0.88-0.96 for the same four biotopes, and lower values of 0.66±0.25 and 0.45±0.25 again associated with SS.SMu.CSaMu.AfilKurAnit and SS.SSa.CMuSa.AalbNuc respectively.

1.4.2.46 **Figure 1.15** to **Figure 1.17** show the mean number of taxa, individuals, abundance, and biomass for each of the major faunal groups (Annelida, Arthropoda, Mollusca, Echinodermata and Other) in each of the biotopes identified from the infaunal grab samples.

1.4.2.47 The biomass of the mixed sediment and fine sand biotopes (SS.SMx.CMx.KurThyMx, SS.SMx.OMx.PoVen and SS.SSa.CFiSa.EpusOborApri) tended to be dominated by Echinodermata, Mollusca, and Arthropoda taxa, while having the highest numbers of Annelida and Mollusca consistently. The muddy and sandy mud biotopes tended to have lower biomass and abundance values for each of these taxa, with the exception of SS.SMu.CSaMu.AfilKurAnit, which noted a high mean biomass due to a high number of Mollusca and Echinodermata compared to all other biotopes with multiple stations sampled, as seen in **Figure 1.15**. It is of note that the biomass values all had large standard deviations, indicating high variability between stations which were grouped together, likely due to differences in faunal diversity between nearshore and offshore sites. This high biomass was reflected in this biotope also having the highest mean number of individuals overall (461), as shown in **Figure 1.16**.

1.4.2.48 As shown in **Figure 1.17**, the proportions of the number of taxa in each major taxonomic group is similar across all biotopes, and broadly mirror the patterns of mean abundance, with Annelida and Mollusca typically comprising the majority of individuals in each biotope. This pattern holds for SS.SSa.CFiSa.EpusOborApri, although this biotope recorded a significantly lower biomass and number of individuals, indicating the low faunal density and diversity in mobile fine sand communities.

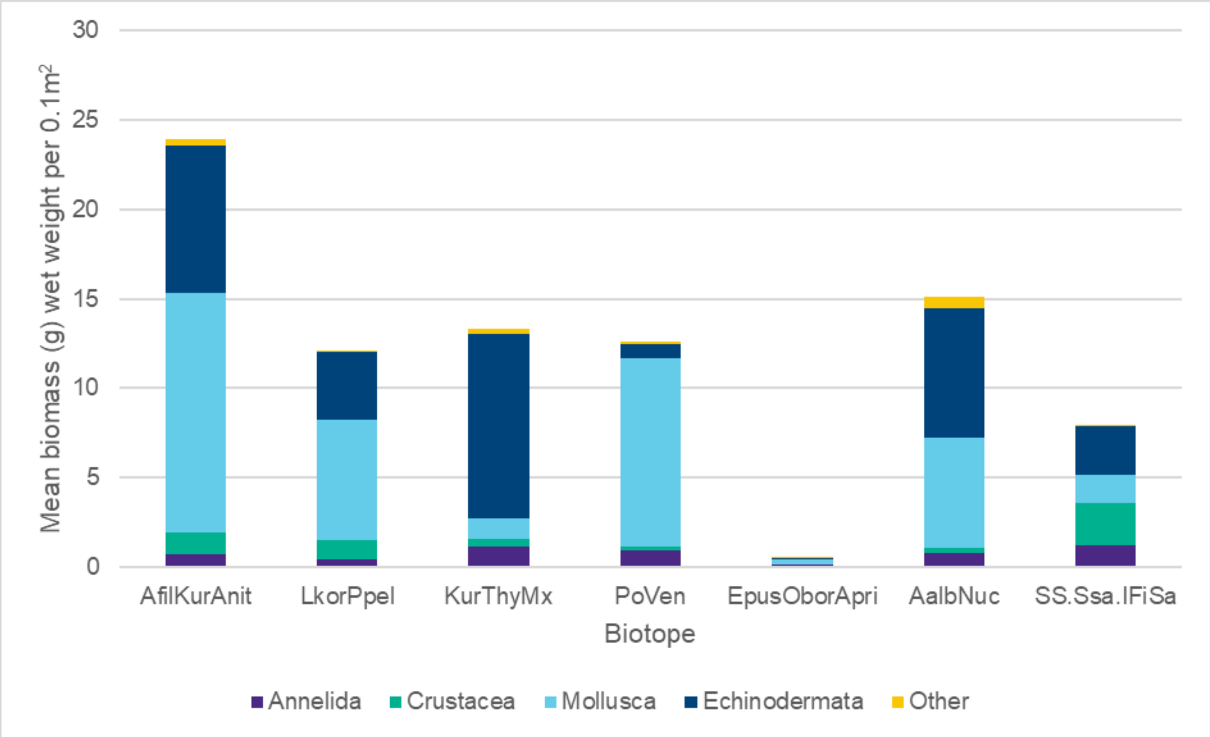


Figure 1.15: Mean biomass (per 0.1 m^2) per taxonomic group for each infaunal biotope

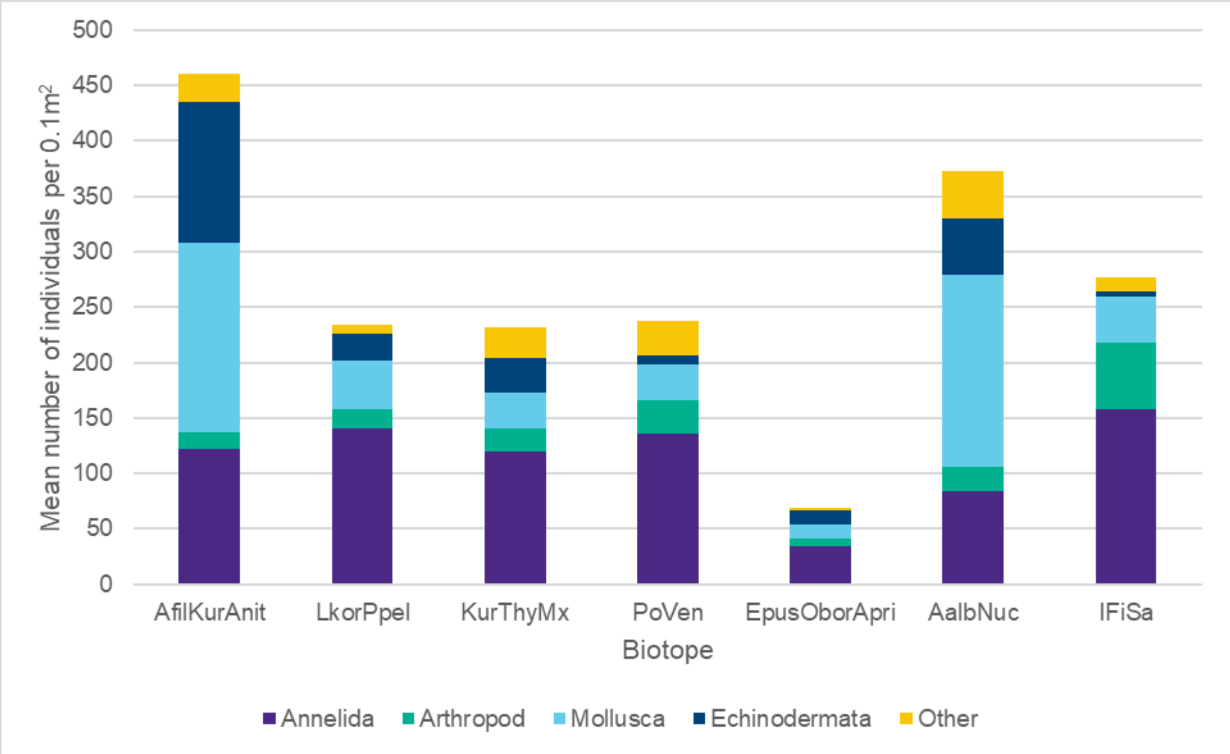


Figure 1.16: Mean abundance of individuals (per 0.1 m^2) per taxonomic group for each infaunal biotope

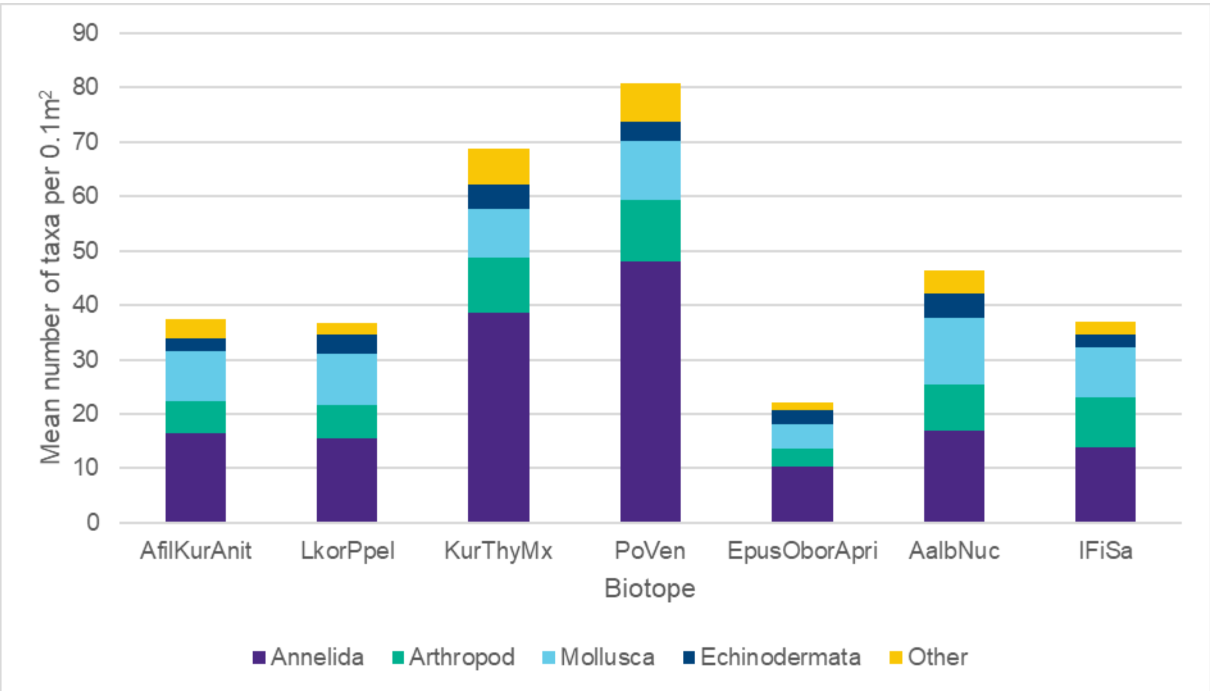


Figure 1.17: Mean number of taxa (per 0.1 m^2) per taxonomic group for each infaunal biotope

Epifaunal analysis

Seabed imagery

1.4.2.49 The sediments recorded in the seabed imagery largely comprised of an amalgamation of subtidal mixed, sandy and muddy sediments, with broadscale homogeneity within biotopes based on visual inspection of station camera stills (**Figure 1.18**).

1.4.2.50 Visible epifauna were dominated by various species of Echinodermata, with Mollusca and Annelida less common but still broadly present throughout the survey area. *Ophiura* spp. was the most abundant taxa and was associated with every sediment type.

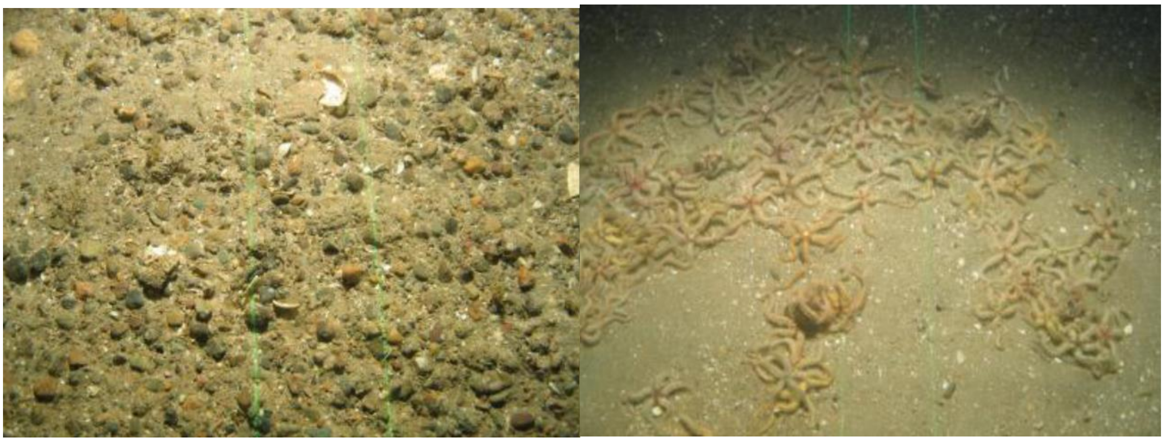


Figure 1.18: Representative DDV image of mixed sediment communities (left) and sandy sediment communities with *Ophiura* (right) across the survey area

1.4.2.51 Across the survey area, the community composition observed from the DDV footage was relatively similar between all identified sediment types, with a broad distribution of taxa including *Serpulidae*, *Alcyonium digitatum* and *Pectinidae*.

Summary statistics

1.4.2.52 The epifaunal data that were recorded as present or absent and therefore removed from the infaunal grab data analysis were instead combined with the epifaunal data from the DDV. A total of 300 unique taxa were recorded to varying levels of identification from the 82 stations at which DDV sampling was undertaken. Of the taxa, none were recorded as being present across all sample stations, although the most common species was *Ophiura ophiura* present at 81 stations, and most abundant at ENV158, east of the Morecambe Offshore Windfarm: Generation Assets approaching the landfall in the nearshore, although not in significantly higher abundance than many other stations. Across the whole survey area, 20 taxa were only present at one sample station. The sample station ENV073 recorded the highest number of epifauna, with 222 individuals noted.

Multivariate community analysis

1.4.2.53 The results of the cluster analysis, SIMPROF test and SIMPER analysis were used, together with the raw untransformed data, to assign epifaunal biotopes to sample stations based on the dataset which combined the DDV data and the epibenthic component of the grab samples (**Table 1.9**). 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 groups could be explained by differences in abundances of characterising species rather than the presence/absence of key species. Full results of the multivariate analysis are presented in **Appendix C.6**.

1.4.2.54 The results of the hierarchical cluster analysis of the square root transformed epifaunal dataset (**Figure 1.19**) together with the SIMPROF test identified 8 faunal groups that were statistically dissimilar. The 2D MDS plot is presented in **Figure 1.20**, noting that the low stress value (0.12) indicates that this is a good representation of the data. The 3D MDS plot has not been presented as the 2D MDS provides a clearer representation of the data.

1.4.2.55 The SIMPROF analysis indicated the taxonomic distinctness of faunal groups F, G and H (**Table 1.9**), but with similar enough species present to be potentially grouped together. Group F accounted for 41 stations (50% of all stations), group G accounted for 18 stations (21.96%), and group H accounted for 6 stations (7.32%), with all of these stations being distributed across the survey area, with no clear pattern dependent on depth or distance from shore. Examination of the community composition and relative abundances allowed faunal group F, which included all of the DDV-only stations within the Fylde MCZ, to be classified as the high level SS.SSa.CMuSa biotope due to the presence of the key characterising species *O. ophiura* and also *Astropecten irregularis*, but the community diversity was too broad to be classified as a more specific biotope.

1.4.2.56 Infaunal groups F and H had a dissimilarity of 70.96% due to significant differences in total species abundances and other dissimilarities between F and G were derived from group F, G and H having diverse communities with a large range of species present. Faunal groups G and H were characterised by the presence of *Actiniaria* and *Ceriantharia* not otherwise present in faunal group F. As the underlying sediment also differed from faunal group F but could not be refined to a single biotope based on the diversity of the communities present, these two groups were classified as the high level SS.SSa.CFiSa biotope. Although the overall species contribution for these three faunal groups had over 80% of their community dominated by *O. ophiura*, the SACFOR abundance over the area covered by the 65 stations within these groupings was too low to be classified as an *O. ophiura* specific biotope.

1.4.2.57 Group E encompassed a range of stations to the west of the Morgan Offshore Wind Project: Generation Assets and was characterised by a variety of species including *Serpulidae* and *A. digitatum* on coarse and mixed sediments. As this grouping encompassed a wide diversity of species, it did not match well to any specific species-level biotope and was instead classified as SS.SMx.CMx.

1.4.2.58 Faunal group A comprised a single outlying station (ENV098) which was highly distinct from all other groups, and examination of the mixed sediments and faunal composition allowed this to be classified as the biotope SS.SMx.CMx.OphMx. The presence of a diverse fauna including *Asterias rubens*, and *A. digitatum* and *Pagurus*, and a high proportion of Echinodermata taxa, tended to support this categorisation as the best fit.

1.4.2.59 The remaining groups B, C and D recorded more diverse communities than are typically expected of epifaunal habitats, with no single biotope fitting the communities found at these stations (**Table 1.9**). Therefore, they were classified at a higher biotope level based on underlying sediment, with groups C and D being grouped SS.SSa.CMuSa, supported by the presence of *Tubularia indivisa* and *Actiniaria* in both, and a dissimilarity of 53.01% between the groups. Due to the difference in sediment and species composition, B was classified alone as SS.SMx.CMx, with a dissimilarity of >60% between this group and both C and D, supporting it being considered on its own.

1.4.2.60 The faunal groups presented in the SIMPER analysis and the raw data were used to assign four epifaunal biotopes to the site-specific survey data (**Table 1.10**). **Figure 1.21** presents the epifaunal biotopes assigned across the survey area from the analyses of the epifaunal component of the grab data and DDV.

Table 1.9: Simprof groups and biotope classifications for the epifaunal dataset (from DDV and epifaunal component of the grab data)

Faunal group	Stations	Depth (m)	EUNIS Folk classification	Characterising species	Biotope	Comments
A	ENV098	37-38	Mixed sediments	*Ophiothrix fragilis* inc., *Psolus phantapus* inc., *Holothuroidea* indet. 01, *Ceriantharia* stet., *Alcyonium digitatum*, *Nemertesia antennina* inc., *Paguroidea* stet., *Cucumariidae* indet. 01, *Ophiura* albida inc.	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	Depth and sediments match, with *Ophiothrix fragilis* abundant alongside diverse epifauna including *Alcyonium digitatum, Nemertesia antennina*, as well as general *Holothuroidea*.
B	ENV100	38-40	Sand and muddy sand	*Metridium* stet., *Ophiura albida* inc., *Actiniaria* indet. 01, *Tubularia indivisa* inc., *Actiniaria* stet, *Cirripedia* stet., *Edwardsiidae* indet. 01, *Paguroidea* stet., *Myxicola* stet., *Serpulidae* stet., *Actiniaria* indet. 05	Circalittoral muddy sand (SS.SSa.CMuSa)	*Ophiura ophiura* not present and community too diverse to fall into any specific biotope, needed to be resolved to lower level of resolution.
C	ENV079, ENV080	37-38	Mixed sediment, sand and muddy sand	*Tubularia indivisa*, *Actiniaria* indet., *Ceriantharia* stet., *Ophiura ophiura* inc., *Pectinidae* stet, *Alcyonium digitatum*	Circalittoral muddy sand (SS.SSa.CMuSa)	*Ophiura ophiura* present, but community too diverse to fall into any specific biotope, needed to be resolved to lower level of resolution.

Faunal group	Stations	Depth (m)	EUNIS Folk classification	Characterising species	Biotope	Comments
D	ENV078	38-40	Mixed sediments	*Serpulidae* stet., *Alcyonium digitatum*, *Spatangus purpureus*, *Paguroidea* stet. *Tubularia indivisa* inc., *Ensis ensis* inc., *Ophiura ophiura* inc., *Echinoidea* indet. GL0002	Sublittoral mixed sediment (SS.SMx.CMx)	Falls between *Ophiura ophiura* on circalittoral muddy sand (SS.SSa.CMuSa.Ooph) and SS.SMx.CMx.OphMx in terms of species, resolved to lower level of resolution, potentially a transition biotope.
E	ENV066, ENV067, ENV068, ENV069, ENV070, ENV071, ENV072, ENV073, ENV074, ENV075, ENV076, ENV077	37-47	Coarse and mixed sediments	*Serpulidae* stet., *Alcyonium digitatum*, *Pectinidae* stet., *Tubularia indivisa*, *Ophiura albida*, *Myxicola* stet.	Circalittoral mixed sediment (SS.SMx.CMx)	Correct depth and sediment, with *Ophiura* species and other echinoderms such as *Asterias rubens*, and *Alcyonium digitatum* and *Pagurus, Serpulidae, Tubularia, Myxicola* species. Lacks exact characterising species (e.g. *Ophiothrix* or *Ophiocomina*) for more specific biotope.
F	ENV085, ENV086, ENV088, ENV089, ENV090, ENV091, ENV092, ENV093, ENV094, ENV095, ENV096, ENV097, ENV117, ENV118, ENV120, ENV121, ENV122, ENV123, ENV124, ENV125, ENV126, ENV127, ENV128, ENV129, ENV130, ENV131, ENV132, ENV155, ENV156, ENV157, ENV158, ENV159, ENV160, ENV161, ENV162, ENV163, ENV164, ENV165, ENV166, ENV167, ENV168	ENV85-132 15-28 ENV155-168 9-22	Mud and sandy mud, Sand and muddy sand	*Ophiura ophiura* inc, *Astropecten irregularis*	Circalittoral muddy sand (SS.SSa.CMuSa)	Correct depth and sediment, with super-abundant *Ophiura ophiura* and also associated *Astropecten irregularis*.

Faunal group	Stations	Depth (m)	EUNIS Folk classification	Characterising species	Biotope	Comments
G	ENV082, ENV083, ENV084, ENV087, ENV103, ENV106, ENV107, ENV108, ENV109, ENV110, ENV111, ENV112, ENV113, ENV114, ENV115, ENV116, ENV119, ENV154	22-36, ENV15 4 8	Mud and sandy mud, Sand and muddy sand	*Ophiura ophiura* inc., *Astropecten irregularis*, *Actiniaria* indet. 07, *Actiniaria* indet. 06, *Ceriantharia* stet.	Circalittoral fine sand (SS.SSa.CFiSa)	Expected depth (except for ENV154), with abundant *Ophiura ophiura* and *Astropecten*, with *Actinaria* community suggesting wide range of associated environmental conditions across stations on sandy sediment.
H	ENV081, ENV099, ENV101, ENV102, ENV104, ENV105	33-49	Sand and muddy sand	*Ophiura ophiura* inc., *Paguroidea* stet., *Astropecten irregularis*, *Ceriantharia* stet., *Adamsia palliata*, *Psolus phantapus* inc.	Circalittoral fine sand (SS.SSa.CFiSa)	Expected depth and sediment conditions and expected *Ophiura ophiura* (although at lower abundance than expected), *Paguridae*, and *Astropecten*, but slightly more diverse community than expected.

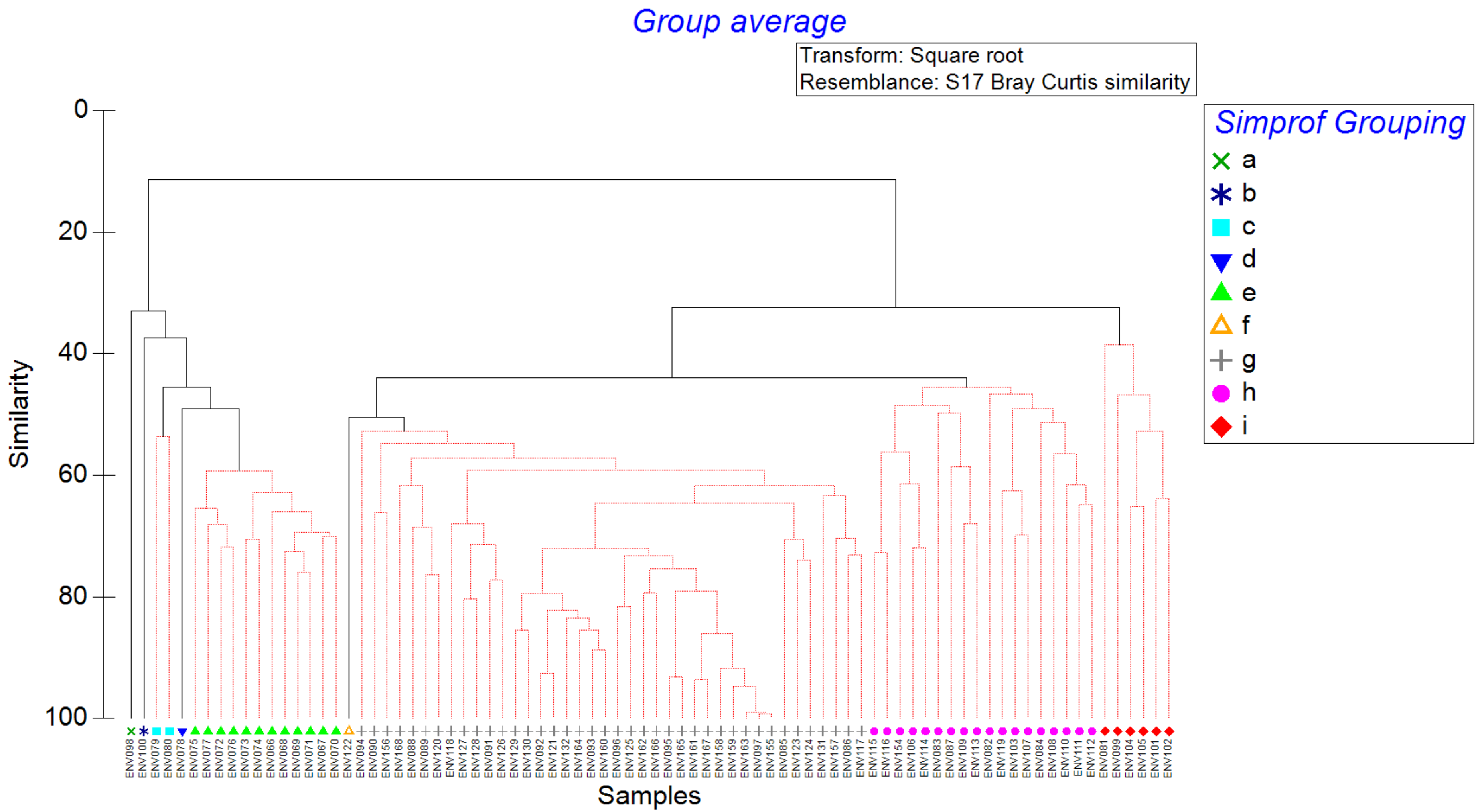


Figure 1.19: Dendrogram of epifaunal communities from DDV and epifaunal component of grab data

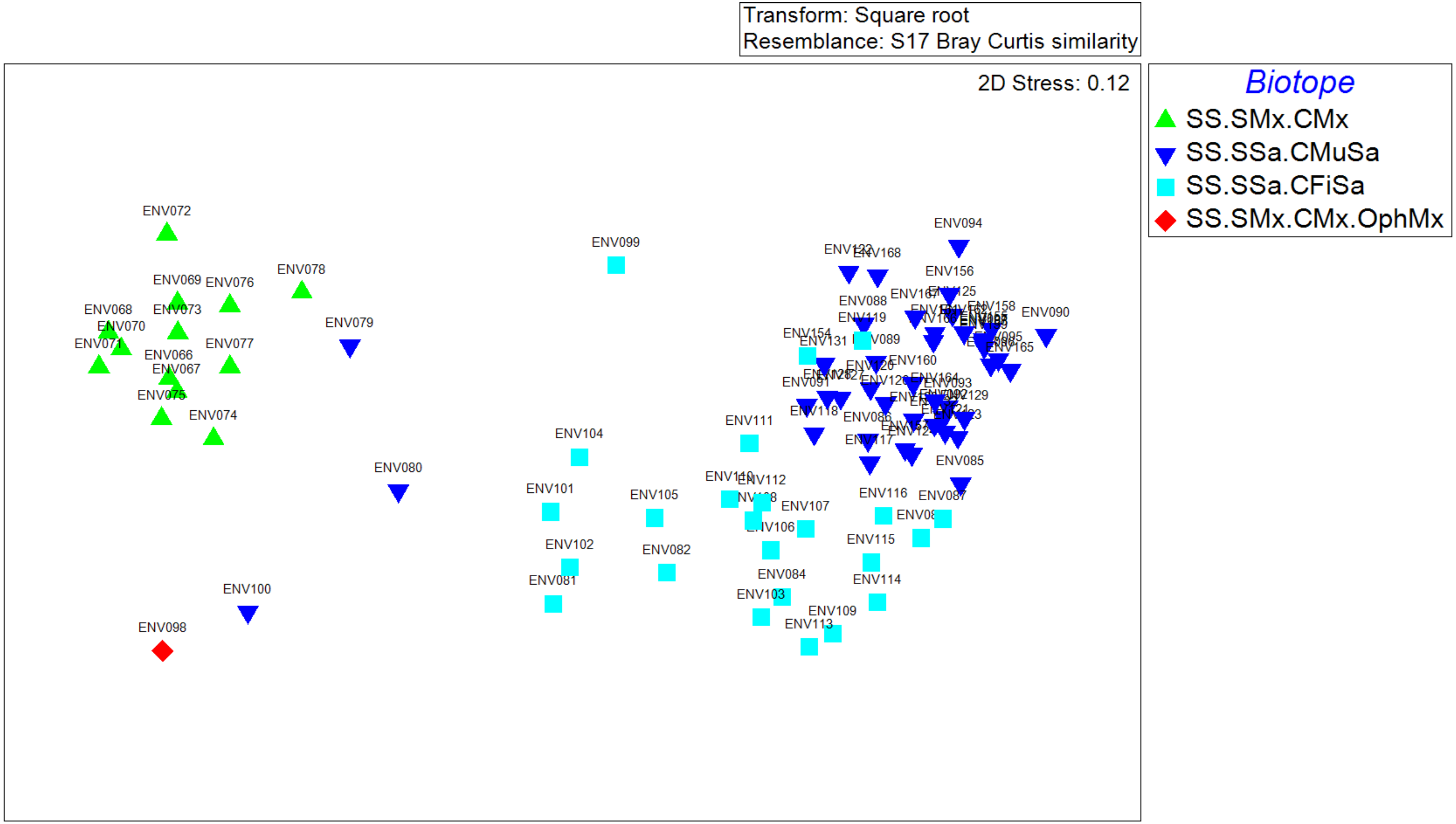


Figure 1.20: 2D MDS plot of epifaunal communities from DDV and epifaunal component of grab data

Table 1.10: Summary of epifaunal biotopes from DDV and epifaunal component of grab data

Epifaunal biotope	Sample stations	Water depth range (m)	Sediment Folk classification	Characterising taxa	Geographic locations
Circalittoral muddy sand (SS.SSa.CMuSa)	ENV079, ENV080, ENV085, ENV086, ENV088, ENV089, ENV090, ENV091, ENV092, ENV093, ENV094, ENV095, ENV096, ENV097, ENV100, ENV117, ENV118, ENV120, ENV121, ENV122, ENV123, ENV124, ENV125, ENV126, ENV127, ENV128, ENV129, ENV130, ENV131, ENV132, ENV155, ENV156, ENV157, ENV158, ENV159, ENV160, ENV161, ENV162, ENV163, ENV164, ENV165, ENV166, ENV167, ENV168	9-40	Mud and sandy mud to muddy sand	*Metridium* stet., *Ophiura albida* inc., *Actiniaria* indet. 01, *Tubularia indivisa* inc., *Actiniaria* stet, *Cirripedia* stet., *Edwardsiidae* indet. 01, *Paguroidea* stet., *Myxicola* stet., *Serpulidae* stet., *Actiniaria* indet. 05, *Ceriantharia* stet., *Ophiura ophiura* inc., *Pectinidae* stet, *Alcyonium digitatum*	North west of the Morecambe Offshore Windfarm: Generation Assets and north east of the Morgan Offshore Wind Project: Generation Assets, in the west and north of the survey area, as well as approaching the landfall in the nearshore.
Sublittoral mixed sediment (SS.SMx.CMx)	ENV066, ENV067, ENV068, ENV069, ENV070, ENV071, ENV072, ENV073, ENV074, ENV075, ENV076, ENV077, ENV078	38-40	Mixed sediments	*Serpulidae* stet., *Alcyonium digitatum*, *Spatangus purpureus*, *Paguroidea* stet. *Tubularia indivisa, Ensis ensis* inc., *Ophiura ophiura* inc., *Echinoidea* indet. GL0002	North west of the Morecambe Offshore Windfarm: Generation Assets in the west of the survey area.

Epifaunal biotope	Sample stations	Water depth range (m)	Sediment Folk classification	Characterising taxa	Geographic locations
Circalittoral fine sand (SS.SSa.CFiSa)	ENV081, ENV082, ENV083, ENV084, ENV087, ENV099, ENV101, ENV102, ENV103, ENV104, ENV105, ENV106, ENV107, ENV108, ENV109, ENV110, ENV111, ENV112, ENV113, ENV114, ENV115, ENV116, ENV119, ENV154	22-49	Sand and muddy sand	*Ophiura ophiura inc., Paguroidea stet., Astropecten irregularis, Ceriantharia stet., Adamsia palliata, Psolus phantapus inc., Actiniaria indet. 07, Actiniaria indet. 06*	North and east of the Morecambe Offshore Windfarm: Generation Assets in the centre and nearshore of the survey area.
Ophiothrix fragilis and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx)	ENV098	37-38	Coarse and mixed sediments	*Ophiothrix fragilis* inc., *Psolus phantapus* inc., *Holothuroidea* indet. 01, *Ceriantharia* stet., *Alcyonium digitatum*, *Nemertesia antennina* inc., *Paguroidea* stet., *Cucumariidae* indet. 01, *Ophiura* albida inc. *Serpulidae* stet., *Pectinidae* stet., *Tubularia indivisa*, *Myxicola* stet.	North east of the Morgan Offshore Wind Project: Generation Assets.

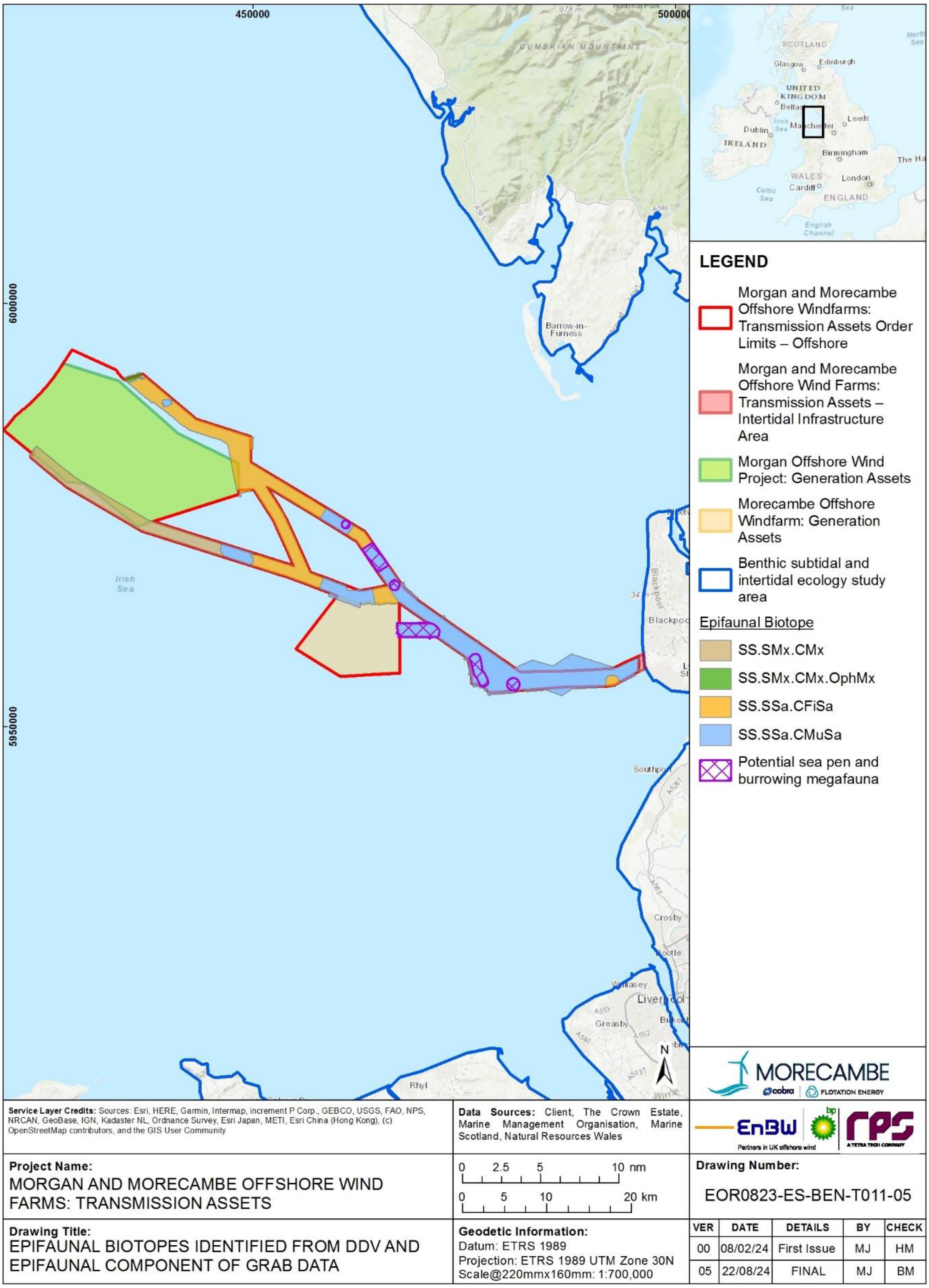


Figure 1.21: Epifaunal biotopes identified from DDV and epifaunal component of grab data

Univariate analysis

1.4.2.61 The following univariate statistics were calculated for the combined epibenthic dataset (i.e. epibenthic components of the grabs and DDV data) for each sample 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 1.11**, with univariate statistics for individual sample stations presented in **Appendix C.7**.

Table 1.11: Mean (± standard deviation) univariate statistics for epifaunal biotopes

Biotope	S	N	D	J'	H'	λ
SS.SSa.CMuSa	5.23±5.21	11.23±8.04	1.57±1.43	0.69±0.31	1.11±0.77	0.57±0.3
SS.SMx.CMx	23.77±5.37	46.31±11.12	5.92±1.09	0.95±0.01	2.97±0.23	0.96±0.01
SS.SSa.CFiSa	9.88±4.01	14.75±5.35	3.25±1.08	0.95±0.04	2.11±0.43	0.92±0.06
SS.SMx.CMx.OphMx	17	40	4.35	0.94	2.65	0.94

1.4.2.62 The biotope SS.SMx.CMx had the highest mean number of taxa (23.77±5.37), and the highest mean number of individuals (46.31±11.12), which was expected as these biotopes are associated with mixed sediments with cobbles and pebbles which provide substrate for a wide range of epifauna to attach to and settle on. The high number of individuals associated with the mixed sediment biotopes were due to high abundances of Echinodermata as well as faunal turfs. The lowest mean number of taxa was associated with the most recorded biotope, SS.SSa.CMuSa, which was reported across the survey area (5.23±5.21), with the corresponding lowest abundance (11.23±8.04), with this muddy sediment biotope being relatively species poor and dominated by *O. ophiura* in most cases.

1.4.2.63 The highest mean diversity scores were associated with the mixed sediment biotopes SS.SMx.CMx (d=5.92±1.09, H'=2.97±0.23) and SS.SMx.CMx.OphMx (d=4.35, H'=2.65), which was expected, given the presence of mixed sediments, and the broader and more diverse community typically associated with the high abundance of *O. ophiura* in this biotope, although this was only represented by a single station to the north east of the Morgan Offshore Wind Project: Generation Assets. The biotope SS.SSa.CMuSa had the lowest diversity scores (d=1.57±1.43, H'=1.11±0.77). The SS.SSa.CFiSa biotope was represented by two stations near to the landfall with indices broadly between the SS.SMx.CMx and SS.SSa.CMuSa biotopes.

1.4.2.64 Pielou's evenness (J') showed limited variation across the mixed sediment biotopes (0.94-0.95±0.04) but was less in the species-poor

SS.SSa.CMuSa biotope (0.69±0.31). The Simpson's Index of Dominance (λ) showed the same pattern across the three more diverse biotopes (0.92±0.06-0.96±0.01) but was lower in SS.SSa.CMuSa biotope (0.57±0.3).

Combined infaunal and epifaunal subtidal biotopes

1.4.2.65 **Figure 1.22** presents the combined infaunal and epifaunal biotopes identified across the survey area (excluding the Generation Assets). The method of classifying combined, holistic biotope codes was informed by the infaunal and epifaunal biotopes, the characterising species for these biotopes (as highlighted by the SIMPER analysis) and environmental variables (e.g. sediment type and water depth) at each site. The quantitative benthic infaunal grab dataset was prioritised when combining the datasets, due to this being the most standardised dataset. The DDV footage and the results of the analysis of the epifaunal component of the grab data were then used to identify any subtle differences in epifaunal communities.

1.4.2.66 Where possible, the infaunal and epifaunal datasets were consolidated into a single biotope code or a biotope mosaic. The biotope mosaics typically comprised an infaunal biotope with an overlaying epifaunal biotope. This was the case for a station (ENV098) to the north east of the Morgan Offshore Wind Project: Generation Assets which was assigned a mosaic of the SS.SMx.CMx.KurThyMx infaunal biotope with an overlaying SS.SMx.CMx.OphMx biotope due to the SACFOR abundance of *O. ophiura* and associated species observed in the DDV footage. At stations where DDV data only was collected (i.e. in the Fylde MCZ), the epifaunal biotopes have been taken as the final biotopes.

1.4.2.67 The combined overall biotope map showing all site-specific survey data within the Offshore Order Limits (i.e. including those derived from the site-specific surveys for the Transmission Assets, Morgan Offshore Wind Project: Generation Assets and Morecambe Offshore Windfarm: Generation Assets) is presented in **Figure 1.23**.

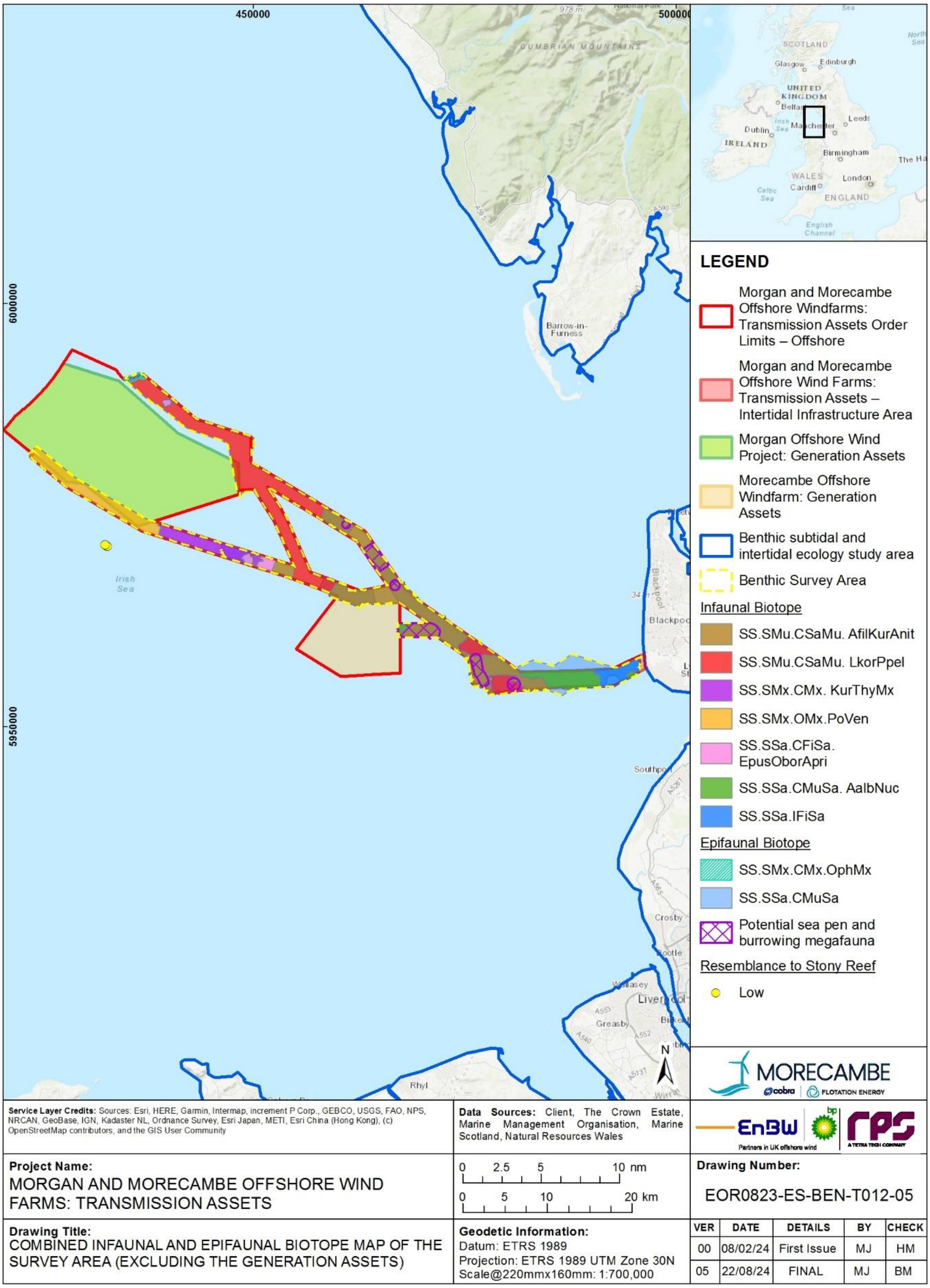


Figure 1.22: Combined infaunal and epifaunal biotope map of the survey area (excluding the Generation Assets)

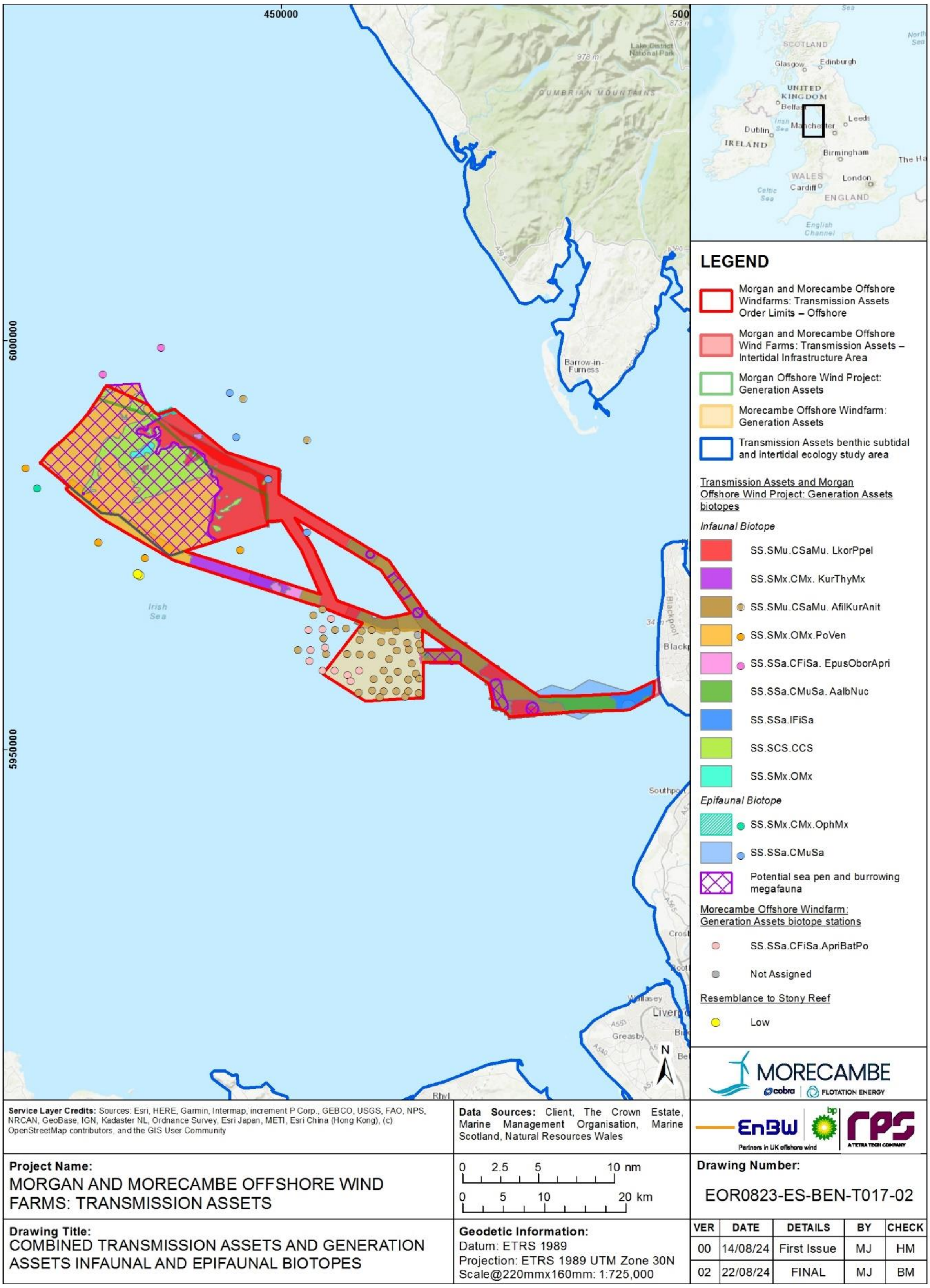


Figure 1.23: Combined Transmission Assets and Generation Assets infaunal and epifaunal biotopes

Results – habitat assessments

1.4.2.68 The following sections detail the results of the habitats assessments undertaken on the DDV data across the survey area, with full results available in **Appendix C.3**. Assessments were undertaken to determine the resemblance of stations to the Annex I habitat 'Sandbanks which are slightly covered by seawater all the time', the seapen and burrowing megafauna communities' habitat as identified by OSPAR (2010) and the 'fragile sponge and anthozoan communities on rocky habitats' as defined by JNCC (2008).

1.4.2.69 There were no observations of boulders during the benthic survey and observed cobbles were isolated and scattered providing no evidence for the potential presence of stony reef which may meet any of the criteria outlined by Irving (2009). These areas of coarser sediment did not, therefore require further assessment for resemblance to Annex I stony reef. Similarly, there were no observations of *S. spinulosa* within the survey area.

Annex I Sandbanks slightly covered by seawater all the time

1.4.2.70 Sandy sediments in less than 20 m of water occur within the survey area. Nearshore stations (ENV154 to ENV168) are within 10 km of the Shell Flat and Lune Deep SAC which is designated for Annex I sandbanks which are slightly covered by sea water all the time. Assessment of the site-specific geophysical data revealed dunes to be present and the seabed intermittently shoaled to less than 20 m LAT. However, these areas were interpreted as shoulders of a deeper channel rather than a sandbank. Therefore, recognised areas of sandy sediments in water depths of less than 20 m LAT within the survey area were considered unlikely to qualify as a Habitats Directive Annex I 'sandbanks which are slightly covered by seawater all of the time' habitat.

Seapen and burrowing megafauna communities

1.4.2.71 No seapen individuals were observed within seabed imagery of the survey area. A total of 1,165 burrows were, however, observed across 22 stations within the survey area. A detailed assessment of the 'seapen and burrowing megafauna communities' habitat, as identified by OSPAR (2010), was therefore undertaken in accordance with the methodology outlined in **section 1.4.1**.

1.4.2.72 Densities of faunal burrows were categorised using the SACFOR classification to assess the similarity of stations to a 'seapen and burrowing megafauna communities' habitat. Densities of burrows ranged from 0.004 burrows per m^2 at station ENV080 to 6.18 burrows per m^2 at station ENV125 (**Table 1.12**). The observed burrows measured between 0.5 cm and 13.8 cm with the majority measuring <1 cm, but with an overall average size of 3.2 cm. The average burrow size per station ranged from 1.2 cm to 7.0 cm. Burrows were classified as 'common' at six stations (ENV125 to ENV127 and ENV130 to ENV132; **Table 1.12**). Examples of these are shown in **Figure 1.24**.

The fines component (<63µm) at these stations constituted 36% of the sediment. The number of burrows at the other stations ranged from ‘frequent’ to ‘rare’.

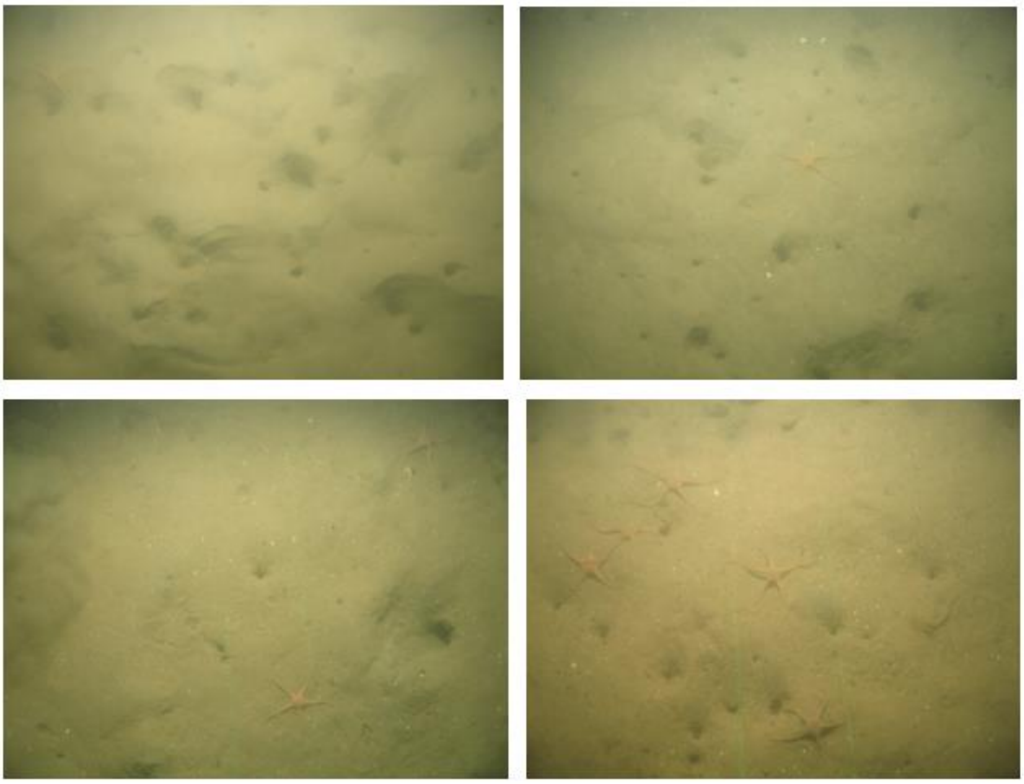


Figure 1.24: DDV images of stations with an average SACFOR abundance of burrows as ‘common’ (top left: ENV125, top right: ENV126, bottom left: ENV130, bottom right: ENV132) (scale: 90 mm between green laser lines)

1.4.2.73 The JNCC (2014) clarification report states that to be considered a ‘seapen and burrowing megafauna community’ habitat, densities of burrows and/or mounds, together with seapens if present need to be classified as ‘frequent’ or above on the SACFOR scale. The presence of burrows were classified as ‘frequent’ or ‘common’ at 11 stations; therefore, these stations show some similarity to the ‘seapen and burrowing megafauna communities’ habitat as defined by OSPAR. Although burrows were present, burrowing fauna were rarely sighted to confirm the burrow inhabitants; therefore, burrows could not confidently be attributed to any of the classified ‘megafauna’ species within the ‘seapen and burrowing megafauna community (SS.SMu.CFiMu.SpnMeg)’ habitat classification. However, a precautionary approach has been adopted which has assumed the presence of burrows to correspond to SS.SMu.CFiMu.SpnMeg habitat, with this labelled as potential seapens and burrowing megafauna habitats in the epifaunal biotopes (**Figure 1.21**) and the combined infaunal and epifaunal biotopes (**Figure 1.22**).

1.4.2.74 The full results of the seapens and burrowing megafauna assessment is presented in **Table 1.12**.

Table 1.12: Seapen and burrowing megafauna communities assessment within the survey area

Station	Total Images Analysed	Camera Transect Length (m)	Estimated Area Investigated (m^2)	Number of burrows	Maximum density (m^2)	Size range of burrows (cm)	Average size (cm)	Average SACFOR
ENV079	52	212	147.24	6	0.04	0.6 to 2.8	1.2	R
ENV080	42	273	247.85	1	0.004	1.2	1.2	R
ENV086	45	221	152.92	30	0.2	1 to 3.4	2.4	O
ENV087	42	233	167.24	15	0.09	0.6 to 4.8	2.8	R
ENV088	58	351	11.02	11	1	2.9 to 2.9	2.9	O
ENV089	57	265	10.83	28	2.59	0.9 to 2.9	2.9	F
ENV090	46	235	8.74	3	0.34	0.9 to 2.9	2.2	O
ENV091	69	276	13.11	4	0.31	2.9 to 2.9	2.9	O
ENV094	82	303	15.58	1	0.06	2.9	2.9	R
ENV118	45	215	127.23	18	0.14	0.5 to 7.8	2.9	O
ENV119	37	215	132.52	12	0.09	1.5 to 4.2	3.1	O
ENV120	49	295	9.31	37	3.97	0.9 to 2.9	2.0	F
ENV121	60	346	11.40	17	1.49	0.9 to 2.9	2.0	F
ENV123	41	302	7.79	23	2.95	0.9 to 2.9	2.9	F
ENV124	33	327	6.27	11	1.75	0.9 to 2.9	2.0	F
ENV125	39	228	43.36	268	6.18	0.7 to 12.5	5.9	C
ENV126	43	242	45.89	188	4.1	0.5 to 8.5	4.2	C
ENV127	39	238	45.29	128	2.83	0.5 to 9.1	3.7	C

Station	Total Images Analysed	Camera Transect Length (m)	Estimated Area Investigated (m^2)	Number of burrows	Maximum density (m^2)	Size range of burrows (cm)	Average size (cm)	Average SACFOR
ENV128	38	283	53.81	3	0.06	2.9 to 7	7.0	O
ENV130	42	240	45.55	46	1.01	0.5 to 13.8	4.9	C
ENV131	47	212	40.22	200	4.97	0.5 to 8.9	3.9	C
ENV132	45	225	42.77	115	2.69	0.7 to 12.2	4.7	C

Fragile sponge and anthozoan communities on subtidal rocky habitats

1.4.2.75 Hard substrate Porifera were observed throughout the survey area with 12 stations showing evidence of Porifera. This evidence comprised single/isolated images showing less than 3%, and often less than 1% of the image occupied by lone sponges such as *Suberites* sp. The typical growth form observed was a sole encrusting individual typically encrusting on *Pectinidae* shells and predominantly observed in areas of coarser substrate (**Figure 1.25**).

1.4.2.76 The greatest percentage of hard substrate Porifera in a single image was observed at Station ENV067 where approximately 2.55% of one image (out of 35 analysed at this station) contained hard substrate Porifera. Averaged over all images collected at station ENV067, the average percentage cover of sponge was 0.21%.

1.4.2.77 At all other stations in the survey area where sponge was recorded, it was limited to a very small number of images at each of these stations (i.e. less than eight, but typically four of less).

1.4.2.78 Though several species of sponges and other non-sponge species (*A. diaphanum* and *Nemertesia antennina*) were present that are listed within the 'fragile sponge and anthozoan communities on rocky habitats' (JNCC, 2008), they were recorded at very low abundances. No stations within the survey area were considered to represent the fragile sponge and anthozoan communities on subtidal rocky habitat. The full results of the sponge habitat assessment (i.e. the per image assessment for stations subject to a fragile sponge and anthozoan communities on subtidal rocky habitats assessment) can be found in **Appendix C.3**.

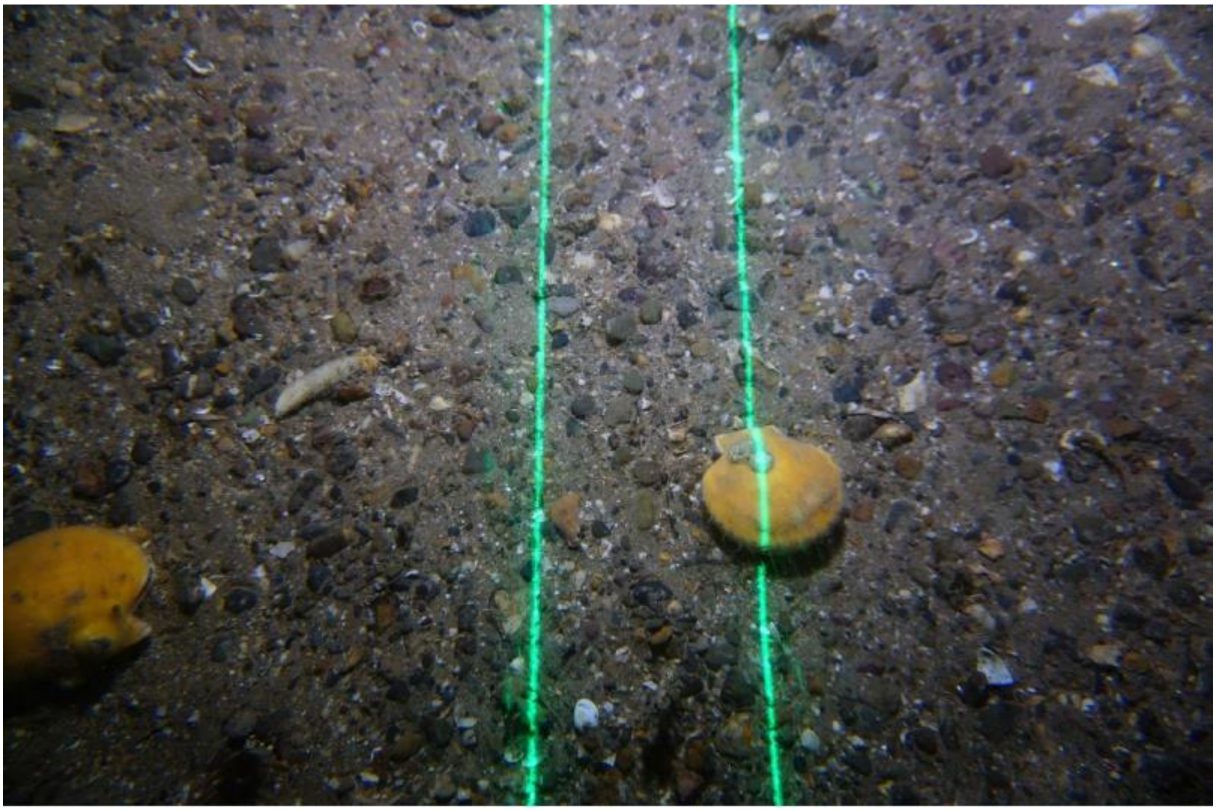


Figure 1.25: Example sponge occurrence on bivalve shell (scale: 90 mm between green laser lines)

Other taxa of conservation interest

1.4.2.79 *Arctica islandica* is on the OSPAR (2008) list of threatened and/or declining species. Eight pairs of *A. islandica* siphons were observed across seven stations (ENV081, ENV104, ENV105, ENV115, ENV117, ENV118 and ENV126, with these stations shown in **Figure 1.8**) and dead *A. islandica* shells were also noted at one station in the west of the survey area, directly to the west of the Morgan Offshore Wind Project: Generation Assets.

1.4.2.80 One individual of *M. modiolus* was observed at a single station, ENV075 (see **Figure 1.8**), to the south west of the Morgan Offshore Wind Project: Generation Assets. This species is a component of the OSPAR threatened and/or declining '*Modiolus modiolus* beds' habitat (OSPAR, 2008). No *M. modiolus* reefs were observed and isolated individuals, such as that observed at station ENV075, are not protected.

1.4.3 Results - intertidal ecology

Overview

1.4.3.1 The Phase I intertidal survey of the Intertidal Infrastructure Area recorded a beach with expansive gently sloping exposed sandflats which dissipated the wave energy associated with incoming tides. A breaker zone was present in the lower shore with well-developed surf and swash zones in the mid shore. The upper beach contained a moderately sloping reflective foreshore leading to a backshore fringed by steep sand dunes built up by *Leymus arenarius* and *Ammophila arenaria*. These dunes, part of which include the Lytham St Annes Dune SSSI, occurred above MHWS (i.e. outside the scope of the survey) and were not surveyed in detail.

1.4.3.2 The mid-section of the beach was dominated by wide mobile sandbars comprised mainly of fine to medium grained sand, with small amounts of large shell fragments and gravels. An anoxic layer was not present. The sand here was elevated, mobile, and free draining and consequently supported a low density of fauna.

1.4.3.3 Typically, three large parallel sandbars occurred at any transect line down the mid-shore, comprising a surf zone spanning approximately 600 m. Narrow waterlogged depressions (troughs) lay between sandbars and contained a fine-grained sand with a slightly higher mud content. These areas contained a diverse fauna dominated by molluscs and polychaetes.

1.4.3.4 The lowest part of the shore was comprised predominantly of fine to medium sand and although the mud content was relatively low it was highest in this location. An anoxic layer was generally present though was often only faintly visible in the top 25 cm of sediment. This layer occurred at variable depths below the surface across the lower shore and appeared absent in places. High densities of invertebrates were present at the lowest part of the shore.

Biotopes

Upper shore

1.4.3.5 A narrow strip of medium to coarse sands and pebbles was present at the top of the beach with moderate populations of amphipods under decomposing seaweed and vascular plant-based detritus along the strandline (Talitrids on upper shore and strandline (LS.LSa.St.Tal, **Figure 1.26** and **Figure 1.27** (full biotope codes presented in **Table 1.13**).

Figure 1.26: LS.LSa.St.Tal on the upper shore

Middle shore

1.4.3.6 The biotope polychaete/amphipod-dominated fine sand (LS.LSa.FiSa) shores occurred in the upper reaches of the mid shore (**Figure 1.27**). Few species were recorded in this habitat other than small spionid polychaete worms and sparse amphipods (**Figure 1.28**).

1.4.3.7 The biotope barren or amphipod dominated mobile sand (LS.LSa.MoSa) community occurred on sandbars intersecting troughs in the mid shore (**Figure 1.27** and **Figure 1.29**). The elevated sandbars were the predominant mid-shore habitat and drained quickly so that the invertebrate density was very low with only a small number of amphipods observed (**Figure 1.30**).

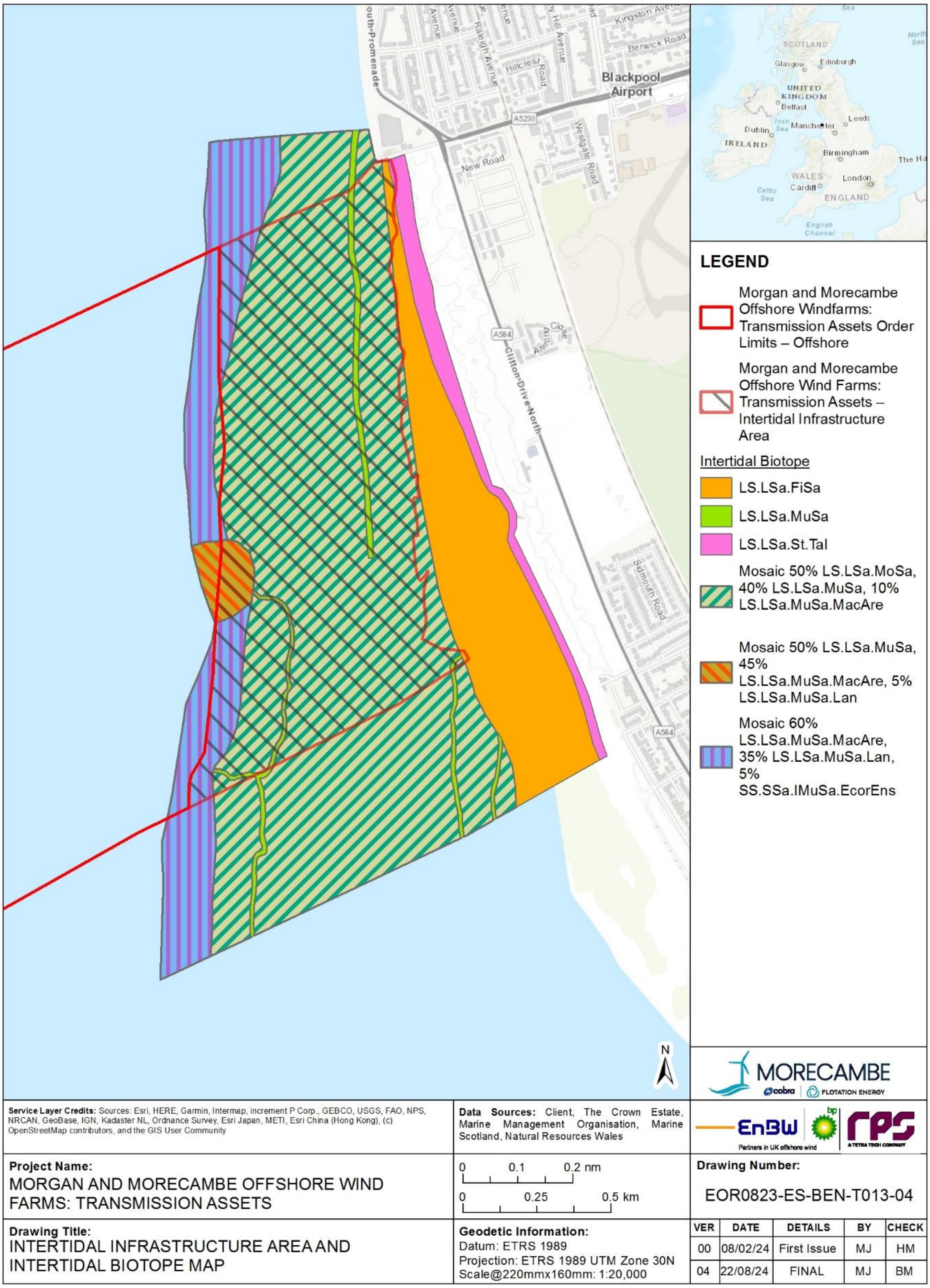


Figure 1.27: Intertidal Infrastructure Area and intertidal biotope map

Table 1.13: Biotopes recorded during the intertidal survey of the Intertidal Infrastructure Area

Biotope code	Full biotope name
LS.LSa.FiSa	Polychaete/amphipod-dominated fine sand shores
LS.LSa.MuSa	Polychaete/bivalve-dominated muddy sand shores
LS.LSa.St.Tal	Talitrids on the upper shore and strand-line
LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores
LS.LSa.MuSa.MacAre	*Macoma balthica* and *Arenicola marina* in littoral muddy sand
LS.LSa.MuSa.Lan	*Lanice conchilega* in littoral sand
SS.SSa.IMuSa.EcorEns	*Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand

Figure 1.28: Sieve station 5 in LS.LSa.FiSa biotope

Figure 1.29: LS.LSa.MoSa Barren or Amphipod dominated mobile sand community biotope

Figure 1.30: Sieve Station 4 in LS.LSa.MoSa biotope

1.4.3.8 The biotope polychaete/bivalve-dominated muddy sand shores (LS.LSa.MuSa) occurred in waterlogged mid-shore areas and in narrow low-lying troughs at the base of sandbars. *A. marina* occurred in low densities with individuals of *H. diversicolor* and *Phyllodoce* spp. recorded during sieve sampling (**Figure 1.31**).

1.4.3.9 Candidate egg cocoons of *S. armiger* were occasionally observed in damp sand.

1.4.3.10 Occasional specimens of the cockles *C. edule* and *Acanthocardia echinata* and four other species of sand-dwelling bivalve molluscs namely, *Macomangulus tenuis*, *Mactra stultorum*, C. *gallina* and *Donax vittatus* (**Figure 1.32**) were recorded. Three species of gastropod molluscs which predate bivalves were present. An individual specimen of *Acteon tornatilis* was recorded in a sandbar trough while several specimens of *Euspira nitida* and *Euspira catena* were observed on damp sands. Egg cases of both *Euspira* species were occasionally present.

1.4.3.11 A single individual shore crab *Carcinus maenas* was recorded as was an individual mussel *Mytilus edulis*. The latter is typical of rocky habitats and in this case was attached to an empty razor shell.

Figure 1.31: Sieve Station 3 in LS.LSa.MuSa biotope

Figure 1.32: *Donax vittatus* in LS.LSa.MuSa biotope

1.4.3.12 The intricate pattern of sandbars, sandbar troughs and other depressions occurred over a wide area and in this setting these habitats are mapped as a mosaic in **Figure 1.27**. Sandbars are mobile habitats, and their positions change over time to varying extents on a daily, seasonal and annual basis. The distribution of these habitats shown in **Figure 1.27** does, however, provide a good indication of the seasonal distribution of sediments.

Lower shore

1.4.3.13 The biotope LS.LSa.MuSa.MacAre was present along the lower shore and to a limited extent in the mid-shore in fine to muddy sand with a patchily distributed anoxic layer (**Figure 1.27** and **Figure 1.33**). *A. marina* occurred frequently accompanied by the bivalve mollusc *M. tenuis*. This species is a close relative of *M. balthica* with similar ecological requirements and while the latter was not recorded it is very likely to occur in this habitat within the survey area.

Figure 1.33: LS.LSa.MuSa.MacAre biotope with *A. marina* casts showing anoxic sediments

1.4.3.14 *A. marina* was largely displaced by *A. defodiens* at low water as noted in distribution of casts and confirmed via the presence of a specimen (**Figure 1.34**). Other species in this biotope included the polychaete worms *L. conchilega*, *Pygospio elegans* and *H. diversicolor* which occurred occasionally, as did the bivalve mollusc *C. edule*, a few specimens of which were obtained during exploratory digging. This association is a variant of the *Macomangulus balthica* - *Arenicola marina* community though is not named or referred to within the Marine Habitat Classification for Britain and Ireland (JNCC, 2015).

Figure 1.34: *Arenicola defodiens* in LS.LSa.MuSa.MacAre biotope

1.4.3.15 The biotope LS.LSa.MuSa.Lan occurred in strips and patches in sandy habitats across the lower shore (**Figure 1.27** and **Figure 1.35**). *L. conchilega* occurred frequently with occasional *A. defodiens*, O*wenia fusiformis*, *Nephtys* spp. and *Glycera* spp.

Figure 1.35: LS.LSa.MuSa.Lan at the lower shore

1.4.3.16 Parts of the LS.LSa.MuSa.Lan biotope contained dense populations of the heart urchin *E. cordatum* (10 per m^2, **Figure 1.36**) which was accompanied by the bivalve *Ensis siliqua* (2 per m^2, **Figure 1.37**).

1.4.3.17 This assemblage indicates the presence of the biotope SS.SSa.IMuSa.EcorEns. However, this biotope is under review due to lack of qualifying data and uncertainly in relation to the suitability of using wide ranging species (particularly *E. cordatum* which extends deep into the sublittoral zone) as characterising taxa (JNCC, 2015). This biotope is mapped in **Figure 1.27** as part of an intricate mosaic containing LS.LSa.MuSa.Lan and LS.LSa.MuSa.MacAre.

Figure 1.36: *Echinocardium cordatum* in SS.SSa.IMuSa.EcorEns

Figure 1.37: *Ensis siliqua* in SS.SSa.IMuSa.EcorEns

Intertidal habitats of conservation importance

1.4.3.18 The seven intertidal biotopes/habitats recorded are listed by one or more of the following schemes because they are of conservation importance (**Table 1.14**):

- EU Habitats Directive Annex 1;
- the Convention for the Protection of the Marine Environment of the North-Eastern Atlantic (aka the 'OSPAR Convention');
- Water Framework Directive (WFD); and/or
- UK BAP.

Table 1.14: Intertidal habitats and biotopes of conservation value recorded during the site-specific intertidal survey

Habitat/Biotope	Annex 1	OSPAR	WFD	UK BAP
LS.LSa.St.Tal	✓	x	✓	Broad
LS.LSa.FiSa	✓	x	✓	Broad
LS.LSa.MoSa	✓	x	✓	Broad
LS.LSa.MuSa	✓	✓	✓	Priority
SS.SSa.IMuSa.EcorEns	✓	✓	✓	Priority
LS.LSa.MuSa.MacAre	✓	✓	✓	Priority
LS.LSa.MuSa.Lan	✓	✓	✓	Priority

1.4.3.19 All of the biotopes recorded in the survey area are part of the Annex I Habitats Directive habitat *1140 Mudflats and sandflats not covered by seawater at low tide* although occur outwith an SAC at the landfall.

1.5 Summary

1.5.1.1 The subtidal site-specific surveys comprised combined grab samples and DDV at 77 stations within the survey area (i.e. the offshore export cable corridor) and a further five DDV only stations within the Fylde MCZ. Subtidal sediments recorded across the survey area graded from gravelly sands, sands and gravelly muddy sands offshore in the west of the survey area to muddy sands which dominated the central and nearshore sections of the survey area (i.e. to the north and east of the Morecambe Offshore Windfarm: Generation Assets). Immediately adjacent to the landfall, the sediments were sands. A total of 46% of the samples were classified as sand and muddy sand, 36% of stations were mud and sandy mud, and 10% were comprised of mixed sediment and 8% comprised coarse sediment. The sediment composition showed a general trend of coarser sediments offshore, in the vicinity of the Morgan Offshore Wind Project: Generation Assets with increasing fines in the central and nearshore parts of the survey area approaching the landfall. This aligned with the desktop data which indicated coarse sediments offshore, and sand and muddy sediments closer to the coast (EMODnet, 2021).

1.5.1.2 A total of 39 sediment samples from across the survey area (i.e. the offshore export cable corridor) were analysed for sediment chemistry. Levels of contamination were generally low throughout the survey area, with levels of most contaminants below the Cefas AL1 and the Canadian TEL. No contaminants were present at levels exceeding the Cefas AL2 or the Canadian PEL. For metals, the only exceptions were nickel, arsenic and mercury. Concentrations of nickel exceeded the Cefas AL1 at one station (but was well below the Cefas AL2). Concentrations of mercury at seven sites largely in the central and nearshore parts of the Offshore Order Limits (i.e. to the east and south east of the Morecambe Offshore Windfarm: Generation Assets), exceeded the Canadian TEL (but were below the Cefas AL1). Concentrations of arsenic exceeded the Canadian TEL at 17 stations (but were below the Cefas AL1) throughout the survey area.

1.5.1.3 Concentrations of some individual PAHs exceeded the Canadian TEL at five stations primarily to the east and south east of the Morecambe Offshore Windfarm: Generation Assets, with one of these stations (ENV097) also exceeding Cefas AL1 for dibenzo[ah]anthracene. However, all stations were below the ERL threshold for total PAH concentration indicating that toxic effects to fauna by PAHs are unlikely. No other contaminants exceeded any threshold levels, with the ICES-7 PCBs also compared to ERL and ERM threshold levels, with these also not exceeding these levels.

1.5.1.4 The site-specific survey data showed that the benthic communities were dominated by the SS.SMu.CSaMu.LkorPpel biotope in the west, with the SS.SMu.CSaMu.AfilKurAnit biotope being present throughout the centre of the survey area. The infaunal communities graded into the SS.SSa.CMuSa.AalbNuc biotope in the nearshore area, and

SS.SSa.IFiSa interspersed with SS.SSa.CMuSa.AalbNuc, approaching the landfall.

1.5.1.5 The epifaunal analysis indicated the presence of SS.SSa.CMuSa throughout the majority of the survey area, largely in the centre and offshore areas surrounding the Generation Assets, and also in the nearshore approaching the landfall. Circalittoral mixed sediments and circalittoral fine sands were also noted in areas corresponding to infaunal biotopes associated with these sediment types, and therefore most epifaunal biotopes assigned were consistent with the underlying infaunal biotope. The exception was ENV098, to the north east of the Morgan Offshore Wind Project: Generation Assets, where a high SACFOR abundance of *O. ophiura* indicated the presence of the biotope SS.SMx.CMx.OphMx, which overlaid the infaunal classification of this station as SS.SMx.CMx.KurThyMx.

1.5.1.6 No Annex I reefs (biogenic or geogenic) were recorded within the survey area. Sandy sediments in less than 20 m of water occurred within the survey area but were considered unlikely to qualify as a Habitats Directive Annex I ‘sandbanks which are slightly covered by seawater all of the time’ habitat.

1.5.1.7 The habitat assessment noted the presence of burrows at 22 stations within the survey area. Whilst no seapens were observed, the presence of burrows was classified as ‘frequent’ or above at 11 stations; therefore, it was concluded that these stations showed some similarity to the ‘seapen and burrowing megafauna communities’ habitat as defined by OSPAR. Whilst seapens were not recorded during the site-specific surveys, it was not possible to determine the species which had formed the burrows. Therefore, in order to adopt a precautionary approach, the ‘seapens and burrowing megafauna communities’ habitat has been assumed to be potentially present within the survey area.

1.5.1.8 Evidence of hard substrate Porifera was observed at 12 stations, but no stations were considered to represent the fragile sponge and anthozoan communities on subtidal rocky habitat.

1.5.1.9 A site-specific Phase 1 intertidal survey was undertaken in the Intertidal Infrastructure Area. The beach contained expansive gently sloping exposed sandflats which dissipated the wave energy associated with incoming tides. A breaker zone was present in the lower shore with well-developed surf and swash zones in the mid shore. The mid-section of the beach was dominated by wide mobile sandbars comprised mainly of fine to medium grained sand, with small amounts of large shell fragments and gravels, and supported a low density of fauna. Typically, three large parallel sandbars occurred at any transect line down the mid-shore. Troughs lay between sandbars and contained a fine-grained sand with a slightly higher mud content. These areas contained a diverse fauna dominated by molluscs and polychaetes. The lowest part of the shore was comprised predominantly of fine to medium sand and although the mud content was relatively low it was highest in this location, in the context of the entire beach profile. An anoxic layer was also generally present. High densities of invertebrates were present at the lowest part of the shore.

Important ecological features

1.5.1.10 In accordance with the best practice guidelines (CIEEM, 2019) for the purposes of the benthic subtidal and intertidal ecology EIA, IEFs have been identified and all potential impacts of the Transmission Assets will be assessed against the IEFs to determine whether they are significant.

1.5.1.11 The IEFs of an area are those that are considered to be important, typically ecologically or commercially, and potentially affected by the Transmission Assets (**Table 1.15**). Specifically, importance may be assigned due to quality or extent of habitats, habitat or species rarity or the extent to which they are threatened (CIEEM, 2019). Species and habitats are considered IEFs if they have a specific biodiversity importance recognised through international or national legislation or through local, regional or national conservation plans (e.g. Annex I habitats under the Habitats Directive, OSPAR, National Biodiversity Plan or the Marine Strategy Framework Directive).

1.5.1.12 The biotopes present across the survey area have been grouped into broad habitat/community types. Features of nature conservation designations have also been considered as IEFs. The identified IEFs will be taken forward for assessment within the benthic subtidal and intertidal ecology EIA Report (Volume 2, Chapter 2: Benthic subtidal and intertidal ecology of the ES) and used to assess impacts associated with the construction, operations and maintenance and decommissioning of the Transmission Assets on benthic subtidal and intertidal ecology.

Table 1.15: Benthic subtidal and intertidal IEFs within the study area

IEF	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the study area
Subtidal habitats				
Subtidal coarse and mixed sediments with diverse benthic communities	Subtidal coarse and mixed sediments characterised by diverse communities of polychaetes, bivalves and mobile crustaceans identified throughout the Offshore Order Limits. • SS.SCS.CCS (within survey area and the Morgan Offshore Wind Project: Generation Assets). • SS.SMx.OMx (within Morgan Offshore Wind Project: Generation Assets). • SS.SMx.OMx.PoVen (across survey area and within Morgan Offshore Wind Project: Generation Assets). • SS.SMx.CMx.KurThyMx (within the survey area).	Within the Offshore Order Limits (and within the Morgan Offshore Wind Project: Generation Assets)	Habitats of Principal Importance in England. Habitats listed as Features of Conservation Interest (FOCI) UK BAP priority habitat.	National

IEF	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the study area
	• SS.SMx.CMx.			
Brittlestar beds	Subtidal mixed sediment dominated by brittlestars which form dense beds. • SS.SMx.CMx.OphMx.	Within the Offshore Order Limits (north east of the Morgan Offshore Wind Project: Generation Assets)	UK BAP priority habitat Habitat of Principal Importance in England (NERC Act 2006)	National
Subtidal muddy sands with relatively species poor benthic communities	Subtidal muddy sands characterised by bivalves, polychaetes, and potential seapen and burrowing megafauna. • SS.SMu.CSaMu.LkorPpel (within survey area and the Morgan Offshore Wind Project: Generation Assets). • SS.SMu.CSaMu.AfilKurAnit (across the survey area and the Morecambe Offshore Windfarm: Generation Assets). • SS.SMu.CMuSa (within the survey area).	Within the Offshore Order Limits (and within the Morecambe Offshore Windfarm: Generation Assets)	Habitats of Principal Importance and Habitats of Conservation Interest in England and Wales.	National
Subtidal sandy sediments characterised by relatively diverse infaunal and epifaunal benthic communities.	Subtidal sandy sediments characterised by echinoderms, polychaetes and bivalves. • SS.SSa.CFiSa.EpusOborApri (across the survey area and the Morecambe Offshore Windfarm: Generation Assets). • SS.SSa.CMuSa.AalbNuc (across the survey area). • SS.SSa.IFiSa (across the survey area near the landfall). • SS.SSa.CFiSa (across the survey area near the landfall). • SS.SSa.CFiSa.ApriBatPo (within the Morecambe Offshore Windfarm: Generation Assets).	Within the Offshore Order Limits (and within the Morgan Offshore Wind Project: Generation Assets)	Habitats of Principal Importance in England. Habitats listed as Features of Conservation Interest (FOCI) UK BAP priority habitat.	National
Annex I low resemblance stony	Cobbles and boulders with indicator species such as *A. digitatum*, *Nemertesia* sp. and *Tubularia* sp. Identified to the	Within wider study area (i.e. outside the	Potential Annex I habitat outside an SAC	National

IEF	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the study area
reef (outside an SAC)	south of the Morgan Offshore Wind Project: Generation Assets. • CR.HCR.XFa.SpNemAdia (within the Morgan Offshore Wind Project: Generation Assets ZOI).	Offshore Order Limits)		
Seapens and burrowing megafauna communities	Plains of fine mud at depths greater than about 15 m may be heavily bioturbated by burrowing megafauna (no seapens recorded in the survey area). • SS.SMu.CFiMu.SpnMeg.	Within the Offshore Order Limits (within the Morecambe Offshore Windfarm: Generation Assets and to the east and north of this)	UK BAP priority habitat OSPAR habitat Habitat of Principal Importance in England (NERC Act 2006)	National
Annex I habitat features of SACs				
Sandbanks which are slightly covered by sea water all the time	Sandbanks slightly covered in sea water at all times typically characterised by mobile epifauna including molluscs and crustaceans, and foliose seaweeds, hydroids and bryozoans where sediment is more stable. Shell Flat and Lune Deep SAC. • SS.SSa.CMuSa.AalbNuc. • SS.SSa.IMuSa.FfabMag. • SS.SMu.ISaMu.KurAbr.	Within wider study area (i.e. outside the Offshore Order Limits)	Annex I Habitats Directive Annex I qualifying feature of the Shell Flat and Lune Deep SAC	International
Reefs	Subtidal rocky marine habitats or biological concretions arising from the seabed, typically characterised by diverse invertebrate and algal communities. • CR.HCR.XFa.FluCoAs.X. • CR.HCR.XFa.FluHocu.	Within wider study area (i.e. outside the Offshore Order Limits)	Annex I Habitats Directive Annex I qualifying feature of the Shell Flat and Lune Deep SAC	International
Broadscale habitats: features of MCZs				

IEF	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the study area
Subtidal mud	Fylde MCZ – designated for subtidal muds which are known to support diverse bivalve and polychaete communities. • SS.SMu.CSaMu.AfilKurAnit. • SS.SSa.CMuSa.AalbNuc. • SS.SSa.CMuSa (confirmed by DDV only surveying within the survey area). • SS.SSa.IMuSa.EcorEns. • SS.SMu.CSaMu.LkorPpel. West of Walney MCZ - Muds and sandy muds in extremely sheltered areas with very weak tidal currents. High numbers of polychaetes, bivalve and echinoderms such as urchins and brittle stars. • SS.SMu.CSaMu.AfilKurAnit.	Fylde MCZ: within both study area and Offshore Order Limits West of Walney MCZ: within wider study area (i.e. outside the Offshore Order Limits)	UK BAP priority habitat Protected feature of: • Fylde MCZ; and • West of Walney MCZ.	National
Subtidal sand	Fylde MCZ – designated for subtidal sands with associated polychaete, amphipod and bivalve communities. • SS.SSa.CMuSa.AalbNuc. • SS.SCS.ICS.MoeVen. • SS.SCS.ICS.Glap. West of Walney MCZ - Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit. • SS.SMx.CMx.KurThyMx. West of Copeland MCZ - Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit.	Fylde MCZ: within both study area and Offshore Order Limits West of Walney MCZ and West of Copeland MCZ: within wider study area (i.e. outside the Offshore Order Limits)	UK BAP priority habitat Protected feature of: • Fylde MCZ; • West of Walney MCZ; and • West of Copeland MCZ.	National
Subtidal coarse sediment	Coarse sand and gravel or shell fragments. Largely characterised by infaunal communities include bristleworms, sand mason worms, burrowing anemones and bivalves. • SS.SCS.CCS.	Within wider study area (i.e. outside the Offshore Order Limits)	UK BAP priority habitat Protected feature of the West of Copeland MCZ	National

IEF	Description and representative biotopes	Location	Protection status/ Conservation interest	Importance within the study area
Subtidal mixed sediment	A range of different types of sediments. Animals found here include worms, bivalves, starfish and urchins, anemones, sea firs and sea mats. • SS.SMx.OMx. • SS.SMx.OMx.PoVen.	Within wider study area (i.e. outside the Offshore Order Limits)	Protected feature of the West of Copeland MCZ	National
Seapens and burrowing megafauna communities	Fine mud heavily bioturbated by burrowing megafauna; burrows and mounds may form a prominent feature with conspicuous populations of seapens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. • SS.SMu.CFiMu.SpnMeg.	Within wider study area (i.e. outside the Offshore Order Limits)	OSPAR habitat, UK BAP priority habitat Protected feature of the West of Walney MCZ	National
Intertidal habitats				
Species poor/barren sands	Clean mobile free draining sand in the middle shore. Amphipods were recorded sparsely or containing spionid polychaete worms and amphipods. • LS.LSa.FiSa. • LS.LSa.MoSa.	Intertidal zone within the Intertidal Infrastructure Area	UK BAP priority habitat. Annex I habitat outside an SAC Feature of the Ribble Estuary SSSI	National
Polychaete/bivalve-dominated muddy sand shores	Large areas of the middle shore contained muddy fine grained waterlogged sand. Several species of bivalve molluscs were observed including *Macomangulus tenuis*. Polychaetes included *Arenicola marina*, and *Lanice conchilega.* • LS.Lsa.MuSa. • LS.Lsa.MuSa.MacAre. • LS.Lsa.MuSa.Lan.	Intertidal zone within the Intertidal Infrastructure Area	UK BAP priority habitat Annex I habitat outside an SAC Feature of the Ribble Estuary SSSI	National
Echinocardium cordatum and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand	Dense populations of the heart urchin *Echinocardium cordatum* in fine sand at the lower shore accompanied by occasional *Ensis siliqua* and *Lanice conchilega*. • SS.SSa.IMuSa.EcorEns.	Intertidal zone within the Intertidal Infrastructure Area	UK BAP priority habitat Annex I habitat outside an SAC Feature of the Ribble Estuary SSSI	National

1.6 References

Antill, R. and Pérez-Domínguez, R. (2021) Morecambe Bay SAC Intertidal Reef Surveys 2015: Final Report. APEM Scientific Report for Natural England. 115 pp.

BEIS (2022) Offshore Energy SEA 4: Appendix 1 Environmental Baseline. From UK Offshore Energy Strategic Environmental Assessment Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil & Gas and Gas Storage and Associated Infrastructure OESEA4 Environmental Report.

Camacho-Ibar, V.F., Wrench, J.J. and Head, P.C. (1992) Contrasting behaviour of arsenic and mercury in Liverpool Bay sediments, Estuarine, Coastal and Shelf Science, 34(1), 23-36.

CCME (2001) Canadian environmental quality guidelines for the protection of aquatic life. CCME water quality index: technical report 1.0.

CCW (2002) Site of Special Scientific Interest Citation - Creigiau Rhiwledyn/Little Ormes Head. Report.

CCW (2003) Site of Special Scientific Interest Citation – Aber Afon Conwy. Report.

CCW (2007) The biodiversity and conservation of the shores of Wales – results from a 10 year intertidal survey of Wales. Accessed: February 2024, Available at: [redacted]

Cefas (2005) A Review of the Contaminant Status of the Irish Sea. Accessed: February 2024, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/197289/SEA6_Contaminant_CEFAS.pdf.

Cefas (2014) Classification of Bivalve Mollusc Production Areas in England and Wales: Sanitary Survey Report Colwyn Bay. Accessed: February 2024, Available at: [redacted]

Celtic Array Ltd. (2014) Preliminary Environmental Information Chapter 9 Benthic Ecology.

Centre for Marine and Coastal Studies Ltd. (2013). Walney Offshore Wind Farm - Year 1 Post-construction Benthic Monitoring Surveys: Centre for Marine and Coastal Studies Ltd.

Clarke, R. and Gorley, R.N. (2006) PRIMER version 6: user manual/tutorial. PRIMER-E, Plymouth, UK, p192.

Clarke, K.R. and Warwick, R.M. (2001) Change in Marine Communities: An Approach to Statistical Analysis and Interpretation. Second Edition, PRIMER-E, Plymouth.

CMACS (2002). Final report to Total Fina Elf by the Centre for Marine and Coastal Studies. Isle of Man intertidal surveys and guide to habitat mapping and GIS. CMACS/PEML.

CMACS (2005a) Burbo Banks Offshore Wind Farm Pre-Construction Contaminants Investigation.

CMACS (2005b) Gwynt y Môr offshore wind farm Marine Benthic Characterisation Survey. A report to NPower renewables (Gwynt y Môr offshore wind farm Environmental Impact Assessment).

CMACS (2009) Walney and Ormonde Offshore Windfarm Benthic Survey Report.

CMACS (2011) Gwynt y Môr Offshore Wind Farm baseline pre-construction benthic survey report (2010 survey). Report to Gwynt y Môr OWF Ltd. July 2011.

CMACS (2012a) Ormonde Offshore Wind Farm Year 1 post-construction benthic monitoring technical survey report (2012 survey). Report to RPS Energy.

CMACS (2012b) Walney Offshore Wind Farm Year 1 post-construction benthic monitoring technical survey report (2012 survey). Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy. July 2012.

CMACS (2013) Walney Offshore Wind Farm Year 1 post-construction benthic monitoring technical survey report (2013 survey). Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy.

CMACS (2014) Walney Offshore Wind Farm Year 3 post-construction benthic monitoring technical survey report (2014 survey). Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy.

CMACS (2015) Benthic and Annex I Habitat Pre-construction Survey Field Report, Report to Burbo Bank Offshore Wind Farms (UK) Ltd/DONG Energy.

Countryside Council for Wales (CCW) (2004) ‘Phase I- Intertidal Survey- Standard Report', 11.55.2 Arfon Clwyd to Llanddulas.

Cumbria Biological Data Network (2010) Coastal Intertidal Habitats, Accessed: February 2024, Available at: [redacted]

Davison D.M. and Hughes D. J. (1998) Zostera Biotopes (volume I). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project), 95pp.

DEFA (2022a) Langness Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376789/langness-mnr-guide.pdf.

DEFA (2022b) Douglas Bay Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1366090/douglas-bay-guide.pdf.

DEFA (2022c) Laxey Bay Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376791/laxey-bay-mnr-guide.pdf.

DEFA (2022d) Baie y Carrickey Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376783/baie-ny-carrickey-mnr-guide.pdf.

DEFA (2022e) Calf of Man and Wart Bank Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376785/calf-wart-bank-mnr-guide.pdf.

DEFA (2022f) Ramsey Bay Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1380263/ramsey-bay-mnr-guide_c.pdf.

DEFA (2022g) Niarbyl Bay Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376796/niarbyl-bay-mnr-spotter-sheet.pdf.

DEFA (2022h) West Coast Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376801/west-coast-mnr-guide.pdf.

DEFA (2022i) Little Ness Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376793/little-ness-mnr-guide.pdf.

DEFA (2022j) Port Erin Bay Marine Nature Reserve Guide. Accessed: February 2024, Available at: https://www.gov.im/media/1376797/port-erin-bay-mnr-guide.pdf.

Defra (2013) Fylde Marine Conservation Zone Fact Sheet. Accessed: February 2024, Available at: https://www.gov.uk/government/publications/marine-conservation-zone-2013-designation-fylde.

Defra (2016) West of Walney Marine Conservation Zone – Factsheet. Accessed: February 2024, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492471/mcz-west-walney-factsheet.pdf.

Defra (2019a) West of Copeland Marine Conservation Zone – Factsheet. Accessed: February 2024, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915435/mcz-west-copeland-2019.pdf.

Defra (2019b) Cumbria Coast Marine Conservation Zone – Factsheet. Accessed: February 2024, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915627/mcz-cumbria-2019.pdf.

DNV (2013). Monitoring of drilling activities in areas with presence of cold-water corals. [pdf] Norske Olie Og Gas (01).

DONG Energy Ltd (2013a) Environmental Statement Volume 2 – Chapter 12: Subtidal and Intertidal Benthic Ecology, Report to Burbo Bank Extension Offshore Wind Farms (UK) Ltd/DONG Energy.

DONG Energy Ltd (2013b) Volume 1 Environmental Statement Walney Extension, Chapter 10: Benthic Ecology, Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy.

Environment Agency (2015). Fylde MCZ Environment Agency Baseline survey PSA analysis 2015: Environment Agency (EA).

Envision Mapping Ltd. (2014). 2014 Shell Flat Lune Deep and Fylde Interpretation Mapping: Envision Mapping Ltd.

European Marine Observation Data Network (EMODnet) (2021) Seabed Habitats Initiative. Financed by the European Union under Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund. Accessed: February 2024, Available at: [redacted]

Folk, R.L. (1954) The distinction between grain size and mineral composition in sedimentary rock nomenclature. Journal of Geology, 62, 344-59.

Folk, R.L. and Ward, W.C. (1957) Brazos river bar: a study of the significance of grain size parameters. Journal of Sedimentary Petrology, 27, 3-26.

Gardline (2022) bp Alternative Energy Investments Limited Gardline Ref 11781, Draft. Great Yarmouth, UK.

Gubbay, S. (2007) Defining and Managing *Sabellaria spinulosa* Reefs; Report of an interagency workshop. JNCC report No.405.

Henry, L.A. and Roberts, J.M. (2014) Applying the OSPAR habitat definition of deep-sea sponge aggregations to verify suspected records of the habitat in UK Waters. JNCC Report No. 508.

Holt, T.J., Shalla, S.H.A. and Brand, A.R. (1997) Broadscale seabed survey to the east of the Isle of Man. A report to British Petroleum, Exploration Team.

Holt, T. J., Rees, E.I., Hawkins, S.J. and Seed, R. (1998) Biogenic Reefs (volume IX). An overview of dynamic and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project). 170pp.

Howe V.L. (2018a) Subtidal Ecology. In: Manx Marine Environmental Assessment (Second Ed). Isle of Man Government, 48pp.

Howe V.L. (2018b) Coastal Ecology. In: Manx Marine Environmental Assessment (Second Ed). Isle of Man Government, 24pp.

Hughes D.J. (1998a) Subtidal brittlestar beds (volume IV). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project), 78pp.

Hughes, D. J. (1998b). Sea pens and burrowing megafauna (Volume III). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project): Scottish Association for Marine Science (SAMS).

Innogy (2002) North Hoyle offshore windfarm environmental statement, 2002. Innogy NWP offshore Ltd.

Irving, R. (2009) The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-7 March 2008.

JNCC (2005) Information Sheer on Ramsar Wetlands, Ribble and Alt Estuaries. Available at: [redacted]

JNCC (2008) UK Biodiversity Action Plan Priority Habitat Descriptions - Fragile sponge and *Anthozoan* Communities of Rocky Habitats. [Online] Accessed: February 2024. Available at: https://data.jncc.gov.uk/data/0a9b6b43-4827-44a4-ab06-0f94d5ad6b93/UKBAP-BAPHabitats-16-FragileSpongeCommunities.pdf.

JNCC (2013) SACFOR abundance scale used for both littoral and sublittoral taxa from 1990 onwards. Accessed: February 2024, Available at: https://mhc.jncc.gov.uk/media/1009/sacfor.pdf.

JNCC (2014) Monitoring, assessment and reporting of UK benthic habitats: A rationalised list. Accessed: February 2024, Available at: https://hub.jncc.gov.uk/assets/fb82e7cc-8ee2-494b-8af7-2360d809dee9.

JNCC (2015) Great Orme's Head/ Pen y Gogarth Standard Data Form. Report, Accessed: February 2024, Available at: https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0014788.pdf.

JNCC (2015a) Ribble and Alt Estuaries Standard Data Form. Report, Accessed: February 2024. Available at: https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9005103.pdf.

JNCC (2016) Liverpool Bay / Bae Lerpwl potential Special Protection Area, Proposal for extension to existing site and adding new features. Departmental Brief, Advice to the Welsh and UK Governments. Accessed: February 2024. Available at: [redacted]

JNCC (2017) Shell Flat and Lune Depp SAC. Accessed: February 2024. Available at: https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0030376.pdf.

JNCC (2018). West of Walney MPA. Accessed: February 2024, Available at: https://jncc.gov.uk/our-work/west-of-walney-mpa/#activities-and-management.

JNCC (2022a) Y Fenai a Bae Conwy/ Menai Strait and Conwy Bay SAC. Accessed: February 2024, Available at: https://sac.jncc.gov.uk/site/UK0030202.

JNCC (2022b) Aber Dyfrdwy / Dee Estuary SAC. Accessed: February 2024, Available at: https://sac.jncc.gov.uk/site/UK0030131.

JNCC (2022c) Morecambe Bay SAC. Accessed: February 2024, Available at: https://sac.jncc.gov.uk/site/UK0013027.

JNCC (2022d) Luce Bay and Sands SAC. Accessed: February 2024, Available at: https://sac.jncc.gov.uk/site/UK0013039.

JNCC (2022e) Solway Bay SAC. Accessed: February 2024, Available at: https://sac.jncc.gov.uk/site/UK0013025.

Leah, R.T., Collings, S.E., Johnson, M.S. and Evans, S.J. (1993) Mercury in plaice (*Pleuronectes platessa*) from the sludge disposal ground of Liverpool Bay. Marine Pollution Bulletin, 26(8), 436-439.

Limpenny, D.S., Foster-Smith, R.L., Edwards, T.M., Hendrick, V.J., Diesing, M., Eggleton, J.D., Meadows, W.J., Crutchfield, Z., Pfeifer, S. and Reach, I.S. (2010) Best methods for identifying and evaluating *Sabellaria spinulosa* and cobble reef.

Long, D. (2006) BGS detailed explanation of seabed sediment modified Folk classification. Accessed: February 2024, Available at: [redacted]

Mackie, A.S.Y. (1990) Offshore benthic communities of the Irish Sea. In The Irish Sea: an environmental review. Part 1. Nature conservation, ed. Irish Sea Study Group, Liverpool University Press, 169-218.

Marine Management Organisation (2015) High Level Review of Current UK Action Level Guidance. A Report Produced for the Marine Management Organisation. MMO Project No 1053, ISBN 978-1-909452-350, Newcastle, UK, 73p.

MarineSpace Ltd (2023) Licence Area 457 Environmental Impact Assessment – Scoping Report. Report for Westminster Gravels Ltd.

MarLIN (2015) Habitats listed as Features of Conservation Interest. Accessed: February 2024, Available at: [redacted].

Mason, C. (2012) North East Atlantic Marine Biological Analytical Quality Control's Best Practice Guidance Particle Size Analysis (PSA) for Supporting Biological

Analysis. Accessed: February 2024, Available at:
h[redacted]

Miller, C., and Green, B. (2017). Fylde Marine Conservation Zones Baseline Survey Report 2015. Environment Agency, Natural England.

Mitchell, P., McIlwaine, P., Arosio, R., Hogg, O. and Clare, D. (2023) West of Walney Marine Conservation Zone Monitoring Report 2018. NERC464. Natural England.

Mona Offshore Wind Ltd (2024) Mona Offshore Wind Project, Environmental Statement, Volume 6, Annex 2.1: Benthic subtidal and intertidal ecology technical report.

Moore, J. (2002) An atlas of marine biodiversity action plan species and habitats and species of conservation concern in Wales. Second Edition. CCW contract science report no 509.

Moore, J. (2018) Menai Strait and Conwy Bay SAC intertidal monitoring summary, 2010 to 2017. NRW Evidence Report No 301, 50+ix pp, Natural Resources Wales, Bangor.

Morecambe Offshore Windfarm Ltd (2024a) Morecambe Offshore Windfarm: Generation Assets. Environmental Statement. Volume 5, Chapter 9 Benthic Ecology, Volume 5.

Morecambe Offshore Windfarm Ltd (2024b) Morecambe Offshore Windfarm: Generation Assets. Environmental Statement. Volume 5, Appendix 9.1: Benthic Characterisation Survey Report.

Morgan Offshore Wind Ltd (2024a) Morgan Offshore Wind Project: Generation Assets, Environmental Statement, Volume 2, Chapter 2: Benthic subtidal ecology.

Morgan Offshore Wind Ltd (2024b) Morgan Offshore Wind Project: Generation Assets, Environmental Statement, Volume 4, Annex 2.1: Benthic subtidal ecology technical report.

Natural England (2008) Ribble Estuary SSSI – Salters Bank Unit 010. Accessed: February 2024, Available at:
[redacted]

Natural England (2012) Shell Flat & Lune Deep candidate Special Area of Conservation - Formal advice under Regulation 35(3) of The Conservation of Habitats and Species Regulations 2010, Accessed: February 2024, Available at:
[redacted]

Natural England (2015) Ribble Estuary SSSI / Ribble & Alt SPA Intertidal sediments condition monitoring. Accessed: February 2024, Available at:
[redacted].

Natural England (2016a) Fylde Marine Conservation Zone Fact Sheet, Accessed: February 2024, Available at:
h[redacted]

Natural England (2016b) West of Walney Marine Conservation Zone. Accessed: February 2024, Available at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492471/mcz-west-walney-factsheet.pdf.

Natural England (2022) Shell Flat and Lune Deep Special Area of Conservation (SAC) Monitoring Report 2017. Natural England Commissioned Report NEXR368, 90pp.

Natural Resources Wales (2016) Marine Phase 1 Intertidal Habitat Survey.

Natural Resources Wales (2019) Y Fenai a Bae Conwy / Menai trait and Conwy Bay Special Area of Conservation Indicative site level feature condition assessments 2018. Accessed: February 2024, Available at: [redacted].

Neff, J.M. (2004). Bioaccumulation in Marine Organisms: Effect of Contaminants from Oil Well.

North West and North Wales Coastal Group (2011) North West England and North Wales Shoreline Management P–an SMP2 - Main SMP2 Document, Accessed: February 2024, [redacted]

Npower Renewables Ltd (2005) Gwynt y Mor Offshore Windfarm Environmental Statement. Accessed: February 2024. Available at: [redacted]

OSPAR (2008) OSPAR List of Threatened and/or Declining Species and Habitats (OSPAR Reference Number: 2008-6). Accessed: February 2024. Available at: [redacted].

OSPAR (2010) Background Document for Seapen and Burrowing megafauna Communities. Accessed: February 2024. Available at: [redacted].

Parry, M.E.V. (2019) Guidance on Assigning Benthic Biotopes using EUNIS or the Marine Habitat Classification of Britain and Ireland (Revised 2019). JNCC Report No. 546, ISSN 0963-8091, Peterborough, UK, JNCC.

Ramsar (2012) Information Sheet on Ramsar Wetlands(RIS) 2009-2012 version: The Dee Estuary. Accessed February 2024. Available at: [redacted]

Rees, E.I.S. (2001) Habitat specialization by *Thia scutellata* (*Decapoda*: *Brachyura*) off Wales. Journal of the marine Biological Association of the United Kingdom, 81, 697-98.

Rees, E.I.S, Walker, A.J.M. and Ward, A.R. (1972) Benthic fauna in relation to sludge disposal. In Out of Sight: Out of mind. Report of a working party on the disposal of sludge in Liverpool Bay, Volume 2: Appendices. Department of the Environment, London, 229-343.

Rowlatt, S.M. and Lovell, D. R. (1994) Lead, zinc and chromium in sediment around England and Wales. Marine Pollution Bulletin, 28, 828-30.

RWE (2022) Awel y Môr Environmental Impact Assessment, Volume 2, Chapter 5: Benthic Subtidal and Intertidal Ecology, Available at https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010112/EN010112-000191-

6.2.5_AyM_ES_Volume2_Chapter5_Benthic_Ecology_vFinal.pdf, Accessed April 2024.

SeaScape Energy (2011) Burbo Offshore Wind Farm, third post-construction benthic grab survey report (2009 survey). Report prepared by Centre for Marine and Coastal Studies Ltd (CMACS).

Seascape Energy Ltd. (2002) Burbo Offshore Wind Farm Environmental Statement. 324pp.

The Centre for Environment, Fisheries and Aquaculture Science (2007). Report to the Department of Trade and Industry - Fish and Fish Assemblages of the British Isles: The Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

Thornton, I. and Farago, M. (1997) The geochemistry of arsenic. In: Abernathy C.O., Calderon R.L., Chappell W.R. (eds) Arsenic. Springer, Dordrecht.

Titan environmental surveys (2005). Walney Offshore Windfarm Project Benthic Baseline Survey: Titan environmental surveys.

Unicomarine Ltd (2005) Results of benthic sampling (macrofauna and sediment composition) at the proposed Ormonde Development Project windfarm site and cable route, in the vicinity of Morecambe Bay.

Wentworth, C.K. (1922) A scale of grade and class terms for clastic sediments. Journal of Geology, 30, 377-92.

White, S. (2011) Biotope distribution and susceptibility to fishing pressure. MSc Thesis, Bangor University.

Appendix A: Morgan Offshore Wind Project: Generation Assets benthic technical report

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Environmental Statement

Volume 4, Annex 2.1: Benthic subtidal ecology technical report

Planning Inspectorate Reference Number: EN010136

Document Number: MRCNS-J3303-RPS-10064

Document Reference: F4.2.1

APFP Regulations: 5(2)(a)

April 2024

F01

Image of an offshore wind farm

www.morganandmona.com/morgan

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
F01	Application	RPS	Morgan Offshore Wind Ltd.	Morgan Offshore Wind Ltd.	April 2024

Prepared by:

RPS

Prepared for:

Morgan Offshore Wind Ltd.

Contents

Tables

Figures

Appendices

Appendices Tables

Appendices Figures

Glossary

Term	Meaning
Annelida	An invertebrate belonging to the phylum annelid. Also known as the ringed worms or segmented worms, are a large phylum, including ragworms, earthworms, and leeches.
Benthic Ecology	Benthic ecology encompasses the study of the organisms living in and on the sea floor, the interactions between them and impacts on the surrounding environment
Biotope	The combination of physical environment (habitat) and its distinctive assemblage of conspicuous species.
Bivalve	A large class of molluscs, also known as pelecypods. They have a hard calcareous shell made of two parts or 'valves'.
Circalittoral	The subzone of the rocky sublittoral below that dominated by algae (i.e. the infralittoral) and dominated by animals.
CLUSTER Analysis	CLUSTER analysis is a statistical method for processing data. It works by organising items into groups, or clusters, on the basis of how closely associated they are.
Crustacean	An invertebrate belonging to the subphylum of Crustacea, of the phylum Arthropoda. Includes crabs, lobsters, shrimps, barnacles and sand hoppers.
Diamicton	A general term used to describe a non-sorted or poorly sorted, sometimes non-calcareous, terrigenous or marine sediment containing a wide range of particle sizes derived from a broad origin.
Echinoderm	An invertebrate animal belonging to the phylum Echinodermata that includes sea stars, brittle stars, feather stars, sea urchins and sea cucumbers.
Environmental DNA	Genetic material obtained directly from environmental samples (soil, sediment, water, etc.) without any obvious signs of biological source material.
Epifauna	Animals living on the surface of the seabed.
Eulittoral	Applied to the habitat formed on the lower shore of an aquatic ecosystem, below the littoral zone. The marine eulittoral zone is marked by the presence of barnacles.
Evidence Plan	The Evidence Plan is a mechanism to agree upfront what information the Applicant needs to supply to the Planning Inspectorate as part of the Development Consent Order (DCO) applications for the Morgan Generation Assets.
Evidence Plan Expert Working Group (EWG)	Expert working groups set up with relevant stakeholders as part of the Evidence Plan process.
Faunal Group	A collections of sample stations identified by Simprof tests to similar enough to each other and dissimilar enough to other sample stations to be considered a distinct group.
Habitat	The environment that a plant or animal lives in.
Infauna	The animals living in the sediments of the seabed.
Infralittoral	A subzone of the sublittoral in which upward-facing rocks are dominated by erect algae.
Intertidal area	The area between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS).
Landfall	The area in which the offshore export cables make landfall and is the transitional area between the offshore cabling and the onshore cabling.

Term	Meaning
Littoral	Residing within the littoral zone which extends from the high water mark, which is rarely inundated, to shoreline areas that are permanently submerged.
Mollusc	Invertebrate animal belonging to the phylum Mollusca that includes the snails, clams, chitons, tooth shells, and octopi.
Morgan Array Area	The area within which the wind turbines, foundations, inter-array cables, interconnector cables, scour protection, cable protection and offshore substation platforms (OSPs) forming part of the Morgan Offshore Wind Project: Generation Assets will be located.
Multivariate	Having or involving a number of independent mathematical or statistical variables.
Polyaromatic hydrocarbons	A class of chemicals that occur naturally in coal, crude oil, and gasoline.
Polychlorinated biphenyls	They belong to a broad family of human-created organic chemicals known as chlorinated hydrocarbons. Although most were banned in 1986, they linger on in detectable levels in animals, fish and humans.
Porifera	A phylum of aquatic invertebrate animals that comprises the sponges.
SIMPER	Calculates the contribution of each species (%) to the dissimilarity between each two groups.
Simprof	A series of similarity profile permutation tests run on biotic data which looks for statistically significant evidence of genuine clusters of sites which were previously unstructured.
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
Special Area of Conservation (SAC)	Special Areas of Conservation (SACs) are areas designated under the European Union (EU) Habitat's Directive to help conserve certain plant and animals species listed in the Directive. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).
Site of Special Scientific Interest (SSSI)	A Site of Special Scientific Interest (SSSI) is a formal conservation designation, and is defined as an area that is of particular interest to science by reason of any of its flora, fauna, geological, geomorphological or physiographical features.
Sublittoral	Area extending seaward of low tide to the edge of the continental shelf.
Subtidal	Area extending from below low tide to the edge of the continental shelf.
Univariate	Analysis of one variable, with the purpose being to understand the distribution of values for a single variable.

Acronyms

Acronym	Description
AL1/AL2	Action Level 1/Action Level 2
BAC	Background Assessment Concentrations
BAP	Biodiversity Action Plan

Acronym	Description
CCW	Countryside Council Wales
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CMACS	Centre for Marine and Coastal Studies
CSQGs	Canadian Sediment Quality Guidelines
DDV	Drop Down Video
DESNZ	Department for Energy Security and Net Zero
eDNA	Environmental Deoxyribonucleic Acid
EIA	Environmental Impact Assessment
ERL	Effects Range Low
ERM	Effects Range Median
EMODnet	European Marine Observation and Data Network
EUNIS	European Nature Information System
EWG	Expert Working Group
FOCI	Feature of Conservation Interest
IEF	Important Ecological Feature
ISQG	Interim Marine Sediment Quality Guidelines
JNCC	Joint Nature Conservation Committee
LOD	Limit of Detection
MCZ	Marine Conservation Zone
MDS	Multi-Dimensional Scaling
MHWS	Mean High Water Spring
MMEA	Manx Marine Environmental Assessment
MMO	Marine Management Organisation
MNR	Marine Nature Reserve
NBN	National Biodiversity Network
NMBAQC	North East Atlantic Marine Biological Analytical Quality Control
NQ	Not Quantifiable
NRW	Natural Resources Wales
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo and Paris Conventions
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEIR	Preliminary Environmental Information Report
PEL	Probable Effect Level
PSA	Particle Size Analysis
SAC	Special Areas of Conservation

Acronym	Description
SACFOR	Super Abundant, Abundant, Common, Frequent, Occasional and Rare
SD	Standard Deviation
SEA	Strategic Environmental Assessment
SNCB	Statutory Nature Conservation Body
SSSI	Site of Special Scientific Interest
TEL	Threshold Effect Level
TOC	Total Organic Carbon
WFD	Water Framework Directive
ZoI	Zone of Influence

Units

Unit	Description
°	Degrees
%	Percentage
μm	Micrometre
mm	Millimetre
cm	Centimetre
m	Metre
m^2	Square metre
km	Kilometre
km^2	Square kilometres
nm	Nautical Miles
g	Grams
mg/kg	Milligrams per kilogram
μg/g	Micrograms per gram
ml	Millilitre
l	Litre
^oC	Degrees Celsius

1 Benthic subtidal ecology technical report

1.1 Introduction

1.1.1.1 This benthic subtidal ecology technical report provides a detailed baseline characterisation of the benthic subtidal ecology (e.g. species, communities and habitats) associated with the Morgan Offshore Wind Project: Generation Assets (hereafter referred to as the Morgan Generation Assets). The Morgan Generation Assets are located within the east Irish Sea, north of Conwy, Wales, and west of Lancashire, England and southeast of the Isle of Man.

1.1.1.2 Data was collected through a detailed desktop study of the existing resources available for benthic subtidal ecology within the regional benthic subtidal ecology study area, incorporating site-specific survey data and data from third party organisations.

1.1.1.3 The aim of this technical report is to provide a robust baseline characterisation of the benthic subtidal ecology resources within the defined study areas (see section 1.2) against which the potential impacts of the Morgan Generation Assets can be assessed. To support the assessment of effects in the Environmental Impact Assessment (EIA), the ecological information presented in this technical report was used to identify a number of Important Ecological Features (IEFs). Benthic IEFs were determined based on the conservation, ecological, and commercial importance of each identified feature within the Morgan Generation Assets and therefore within the Morgan benthic subtidal ecology study area.

1.1.1.4 This technical report is structured as follows:

- Section 1.2: Study area – Overview of the study areas that are relevant to the report
- Section 1.3: Consultation – Communication with Statutory Nature Conservation Bodies (SNCBs) and other stakeholders
- Section 1.4: Methodology – Overview of desktop study and site-specific surveys used to inform the baseline
- Section 1.5: Desktop study baseline characterisation – Details the results of the desktop study
  - Section 1.5.1: Regional benthic subtidal ecology study area
  - Section 1.5.2: Benthic subtidal ecology study area
- Section 1.6: Designated sites – Details the sites of nature conservation importance, which are designated for benthic ecology features, within the regional benthic subtidal ecology study area
- Section 1.7: Site-specific survey baseline characterisation – Details the results of the site-specific surveys
  - Section 1.7.1: Methodology
  - Section 1.7.2: Results - Sediment analysis
  - Section 1.7.3: Results - Infaunal analysis
  - Section 1.7.4: Results - Epifaunal analysis
  - Section 1.7.5: Results - Habitat assessments
  - Section 1.7.6: Results - Combined infaunal and epifaunal subtidal biotopes

- Section 1.8: Summary.

1.2 Study area

1.2.1.1 For the purposes of the benthic subtidal ecology assessment, two study areas have been defined:

- The Morgan benthic subtidal ecology study area has been defined as the area encompassing the Morgan Array Area. The Morgan benthic subtidal ecology study area also includes the area within one tidal excursion around the Morgan Array Area referred to as the Zone of Influence (ZoI). These are the areas within which the site-specific benthic subtidal surveys have been undertaken. The site-specific subtidal surveys within the Morgan benthic subtidal ecology study area were undertaken in conjunction with the site-specific benthic surveys for the neighbouring Mona Offshore Wind Project (which partially overlapped with the Morgan Array Area ZoI). The statistical analysis, presented in this technical report, has been undertaken on the combined dataset collected within both the Morgan Array Area (including the ZoI) and the Mona Array Area with the data collected for the Mona Offshore Wind Project used to provide additional context for the data within the Morgan Array Area.
- The regional benthic subtidal ecology study area for the Morgan Generation Assets encompasses the wider east Irish Sea habitats and includes the neighbouring consented offshore wind farms and designated sites (Figure 1.1). It has been characterised by desktop data and provides a wider context to the site-specific data collected within the Morgan benthic subtidal ecology study area.

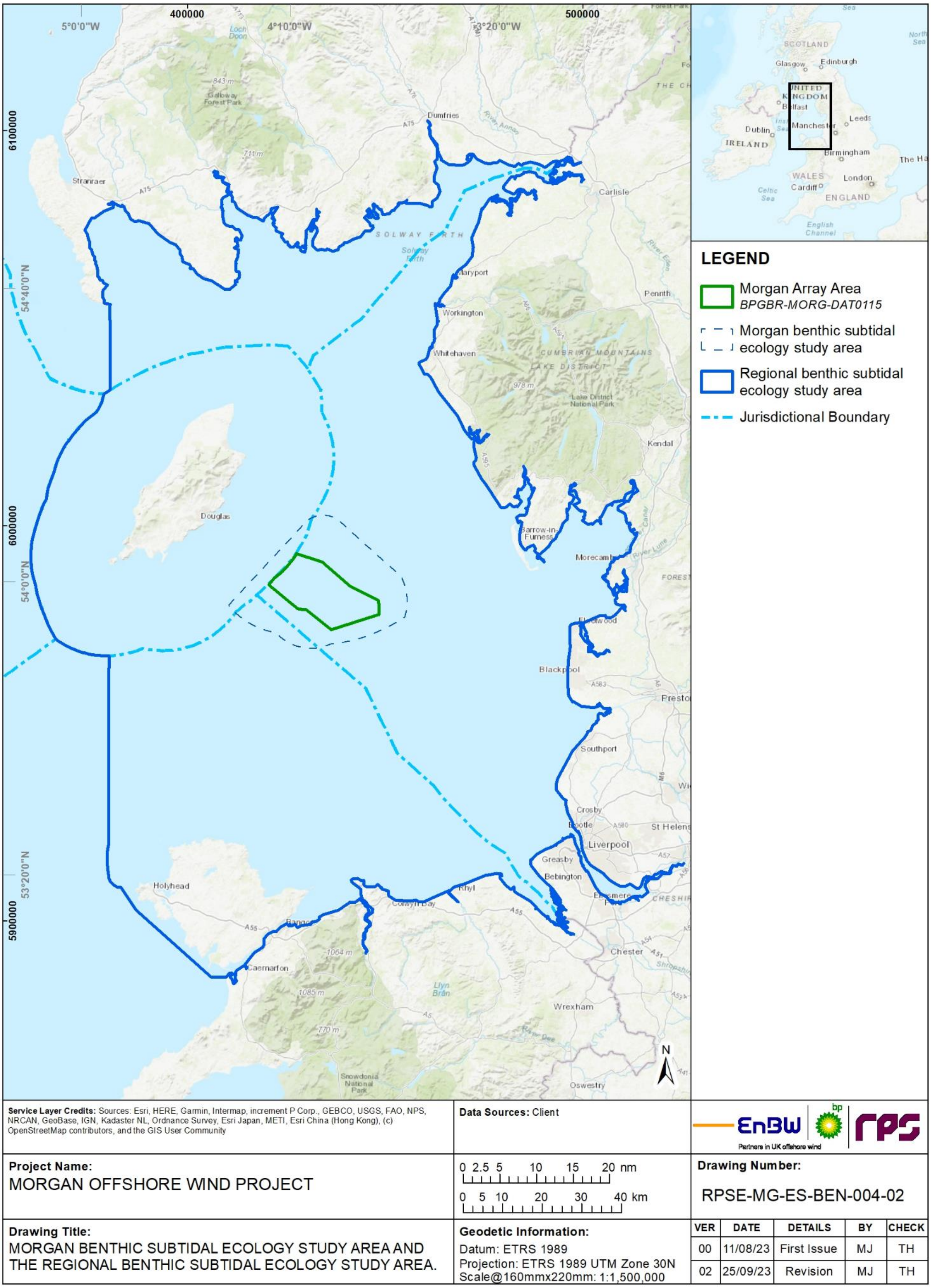


Figure 1.1: Morgan benthic subtidal ecology study area and the regional benthic subtidal ecology study area.

1.3 Consultation

1.3.1.1 A summary of the key matters raised during consultation activities undertaken to date specific to benthic subtidal ecology is presented in Table 1.1 below.

Table 1.1: Summary of key matters raised during consultation activities undertaken for the Morgan Generation Assets relevant to benthic subtidal ecology.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this technical report
March 2021	Joint Nature Conservation Committee (JNCC), Natural England and Natural Resources Wales (NRW) - email	Provision of initial information on the geophysical and benthic survey for the Morgan Array Area only.	The methods used for the site-specific surveys within the Morgan benthic subtidal ecology study area are presented in section 1.7.1. The site-specific surveys relevant to this technical report are listed in Table 1.4.
May 2021	JNCC, Natural England and NRW - email	Provision of the benthic survey strategy for the Morgan Array Area only.	The methods used for the site-specific surveys within the Morgan benthic subtidal ecology study area are presented in section 1.7.1.
June 2021	JNCC, Natural England and NRW – email/meeting	Provision of the updated benthic survey strategy and summary of changes. Benthic survey scope meeting. Provision of updated survey plan and final meeting minutes incorporating stakeholder comments.	The methods used for the site-specific surveys within the Morgan benthic subtidal ecology study area are presented in section 1.7.1.
December 2021	RPS - email	Provision of various guidance documents on Water Framework Directive (WFD), Marine Mammal (MM) and benthic topics. High level comments on the cable routing study.	Any guidance used to inform this technical report has been listed in section 1.7.1.
February 2022	Benthic ecology, fish and shellfish and physical process Expert Working Group (EWG) meeting	The purpose of this meeting was to introduce the project, discuss the remit of the EWG and Ways of Working. Also discussed were the ongoing surveys and preliminary results from these. Historic feedback received from SNCBs on the surveys and approach to addressing these comments (e.g. filling any potential data gaps) as part of the wider baseline characterisation for the relevant topics was also discussed.	The methods used for the site-specific surveys within the Morgan benthic subtidal ecology study area are presented in section 1.7.1 and the results are presented in section 1.7.2 to 1.7.6.
March 2022	JNCC – EWG meeting response	JNCC note the presence and initial analysis of sea-pen and burrowing megafauna communities within the array area and welcome the opportunity to review the assessment of this feature. JNCC provided information which may prove useful in further analysis.	The seapen and burrowing megafauna habitats assessments are presented in section 1.7.5.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this technical report
		JNCC also notes the presence of habitat which is being categorised as 'low' resemblance to stony reef habitat and provided guidance to ensure JNCC Report 6562 published in September 2020 is considered in the assessment of this habitat.	The stony reef assessments are presented in section 1.7.5 with the full data provided in Appendix B. This assessment has been undertaken in accordance with the Irving (2009) and Golding *et al*. (2020) guidance.
April 2022	RPS - email	Provision of the Survey Scope of Work for the Morgan 2022 Benthic Ecology Subtidal Survey covering the Morgan ZoI for the Array Area.	The methods used for the site-specific surveys within the Morgan benthic subtidal ecology study area are presented in section 1.7.1.
	NRW - email	NRW recommend one sample station per habitat increasing accordingly depending on the coverage of the habitat. NRW broadly agree with the sample spacing but advise that frequency increase in the nearshore/intertidal. NRW welcome the avoidance of sensitive habitats (i.e. *Sabellaria spinulosa* reef, *Sabellaria alveolata* reef, *Modiolus* etc.) encountered during grab sampling. Recommend moving grab sample (e.g. 50m based on habitat sensitivity or survey specificity).	The sampling approach is described in section 1.7.1 and has been designed using a combination of desktop data and site specific geophysical data to ensure coverage all of potential habitats in the Morgan benthic subtidal ecology study area.
	JNCC - email	Requested clarification as to whether the number of stations specified is for both Morgan Generation Assets and Mona Offshore Wind Project or will apply separately to each. JNCC requested information on low resemblance reefs be shared. JNCC appreciate Ocean quahogs *Arctica islandica* being returned to the sea and recommend return to suitable habitat.	The number of stations assessed for the Morgan Generation Assets has been stated in section 1.7.1. The stony reef assessments are presented in section 1.7.5 with the full data provided in Appendix B.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this technical report
	Natural England – email	Natural England welcomed the wide scope of the 2022 survey area including the ZoI. Any maps should include all relevant designated sites. Natural England also requested a map of the expected habitats within the 2022 survey area and the sample stations should be arranged to ground truth this information. Supported the use of video and stills to assess habitats. Welcomed the avoidance of sensitive habitats and the collection of environmental DNA (eDNA) information.	Figure 1.4 shows all the relevant designated sites within the regional benthic subtidal and intertidal ecology study area. Desktop data regarding the habitats which may be expected in the Morgan benthic subtidal ecology study area can be found in section 1.5 as well as Figure 1.2 and Figure 1.3. The sampling strategy for the 2022 survey considered this desktop data and was further refined by site specific geophysical data to capture the full range of habitats within the Morgan benthic subtidal ecology study area.
	Marine Management Organisation (MMO) – EWG meeting response	The MMO requests confirmation that the benthic grab samples collected in relation to the developments will be processed to the recommended national processing guidelines (Worsfold and Hall, 2010) and that the resultant data will be made available as soon as possible.	The macrofaunal analysis was undertaken by Thomson Ecology to North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) processing guidelines (Worsfold and Hall, 2010). The full data is available on request.
		The MMO noted that the sampling stations should be suitably located and representative to allow ground truthing of the indicative habitats. Should habitats encountered differ from those expected based on the geophysical data acquired then we would expect to see an increase in sample stations to ensure that all potential habitats are sampled and mapped. The stations should ensure sampling of all habitats and particularly transitions between habitats.	The sample stations were located to sample the full range of habitats expected to occur in the Morgan Array Area and ZoI. The survey scope was kept flexible to allow for the addition of sample stations if necessary.
		The MMO requested clarity on whether the 50 stations for co-located camera and sediment sampling across the Morgan and Mona Array Areas and ZOIs were the combined total for both projects or 50 stations per project. JNCC recommended that the number of sample sites not be capped at 50 and should instead be based on geophysical evidence.	As noted above, the scope of works was kept flexible so that sample stations could be added based on the geophysical data.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this technical report
May 2022	Isle of Man Department of Infrastructure – Scoping Opinion	The Territorial Sea Committee would draw the applicant's attention to the Manx Marine Environmental Assessment (MMEA) which provides a useful overview of the Island's marine environment and should be taken into account as part of both the transboundary and possibly also the cumulative impacts assessment as part of this application. Specifically chapter 3.3 of the Scoping Report (Subtidal Ecology) contains information that would improve upon the data provided, including in sections 4.1.4.18 (*S. spinulosa*) and 4.1.4.19 (*Modiolus reefs*).	The MMEA has been used as a source in the desktop study baseline characterisation (section 1.5).
		The regional benthic subtidal ecology study area (Figure 4.1): The straight line seems rather arbitrary from an effects perspective. It appears odd that the southwest part of the Manx territorial sea has not been included. This appears to be neither an ecological or jurisdictional- based boundary decision and warrants further clarification.	The regional benthic subtidal ecology study area (Figure 1.1) has been amended to include the Isle of Man's territorial waters.
		Given the inclusion of a substantial part of the Manx territorial sea, and a request for complete inclusion, there are no datasets or reports indicated for the area of the Manx territorial sea.	The MMEA as well as other sources has been used in the desktop study baseline characterisation as well as the identification of designated sites (section 1.5 and 1.6.4 respectively).
	NRW – Scoping Opinion	NRW (A) would add the following data sources to Parts 2 & 3: Table 4.1 Summary of key desktop datasets and reports: • Lle Geo-Portal for Wales: Lle - Home (gov.wales) • Data Map Wales: Home | DataMapWales (gov.wales).	The Lle Geo-portal and the DataMapWales have both been used to define the baseline for the regional benthic subtidal and intertidal ecology study area (section 1.5).
		Please note that all reference to 'Cobble reef' should be amended to 'Stony reef' as this is the correct habitat name/definition under the Habitats Directive.	All references to cobble reef have been removed and replaced with stony reef within this technical report.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this technical report
June 2022	The Planning Inspectorate – Scoping Opinion	The regional benthic subtidal study area includes a straight-line boundary on the west edge which appears arbitrary from an effects perspective. The study area should sufficiently encompass the full extent of any receptors likely to be significantly affected.	The regional benthic subtidal ecology study area (Figure 1.1) has been amended to include the Isle of Man's territorial waters.
		The Scoping Report states that from initial analysis of data, the Morgan Potential Array Area is unlikely to have more than a low resemblance to the habitat 'sea pen and burrowing megafauna communities'. There is a possible presence of two areas that show a low resemblance to a 'rocky reef' habitat. The Applicant's attention is directed to JNCC Report No 656: Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef', which may be useful for the determination of such habitat.	The stony reef assessments are presented in section 1.7.5 with the full data provided in Appendix B. This assessment has been undertaken in accordance with the Irving (2009) and Golding *et al*. (2020) guidance.
December 2022	Benthic ecology, fish and shellfish and physical process EWG meeting 2	The meeting presented the result of the baseline characterisation and the preliminary outputs of the impact assessment. NRW provided updated guidance for Wales on when low resemblance rocky reef should be considered as Annex I features.	The results for the site-specific surveys within the Morgan benthic subtidal ecology study area are presented in section 1.7.2 to 1.7.6. The methodology used to determine the low resemblance stony reef has been defined in section 1.7.1. No rocky reef was identified within the Morgan benthic subtidal ecology study area.
March 2023	Benthic ecology, fish and shellfish and physical process EWG meeting 3	The Centre for Environment, Fisheries and Aquaculture Science (Cefas) highlighted they may have queries later in terms of where the grab imagery data and eDNA will be shown.	The drop down video (DDV) imagery data has been included in the epifaunal analysis (section 1.7.4) and the eDNA analysis is included in Appendix H, the full data is available on request.
June 2023	MMO – Section 42 Consultation on the Preliminary Environmental Information Report (PEIR)	The MMO considers that the 'seapens and burrowing megafauna' sensitive habitat is present in the Morgan benthic subtidal ecology study area and should be scoped in to assessments.	The assessment for seapens and burrowing megafauna habitat can be found in section 1.7.5, the results of this assessment have led to this habitat being added as an IEF (Table 1.19)

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this technical report
		The MMO recommends more information should be provided to compare the observed presence of characteristic species of the ‘fragile sponge and anthozoan communities on rocky habitats’, to any quantitative thresholds referenced in the definition of this habitat. If such thresholds are not defined or the available data doesn’t allow a comparison to such thresholds, then it is appropriate to be precautionary and assume that this habitat is present in the areas, even where only a low abundance has been observed.	An assessment regarding ‘fragile sponge and anthozoan communities on rocky habitats’ can be found in section 1.7.5 and the full image analysis for stations where sponges and anthozoans were identified can be found in Appendix B.
		The MMO noted that Thomson Environmental Consultants are not validated by the MMO to undertake particle size analysis (PSA) in support of marine licences, and therefore these results cannot be considered for purposes of dredge and disposal operations.	The PSA analysis was conducted by Kenneth Pye Associates Ltd. and Ocean Ecology (both MMO validated laboratories).
		The MMO noted that some inconsistencies regarding sediment contamination data e.g. the number of samples taken and the number presented.	Inconsistencies regarding the sediment chemistry analysis have been addressed. Analysis is presented in section 1.7.2 and full data is presented in Appendix F.
	The Isle of Man Department of Infrastructure	The Isle of Man Department of Infrastructure would draw the applicant's attention to MMEA which provides a useful overview of the Island's marine environment and should be taken into account as part of both the transboundary and possibly also the cumulative impacts assessment as part of this application. More detail will be provided below in respect of specific areas of the MMEA that should be reviewed.	The MMEA has been used as a source in the desktop study baseline characterisation (section 1.5).
	Natural England – Section 42 Consultation on PEIR	Natural England noted that further surveys were undertaken in summer 2022, but no results are currently included in the technical report. It would have been beneficial for the survey locations to be included as a figure in the report. They have reserved the right to change their comments and position during the Environmental Statement consultation, subject to the outcome of further data analysis.	The analysis of data collected in the Morgan Array Area ZoI in 2022 have been added to the analysis in section 1.7 to define the baseline characterisation for the Morgan benthic subtidal ecology study area. The full data is available on request.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this technical report
		Natural England noted that there is no indication of how the geophysical data was used to inform the positioning of the sample stations or any indication of the bedforms encountered and how they may have related to the ecology or have been used to create the habitat map. Natural England advised that details of geophysical surveys, and correlation of the geophysical data is included with benthic ecology data to provide confidence in the mapped outputs.	Information regarding the use of geophysical information to support the sampling regime has been added to section 1.7.1. Furthermore a summary of the results of the geophysical data has been added to section 1.7.2.
		Natural England advised that details of geophysical surveys, and correlation of the geophysical data is included with benthic ecology data to provide confidence in the mapped outputs. They noted there is no legend to explain the colours within the Morgan Array Area in Figure 1.21. They asked that a legend is included for all the features displayed in the map in Figure 1.21.	Information regarding the use of geophysical information to support the sampling regime has been added to section 1.7.1. Furthermore a summary of the results of the geophysical data has been added to section 1.7.2. Legends have been included for all figures in this report.
		Natural England welcomes the inclusion of the Mona survey results, which help to provide context to the results within Morgan benthic study area.	Infauna and epifauna data collected within the Mona Array Area is included in the infaunal and epifaunal analysis presented in sections 1.7.3 and 1.7.4.
July 2023	Benthic ecology, fish and shellfish and physical process EWG meeting 4	The meeting presented the some of the most prominent section 42 responses and how they will be addressed in the Environmental Statement. This included comments regarding the PSA analysis and sediment contamination data.	The relevant benthic ecology section 42 responses have been recorded above in this table along with how they have been addressed in this technical report.

1.4 Methodology

1.4.1 Overview

1.4.1.1 A desktop review has been undertaken to inform the baseline for benthic subtidal ecology, including a review of a number of academic reports and reports from surveys undertaken to support other project consents. These provide further context to the site-specific surveys.

1.4.1.2 A benthic subtidal survey of the Morgan Array Area was undertaken in 2021 and a benthic subtidal survey of the Morgan Array Area and ZoI (i.e. the Morgan benthic subtidal ecology study area) was undertaken in 2022. The results of these surveys have been used to characterise the Morgan benthic subtidal ecology study area, for the purposes of informing the benthic subtidal ecology EIA chapter (Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement).

1.4.1.3 The subtidal benthic ecology surveys of the Morgan benthic subtidal ecology study area consisted of grab sampling and DDV sampling. Analysis of results included multivariate and univariate statistical analyses as well as descriptions of the raw data. As outlined in section 1.2, the 2021 surveys within the Morgan Array Area were undertaken in conjunction with the site-specific benthic surveys for the neighbouring Mona Offshore Wind Project. The statistical analysis, presented in this technical report, has been undertaken on the combined dataset collected within both the Morgan Array Area (in 2021) and ZoI (in 2022) and the Mona Array Area (in 2021). Since the submission of the PEIR for the Morgan Generation Assets, there has been a refinement of the Morgan Array Area. The result of this is that some of the 2021 sample stations which were previously located in the Morgan Array Area now fall within the Morgan Array Area ZoI. The data collected for the Morgan Generation Assets has been used to provide additional context for the data within the Morgan benthic subtidal ecology study area.

1.4.1.4 Detailed methodologies for all site-specific surveys and analyses are presented in section 1.7.1.

1.4.2 Desktop study

1.4.2.1 Information on benthic subtidal ecology within the regional benthic subtidal ecology study area and the Morgan benthic subtidal ecology study area was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 1.2: below.

Table 1.2: Summary of key desktop sources.

Title	Source	Year	Author
Mona Offshore Wind Project, Volume 6, Annex 2.1: Benthic subtidal and intertidal ecology technical report of the Environmental Statement	Mona Offshore Wind Ltd.	2024	Mona Offshore Wind Ltd.
Morecambe Offshore Windfarm: Generation Assets PEIR, Volume 1, Chapter 9: Benthic ecology	Morecambe Offshore Windfarm Ltd.	2023	Morecambe Offshore Windfarm Ltd.
Data Map Wales	Welsh Government	2023	Welsh Government
Awel y Môr Environmental Impact Assessment, Volume 2, Chapter 5: Benthic Subtidal and Intertidal Ecology	RWE	2022	RWE
The National Biodiversity Network (NBN) Gateway	https://nbnatlas.org/	Accessed April 2022	https://nbnatlas.org/
European Marine Observation and Data Network (EMODnet) broadscale seabed habitat map for Europe (EUSeaMap)	EMODnet-Seabed Habitats	2019	EMODnet-Seabed Habitats
Subtidal Ecology. In: Manx Marine Environmental Assessment (2nd Ed).	The Government of the Isle of Man	2018	Lara Howe

Title	Source	Year	Author
Coastal Ecology. In: Manx Marine Environmental Assessment (2nd Ed).	The Government of the Isle of Man	2018	Lara Howe
Burbo Bank Offshore Wind Farm Benthic and Annex I Habitat Pre-construction Survey Field Report	Burbo Bank Offshore Wind Farms (UK) Ltd/DONG Energy	2015	Burbo Bank Offshore Wind Farm Benthic and Annex I Habitat Pre-construction Survey Field Report
Rhiannon Wind Farm Preliminary Environmental Information Chapter 9 Benthic Ecology	Celtic Array Ltd	2014	Celtic Array Ltd
Burbo Bank Extension Offshore Wind Farm Environmental Statement Volume 2 – Chapter 12: Subtidal and Intertidal Benthic Ecology	Dong Energy Ltd	2013	Dong Energy Ltd
Volume 1 Environmental Statement Walney Extension, Chapter 10: Benthic Ecology	Dong Energy Ltd	2013	Dong Energy Ltd
Ormonde Offshore Wind Farm Year 1 post-construction benthic monitoring technical survey report (2012 survey)	RPS Energy	2012	CMACS
Walney Offshore Wind Farm Year 1 postconstruction benthic monitoring technical survey report (2012 survey)	Walney Offshore Wind Farms (UK) Ltd/DONG Energy	2012	CMACS
A Review of the Contaminant Status of the Irish Sea	Cefas	2005	Cefas
Gwynt y Môr offshore wind farm Marine Benthic Characterisation Survey	Gwynt y Môr offshore wind farm Ltd	2005	Centre for Marine and Coastal Studies (CMACS)
Phase I- Intertidal Survey- Standard Report'	Countryside Council for Wales	2004	Countryside Council for Wales
North Hoyle offshore windfarm Environmental Statement	Innogy NWP offshore Ltd.		North Hoyle offshore windfarm Environmental Statement
Broadscale seabed survey to the east of the Isle of Man	Holt et al.	1997	Holt *et al*.
Offshore benthic communities of the Irish Sea	Mackie	1990	Mackie

1.5 Desktop study baseline characterisation

1.5.1 Regional benthic subtidal ecology study area

Subtidal sediments

1.5.1.1 The Offshore Energy Strategic Environmental Assessment (SEA), produced by Department for Energy Security and Net Zero (DESNZ), Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), and Department for Business, Energy & Industrial Strategy (DBEIS) (2023), included a baseline of the offshore benthic environment around the UK. The SEA process aims to help inform licensing and leasing decisions by considering the environmental implications of the proposed plan/programme and the potential activities which could result from their implementation (DESNZ *et al*., 2023). The benthic baseline information for the Offshore Energy SEA 4 was created from an amalgamation of sources such as Jones *et al.* (2004a-f), MESH (2005-2008), EUSeaMap2 (found on EMODnet) and EMODnet (2019). Offshore Energy SEA 4 divided the UKs exclusive economic zone into regional seas to characterise them; the regional benthic subtidal ecology study area lies within regional sea 6, the Irish Sea. It identified that the offshore seabed in the east Irish Sea, within the regional benthic subtidal ecology study area, is predominantly sedimentary, mainly of glacial origin, consisting mostly of sands and muddy sands, coarse and mixed sediments. In deeper sections tide-swept circalittoral mixed sediments were identified, in the south of the regional benthic subtidal ecology study area. In the nearshore, along the north Wales coast, the sediment is largely sandy mud or muddy sand (where it has been defined). Similar sediments are located along the west coast of England.

1.5.1.2 A large broadscale subtidal survey carried out in 1997 by the University of Liverpool, on behalf of bp (Holt *et al*., 1997), used side scan sonar and video survey methods to characterise the benthos in the region east of the Isle of Man within the regional benthic subtidal ecology study area. The survey showed the area to be relatively uniform, consisting of fine and medium sands with varying proportions of stones and shells. The surveys also identified widespread areas of fine scale sand waves or sand ripples. The sand waves and sand ripples identified consisted of much coarser sands, stones and gravel often with very large proportions of dead shell material. Muddy sediments were recorded in only a few patches in the regional benthic subtidal ecology study area, the largest of which were to the west of the Isle of Man.

1.5.1.3 The EMODnet broad-scale habitat map for Europe (EUSeaMap) presents the European Nature Information System (EUNIS) habitat classifications for the Irish Sea (Figure 1.2). The subtidal sediments of the regional benthic subtidal ecology study area have been recorded by the EMODnet (2019) as being dominated by deep circalittoral coarse sediment, offshore circalittoral sand, circalittoral mixed sediment and offshore circalittoral mud which is characteristic of the Irish Sea (EMODnet, 2019). The EMODnet broad-scale habitat map predicts large areas of high energy infralittoral habitat at the mouth of the river Mersey, the river Dee and river Conwy in the south and southeast of the regional benthic subtidal ecology study area, as well as the river Kent, river Leven, river Lune and the river Duddon in the east around Morecambe Bay. High energy infralittoral habitat is also predicted in Luce Bay and Wigtown Bay in the north of the regional benthic subtidal ecology study area. There is also a large area of infralittoral sand at the entrance of the Solway Firth which is determined to be a moderate energy environment (EMODnet, 2019). Deep circalittoral coarse sediments were recorded to the south and east of the Isle of Man, while infralittoral coarse sediments were recorded to the north of the Isle of Man (EMODnet, 2019). A mix of circalittoral coarse sediments and infralittoral coarse sediments were present in the east and west of the Isle of Man (EMODnet, 2019).

1.5.1.4 Surveys conducted by the Gwynt y Môr offshore wind farm, Burbo Banks offshore wind farm and Burbo Bank Extension (Figure 1.3) were located in the south of the regional benthic subtidal ecology study area. Pre-construction and post-construction monitoring and baseline characterisation surveys were undertaken for these projects between 2010 and 2012. These surveys characterised the sediments in the south of the regional benthic subtidal ecology study area as being dominated by circalittoral sand and coarse sediment, as well as muddy sand and sandy mud further inshore towards the north Wales coast (CMACS, 2011; SeaScape Energy, 2011; Dong Energy Ltd, 2013a). These areas of circalittoral sand in the south of the regional benthic subtidal ecology study area were interspersed with areas of circalittoral rock around the northwest coast of Anglesey (EMODnet, 2019).

1.5.1.5 The EMODnet seabed map (2019) shows subtidal sediments along the north Wales coast as being dominated by circalittoral fine sand and circalittoral muddy sands in a high energy environment, with areas of coarse sediment closer to shore around the Great Orme headland, interspersed with sections of infralittoral rock close to shore on the east and west sides of the Great Orme headland. A larger area of coarse sediment is mapped north of Colwyn Bay which extends slightly east of Rhyl (shown in Figure 1.2; EMODnet, 2019).

1.5.1.6 The proposed, and now dropped, Rhiannon Wind Farm was to be located in the east of the regional benthic subtidal ecology study area (Figure 1.3). Baseline characterisation surveys in 2010 and 2012 for the Rhiannon Wind Farm identified two large sandbanks off Lynas point, north Anglesey and in the east of the regional benthic subtidal ecology study area. These were composed of very well sorted mobile sand that remained submerged at all times (Celtic Array Ltd, 2014). The banks consist of medium and coarse sands with minimal mud or gravel content (Celtic Array Ltd, 2014). These banks were considered to be examples of the Annex I habitat sandbanks which are slightly covered by sea water at all times (Celtic Array Ltd, 2014).

1.5.1.7 The Mona Offshore Wind Project is located in the south of the regional benthic subtidal ecology study area (Figure 1.3). Baseline characterisation surveys of the Mona Array Area and ZoI determined that the sediment ranged from sandy gravel to slightly gravelly muddy sand with most samples classified as gravelly muddy sand (Mona Offshore Wind Ltd., 2024). Within the Mona Offshore Cable Corridor the sediment was predominantly classified as either gravelly muddy sand or sand, becoming finer closer to the coast (Mona Offshore Wind Project Ltd., 2024).

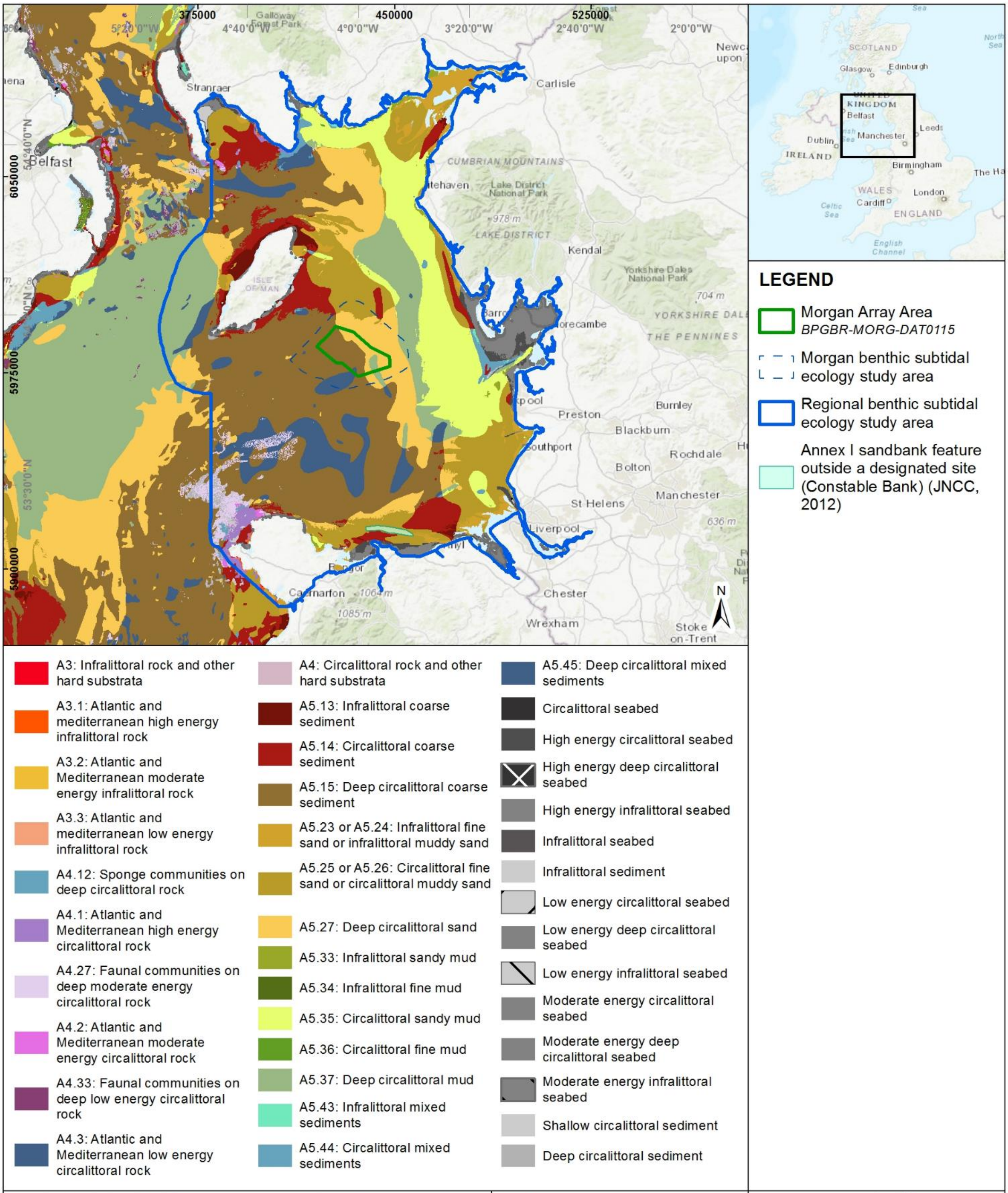
1.5.1.8 The Morecambe Offshore Windfarm is located in the east of the regional benthic subtidal ecology study area (Figure 1.3). Baseline characterisation surveys for the of the Morecambe Offshore Windfarm determined that the most common sediment type was muddy sand but sediment types ranged from slightly gravelly sand to sandy mud (Morecambe Offshore Windfarm Ltd., 2023). Sediment composition at all stations was dominated by sand with sample stations in the west and south west of the survey area being slightly coarser than those in the east (Morecambe Offshore Windfarm Ltd., 2023)

1.5.1.9 The proposed Awel y Môr offshore wind farm, also in the south of the regional benthic subtidal ecology study area, undertook site specific baseline characterisation surveys in 2022 (RWE, 2022). The survey identified the seafloor in the southeast of the array area was characterised by numerous sandwaves and megaripples, while the west of the site was relatively flat and featureless (RWE, 2022). Sandwaves were reported to be actively mobile and migrating. In the west of the survey area sediments contained a sand, gravel and a small fines fraction (RWE, 2022). In the east of the array area, sandwaves and megaripples were evident and were formed by sands with a low gravel content (RWE, 2022).

1.5.1.10 The Walney and Ormonde offshore wind farms are located in the east of the regional benthic subtidal ecology study area (Figure 1.3). Pre-construction and post-construction monitoring, and baseline characterisation surveys were undertaken for these projects between 2009 and 2014. Surveys conducted for Ormonde offshore wind farm and Walney offshore wind farm (Figure 1.3) found the subtidal sediments in the east of the regional benthic subtidal ecology study area were dominated by circalittoral sandy mud or circalittoral muddy sand (CMACS, 2012a; CMACS, 2012b; CMACS, 2012c; CMACS, 2013; CMACS, 2014). The 1-year post-construction surveys (2012) for the Ormonde offshore wind farm recorded a higher percentage of mud further offshore and a lower percentage of mud in the southerly inshore areas (CMACS, 2012a). East of Morecambe Bay in the east of the regional benthic subtidal ecology study the sediment becomes coarser than at the Ormonde offshore wind farm. During the 1 year post-construction monitoring of Walney offshore wind farm in 2013, the Walney array area was shown to be dominated by sandy mud with sediments transitioning to coarse sediment further offshore and inshore of the array area (CMACS, 2013).

1.5.1.11 The subtidal sediments in the southwest of the regional benthic subtidal ecology study area, as determined by baseline characterisation surveys for the Rhiannon Wind Farm, have been recorded as being dominated by sandy gravels or gravelly sand, generally coarse sediments with generally low mud content (Celtic Array Ltd, 2014).

1.5.1.12 The Isle of Man territorial waters also fall within the regional benthic subtidal ecology study area. A marine environmental assessment was undertaken by Howe (2018a) to bring together subtidal surveys which have been conducted around the Isle of Man to create an extensive characterisation of the subtidal environment. The subtidal habitats to the west of the island were shown to be predominantly mixed gravel, mixed stone and mixed sand seabed which extended to the north and the south with a small area of sand/muddy sand in the southeast. The seabed located to the southwest of the island comprises an extensive area of mud/fine sand. The EUSeaMap (Figure 1.2) is aligned with data from Howe (2018a) showing that sediment around the Isle of Man is made of coarse material with sections of fine sand in the southeast as well as the northeast.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, EMODnet, Lle Welsh Geoportal

Project Name: MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

Drawing Number: RPSE-MG-ES-BEN-005-02

Drawing Title: BENTHIC HABITAT TYPES WITHIN MORGAN REGIONAL STUDY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,450,000

VER	DATE	DETAILS	BY	CHECK
00	11/08/23	First Issue	MJ	TH
02	21/09/23	Revision	MJ	TH

Figure 1.2: Benthic habitats (EMODNet, 2019) within the regional benthic subtidal ecology study area.

Sediment contamination

1.5.1.13 Metals occur naturally in the marine environment. Generally elevated contaminant concentrations, such as metals, in the Irish Sea can originate from natural mineralisation or anthropogenic sources (Cefas, 2005). Rowlatt and Lovell (1994) recorded elevated levels of metals in the northeast Irish Sea, which is attributed to inputs from the industrial areas of northwest England for example, Merseyside and Lancashire.

1.5.1.14 Pre-construction surveys conducted for the Burbo Bank offshore wind farm (CMACS, 2005a) identified that seven of the nine core samples across the array area contained metals at, or above, Interim marine Sediment Quality Guidelines (ISQG) levels/Canadian Threshold Effect Levels (TEL). Additionally two metals (lead and mercury) were present in excess of the Canadian Probable Effect Levels (PEL). The Canadian PEL establishes the concentration range within which adverse effects frequently occur (CCME, 2001). A greater proportion of surface sediment samples, especially in the top metre, contained metals above ISQG/Canadian TEL. No metals were in excess of ISQG/Canadian TEL below 1.5 m. Six of these samples were collected in the Burbo Bank offshore wind farm array area (6.4 km from the Sefton coastline) and three in the export cable corridor. The pre-construction site investigation survey concluded that as the contamination occurred in the upper metre of the seabed they would be naturally mobile and therefore any additional works from offshore wind farms would not mobilise any sediment not naturally mobile.

1.5.1.15 Site-specific surveys for Awel y Môr found total Polycyclic Aromatic Hydrocarbons (PAH) concentrations were higher in the array area than the median concentration recorded from the Strategic Environmental Assessment 6 (SEA6) (Cefas, 2005) Irish Sea surveys (0.0237 μg/g) at six stations; however, the median value from the site specific survey was broadly comparable to the SEA6 median value (RWE, 2022). The bioavailable metals concentrations in sediments were all below their respective Cefas ALs (RWE, 2022).

1.5.1.16 Arsenic has regularly been recorded at elevated levels in the east Irish Sea (e.g. Camacho-Ibar *et al*., 1992). Arsenic was recorded above ISQG/Canadian TEL thresholds but below the Canadian PEL at four sites across the Walney offshore wind farm array area as part of the benthic baseline characterisation surveys (Dong Energy Ltd, 2013b) as well as across the former Rhiannon Wind Farm site (Centrica Plc and Dong Energy Ltd, 2014). Studies have found that such elevated arsenic levels were not attributable to anthropogenic sources, the source is considered to be weathering of glaciated regions of north Wales and the Lake District (e.g. Thornton and Farago, 1997).

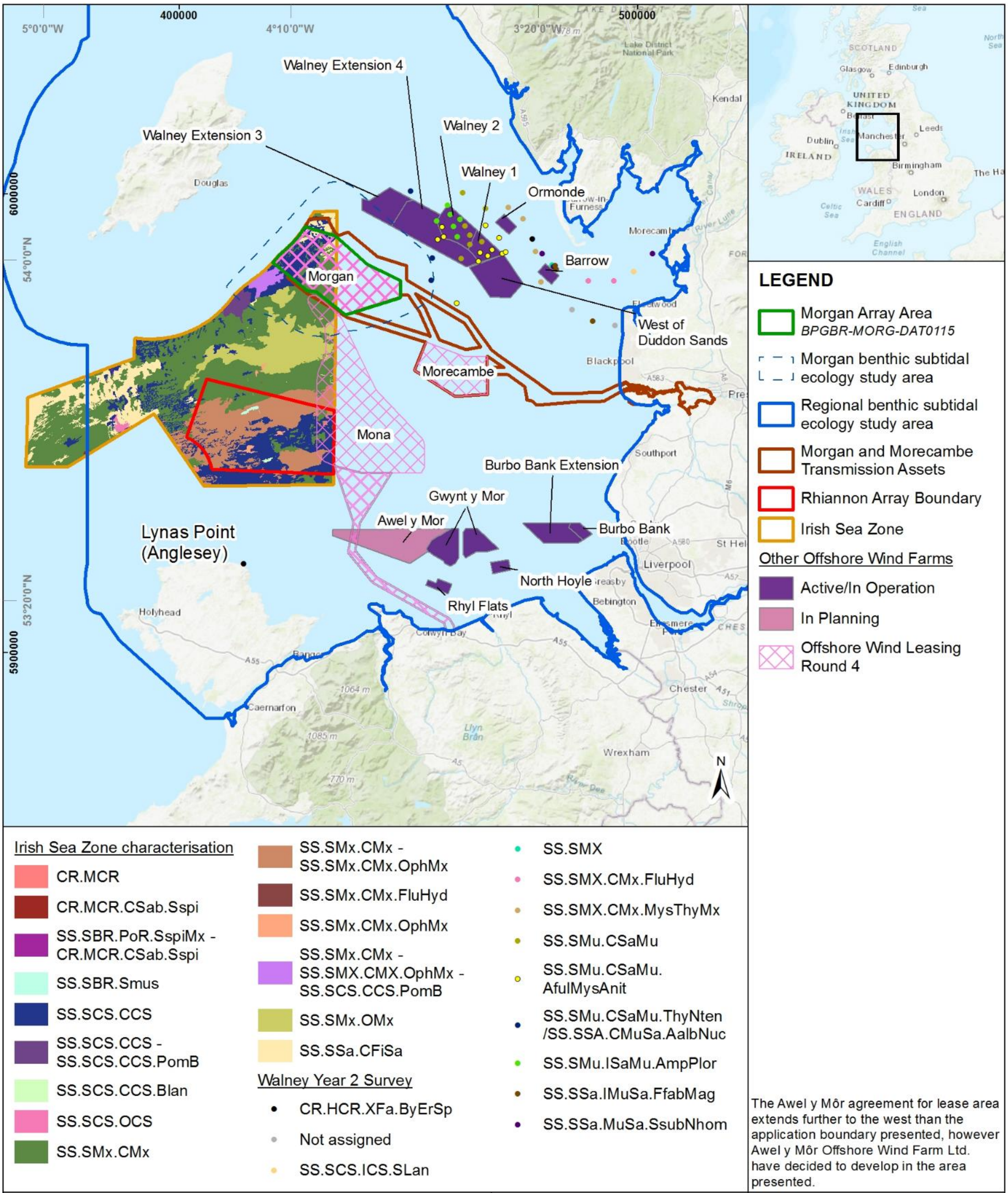
1.5.1.17 Benthic characterisation surveys for the Walney offshore wind farm Environmental Statement (Dong Energy, 2013b) in the north of the regional benthic subtidal ecology study area also identified one sample of mercury above ISQG/Canadian TEL levels. Mercury levels were thought to be reducing in the years leading up to 1993 based in samples from the muscles of plaice *Pleuronectes platessa*, reducing from a mean value of the order of 0.5 mg/kg wet weight in the early 1970s, to approximately 0.2 mg/kg in 1991 (Leah *et al*., 1993). These reductions are due to reduced discharge into the Mersey estuary by the chloro-alkali chemical industry (Dong Energy, 2013b).

1.5.1.18 Surveys at Burbo Bank Extension (Dong Energy Ltd, 2013a) in the southeast of the regional benthic subtidal ecology study area (see Figure 1.3) found no contaminants were present above Canadian PEL however the array area had elevated levels of iron, aluminium, arsenic, copper, zinc and lead above natural background levels, no contaminant was present above Canadian PEL. These results are consistent with the results from surveys for other wind farms in the area which also found elevated levels of the same metals but no exceedances of Canadian PEL thresholds (Burbo Bank (Seascape Energy Ltd, 2002), North Hoyle (RWE, 2002), and Gwynt y Môr (CMACS, 2005b)). The Environmental Statement for Burbo Bank Extension (Dong Energy Ltd, 2013a) found no organochlorine and organophosphorus pesticides were present at detectable levels and no sample at any depth contained polychlorinated biphenyls (PCBs) in excess of the ISQC level. PAHs were present above the limit of detection in only one sample from a single depth in the southwest of the Burbo Bank offshore wind farm.

1.5.1.19 Of the 40 stations sampled for sediment chemistry (metals, organotins, PCBs and PAHs) for the Mona Offshore Wind Project, none exceeded the relevant Cefas AL2, Canadian PEL, Effects Range Median (ERM) or Effects Range Low (ERL) thresholds where these exist (Mona Offshore Wind Ltd, 2024). In the Mona Array Area and ZoI two sample stations exceeded Cefas Action Level 1 (AL1) for arsenic but was below the Cefas Action Level 2 (AL2) threshold, and all but one sample station exceeded the Canadian Threshold Effect Levels (TEL) but was below the Probable Effect Level (PEL) for arsenic. Furthermore, one sample station exceeded the Cefas AL1 for cadmium but was below Cefas AL2. In the Mona Offshore Cable Corridor the concentrations of arsenic exceeded Cefas AL1 at three sample stations and 17 stations were above the Canadian TEL however all were below Cefas AL2 and the Canadian PEL. No samples exceeded the relevant Cefas ALs or the Canadian TEL or PEL for PCBs. Levels of PAHs were below the relevant Canadian TEL and PEL levels, or ERM and ERL thresholds. Concentrations of organotins where below the limit of detection (LOD) at all stations.

1.5.1.20 The Morgan and Morecambe Offshore Wind Farms: Transmission Assets (hereafter referred to as the Transmission Assets) also completed sediment chemistry analysis at 39 stations (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd, 2023). No contaminants were present at levels exceeding the Cefas AL2 or the Canadian PEL thresholds where these exist. Concentrations of nickel exceeded the Cefas AL1 at one station (but was below the Cefas AL2). Concentrations of mercury at seven sites in the nearshore area exceeded the Canadian TEL (but were below the Canadian PEL). Concentrations of arsenic exceeded the Canadian TEL at 17 stations (but were below the Canadian PEL). Concentrations of some PAHs exceeded the Canadian TEL at five stations primarily near the landfall. No other contaminants exceeded any threshold levels.

1.5.1.21 Trace and heavy metal concentrations were overall low across the Morecambe Offshore Windfarm site with none of the metals analysed, except for arsenic, exceeding any of the reference levels (Cefas AL1, Cefas AL2 and Canadian PEL) (Morecambe Offshore Windfarm Ltd., 2023). In general metal concentrations were higher to the east, closer to land than stations located further offshore. Arsenic concentrations exceeded the Canadian TEL at three sample stations. Among all PAHs, naphthalene and pyrene were the ones found to exceed 'Oslo and Paris Convention for the protection of the marine environment of the North-Eastern Atlantic' (OSPAR) Background Assessment Concentrations (BAC) reference levels at six stations. None of the other reference levels (Cefas AL1/AL2, ERL/ERM, Canadian TEL and PEL) was exceeded by any of the analysed PAHs.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Marine Data Exchange, TCE

Project Name: MORGAN OFFSHORE WIND PROJECT

Drawing Number: RPSE-MG-ES-BEN-006-05

Drawing Title: BENTHIC SURVEY RESULTS FOR THE OTHER OFFSHORE WIND PROJECTS IN RELATION TO THE MORGAN BENTHIC SUBTIDAL ECOLOGY STUDY AREA (ALL BIOTOPE CODES ARE DEFINED IN APPENDIX G).

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,400,000

VER	DATE	DETAILS	BY	CHECK
00	11/08/23	First Issue	MJ	TH
05	19/10/23	Revision	MJ	TH

Figure 1.3: Benthic survey results for the other offshore wind projects in relation to the Morgan benthic subtidal ecology study area (all biotope codes are defined in Appendix G).

Subtidal benthic ecology

1.5.1.22 Figure 1.3 displays all the mapped subtidal ecology data available from the offshore wind farms which fall within the regional benthic subtidal ecology study area. Appendix G provides the full names for all the biotopes which are presented in Figure 1.3 and discussed in this technical report.

1.5.1.23 The subtidal benthic communities of the regional benthic subtidal ecology study area were characterised by its sedimentary habitats, Mackie (1990) describes most of the east Irish Sea as being dominated by *Venus* communities. Deep *Venus* communities were characterised by occurrence at depths of 40 to 100 m in coarse sand/gravel/shell sediments and for containing species such as *Spatangus purpureus, Glycimeris*, *Asarte sulcata* and venus clams (Mackie, 1990) (full list of species' common names can be found in Appendix G). Deep *Venus* communities are present in the central and west sections of the regional benthic subtidal ecology study area (Mackie, 1990). Much of the inshore area of the regional benthic subtidal ecology study area can be characterised by shallow *Venus* communities on nearshore sand, tending to occur in waters 5 to 40 m deep, with strong currents and sand. Mackie (1990) also identified pockets of *Abra* communities along the north Wales coastline as well as in the east of the regional benthic subtidal ecology study area. These communities are dominated by the bivalve species *Abra alba* and the polychaete worm *Lagis koreni* (Rees *et al.,* 1972) and the biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (SS.SSa.CMuSa.AalbNuc) (all biotopes codes are defined in full in Appendix G).

1.5.1.24 The Gwynt y Môr (Figure 1.3) pre-construction benthic monitoring surveys (CMACS, 2011) identified the *Moerella* sp. with venerid bivalves in infralittoral gravelly sand (SS.SCS.ICS.MoeVen) biotope and the circalittoral fine sand (SS.SSa.CFiSa) biotope as the most extensively distributed biotopes throughout the survey site. These biotopes are common and widespread biotopes in the local area (i.e. Liverpool Bay and northeast Irish Sea). The biotope *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat) was identified at a few locations within the Gwynt y Môr site but was more dominant at the inshore export cable route and inshore west reference sites. The *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods (SS.SSa.IMuSa.FfabMag) biotope was also described at stations on the south side of the array area, close to the Welsh coast.

1.5.1.25 The Burbo Bank offshore wind farm is located approximately 8 km to the east of Gwynt y Môr offshore wind farm (Figure 1.3). The Environmental Statement for the original Burbo Bank offshore wind farm (SeaScape Energy, 2011) confirms the biotopes found at the extension site. The array area was dominated by the SS.SSa.IMuSa.FfabMag with a small section of SS.SSa.CMuSa.AalbNuc identified in the east of the array area. The wider area around the array area was classified as *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat).

1.5.1.26 The Environmental Statement for this the Burbo Bank offshore wind farm (Dong Energy Ltd, 2013a) reported a variety of biotopes. The south section of the array area was dominated by the *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit) biotope with a large proportion of the north section characterised by the SS.SCS.ICS.MoeVen biotope. The west of the array was characterised by combinations of the biotopes *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel) and SS.SSa.CMuSa.AalbNuc. The cable corridor, which extends across the mouth of the river Dee, largely consisted of the SS.SSa.IFiSa.NcirBat biotope.

1.5.1.27 Surveys conducted by CMACS (2009) at Walney offshore wind farm (Figure 1.3) found that SS.SMu.CSaMu.AfilKurAnit (in the east of the site) and *Thyasira sp.* and *Ennucula tenuis* in circalittoral sandy mud (SS.SMu.CSaMu.ThyEten) (in the west of the site where sediment has a higher gravel content) were the main biotopes in the survey area. Along the export cable corridor the biotopes SS.SMu.CSaMu.AfilKurAnit and SS.SSa.IMuSa.FfabMag were recorded.

1.5.1.28 Nearby Ormonde offshore wind farm (Figure 1.3) reported very similar results in its Environmental Statement which covered an area in the east of the regional benthic subtidal ecology study area from Duddon sands to the Lune deep. The Environmental Statement found the array area itself to be mostly composed of SS.SMu.CSaMu.AfilKurAnit with bands of SS.SMu.CSaMu.LkorPpel and SS.SSa.CMuSa.AalbNuc with increasing proximity to the coast (Unicomarine Ltd, 2005).

1.5.1.29 The Rhiannon Wind Farm was proposed to be located in the west of the regional benthic subtidal ecology study area (Figure 1.3). The dominant biotopes were SS.SCS.CCS and *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx). The SS.SMx.CMx.OphMx biotope consists of circalittoral sediments dominated by brittlestars forming dense beds, living on boulder, gravel or sedimentary substrate. Large patches of circalittoral fine sand (SS.SSa.CFiSa) were recorded further west and to the north of the Rhiannon Wind Farm survey area in the central west of the regional benthic subtidal ecology study area (Figure 1.3; Celtic Array Ltd, 2014).

1.5.1.30 The nationally scarce *Thia scutellata* has been recorded in the south of the regional benthic subtidal ecology study area (Clark, 1986; Rees 2001; Moore, 2002). This small crab inhabits a specific habitat of loose, well-sorted medium sands into which it can easily burrow. This species was recorded during benthic surveys for the Burbo Bank, Burbo Bank Extension and the Gwynt y Môr offshore wind farms.

1.5.1.31 The Walney offshore wind farm (Figure 1.3) overlaps with a number of protected species which are protected by designated areas. There is an Annex I stony reef within the Shell Flats and Lune Deep Special Area of Conservation (SAC) (reefs are a designated feature of the SAC) which is located inshore of the Walney offshore wind farm array area in the central east section of the regional benthic subtidal ecology study area (Dong Energy Ltd, 2013b). Stony reefs have also been identified at a few sample locations along the export cable corridor of Walney extension and within Morecambe Bay, all were classified as low 'reefiness' (Dong Energy Ltd., 2013b). The habitat burrowed mud was also recorded in the east of the Walney offshore wind farm array area and is listed as a UK Biodiversity Action Plan (BAP) habitat as well as an 'OSPAR habitat under 'seapens and burrowing megafauna'. This biotope has also been recorded in the Ormonde offshore wind farm, West of Duddon offshore wind farm, and Walney offshore wind farm extension. The sample sites where the burrowed mud biotope has been found within the Ormonde and Walney offshore wind farms are both located within the West of Walney Marine Conservation Zone (MCZ) zone, west of the Ormonde offshore wind farm, and is designated for the protection of sea pens and burrowing megafauna among other features. Although no sea pens were recorded at the sample sites within the Walney offshore wind farms during the post-construction monitoring surveys, evidence of burrowing megafauna was present (CMACS, 2014).

1.5.1.32 The baseline characterisation surveys for the Awel y Môr offshore wind farm showed that the majority of the array area was classified the *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand (SS.SCS.CCS.PKef) biotope with some areas of higher sand content characterised by the *Branchiostoma* *lanceolatum* in circalittoral coarse sand with shell gravel (SS.SCS.CCS.Blan) biotope and the SS.SSa.IFiSa.NcirBat biotope (RWE, 2022). No Annex I habitats or Annex II species, OSPAR threatened and/ or declining species and habitats, or habitats and species listed under Section 7 of the Environment (Wales) Act 2016, were observed within the array area.

1.5.1.33 In the east of the regional benthic subtidal ecology study area, baseline characterisation surveys were also conducted for Morecambe Offshore Windfarm Generation Assets (Morecambe Offshore Windfarm, 2023). These surveys identified two biotopes, *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (SS.SSa.CFiSa.ApriBatPo) and *Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit).

1.5.1.34 In the south of the regional benthic subtidal ecology study area, the Mona Offshore Wind Project was characterised by grab sampling and DDV in 2021 and 2022 (Mona Offshore Wind Ltd., 2024). The Mona Array Area was primarily characterised by the polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) biotope with areas of SS.SCS.CCS. The Mona Array Area ZoI also contained small areas characterised by the circalittoral mixed sediment (SS.SMx.CMx) and *Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.KurThyMx) biotopes in the southeast of the Mona Array Area ZoI. The SS.SMx.CMx biotope and the SS.SSa.CFiSa biotope were also identified in the southeast of the Mona Array Area ZoI. In the southwest of the Mona Array Area ZoI, brittlestar beds were recorded at two stations and the communities were characterised by the SS.SMx.CMx.OphMx biotope. In the Mona Offshore Cable Corridor the SS.SMx.OMx.PoVen biotope was dominant in the north, in the area adjacent to the Mona Array Area. The central section, to the north of Constable Bank, was dominated by the SS.SSa.CFiSa biotope. In the area of overlap with Constable Bank, the sediments and communities were characterised by the SS.SMx.CMx and SS.SSa.IFiSa.NcirBat biotopes. In the area of overlap with the Menai Strait and Conwy Bay SAC, and also the part of the Mona Offshore Cable Corridor to the south of the SAC, the communities were characterised by the SS.SMx.CMx.KurThyMx, SS.SSa.IFiSa.NcirBat and SS.SCS.CCS biotopes. The section of the Mona Offshore Cable Corridor approaching the coast was defined by muddy sand and mixed sediments which were characterised by communities typical of the SS.SSa.IMuSa.FfabMag biotope.

1.5.1.35 Within the Mona benthic subtidal and intertidal ecology study area Annex I low resemblance stony reef was identified five sample stations within the Mona Array Area and ZoI (Mona Offshore Wind Ltd., 2024). The habitat assessment noted the presence of burrows at 54 stations within the Mona benthic subtidal and intertidal ecology study area. Whilst no sea pens were observed, the presence of burrows was classified as ‘frequent’ or above at 37 stations; therefore, it was concluded that these stations showed some similarity to the ‘sea pen and burrowing megafauna communities’ habitat as defined by OSPAR. Annex I stony reef assessments identified four stations which were classified as Annex I low resemblance stony reef located in the west of the Mona Array Area. In the Mona Array Area and ZoI only one station in the north was classified as Annex I low resemblance stony reef. An assessment for sponge dominated habitat was also undertaken for the Mona Offshore Wind Project but no stations were found to represent the fragile sponge and anthozoan communities on subtidal rocky habitat.

1.5.1.36 The site-specific survey data for the Transmission Assets, collected in 2022, showed that the benthic communities were dominated by the SS.SMu.CSaMu.LkorPpel biotope in the west, with the SS.SMu.CSaMu.AfilKurAnit biotope being present throughout the centre of the Transmission Assets survey area (Morecambe Offshore Windfarm Ltd. and Morgan Offshore Wind Ltd, 2023). The infaunal communities graded into the SS.SSa.CMuSa.AalbNuc biotope in the nearshore area, and SS.SSa.IFiSa interspersed with SS.SSa.CMuSa.AalbNuc, approaching the landfall. The epifaunal analysis indicated the presence of SS.SSa.CMuSa throughout the majority of the Transmission Assets survey area. Circalittoral mixed sediments and circalittoral fine sands were also noted in areas corresponding to infaunal biotopes associated with these sediment types, and therefore most epifaunal biotopes assigned were consistent with the underlying infaunal biotope. The exception is in the north east of the Morgan Generation Assets, where a high SACFOR (Super abundant, Abundant, Common, Frequent, Occasional, Rare) abundance of *O. ophiura* indicated the presence of the biotope SS.SMx.CMx.OphMx.

1.5.1.37 No Annex I reefs (biogenic or geogenic) were recorded within the Transmission Assets. Sandy sediments in less than 20 m of water occurred within the Transmission Assets survey area but were considered unlikely to qualify as a Habitats Directive Annex I ‘sandbanks which are slightly covered by seawater all of the time’ habitat (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd, 2023). The habitat assessment noted the presence of burrows at 22 stations within the Transmission Assets survey area. Whilst no sea pens were observed, the presence of burrows was classified as ‘frequent’ or above at 13 stations; therefore, it was concluded that these stations showed some similarity to the ‘sea pen and burrowing megafauna communities’ habitat as defined by OSPAR. Evidence of hard substrate Porifera was observed at 12 stations, but no stations were considered to represent the fragile sponge and anthozoan communities on subtidal rocky habitat.

1.5.1.38 The baseline characterisation for the Morecambe Offshore Windfarm, in the east of the regional benthic subtidal ecology study area, identified two different biotopes (Morecambe Offshore Windfarm Ltd., 2023). The majority of the Morecambe Offshore Windfarm was characterised by the SS.SSa.CFiSa.ApriBatPo biotope transitioning to SS.SMu.CSaMu.AfilKurAnit in the west. Within the circalittoral muddy sand sediments which occurred across the majority of the central and east regions of the Morecambe Offshore Windfarm, burrows were identified. Areas where megafaunal burrows were present matched the criteria required to be classified as the OSPAR/Feature of Conservation Interest (FOCI) habitat ‘Seapens and burrowing megafauna’. No seapens were identified in the survey however they are not required for the allocation of this habitat based on JNCC’s interpretation of the OSPAR habitat definition (Robson, 2014). No clear pattern in the distribution of burrow density was identified in the data, with areas of higher and lower burrow density interspersed throughout the windfarm site. No areas of potential Annex I reef were identified in DDV imagery and therefore no formal reef assessments were conducted.

1.5.1.39 The Isle of Man territorial waters also fall within the regional benthic subtidal ecology study area. A marine environmental assessment was undergone by Howe (2018a) to bring together subtidal surveys which have been conducted around the Isle of Man to create an extensive characterisation of the subtidal environment. Howe (2018a) describes White’s (2011) analysis of 7325 seabed images from a 2008 benthic survey around the Isle of Man and identified 20 different biotopes. Some of the most common included *Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud (SS.SMu.CFiMu.BlyrAchi) which was recorded over a broad area in the southwest of the Isle of Man. *Cerianthus lloydii* with the *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment (SS.SMx.CMx.ClloMx.Nem) biotope characterising an extensive area of the southwest of the Isle of Man. The sediments to the north of the island were characterised by biotopes typical of mixed sediment and sand-based habitats. Intermittently around the island there are also a number of rocky biotopes including sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (CR.HCR.XFa.SpNemAdia) and faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock (CR.MCR.EcCr.FaAlCr). Three main habitats of international conservation interest were identified during the survey, horse mussel reefs, maerl beds and Ross worm habitats (*Sabellaria spinulosa*), all of which are OSPAR priority habitats (OSPAR 2008-16). Individuals of the UK BAP priority species, the sea anemone *Edwardsia timida*, were also recorded. Ocean quahog *Arctica islandica*, a threatened or declining species in the North Sea region as defined by the OSPAR Convention, has long been known to populate Laxey Bay in the east of the Isle of Man, as well as in Niarbyl Bay and Port Erin Bay. *Zostera marina* meadows are an important nursery area for many marine species (Davison and Hughes, 1998) and play an important role as a marine carbon sink. In recent years, eelgrass has only been recorded in four sites in Isle of Man waters spread along the east coast of the island.

1.5.1.40 Areas of stony and rocky reefs have also been identified within and around the Rhiannon Wind Farm array area and all of which are present in the northwest of the Rhiannon Wind Farm coinciding with the central west area of the regional benthic subtidal ecology study area. The stony reefs identified have 'reefiness' classifications (stony reef criteria of Irving *et al*. (2009) and redescribed for stony reef in Limpenny *et al*. (2010)) of low to moderate. Additionally, there was an area of Annex I rocky reef composed of bedrock occurring entirely within the Rhiannon Wind Farm which was assigned a high 'reefiness' (Celtic Array Ltd., 2014). *Sabellaria spinulosa* reefs were identified 20 km northwest of the Rhiannon Wind Farm array area (in the central west part of the regional benthic subtidal ecology study area) with some small areas closer. All were deemed to be of low or low to medium 'reefiness' when assessed against the criteria proposed by Gubbay (2007). The Gwynt y Môr pre-construction benthic survey recorded seven *S. spinulosa* individuals across five stations out of a total of 126 stations overall, however no reefs were identified in these pre-construction site investigation surveys (CMACS, 2011). No Annex I *S. spinulosa* reefs were recorded within the Rhiannon Wind Farm but a small area of low to moderate 'reefiness' *S. spinulosa* reef of 0.22 km^2 in extent was recorded within the export cable area and one small area of low 'reefiness' was associated with less coarse sediments 20km to the northwest of the Rhiannon Wind Farm array area (in the central west area of the regional benthic subtidal ecology study area).

1.5.1.41 Bangor University conducted benthic habitat survey of waters around the Isle of Man in 2008 and recorded *S. spinulosa* to the south of Manx waters, the habitat had not previously been formally recorded. The coast of the Isle of Man from Peel round to Maughold Head is primarily rocky, creating rocky reef habitat subtidally. The rocky reef habitats of the Isle of Man are deemed to be of high diversity. There are also extensive *Modiolus* reefs around the Isle of Man with recent surveys identifying clusters of reefs at the north and south points of the island (Howe, 2018a). Other notable habitats around the Isle of Man include extensive sandbanks off the north coast. Under the EU Habitats Directive, subtidal mobile sandbanks are included under 'Sandbanks which are slightly covered by seawater at all times'. Additionally brittlestar beds were identified as important biogenic habitats in the UK Marine SAC review in the 1990s (Hughes, 1998a). The Bangor University benthic survey in 2008 indicated that seabed dominated by brittlestar beds is widespread in Manx waters.

1.5.1.42 One individual of *A. islandica* which is on the OSPAR threatened species list was recorded in a grab sample which was taken for the baseline characterisation surveys for the Walney Extension offshore wind farm (Dong Energy Ltd, 2013b).

1.5.1.43 Desktop baseline information from Celtic Array Ltd (2014) shows that there is an Annex I sandbank within the regional benthic subtidal ecology study area. Side scan sonar data from Rhiannon Wind Farm also showed that in the far southwest of the regional benthic subtidal ecology study area there are numerous *Modiolus modiolus* reefs (class 2 reefs) (Celtic Array Ltd, 2014).

1.5.2 Morgan benthic subtidal ecology study area

Subtidal sediments

1.5.2.1 Based on the EUSeaMap (Figure 1.2), sediments in the Morgan benthic subtidal ecology study area are dominated by a variety of sediment types (EMODnet, 2019). The sediments transition from west to east across the Morgan benthic subtidal ecology study area grading from deep circalittoral coarse sediments to deep circalittoral sands.

Subtidal benthic ecology

1.5.2.2 Site-specific surveys conducted for the Rhiannon Wind Farm benthic ecology PEIR (Celtic Array Ltd, 2014) overlap with the west side of the Morgan benthic subtidal ecology study area.

1.5.2.3 Within the Rhiannon Wind Farm PEIR site-specific survey area which overlaps with the Morgan benthic subtidal ecology study area six biotopes where identified (Celtic Array Ltd, 2014) (Figure 1.3). In the central north of the Morgan benthic subtidal ecology study area (i.e. the north of the Mona Array Area and ZoI) SS.SSa.CFiSa and SS.SCS.CCS are the most common biotopes. Further south, west of the centre of the Morgan benthic subtidal ecology study area SS.SMx.CMx with some areas of SS.SMx.OMx along the other border of the Morgan benthic subtidal ecology study area. In the southwest of the Morgan benthic subtidal ecology study area sections of SS.SCS.CCS/*Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles (SS.SCS.CCS.PomB) and SS.SMx.CMx/SS.SMx.CMx.OphMx/SS.SCS.CCS.PomB.

1.5.2.4 Additionally a marine environmental assessment of the subtidal ecology around the Isle of Man (MMEA, 2018) showed that in the northwest of the Morgan benthic subtidal ecology study area the seabed was dominated by SS.SCS.CCS, *Cerianthus. lloydii* with *Nemertesia* spp. and other hydroids in circalittoral mixed sediment (SS.SMx.CMx.ClloMx.Nem) and SS.SMx.CMx.OphMx. The Isle of Man marine environmental assessment also recorded *M. modiolus* and *S. spinulosa* within the northwest and *A. islandica* within the north of the Morgan benthic subtidal ecology study area.

1.5.2.5 Surveys for the Transmission Assets also included survey locations that overlapped with the Morgan benthic subtidal ecology study area (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd, 2023). In the north of the Morgan Array Area, along the border with the Morgan Array Area ZoI the SS.SMu.CSaMu.LkorPpel biotope was dominant and extended to the edge of the Morgan benthic subtidal ecology study area. In the northwest edge of the Transmission Assets, in the overlap with the Morgan Array Area ZoI, there were also small sections of SS.SMx.CMx.KurThyMx and *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx). In the south of the Transmission Assets survey area which is within the Morgan benthic subtidal ecology study area, the SS.SMx.OMx.PoVen biotope was also identified (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd, 2023).

1.6 Designated sites

1.6.1 Overview

1.6.1.1 There are a number of sites of nature conservation importance, which are designated for relevant benthic subtidal ecology features within the regional benthic subtidal ecology study area. The designated sites are described in Table 1.3 and shown in Figure 1.4. Those sites located within the ZoI of the Morgan Generation Assets have been characterised in sections 1.6.1 and 1.6.2 respectively.

Table 1.3: Summary of designated sites within the regional benthic subtidal ecology study area and relevant qualifying interest features.

Designated site	Distance from the Morgan Array Area (km)	Relevant qualifying features
West of Copeland MCZ	8.8	• Subtidal coarse sediment • Subtidal sand • Subtidal mixed sediment.
West of Walney MCZ	9.3	• Subtidal sand • Subtidal mud • Seapen and burrowing megafauna communities.
Langness Marine Nature Reserve (MNR)	17.0	• Eelgrass meadow • Intertidal mud • Kelp forest • Sea caves.
Little Ness MNR	20.4	• Horse mussel reef • Maerl.
Douglas Bay MNR	22.3	• Beaumont's nudibranch (*Cumanotus beaumonti*) • Maerl beds • Rocky reef • Kelp forest.
Laxey Bay MNR	22.4	• Eel grass meadow • Rocky reef • Sandy seabed • Maerl • Ocean quahog (*Arctica islandica*) • Common whelk.

Designated site	Distance from the Morgan Array Area (km)	Relevant qualifying features
Ramsey Bay MNR	27.4	• Maerl beds • Eelgrass meadows • Horse mussel reefs • Rocky shore and reef.
Fylde MCZ	29.2	• Subtidal sand • Subtidal mud.
Shell Flat and Lune Deep SAC	29.6	• Sandbanks which are slightly covered by sea water all the time • Reefs.
Baie y Carrickey MNR	30.3	• Rocky reef • Sea caves • Kelp forest • Eelgrass meadows.
Morecambe Bay SAC	36.6	• Estuaries • Mudflats and sandflats not covered by seawater at low tide • Large shallow inlets and bays • Sandbanks slightly covered by sea water at all times • Large shallow inlets and bays • Coastal lagoon • *Salicornia* and other annuals colonising mud and sand • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • Reefs.
Calf of Man and Wart Bank MNR	35.9	• Rocky reef • Sand banks • Kelp forest.
Niarbyl Bay MNR	36.8	• Rocky reef • Kelp forest • Sea caves • Intertidal blue mussel beds • Ocean quahog (*Arctica islandica*).
Port Erin Bay MNR	36.8	• Rocky reef • Brittlestar beds • Kelp forest • Stalked jellyfish • Flame shell.

Designated site	Distance from the Morgan Array Area (km)	Relevant qualifying features
West Coast MNR	38.7	• Rocky reef • Intertidal blue mussel • Mixed soft sediment • Kelp forest • Burrowing anemone (*Edwardsia timida*).
Cumbria Coast MCZ	47.9	• Intertidal under boulder communities • *Sabellaria alveolata* reefs.
Ribble Estuary Site of Special Scientific Interest (SSSI)	50.9	• Intertidal mudflats • Intertidal sandflats.
Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC	60.2	• Sandbanks which are slightly covered by sea water all the time • Mudflats and sandflats not covered by seawater at low tide • Submerged or partially submerged sea caves • Large shallow inlets and bays • Reefs.
Pen Y Gogarth/Great Ormes Head SSSI	63.1	• Caves and overhangs • Moderately exposed rock • Rockpools • Soft piddock bored substrata • Under boulders.
Aber Afon/Conwy SSSI	63.7	• Coastal plain estuary ecology.
Creigiau Rhiwledyn/Little Ormes Head SSSI	65.8	• Caves and overhangs • Moderately exposed rock • Rockpools • Soft piddock bored substrata • Under-boulders.
Luce Bay and Sands SAC	69.4	• Large shallow inlets and bays • Sandbanks which are slightly covered by sea water all the time • Mudflats and sandflats not covered by seawater at low tide • Reefs.
Aber Dyfrdwy/Dee Estuary SAC	70.0	• Estuaries • Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • Mudflats and sandflats not covered by seawater at low tide.
Dee Estuary Ramsar site	70.0	• Ramsar criterion 1 - Extensive intertidal mud and sand flats with large expanses of saltmarsh towards the head of the estuary.

Designated site	Distance from the Morgan Array Area (km)	Relevant qualifying features
Traeth/Pensarn SSSI	72.4	• Coastal vegetated shingle ridge.
Allonby Bay MCZ	81.4	• Blue mussel beds • *Sabellaria alveolata* reefs.
Solway Firth SAC	87.6	• Sandbanks which are slightly covered by sea water all the time • Reefs.

1.6.1 International designations

Shell Flats and Lune Deep SAC

1.6.1.1 The Shell Flats and Lune Deep SAC is located on the north boundary of Fylde MCZ in the east Irish sea, 29.6 km southeast of the Morgan Array Area at its closest point.

1.6.1.2 Shell Flat sandbank runs northeast from the south corner of the site. The bank is an example of a Banner Bank, which are generally only a few kilometres in length with an elongated pear/sickle-shaped form, located in water depths less than 20 m below chart datum (Natural England, 2012). This feature is designated as a sandbank which is slightly covered by seawater all the time. Lune Deep is designated for its reef habitat which represents a good example of boulder and bedrock reef (Natural England, 2012). The presence of stony reef, cobbles and small boulders supporting tide-swept fauna including hydroids, bryozoans, anemones and sponges.

Morecambe Bay SAC

1.6.1.3 The Morecambe Bay SAC is located on the west coast of England, in the county of Lancashire. The site is located 36.6 km east of the Morgan Array Area at its nearest point to the Morgan Generation Assets. The variation in physical and environmental conditions throughout the site, including rock and soft sediment types, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.6.1.4 This SAC is designated for numerous Annex I habitats throughout the subtidal and intertidal environment. One of the key habitats being the estuaries in this area, within the SAC four rivers contribute to the estuary resulting in the largest single area of continuous intertidal mudflats and sandflats in the UK and the best example of muddy sandflats on the west coast (JNCC, 2022a). Mudflats and sandflats not covered by seawater at low tide is another Annex I habitat that this SAC is designated for. Furthermore the Morecambe Bay is the second-largest embayment in the UK, after the Wash and as such, it has also been designated for its large shallow inlets and bays habitat (JNCC, 2022a).

Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC

1.6.1.5 The Menai Strait and Conwy Bay SAC is located in northwest Wales, between mainland Wales and the island of Anglesey. The site is located 60.2 km from the Morgan Array Area. The variation in physical and environmental conditions throughout the site, including rock and sediment type, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.6.1.6 For the qualifying habitats (sandbanks which are slightly covered by sea water all the time, mudflats and sandflats not covered by seawater at low tide, submerged or partially submerged sea caves and reefs), the SAC is considered to be one of the best areas in the UK for mudflats and sandflats not covered by seawater at low tide, reefs and sandbanks which are slightly covered by seawater all the time. The features are distributed throughout the SAC with no single feature occupying the entire SAC and with features overlapping in some locations. According to the most recent condition assessment (NRW, 2018), three features of the SAC are considered to be in favourable condition (sandbanks which are slightly covered by sea water all the time, mudflats and sandflats not covered by seawater at low tide, and reefs) and the large shallow inlets and bays feature is in unfavourable condition.

1.6.1.7 Within the Menai Strait and Conwy Bay SAC the sandbanks which are slightly covered by seawater all the time and reefs are notable features. The reef feature is further defined by the JNCC (2022b) as rocky reefs dominated by communities of filter feeders such as sponges. The sandbanks vary from stable muddy sands in areas with weak tidal streams to relatively clean well-sorted and rippled sand where tidal streams were stronger (JNCC, 2022b). In very shallow waters relatively species-rich sandy communities are dominated by polychaetes (JNCC, 2022b).

Luce Bay and Sands SAC

1.6.1.8 The Luce Bay and Sands SAC is located on the southwest coast of Scotland. The site is located 69.4 km from the Morgan Array Area at its nearest point to the Morgan Generation Assets. The variation in physical and environmental conditions throughout the site, including rock and soft sediment types, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.6.1.9 In the marine environment this SAC is designated for one Annex I feature, large shallow inlets and bays, of which Luce Bay and Sands is a high quality example (JNCC, 2022c). The sediments within Luce Bay range from boulders to highly mobile sands, which support rich plant and animal communities typical of a large bay in southwest Scotland (JNCC, 2022c). The shallow depths of the bay (0 to 10 m) contain major sandbanks along the west and north shores. Most of the intertidal area of the bay comprises small boulders on sandy sediment. Some larger boulders on the lower shores have spaces beneath and between them which provide shelter for false Irish moss *Mastocarpus stellatus* and allowing for under-boulder communities to develop, including ascidians, sponges and crustose coralline algae. In the subtidal area communities of sparse kelp *Laminaria hyperborea* and sea-oak *Halidrys siliquosa*, red algae and the dahlia anemone *Urticina felina* have been identified. Much of the central part of Luce Bay consists of slightly deeper-water that support a rich community of polychaete worms, bivalves, echinoderms, brittlestars, particularly *Ophiura* spp.

Aber Dyfrdwy/Dee Estuary SAC

1.6.1.10 The Aber Dyfrdwy/Dee Estuary SAC is located on the north Wales coast in the southeast of the east Irish sea, 70 km southeast of the Morgan Array Area at its closest point.

1.6.1.11 The Aber Dyfrdwy/Dee Estuary SAC covers an area of 158.05 km^2 (JNCC,2022d). This site is designated for three main features: mudflats and sandflats not covered by seawater at low tide, *Salicornia* and other annuals colonising mud and sand and Atlantic salt meadows *Glauco-Puccinellietalia maritimae*. Other Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site include estuaries and various dune habitats. The majority of these features are in good conditions and targets are currently in place to maintain this condition.

Dee Estuary Ramsar site

1.6.1.12 The Dee Estuary Ramsar site is located on the north Wales coast in the southeast of the east Irish sea, 70 km southeast of the Morgan Array Area at its closest point.

1.6.1.13 The Dee Estuary Ramsar site covers an area of 143.02 km^2 (Ramsar, 2012). This site is classified under criterion 1 for extensive intertidal mud and sandflats with large expanses of saltmarsh towards the head of the estuary (Ramsar, 2012). Much of the upper part of the estuary consists of muddy fine sand dominated by *Hediste diversicolor* and *Macoma balthica*. The sediment flats in the outer estuary also have fine muddy sands but here they are dominated by *Cerastoderma edule* and *Arenicola marina*. Where water movement is greater the sediments tend to be coarser and sandier, with *Nephtys* sp. and *Bathyporeia* sp. It also supports some nationally scarce biotopes including *Sabellaria alveolata* reefs around Hilbre Island and piddock beds (*Barnea candida*) on Holocene clay banks within the estuary (Ramsar 2012).

Solway Firth SAC

1.6.1.14 The Solway Firth SAC is located on the west coast boarder between England and Scotland and is formed by the river Solway. It is one of the least-industrialised and most natural large estuaries in Europe (JNCC, 2022e). The site is located 87.6 km from the Morgan Array Area at its nearest point to the Morgan Generation Assets. The variation in physical and environmental conditions throughout the site, including rock and soft sediment types, water clarity and exposure to tidal currents and wave action result in a wide range of habitats and associated marine communities.

1.6.1.15 This SAC is designated for numerous Annex I habitat including sandbanks which are slightly covered by sea water all the time, estuaries and mudflats and sandflats not covered by seawater at low tide (JNCC, 2022e). The sandbanks in the Solway Firth are mainly composed of gravelly and clean sands, due to the very dynamic nature of the estuary. The dominant species of the infaunal communities comprise different annelid worms, crustaceans, molluscs and echinoderms, depending on the nature of the substrate. As a very natural estuary with limited industrialisation highly mobile, predominantly sandy intertidal flats have been able to form on the west coast. The Solway Firth contains the third-largest area of continuous littoral mudflats and sandflats in the UK.

1.6.2 National designations – Marine Conservation Zones (MCZs)

West of Copeland MCZ

1.6.2.1 West of Copeland MCZ is located in the east Irish sea, 8.8 km north of the Morgan Array Area and it covers an area of 158 km^2. The seabed within the West of Copeland MCZ is predominantly composed of a mix of subtidal sediments from fine sand through to coarse sediment (Defra, 2019a). It is these sedimentary habitats which are the protected features of this site (subtidal sand, subtidal coarse sediment and subtidal mixed sediment). The subtidal sand habitat is in favourable condition, but the subtidal coarse and subtidal mixed sediments are recovering to favourable condition (Defra, 2019a). This range of habitats supports a wide variety of species including bivalve molluscs (such as venus clams and razor clams), worms, sea urchins, anemones, starfish, crabs and sea mats (Defra, 2019a).

1.6.2.2 The majority of the MCZ is characterised by the subtidal coarse sediments feature, which dominates the west border and central section, primarily at a depth of 20 to 30 m. This feature is surrounded and interspersed by a patchy distribution of the subtidal sands feature, covering most of the northwest and south of the MCZ in the 20 to 50 m depth range, with a relatively small portion of the south being covered by the subtidal coarse sediments feature (Defra, 2019a; EMODnet, 2019). The northeast border of the MCZ is largely characterised by subtidal mixed sediments interspersed with patches of the subtidal coarse sediment and subtidal sand features. This range of habitats support a variety of communities, with common species being the clam *Chamelea gallina* and razor clams *Ensis ensis*, which are found within all designated feature habitats.

West of Walney MCZ

1.6.2.3 West of Walney MCZ Is located in the Irish Sea, off the coast of Cumbria and to the west of Walney Island. The MCZ is 9.3 km northeast of the Morgan Array Area at its closest point. The MCZ covers an area of 388 km^2 most of which is in inshore waters, but with a small section crossing the 12 nm boundary into offshore waters (Defra, 2016a).

This site is notable as it is part of a network of mud-based sea pen and burrowing megafaunal habitats in this region (Defra, 2016a). All of the designated features (subtidal sand, subtidal mud and sea pens and burrowing megafauna communities) are currently recovering to favourable condition (Defra, 2016a; JNCC, 2018).

1.6.2.4 The MCZ provides important protected habitats to worms, molluscs, sea urchins and Crustaceans, and the subtidal sands support high densities of burrowing brittlestars, along with flatfish. The sea pens are colonial cnidarians which thrive within the subtidal mud habitats protected within the MCZ boundary, while also providing habitats for brittlestars *A. filiformis*, horseshoe worms *Phoronid* species, polychaete worms *Scalibregma inflatum* and *Nephtys hombergii*, bivalves *M. bidentata* and *A. nitida* and the burrowing crustaceans *Callianassa subterranean* and *Goneplax rhomboides* (CMACS, 2013). The subtidal sands act as habitats for the same polychaete and echinoderm species, differing by also providing habitats to the bivalves *K. bidentata*, and *Chamelea striatula*, and crustaceans *Corystes cassivelaunus* (The Centre for Environment, 2007).

1.6.2.5 Most of the substrate is subtidal muds, with exception of the north east corner, where a relatively small area of subtidal sands are present and limited to the shallowest region of the MCZ. The sea-pen and burrowing megafauna communities feature also covers the majority of the site with the seapens *Virgularia mirabilis* found sparsely throughout the entire site, but mainly focused along the south boundaries of the designated area (Titan Environmental Surveys, 2005). Burrowing megafauna, such as *Nephrops norvegicus* and *C. subterranea,* and worms - such as the echiuran, or spoon-worm *Maxmuelleria lankesteri* (Hughes, 1998b) exist almost uniformly across the entire site, except for the subtidal sands in the north east, which host burrowing brittlestars and some species of flatfish.

1.6.2.6 Site-specific infaunal grab sample surveys carried out in 2016 and 2018 (Mitchell *et al*., 2023) broadly supported these findings. Specifically, the 2018 survey found 89 sites comprised subtidal muds, and 11 comprised subtidal sand in the north east of the designated area. Infaunal analysis indicated the site to be dominated by a mix of

SS.SSa.CMuSa.AalbNuc, SS.SMu.CSaMu.AfilKurAnit, and burrowing megafauna and *M. lankesteri* in circalittoral mud (SS.SMu.CFiMu.MegMax). The designated habitat assessment indicated that all subtidal mud sites throughout the MCZ contained species indicative of the seapen and burrowing megafauna communities, aligning with previous surveys within this area (Titan Environmental Surveys, 2005).

Fylde MCZ

1.6.2.7 Fylde MCZ is located in Liverpool Bay, between 3 and 20 km off the Fylde coast and Ribble estuary. The site is located 29.2 km from the Morgan Array (Figure 1.4). The MCZ protects an area of approximately 260 km^2 and was originally designated in 2013 to protect 156 km^2 of subtidal sands, with this updated in 2016 to also include 104 km^2 of subtidal muds. The depth of the seabed within the site ranges from almost being exposed on low tide (just 35 cm depth) to 22 m at its deepest part (Defra, 2013). The site is located in proximity to the Shell Flat and Lune Deep SAC and is co-located within the Liverpool Bay Special Protection Area.

1.6.2.8 Both broadscale habitat features are considered to be good representatives of these habitats in the east of the Liverpool Bay area, with the general management approach recommended to maintain both habitat types in favourable condition. There are pockets of mud present in small areas across the rest of the site (Environment Agency, 2015).

1.6.2.9 The MCZ acts as a protected habitat for crabs, brittle stars, a rich community of bivalve molluscs such as the razor shell *Pharus legumen* and *A. alba* (Kaiser *et al*., 2006), polychaetes primarily within the genera *Nephtys* and *Pholoe*, and demersal flatfish species including sole *Solea solea* and plaice *P. platessa* (Natural England, 2016).

1.6.2.10 The habitats within the Fylde MCZ were characterised in a baseline survey of the area by Natural England (Miller and Green, 2017). Specifically, this found that subtidal sand substrate dominated approximately the south three fifths of sampled sites, largely as a result of sediment outflows from the Ribble estuary to the southeast. The benthic community is characterised by a variety of species, ranging from a low-abundance bivalve-dominated community including *Corbula gibba*, *C. striatula* and *Dosinia* spp. to a mixed polychaete and bivalve community which includes *Ophelia* sp., *K. bidentata* and *Glycera tridactyla* (Environment Agency, 2015). Subtidal muds dominated the north two fifths, with an overall trend of increasing mud percentage moving north within the MCZ.

1.6.2.11 Multivariate analysis of the 2017 grab sample data showed significantly increased biodiversity in the north of the MCZ compared to the south. The biotopes *Glycera lapidum* in impoverished infralittoral mobile gravel and sand/*Morella* spp. with venerid bivalves in infralittoral gravelly sand biotope (SS.SCS.ICS.Glap/ SS.SCS.ICS.MoeVen) covered a large proportion of the south part of the MCZ in association with the sandy substrates. The number and variety of biotopes increased further north, with the SS.SMu.CSaMu.AfilMysAnit biotope dominating the subtidal muds, with this being geographically and statistically grouped alongside the SS.SSa.CMuSa.AalbNuc biotope, with these two biotopes having been recognised as grading into one another (Envision Mapping Ltd., 2015. Occasional sites characterised as *Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand (SS.SSa.IMuSa.EcorEns) have also been noted in the northwest of the MCZ.

Cumbria Coast MCZ

1.6.2.12 The Coast of Cumbria MCZ is located on the west coast of England, within the county of Cumbria. The MCZ is 47.9 km north east of the Morgan Array Area at its closest point. The MCZ is an inshore site that stretches for approximately 27 km along the coast of Cumbria and in total it covers an area of 22 km^2 (Defra, 2019b). This site is notable as it is an extensive and important example of intertidal rocky shore habitats and associated communities on the sedimentary coast of northwest England (Defra, 2019b). All of the designated habitat features of this MCZ (high energy intertidal rock, *S. alveolata* reefs, intertidal biogenic reefs, intertidal sand and muddy sand, intertidal underboulder communities, moderate energy infralittoral rock and peat and clay exposures) are currently being maintained to preserve their favourable status (Defra, 2019b).

1.6.2.13 The diverse physical habitat at this MCZ helps to support this wide variety of designated features. The extensive intertidal boulder and cobble reefs within the site support good examples of nationally important *S. alveolata* reefs (Defra, 2019b). Where this habitat extends towards and below the low water mark examples of under-boulder communities are prevalent supporting unusual algae and mobile animals such as long-clawed porcelain crabs, sea slugs and brittlestars shelter among sponges (Defra, 2019b).

Allonby Bay MCZ

1.6.2.14 The Allonby Bay MCZ is located on the west coast of England, within the county of Cumbria. The MCZ is 81.4 km northwest of the Morgan Array Area at its closest point. The MCZ is an inshore site on the English side of the Solway Firth and in total it covers an area of 40 km^2 (Defra, 2016b). This site is notable for large areas of reefs, including *S. alveolata* reefs and blue mussel beds (Defra, 2016b). All of the designated habitat features of this MCZ (intertidal rock, *S. alveolata* reefs, intertidal biogenic reefs/sand and muddy sand/coarse sediment, subtidal biogenic reefs, subtidal coarse/sand/mixed sediment, moderate energy infralittoral rock and peat and clay exposures) are currently being maintained to preserve their favourable status (Defra, 2022c).

1.6.3 National designations – Site of Special Scientific Interest (SSSI)

Ribble Estuary SSSI

1.6.3.1 The Ribble Estuary SSSI is located on the Irish Sea coast of the counties of Lancashire and Merseyside. The site is located 50.9 km from the Morgan Array Area. This SSSI is 92.26 km^2 in area and also contains the Ribble Marshes National Nature Reserve.

1.6.3.2 The estuary and in particular its extensive sand flats, mud flats and salt marshes, is especially important for migratory birds, as well as overlapping with the Salter's Bank unit designated for the presence of favourable status littoral sediments (Natural England, 2008). The Ribble Estuary is intersected by numerous water channels with extensive sandbanks in the outer estuary such as Foulnaze Bank which is in the middle of the outer estuary (Natural England, 2015). A survey in the north of the site (Natural England, 2015), near Lytham-St-Annes, found the upper shore to be characterised by sandy habitat with a range of polychaete species and amphipods. The fauna in sediments on the lower shore area identify high numbers of juvenile brittlestars and fragments of hydroids and bryozoans. A large number of empty razor shells *Ensis* spp. Were also present scattered over the sediment surface.

1.6.3.3 The Ribble Estuary is a highly dynamic environment subject to a range of environmental influences including wave and wind action as well as flow from the Ribble river channel. The locations of channels and surface features of the sandflats can vary weekly and seasonal variation in the faunal communities occurs both within and across years.

Pen Y Gogarth/Great Ormes Head SSSI

1.6.3.4 Pen Y Gogarth/Great Ormes Head SSSI is located on the north Wales coastline and overlaps the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. The site is located 63.1 km from the Morgan Array Area. Pen Y Gogarth/Great Ormes Head SSSI covers an area of 3.03 km^2 (Countryside Council Wales (CCW), 2013). This site is notable for having the largest extent of moderately exposed rock, supporting a complete zonation of marine biotopes, as well as specialised and nationally scarce flora and fauna, most typically associated with rock pool, cave and limestone rock habitats found between the Great Orme and the Solway Firth (CCW, 2013).

Aber Afon/Conwy SSSI

1.6.3.5 Aber Afon/Conwy SSSI is located on the north Wales coastline, at the mouth of the river Conwy and overlapping with the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. The site is located 63.7 km from the Morgan Array Area. Aber Afon/Conwy SSSI covers an area of 12.95 km^2 (CCW, 2003). This site is notable as a high-quality example of an intertidal estuarine community (CCW, 2003). The site supports nationally important ‘piddock’ communities on; eulittoral peat, eulittoral firm clay with *Mytilus edulis*, lower eulittoral soft rock with *Fucus serratus* and sublittoral fringe soft rock with *Laminaria digitata* (CCW, 2003). In addition the site supports specialised communities of shallow pools on mixed substrata with hydroids, ephemeral algae and *Littorina littorea* (CCW, 2003).

Creigiau Rhiwledyn/Little Ormes Head SSSI

1.6.3.6 Creigiau Rhiwledyn/Little Ormes Head SSSI is located on the north Wales coastline and overlaps the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. The site is located 65.8 km from the Morgan Array Area. Creigiau Rhiwledyn/Little Ormes Head SSSI covers an area of 0.36 km^2 (CCW, 2002). This site is notable for various marine biological features including specialised and nationally scarce cave, rockpool, overhang and rock-boring bivalve biotopes (physical habitats and their associated community of species including animals and plants) within the intertidal zone (CCW, 2002).

Traeth/Pensarn SSSI

1.6.3.7 Traeth Pensarn SSSI is located on the north Wales coastline and is located 72.4 km from the Morgan Array Area. Traeth Pensarn SSSI covers an area of 51.67 km^2, of which 42.46 km^2 is within the intertidal zone (82%). This site is notable for its coastal vegetated shingle beach as well as exposed sand and littoral sediment. All designated features of this site are located above the Mean High Water Spring (MHWS) mark.

1.6.4 National designations – Marine Nature Reserves (MNRs)

Langness MNR

1.6.4.1 The Langness MNR is located to the southeast of the Isle of Man and northwest of the Morgan Generation Assets, 17.0 km from the Morgan Array Area at its closest point. Langness MNR is 88.67 km^2, or 10.67% of the 0 to 3 nm inshore zone, and is the third largest MNR (DEFA, 2022a).

1.6.4.2 The Langness MNR is important for a variety of fauna including sea birds and seals as well as benthic species such as grooved topshell *Jujubinus striatus* and the bivalve *Loripes lucinalis*, (DEFA, 2022a). The site also home to seagrass meadows growing at depths between 5 and 12 m, as well as kelp forests (DEFA, 2022a). At the coast there is also a series of small subtidal caves which are thought to be nursery sites for lobsters.

Little Ness MNR

1.6.4.3 The Little Ness MNR is located to the east of the Isle of Man and northwest of the Morgan Generation Assets, 20.4 km from the Morgan Array Area at its closest point. Little Ness MNR is relatively small at 10 km^2, but one of the most important sites because of its very high species diversity (DEFA, 2022b).

1.6.4.4 The Little Ness MNR encompasses a variety of habitats including horse mussel reefs and maerl beds (DEFA, 2022b). This site also has an important population of critically endangered European eels where young eels can be found in spring before travelling up rivers (DEFA, 2022b). As a result of this rich benthic environment a variety of seabird and marine mammals can also be found in this area.

Douglas Bay MNR

1.6.4.5 The Douglas Bay MNR is located to the east of the Isle of Man and northwest of the Morgan Generation Assets, 22.3 km from the Morgan Array Area at its closest point. Douglas Bay MNR covers an area of 4.6 km^2 (DEFA, 2022c).

1.6.4.6 This MNR encompasses an area of maerl bed, a red coralline seaweed which creates a fine layer over the seabed. This habitat attracts a high diversity of species including shellfish and anemones, as well as being a refuge for juvenile queen scallops and whelks which are commercially important to the Isle of Man (DEFA, 2022c). Rocky reefs and kelp forests are also found in this MNR. Beaumont's nudibranch is an important species in this MNR due to its limited range only occurring between the UK and Norway (DEFA, 2022c).

Laxey Bay MNR

1.6.4.7 The Laxey Bay MNR is located to the east of the Isle of Man and northwest of the Morgan Generation Assets, 22.4 km from the Morgan Array Area at its closest point. Laxey Bay MNR is approximately 4 km^2 in size which equates to around 0.5% of the 0 to 3 nm area, or 1% of the reserves network (DEFA, 2022d).

1.6.4.8 The Laxey Bay MNR is one of the smallest MNRs around the Isle of Man however it contains a wide variety of benthic habitats such as seagrass meadows, rocky reefs, sandy seabed and maerl beds (DEFA, 2022d). This MNR supports ocean quahog *A. islandica* and common whelk *Buccinum undatum* which is one of the five commercially fished species around the Isle of Man (DEFA, 2022d).

Ramsey Bay MNR

1.6.4.9 The Ramsey Bay MNR is located to the northeast of the Isle of Man and northwest of the Morgan Generation Assets, 27.4 km from the Morgan Array Area at its closest point. Ramsey Bay MNR covers an area of around 97 km^2, half of which is highly protected. Designated in 2011 as the island's first MNR, it is divided into five zones, four of which are highly protected for important habitats, such as horse mussel reef and eelgrass meadow (DEFA, 2022e).

1.6.4.10 Horse mussels can reach 15 cm in length and attach to the seabed with threadlike hairs. Over time the number of mussels increases, and they can form a reef structure with highly a complex three-dimensional structure which can be colonised by sponges, tube worms, soft corals and barnacles. Rocky reefs are also present in the intertidal and subtidal environment (DEFA, 2022e).

Baie y Carrickey MNR

1.6.4.11 The Baie y Carrickey MNR is located to the south of the Isle of Man and west of the Morgan Generation Assets, 30.3 km from the Morgan Array Area at its closest point. Baie ny Carrickey MNR covers an area of 11.37 km^2 and was originally established as a fishery-restricted area in 2012 to reduce gear conflict between scallopers and pot fishermen and protect rocky reefs (DEFA, 2022f).

1.6.4.12 The Baie y Carrickey MNR encompasses an area of rocky reef, kelp forest and seagrass meadows as well as sea caves which all contribute to its designated status (DEFA, 2022f).

Calf of Man and Wart Bank MNR

1.6.4.13 The Calf of Man and Wart Bank MNR is located to the southwest of the Isle of Man and west of the Morgan Generation Assets, 35.9 km from the Morgan Array Area at its closest point. The Calf of Man and Wart Bank MNR is 20.15 km^2, or 2.4% of the 0 to 3 nm inshore zone (DEFA, 2022g).

1.6.4.14 The Calf of Man and Wart Bank MNR encompasses habitats such as rocky reefs and kelp forests (DEFA, 2022g). This MNR also contains sandbanks composed of sandy sediment and influenced by the waves and tide resulting in a dynamic habitat of mounds and sand ripples (DEFA, 2022g). This habitat is home to sandeels which are an important prey species for a number of marine mammals and seabirds.

Niarbyl Bay MNR

1.6.4.15 The Niarbyl Bay MNR is located to the west of the Isle of Man and northwest of the Morgan Generation Assets, 36.8 km from the Morgan Array Area at its closest point. First established as a Fisheries Closed Area for scallop reseeding trials in 2009, this MNR is 5.66 km^2 and makes up just over 1% of the reserves network (DEFA, 2022h).

1.6.4.16 The Niarbyl Bay MNR encompasses habitats such as rocky reefs, kelp forest and sea caves as well as intertidal blue mussel beds (DEFA, 2022h). The Ocean quahog is also an important feature of this MNR due to the coarse gravel habitats found in the south of the site (DEFA, 2022h).

Port Erin Bay MNR

1.6.4.17 The Port Erin Bay MNR is located to the west of the Isle of Man and northwest of the Morgan Generation Assets, 36.8 km from the Morgan Array Area at its closest point. Port Erin Bay MNR is relatively small at approximately 4.5 km^2. Facing due west, the bay acts as a funnel for wind and wave from the Irish Sea and these forces have produced one of the best sandy beaches on the island (DEFA, 2022i).

1.6.4.18 The Port Erin Bay MNR encompasses habitats such as rocky reefs, kelp forest and brittlestar beds (DEFA, 2022i), all of which take advantage of the site being closed for fishing since 1989 (DEFA, 2022i). The site is also notable for having stalked jellyfish *Stauromedusae* which are rare across the British Isles as well as the Flame shell *Limaria hians* which is a species of marine clam named for its fiery orange colours.

West Coast MNR

1.6.4.19 The West Coast MNR is located to the west of the Isle of Man and northwest of the Morgan Generation Assets, 38.7 km from the Morgan Array Area at its closest point. The West Coast MNR is the largest of the nature reserves at around 185 km^2, which equates to 43% of the protected area network (DEFA, 2022j).

1.6.4.20 The West Coast MNR has a distinctive physical environment as a result of the strong tidal currents around the Point of Ayre (DEFA, 2022j). The seabed is composed of sand deposits as well as rock fragments as a result of the glacial history of this area. These sediments have enabled the creation of rocky reefs, intertidal mussel beds and kelp beds (DEFA, 2022j). The main habitat within this MNR is mixed soft sediment which is inhabited by scallops and whelks as well as the burrowing sea anemone (*E. timida*) (DEFA, 2022j).

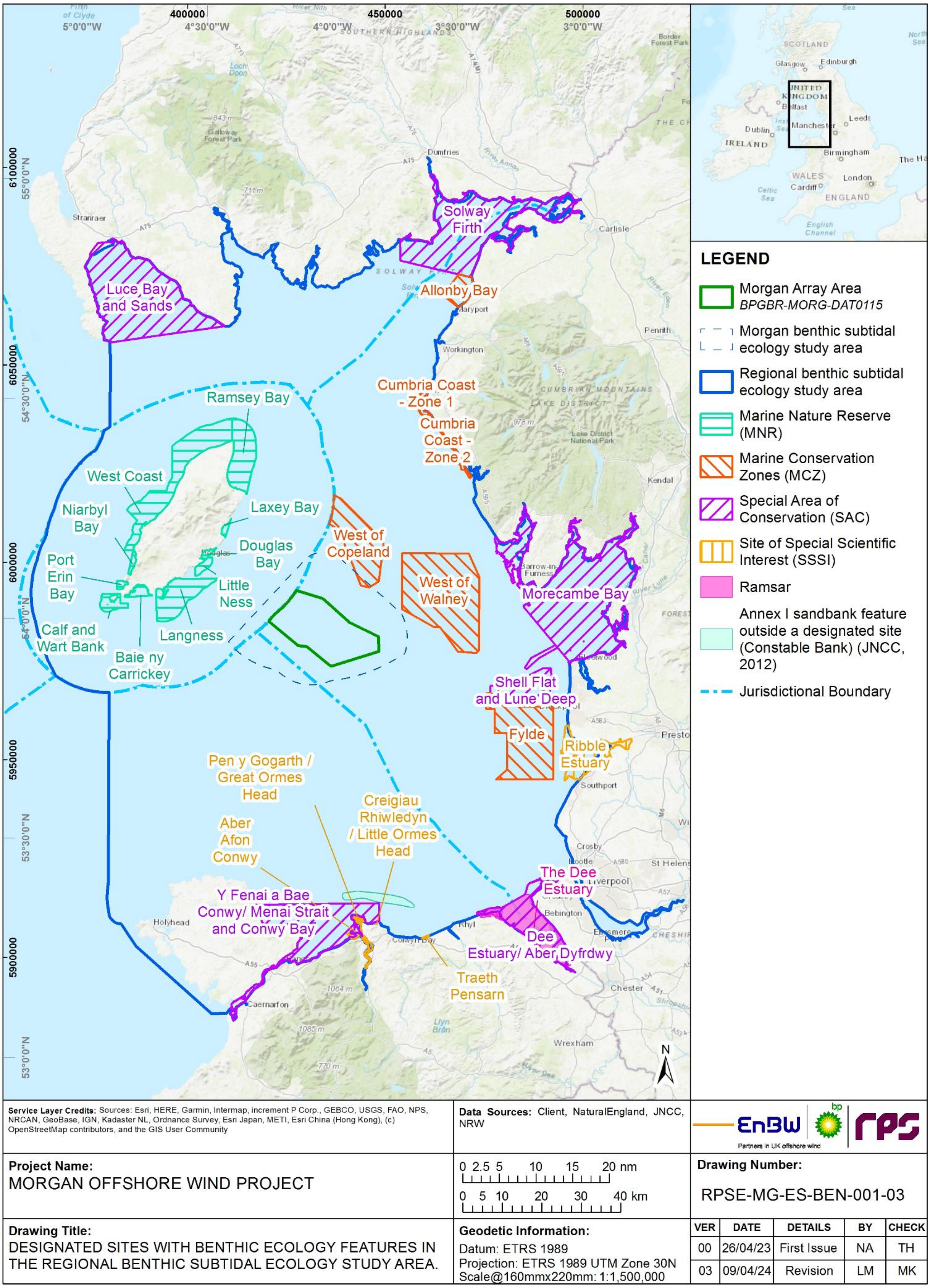


Figure 1.4: Designated sites with benthic ecology features in the regional benthic subtidal ecology study area.

1.7 Site-specific subtidal survey baseline characterisation

1.7.1.1 A benthic subtidal survey was undertaken in 2021 to characterise the Morgan Array Area within the Morgan benthic subtidal ecology study area. A further benthic subtidal survey was undertaken in 2022 to characterise the Morgan Array Area ZoI and to resample the Morgan Array Area within the Morgan benthic subtidal ecology study area (resampling of seven stations sampled during the 2021 survey was undertaken to enable understanding of temporal changes in community types within the Morgan benthic subtidal ecology study area). A summary of these surveys is outlined in Table 1.4 with full detailed results of the benthic subtidal surveys presented in sections 1.7.2 to 1.7.6. The full data is available on request.

1.7.1.2 As outlined in section 1.2, the surveys within the Morgan Array Area were undertaken in conjunction with the site-specific benthic surveys for the neighbouring Mona Offshore Wind Project. The statistical analysis, presented in this technical report, has been undertaken on the combined dataset collected within both the Morgan benthic subtidal ecology study area (i.e. the Morgan Array Area and ZoI) and the Mona Array Area with the data collected for the Mona Offshore Wind Project used to provide additional context for the data within the Morgan benthic subtidal ecology study area.

Table 1.4: Summary of surveys undertaken to inform benthic subtidal ecology.

Title	Survey extent	Overview of survey	Survey contractor	Date	Reference to further information
Pre-construction site investigation surveys	Morgan Array Area	Geophysical surveys to establish bathymetry, seabed sediment and identify seabed features.	XOcean Ltd	June 2021 to March 2022	Volume 4, Annex 1.1: Physical processes technical report of the Environmental Statement. Summary provided in paragraphs 1.7.2.1 to 1.7.2.3.
	Morgan Array Area	High resolution side scan sonar and multibeam bathymetry	Gardline Ltd.	June to September 2021	
Benthic subtidal surveys	Morgan Array Area	Grab and DDV sampling.	Gardline Ltd.	8 August 2021-20 September 2021	Section 1.7.1
	Morgan Array Area and ZoI	Grab and DDV sampling.	Gardline Ltd.	01 April 2022 – 14 August 2022	Section 1.7.1

1.7.1 Methodology

Sample collection

1.7.1.1 The 2021 site-specific subtidal survey was undertaken across the Morgan Array Area (and the Mona Array Area) within the Morgan benthic subtidal ecology study area. Site-specific subtidal surveys were also undertaken in 2022 to characterise the Morgan Array Area ZoI. The sampling strategies were designed to adequately sample the area to provide data for baseline characterisation. The survey designs were discussed and agreed with Natural England, JNCC and NRW (Table 1.1). The benthic subtidal surveys for the Morgan benthic subtidal ecology study area were undertaken by Gardline Limited (Gardline) in June to September 2021 and April to August 2022 respectively. The surveys were conducted onboard the vessels Ocean Resolution in 2021 and Ocean Observer and Titan Endeavour in 2022.

1.7.1.2 The 2021 subtidal survey comprised 37 sample stations located in the Morgan Array Area (two of which were DDV only, the rest were combined grab and DDV) (Figure 1.5). An additional 60 sample locations (nine of which were DDV only) were collected within the neighbouring Mona Array Area during the same survey. The intention of the sampling strategy was to characterise the benthic communities associated with all broadscale habitats and identify any potentially sensitive features. Upon acquisition of the geophysical data, the provisional targets were adjusted to target representative habitats and to provide coverage to assess the current condition of any potentially sensitive features evident in the geophysical data. Upon receipt of the geophysical dataset acquired by XOcean, three proposed stations (ENV07, ENV13 and ENV27) were adjusted in the Morgan Array Area.

1.7.1.3 Upon completion of the 2021 survey, 35 stations had been successfully sampled with an additional two DDV only stations within the Morgan Array Area and ZoI (Figure 1.5). Since the submission of the PEIR for the Morgan Generation Assets, there has been a refinement of the Morgan Array Area. The result of this is that six of the 2021 sample stations which were previously located in the Morgan Array Area now fall within the Morgan Array Area ZoI.

1.7.1.4 The 2022 survey was comprised 11 sample stations located within the Morgan Array Area and 15 sample stations located within the Morgan Array Area ZoI. Of the stations sampled in the Morgan Array Area seven were locations previously sampled in 2021, resampling was conducted to enable comparison between years and to determine if there had been any temporal changes in the communities present. All of the stations sampled in the 2022 comprised combined grab and DDV sampling (Figure 1.5). The Morgan Array Area and ZoI 2022 sample locations were proposed based upon publicly available data prior to any survey acquisition such as EMODnet data (Figure 1.2) to ensure sample stations were spread across a variety of habitats. Detailed geophysical data was reviewed during the field acquisition to refine the final sampling station locations and to determine sampling intensity.

Grab sampling

1.7.1.5 A total of 248 single grab samples were retained from 273 deployments of a 0.1 m^2 mini-Hamon grab during the 2021 survey, of which 104 were within the Morgan Array Area at 35 sample stations (noting that six of these stations now fall in the Morgan Array Area ZoI following refinement to the Morgan Array Area post-PEIR) (sampling (Figure 1.5). The Morgan Array Area and ZoI 2022 sample locations were proposed based upon publicly available data prior to any survey acquisition such as EMODnet data (Figure 1.2) to ensure sample stations were spread across a variety of habitats. Detailed geophysical data was reviewed during the field acquisition to refine the final sampling), to ensure adequate data coverage for both infaunal and epifaunal communities at each location. During the 2022 subtidal survey 52 grab samples were collected using a 0.1 m^2 mini-Hamon grab from 26 sample stations within the Morgan Array Area and ZoI (Figure 1.5).

1.7.1.6 Macrofaunal, particle size and eDNA (see Appendix H) samples were collected from all stations. Samples for chemical analysis were collected at 11 stations within the Morgan Array Area in the 2021 surveys (noting that six of these stations now fall in the Morgan Array Area ZoI following refinement to the Morgan Array Area post-PEIR) and

13 samples for chemical analysis were collected in the Morgan Array Area and ZoI in the 2022 surveys (of the 2022 sediment chemistry sample stations two were resampled stations which were also sampled in 2021).

1.7.1.7 Initial processing of all mini Hamon grab samples was undertaken aboard the survey vessel in line with the following methodology:

- Assessment of sample size and acceptability made
- Photograph of sample with station details, scale bar taken and described prior to sub-sampling
- Surficial (<2 cm depth) sediments were taken directly from the mini-Hamon grab for chemical and biological analysis
- One sediment grab was obtained which was divided into six sub-samples; two approximately 1 l samples for chemical analysis, and a spare, particle size analysis (PSA) with a spare taken using a plastic scoop and placed into plastic zip-lock bags
- Two separate grab samples from each station were collected for infaunal macroinvertebrate identification. Each faunal sample was washed with seawater and transferred to a 0.5 mm sieve, and finer sediment fractions were washed from the sample using an auto-sieve
- The sieve residue was transferred to a uniquely labelled sample jar using scoops and/or funnels and fixed with formaldehyde solution (less than 20% formalin)
- eDNA samples were taken from two grabs at each sampling location. If the sediment was undisturbed, two 50 ml cores were taken to a depth of 5 cm. If this sediment was homogenised, a sample of approximately 40 g in 2021 and >30 g in 2022 was taken as a small scoop from various points in the decanted sample. These samples were then stored in an airtight bag shielded from ultraviolet light and stored at less then -18^{o}C prior to analysis.

Drop down video

1.7.1.8 All stations sampled by grab in the Morgan benthic subtidal ecology study area in the 2021 and 2022 surveys were also surveyed with DDV. In the 2021 survey a minimum of 70 seabed photographs and 27 minutes of footage collected at each station at appropriate intervals including stations which had two attempts. In the 2022 survey a minimum of 22 seabed photographs and 12 minutes of footage were collected at each station at intervals of 10 to 15 seconds, including stations which had multiple attempts. In the 2021 and 2022 surveys environmental seabed images were taken by means of a digital stills shallow water camera system with a dedicated strobe and video lamp, mounted within a stainless-steel frame. Video footage was also acquired throughout all stations using a high definition video camera. Initially the survey was conducted with the C-Tecnics CT3022 camera system though this encountered a timing issue with its flash gun in the 2021 survey and the pictures were found to be out of focus in the 2022 survey so was swapped to the back-up Kongsberg OE14- 208 system after completion of the first sample stations.

1.7.1.9 In the 2021 survey a total of 9,216 photos were taken using the stills camera system across 97 stations. All of the photographs were taken less than 64 m from the target location. On average, photographs were taken 29 m (±14 standard deviation (SD) from their target locations. For the 2022 survey a total of 5,191 photos were taken using the stills camera system across 108 stations of which 26 where within the Morgan benthic subtidal ecology study area.

1.7.1.10 In the 2021 survey a further seven sample stations ENV72, ENV73 and ENV90 to ENV94 were added to the 28 original locations within the Morgan Array Area and ZoI comprising two camera-only stations to target boulder areas and five co-located camera and grab stations to target additional features of interest in the newly reviewed data. No additional stations were added in the 2022 survey campaign.

1.7.1.11 The camera investigations were in line with the epibiota monitoring operational and interpretation guidelines (Hitchin *et al*., 2015; Turner *et al*., 2016). 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 PC hard drive. On completion, photographs were downloaded onto a computer. All hard disk drives were labelled with the relevant job details, write-protected and stored.

Survey limitations

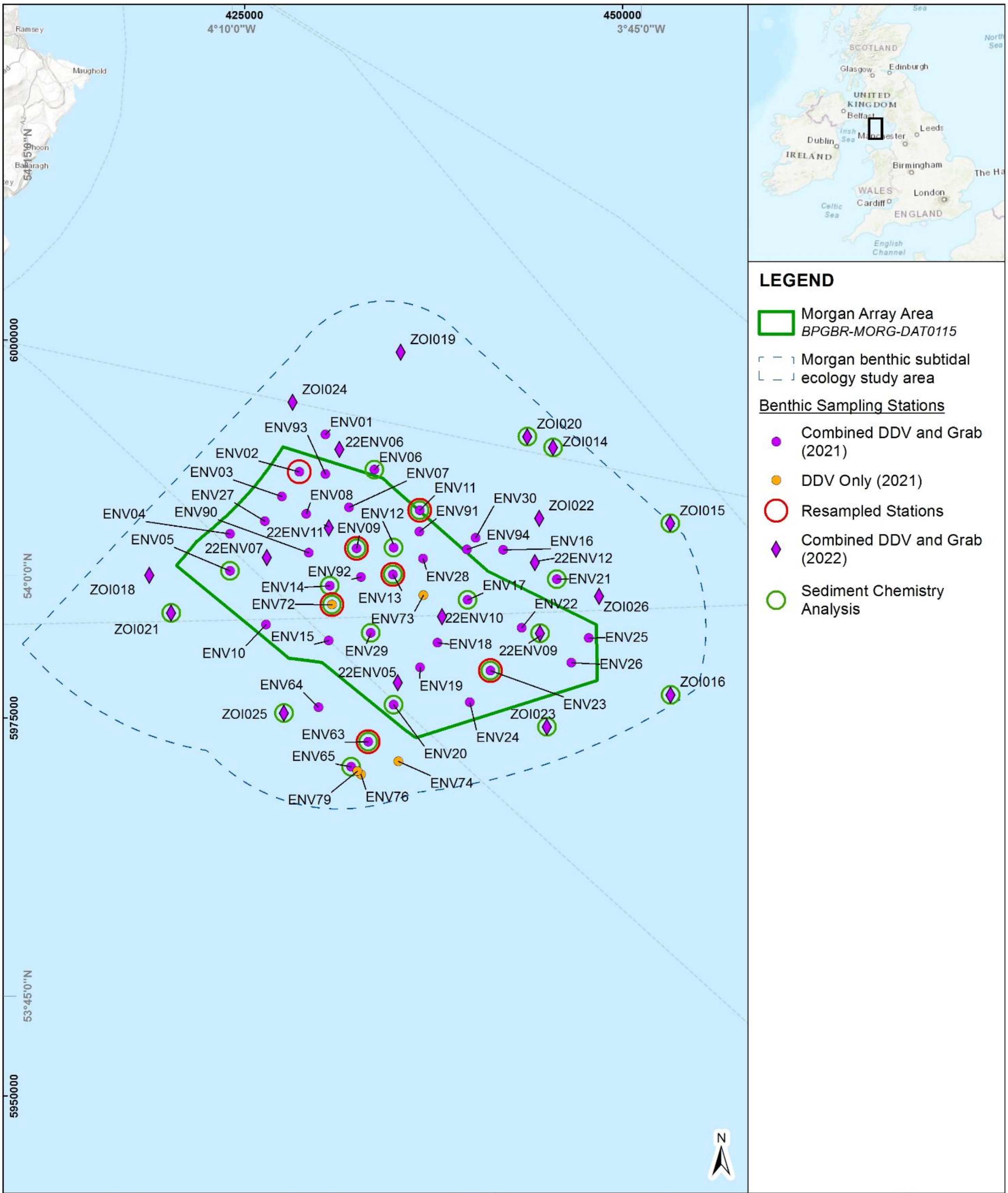
1.7.1.12 During the 2021 survey campaign due to operational weather conditions and advised client priorities to maximise weather windows, the original locations of sample stations ENV05 and ENV10 were relocated due to anomalies, so the DDV and grab station positions differ slightly.

1.7.1.13 In the 2021 survey campaign one sample station within the Morgan Array Area (ENV30) was also relocated during the survey due to lying within, or in close proximity to, exclusion zones for cables.

1.7.1.14 In the 2021 survey campaign during the surveys a number of stations were added to ensure adequate coverage of the survey area and its features. Further, from reviews of this additional data such as the geophysical data which was used to inform the micro siting of sample locations, additional stations were selected to cover features not already targeted. As a consequence, a further seven sample stations (ENV72, ENV73 and ENV90 to ENV94) were proposed to be added to the 28 original locations within the Morgan Array Area and ZoI comprising two camera-only stations to target boulder areas and five co-located camera and grab stations to target additional features of interest in the newly reviewed data such as the geophysical data.

1.7.1.15 In the 2021 survey four sample stations were sampled by DDV only (ENV72, ENV73, ENV76 and ENV79). These stations were DDV only because they were located in areas with potential stony features which would have been unsuitable for grab sampling or were identified as having potentially sensitive features, including stony reef and herring spawning habitat and which would have been damaged by grab sampling.

1.7.1.16 No adjustments or limitations were noted regarding sampling for the 2022 subtidal survey campaign.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community	**Data Sources:** Client	
Project Name: MORGAN OFFSHORE WIND PROJECT	0 1 2 4 6 nm 0 1 2 4 6 8 10 12 km	**Drawing Number:** RPSE-MG-ES-BEN-008-04
Drawing Title: COMPLETED SITE-SPECIFIC SAMPLE LOCATIONS WITHIN THE MORGAN BENTHIC SUBTIDAL ECOLOGY STUDY AREA.	**Geodetic Information:** Datum: ETRS 1989 Projection: ETRS 1989 UTM Zone 30N Scale@160mmx220mm: 1:425,000	

VER	DATE	DETAILS	BY	CHECK
00	11/08/23	First Issue	MJ	TH
04	09/04/24	Revision	LM	MK

Figure 1.5: Completed site-specific sample locations within the Morgan benthic subtidal ecology study area.

Sample analysis

Benthic infaunal analysis

1.7.1.17 Two separate grab samples from each station were collected for infaunal macroinvertebrate identification. For each faunal sample the entire contents of a single grab were washed into a clean plastic tray using seawater and then transferred to a 0.5 mm sieve. Finer sediment fractions were washed from the sample using an auto-sieve, which sprayed a low-powered seawater jet onto the underside of the sieve. The sieve residue was transferred to uniquely labelled sample jars using a scoop and/or funnel, making sure that none of the sample was lost or trapped in the sieve mesh. Sieved samples were immediately fixed with a known concentration of formaldehyde solution ('formalin', less than 20%). The formalin in the sample pots was subsequently diluted to a concentration of approximately 4%. One of the faunal samples (normally those identified as A) were worked up as a matter of course and a second retained as a spare (sample B). The benthic macrofaunal identification was undertaken by Thomson Ecology to NMBAQC processing guidelines (Worsfold and Hall, 2010).

1.7.1.18 Additionally, eDNA samples were taken from two grabs at each sampling location where possible (see Appendix I). If the sediment was undisturbed, two 50 ml cores were taken to a depth of 5 cm. If this sediment was homogenised, a sample of approximately 40 g was taken as small scoops from various points in the decanted sample. These were then combined in and stored in an airtight bag shielded from UV light and stored at less than -18 °C prior to analysis. DNA analysis was undertaken by NatureMetrics.

Sediment characteristic analysis

1.7.1.19 PSA was carried out by Kenneth Pye Associates Ltd. and Ocean Ecology (both MMO validated laboratories), in accordance with NMBAQC methods for diamictons (Mason, 2016). No dispersants were used, and the sediment was not treated to remove carbonates or organic matter prior to analysis. The sieve sizes ranged from 63 mm to <1 μm and were all assigned to a Wentworth classification (Wentworth, 1922). The results present particle size distributions in terms of mean phi, fraction percentages (i.e. gravel, sand and fines), sorting (mixture of sediment sizes) and skewness (weighting of sediment fractions above and below the mean sediment size) and kurtosis (degree of peakedness of a distribution) (Folk and Ward, 1957). The sediment samples were additionally classified using the modified Folk triangle classification and the EUNIS classification. These classifications use the sand:mud ratio and the percentage of gravel (Folk, 1954; Parry, 2019).

Sediment chemistry analysis

1.7.1.20 As part of the subtidal survey, sediment samples were taken for the purpose of sediment chemistry analysis (Figure 1.5). Sediment chemistry stations were selected with consideration of the likely sediments, predicted habitats and previous survey locations, along with observed bathymetric features. Sediment hydrocarbon, metals, total organic carbon (TOC), organotins and PCB analyses were carried out by SOCOTEC UK. Samples were transferred to an appropriate sample container, labelled and sent to a suitable qualified laboratory for analysis. Samples were analysed for the following contaminants:

- Metals

- PCBs
- Organotins
- PAHs.

Data analysis

Sediment characterisation analysis

1.7.1.21 The PSA data were categorised using the Folk classification which groups particles into mud, sand and gravel (mud 2 mm) and the relative proportion of each used to ascribe the sediment to one of 15 classes (e.g. slightly gravelly sand, muddy sand etc.) (Folk, 1954; Long, 2006). These classifications were then used to describe the data in the analysis. Proportions of mud, sand and gravel, as well as the Folk and Ward sorting coefficient, were also used to describe the sediment data. The Folk and Ward sorting coefficient describes the extent of deviation from lognormality of the particle size distribution (i.e. the variation in particle size with a sample).

Sediment chemistry analysis

1.7.1.22 The results of the sediment chemistry analysis were compared to the Cefas ALs (Cefas, 1994). Cefas AL1 and AL2 are thresholds which give an indication of how suitable the sediments are for disposal at sea. Contaminant levels which are below Cefas AL1 are of no concern and are unlikely to influence the marine licensing decision while those above Cefas AL2 are considered unsuitable for disposal at sea. Those between Cefas AL1 and AL2 would require further consideration before a licensing decision can be made.

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

Macrofaunal analysis

1.7.1.24 Destructive sampling techniques and sieving may damage delicate benthic organisms. It is, therefore, commonplace for fragmented organisms to be found in faunal samples. The following conditions were applied to the recording of damaged specimens and fragments:

- Fragments that constituted a major component of an individual, that unequivocally represented the presence of an entire organism, and that could be identified to species level, were recorded and included with other counts of that species
- Fragments that constituted a significant component of an individual, that unequivocally represented the presence of an entire organism, but that could not be identified to species by virtue of their incompleteness, were recorded to the lowest possible taxonomic level

- Fragments that did not unequivocally represent the presence of an entire organism were ignored (e.g. *Ophiura* arms, *Echinocardium* shell fragments, etc).

1.7.1.25 Recorded fragments, therefore, represent discrete observations of individuals that were present at the time of sampling and were included in the analysed data set.

1.7.1.26 Macrofauna was defined as organisms that are normally larger that the mesh size of the sieve used to separate them from the sediment. Meiofaunal organisms, such as the *Ostracoda* and *Copepoda*, which would not be consistently sampled, were not recorded. Due to their generally small size (in fully marine environments), species from the *Oligochaeta*, *Tardigrada* and *Gnathostomulida* were only enumerated when a sieve with a mesh size of 0.5 mm or less was used to separate organisms from sediments; otherwise, these organisms were noted to be present, but not enumerated.

1.7.1.27 Planktonic organisms, such as *Mysidacea* were not recorded. The presence of nektonic species, such as fish, was recorded, but were not enumerated. Colonial, stoloniferous and encrusting epibenthic species were identified but not enumerated. With the exception of discrete sea pen *Pennatulacea* colonies, only solitary tunicates and cnidarians were enumerated and included in statistical analyses. Colonial tunicates and cnidarians were identified but not enumerated. The testate amoeba *Astrorhiza* sp. was the only foram (amoeba-like, single-celled organisms) routinely enumerated. When found, the presence of Porifera sponges was recorded, but not identified to lower taxonomic levels, enumerated, or included in statistical analyses. Where *Gnathiidae* were recorded, those individuals not identified to species level were grouped as a single indeterminate *Gnathiidae* entry. The following organisms were not identified to species, but were enumerated and included in the data set for analyses at a higher taxonomic level:

- *Nemertea* – identified to phylum
- *Platyhelminthes* – identified to phylum
- *Oligochaeta* – identified to genus
- *Phoronida* – identified to genus
- *Cephalochordata* – identified to subphylum
- *Hemichordata* – identified to phylum.

Data rationalisation

1.7.1.28 The benthic infaunal and epifaunal datasets were initially transformed to down-weight the species with the highest abundances for multivariate community analysis. The analysis of the infaunal community was made using the enumerated taxa only dataset to avoid skewing the results with the encrusting/colonial taxa recorded as ‘present’; these taxa were combined with the DDV data and analysed separately.

1.7.1.29 Juveniles of some species were recorded in the raw infaunal data including species such as *Aphroditidae, Liocarcinus, Solecurtidae, Mytilidae, Asteroidea, Echinoidea, Dendrochirotida, Ophiuroidea, Spatangoida*, *Pisidia longicornis*, *Corystes cassivelaunus*, *Lucinoma borealis* and *Sthenelais boa*. Juveniles were however excluded from the multivariate analysis as they represented a very minor fraction of the infaunal taxon and abundance for the 2021 survey data. Juveniles were left in for the analysis of the 2022 Morgan Array Area ZoI data as a RELATE test found they did not skew the data.

1.7.1.30 All fish species were removed prior to analysis and discussed separately and within Volume 4, Annex 3.1: Fish and shellfish ecology technical report of the Environmental Statement.

1.7.1.31 Colonial/encrusting taxa within the grab samples, which were recorded only as present, were combined with the DDV data and given an abundance of 1 or 0 respectively to enable them to be included in a separate multivariate analysis. The combined DDV and grab epifaunal dataset was square root transformed.

1.7.1.32 The epifaunal data that were recorded as present/absent, and therefore removed from the infaunal grab data analysis, were combined with the epifaunal data from the DDV. The full data is available on request.

Univariate analysis

1.7.1.33 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 sample station, the percentage contribution of each taxonomic group to the total number of taxa and to the total number of individuals.

1.7.1.34 A number of univariate indices were calculated 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 for each identified biotope.

Multivariate community analysis

1.7.1.35 The benthic infaunal grab data and combined DDV and grab epifaunal data were analysed using the PRIMER v7 software (Clarke and Gorley, 2006). As outlined in section 1.2, the multivariate community analysis, presented in this technical report, has been undertaken on the combined dataset collected within both the Morgan and Mona Array Areas with the data collected for the Mona Offshore Wind Project used to provide additional context for the data within the Morgan Array Area. The Morgan Array Area ZoI data has been incorporated and analysed together with the Morgan Array Area data as well as the Mona Array Area dataset to provide a comprehensive characterisation (and updated characterisation since the PEIR) of the Morgan benthic subtidal ecology study area.

1.7.1.36 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. This used the Bray Curtis similarity coefficient to assess the similarity of sites 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.

1.7.1.37 Similarity Percentages (SIMPER) analyses were subsequently undertaken on the infaunal and two 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 and Warwick (2001).

1.7.1.38 CLUSTER analysis and ANOSIM test were conducted on a merged dataset of the 2021 and 2022 Morgan Array Area data including the resampled stations to determine how similar the two datasets were and if there had been any change in community between the survey dates.

Biotope allocation

1.7.1.39 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 clusters identified, several sites within a cluster and, where appropriate several clusters, were assigned to a single biotope, where possible, based on relatedness and presence/absence of key indicator species for a particular biotope. The preliminary infaunal and epifaunal biotopes were plotted over the results of the geophysical surveys (see section 1.7.2) for the Morgan subtidal ecology study 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 preliminary infaunal and epifaunal biotope maps. The infaunal and epifaunal biotope allocations were combined to provide a final combined biotope map.

Habitat analyses

Seapens and burrowing megafauna communities assessment

1.7.1.40 The seapens and burrowing megafauna habitat is described by OSPAR as ‘Plains of fine mud, at water depths ranging from 15 to 200 m or more, which are heavily bioturbated by burrowing megafauna with burrows and mounds typically forming a prominent feature of the sediment surface. The habitat may include conspicuous populations of seapens, typically *Virgularia mirabilis* and *Pennatula phosphorea*’.

1.7.1.41 Guidance by the JNCC (2014) clarifies how to identify this habitat and suggests that burrowed areas of mud should be deemed to be a ‘sea pen and burrowing megafauna communities’ habitat regardless of the presence of sea pens if multiple sightings of burrows and/or mounds attributable to the relevant species are observed. Habitats can be classed as ‘sea pen and burrowing megafauna communities’ regardless of the grain size composition of the sediment (JNCC, 2014).

1.7.1.42 The clarifications (JNCC, 2014) advocate utilising seabed video imagery and/or photographs to confirm the presence of burrows or mounds and sea pens, where present. The density classifications as laid out by the Marine Nature Conservation Review (MNCR) SACFOR scale (JNCC, 2013) were used to quantify these defining features. The overall density of burrows was assessed in order to consider whether their density was a ‘prominent’ feature of the sediment surface and potentially indicative of a sub-surface complex gallery burrow system.

1.7.1.43 The JNCC (2014) guidance also states that the habitat occurs predominantly in fine mud sediments. However, some examples of this habitat have been identified in areas of sandy muds. As such, where there is clear evidence of the relevant biological assemblages (burrowing megafauna and in some examples, sea-pens), such habitats can be classified as ‘Sea-pen and burrowing megafauna communities’ regardless of the grain size composition of the sediment (JNCC, 2014).

1.7.1.44 The overall or average burrow densities were calculated for each target using the total area covered by the seabed imagery (average image swathe width x camera transect length). In total, analysis was conducted of 9,320 fixes. It should be noted that there was no attempt to ascertain species due to the inherent complexities of detail needed (ICES, 2011) which is not available with the data acquired. As such and in line with the JNCC report (JNCC, 2013) recommendations, a degree of caution should be applied to these density results as they are not necessarily definitive of the habitats condition.

Annex I stony reef assessment

1.7.1.45 A multi-criteria scoring system was used to assess the characteristics of areas of potential stony reef. Each characteristic was scored as low, medium or high; with spatial extent (m^2), substratum composition (% cover) and elevation (m) as the primary characteristics, as defined by Irving (2009); see Table 1.5.

Table 1.5: Stony reef criteria.

Characteristics	Resemblance to 'Stony Reef'			
	NOT a 'Stony Reef'	Low	Medium	High
Composition	<10% cobbles/boulders	10 - <40% cobbles/boulders	40-<95% cobbles/boulders	≥95% cobbles/boulders
		Matrix supported: dominated by sediment	Clast supported: dominated by cobbles/boulders	Clast supported: dominated by cobbles/boulders
Elevation	Flat seabed	<0.064 mm	0.064-<5 m	≥5 m
Extent	≤25 m^2	>25 m^2	>25 m^2	>25 m^2
Biota	Dominated by infaunal species			>80% of species present composed of epifaunal species

1.7.1.46 The patchiness of potential reef sites was also considered including aspects such as average percentage cover; and the presence or absence of key biota. This approach is similar to that developed by Jenkins *et al*. (2015), which is considered in line with Golding *et al*. (2020) recommendations as part of assessing the composition of stony reefs in Table 1.5.

1.7.1.47 The more recent guidance by Golding *et al*. (2020) on refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef were also considered in the analysis.

Fragile sponge and anthozoan communities on rocky habitats assessment

1.7.1.48 Recent attempts to formally quantify a threshold as to what density of sponges define a deep-sea sponge habitat have been made by the DNV (2013) and the JNCC (Henry and Roberts, 2014). The DNV approach is based upon assessment of the percentage cover of sponges in each image. Only images with >10% sponge cover (High) are thought to constitute an OSPAR deep-sea sponge aggregation (DNV, 2013). This approach is useful as a field guide as to whether an aggregation may occur though is subject to a lot of variation due to differences in camera height above and angle to the seabed.

1.7.1.49 Imagery acquired during the site-specific survey was acquired using a drop-down camera system, therefore it was subjected to wave effects which varied the camera height above the seabed which may have altered the still imagery field of view. Consequently, any determination of habitats by this approach should be considered as a coarse indication of the habitat's presence.

1.7.1.50 Further, evidence of the species communities being present that are listed in biotopes that constitute 'fragile sponge and anthozoan communities on rocky habitats' (MarLIN, 2015) were also assessed to define the habitat.

1.7.2 Results – sediment analysis

Results – sediment characteristics (geophysical survey)

1.7.2.1 Across the Morgan Array Area side scan sonar reflectivity was relatively homogenous. Environmental and geotechnical sampling indicated that seabed sediments predominantly comprised gravelly sand, with varying amounts of associated shell fragments. This aligns with the grab sampling PSA data which showed the Morgan Array Area to be dominated by gravelly muddy sand and gravelly sand (paragraph 1.7.2.4).

1.7.2.2 In the Morgan Array Area, sonar reflectivity in the east of the area was lower, and the ground truthing results showed sediments comprised predominantly shelly sand. Megaripples were present across much of the seabed in this area. Across the central Morgan benthic subtidal ecology study area, sandwaves were present and were associated with an increased gravel content in the sediments. In the west of the Morgan Array Area, an increased sonar reflectivity resulted from an increased gravel content.

1.7.2.3 Geophysical surveys were not conducted throughout the Morgan Array Area ZoI however surveys for the Transmission Assets crossed some of the north, south and east of the Morgan Array Area ZoI (Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd, 2023). These surveys found the seabed typically undulated with gradients <2°, with steeper gradients associated with outcrops of the underlying geology in the northeast of the Morgan Array Area ZoI. Sand ripples were present at seabed over the majority of the Transmission Assets including within the Morgan Array Area ZoI, with patches of featureless seabed. The seabed sediments in areas of sand ripples were generally characterised as clayey sand, with patches of slightly gravelly clayey sand in areas of subcrop. Where the seabed was featureless sediments were composed of clayey sand in the north of the Morgan Array Area ZoI and slightly gravelly clayey sand in the south of the Morgan Array Area ZoI.

Results – physical sediment characteristics (PSA)

1.7.2.4 The subtidal benthic sediments across the Morgan Array Area within the Morgan benthic subtidal ecology study area were classified into sediment types according to the Folk classification. Sediments ranged from gravelly sand to muddy sandy gravel, with the majority of the samples in the Morgan Array Area classified as gravelly muddy sand or gravelly sand (Figure 1.6). Across the Morgan Array Area ZoI sediments ranged from muddy sandy gravel to gravelly muddy sand, with the majority of samples classified as sand. Of all the samples in the Morgan benthic subtidal ecology study area, the majority were classified as gravelly sand (36.51%), gravelly muddy sand (30.16%) and sand (19.05%), representing the three most common sediment types through-out the Morgan benthic subtidal ecology study area. The sediments in the west of the Morgan Array Area were typically gravelly muddy sands and muddy sandy gravels which graded into to gravelly sands in the centre of the Morgan Array Area and then muddy sands and sands in the east of the Morgan Array Area ZoI. These findings are consistent with the results of the geophysical surveys which identified an increased gravel content in the west and sand based sediment with a notable clay content in the east (see paragraphs 1.7.2.2 and 1.7.2.3). According to the simplified Folk Classification (Long, 2006), most stations were classified as mixed or coarse sediments with areas of mixed sediment and sand and muddy sand sediment.

1.7.2.5 The percentage sediment composition (i.e. mud ≤0.63 mm; sand <2 mm; gravel ≥2 mm) at each grab sample station in the Morgan benthic subtidal ecology study area is presented in Figure 1.7 and Appendix A. Across all sample stations in the Morgan benthic subtidal ecology study area, the average percentage sediment composition was 12.52% gravel, 79.53% sand and 7.95% mud. The average composition of sediment across Morgan benthic subtidal ecology study area were very similar. Across the Morgan benthic subtidal ecology study area sand made up the highest proportion of the sediment composition. The sediment composition also showed a higher percentage of gravels within the central and west section of the Morgan Array Area and particularly the southwest of the Morgan Array Area ZoI. These findings are consistent with the results of the geophysical surveys which also identified coarse sediments in the west and fine sediments predominantly in the east (paragraph 1.7.2.2). The sample stations with the highest percentage composition of mud were generally found along the central and west section of the Morgan Array Area and the northeast of the Morgan Array Area ZoI (Figure 1.6).

1.7.2.6 Sediments across the Morgan benthic subtidal ecology study area were typically poorly sorted or very poorly sorted, and a small number of samples were classified as moderately sorted. Two sample stations in the Morgan Array Area ZoI (ENV26 and ENV30) were moderately well sorted, this station was classified as sand with 0.08% gravel, 99.92% sand and 0.00% mud, and 0.23% gravel, 99.77% sand and 0.00% mud respectively (Figure 1.7 and Appendix A). One sample in the Morgan Array Area ZoI (ZOI021) was classified as extremely poorly sorted, this station was classified as muddy sandy gravel with 32.06% gravel, 53.55% sand and 14.39% mud (Figure 1.7 and Appendix A).

Comparison between Morgan Array Area 2021 and 2022 survey

1.7.2.7 In the 2022 site-specific surveys seven sample stations which had been sampled in the 2021 site-specific survey were resampled (Figure 1.5) (resampling was undertaken to enable comparison between years and to determine if there had been any temporal changes in the communities present within the Morgan benthic subtidal ecology study area). Additionally, five new sample stations were added to the Morgan Array Area for the 2022 site specific survey (Figure 1.5) (further sample stations were added to the Morgan Array Area in the 2022 site specific survey to capture any temporal changes in community type).

1.7.2.8 Of the resampled stations one sample station had the same Folk modified sediment classification as was assigned from the 2021 analysis, the other samples only showed minor variation in their classification from 2021 to 2022 (e.g. changing from gravelly muddy sand to gravelly sand). All the sediments were sand based, as they was observed in the 2021 survey.

1.7.2.9 The Folk modified sediment classifications for the new sample stations in the Morgan Array Area did not result in the identification of any new sediment classifications beyond what was identified in 2021. The sediments identified were all sand based and the majority were classified as gravelly sands which was prevalent in the Morgan Array Area in the 2021 site specific survey.

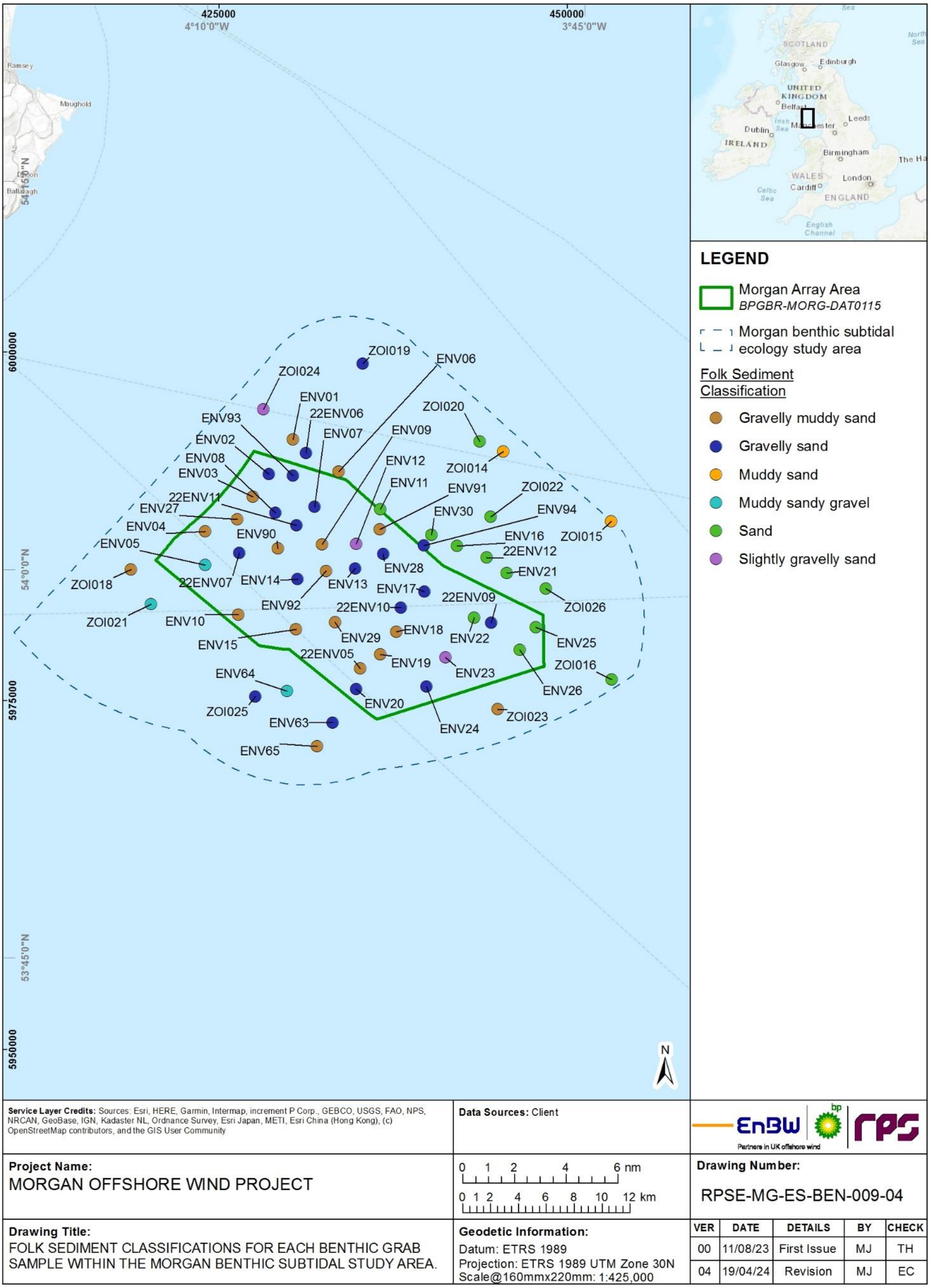
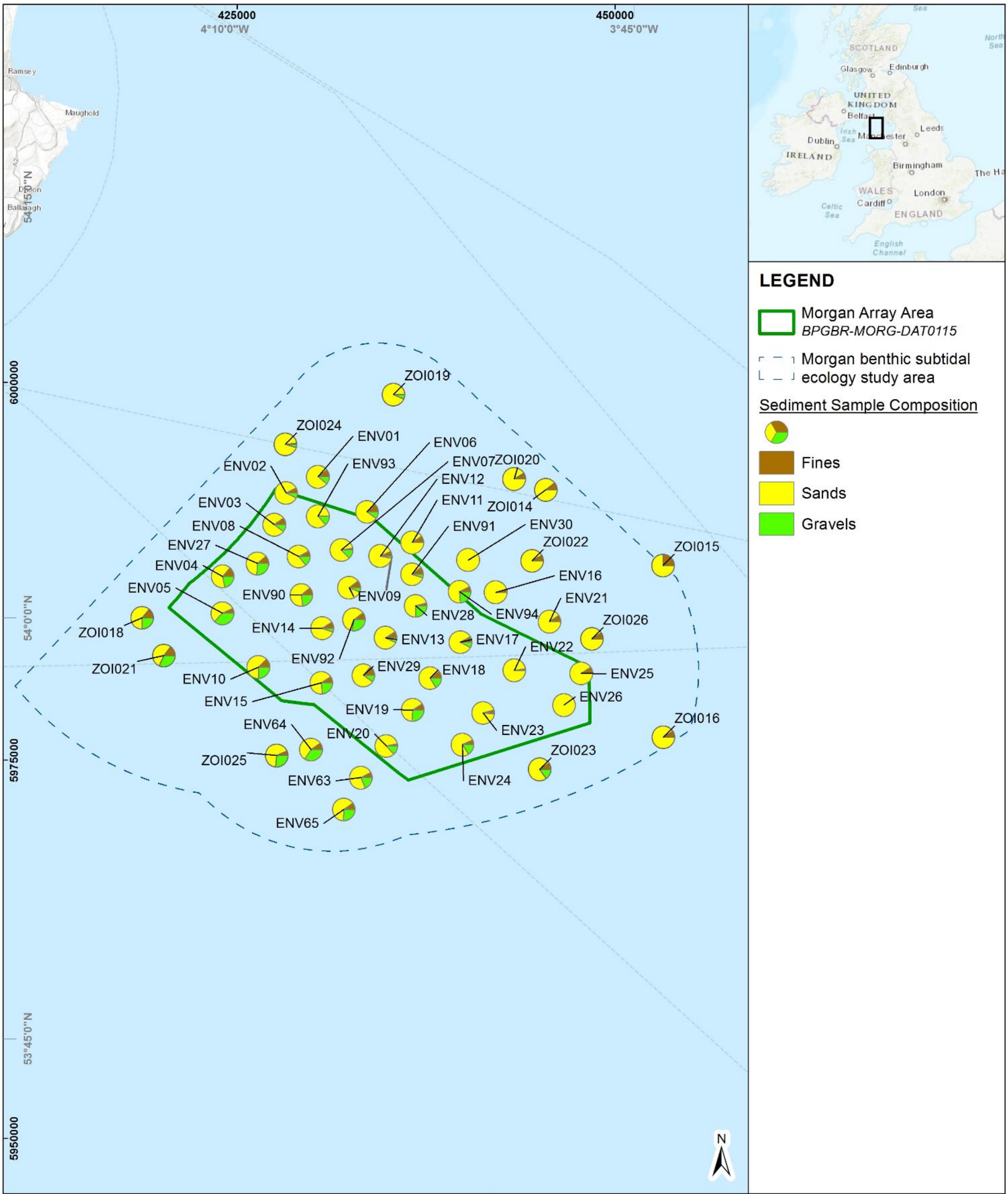


Figure 1.6: Folk sediment classifications for each benthic grab sample within the Morgan benthic subtidal study area.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 nm
0 1 2 4 6 8 10 12 km

Drawing Number:
RPSE-MG-ES-BEN-010-03

Drawing Title:
SEDIMENT COMPOSITION (FROM PSA) AT EACH BENTHIC GRAB SAMPLE LOCATION WITHIN THE MORGAN BENTHIC SUBTIDAL STUDY AREA.

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:425,000

VER	DATE	DETAILS	BY	CHECK
00	11/08/23	First Issue	MJ	TH
03	09/04/24	Revision	LM	MK

Figure 1.7: Sediment composition (from PSA) at each benthic grab sample location within the Morgan benthic subtidal study area.

Results - Sediment contamination

Metals

1.7.2.10 Heavy metals are readily adsorbed by sediments which can lead to metals accumulating to concentrations far higher than the surrounding environment. These sediments can become re-suspended through bioturbation or through physical processes/disturbances. Metals will tend to accumulate in these fine-grained sediments and can become bioavailable to marine organisms through ingestion. The uptake of heavy metals by marine organisms can lead to bioaccumulation through trophic levels leading to apex organisms accumulating metals to adverse and toxic levels. This could result in significant adverse effects including mortality, impaired reproduction, reduced growth, alterations in metabolism as a result of oxidative stress and disruption to the food chain.

1.7.2.11 Table 1.6 presents the levels of metals that were recorded in the sediment samples collected from 11 stations in the Morgan Array Area and the 13 stations within the Morgan Array Area ZoI. The results showed that, on the whole, levels of metal contamination were very low across the Morgan subtidal ecology study area and, with a few exceptions which are discussed below, were below the relevant Cefas ALs and Canadian thresholds.

1.7.2.12 The sediment chemistry results for the Morgan benthic subtidal ecology study area, presented in Table 1.6, show that levels of cadmium, chromium, copper, nickel, lead, mercury and zinc did not exceed the relevant Cefas AL1 or the Canadian TEL in any of the samples.

1.7.2.13 Concentrations of arsenic marginally exceeded the Cefas AL1 (20 mg/kg) at one station in the Morgan Array Area (ENV23) and two stations in the Morgan Array Area ZoI (22ENV06 and ENV65) (Figure 1.8) but were well below the Cefas AL2 (Figure 1.8). Within the Morgan Array Area 10 sample stations exceeded the Canadian TEL for arsenic, as did seven sample stations in the Morgan Array Area ZoI however all were below the Canadian PEL.

Comparison of Morgan Array Area 2021 and 2022 data

1.7.2.14 Two stations from the 2021 survey were resampled for sediment chemistry in the 2022 survey (ENV13 and ENV63) (Figure 1.8). The results of the 2022 survey identified only minimal changes from 2021 to 2022. At station ENV13 in the Morgan Array Area there was a small increase in the concentrations of all metals except for mercury which decreased slightly (Figure 1.8). At sample station ENV63 in the Morgan Array Area ZoI, changes were again minimal between 2021 and 2022 with six metals increasing in concentration and two decreasing. None of these changes in concentration led to any metals exceeding their relevant thresholds apart from arsenic which remains over the Canadian TEL but below the Cefas AL1 at this station.

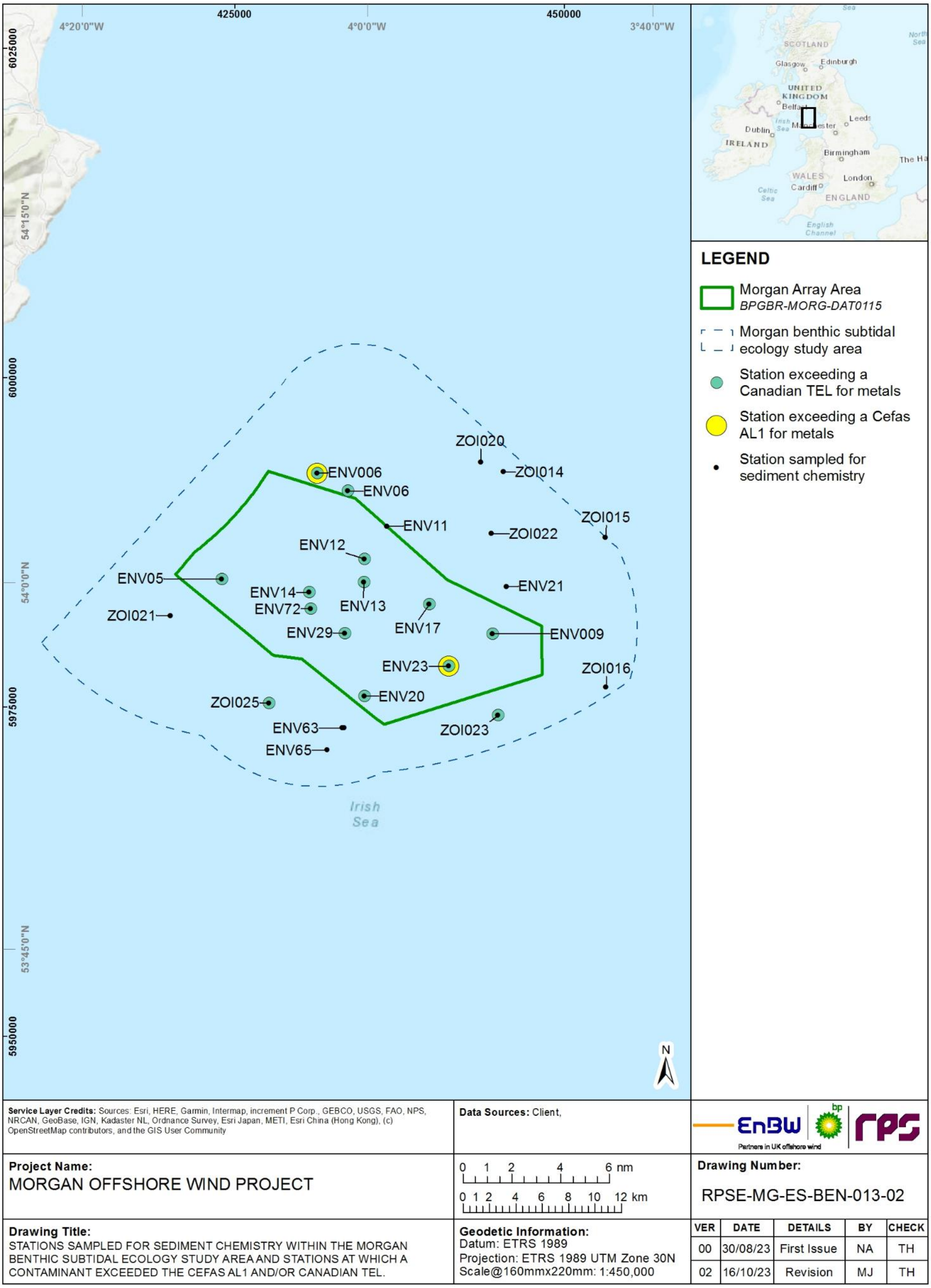


Figure 1.8: Stations sampled for sediment chemistry within the Morgan benthic subtidal ecology study area and stations at which a contaminant exceeded the Cefas AL1 and/or Canadian TEL.

Table 1.6: Concentrations of metals recorded in sediments within the Morgan benthic subtidal ecology study area[1].

Stations and thresholds	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
Units	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Detection Limit	1	0.1	0.5	2	2	0.01	0.5	3
Threshold: Cefas AL1 (mg/kg)	20	0.4	40	40	50	0.3	20	130
Threshold: Cefas AL2 (mg/kg)	100	5	400	400	500	3	200	800
Threshold: Canadian TEL (mg/kg)	7.24	0.7	52.3	18.7	30.2	0.13	N/A	124
Threshold: Canadian PEL (mg/kg)	41.6	4.2	160	108	112	0.7	-	271
Morgan Array Area								
2021 stations and resampled stations								
ENV05	11.4	0.10	17.3	7.3	10.9	0.05	14.1	29.5
ENV12	12.5	0.04	7.9	4.7	10.4	0.05	6.8	18.5
ENV13	11.8 (2021) 15.2 (2022)	0.05 (2021) 0.07 (2022)	8.2 (2021) 12.5 (2022)	5.0 (2021) 6.6 (2022)	11.1 (2021) 14.4 (2022)	0.04 (2021) 0.02 (2022)	7.3 (2021) 11.1 (2022)	21.5 (2021) 31.4 (2022)
ENV14	8.4	0.05	8.3	4.9	10.1	0.04	7.6	21.0
ENV17	18.0	0.07	10.5	5.4	14.4	0.05	9.1	28.7
ENV20	18.7	0.10	10.4	5.2	9.0	0.06	10.9	21.2
ENV29	13.3	0.08	10.9	5.7	15.3	0.06	9.5	25.6
2022 stations								
ENV11	5.1	0.16	6.6	7.2	6.5	0.04	5.2	34.7
ENV23	27.5	0.07	9.3	5.7	15.5	0.01	8.8	28.8
ENV72	17.5	0.07	12.0	6.6	9.3	0.01	13.6	23.8
22ENV09	16.4	0.07	14.3	7.3	10.0	0.02	10.8	29.8
Morgan Array Area ZoI								
2021 stations								
ENV06	14.1	0.06	10.0	5.9	14.5	0.05	8.6	28.7
ENV21	5.3	0.04	7.4	4.3	8.1	0.06	5.3	21.0

[1] Where contaminant levels exceed the relevant thresholds, the cells are shaded with the relevant colours (i.e. samples that exceed Cefas AL1 are coloured yellow, samples that exceed Cefas AL2 are coloured red, samples that exceed Canadian TEL are coloured turquoise and samples that exceed Canadian PEL are coloured purple. Where a sample exceeds two thresholds the higher threshold has been used to determine the colour).

Stations and thresholds	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
ENV63	9.9 (2021) 12.0 (2022)	0.05 (2021) 0.07 (2022)	9.4 (2021) 10.1 (2022)	6.3 (2021) 6.8 (2022)	10.0 (2021 12.0 (2022)	0.07 (2021) 0.01 (2022)	8.3 (2021) 8.6 (2022)	27.2 (2021) 27.0 (2022)
ENV65	20.2	0.08	11.4	5.6	10.6	0.05	10.3	31.4
2022 stations								
22ENV06	23.5	0.08	14.8	7.9	13.7	0.02	13.9	30.6
ZOI14	4.3	0.05	10.0	7.1	9.2	0.03	9.2	28.0
ZOI15	4.3	0.10	13.8	8.3	13.3	0.07	13.3	40.8
ZOI16	5.3	0.04	7.9	5.9	8.7	0.02	8.7	27.6
ZOI20	6.1	0.05	8.1	5.4	9.7	0.04	9.7	39.5
ZOI21	7.1	0.08	13.7	7.4	9.0	0.01	9.0	31.0
ZOI22	5.3	<0.04	8.8	6.1	8.1	<0.01	8.1	24.5
ZOI23	10.9	0.04	10.8	6.3	12.6	<0.01	12.6	28.4
ZOI25	12.7	<0.04	15.3	7.1	9.4	<0.01	9.4	30.4

Organotins

1.7.2.15 Organotins are a large class of organometallic compounds which contain tin-carbon bonds. They are also an important environmental contaminant associated with agricultural, industrial and biomedical activities (Okoro *et al*., 2014). Organotins are toxic to many marine organisms even at very low concentrations. High concentrations can cause shell deformities in oysters and impair reproduction (Alzieu *et al*., 1982).

1.7.2.16 The 2021 site specific survey found organotin concentrations across the Morgan benthic subtidal ecology study area were below LOD at all stations surveyed.

1.7.2.17 The 2022 site specific survey found organotin concentrations across the Morgan benthic subtidal ecology study area were below LOD at all stations surveyed.

Polychlorinated biphenyls (PCBs)

1.7.2.18 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.

1.7.2.19 Table 1.7 presents the total PCBs and the total of the ICES-7 PCBs that were recorded in the sediment samples collected from 11 stations in the Morgan Array Area and the 13 stations within the Morgan Array Area ZoI. The full results for the individual PCBs are presented in Appendix F.

1.7.2.20 The results show that levels of PCBs were typically recorded below the LOD across the Morgan benthic subtidal ecology study area with the exception of two stations (ENV05 and ZOI15) (Figure 1.8). The levels of the total ICES-7 PCBs were however below the relevant Cefas AL1 (0.01 mg/kg) at these stations and levels of total PCBs were also below the Cefas AL1 (0.02 mg/kg) and Cefas AL2 (0.2 mg/kg) as shown in Table 1.7.

Comparison between Morgan Array Area 2021 and 2022 survey

1.7.2.21 Two stations from the 2021 survey were resampled for sediment chemistry in the 2022 survey (ENV13 and ENV63) (Figure 1.8). There was no change in the levels of PCBs between 2021 and 2022 with the concentration being below the LOD in both years at both sample stations (Table 1.7).

Table 1.7: Concentrations of total PCBs and ICES-7 PCBs in sediments within the Morgan benthic subtidal ecology study area[2].

Stations and thresholds	Total PCBs	Total ICES-7 PCBs
Units	mg/kg	mg/kg
Threshold: Cefas AL1 (mg/kg)	0.02	0.01
Threshold: Cefas AL2 (mg/kg)	0.2	N/A
Threshold: Canadian TEL (mg/kg)	21.5	N/A
Threshold: Canadian PEL (mg/kg)	189	N/A
Morgan Array Area		
2021 stations and resampled stations		
ENV05	0.00439	0.00195
ENV12	Not Quantifiable (NQ)	NQ
ENV13	NQ (2021) NQ (2022)	NQ (2021) NQ (2022)
ENV14	NQ	NQ
ENV17	NQ	NQ
ENV20	NQ	NQ
ENV29	NQ	NQ
2022 stations		
ENV11	NQ	NQ
ENV23	NQ	NQ
ENV72	NQ	NQ
22ENV09	NQ	NQ
Morgan Array Area ZoI		
2021 stations		

[2] Where contaminant levels exceed the relevant thresholds, the cells are shaded with the relevant colours (i.e. samples that exceed Cefas AL1 are coloured yellow, samples that exceed Cefas AL2 are coloured red, samples that exceed Canadian TEL are coloured turquoise and samples that exceed Canadian PEL are coloured purple. Where a sample exceeds two thresholds the higher threshold has been used to determine the colour).

Stations and thresholds	Total PCBs	Total ICES-7 PCBs
ENV06	NQ	NQ
ENV21	0.1	NQ
ENV63	NQ (2021) NQ (2022)	NQ (2022) NQ (2022)
ENV65	NQ	NQ
2022 stations		
22ENV06	NQ	NQ
ZOI14	NQ	NQ
ZOI15	0.00049	0.00037
ZOI16	NQ	NQ
ZOI20	NQ	NQ
ZOI21	NQ	NQ
ZOI22	NQ	NQ
ZOI23	NQ	NQ
ZOI25	NQ	NQ

Polycyclic aromatic hydrocarbons (PAHs)

1.7.2.22 PAHs enter the environment through a number of sources, these include road run-off, sewage, atmospheric circulation and from historical industrial discharge. Once in the environment, PAHs exert a strong affinity for organic carbon and as such organic sediment in rivers 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 can bioaccumulate to toxic levels.

1.7.2.23 Table 1.8 presents the concentrations of PAHs that were recorded in the sediment samples collected from the 11 stations in the Morgan Array Area and the 13 stations within the Morgan Array Area ZoI. Table 1.8 presents those PAHs for which a threshold is available with the full results for the individual PAHs, including those without Canadian thresholds, presented in Appendix F.

1.7.2.24 Total PAH concentrations ranged from 60 µg/kg to 363 µg/kg across the Morgan benthic subtidal ecology study area (see Appendix F). Concentrations of all PAHs in samples in the Morgan benthic subtidal ecology study area were below the relevant Canadian TEL (where one is specified). PAH concentrations were also well below their respective ERL values, indicating toxic effects to fauna from PAHs is unlikely.

Comparison between Morgan Array Area 2021 and 2022 survey

1.7.2.25 Two of the sample locations within the Morgan benthic subtidal ecology study area were resampled as a result of the 2022 site specific survey campaign. The results of resampling at ENV13 (Figure 1.8) found that concentrations of eight PAHs had increased, concentrations of two PAHs had remained the same and concentrations of one PAH had decreased. The results of resampling at ENV63 (Figure 1.8) found that concentrations of seven PAHs had increased and concentrations of five PAHs had remained the same. Despite these changes all PAHs remained below their respective Canadian TEL and PEL as well as their respective ERL and ERM.

Table 1.8: Concentrations of PAHs (µg/kg) in sediments within the Morgan benthic subtidal ecology study area[3].

	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo[a]anthracene (µg/kg)	Benzo[a]pyrene (µg/kg)	Chrysene (µg/kg)	Dibenzo[ah]anthracene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)
Canadian TEL (µg/kg)	6.71	5.87	46.9	74.8	88.8	108	6.22	113	21.2	34.6	86.7	153
Threshold: Canadian PEL (µg/kg)	88.9	128	245	693	763	846	135	1,494	144	391	544	1,398
Threshold: ERL (µg/kg)	16	44	85.3	261	430	384	63.4	600	19	160	240	665
Threshold: ERM (µg/kg)	500	640	110	1,600	1,600	2,800	260	5,100	540	2,100	1,500	2,600
Morgan Array Area												
2021 stations and resampled stations												
ENV05	<1	<1	<1	3	3	4	1	4	1	3	5	4
ENV12	<1	<1	<1	2	3	3	1	4	<1	2	3	3

[3] Where contaminant levels exceed the relevant thresholds, the cells are shaded with the relevant colours (i.e. samples that exceed Canadian TEL are coloured turquoise, samples that exceed Canadian PEL are coloured purple, samples that exceed ERL are coloured orange and samples that exceed ERM are coloured pink. Where a sample exceeds two thresholds the higher threshold has been used to determine the colour).

	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo[a]anthracene (µg/kg)	Benzo[a]pyrene (µg/kg)	Chrysene (µg/kg)	Dibenzo[ah]anthracene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)
ENV13	<1 (2021) <1 (2022)	<1 (2021) <1 (2022)	<1 (2021) 1 (2022)	3 (2021) 5 (2022)	4 (2021) 10 (2022)	4 (2021) 6 (2022)	1 (2021) 2 (2022)	5 (2021) 8 (2022)	<1 (2021) 2 (2022)	3 (2021) 2 (2022)	4 (2021) 8 (2022)	5 (2021) 7 (2022)
ENV14	<1	<1	<1	3	4	5	1	5	1	3	5	5
ENV17	<1	<1	<1	4	5	5	2	6	1	3	6	6
ENV20	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	1	<1
ENV29	<1	<1	<1	4	5	6	2	7	1	3	7	6
2022 stations												
ENV11	<1	<1	<1	2	3	3	<1	4	<1	1	4	3
ENV23	<1	<1	<1	1	1	1	<1	2	<1	<1	3	2
ENV72	<1	<1	<1	4	4	5	1	6	2	3	7	6
22ENV09	<1	<1	<1	3	5	5	1	6	1	3	6	7
Morgan Array Area ZoI												
2021 stations												
ENV06	<1	<1	<1	3	4	5	2	5	1	3	5	5
ENV21	<1	<1	<1	3	4	4	1	5	<1	2	4	5
ENV63	<1 (2021) <1 (2022)	<1 (2021) <1 (2022)	<1 (2021) <1 (2022)	2 (2021) 3 (2022)	3 (2021) 3 (2022)	3 (2021) 4 (2022)	<1 (2021) 1 (2022)	3 (2021) 5 (2022)	<1 (2021) 1 (2022)	3 (2021) 3 (2022)	4 (2021) 7 (2022)	3 (2021) 5 (2022)
ENV65	<1	<1	<1	2	3	3	<1	4	<1	2	4	3

	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo[a]anthracene (µg/kg)	Benzo[a]pyrene (µg/kg)	Chrysene (µg/kg)	Dibenzo[ah]anthracene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)
2022 stations												
22ENV06	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
ZOI14	<1	<1	1	4	6	5	2	8	2	3	7	8
ZOI15	2	2	4	14	20	15	5	25	4	7	20	26
ZOI16	<1	<1	<1	3	4	4	1	5	<1	2	4	5
ZOI20	<1	<1	<1	2	3	3	1	4	<1	2	4	4
ZOI21	<1	<1	<1	3	4	4	1	6	1	3	7	6
ZOI22	<1	<1	<1	2	3	3	<1	4	1	2	4	4
ZOI23	<1	<1	<1	3	3	4	<1	5	1	3	8	5
ZOI25	<1	<1	<1	3	3	3	<1	5	1	2	7	4

1.7.3 Results – infaunal analysis

Summary statistics

1.7.3.1 A total of 404 taxa were recorded during the 2021 survey in the Morgan benthic subtidal ecology study area and a total of 355 taxa were recorded during the 2022 surveys campaign in the Morgan benthic subtidal ecology study area. Of these, 155 taxa were colonial or taxa whose abundance could not be enumerated, and therefore were recorded as present in the 2021 survey campaign. In the 2022 site campaign 210 were colonial or taxa whose abundance could not be enumerated. These taxa were removed from the infaunal numerical and statistical analysis but were included in the epifaunal numerical analysis (section 1.7.4).

1.7.3.2 A total of 10,088 individuals representing 470 enumerated taxa were recorded across both site-specific surveys. Of these, juveniles accounted for 358 individuals from 13 taxa representing 3.54% of the total number of individuals and 2.77% of the total number of taxa recorded. Two of the recorded taxa were bony fish species (true gobies *Gobiidae* and ray finned fish *Actinopterygii*) and represented eight individuals. As fish are highly mobile species, they were removed from the statistical analysis but are discussed in Volume 4, Annex 3.1: Fish and shellfish ecology technical report of the Environmental Statement.

1.7.3.3 Of the 480 total taxa enumerated from the site-specific survey data, none were observed at all stations. A total of 146 taxa (31.06%) were recorded as single individuals; these rarely recorded taxa were distributed across the Morgan benthic subtidal ecology study area. A total of 367 taxa (78.08%) were represented by <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 and Warwick, 2001). The relatively high numbers of single and low abundance species recorded in this survey could suggest a reasonably diverse community that has been subjected to relatively limited disturbance or contamination.

1.7.3.4 Juveniles were recorded from stations across the Morgan benthic subtidal ecology study area from taxa including Mollusca, Echinodermata, Crustacea and Annelida. The five most abundant juvenile taxa were within the Annelida (*Aphroditidae* juveniles and *Sthenelais boa* juveniles) and Echinodermata (*Spatangoida* juveniles, *Ophiuroidea* juveniles and *Dendrochirotida* juveniles). Juveniles of these five taxa made up 84.85% of the total number of juvenile individuals.

1.7.3.5 Sample station ENV10 recorded the highest numbers of juvenile individuals (24; mainly *Ophiuroidea* and *Echinidea*) as well as the highest number of juvenile taxa (8) alongside ENV15. In addition to juvenile taxa, Decapoda megalopa and zoea were recorded. Decapoda megalopa was recorded at the majority of sample stations and zoea were recorded at sample stations ENV03 and ENV64, however all juveniles were excluded from further analysis as they represent a very small proportion of the overall enumerated taxa.

1.7.3.6 As discussed in paragraph 1.7.3.1, 155 taxa in the 2021 site specific survey and 210 taxa in the 2022 site specific survey were recorded only as present; these taxa were dominated by Annelida, Crustacea and Bryozoa. Of these taxa, Nematoda were present across the greatest number of sample stations. Sample station ZOI18 recorded the highest number of colonial/encrusting taxa.

1.7.3.7 Initially the dataset was divided into the five major taxonomic groups: Annelida (Polychaeta), Crustacea, Mollusca, Echinodermata and 'Other'. The 'Other' group comprised of:

- Seven taxa of Cnidaria (Cnidaria, Actiniaria, *Edwardsiidae, Edwardsiaclaparedii, Adamsia palliata, Pennatula phosphorea* and *Cerianthus lloydii*)
- Three taxa of Chordata (*Ascidiacea, Dendrodoa grossularia* and *Polycarpa fibrosa*)
- Seven taxa of Sipuncula (Sipuncula, *Golfingiidae, Golfingia (Golfingia) elongata, Golfingia (Golfingia) vulgaris vulgaris, Nephasoma (Nephasoma) minutum, Thysanocardia procera* and *Phascolion (Phascolion) strombus strombus*)
- One taxa of Foraminifera (*Astrorhiza*)
- One taxa of Hemichordata (*Enteropneusta*)
- One taxa of Phronida (*Phoronis*)
- One taxa of Platyhelminthes (*Platyhelminthes*)
- One taxa of Arthropoda (*Pycnogonida*)
- One taxa of Priapulida (*Priapulus caudatus*)
- One taxa of Nemertea (*Nemertea*).

1.7.3.8 The absolute and proportional contributions of these five taxonomic groups to the overall community structure is summarised in Table 1.9 whilst biomass values by gross taxonomic groups are presented in Figure 1.14 and discussed in paragraph 1.7.3.38. The full data is available on request.

Table 1.9: Contribution of gross taxonomic groups recorded in the infaunal grab samples.

Group	Individual Abundance	Proportional Contribution	Taxa Abundance	Proportional Contribution
Annelida	5,418	53.71	222	46.25%
Crustacea	1,649	16.35	112	23.33%
Mollusca	1,544	15.31	95	19.79%
Echinodermata	580	5.75	27	5.63%
Other	897	8.89	24	5.00%
Total	**10,088**	**100.00**	**480**	**100.00**

1.7.3.9 The faunal communities were generally dominated by Annelida (n=5,418) which contributed 53.71% of the total number of individuals followed by Crustacea (n=1,649) and Mollusca (n=1,554) which contributed 16.35% and 15.31% of the total number of individuals respectively. Number of taxa were also dominated by Annelida which contributed 46.25% of the total number of taxa. At individual sample stations, gross taxonomic group proportions reflected these results, with Annelida making up the highest proportion of the taxa at all sample stations. Annelida made up the highest proportion of individuals at all but three sample stations (ZOI15, ZOI22 and ENV17) with proportion ranging from 36.96 to 86.76% of the total individuals. At sample stations ENV17 and ENV67A Crustacea made up the highest proportion of individuals, accounting for 54.06% and 48.67% of the total individuals respectively. At sample stations ZOI15 and ZOI22 Mollusca made up the highest proportion of individuals accounting for 41.13% and 37.04% of the total individuals respectively.

1.7.3.10 In terms of biomass however Mollusca were dominant, with Mollusca providing the highest proportion of the biomass at 42.86% of sample stations. Annelida contributed the second highest proportion of biomass at the greatest number of sample stations (n=32, 30.36%). Echinodermata contributed the highest proportion of the biomass (97.28%) at the sample station with the highest total biomass (ZOI22). At the highest biomass station the peanut worm (*Nephasoma minutum)* made up the highest proportion of the biomass. The polychaete *N. minutum* can reach up to 1.5 cm in length (Barnes, 2008). The next two highest biomass sample stations (ENV14 and ENV03) were all dominated by Mollusca which are also able to grow to large body sizes, these stations were dominated by a variety of bivalves (e.g. *Laevicardium crissum*, *Ensis magnus* and *Dosinia lupinus*).

1.7.3.11 The most abundant individuals generally belonged to Annelida with the polychaete *Scalibregma inflatum* being overall the most abundant species with a total of 936 individuals recorded. These individuals were distributed throughout the Morgan benthic subtidal ecology study area with no one sample station skewing the abundance. The highest abundance of *S. inflatum* occurred at sample station 22ENV09 in the east of the Morgan Array Area.

1.7.3.12 The species with the second highest abundance was the polychaete *Poecilochaetus serpens* with 424 individuals. These individuals were distributed throughout the Morgan benthic subtidal ecology study area with no one sample station skewing the abundance. The highest abundance of *P. serpens* occurred at sample station ENV94 in the area surveyed in the north of the Morgan Array Area ZoI. Sample station ZOI25, in the southwest of the Morgan Array Area ZoI, recorded the highest total number of individuals (333) across only 99 taxa. Sample station ZOI25 recorded the highest number of taxa (99) with the next highest being sample stations 22ENV06 (90 taxa) and ENV65 (80 taxa), both of which can be found in the south of the Morgan Array Area ZoI.

Multivariate community analysis

1.7.3.13 The results of the CLUSTER analysis, SIMPROF tests and SIMPER analyses were used, together with the raw untransformed infaunal data, to assign preliminary infaunal biotopes to each sample station. 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 groups could be explained by differences in abundances of characterising species rather than the presence/absence of key species.

1.7.3.14 The results of the hierarchical clusters analysis of the square root transformed infaunal dataset (excluding juveniles) together with the SIMPROF test identified 33 faunal groups that were statistically dissimilar, based on the SIMPROF test. Of these faunal groups, 12 were represented by a single outlier sample station (Figure 1.9 and Table 1.10). The 2D MDS plot is presented in Figure 1.10 and the low stress value (0.18) indicates that this is a good representation of the data. The 3D MDS plot has not been presented as the 2D MDS plot presents a clearer representation of the data.

1.7.3.15 Based on the multivariate analysis of the 2021 and 2022 site-specific data Faunal group A showed the lowest Bray-Curtis similarity of 21.08%, while Faunal group S showed the highest Bray-Curtis similarity (58.04%), of all Faunal groups that contained more than one sample station. Faunal groups S and F showed the lowest Bray-Curtis dissimilarity (50.65%).

1.7.3.16 Samples within the south and west of the Morgan Array Area, as well as those in the southwest of the Morgan Array Area ZoI extending along the west and north edge of the Morgan Array Area, within the Morgan benthic subtidal ecology study area clustered together in Faunal groups E, AB, AC, AD, AF and AG as well as some stations being in Faunal groups M and U. This cluster also included a sample station in the centre of the Morgan Array Area in Faunal group U. The mixed sediments associated with these groups were characterised by a variety of polychaetes as well as a small number of bivalves. Samples within Faunal groups E, AB, AC, AD, AF and AG as well as some stations in Faunal groups M and U were assigned the polychaete-rich deep *Venus* community in offshore mixed sediments (SS.SMx.OMx.PoVen) biotope (Figure 1.11).

1.7.3.17 In the north and centre of the Morgan Array Area and north of the Morgan Array Area ZoI, samples within the Faunal groups F and R as well as some stations in Faunal groups A, E and G were associated with coarse sediments and varied infaunal communities characterised by bivalves, polychaetes and echinoderms including species such as *Echinocyamus pusillus* and *Scoloplos armiger* (Table 1.10). Samples within these Faunal groups were assigned the SS.SCS.CCS biotope. The SS.SCS.CCS biotope was recorded in samples across a large central section of the Morgan Array Area as well as in smaller sections further north in the Mona Array Area ZoI where the mixed sediment SS.SMx.OMx.PoVen habitat is interspersed by coarse sediments and specific features which have also been designated as SS.SCS.CCS (Figure 1.11).

1.7.3.18 In the centre of the Morgan Array Area, one station in Faunal group I was found to be on sandwave crests which were composed of mixed sediments and characterised by a variety of bivalves and polychaetes such as *Leptochiton asellus* as well as Nemertea. As a result one station in Faunal group I and the geophysical feature associated with it were assigned the SS.SMx.OMx biotope. The central section of the Morgan Array Area is transitional, demonstrating the change in sediments across the Morgan Array Area with sediments becoming finer moving from west to east (Figure 1.11).

1.7.3.19 The sediments along north boundary and east side of the Morgan benthic subtidal ecology study area were characterised by samples in Faunal groups K and N as well as some stations in Faunal group M. The sediments in this section of the Morgan benthic subtidal ecology study area were characterised by sand and muddy sands. The communities in these faunal groups were also characterised by polychaetes and bivalves but included species which are adapted to sandy habitats. Based on the distinct nature of the faunal community and the sediment type these Faunal groups were allocated the SS.SMu.CSaMu.LkorPpel biotope.

1.7.3.20 The one sample station within Faunal group H (ZOI21) was in the southwest of the Morgan Array Area ZoI and was characterised by mixed sediments and diverse communities but with a particularly large abundance of *Ophiothrix fragilis,* with 49 individuals identified in the grab sample. Therefore the infaunal community was allocated the SS.SMx.CMx.OphMx biotope. This conclusion is supported by data collected for the Rhiannon Wind Farm (Figure 1.3) (Celtic Array Ltd, 2014) which also identified the SS.SMx.CMx.OphMx biotope in this region of the Morgan Array Area ZoI, however it was identified in combination with *Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles (SS.SCS.CCS.PomB) biotope. The SS.SCS.CCS.PomB biotope may not have been identified by surveys in the Morgan benthic subtidal ecology study area due to the highly targeted nature of the sampling in the Morgan Array Area ZoI.

1.7.3.21 Samples clustered within Faunal groups B and C were also associated with sediments sampled to the east and north of the Morgan Array Area ZoI and were characterised by muddy sand sediments and diverse communities with no distinguishable characteristic species associated with any other biotopes identified. The infaunal community was dominated by polychaetes and crustaceans such as *K. bidentata* and *Bathyporeia tenuipes*. As a result Faunal groups B and C were allocated the circalittoral muddy sand (SS.SSa.CMuSa) biotope.

1.7.3.22 Samples in Faunal group D were found in the of northeast of the Morgan Array Area ZoI. These sample stations were characterised by sandy sediments with a notable muddy element. These sample stations were also characterised by a greater number of echinoderms such as *K. bidentata* which resulted in these samples being allocated the biotope SS.SMu.CSaMu.AfilKurAnit.

1.7.3.23 The Faunal groups J and AE and a sample station in Faunal group AD had finer sediments and were characterised by a greater number of echinoderms such as *Echinocyamus pusillus* as well as the bivalve *Abra* which resulted in these samples being allocated the biotope SS.SSa.CFiSa.EpusOborApri. This conclusion is supported by data collected for the Rhiannon Wind Farm (Figure 1.3) (Celtic Array Ltd, 2014) which identified the broader SS.SSa.CFiSa biotope in the north of the Morgan Array Area ZoI (Figure 1.3).

1.7.3.24 The sediments and infaunal communities within the samples collected in the wider regional benthic subtidal ecology study area to the south of the Morgan benthic subtidal ecology study area (i.e. within the Mona Array Area) were largely homogenous. The samples from the north, central and the boundary in the south of the wider regional benthic subtidal ecology study area to the south of the Morgan Array Area (i.e. within the Mona Array Area) were associated with the sample stations in Faunal groups O, S, V, W, X, Y, Z, AA and AB as well as stations in Faunal group U all of which were characterised predominantly as mixed sediment (Table 1.10). These faunal groups were characterised of a variety of taxa, but all were dominated by polychaetes such as *Glycera lapidum, Aonides paucibranchiata* and *Laonice bahusiensis*. All samples within these groups were allocated the SS.SMx.OMx.PoVen biotope which covers the majority of the wider regional benthic subtidal ecology study area to the south of the Morgan Array Area (i.e. within the Mona Array Area) (Figure 1.11).

1.7.3.25 Sediments in samples collected in the wider regional benthic subtidal ecology study area to the south of the Morgan benthic subtidal ecology study area (i.e. within the Mona Array Area) clustered in Faunal groups G and Q were characterised by coarse sediments and taxa such as polychaetes and bivalves. Samples in this area were allocated the SS.SCS.CCS biotope, which was mapped as a band extending from east to west in the wider regional benthic subtidal ecology study area to the south of the Morgan Array Area (i.e. within the Mona Array Area), broadening in the east (Figure 1.11).

1.7.3.26 The faunal community at a few sample stations within Faunal group T were characterised by the bivalve *K. bidentata* as well as polychaetes such as *S. inflatum*, *L. koreni* and *Polycirrus*. This combination of factors led to the allocation of the *Kurtiella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.KurThyMx) biotope to a small section in the southeast of the wider regional benthic subtidal ecology study area to the south of the Morgan benthic subtidal ecology study area (i.e. within the Mona Array Area). Whilst some other key species which characterise this biotope were missing (e.g. *Thyasira* sp.), this biotope was considered to be the best fit and possibly representing a transition community.

1.7.3.27 The samples in Faunal group P as well as a station in Faunal group M were also associated with sediments sampled to the south of the Morgan benthic subtidal ecology study area (i.e. within the Mona Array Area) and were characterised by mixed sediments and diverse communities with no distinguishable characteristic species associated with any other biotopes identified. The infaunal community was dominated by polychaetes, bivalves and echinoderm such as *L. koreni* and *E. pusillus*. As a result Faunal group P as well as a station in Faunal group M were allocated the SS.SMx.CMx biotope.

1.7.3.28 The Faunal groups identified in the SIMPER analysis were used together with the raw data to assign six preliminary biotopes (Table 1.10; Figure 1.11). Although *S. spinulosa* was recorded in samples in Faunal group H (not in the top 50% of abundant species), abundance was no higher than three at each sample station and no aggregations qualifying as a reef forming structure were recorded in any of the areas surveyed, including within the Morgan Array Area and no *S. spinulosa* reef assessment was required. Full SIMPER analysis results are presented in Appendix C.

Table 1.10: Simprof groups and biotope classifications for the infaunal dataset.

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
A	ZOI19	37 to 38	Coarse sediments	*Abra, Scoloplos armiger, Echinocyamus pusillus, Spio, Bivalvia*	SS.SSa.CFiSa.EpusOborApri	Faunal group A showed the highest Bray Curtis dissimilarity with Faunal group H (94.96%) due a lack of common species. Faunal group A showed the lowest Bray Curtis dissimilarity with Faunal group C (79.24%) due to both having species such as *Scalibregma inflatum* and *Kurtiella bidentata*.
	ENV22		Sand and muddy sand		SS.SCS.CCS	
	ENV28		Coarse sediment		SS.SCS.CCS	
B	ZOI16	33 to 42	Sand and muddy sand	*Sthenelais limicola, Tellimya ferruginosa, Kurtiella bidentata, Phoronis, Bathyporeia tenuipes, Nephtys, Pectinariidae*	SS.SSa.CMuSa	Faunal group B showed the highest Bray Curtis dissimilarity with Faunal group G (95.46%) due a lack of common species. Faunal group B showed the lowest Bray Curtis dissimilarity with Faunal group E (75.51%) due to both having species such as *Scalibregma inflatum* and *Pectinariidae*.
	ZOI20		Sand and muddy sand			
	ZOI26		Sand and muddy sand			
C	ZOI22	45	Sand and muddy sand	*Thracioidea, Kurtiella bidentata, Abra, Megaluropus agilis, Bathyporeia tenuipes, Poecilochaetus serpens*	SS.SSa.CMuSa	N/A
D	ZOI14	34 to 58	Sand and muddy sand	*Kurtiella bidentata, Lumbrineris aniara, Pectinariidae, Tellimya ferruginosa, Amphiura filiformis, Sthenelais limicola, Nucula, Echinocardium cordatum*	SS.SMu.CSaMu.AfilKurAnit	Faunal group D showed the highest Bray Curtis dissimilarity with Faunal group G (94.26%) due a lack of common species. Faunal group D showed the lowest Bray Curtis dissimilarity with Faunal group E (66.49%) due to both having species such as *Scalibregma inflatum* and *Scoloplos armiger.*
	ZOI15		Mud and sandy mud			
E	22ENV09	37 to 43	Coarse sediment		SS.SCS.CCS	

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ZOI23		Mixed sediments	*Pectinariidae, Scalibregma inflatum, Kurtiella bidentata, Scoloplos armiger, Pholoe baltica, Pseudopolydora pulchra, Amphiura filiformis, Echinocyamus pusillus, Lumbrineris aniara*	SS.SMx.OMx.PoVen	Faunal group E showed the highest Bray Curtis dissimilarity with Faunal group F (94.81%) due a lack of common species. Faunal group D showed the lowest Bray Curtis dissimilarity with Faunal group E (66.49%) due to both having species such as *Scalibregma inflatum* and *Scoloplos armiger.*
F	ENV07	36 to 38	Coarse sediment	*Syllis, Grania, Goniadidae*	SS.SCS.CCS	N/A
G	ENV43	38 to 48	Coarse sediment	*Pisione remota, Hesionura elongata, Polygordius, Aonides paucibranchiata, Grania, Nemertea*	SS.SCS.CCS	Faunal group G showed the highest Bray Curtis dissimilarity with Faunal group B (95.46%) due a lack of common species. Faunal group G showed the lowest Bray Curtis dissimilarity with Faunal group AD (74.08%) due to both having species such as *Pisione remota* and *Aonides paucibranchiata.*
	ENV44		Coarse sediment			
	ENV57		Coarse sediment			
	ENV66		Coarse sediment			
	ENV67A		Sand and muddy sand			
	ENV70		Coarse sediment			
	ENV83		Sand and muddy sand			
	ENV89		Coarse sediment			
	ENV93		Coarse sediment			
	ENV96		Coarse sediment			
H	ZOI21	41 to 42	Mixed sediments	*Polynoidae, Serpulidae, Spirobranchus triqueter, Ericthonius, Anomiidae, Ophiothrix fragilis, Phoronis, Spirobranchus lamarcki*	SS.SMx.CMx.OphMx	N/A

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
I	ENV50	41	Mixed sediment	*Pholoe baltica, Dialychone, Leptochiton asellus, Kurtiella bidentata*	SS.SMx.OMx	N/A
J	22ENV12	35 to 38	Sand and muddy sand	*Scoloplos armiger, Scolelepis bonnieri, Abra alba, Echinocyamus pusillus, Nemertea*	SS.SSa.CFiSa.EpusOborApri	N/A
K	ENV16	34 to 41	Sand and muddy sand	*Spiophanes bombyx, Scoloplos armiger, Lagis koreni, Poecilochaetus serpens, Sthenelais limicola, Amphiuridae*	SS.SMu.CSaMu.LkorPpel	Faunal group K showed the highest Bray Curtis dissimilarity with Faunal group H (95.14%) due a lack of common species. Faunal group K showed the lowest Bray Curtis dissimilarity with Faunal group J (65.93%) due to both having species such as *Lagis koreni* and *Spiophanes bombyx.*
	ENV21		Sand and muddy sand			
	ENV25		Sand and muddy sand			
	ENV26		Sand and muddy sand			
L	ENV09	41 to 42	Mixed sediment	*Lagis koreni, Urothoe marina, Pholoe baltica, Sthenelais limicola, Poecilochaetus serpens, Ampharete lindstroemi agg.*	SS.SMx.OMx	N/A
M	ENV11	35 to 51	Sand and muddy sand	*Poecilochaetus serpens, Lagis koreni, Scalibregma inflatum, Owenia, Scoloplos armiger, Sthenelais limicola*	SS.SMu.CSaMu.LkorPpel	Faunal group M showed the highest Bray Curtis dissimilarity with Faunal group F (91.18%) due a lack of common species. Faunal group M showed the lowest Bray Curtis dissimilarity with Faunal group R (60.05%) due to both having species such as *Poecilochaetus serpens* and *Aoridae.*
	ENV18		Mixed sediment		SS.SMx.CMx	
	ENV23		Mixed sediments		SS.SMx.OMx.PoVen	
	ENV30		Sand and muddy sand		SS.SMu.CSaMu.LkorPpel	
	ENV91		Mixed sediment		SS.SMu.CSaMu.LkorPpel	

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ENV94		Coarse sediment		SS.SMu.CSaMu.LkorPpel	
N	ENV92	38 to 40	Mixed sediment	*Polynoidae, Pholoe inornata, Lumbrineris aniara agg., Scalibregma inflatum, Caulleriella alata, Spirobranchus triqueter, Ophiothrix fragilis*	SS.SMu.CSaMu.LkorPpel	N/A
O	ENV69	41 to 42	Mixed sediment	*Scalibregma inflatum, Pholoe baltica, Urothoe marina, Paradoneis lyra, Notomastus, Aonides paucibranchiata, Goniadella gracilis, Leptocheirus hirsutimanus, Kurtiella bidentata, Nemertea, Glycera lapidum, Lysilla nivea, Owenia, Ericthonius punctatus*	SS.SMx.OMx.PoVen	Faunal group O showed the highest Bray Curtis dissimilarity with Faunal group J (92.54%) due a lack of common species. Faunal group O showed the lowest Bray Curtis dissimilarity with Faunal group AC (66.39%) due to both having species such as *Scalibregma inflatum* and *Ericthonius punctatus.*
	ENV84		Mixed sediment			
P	ENV82	36 to 38	Mixed sediment	*Pholoe, Scalibregma inflatum, Ampharete lindstroemi agg., Photis longicaudata, Kurtiella bidentata, Cerianthus lloydii, Mediomastus fragilis, Leiochone, Spiophanes bombyx, Chaetozone zetlandica, Sabellaria spinulosa, Grania*	SS.SMx.CMx	N/A
Q	ENV68	43	Sand and muddy sand	*Pholoe baltica, Eteone cf. longa, Scalibregma inflatum, Ampharete lindstroemi agg., Lagis koreni, Urothoe elegans, Abra, Nemertea*	SS.SCS.CCS	N/A

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
R	ENV12	39 to 43	Sand and muddy sand	*Lagis koreni, Scalibregma inflatum, Ampharete lindstroemi agg., Owenia, Abra, Echinocyamus pusillus, Nemertea, Spio symphyta, Aoridae, Phoronis, Pholoe baltica*	SS.SCS.CCS	Faunal group R showed the highest Bray Curtis dissimilarity with Faunal group F (94.75%) due a lack of common species. Faunal group R showed the lowest Bray Curtis dissimilarity with Faunal group T (51.56%) due to both having species such as *Urothoe* and *Poecilochaetus serpens.*
	ENV13		Coarse sediment			
S	ENV33	40 to 46	Mixed sediment	*Ampharete lindstroemi agg., Poecilochaetus serpens, Ampelisca provincialis, Phoronis, Nemertea, Pholoe baltica, Owenia, Scalibregma inflatum, Cerianthus lloydii, Spiophanes bombyx, Chaetozone zetlandica, Photis longicaudata, Cirrophorus branchiatus, Leiochone*	SS.SMx.OMx.PoVen	Faunal group S showed the highest Bray Curtis dissimilarity with Faunal group F (89.28%) due a lack of common species. Faunal group R showed the lowest Bray Curtis dissimilarity with Faunal group AA (50.65%) due to both having species such as *Ampelisca provincialis* and *Ampharete lindstroemi* agg.
	ENV34		Mixed sediment			
	ENV35		Mixed sediment			
T	ENV40	35 to 40	Mixed sediment	*Ampharete lindstroemi agg., Nemertea, Scalibregma inflatum, Kurtiella bidentata, Lagis koreni, Pholoe baltica, Polycirrus, Paradoneis lyra, Owenia, Photis longicaudata, Tanaopsis graciloides, Platyhelminthes, Eteone cf. longa*	SS.SMx.CMx.KurThyMx	Faunal group T showed the highest Bray Curtis dissimilarity with Faunal group AD (82.22%) due a lack of common species. Faunal group T showed the lowest Bray Curtis dissimilarity with Faunal group S (50.16%) due to both having species such as *Phoronis* and *Ampharete lindstroemi* agg.
	ENV45		Mixed sediment			
U	ENV01	37 to 45	Mixed sediment	*Poecilochaetus serpens, Nemertea, Urothoe elegans, Scalibregma inflatum, Lysidice unicornis, Lagis koreni, Pholoe baltica, Pholoe inornata, Ampharete lindstroemi agg.,*	SS.SMx.OMx.PoVen	Faunal group U showed the highest Bray Curtis dissimilarity with Faunal group F (91.48%) due a lack of common species. Faunal group U showed the lowest Bray Curtis dissimilarity with Faunal group Z (56.10%) due to both having species
	ENV04		Mixed sediment			
	ENV05		Mixed sediment			
	ENV10		Mixed sediment			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ENV14		Coarse sediment	*Phoronis, Spiophanes bombyx, Chaetozone zetlandica, Ampelisca, Ophelina acuminata, Pista lornensis, Cirrophorus branchiatus, Ampelisca spinipes, Pseudopolydora pulchra, Urothoe*		such as *Leptochiton asellus* and *Ampharete lindstroemi* agg.
	ENV15		Mixed sediment			
	ENV19		Mixed sediment			
	ENV27		Mixed sediment			
	ENV59		Coarse sediment			
	ENV63		Coarse sediment			
	ENV64		Mixed sediment			
V	ENV32	41	Mixed sediment	*Lysidice unicornis, Praxillella affinis, Ophelina acuminata, Scalibregma inflatum, Urothoe marina*	SS.SMx.OMx.PoVen	N/A
W	ENV39	39 to 46	Mixed sediment	*Scalibregma inflatum, Golfingia (Golfingia) elongata, Unciola planipes, Owenia, Echinocyamus pusillus, Syllis, garciai/mauretanica, Phoronis, Nereididae, Nemertea, Golfingiidae, Ampharete lindstroemi agg., Syllis, Lagis koreni, Eulalia mustela, Mediomastus fragilis, Paraonidae, Paradoneis ilvana*	SS.SMx.OMx.PoVen	Faunal group W showed the highest Bray Curtis dissimilarity with Faunal group A (91.07%) due a lack of common species. Faunal group W showed the lowest Bray Curtis dissimilarity with Faunal group AA (54.75%) due to both having species such as *Syllis* and *Pholoe baltica.*
	ENV42		Mixed sediment			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
X	ENV53	43 to 44	Mixed sediment	*Terebelliformia, Leptocheirus hirsutimanus, Ampharete lindstroemi agg., Aonides paucibranchiata, Glycera lapidum, Mediomastus fragilis, Laonice bahusiensis agg., Unciola planipes, Leptochiton asellus, Nemertea*	SS.SMx.OMx.PoVen	N/A
Y	ENV31	40 to 48	Mixed sediment	*Nemertea, Scalibregma inflatum, Aonides paucibranchiata, Ampharete lindstroemi agg., Leptochiton asellus, Dialychone, Pholoe inornata, Golfingiidae, Pholoe baltica, Leiochone, Glycera lapidum, Laonice bahusiensis agg., Goniadella gracilis, Serpulidae, Lysidice unicornis, Eulalia mustela, Notomastus, Jasmineira caudata, Owenia, Paraonidae*	SS.SMx.OMx.PoVen	Faunal group Y showed the highest Bray Curtis dissimilarity with Faunal group J (91.57%) due a lack of common species. Faunal group Y showed the lowest Bray Curtis dissimilarity with Faunal group U (61.63%) due to both having species such as *Leptochiton asellus* and *Aonides paucibranchiata.*
	ENV36		Mixed sediment			
	ENV37		Mixed sediment			
	ENV41		Mixed sediment			
	ENV47		Mixed sediment			
	ENV97		Mixed sediment			
Z	ENV60	38 to 43	Coarse sediment	*Ampharete lindstroemi agg., Nemertea, Leptochiton asellus, Aonides paucibranchiata, Pholoe inornata, Cirrophorus branchiatus, Lysidice unicornis, Phoronis, Ophelina acuminata, Praxillella affinis, Chaetozone zetlandica, Golfingiidae, Pholoe baltica, Euchone pararosea, Scoloplos armiger, Eteone cf. Longa, Parexogone hebes, Terebellides*	SS.SMx.OMx.PoVen	Faunal group Z showed the highest Bray Curtis dissimilarity with Faunal group C (91.63%) due a lack of common species. Faunal group Z showed the lowest Bray Curtis dissimilarity with Faunal group U (56.10%) due to both having species such as *Leptochiton asellus* and *Ampharete lindstroemi* agg.
	ENV61		Mixed sediment			
	ENV65		Mixed sediment			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
AA	ENV38	39 to 47	Mixed sediment	*Scalibregma inflatum, Nemertea, Ampharete lindstroemi agg., Pholoe baltica, Aonides paucibranchiata, Phoronis, Cirrophorus branchiatus, Lysidice unicornis, Leptochiton asellus, Ophelina acuminata, Polycirrus, Ampelisca, Poecilochaetus serpens, Paradoneis ilvana, Chaetozone zetlandica, Urothoe marina, Urothoe, Laonice bahusiensis agg., Dialychone, Lagis koreni, Nototropis vedlomensis, Aricidea (Acmira) cerrutii*	SS.SMx.OMx.PoVen	Faunal group AA showed the highest Bray Curtis dissimilarity with Faunal group F (93.40%) due a lack of common species. Faunal group AA showed the lowest Bray Curtis dissimilarity with Faunal group U (57.15%) due to both having species such as *Scalibregma inflatum* and *Ampharete lindstroemi* agg.
	ENV48		Mixed sediment			
	ENV49		Mixed sediment			
	ENV51		Mixed sediment			
	ENV52		Mixed sediment			
	ENV54		Mixed sediment			
	ENV55		Mixed sediment			
	ENV56		Coarse sediment			
	ENV71		Mixed sediment			
	ENV86		Mixed sediment			
	ENV88		Mixed sediment			
AB	ENV29	39 to 42	Mixed sediment	*Nemertea, Ampharete lindstroemi agg., Phascolion (Phascolion) strombus strombus, Parexogone hebes, Syllis, Golfingiidae, Poecilochaetus serpens, Cirrophorus branchiatus, Podarkeopsis, Cheirocratus*	SS.SMx.OMx.PoVen	Faunal group AB showed the highest Bray Curtis dissimilarity with Faunal group F (92.48%) due a lack of common species. Faunal group AB showed the lowest Bray Curtis dissimilarity with Faunal group Z (58.98%) due to both having species such as *Leptochiton asellus* and *Phoronis.*
	ENV62		Mixed sediment			
	ENV95		Sand and muddy sand			
AC	ENV02	35 to 41	Coarse sediment	*Nemertea, Echinocyamus pusillus, Goniadella gracilis, Poecilochaetus serpens, Scalibregma inflatum, Owenia, Pholoe baltica, Polynoidae, Golfingiidae, Kurtiella bidentata,*	SS.SMx.OMx.PoVen	Faunal group AC showed the highest Bray Curtis dissimilarity with Faunal group J (95.49%) due a lack of common species. Faunal group AC showed the lowest Bray Curtis dissimilarity with Faunal group U (65.41%) due to both
	ENV03		Mixed sediment			
	ENV06		Coarse sediment			
	ENV08		Coarse sediment			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ENV17		Coarse sediment	*Bivalvia, Pholoe inornata, Aonides paucibranchiata, Nereididae*		having species such as *Kurtiella bidentata* and *Lagis koreni.*
	ENV20		Coarse sediment			
	ENV24		Coarse sediment			
	ENV90		Mixed sediment			
AD	22ENV11	35 to 43	Coarse sediments	*Grania, Goniadella gracilis, Aonides paucibranchiata, Echinocyamus pusillus, Goniadidae, Pisione remota, Nemertea, Obtusella intersecta, Spisula, Caulleriella alata*	SS.SMx.OMx.PoVen	Faunal group AD showed the highest Bray Curtis dissimilarity with Faunal group D (90.23%) due a lack of common species. Faunal group AD showed the lowest Bray Curtis dissimilarity with Faunal group AE (66.75%) due to both having species such as *Kurtiella bidentata* and *Aonides paucibranchiata.*
	ZOI24		Coarse sediments		SS.SSa.CFiSa.EpusOborApri	
AE	22ENV10	37 to 39	Coarse sediments	*Echinocyamus pusillus, Obtusella intersecta, Kurtiella bidentata, Nemertea, Thracioidea, Abra alba, Asbjornsenia pygmaea*	SS.SSa.CFiSa.EpusOborApri	N/A
AF	22ENV05	41 to 49	Mixed sediment	*Nemertea, Paradoneis lyra, Ascidiacea, Sipuncula, Syllis armillaris, Echinocyamus pusillus, Leiochone, Lysidice unicornis, Spisula, Pseudopolydora pulchra, Gnathiid indet., Cirrophorus branchiatus, Aonides paucibranchiata, Grania, Obtusella intersecta, Pholoe inornata. Kurtiella bidentata, Tharyx killariensis, Abra*	SS.SMx.OMx.PoVen	Faunal group AF showed the highest Bray Curtis dissimilarity with Faunal group F (90.32%) due a lack of common species. Faunal group AF showed the lowest Bray Curtis dissimilarity with Faunal group AE (63.74%) due to both having species such as *Kurtiella bidentata* and *Asbjornsenia pygmaea.*
	22ENV06		Coarse sediments			
	ZOI17		Coarse sediments			
	ZOI25		Coarse sediments			
AG	22ENV07	41 to 44	Coarse sediments		SS.SMx.OMx.PoVen	

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ZOI18		Mixed sediments	*Lumbrineris aniara, Pholoe inornata, Syllis armillaris, Ampelisca spinipes, Nemertea, Lysidice unicornis, Leptochiton asellus, Glycera lapidum, Caulleriella alata, Dialychone dunerificta, Anomiidae*		Faunal group AG showed the highest Bray Curtis dissimilarity with Faunal group B (86.31%) due a lack of common species. Faunal group AG showed the lowest Bray Curtis dissimilarity with Faunal group AF (63.74%) due to both having species such as *Kurtiella bidentata* and *Asbjornsenia pygmaea.*

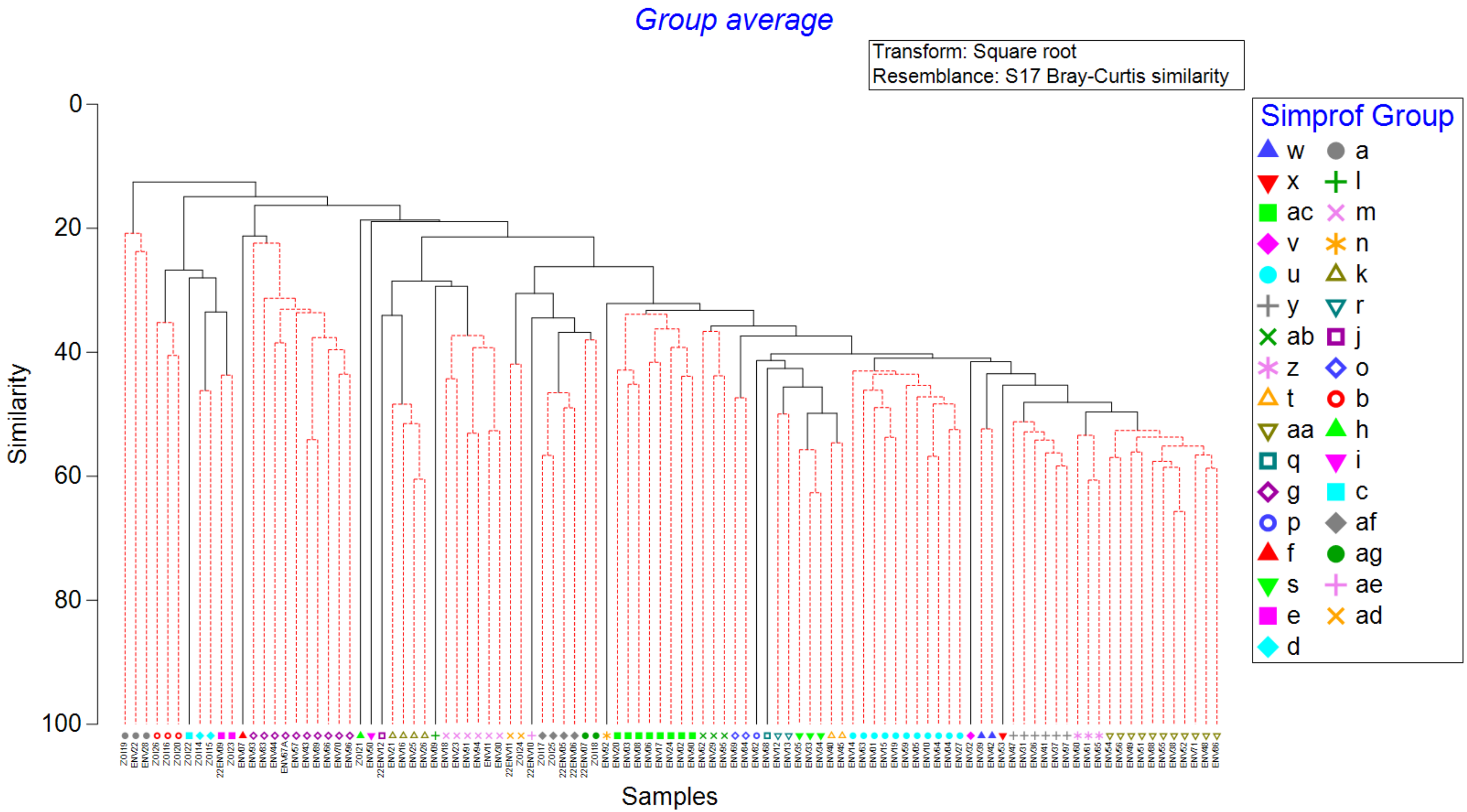


Figure 1.9: Dendrogram of infaunal communities from benthic grab samples.

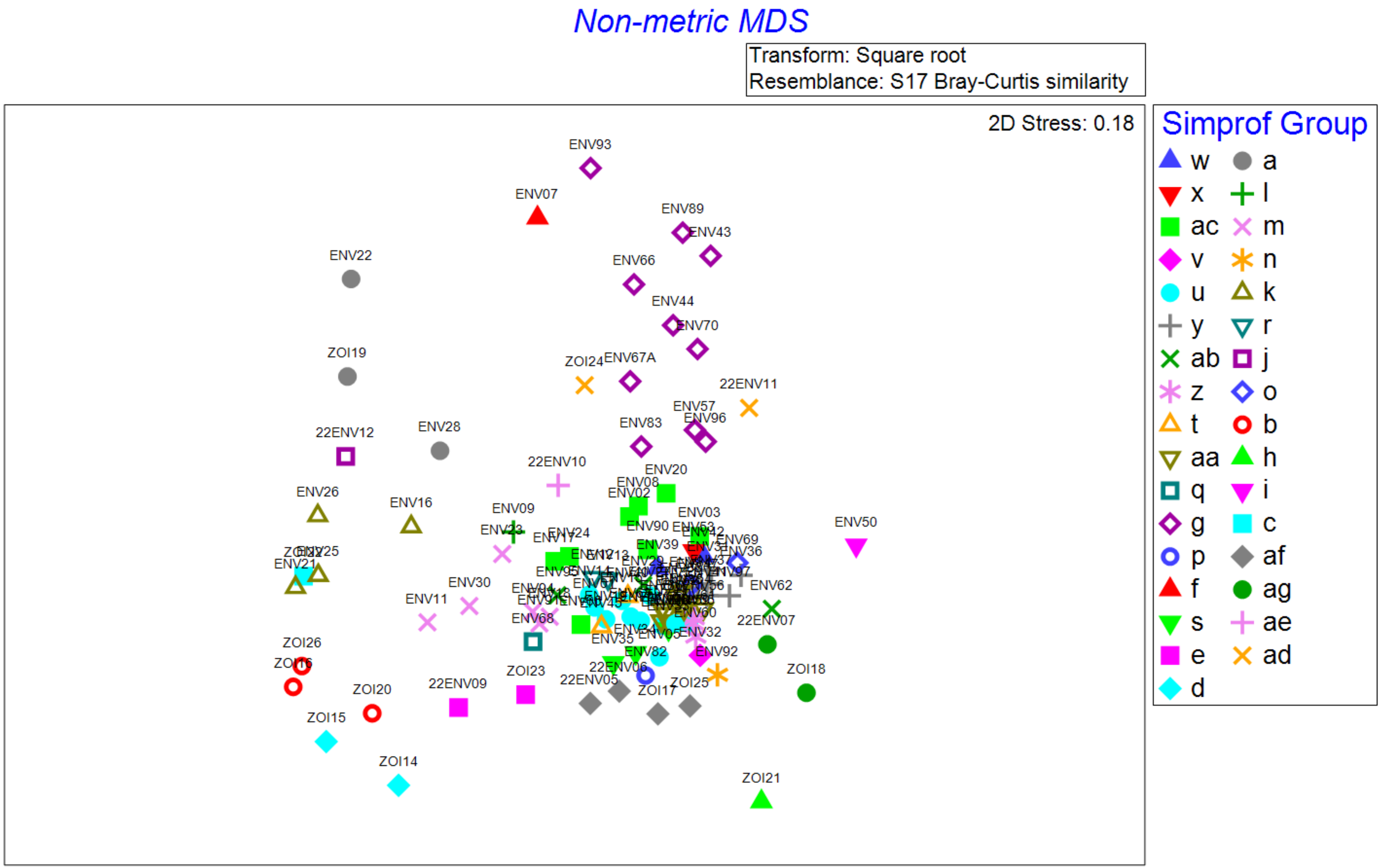


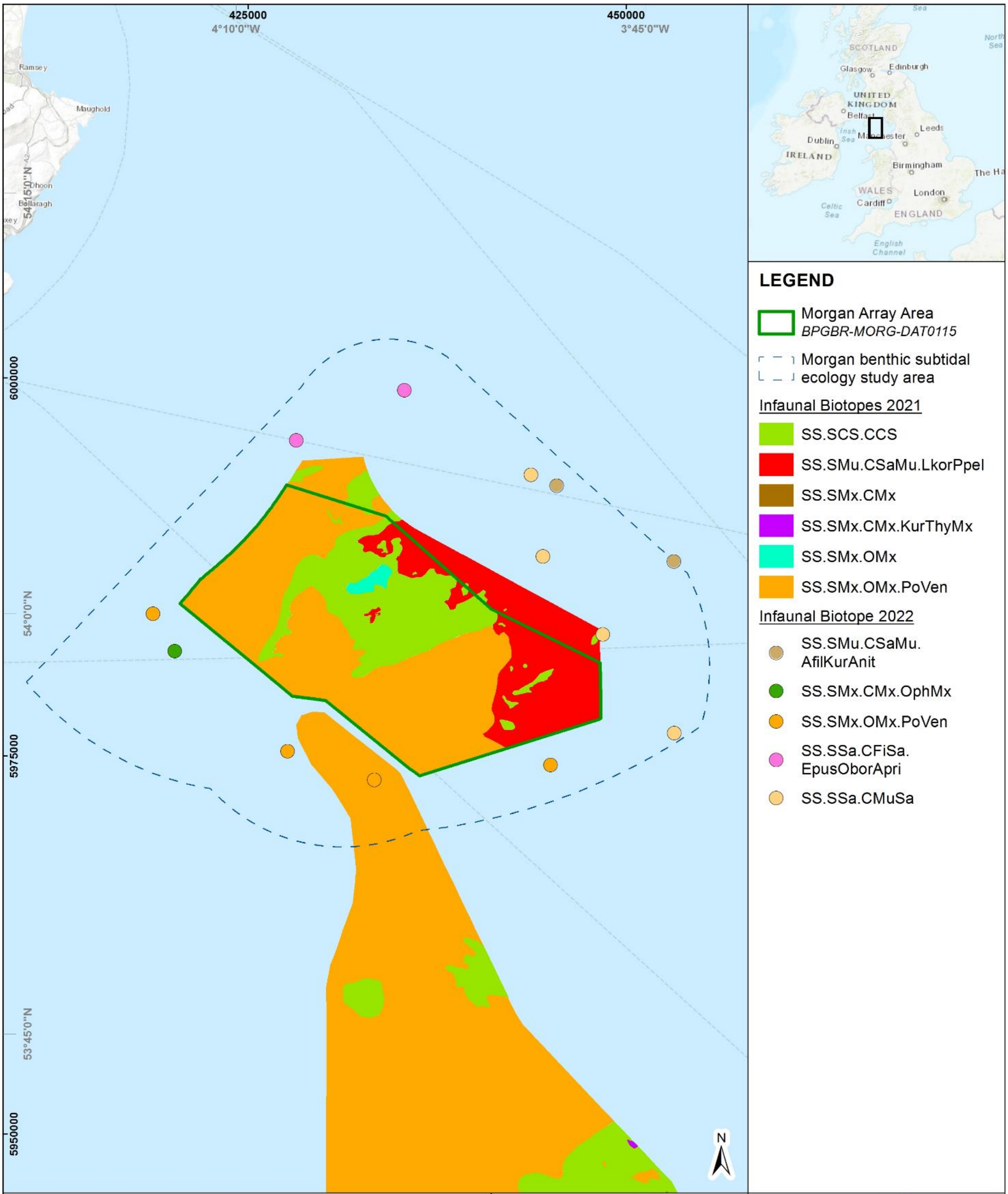
Figure 1.10: 2D MDS plot of infaunal communities from grab samples.

Table 1.11: Summary of infaunal biotopes identified from grab samples.

Preliminary infaunal biotope	Grab sample stations	Water depth range	Sediment classification	Characterising species	Geographic location
SS.SCS.CCS	ENV22, ENV28, ENV07, ENV43, ENV44, ENV57, ENV66, ENV67A, ENV70, ENV83, ENV89, ENV93, ENV96, ENV68, ENV12, ENV13, 22ENV09	38 to 48	Sand and muddy sand/Coarse sediment	*Scoloplos armiger, Abra, Echinocyamus pusillus, Hesionura elongata, Nemertea, Owenia, Pholoe*	Centre and north Morgan Array Area as well as the north of the Morgan Array Area ZoI. Across the wider regional benthic subtidal ecology study area to the south of the Morgan Array Area (i.e. Mona Offshore Wind Project).
SS.SMx.OMx	ENV09	42 to 43	Mixed sediment	*Nemertea, Glycera lapidum, Leptochiton asellus, Syllis,*	Centre of the Morgan Array Area.
SS.SMu.CSaMu.LkorPpel	ENV92, ENV16, ENV21, ENV25, ENV26, ENV91, ENV94, ENV11, ENV30	34 to 51	Mixed sediment/Sand and muddy sand/Coarse sediment	*Spiophanes bombyx, Scalibregma inflatum, Lagis koreni, Abra, Nemertea, Owenia, Pholoe baltica, Pholoe inornata*	Northeast Morgan Array Area as well as the northeast of the Morgan Array Area ZoI.

Preliminary infaunal biotope	Grab sample stations	Water depth range	Sediment classification	Characterising species	Geographic location
SS.SMx.OMx.PoVen	ENV23, ENV69, ENV84, ENV33, ENV34, ENV35, ENV01, ENV04, ENV05, ENV10, ENV14, ENV15, ENV19, ENV27, ENV59, ENV63, ENV64, ENV32, ENV39, ENV42, ENV53, ENV31, ENV36, ENV37, ENV41, ENV47, ENV97, ENV60, ENV61, ENV65, ENV38, ENV48, ENV49, ENV50, ENV51, ENV52, ENV54, ENV55, ENV56, ENV71, ENV86, ENV88, ENV29, ENV62, ENV95, ENV02, ENV03, ENV06, ENV08, ENV17, ENV20, ENV24, ENV90, ZOI17, ZOI18, ZOI23, ZOI25, 22ENV05, 22ENV06, 22ENV07, 22ENV11	39 to 51	Mixed sediment/Coarse sediment/Sand and muddy sand	*Scalibregma inflatum, Aonides paucibranchiata, Glycera lapidum, Mediomastus fragilis, Laonice bahusiensis, Ampharete lindstroemi, Pholoe, Ampelisca, Nemertea, Unciola planipes, Echinocyamus pusillus, Pholoe inornata*	West and south-central Morgan Array Area. Across the north, south and west of the Morgan Array Area ZoI. Across the wider regional benthic subtidal ecology study area to the south of the Morgan Array Area. (i.e. Mona Offshore Wind Project).
SS.SMx.CMx.OphMx	ZOI21	41 to 2	Mixed sediments	*Polynoidae, Serpulidae, Spirobranchus triqueter, Ericthonius, Anomiidae, Ophiothrix fragilis, Phoronis, Spirobranchus lamarcki*	Southwest of the Morgan Array Area ZoI.
SS.SSa.CMuSa	ZOI16, ZOI20, ZOI26, ZOI22	33 to 45	Sand and muddy sand	*Kurtiella bidentata, Phoronis, Bathyporeia tenuipes, Nephtys, Abra, Megaluropus agilis*	East and north of the Morgan Array Area ZoI.
SS.SMu.CSaMu.AfilKurAnit	ZOI14, ZOI15	34 to 58	Sand and muddy sand/Mud and sandy mud	*Kurtiella bidentata, Lumbrineris aniara, Pectinariidae, Amphiura filiformis, Echinocardium cordatum*	Northeast of the Morgan Array Area ZoI.

Preliminary infaunal biotope	Grab sample stations	Water depth range	Sediment classification	Characterising species	Geographic location
SS.SSa.CFiSa.EpusOborApri	ZOI19, ZOI24, 22ENV10, 22ENV12	31 to 36	Sand and muddy sand/Coarse sediments	*Echinocyamus pusillus, Abra, Spisula, Scoloplos armiger, Goniadella gracilis, Hesionura elongata*	North of the Morgan Array Area ZoI.
SS.SMx.CMx	ENV18, ENV82	36 to 38	Mixed sediment/Sand and muddy sand	*Scalibregma inflatum, Kurtiella bidentata, Mediomastus fragilis, Spiophanes bombyx, Chaetozone*	Across the wider regional benthic subtidal ecology study area to the southeast of the Morgan benthic subtidal ecology study area (i.e. Mona Offshore Wind Project).
SS.SMx.CMx.KurThyMx	ENV40, ENV45	37 to 41	Mixed sediment	*Nemertea, Scalibregma inflatum, Pholoe and Owenia*	Across the wider regional benthic subtidal ecology study area to the southeast of the Morgan Array Area (i.e. Mona Offshore Wind Project).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Guardline, EMODnet, Seabed Habitats (2021)

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 nm
0 1 2 4 6 8 10 12 km

Drawing Number:
RPSE-MG-ES-BEN-011-03

Drawing Title:
PRELIMINARY INFAUNAL BIOTOPES RECORDED FROM GRAB SAMPLES ACROSS THE MORGAN BENTHIC SUBTIDAL ECOLOGY STUDY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:425,000

VER	DATE	DETAILS	BY	CHECK
00	11/08/23	First Issue	MJ	TH
03	09/04/24	Revision	LM	MK

Figure 1.11: Preliminary infaunal biotopes recorded from grab samples across the Morgan benthic subtidal ecology study area (all biotope codes are defined in Appendix G).

Comparison between Morgan Array Area 2021 and 2022 survey

1.7.3.29 To determine if there had been any measurable shift in the communities in the Morgan Array Area between the 2021 and 2022 surveys, seven stations were resampled in 2022 (DDV and grab sampling data) so that the abiotic and biotic conditions could be compared. Analysis of the infaunal grab sample data from these stations suggested some dissimilarity in the infaunal communities. A CLUSTER analysis, including a SIMPROF test, did not group the 2021 and 2022 sample stations of the same location together. The results of the SIMPER analysis identified three separate groups with the 2021 and 2022 sample points were largely clustered apart. The 2021 samples all clustered in one group and the 2022 samples were largely clustered in another group with a single station outlier (ENV11 from 2022). A SIMPER test on these clusters showed a dissimilarity between the two main groups of 72.9%.

1.7.3.30 An ANOSIM test was undertaken which determines if the difference between SIMPROF groups is greater than the difference within SIMPROF groups. The results of this analysis provided an R statistic of 0.79 which suggested that were was a greater difference between Faunal groups than within them. Overall, the conditions within the Morgan benthic subtidal ecology study area are highly changeable as a result of ocean current and tidal influences which can result in the movement of sediment and geophysical features.

Univariate analysis

1.7.3.31 The following univariate statistics were calculated for each benthic infaunal grab sample station: 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 preliminary infaunal biotopes identified from the infaunal data and these are summarised in Table 1.12 with univariate statistics for individual sites presented in Appendix D.

1.7.3.32 The univariate statistics indicate that the SS.SMx.OMx.PoVen biotope, had the highest number of taxa (75.57 ± 16.94) followed by SS.SMx.CMx.OphMx (74). The SS.SMu.CSaMu.AfilKurAnit biotope had the lowest number of taxa (32.50 ± 4.95). The highest mean number of individuals was associated with SS.SMx.CMx.OphMx (412), SS.SMx.CMx.KurThyMx biotopes (249.50 ± 79.90) and SS.SMx.OMx.PoVen (238.23 ± 95.90) (Table 1.12); this was expected as these biotopes contained the highest number of taxa. The sandy mud biotopes, such as SS.SMu.CSaMu.AfilKurAnit and SS.SMu.CSaMu.LkorPpel, typically had a lower number of taxa compared to the mixed sediment biotopes. The lowest mean number of individuals (91) was recorded in association with the SS.SSa.CFiSa.EpusOborApri biotope.

1.7.3.33 The highest mean diversity score of all the identified biotopes was associated with the biotope SS.SMx.OMx.PoVen (d = 13.73 ± 2.37 and H' = 3.83 ± 0.30) which was expected as this biotope had the highest number of taxa. The SS.SMx.CMx.KurThyMx and SS.SMx.CMx.OphMx biotopes had the next highest mean diversity scores (d = 12.02 ± 0.20 and H' = 3.65 ± 0.05; d = 12.12 and H' = 3.31). The lowest diversity recorded was associated with the SS.SCS.CCS biotope (d = 7.28 ± 2.78 and H' = 2.86 ± 0.59) and the SS.SMu.CSaMu.AfilKurAnit (d = 6.54 ± 0.75 and H' = 2.93 ± 0.70). This was expected as these biotopes also exhibited the lowest numbers of taxa and second lowest number of individuals. The SS.SCS.CCS biotope is associated with coarse sediments which may suggest high energy current in these areas as well as an exposed aspect, leading to greater disturbance than in other communities, potentially explaining the reduced diversity of these communities. This biotope is known to be found in tide swept areas and in tidal channels (JNCC, 2015), which also suggests a high level of disturbance within this biotope which can result in lower diversity. The high diversity score associated with the SS.SMx.OMx.PoVen biotope is likely to be driven by the diverse biotic community that inhabits this biotope, which is characterised by a diverse group of polychaetes. Comparatively the SS.SMu.CSaMu.AfilKurAnit biotope is often found in very low energy habitats however this biotope is characterised by a specific community of echinoderms. The biotope has very little structural complexity with most species living in or on the sediment (De-Bastos and Hill, 2016). The specific conditions and community associated with this biotope may result in habitats assigned this biotope having low species diversity. Overall, the mixed sediment habitats had higher biodiversity than the coarse or sandy mud-based habitats; this was expected due to the greater habitat diversity provided by the mixed sediment environment compared to the other sediment types therefore supporting a higher number of species. For example, the SS.SMu.CSaMu.LkorPpel biotope which was associated with sand and mud based sediments had one of the lowest mean diversity scores (d = 7.63 ± 2.27 and H’ = 3.03 ± 0.28).

1.7.3.34 Pielou’s evenness scores (J’) and the Simpson’s index of Dominance (λ) scores were similar across all the biotopes. Values of J’ were between 0.77 and 0.91 for all of the biotopes with the highest value of J’ for SS.SSa.CFiSa.EpusOborApri (J’=0.91). This indicated an even distribution of abundances among taxa and that this biotope was not dominated by a high number of individuals within a small number of species. Values of J’ were lowest for the SS.SMx.CMx.OphMx biotope (J’=0.77) which shows that although this value is slightly lower it shows a very small range which indicates the same even distribution of abundances among taxa and that this biotope was not dominated by a high number of individuals within a small number of species. Values for λ showed the same range (0.90 to 0.97) which indicates that all of the biotopes are represented by a wide diversity of species.

Table 1.12: Mean (± standard deviation) univariate statistics for the preliminary infaunal benthic biotopes.

Biotope	S	N	Biomass (g)	d	J’	H’	λ
SS.SCS.CCS	36.00 ±18.31	140.47 ± 107.20	0.58±0.92	7.28 ± 2.78	0.82 ± 0.12	2.86 ± 0.59	0.90 ± 0.09
SS.SMx.OMx	50.50 ± 20.51	128.00 ± 106.77	4.55 ±7.15	10.42 ±2.27	0.90 ± 0.09	3.45 ± 0.03	0.96 ± 0.03
SS.SMx.CMx	59	216	41.46 ± 13.44	10.79	0.83	3.39	0.94
SS.SMu.CSaMu.LkorPpel	39.80 ±13.74	160.40 ± 58.91	0.86 ± 0.95	7.63 ± 2.27	0.84 ± 0.06	3.03 ± 0.28	0.92 ± 0.03
SS.SMx.OMx.PoVen	75.57 ±16.94	238.23 ± 95.90	13.73 ±2.36	13.73 ± 2.37	0.89 ± 0.05	3.83 ± 0.30	0.97 ± 0.03
SS.SMx.CMx.KurThyMx	67 ±2.83	249.50 ± 79.90	2.71 ± 3.77	12.02 ± 0.20	0.90 ± 0.02	3.65 ± 0.05	0.96 ± 0.002
SS.SMu.CSaMu.AfilKurAnit	32.50 ± 4.95	123 ± 25.46	2.29 ± 4.75	6.54 ± 0.75	0.84 ± 0.02	2.93 ± 0.7	0.92 ± 0.01
SS.SSa.CMuSa	37.25 ± 6.70	100 ± 46.43	8.55 ± 7.91	7.96 ± 0.69	0.88 ± 0.04	3.16 ± 0.10	0.94 ± 0.02

Biotope	S	N	Biomass (g)	d	J’	H’	λ
SS.SSa.CFiSa.EpusOborApri	37.00 ± 21.00	91.33 ± 73.70	3.12 ± 6.65	7.96 ± 3.61	0.91 ± 0.03	3.19 ± 0.37	0.96 ± 0.004
SS.SMx.CMx.OphMx	74	412	6.72 ±14.03	12.12	0.77	3.31	0.93

1.7.3.35 Figure 1.12 to Figure 1.14 show the mean number of taxa, individuals, abundance, and biomass for each of the major faunal groups (i.e. Annelida, Crustacea, Mollusca, Echinodermata and other) in each of the biotopes identified, within the Morgan benthic subtidal ecology study area, from the benthic infaunal grabs.

1.7.3.36 As shown in Figure 1.12, the proportions of the number of taxa in each major taxonomic group were similar across the biotopes and mirrored the patterns observed in the mean abundance, as described in paragraph 1.7.3.37, with Annelida and Crustacea making up the highest proportion of the taxa in the majority of biotopes. Crustaceans also made up a significant proportion of the taxa in the SS.SMx.CMx.OphMx, SS.SSa.CMuSa and SS.SSa.CFiSa.EpusOborApri. All major taxonomic groups were represented in all biotopes. The proportion of Crustacea in the number of taxa in each biotope was slightly greater than the proportion of Crustacea in the number of individuals for all biotopes, highlighting that each of the Crustacea taxa are represented by a small number of individuals.

1.7.3.37 Figure 1.13 shows the distribution of the taxonomic groups within each biotopes. The mixed sediment biotopes (SS.SMx.CMx, SS.SMx.CMx.OphMx SS.SMx.CMx.KurThyMx and SS.SMx.OMx.PoVen) as well as SS.SCS.CCS exhibited particularly high numbers of Annelida taxa and individuals, also with large numbers of Crustacea and Other taxa (this group includes taxa such as Cnidaria, Chordata, Foraminifera and Hemichordata). These biotopes also exhibited the highest number of individuals overall (with a range of 216 to 412). Overall the mixed sediment biotopes (SS.SMx.OMx.PoVen, SS.SMx.CMx.KurThyMx and SS.SMx.CMx) had high abundances of taxa, with the exception of SS.SMx.OMx and SS.SMx.CMx.OphMx which were represented by a single sample station each and therefore may not be representative of these biotopes as a whole. This shows that SS.SMx.CMx.KurThyMx had a higher proportion of Crustacea compared with the other biotopes. This was due to the relatively small number of species which characterised this biotope which resulted in the 20 Crustacean taxa having a large impact on the number of taxa but low impact on the biomass.

1.7.3.38 Biomass was considerably higher in association with the SS.SSa.CMuSa, SS.SMx.CMx.OphMx, SS.SMx.OMx and SS.SMx.CMx biotopes, although noting that these were represented by a few or only one sample station. Biomass for the SS.SMx.CMx.KurThyMx biotope and the SS.SMx.OMx.PoVen biotope was dominated by Mollusca. The biomass for SS.SMx.CMx.OphMx and SS.SMx.OMx biotopes was dominated by echinoderms. For the SS.SMx.CMx.OphMx biotope *O. fragilis* was the dominant echinoderm species. For the SS.SMx.OMx biotope the heart urchin *Spatangoida* was the dominant echinoderm species. SS.SSa.CMuSa was dominated by the Other taxa, this was due to communities at station ZOI22 being dominated by two species of peanut worm, which can reach 1.5 cm in length (Barnes, 2008). The muddy sand communities associated with the SS.SMu.CSaMu.LkorPpel biotope had an overall lower mean biomass and were dominated by Echinodermata. Annelida made up a smaller proportion of the total biomass in each biotope, which is expected due to the small size of Annelida (Figure 1.14). Biomass per taxonomic group for each sample station is presented in Appendix D.

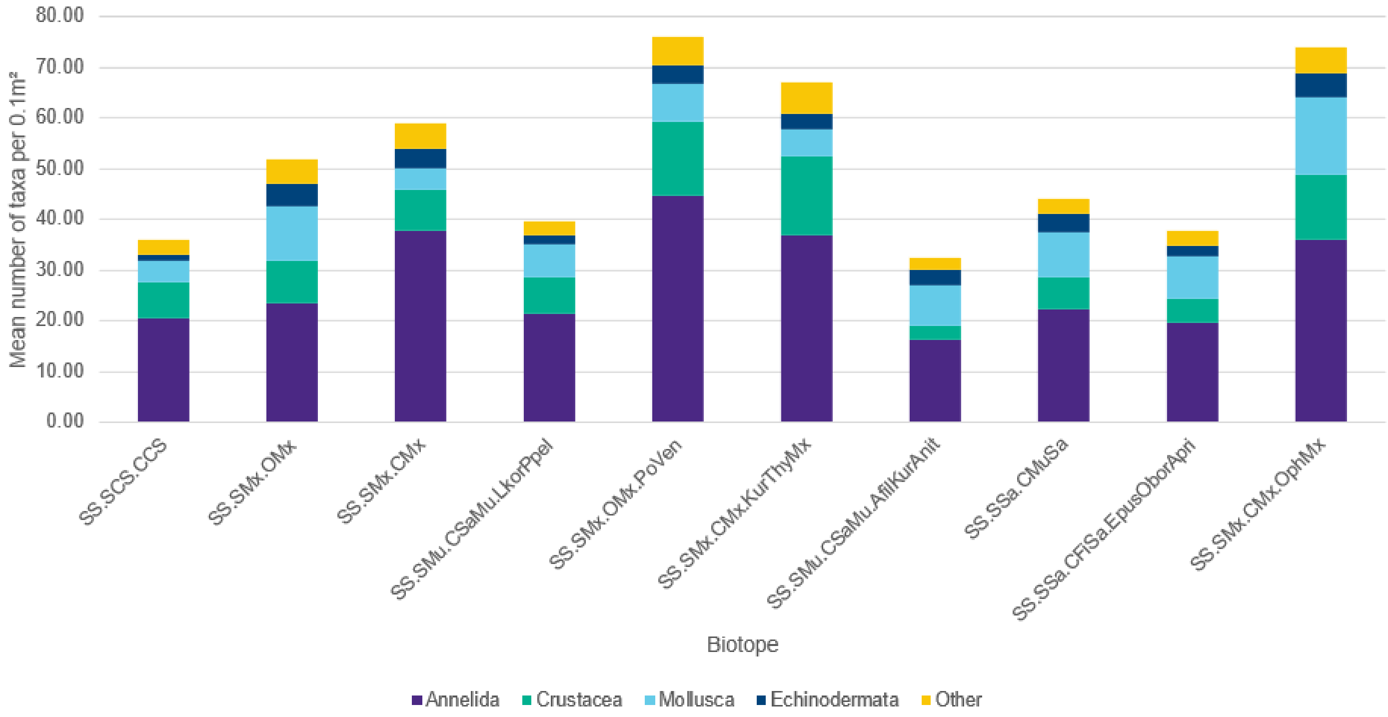


Figure 1.12: Mean abundance of taxa (per 0.1 m^2) per taxonomic group for each infaunal biotope.

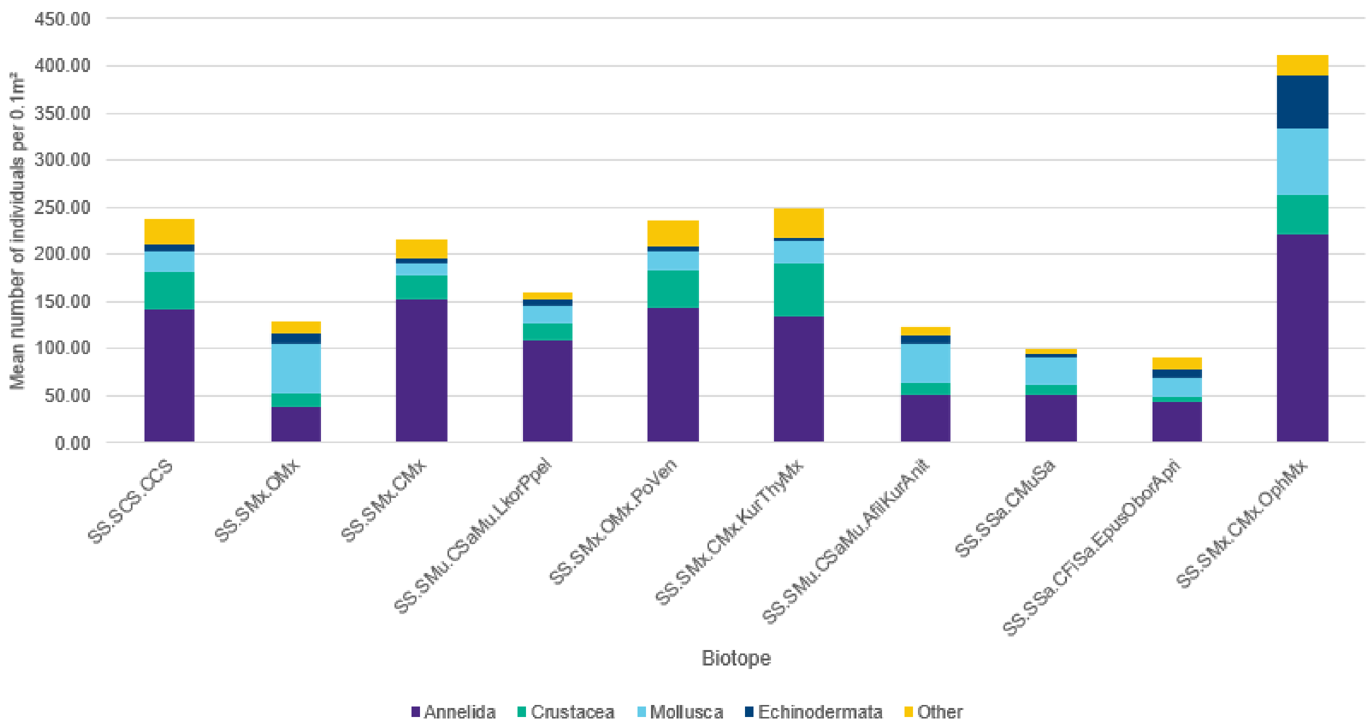


Figure 1.13: Mean abundance of individuals (per 0.1 m^2) per taxonomic group for each infaunal biotope.

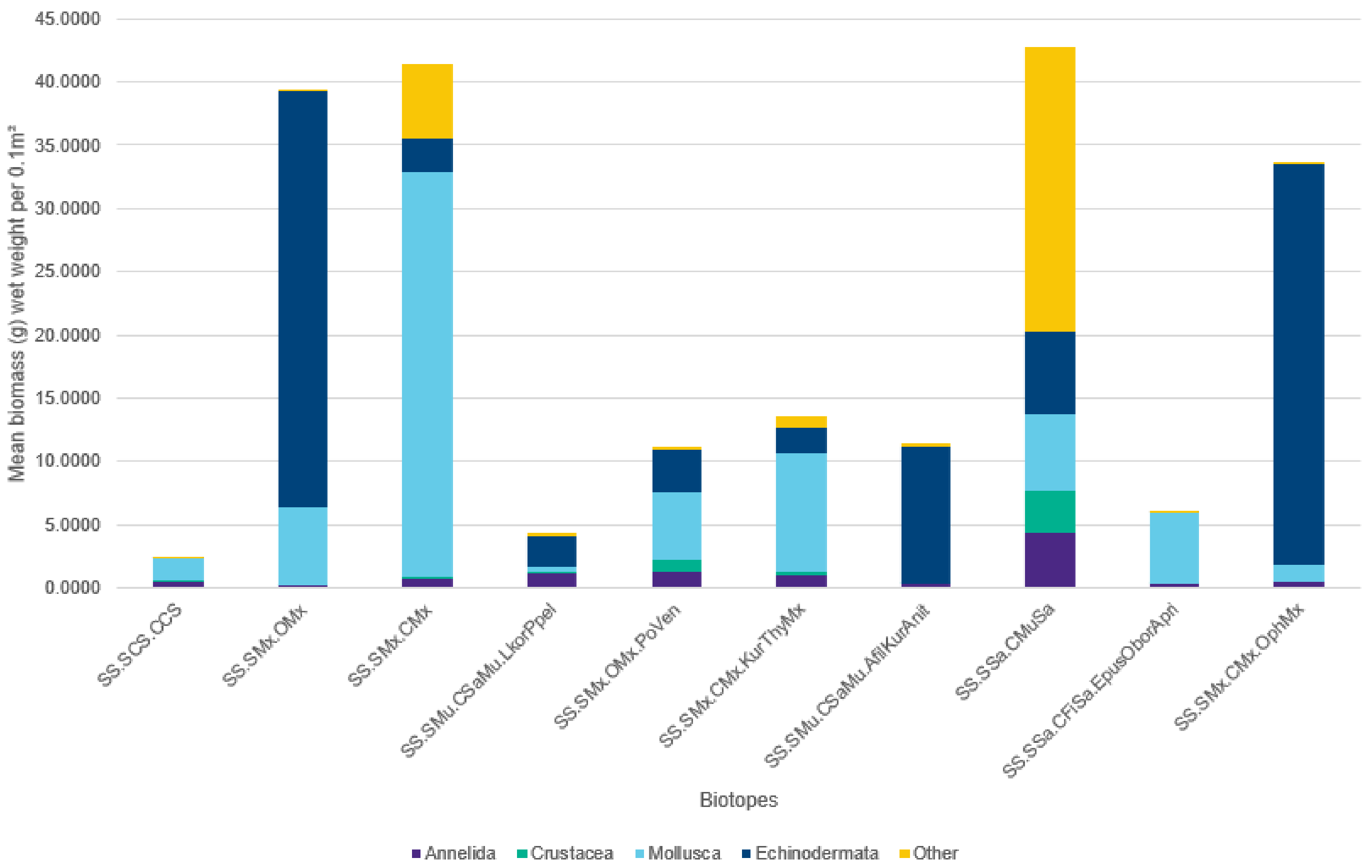


Figure 1.14: Mean biomass (per 0.1 m^2) per taxonomic group for each infaunal biotope.

1.7.4 Results – epifaunal analysis

Seabed imagery

1.7.4.1 The sediments recorded in the seabed imagery largely comprised of an amalgamation of subtidal mixed sediments and coarse sediments with some circalittoral fine sands within the Morgan Array Area. In the Morgan Array Area ZoI, the sediments were observed to be mainly composed of sands of varying sizes (fine to coarse) with some areas also having shell fragments or pebbles. One station of sandy gravel was also observed in the east of the Morgan Array Area ZoI. In the Morgan Array Area, high numbers of epifaunal species were recorded in association with the coarser sediments (coarse and mixed sediments). Epifaunal species recorded in the Morgan Array Area were dominated by annelids and cnidarians with low numbers of molluscs and chordates. In the Morgan Array Area *Ophiura* sp. was the most abundant taxa and was associated with every sediment type (Figure 1.15). In the Morgan Array Area ZoI, the epifaunal communities were composed of fewer taxa and were typically dominated by echinoderms however the polychaete *Serpulidae* was the most abundant across all stations.

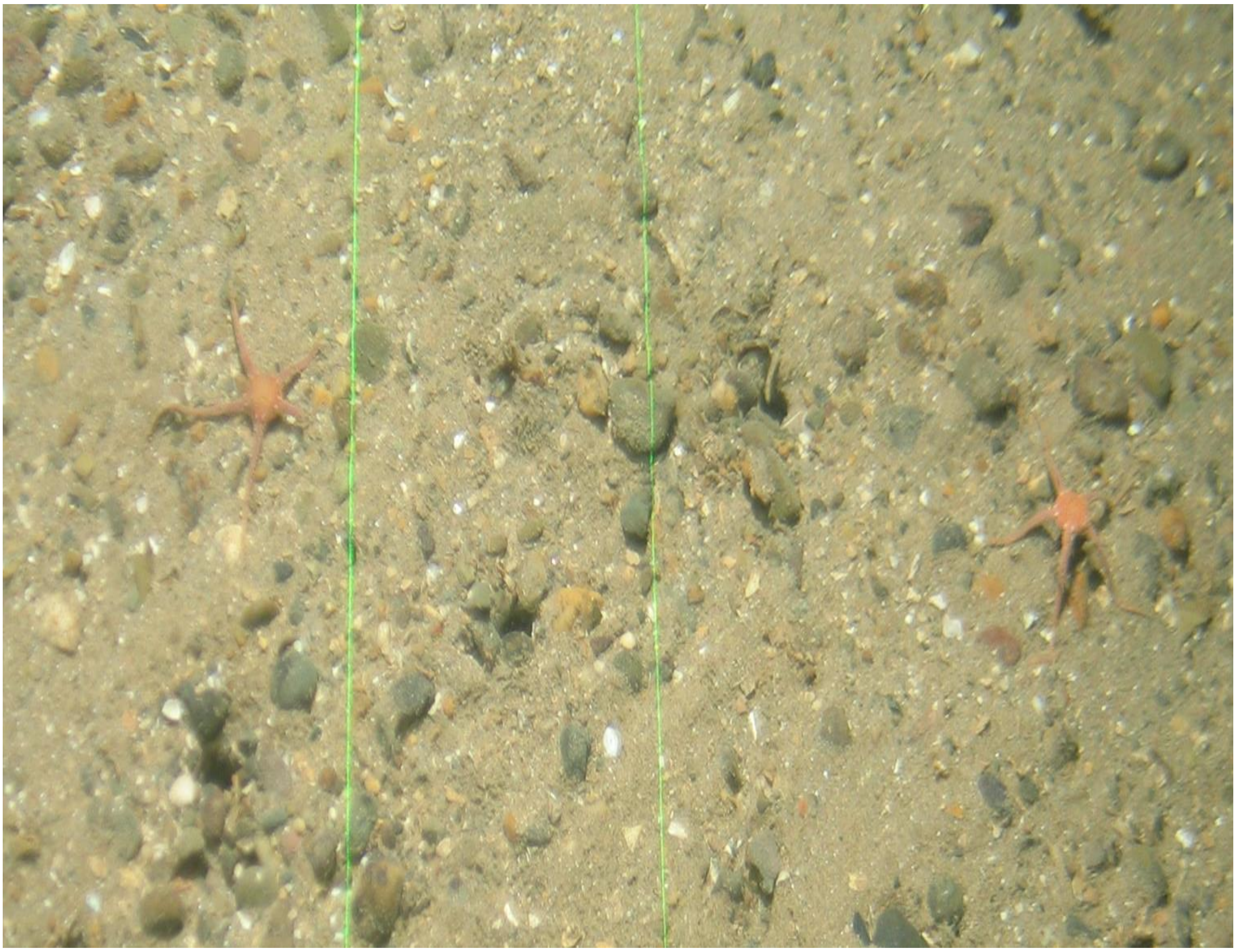


Figure 1.15: *Ophiura* sp. on mixed sediment at sample station ENV04.

1.7.4.2 Across the Morgan Array Area, the community composition observed from the DDV footage was similar between the coarse, mixed and sandy and muddy sediment. Some of the most prominent species across the Morgan Array Area included *Paguroidea*, *A. digitatum*, *Tubularia*, and Nematoda. Across the Morgan Array Area ZoI, the community composition observed from the DDV footage was similarly homogeneous however with a few prominent characterising species. Some of the most prominent species across the Morgan Array Area ZoI included *A. digitatum*, *Ceriantharia*, and *Ophiura albida* (Figure 1.16). Another notable species observed consistently in the DDV imagery across the Morgan benthic subtidal ecology study area were scallops (*Pectinidae*) with the greatest abundances identified in the Morgan Array Area ZoI (e.g. 35 were identified in imagery for ZOI25).

Figure 1.16: *Ophiura* sp. on mixed sediment at sample station ZOI21.

Summary statistics

1.7.4.3 The epifaunal data that were recorded as present/absent, and therefore removed from the infaunal grab data analysis, were combined with the epifaunal data from the DDV. A total of 498 taxa and two categories of burrows and waste casts were recorded from the 154 infaunal grabs and DDV stations sampled during the site-specific benthic surveys in the Morgan benthic subtidal ecology study area. Of the total 498 taxa, *A. digitatum*, *Ophiura* sp., *Paguroidea*, *Nematoda* and fauna turf were recorded across the most sample stations in the 2021 and 2022 site specific survey. Of the taxa identified within the Morgan benthic subtidal ecology study area, 202 taxa occurred at less than three sample stations. Sample station ENV90 recorded the highest number of epifaunal taxa (west Morgan Array Area), with sample station ENV06 (north Morgan Array Area ZoI) recording the highest number of burrows.

Multivariate community analysis

1.7.4.4 The results of the cluster analysis, SIMPROF test and SIMPER analysis were used, together with the raw untransformed data, to assign preliminary epifaunal biotopes to sample stations based on the dataset which combined the DDV data and the epibenthic component of the grab samples (Table 1.13). 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 groups could be explained by differences in abundances of characterising species rather than the presence/absence of key species. The communities recorded in each of the habitats described resulted in the allocation of high level biotopes largely guided by sediment type. Full results of the multivariate analysis are presented in Appendix C.

1.7.4.5 The results of the hierarchical cluster analysis of the square root transformed epifaunal dataset (Table 1.13) together with the SIMPROF test identified 21 Faunal groups (Figure 1.17) that were statistically dissimilar, based on the SIMPROF test. The 2D MDS plot is presented in Figure 1.18 and the low stress value (0.12) indicates that this is a good representation of the data. The 3D MDS plot has not been presented as the 2D MDS plot presents a clearer representation of the data.

1.7.4.6 Faunal group U, which was composed of stations only in the Morgan Array Area ZoI, showed distinct clustering away from other Faunal groups (Table 1.13). The three stations in Faunal group J showed tight clustering with a Bray-Curtis similarity of 78.17%. Faunal group D was the largest SIMPROF group identified (43 sample stations) with a Bray-Curtis similarity of 51.04%. The difference in Faunal groups is discussed in the following paragraphs.

1.7.4.7 Faunal groups A, D, E, O, P, Q, R and S as well as sample stations in Faunal groups B, C, N and T were located within the west of the Morgan benthic subtidal ecology study area. These stations were associated with mixed sediments and communities characterised by a variety of polychaetes, crustaceans and echinoderms. These groups and sample stations were assigned the SS.SMx.CMx biotope from the epifaunal data (Figure 1.19).

1.7.4.8 Faunal groups L and M, as well as sample stations in Faunal groups B, C and F, had sample stations in the centre of the Morgan Array Area and were all characterised by coarse sediments and communities of polychaetes, echinoderms and Crustacea with some bryozoans such as *Serpulidae, Pagurus prideaux* and *A. digitatum*. The habitats represented in this faunal group are varied and did not contain the characteristic species which would lead to a more specific biotope allocation. Therefore, on the basis of the epifaunal data, Faunal groups L and M, as well as sample stations in Faunal groups B, C and F were allocated the SS.SCS.CCS biotope.

1.7.4.9 Faunal group U, as well as sample stations in Faunal group N, had sample stations distributed throughout the west section of the Morgan Array area and along the north boundary of the Morgan Array Area. Sample stations in Faunal group N and U were characterised by sand and muddy sand sediments. The associated communities recorded from the epifaunal data were largely characterised by echinoderms and crustaceans such as *O. ophiura* and *Pagurus bernhardus*. Therefore, on the basis of the epifaunal data, Faunal group U, as well as sample stations in Faunal group N, were allocated the SS.SSa.CMuSa biotope. Similarly, to the patterns observed in the infaunal multivariate analysis, the epifaunal analysis showed a transition in the epifaunal communities associated with the coarser sediment in the west of the Morgan benthic subtidal ecology study area to the communities associated with finer sediments in the east of the Morgan benthic subtidal ecology study area.

1.7.4.10 Sample stations in the wider regional benthic subtidal ecology study area located to the south of the Morgan benthic subtidal ecology study area (i.e. within the Mona Array Area) were associated with Faunal groups A, D, E, G, H, I, J and K, as well as sample stations in Faunal group N. These sample stations were largely characterised by mixed sediments. The faunal communities in these sample stations were characterised by taxa such as polychaetes, echinoderms and Crustacea which included *Tubularia, Ophiura,* and *Paguroidea.* These faunal groups were allocated the SS.SMx.CMx biotope. The wide distribution of the sample stations in Faunal groups A, D, E, G, H, I, J and K, as well as sample stations in Faunal group N resulted in the majority of the wider regional benthic subtidal ecology study area to the south of the Morgan benthic subtidal ecology study area (i.e. within the Mona Array Area) being allocated the SS.SMx.CMx biotope (Figure 1.19).

1.7.4.11 These results are largely supported by the survey results of the baseline characterisation surveys undertaken for the Rhiannon Wind Farm (Figure 1.3) (Celtic Array Ltd, 2014) which characterised the area coinciding with the west the Morgan Array Area and southwest of the Morgan Array Area ZoI. These surveys identified mixed sediment biotopes (e.g. SS.SMx.CMx) in the west of the Morgan Array Area and also the SS.SCS.CCS biotope in the northwest of the Morgan Array Area. Finally although the Rhiannon Wind Farm survey did not extend far in to the north of the Morgan Array Area or east in to the Morgan Array Area ZoI the data collected does suggest finer sediments and biotopes such as SS.SSa.CFiSa were more prevalent in these areas as found during the site specific surveys for the Morgan Array Area ZoI.

1.7.4.12 The Faunal groups presented in the SIMPER analysis and the raw data were used to assign three preliminary epifaunal biotopes to the site-specific survey data (Table 1.13). Figure 1.19 presents the preliminary epifaunal biotopes assigned across the Morgan benthic subtidal ecology study area from the analyses of the epifaunal component of the grab data and DDV.

Table 1.13: Simprof groups and biotope classifications for the epifaunal dataset (from DDV and epifaunal component of grab data).

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
A	ENV09	34 to 42	Mixed sediment	*Nematoda, Copepoda*, Faunal turf, *Ophiura, Serpulidaem, Amphipoda, Paguroidea*, Animalia tubes	SS.SMx.CMx	Faunal group A showed the highest Bray Curtis dissimilarity with Faunal group O (96.03%) due a lack of common species. Faunal group A showed the lowest Bray Curtis dissimilarity with Faunal group E (58.00%) due to both having similar abundances of *Decapoda* and *Penetrantia*.
	ENV23		Sand and muddy sand			
	ENV40		Mixed sediment			
	ENV43		Coarse sediment			
	ENV45		Mixed sediment			
	ENV67		Sand and muddy sand			
	ENV68		Sand and muddy sand			
	ENV70		Coarse sediment			
	ENV95		Sand and muddy sand			
B	ENV14	36 to 45	Coarse sediment	*Euclymeninae, Nematoda, Scoloplos armiger, Decapoda, Penetrantia, Alcyonium digitatum*	SS.SMx.CMx	Faunal group B showed the highest Bray Curtis dissimilarity with Faunal group Q (96.30%) due a lack of common species. Faunal group B showed the lowest Bray Curtis dissimilarity with Faunal group E (57.55%) due to both having similar abundances of *Euclymeninae* and *Sertulariidae*.
	ENV28		Coarse sediment		SS.SCS.CCS	
C	ENV01	35 to 45	Mixed sediment	Burrows, *Sertulariidae, Hydrallmania falcata, Copepoda, Schizomavella*, Faunal turf	SS.SMx.CMx	Faunal group C showed the highest Bray Curtis dissimilarity with Faunal group U (95.22%) due a lack of common species. Faunal group C showed the lowest Bray Curtis dissimilarity with Faunal group D (58.22%) due to both having similar abundances of *Nematoda* and *Porella concinna*.
	ENV08		Coarse sediment		SS.SMx.CMx	
	ENV94		Coarse sediment		SS.SCS.CCS	

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
D	ENV04	40 to 49	Mixed sediment	*Nematoda, Serpulidae, Sertulariidae, Hydrallmania falcata, Copepoda, Alcyonium digitatum, Ophiura, Pectinidae, Decapoda*	SS.SMx.CMx	Faunal group D showed the highest Bray Curtis dissimilarity with Faunal group U (95.05%) due a lack of common species. Faunal group D showed the lowest Bray Curtis dissimilarity with Faunal group E (58.22%) due to both having similar abundances of *Hydrallmania falcata* and *Sertulariidae*.
	ENV05		Mixed sediment			
	ENV10		Mixed sediment			
	ENV15		Mixed sediment			
	ENV20		Coarse sediment			
	ENV27		Mixed sediment			
	ENV29		Mixed sediments			
	ENV31		Mixed sediment			
	ENV32		Mixed sediment			
	ENV33		Mixed sediment			
	ENV34		Mixed sediment			
	ENV35		Mixed sediments			
	ENV36		Mixed sediments			
	ENV37		Mixed sediments			
	ENV38		Mixed sediments			
	ENV41		Mixed sediment			
	ENV42		Mixed sediment			
	ENV47		Mixed sediments			
	ENV48		Mixed sediments			
	ENV49		Mixed sediments			
	ENV50		Mixed sediments			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ENV51		Mixed sediments			
	ENV52		Mixed sediments			
	ENV53		Mixed sediments			
	ENV54		Mixed sediments			
	ENV55		Mixed sediments			
	ENV56		Coarse sediments			
	ENV57		Coarse sediment			
	ENV59		Mixed sediments			
	ENV60		Mixed sediments			
	ENV61		Mixed sediments			
	ENV62		Coarse sediments			
	ENV63		Mixed sediments			
	ENV64		Mixed sediment			
	ENV65		Mixed sediment			
	ENV71		Mixed sediment			
	ENV82		Mixed sediment			
	ENV84		Mixed sediment			
	ENV86		Mixed sediments			
	ENV88		Mixed sediments			
	ENV90		Mixed sediment			
	ENV92		Mixed sediment			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ENV97		Mixed sediment			
E	ENV02	37 to 51	Coarse sediment	*Nematoda, Copepoda, Decapoda, Penetrantia, Alcyonium digitatum, Amphipoda*, Faunal turf, *Serpulidae*	SS.SMx.CMx	Faunal group E showed the highest Bray Curtis dissimilarity with Faunal group O (94.92%) due a lack of common species. Faunal group E showed the lowest Bray Curtis dissimilarity with Faunal group D (56.06%) due to both having similar abundances of *Hydrallmania falcata* and *Sertulariidae*.
	ENV03		Mixed sediment			
	ENV06		Mixed sediment			
	ENV12		Mixed sediment			
	ENV13		Sand and muddy sand			
	ENV17		Coarse sediment			
	ENV18		Coarse sediment			
	ENV19		Coarse sediment			
	ENV24		Mixed sediment			
	ENV39		Mixed sediment			
	ENV69		Coarse sediment			
F	ENV66	36 to 41	Coarse sediment	*Nematoda, Serpulidae*, Faunal turf, Animalia tubes	SS.SCS.CCS	Faunal group F showed the highest Bray Curtis dissimilarity with Faunal group P (95.74%) due a lack of common species. Faunal group F showed the lowest Bray Curtis dissimilarity with Faunal group G (59.47%) due to both having similar abundances of *Alcyonium digitatum* and *Paguroidea*.
	ENV83		Mixed sediment		SS.SMx.CMx	
	ENV89		Coarse sediment		SS.SCS.CCS	
G	ENV72	36 to 41	Mixed sediment	*Serpulidae, Tubularia, Alcyonium digitatum, Pectinidae, Echinoidea, Pagurus bernhardus*, Faunal turf	SS.SMx.CMx	Faunal group G showed 100% Bray Curtis dissimilarity with Faunal groups Q, P, S, T, U, R and O due a lack of common species. Faunal
	ENV75		Coarse sediment			
	ENV77		Mixed sediment			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ENV78		Coarse sediment			group G showed the lowest Bray Curtis dissimilarity with Faunal group I (45.91%) due to both having similar abundances of *Ophiura* and *Serpulidae*.
H	ENV73	36 to 38	Mixed sediment	*Serpulidae, Alcyonium digitatum, Ophiura, Echinoidea, Pectinidae*, Faunal turf	SS.SMx.CMx	N/A
I	ENV58	38 to 39	Mixed sediment	*Echinoidea, Ophiura, Serpulidae, Actiniaria, Alcyonium digitatum, Pectinidae*	SS.SMx.CMx	N/A
J	ENV74	38 to 41	Mixed sediment	*Serpulidae, Alcyonium digitatum, Ophiura, Echinoidea, Pectinidae,* Faunal turf	SS.SMx.CMx	Faunal group G showed 100% Bray Curtis dissimilarity with Faunal groups Q, P, S, T, U, R and O due a lack of common species. Faunal group G showed the lowest Bray Curtis dissimilarity with Faunal group I (30.66%) due to both having similar abundances of *Actiniaria* and *Ceriantharia*.
	ENV76		Mixed sediment			
	ENV79		Mixed sediment			
K	ENV46	38 to 42	Mixed sediment	*Serpulidae, Alcyonium digitatum, Ophiothrix fragilis, Ophiura*, Faunal turf, *Pectinidae, Actiniaria, Pagurus bernhardus*	SS.SMx.CMx	Faunal group G showed 100% Bray Curtis dissimilarity with Faunal groups Q, P, S, T, U, R and O due a lack of common species. Faunal group G showed the lowest Bray Curtis dissimilarity with Faunal group I (34.61%) due to both having similar abundances of *Echinoidea* and *Ophiothrix fragilis.*
	ENV80		Mixed sediment			
	ENV81		Mixed sediment			
	ENV85		Mixed sediment			
L	ENV07	36 to 48	Coarse sediment		SS.SCS.CCS	

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ENV93		Coarse sediment	Burrows, *Nematoda, Polygordius, Serpulidae, Alcyonium digitatum*		Faunal group L showed the highest Bray Curtis dissimilarity with Faunal group O (97.99%) due a lack of common species. Faunal group L showed the lowest Bray Curtis dissimilarity with Faunal group H (58.92%) due to both having similar abundances of *Tubularia* and *Alcyonium digitatum*.
M	ENV11	42 to 48	Sand and muddy sand	*Nematoda, Decapoda, Sertularella*, Faunal turf, *Ophiura, Actiniaria*	SS.SCS.CCS	Faunal group M showed the highest Bray Curtis dissimilarity with Faunal group R (97.46%) due a lack of common species. Faunal group M showed the lowest Bray Curtis dissimilarity with Faunal group H (57.91%) due to both having similar abundances of *Ophiothrix fragilis* and *Ophiocomina nigra*.
	ENV91		Mixed sediment			
N	ENV16	34 to 41	Sand and muddy sand	Faunal turf, *Ophiura, Phoronis, Paguroidea, Amphipoda, Astropecten irregularis*	SS.SSa.CMuSa	Faunal group N showed the highest Bray Curtis dissimilarity with Faunal group Q (97.98%) due a lack of common species. Faunal group N showed the lowest Bray Curtis dissimilarity with Faunal group H (57.91%) due to both having similar abundances of *Nematoda* and *Amphiura filiformis*.
	ENV21		Sand and muddy sand		SS.SSa.CMuSa	
	ENV22		Sand and muddy sand		SS.SSa.CMuSa	
	ENV25		Sand and muddy sand		SS.SSa.CMuSa	
	ENV26		Sand and muddy sand		SS.SSa.CMuSa	
	ENV30		Sand and muddy sand		SS.SMx.CMx	
	ENV44		Coarse sediment		SS.SMx.CMx	
O	ZOI18	41 to 42	Mixed sediments		SS.SMx.CMx	

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ZOI21		Mixed sediments	*Serpulidae stet., Alcyonium digitatum, Ophiura albida inc., Ophiothrix fragilis inc., Ceriantharia stet., Actiniaria indet.*		Faunal group P showed 100% Bray Curtis dissimilarity with Faunal groups K, I, F, G and H due a lack of common species. Faunal group P showed the lowest Bray Curtis dissimilarity with Faunal group R (46.20%) due to both having similar abundances of *Serpulidae* and *Tubularia indivisa*.
P	22ENV06	41	Coarse sediments	*Pectinidae, Scaphopoda, Ophiura albida, Tubularia indivisa, Nemertesia antennina, Hydrozoa, Ceriantharia, Alcyonium digitatum, Actiniaria, Paguroidea, Serpulidae*	SS.SMx.CMx	N/A
Q	22ENV05	41	Mixed sediments	*Serpulidae, Alcyonium digitatum, Paguroidea, Echinoidea, Scaphopoda*	SS.SMx.CMx	N/A
R	ZOI17	45	Coarse sediments	*Serpulidae stet., Alcyonium digitatum, Pectinidae stet., Ophiura albida inc., Echinoidea indet., Suberites indet., Psolus phantapus inc., Asterias rubens, Ophiura ophiura inc., Pecten maximus*	SS.SMx.CMx	Faunal group P showed 100% Bray Curtis dissimilarity with Faunal groups K, I, J, F, G and H due a lack of common species. Faunal group P showed the lowest Bray Curtis dissimilarity with Faunal group Q (39.34%) due to both having similar abundances of *Pectinidae* and *Ophiura albida*.
	ZOI25		Coarse sediments			
S	22ENV07	43 to 44	Coarse sediments		SS.SMx.CMx	

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	22ENV11		Coarse sediments	*Serpulidae stet., Alcyonium digitatum, Pectinidae stet., Paguroidea stet., Nematoda*		Faunal group P showed 100% Bray Curtis dissimilarity with Faunal groups K, I, J and H due a lack of common species. Faunal group P showed the lowest Bray Curtis dissimilarity with Faunal group S (53.32%) due to both having similar abundances of *Ophiura albida* and *Serpulidae*.
T	22ENV09	32 to 43	Coarse sediments	Tubularia indivisa inc., *Alcyonium digitatum, Ophiura ophiura inc., Paguroidea stet., Serpulidae stet., Psolus phantapus inc.*	SS.SMx.CMx	Faunal group T showed 100% Bray Curtis dissimilarity with Faunal groups J, G and H due a lack of common species. Faunal group T showed the lowest Bray Curtis dissimilarity with Faunal group P (58.35%) due to both having similar abundances of *Ceriantharia* and *Actiniaria*.
	22ENV10		Coarse sediments			
	ZOI23		Mixed sediments			
	ZOI24		Sand and muddy sand			
U	22ENV12	32 to 58	Sand and muddy sand	*Ophiura ophiura inc., Astropecten irregularis, Nematoda, Paguroidea stet., Leptothecata*	SS.SSa.CMuSa	Faunal group T showed 100% Bray Curtis dissimilarity with Faunal groups K, I, J, G and H due a lack of common species. Faunal group T showed the lowest Bray Curtis dissimilarity with Faunal group T (77.59%) due to both having similar abundances of *Tubularia indivisa* and *Pectinidae*.
	ZOI14		Sand and muddy sand			
	ZOI15		Mud and sandy mud			
	ZOI16		Sand and muddy sand			
	ZOI19		Sand and muddy sand			
	ZOI20		Mixed sediments			
	ZOI22		Sand and muddy sand			

Simprof group	Station	Depth range (m)	EUNIS Folk classification	Characterising infaunal taxa according to SIMPER analysis	Biotope	Comments
	ZOI26		Sand and muddy sand			

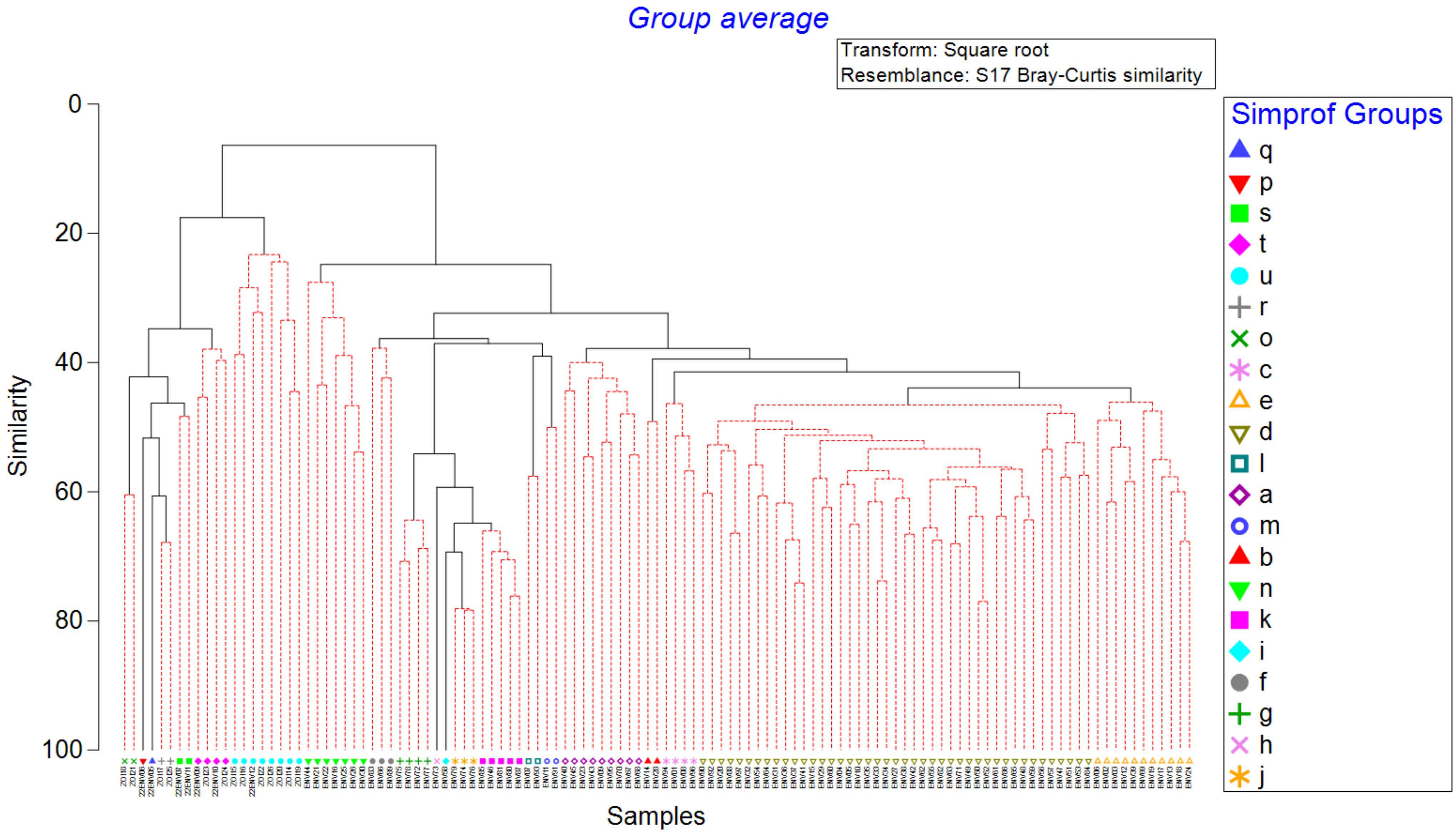


Figure 1.17: Dendrogram of epifaunal communities (from DDV and epifaunal component of grab data).

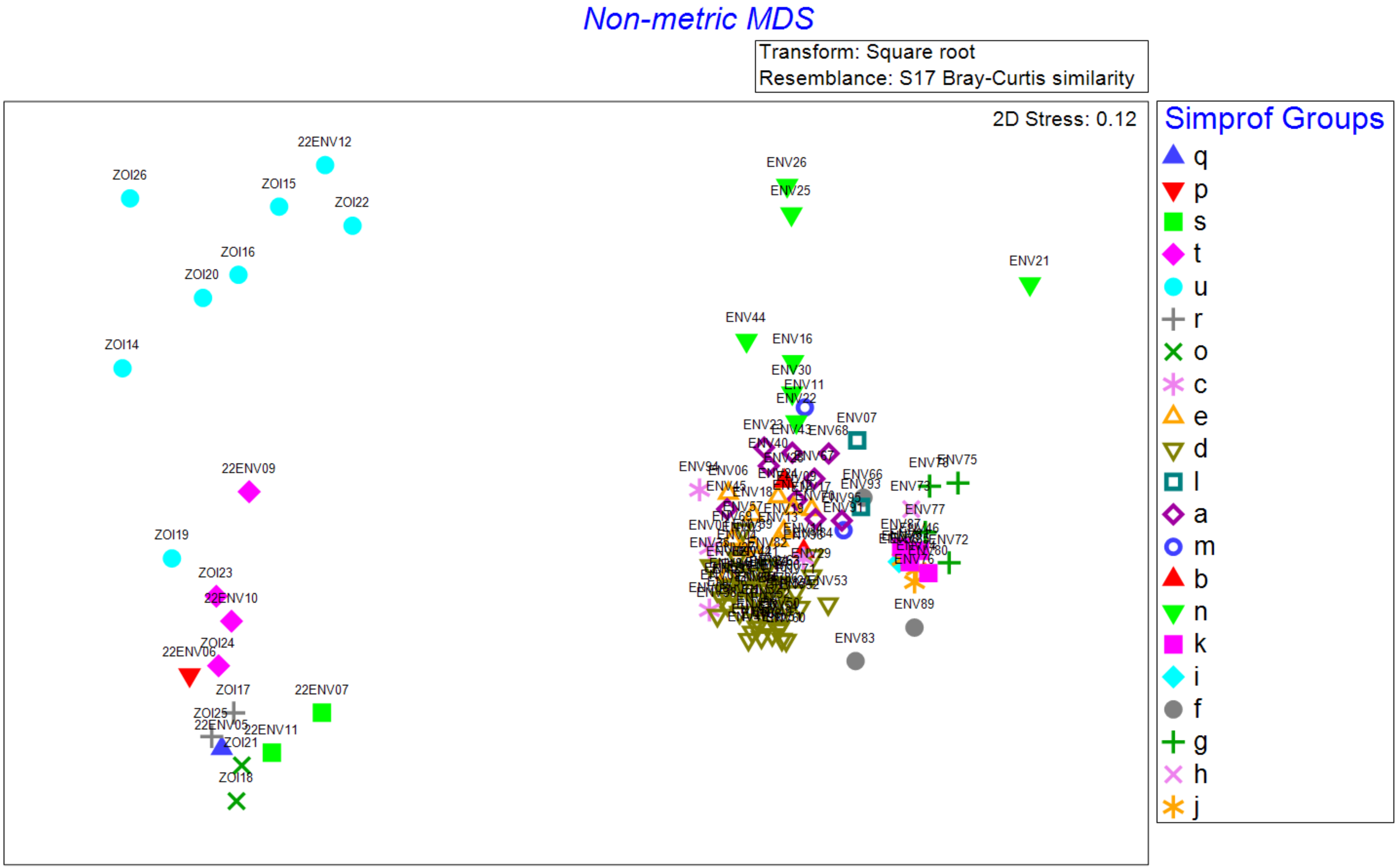


Figure 1.18: 2D MDS plot of epifaunal communities (from DDV and epifaunal component of grab data).

Table 1.14: Summary of preliminary epifaunal biotopes identified from the site-specific surveys (from DDV and epifaunal component of grab data).

Preliminary epifaunal biotopes	Sample station	Water depth range (m)	Sediment classification	Characterising taxa accounting for up to 50% of cumulative similarity (SIMPER)	Geographic location
SS.SMx.CMx	ENV01, ENV02, ENV03, ENV04, ENV05, ENV06, ENV08, ENV09, ENV10, ENV15, ENV18, ENV19, ENV20, ENV23, ENV24, ENV27, ENV29, ENV31, ENV32, ENV33, ENV34, ENV35, ENV36, ENV27, ENV38, ENV39, ENV40, ENV41, ENV42, ENV43, ENV44, ENV45, ENV46, ENV47, ENV48, ENV49, ENV50, ENV51, ENV52, ENV53, ENV54, ENV55, ENV56, ENV57, ENV58, ENV59, ENV60, ENV61, ENV62, ENV63, ENV64, ENV65, ENV67, ENV68, ENV69, ENV70, ENV71, ENV72, ENV73, ENV74, ENV75, ENV76. ENV77, ENV79, ENV80, ENV81, ENV82, ENV83, ENV84, ENV85, ENV86, ENV87, ENV88, ENV90, ENV90, ENV92, ENV95, ENV96, ENV97, ZOI17, ZOI18, ZOI21, ZOI23, ZOI24, ZOI25, 22ENV05, 22ENV06, 22ENV09, 22ENV10, 22ENV11	37 to 51	Sand and muddy sand, mixed sediment, coarse sediment	*Nematoda,* faunal turf*, Amphipoda, Paguroidea, Ophiura, Terebellidae, Animalia Tubes, Alcyonium digitatum, Tubularia, Pectinidae, Copepoda, Pagurus bernhardus, Serpulidae, Echinoidea, Buccinidae, Spatangus purpureus, Ophiothrix fragilis, Actinaria, Asteria rubens, Cirripedia, Paguroidea, Eucratea loricata, Adamsia palliata, Penetrantia, Euclymeninae, Sertulariidae, Hydrallmania falcata, Schizomavella*	Across the west and south of the Morgan benthic subtidal ecology study area. Across the wider regional benthic subtidal ecology study area to the south of the Morgan benthic subtidal ecology study area (i.e. the Mona Offshore Wind Project).
SS.SCS.CCS	ENV07, ENV13, ENV14, ENV17, ENV28, ENV66,	36 to 51	Coarse sediment, mixed sediment	*Animalia Tubes, Serpulidae, Pagurus prideaux, Bryozoan,* Burrows*, Actiniaria, Adamsia palliata,*	Centre of the Morgan Array Area.

Preliminary epifaunal biotopes	Sample station	Water depth range (m)	Sediment classification	Characterising taxa accounting for up to 50% of cumulative similarity (SIMPER)	Geographic location
	ENV78, ENV89, ENV91, ENV93, ENV94			*Alyconium digitatum, Ophiura, Pectinidae, Scaphapoda, Nematoda,* faunal turf, *Tubularia, Ceriantharia, Actinopterygii, Decapoda, Ophiuroidea, Terebellidae, Ascidiacea*	Across the wider regional benthic subtidal ecology study area to the south of the Morgan benthic subtidal ecology study area (i.e. the Mona Offshore Wind Project).
SS.SSa.CMuSa	ENV11, ENV12, ENV16, ENV21, ENV22, ENV25, ENV26, ENV30, ZOI14, ZOI15, ZOI16, ZOI20, ZOI22, ZOI26, 22ENV12	32 to 58	Sand and muddy sand, mud and sandy mud	Faunal turf, *Ophiura, Paguroidea, Astropecten irregularis, Ceriantharia, Alcyonium digitatum, Pagurus bernhardus, Phoronis*	East of the Morgan Array Area. Across the north and east of the Morgan Array Area ZoI.

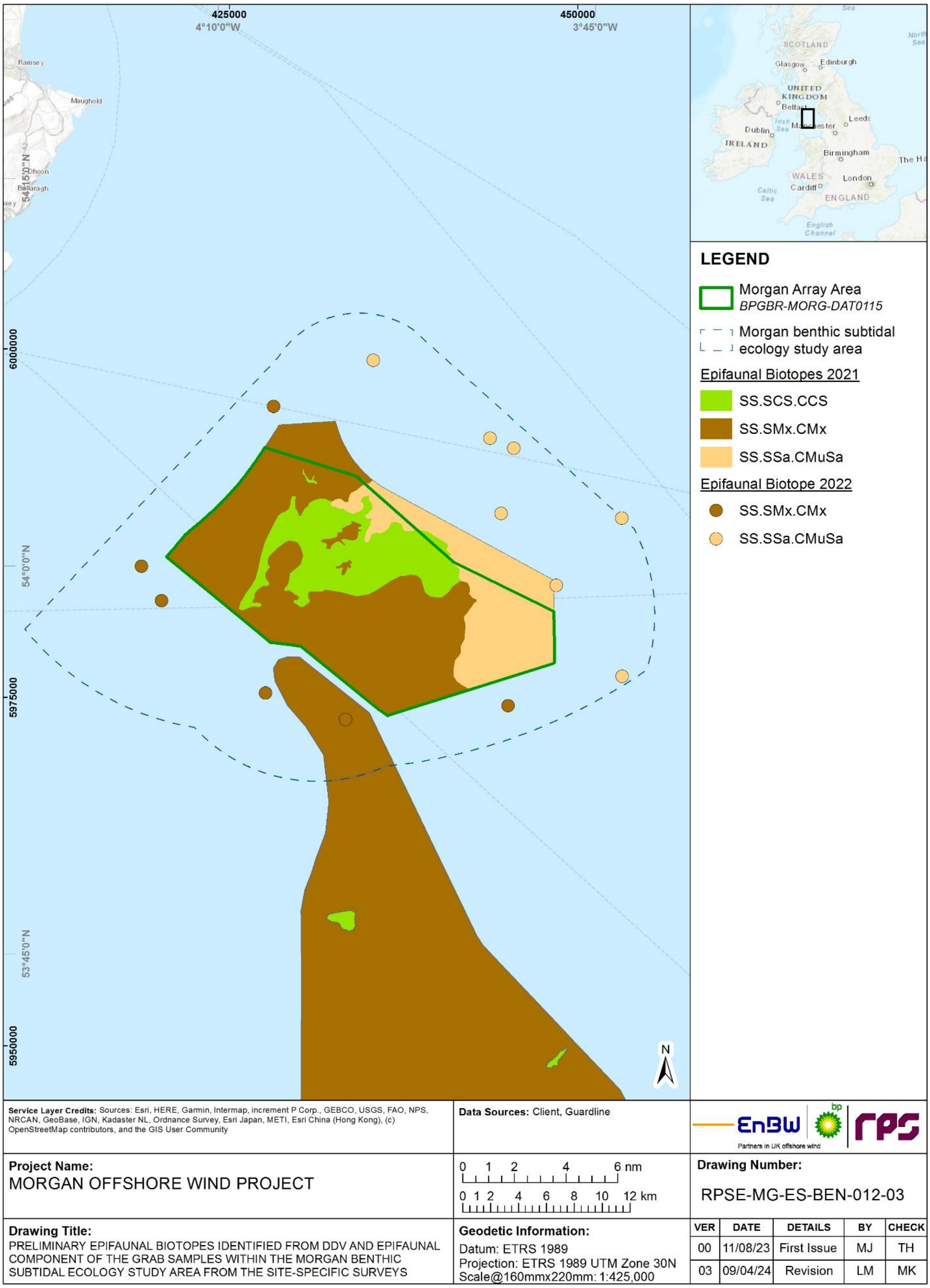


Figure 1.19: Preliminary epifaunal biotopes identified from DDV and epifaunal component of the grab samples within the Morgan benthic subtidal ecology study area from the site-specific surveys (all biotope codes are defined in Appendix G).

Comparison between Morgan Array Area 2021 and 2022 data

1.7.4.13 To determine if there had been any measurable shift in the communities in the Morgan Array Area between the 2021 and 2022 surveys, seven stations were resampled in 2022 (DDV and grab sampling data) so that the abiotic and biotic conditions could be compared. Analysis of the epifaunal grab sample data from these stations suggested some dissimilarity in the epifaunal communities. A CLUSTER analysis, including a SIMPROF test, did not group the 2021 and 2022 sample stations of the same location together. The results of the SIMPER analysis identified four separate groups with the 2021 and 2022 sample points largely clustered apart. The 2021 samples all clustered in one group and the 2022 samples were clustered in three groups with two groups containing single sample stations. A SIMPER test on these clusters showed a dissimilarity between the two main groups of 97.55%.

1.7.4.14 An ANOSIM test was undertaken which determines if the difference between SIMPROF groups is greater than the difference within SIMPROF groups. The results of this analysis provided an R statistic of 0.90 which suggested that were was a greater difference between Faunal groups than within them. Overall, the conditions within the Morgan benthic subtidal ecology study area are highly changeable allowing for community shift over time however due to the broad biotopes assigned to these sample stations it is reasonable that they can be assigned different cluster groups with varying communities but still be allocated the same biotope.

Univariate analysis

1.7.4.15 The following univariate statistics were calculated for the combined epibenthic dataset (i.e. epibenthic components of the grabs and DDV data) for each sample 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 1.15, with univariate statistics for individual sites presented in Appendix E

1.7.4.16 The biotope SS.SMx.CMx had the highest number of taxa (46.39 ± 8.76) and mean number of individuals (33.99 ± 52.41; Table 1.15); this was expected as this biotope is composed of mixed sediments with cobbles and pebbles which provide substrate for epifauna to attach to. The high number of individuals associated with this biotope were due to high abundances of annelids and Crustaceans as well as faunal turf. The lowest mean number of taxa was recorded in association with the SS.SSa.CMuSa biotope (24.38 ± 11.46). The lowest mean number of individuals was recorded in association with the SS.SCS.CCS biotope (12.81 ± 6.97). Overall, the highest number of taxa were recorded at biotopes with greater proportions of coarse substrate and the lowest numbers were recorded in muddy sand sediment habitats.

1.7.4.17 The highest mean diversity scores were associated with the SS.SCS.CCS biotope (d = 19.63 ± 9.44 and H' = 2.60 ± 0.44) and the SS.SMx.CMx (d = 18.08 ± 11.12 and H' = 2.93 ± 0.24). This was expected, as these biotopes had the highest number of taxa and were characterised by coarser substrate. The communities associated with the SS.SSa.CMuSa biotope had the lowest mean diversity score (d = 10.58 ± 7.15, H' = 2.28 ± 0.44). Overall, the highest diversity was recorded at biotopes with coarser substrate and the lowest was recorded in sand sediment habitats.

1.7.4.18 Pielou's evenness (J') scores showed limited variation across the epifaunal biotopes. Mean J' was 0.76, 0.70 and 0.74 at SS.SMx.CMx, SS.SCS.CCS and SS.SSa.CMuSa, respectively, indicating a relatively even distribution of abundance among taxa in these biotopes. This was expected, as all of these biotopes show a relatively similar level of abundance. The Simpson's index of Dominance (λ) was also similar for all the biotopes, ranging from 0.94 to 1.05, indicating that these biotopes have a similar number of species as well as there being a similar abundance of each species. Simpson's index of Dominance was lowest at SS.SSa.CMuSa indicating that this biotope had a slightly more even distribution of taxa.

Table 1.15: Mean (± standard deviation) univariate statistics for epifaunal biotopes (from DDV and grab data).

Biotope	S	N	d	J'	H'	λ
SS.SMx.CMx	46.39 ± 8.76	33.99 ± 52.41	18.08 ± 11.12	0.76 ± 0.05	2.93 ± 0.24	1.04 ± 0.31
SS.SCS.CCS	42.55 ± 11.80	12.81 ± 6.97	19.63 ± 9.44	0.70 ± 0.09	2.60 ± 0.44	1.05 ± 0.30
SS.SSa.CMuSa	24.38 ± 11.46	23.85 ± 22.08	10.58 ± 7.15	0.74 ± 0.10	2.28 ± 0.44	0.94 ± 0.13

1.7.5 Results – habitat assessments

Seapens and burrowing megafauna communities assessment

1.7.5.1 Across the Morgan benthic subtidal ecology study area small pencil burrows were observed in the site-specific surveys. Although no seapens were observed during the site-specific surveys, the JNCC (2013) guidance stipulates that the 'seapens and burrowing megafauna communities' habitat can occur without seapens. Additionally the sediment within the Morgan benthic subtidal ecology study area is considered unlikely to be consistent with this habitat as it is predominantly gravelly muddy sand whereas the seapens and burrowing megafauna habitat is characterised by circalittoral fine mud. However as a precaution an analysis of this habitat was undertaken for the stations where burrows were recorded across the Morgan benthic subtidal ecology study area.

1.7.5.2 The assessment was undertaken by determining the density of burrows and their abundance which was then categorised using the SACFOR classification. This assessed whether the density of the burrows makes them a prominent feature of the sediment surface and therefore an indication of the sub-surface complex burrowing communities. The burrowing fauna which formed the burrows were rarely sighted during the survey to confirm the burrow inhabitants; therefore, burrows could not confidently be attributed to any of the classified 'megafauna' species within the 'seapen and burrowing megafauna community' habitat classification. As such, and in keeping with the JNCC report (JNCC, 2013) recommendations, caution should be applied when interpreting these density results as they are not necessarily definitive of the habitats condition.

1.7.5.3 At the 36 stations where burrows were observed, the maximum burrow density varied from 0.02 burrows per m^2 at station ZOI22 in the Morgan Array Area ZoI to 6.62 burrows per m^2 at ENV73 within the Morgan Array Area ZoI. It should be noted that the maximum burrow density is considered to be highly precautionary. This is because total burrows per image were not recorded, rather burrows were assigned a range (i.e. 1 to 5, 6 to 10 etc.) and, to determine the maximum burrow density, the top end of the range bracket was used to obtain the maximum total number of burrows and from that the density then calculated.

1.7.5.4 The majority of burrows were very small and in the 0 to 1 cm size range category with 73% of images from the Morgan benthic subtidal ecology study area falling within this range (see Figure 1.20 for example images). Burrow density was not identified as greater than ‘frequent’ on the SACFOR scale at any station across the Morgan benthic subtidal ecology study area. Within the Morgan Array Area 18 of stations subject to an assessment for the presence of this habitat had an average SACFOR abundance of ‘frequent’, and in the Morgan Array Area ZoI this was less with six stations recording an average SACFOR abundance of ‘frequent’. The average burrow SACFOR per station is presented in Table 1.16.

1.7.5.5 Very few burrows were observed at stations where soft sediment (i.e. fine muds) was dominant (Table 1.16). In combination with an absence of associated fauna and gravelly sediment, it was concluded that these areas have only a negligible resemblance to the ‘seapens and burrowing megafauna communities’ habitat. However, in order to adopt a precautionary approach and on the basis that burrows were observed at an average SACFOR of ‘frequent’ at 24 stations (see Table 1.16 and Figure 1.21), these stations have, for the purposes of the assessment, been assumed to represent the ‘seapens and burrowing megafauna communities’ habitat. It should be noted however, that no seapens were recorded in the Morgan benthic subtidal ecology study area and, as shown in Table 1.16. The sediment within the Morgan benthic subtidal ecology study area is considered unlikely to be consistent with this habitat as it is predominantly gravelly muddy sand whereas the seapens and burrowing megafauna habitat is typically characterised by circalittoral fine mud. It is notable that seven stations in the Morgan Array Area were resampled during the 2022 survey but at those stations where burrows were observed in the 2021 survey, no burrows were visible in the imagery during the 2022 survey. This approach of assuming that the ‘seapens and burrowing megafauna communities’ habitat is present is therefore deemed to be highly precautionary.

1.7.5.6 The full results of the seapens and burrowing megafauna habitat assessment can be found in Table 1.16 with some DDV images of stations assigned an average SACFOR abundance of ‘frequent’ presented in Figure 1.20. As mentioned however in paragraph 1.7.5.1 this conclusion is precautionary as no seapens were observed across the Morgan benthic subtidal ecology study area and the sediment type is unlikely to be compatible with this habitat.

1.7.5.7 During imagery analysis, burrowing fauna not associated with the ‘seapens and burrowing megafauna communities’ habitat locations were observed across the Morgan benthic subtidal ecology study area including *Ceriantharia* and *Ensis* (an abundance of 686 and 200 respectively across the Morgan benthic subtidal ecology study area). There was also no evidence of any species associated with ‘seapens and burrowing megafauna communities’ habitat supporting the conclusion that it is highly unlikely that any habitat across the Morgan benthic subtidal ecology survey area constitutes anything other than a negligible resemblance to the ‘seapens and burrowing megafauna communities’ habitat. However, as stated above, for the purposes of the assessment a precautionary approach has been adopted which assumes that this habitat could be present (with the absence of seapens) at all stations shown in Figure 1.21 where the average burrow SACFOR was frequent or greater.

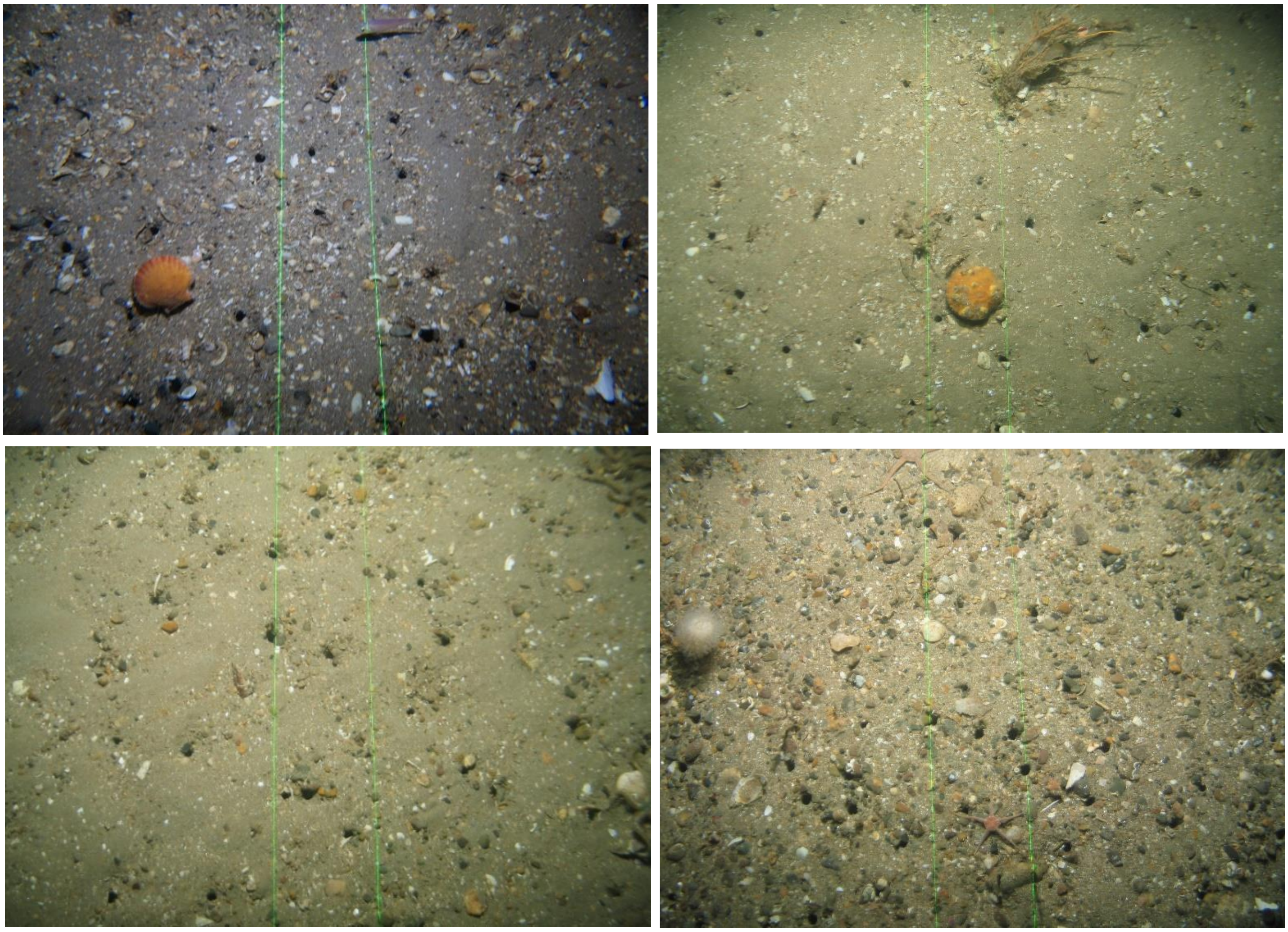


Figure 1.20: DDV images of stations with an average SACFOR abundance of 'frequent' (top left: ENV01, top right: ENV07, bottom left: ENV73 and bottom right: ENV90).

Table 1.16: Seapens and burrowing megafauna assessment within the Morgan benthic subtidal ecology study area.

Station	Total images	Camera transect length (m)	Estimated area investigated (m^2)	Folk sediment classification	Number of burrows				Maximum density m^2	Size of burrows			Average size (cm)	Average SACFOR
					1 to 5	6 to 10	11+	Max Total		0 - 1	1.1 - 3	3 +		
Morgan Array Area														
ENV02 (2021)	102	261	135.80	Gravelly sand	35	19	10	475	3.50	61	2	0	1.0	O
ENV02 (2022)	49	227	223.81	Slightly gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ENV03	77	267	170.17	Gravelly muddy sand	27	29	19	634	3.73	71	4	0	1.0	F
ENV04	100	258	150.86	Gravelly muddy sand	37	40	8	673	4.46	81	4	0	1.0	O
ENV05	84	278	184.97	Muddy sandy gravel	52	30	2	582	3.15	78	6	0	1.0	F
ENV07	97	273	208.27	Gravelly sand	3	1	14	179	0.86	18	0	0	0.9	R
ENV08	104	296	180.41	Gravelly sand	53	8	0	345	1.91	51	10	0	1.2	F
ENV09 (2021)	94	269	178.96	Gravelly muddy sand	36	32	21	731	4.08	21	67	0	2.4	F
ENV09 (2022)	36	254	212.97	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ENV10	90	258	145.13	Gravelly muddy sand	67	2	0	355	2.45	46	23	0	1.6	F
ENV11 (2021)	109	331	217.96	Sand	0	0	0	0	0	0	0	0	0	N/A
ENV11 (2022)	49	247	153.32	Sand	0	0	0	0	0	0	0	0	0	N/A
ENV12	91	272	226.66	Slightly gravelly sand	11	5	0	105	0.46	13	3	0	1.3	O

Station	Total images	Camera transect length (m)	Estimated area investigated (m^2)	Folk sediment classification	Number of burrows				Maximum density m^2	Size of burrows			Average size (cm)	Average SACFOR
					1 to 5	6 to 10	11+	Max Total		0 - 1	1.1 - 3	3 +		
ENV13 (2021)	94	281	215.18	Gravelly sand	43	37	14	739	3.43	42	52	0	2.0	F
ENV13 (2022)	57	484	400.68	Gravelly muddy sand	0	0	0	0	0	0	0	0	0	N/A
ENV14	93	278	245.54	Gravelly sand	30	0	0	150	0.61	28	2	0	1.0	O
ENV15	106	292	177.55	Gravelly muddy sand	79	3	0	425	2.39	69	14	0	1.2	F
ENV17	95	275	185.09	Sand	23	36	37	882	4.77	48	48	0	1.9	F
ENV18	92	279	163.11	Gravelly sand	18	48	26	856	5.25	39	53	0	2.1	F
ENV19	81	273	182.01	Gravelly muddy sand	51	28	2	557	3.06	56	25	0	1.5	F
ENV20	104	277	196.79	Gravelly sand	38	1	0	200	1.02	39	0	0	0.9	O
ENV22	95	269	209.32	Sand	0	0	0	0	0	0	0	0	0	N/A
ENV23 (2021)	82	271	169.30	Sand	0	0	0	0	0	0	0	0	0	N/A
ENV23 (2022)	33	332	286.64	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ENV24	95	272	173.17	Slightly gravelly sand	66	17	4	539	3.11	65	22	0	1.4	F
ENV25	73	278	169.82	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ENV26	83	274	180.98	Sand	0	0	0	0	0	0	0	0	0	N/A
ENV27	84	266	149.91	Sand	81	1	0	415	2.77	79	1	0	0.9	O
ENV28	99	272	228.41	Gravelly muddy sand	11	24	64	999	4.37	48	51	0	1.9	F

Station	Total images	Camera transect length (m)	Estimated area investigated (m^2)	Folk sediment classification	Number of burrows				Maximum density m^2	Size of burrows			Average size (cm)	Average SACFOR
					1 to 5	6 to 10	11+	Max Total		0 - 1	1.1 - 3	3 +		
ENV29	78	274	190.50	Gravelly sand	24	39	15	675	3.54	28	50	0	2.2	F
ENV72 (2021)	89	268	234.62	Gravelly sand with shell fragments	36	10	8	368	1.57	47	7	0	1.2	F
ENV72 (2022)	58	261	135.80	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ENV73	143	279	207.17	Gravelly sand with shell fragments.	27	39	77	1372	6.62	88	55	0	1.7	F
ENV90	96	270	213.20	Gravelly muddy sand	6	7	81	991	4.65	35	59	0	2.2	F
ENV91	91	272	210.86	Gravelly muddy sand	40	20	16	576	2.73	68	8	0	1.1	F
ENV92	94	265	285.11	Gravelly muddy sand	11	41	38	883	3.10	42	48	0	2.0	F
ENV93	93	284	274.40	Gravelly sand	34	23	14	554	2.02	69	1	1	1.0	O
22ENV06	56	374	174.63	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
22ENV07	57	479	375.17	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
22ENV09	49	266	188.28	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
22ENV10	48	225	142.89	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
22ENV11	45	245	177.98	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
Morgan Array Area ZoI														
ENV01	126	270	160.65	Gravelly muddy sand	40	55	20	970	6.04	97	18	0	1.2	F

Station	Total images	Camera transect length (m)	Estimated area investigated (m^2)	Folk sediment classification	Number of burrows				Maximum density m^2	Size of burrows			Average size (cm)	Average SACFOR
					1 to 5	6 to 10	11+	Max Total		0 - 1	1.1 - 3	3 +		
ENV06	90	272	149.08	Gravelly muddy sand	8	41	41	901	6.04	89	1	0	0.9	O
ENV16	91	270	194.82	Sand	0	0	0	0	0	0	0	0	0	N/A
ENV21	101	314	215.35	Sand	0	0	0	0	0	0	0	0	0	N/A
ENV30	94	268	194.57	Sand	16	0	0	80	0.41	16	0	0	0.9	R
ENV63 (2021)	84	276	186.02	Gravelly sand	73	8	0	445	2.39	72	9	0	1.1	F
ENV63 (2022)	48	1784	956.93	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ENV64	70	260	164.85	Muddy sandy gravel	68	4	0	330	2.00	59	3	0	1.0	O
ENV65	75	273	211.05	Gravelly muddy sand	41	32	2	547	2.59	54	19	0	1.4	F
ENV74	97	269	222.46	Gravelly sand	20	52	22	862	3.87	73	21	0	1.3	F
ENV76	105	274	245.90	Coarse, gravelly sand with shell fragments	8	12	10	270	1.10	21	9	0	1.5	F
ENV79	77	273	205.22	Very gravelly sand with shell fragments.	23	39	14	659	3.21	64	12	0	1.2	F
ENV94	85	270	225.75	Gravelly sand	0	0	8	88	0.39	8	0	0	0.9	R
22ENV05	48	328	215.69	Gravelly muddy sand	0	0	0	0	0	0	0	0	0	N/A
22ENV12	42	216	147.67	Sand	0	0	0	0	0	0	0	0	0	N/A

Station	Total images	Camera transect length (m)	Estimated area investigated (m^2)	Folk sediment classification	Number of burrows				Maximum density m^2	Size of burrows			Average size (cm)	Average SACFOR
					1 to 5	6 to 10	11+	Max Total		0 - 1	1.1 - 3	3 +		
ZOI13	49	277	223.81	Slightly gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ZOI14	53	243	189.34	Muddy sand	0	0	0	0	0	0	0	0	0	N/A
ZOI15	41	271	180.40	Muddy sand	NQ	NQ	NQ	16	0.09	NQ	NQ	NQ	2.0	R
ZOI16	61	1853	1377.79	Sand	0	0	0	0	0	0	0	0	0	N/A
ZOI17	48	1784	956.93	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ZOI18	55	428	255.37	Gravelly muddy sand	0	0	0	0	0	0	0	0	0	N/A
ZOI19	49	276	228.84	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ZOI20	44	222	176.01	Sand	0	0	0	0	0	0	0	0	0	N/A
ZOI21	54	308	257.51	Muddy sandy gravel	0	0	0	0	0	0	0	0	0	N/A
ZOI22	59	261	135.34	Sand	NQ	NQ	NQ	3	0.02	NQ	NQ	NQ	0.8	R
ZOI23	42	243	115.22	Gravelly muddy sand	0	0	0	0	0	0	0	0	0	N/A
ZOI24	56	341	246.05	Slightly gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ZOI25	61	275	201.60	Gravelly sand	0	0	0	0	0	0	0	0	0	N/A
ZOI26	48	214	2425.96	Sand	0	0	0	0	0	0	0	0	0	N/A

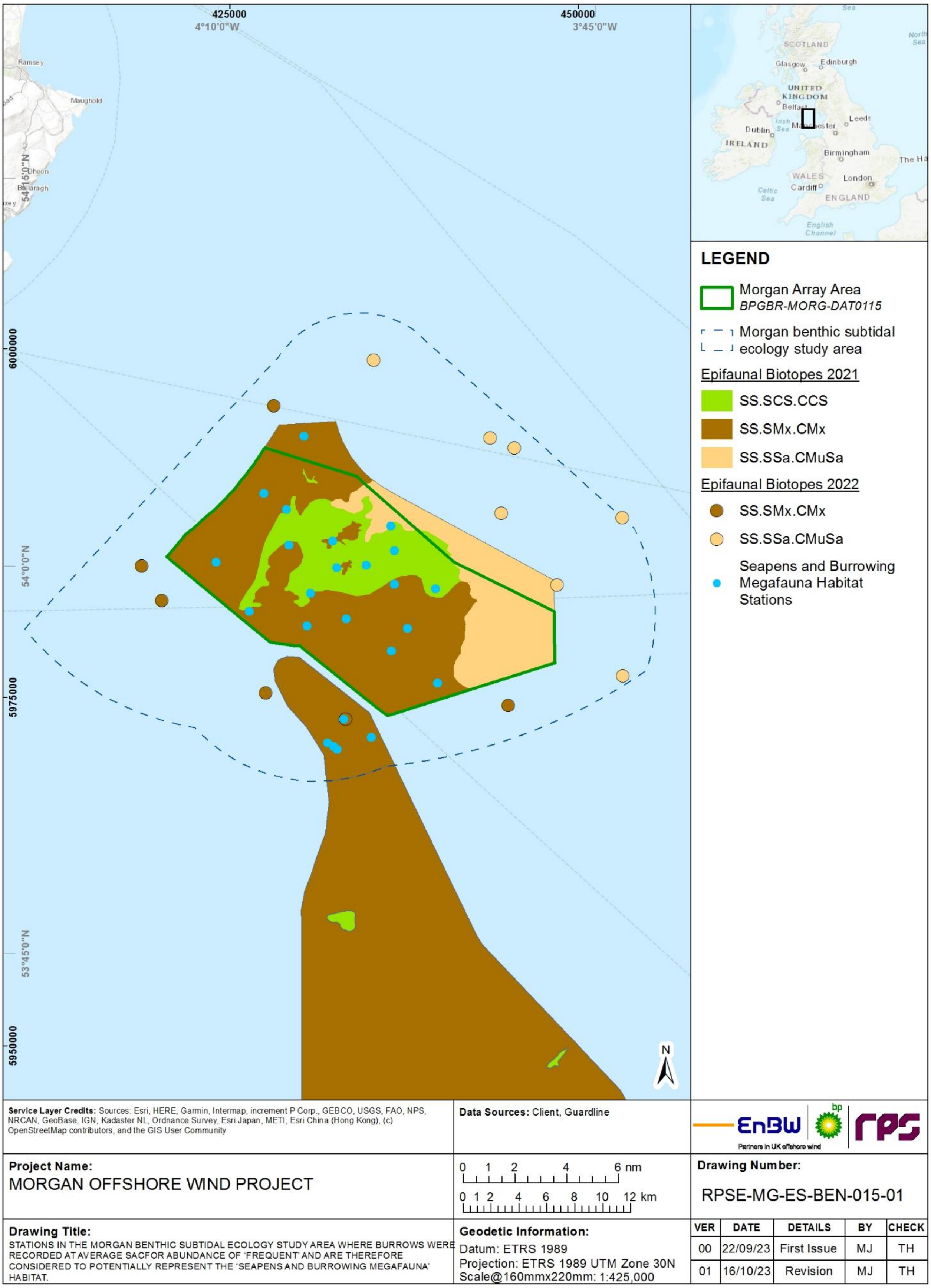


Figure 1.21: Stations in the Morgan benthic subtidal ecology study area where burrows were recorded at average SACFOR abundance of 'Frequent' and are therefore considered to potentially represent the 'seapens and burrowing megafauna' habitat.

Annex I stony reef assessment

1.7.5.8 Seabed imagery indicated potential stony reef at two sample stations (ENV76 and ENV79) in the south of the Morgan Array Area ZoI during the 2021 survey campaign (Figure 1.22 to Figure 1.24). As a result, a full Annex I stony reef assessment was undertaken for these two stations to determine if there was a resemblance to the protected habitat based on criteria set out by Irving (2009) and Golding *et al* (2020). Seabed imagery did not indicate any potential stony reefs within the Morgan Array Area during any of the site-specific surveys.

1.7.5.9 Low resemblance stony reef was recorded in 38 of the 105 images analysed at station ENV76 in the south of the Morgan Array Area ZoI (see Figure 1.22 and Figure 1.24). Station ENV76 occurred along a ridge feature which appeared to be composed of clusters of cobbles (Figure 1.22). The reef height ranged from 0.1 cm to 8.6 cm with the average reef height of 3.93 cm in images where cobbles were observed, and low resemblance reef was identified. The stony reef coverage ranged from 0.33% to 31.86% with an average coverage of 9.59% in images where reef features were observed, and low resemblance reef was identified. Stony reef associated epifauna at this station included *Nemertesia, Tubularia* and faunal turf. On the basis of the above, and in accordance with the Irving (2009) and Golding *et al*. (2020) guidance, the stony reef at ENV76 was considered to represent Annex I low resemblance stony reef (outside a designated site).

1.7.5.10 Low resemblance stony reef was recorded in 14 of the 77 images analysed at station ENV79 located in the south of the Morgan Array Area ZoI and one image was classified as medium resemblance stony reef (see Figure 1.23 and Figure 1.24). Station ENV79 included small, raised relief features in the bathymetry which corresponded with the increased density of cobbles and boulders observed in the imagery (Figure 1.23) but was predominantly composed of a sediment dominated matrix. The reef height ranged from 2.1 cm to 9.3 cm with the average reef height of 4.1 cm in images where reef features were observed, and low resemblance reef was identified. The stony reef coverage ranged from 0.34% to 41.27% with an average coverage of 10.96% in images where reef features were observed, and low resemblance reef was identified. Stony reef associated epifauna at this site included *Nemertesia, Tubularia,* faunal turf, *Metridium dianthus* and *Suberites*. On the basis of the above, and in accordance with the Irving (2009) and Golding *et al*. (2020) guidance, the stony reef at ENV79 was considered to represent Annex I low resemblance stony reef (outside a designated site).

1.7.5.11 No sample stations from the 2022 site specific survey campaign required an assessment for geogenic reef.

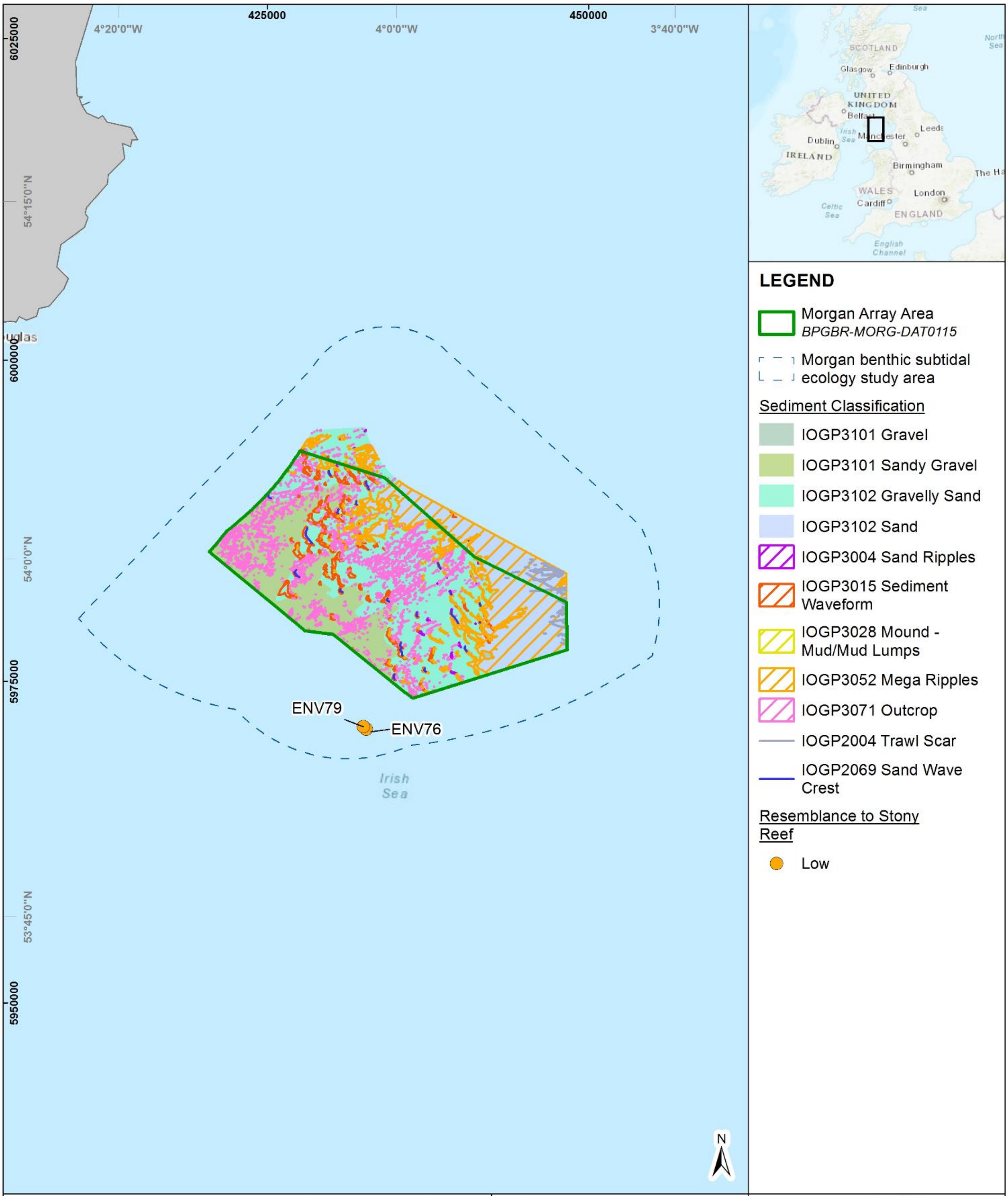
1.7.5.12 In conclusion the stony reef assessments which have been undertaken within the Morgan benthic subtidal ecology study area have been undertaken in accordance with the criteria as set out by Irving (2009) and Golding *et al.* (2020). These assessments have concluded that Annex I low resemblance stony reef was present at two stations within the Morgan Array Area ZoI.

Figure 1.22: Example of typical seabed at sample station ENV76 within the Morgan Array Area ZoI.

Figure 1.23: Example of typical seabed at sample station ENV79 within the Morgan Array Area ZoI.

Table 1.17: Annex I stony reef assessment summary for Morgan Array Area ZoI.

Station	Total Images	Camera Transect Length (m)	Area Investigated (m^2)	Number of Photos with Stony Features	Mean Stony Reef Cover (%)	Range of stony Reef Cover (%)	Range of Reef Height (cm)	Average Reef Height (cm)	Resemblance to Stony Reef	Associated Epifaunal Species	Comments
ENV76	105	274.2	245.9	38	9.59	0.33 to 31.86	0.1 to 8.6	3.93	Low	*Nemertesia, Tubularia* and faunal turf	Observations occurred along ridge features targeted by investigation which appeared to be aggregated clusters of cobbles.
ENV79	77	273.5	205.22	21	10.96	0.34 to 41.27	2.1 to 9.3	4.1	Low	*Nemertesia, Tubularia,* faunal turf, *Metridium dianthus* and *Suberites*	Small, raised relief features in the bathymetry corresponded with the increased density of cobbles and boulders.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client. Guardline

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 nm
0 2.5 5 10 km

Drawing Number:
RPSE-MG-ES-BEN-002-04

Drawing Title:
RESULTS OF THE STONY REEF ASSESSMENTS UNDERTAKEN WITHIN THE MORGAN SUBTIDAL ECOLOGY STUDY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:500,000

VER	DATE	DETAILS	BY	CHECK
00	09/08/23	First Issue	MJ	TH
04	09/04/24	Revision	LM	MK

Figure 1.24: Results of the stony reef assessments undertaken within the Morgan subtidal ecology study area (based on XOcean 2021 survey).

Fragile sponge and anthozoan communities on subtidal rocky habitats

1.7.5.13 Hard substrate Porifera were observed across the Morgan benthic subtidal ecology study area with 12 stations across the Morgan Array Area and five stations in the Morgan Array Area ZoI showing evidence of Porifera (see Table 1.18). This evidence comprised single/isolated images showing less than 3% of the image, often less than 1%, occupied by lone sponges such as cf. *Polymastia* sp., cf. *Suberites* sp. and cf. *Tethya* sp. Typical densities observed within the images was a sole individual most often found in coarser substrates.

1.7.5.14 At sample station 22ENV07 within the Morgan Array Area (Figure 1.25) 57 stills images were analysed and a sponge (*Suberites*) was recorded in one image at a percentage cover of 2.59% in that one image (Table 1.18). This was the greatest percentage of any image occupied by Porifera across all images analysed across the Morgan benthic subtidal ecology study area. The second highest percentage cover identified in a single image was from station ZOI25in the Morgan Array Area ZoI (Figure 1.26) where, out of 61 stills images analysed, sponges (*Suberites*) were recorded in 13 images and the maximum percentage cover was 1.73% in a single image and the average percentage cover from all images at this station was 0.18% (Table 1.18).

1.7.5.15 At all of the other stations where sponge was recorded in the Morgan benthic subtidal ecology study area, it was limited to a very small number of images at each of these stations (i.e. seven images or less, but typically only one or two). At sample station ZOI13 for example, seven images out of 49 images recorded evidence of hard substrate Porifera but the average percentage cover across the station was very low at <0.2%.

1.7.5.16 Although several of the sponge taxa present (including *P. johnstonia*, *Polymastia* sp., *Suberites* sp., *Raspailia ramosa* and *Tethya* sp.) and non-sponge species (e.g. *Nemertesia* sp. and *A. digitatum*) are listed within the fragile sponge and anthozoan communities on rocky habitats (JNCC, 2008; JNCC, 2014) they were only recorded at very low abundances and were therefore not considered to represent this habitat. On the basis of the above, the ‘fragile sponge and anthozoan communities on rocky habitat’ community was not considered to be present anywhere within the Morgan benthic subtidal ecology study area. The full results of the sponge habitat assessment (i.e. the per image assessment for stations subject to a fragile sponge and anthozoan communities on subtidal rocky habitats assessment) can be found in Appendix B.

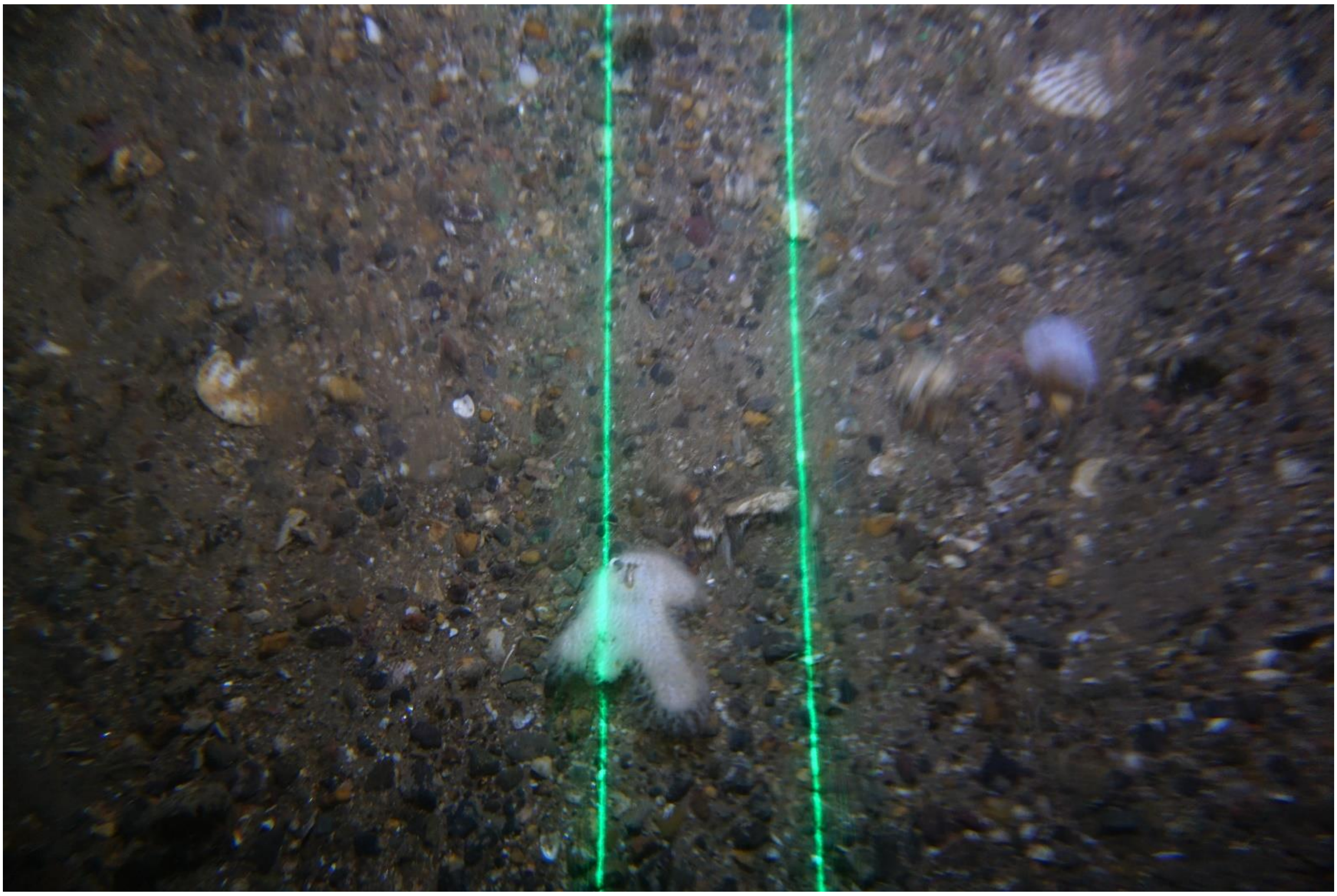


Figure 1.25: Example sponge occurrence at sample station 22ENV07 within the Morgan Array Area ZoI.

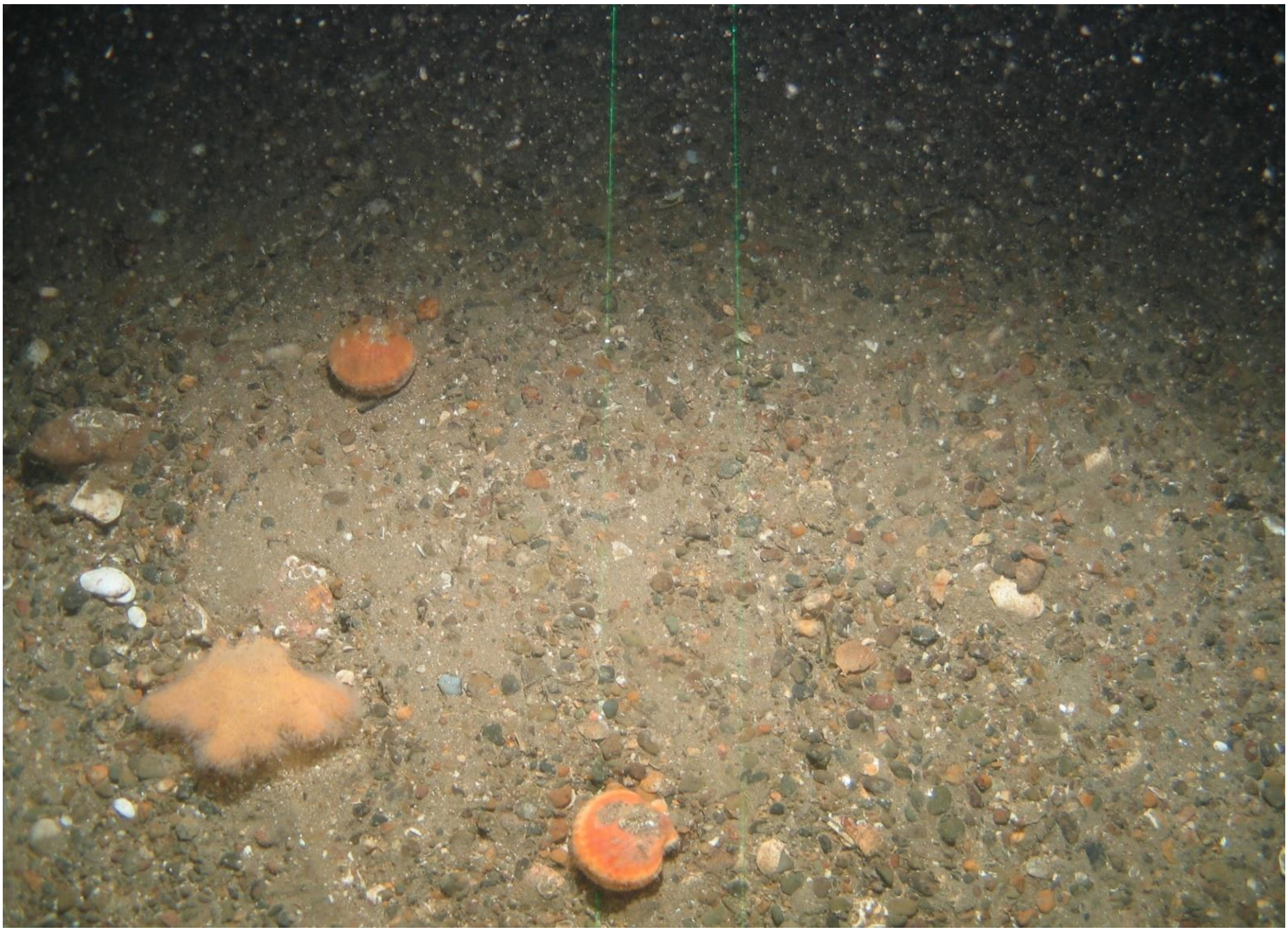


Figure 1.26: Example sponge occurrence at sample station ZOI25 within the Morgan Array Area ZoI.

Table 1.18: Summary of hard substrate Porifera coverage at stations within the Morgan benthic subtidal ecology study area.

Station	Number of Images Assessed with Visibility	Number of Images with Hard Substrate Porifera	Average % coverage of Hard Substrate Porifera	Max % of Hard Substrate Porifera
Morgan Array Area				
ENV02 (2021)	102	6	0.12	0.32
ENV02 (2022)	49	7	0.14	1.61
ENV03	77	0	NA	NA
ENV04	100	0	NA	NA
ENV05	84	1	0.21	0.21
ENV07	97	0	NA	NA
ENV08	104	0	NA	NA
ENV09 (2021)	94	1	0.06	0.06

Station	Number of Images Assessed with Visibility	Number of Images with Hard Substrate Porifera	Average % coverage of Hard Substrate Porifera	Max % of Hard Substrate Porifera
ENV09 (2022)	36	4	0.08	1.62
ENV10	90	0	NA	NA
ENV11 (2021)	109	0	NA	NA
ENV11 (2022)	49	1	0.01	0.30
ENV12	91	0	NA	NA
ENV13 (2021)	94	0	NA	NA
ENV13 (2022)	57	2	0.03	1.04
ENV14	93	1	0.55	0.55
ENV15	106	0	NA	NA
ENV17	95	0	NA	NA
ENV18	92	0	NA	NA
ENV19	81	0	NA	NA
ENV20	104	2	0.30	0.49
ENV22	95	0	NA	NA
ENV23	82	1	0.65	0.65
ENV23 (2022)	33	0	NA	NA
ENV24	95	0	NA	NA
ENV25	73	0	NA	NA
ENV26	83	0	NA	NA
ENV27	84	0	NA	NA
ENV28	99	0	NA	NA
ENV29	78	0	NA	NA
ENV72 (2021)	89	0	NA	NA
ENV72 (2022)	58	1	0.004	0.21
ENV73	143	0	NA	NA
ENV90	96	0	NA	NA
ENV91	91	0	NA	NA
ENV92	94	0	NA	NA
ENV93	93	0	NA	NA
22ENV06	48	5	0.08	1.20
22ENV07	57	1	0.04	2.59
22ENV09	49	0	NA	NA
22ENV10	48	1	0.03	1.23

Station	Number of Images Assessed with Visibility	Number of Images with Hard Substrate Porifera	Average % coverage of Hard Substrate Porifera	Max % of Hard Substrate Porifera
22ENV11	45	0	NA	NA
Morgan Array Area ZoI				
ENV01	126	0	NA	NA
ENV06	90	0	NA	NA
ENV16	91	0	NA	NA
ENV21	101	0	NA	NA
ENV30	94	0	NA	NA
ENV63 (2021)	84	0	NA	NA
ENV63 (2022)	48	5	0.09	1.45
ENV64	70	0	NA	NA
ENV65	75	0	NA	NA
ENV74	97	0	NA	NA
ENV76	105	0	NA	NA
ENV79	77	1	0.09	0.09
ENV94	85	0	NA	NA
22ENV05	56	3	0.06	2.20
22ENV12	42	0	NA	NA
ZOI14	53	0	NA	NA
ZOI15	41	0	NA	NA
ZOI16	61	0	NA	NA
ZOI18	55	0	NA	NA
ZOI19	49	0	NA	NA
ZOI20	44	0	NA	NA
ZOI21	54	0	NA	NA
ZOI22	59	0	NA	NA
ZOI23	42	0	NA	NA
ZOI24	56	6	0.09	1.29
ZOI25	61	13	0.18	1.73
ZOI26	48	0	NA	NA

1.7.6 Results - combined infaunal and epifaunal subtidal biotopes

1.7.6.1 Figure 1.27 presents the combined infaunal and epifaunal biotopes identified across the Morgan benthic subtidal ecology study area. The method of classifying combined, holistic biotope codes was informed by the preliminary infaunal and epifaunal biotopes, the characterising species for these biotopes (as highlighted by the SIMPER analysis) and environmental variables (e.g. sediment type and water depth) at each site. The quantitative benthic infaunal grab dataset was prioritised when combined the datasets, due to this being the most standardised dataset. The DDV footage, the results of the analysis of the epifaunal component of the grab data were then used to identify any subtle differences in epifaunal communities.

1.7.6.2 The combined biotope map shown in Figure 1.27 confirms many of the patterns described previously for the subtidal communities present in the Morgan benthic subtidal ecology study area when looking at the infaunal and epifaunal data separately. The results of the epifaunal overall supported the more refined classifications resulting from the infaunal analysis.

1.7.6.3 The infaunal and epifaunal biotopes have been combined to assign single biotopes across the Morgan benthic subtidal ecology study area (i.e. no biotope mosaics were mapped), due to the typically sparse epifaunal communities characterising these areas as well as due to the epifaunal biotopes corroborating what was found in the infaunal biotope analysis. Where DDV data only was taken, these infaunal biotopes have been taken as the final biotopes. To create the biotope maps for the Morgan benthic subtidal ecology study area the sample points were mapped over the geophysical data to ensure that the boundaries between biotopes were aligned with the natural transitions in sediment identified in the geophysical data as well as being mindful of features such as megaripples and sand ripples. The epifaunal data identified a large area of SS.SMx.CMx in the west and most of the south of the Morgan benthic subtidal ecology study area. This was mirrored and expanded upon in the infaunal biotopes which identified SS.SMx.OMx.PoVen across the area mapped from the epifauna as SS.SMx.CMx, with the infaunal communities providing greater insight allowing the identification of a more specific community.

1.7.6.4 Within the Morgan Array Area ZoI the infaunal data also identified an area of SS.SMx.CMx.OphMx at one sample location. The epifaunal analysis identified the SS.SCS.CCS biotope in the centre of the Morgan Array Area. This same biotope was identified in the infaunal analysis but also contained an area mapped as SS.SMx.OMx in the centre of this area. The majority of the east of the Morgan benthic subtidal ecology study area was identified by the epifaunal analysis as SS.SSa.CMuSa, which was further defined as SS.SMu.CSaMu.LkorPpel in the infaunal analysis, again showing the deeper level of classification provided by the infaunal analysis but supported by the epifaunal and sediment analysis. The area of SS.SMu.CSaMu.LkorPpel was interspersed with smaller areas of SS.SCS.CCS. In the north of the Morgan Array Area ZoI infaunal data indicated an area of SS.SSa.CFiSa.EpusOborApri which was assigned based on the greater context provided by infaunal analysis regarding species and sediment composition. In the east of the Morgan Array Area ZoI the communities changed from those typical of the SS.SSa.CMuSa biotope to those associated with the SS.SMu.CSaMu.AfilKurAnit biotope due to the identification of some key infaunal species.

1.7.6.5 In the area surveyed to the south of the Morgan Array Area, the epifaunal communities were predominantly characterised by the SS.SMx.CMx biotope. This provides support to the dominant infaunal biotopes recorded in the wider regional benthic subtidal ecology study area to the south of the Morgan Array Area which was SS.SMx.OMx.PoVen with additional small areas of SS.SMx.CMx.KurThyMx and SS.SMx.CMx. In addition to the sediment type and general community identified by the epifaunal analysis, the infaunal analysis yielded a more specific community allowing a more detailed level of classification. The epifaunal data in the in the wider regional benthic subtidal ecology study area located to the south of the Morgan Array Area also identified areas of SS.SCS.CCS. These were mirrored and expanded upon in the infaunal biotopes, with SS.SCS.CCS forming a band from east to west in the centre of the area corresponding to the wider regional benthic subtidal ecology study area to the south of the Morgan Array Area (i.e. within the Mona Array Area).

1.7.6.6 Based on the habitats assessment presented in section 1.7.5, the potential for the seapens and burrowing fauna habitat to be present across the Morgan benthic subtidal ecology study area was also identified (Figure 1.27). This assessment was primarily based on the abundance of burrows identifies in DDV imagery and is considered to be precautionary. The seapens and burrowing fauna habitat has, however, been mapped as an overlay over the Morgan Array Area and parts of the Morgan Array Area ZoI.

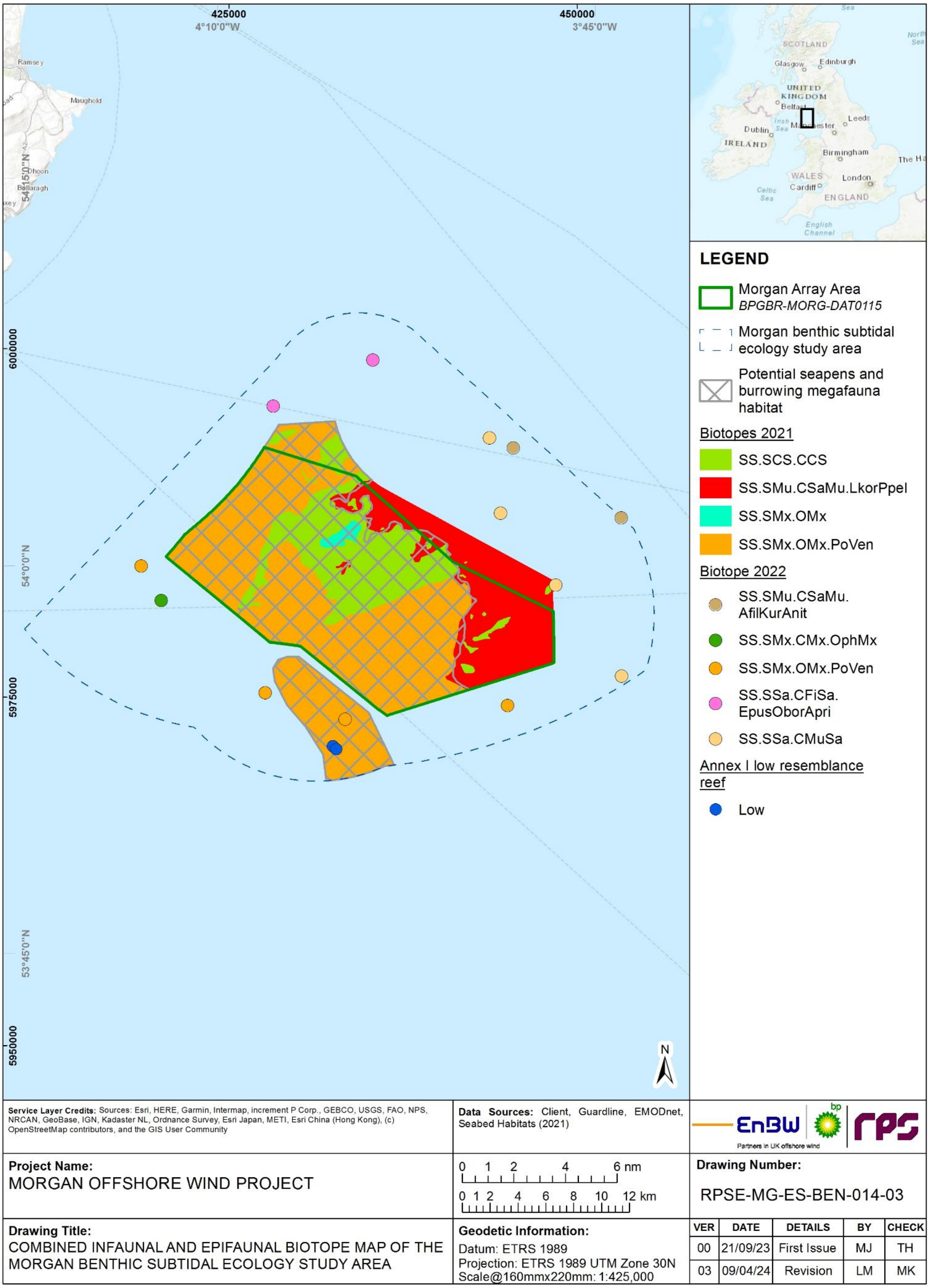


Figure 1.27: Combined infaunal and epifaunal biotope map of the Morgan benthic subtidal ecology study area (all biotope codes are defined in Appendix G).

1.8 Summary

1.8.1.1 The subtidal site-specific surveys consisted of infaunal grab samples and DDV surveys. Subtidal sediments recorded across the Morgan benthic subtidal ecology study area ranged from muddy sandy gravel to gravelly muddy sand with most samples classified as gravelly muddy sand in the Morgan Array Area and sand in the Morgan Array Area ZoI. In the Morgan benthic subtidal ecology study area sediments graded from coarser sediments in the west to finer sediments in the east. The Morgan Array Area was predominantly gravelly muddy sand interspersed with areas of muddy sandy gravel and gravelly sand. The Morgan Array Area ZoI was composed of a wide variety of sediment types all of which were dominated by sand with varying proportions of fines and gravels. This aligned with the desktop data which indicated coarse sediments, sand and mixed sediments across the Morgan benthic subtidal ecology study area (EMODnet, 2019).

1.8.1.2 A total of 24 sediment samples from across the Morgan benthic subtidal ecology study area were analysed for sediment chemistry. Overall, levels of contamination were low across the Morgan benthic subtidal ecology study area. Concentrations of most metals were below the Cefas AL1 and the Canadian TEL and all were below the Cefas AL2 and Canadian PEL. The exception was arsenic which exceeded Cefas AL1 at three sample stations however all were below Cefas AL2, and 17 sample stations exceeded Canadian TEL but were below Canadian PEL. No samples were found to exceed the relevant thresholds for PCBs or PAHs in the Morgan benthic subtidal ecology study area. Concentrations of organotins where below the LOD at all stations.

1.8.1.3 The site-specific survey data showed that the benthic communities in the west and south sections of the Morgan benthic subtidal ecology study area were characterised by the polychaete-rich deep Venus community in offshore mixed sediments (SS.SMx.OMx.PoVen) biotope. Additionally in the west, in the Morgan Array Area ZoI, a single station was assigned to the *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (SS.SMx.CMx.OphMx) biotope. The centre of the Morgan Array Area was characterised by circalittoral coarse sediment (SS.SCS.CCS) with a small area characterised by offshore circalittoral mixed sediment (SS.SMx.OMx). The east and most of the north edge of the Morgan Array Area were characterised by muddier sediments and the *Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud (SS.SMu.CSaMu.LkorPpel) biotope. Further east in the Morgan Array Area ZoI a broader circalittoral muddy sand biotope was prevalent (SS.SSa.CMuSa) which graded into communities characterised by the *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud (SS.SMu.CSaMu.AfilKurAnit) biotope at the east edge of the Morgan Array Area ZoI. The habitats and communities in the north of the Morgan Array Area ZoI were characterised by the *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (SS.SSa.CFiSa.EpusOborApri) biotope.

1.8.1.4 The habitat assessment concluded that 24 stations distributed across the Morgan Array Area and the south of the Morgan Array Area ZoI had a negligible resemblance to the ‘seapens and burrowing megafauna communities’ habitat on the basis of the presence of ‘frequent’ burrows on the SACFOR scale. Whilst seapens were not recorded during the site-specific surveys, and whilst the sediment types at these stations was predominantly gravelly muddy sand (and so unlikely to be consistent with this habitat), it was not possible to determine the species which had formed the burrows. Therefore, in order to adopt a precautionary approach, the ‘seapens and burrowing megafauna communities' habitat has been assumed to be potentially present within the Morgan benthic subtidal ecology study area.

1.8.1.5 Annex I stony reef assessments identified two stations which were classified as Annex I low resemblance stony reef in the south of the Morgan Array Area ZoI. No areas of stony reef were identified in the Morgan Array Area. An assessment for sponge dominated habitat was also undertaken but no stations were found to represent the fragile sponge and anthozoan communities on subtidal rocky habitat.

1.8.2 Important ecological features

1.8.2.1 In accordance with the best practice guidelines (CIEEM, 2019), for the purposes of the benthic subtidal ecology EIA, IEFs have been identified and all potential impacts of the Morgan Generation Assets will be assessed against the IEFs to determine whether or not they are significant. The IEFs of an area are those that are considered to be important and potentially affected by the Morgan Generation Assets (Table 1.19). Importance may be assigned due to quality or extent of habitats, habitat or species rarity or the extent to which they are threatened (CIEEM, 2019). Species and habitats are considered IEFs if they have a specific biodiversity importance recognised through international or national legislation or through local, regional or national conservation plans (e.g. Annex I habitats under the Habitats Directive, OSPAR, National Biodiversity Plan or the Marine Strategy Framework Directive).

1.8.2.2 The biotopes present across the Morgan benthic subtidal ecology study area have been grouped into broad habitat/community types. The identified IEFs will be taken forward for assessment within the benthic subtidal ecology EIA Report (Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement) and used to assess impacts associated with the construction, operations and maintenance and decommissioning of the Morgan Generation Assets on benthic subtidal ecology.

Table 1.19: IEFs within the regional benthic subtidal ecology study area.

IEF	Description and representative biotopes	Protection status/ Conservation interest	Location	Importance within the regional benthic subtidal ecology study area
Subtidal habitats				
Subtidal sand and muddy sand sediments with benthic communities dominated by *Lagis koreni* and other polychaetes.	Sand and muddy sand, characterised by tube building polychaete *Lagis koreni*, and other polychaetes such as *Mediomastus fragilis* and *Spiophanes bombyx*, as well as bivalves and arthropods. • SS.SSa.CMuSa • SS.SMu.CSaMu.AfilKurAnit • SS.SMu.CSaMu.LkorPpel • SS.SSa.CFiSa.EpusOborApri.	UK BAP priority habitat Habitat of Principal Importance in England (NERC Act 2006)	In the west of the Morgan benthic subtidal ecology study area (i.e. within the Morgan Generation Assets Red Line Boundary)	National
Subtidal coarse and mixed sediments	Subtidal coarse and mixed sediments characterised by	UK BAP priority habitat	Centre and east of the Morgan benthic subtidal ecology	National

IEF	Description and representative biotopes	Protection status/ Conservation interest	Location	Importance within the regional benthic subtidal ecology study area
with diverse benthic communities	polychaetes, bivalves and mobile crustaceans. • SS.SCS.CCS • SS.SMx.OMx • SS.SMx.OMx.PoVen.	Habitat of Principal Importance in England (NERC Act 2006)	study area (i.e. within the Morgan Generation Assets Red Line Boundary)	
Brittlestar beds	Subtidal mixed sediment dominated by brittlestars which form dense beds. • SS.SMx.CMx.OphMx.	UK BAP priority habitat Habitat of Principal Importance in England (NERC Act 2006)	Southwest of the Morgan Array Area ZoI (i.e. outside the Morgan Generation Assets Red Line Boundary)	National
Annex I low resemblance stony reef (outside an SAC)	Cobbles and boulders with indicator species such as *A. digitatum*, *Nemertesia* sp. and *Tubularia* sp. • CR.HCR.XFa.SpNemAdia.	Annex I habitat outside an SAC	South of the Morgan Array Area ZoI (i.e. outside the Morgan Generation Assets Red Line Boundary)	National
Seapens and burrowing megafauna communities	Plains of fine mud at depths greater than about 15 m may be heavily bioturbated by burrowing megafauna. • SS.SMu.CFiMu.SpnMeg.	UK BAP priority habitat OSPAR habitat Habitat of Principal Importance in England (NERC Act 2006)	Morgan Array Area and south of Morgan Array Area ZoI (i.e. within the Morgan Generation Assets Red Line Boundary)	National
West of Walney MCZ				
Subtidal mud	Muds and sandy muds in extremely sheltered areas with very weak tidal currents. High numbers of polychaetes, bivalve and echinoderms such as urchins and brittle stars. • SS.SMu.CSaMu.AfilKurAnit.	UK BAP priority habitat Protected feature of an MCZ Habitat of Principal Importance in England (NERC Act 2006)	Within wider regional benthic subtidal ecology study area (i.e. outside the Morgan Generation Assets Red Line Boundary)	National
Subtidal sand	Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit • SS.SMx.CMx.KurThyMx.	UK BAP priority habitat Habitat of Principal Importance in England (NERC Act 2006)Protected feature of an MCZ	Within wider regional benthic subtidal ecology study area (i.e. outside the Morgan Generation Assets Red Line Boundary)	National
Sea-pens and burrowing	Fine mud heavily bioturbated by burrowing megafauna; burrows and mounds may form a prominent feature with	OSPAR habitat Habitat of Principal Importance in	Within wider regional benthic subtidal ecology study area (i.e.	National

IEF	Description and representative biotopes	Protection status/ Conservation interest	Location	Importance within the regional benthic subtidal ecology study area
megafauna communities	conspicuous populations of sea pens, typically *Virgularia mirabilis* and *Pennatula phosphorea*. • SS.SMu.CFiMu.SpnMeg.	England (NERC Act 2006) Protected feature of an MCZ	outside the Morgan Generation Assets Red Line Boundary)	
West of Copeland MCZ				
Subtidal coarse sediment	Coarse sand and gravel or shell fragments. Largely characterised by infaunal communities include bristleworms, sand mason worms, burrowing anemones and bivalves. • SS.SCS.CCS.	UK BAP priority habitat Protected feature of an MCZ	Within wider regional benthic subtidal ecology study area (i.e. outside the Morgan Generation Assets Red Line Boundary)	National
Subtidal mixed sediment	A range of different types of sediments. Animals found here include worms, bivalves, starfish and urchins, anemones, sea firs and sea mats. • SS.SMx.OMx • SS.SMx.OMx.PoVen.	Protected feature of an MCZ Habitat of Principal Importance in England (NERC Act 2006)	Within wider regional benthic subtidal ecology study area (i.e. outside the Morgan Generation Assets Red Line Boundary)	National
Subtidal sand	Sand seascapes with infaunal polychaetes and bivalves. • SS.SMu.CSaMu.AfilKurAnit.	UK BAP priority habitat Habitat of Principal Importance in England (NERC Act 2006) Protected feature of an MCZ	Within wider regional benthic subtidal ecology study area (i.e. outside the Morgan Generation Assets Red Line Boundary)	National

1.9 References

Allison, S.D. and Martiny, J.B.H., 2008. Resistance, resilience, and redundancy in microbial communities. Proceedings of the National Academy of Sciences of the United States of America, 12 August. pp.11512-19.

Alzieu, C., Heral, M., Thibaud, Y., Dardignac, M., and Feuillet, M. (1982). Influence des peintures antisalissures a base d'organostanniques sur la calcification de la coquille de l'huitre Crassostrea gigas. Revue des Travaux de l'Institut des pêches maritimes. 45, pp 101–116.

Barnes, M.K.S. (2008) *Nephasoma* (*Nephasoma*) *minutum* A peanut worm. In Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 21-09-2023]. Available [redacted]

Camacho-Ibar, V.F., Wrench, J.J., and Head, P.C. (1992) *Contrasting behaviour of arsenic and mercury in Liverpool Bay sediments, Estuarine, Coastal and Shelf Science*, Volume 34, Issue 1, Pages 23-36, ISSN 0272-7714.

CCME (2001) Canadian environmental quality guidelines for the protection of aquatic life, CCME water quality index: technical report, 1.0.

Cefas, 1994. Use of Action Levels in Dredged Material Assessments. Available at: https://webarchive.nationalarchives.gov.uk/20140305115044/http:/cefas.defra.gov.uk/media/562541/cefas%20action%20levels.pdf, Accessed September 2023.

Cefas (2005) A Review of the Contaminant Status of the Irish Sea, Available at: untitled (publishing.service.gov.uk), Accessed September 2023.

Celtic Array Ltd. (2014) *Preliminary Environmental Information Chapter 9 Benthic Ecology*, Accessed on: 08 March 2022.

Centrica Plc and Dong Energy Ltd (2014) Stage 2 Preliminary Environmental Information Chapter 9 Benthic Ecology, Available at: [redacted]

CIEEM (2019) Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater, Coastal and Marine, Version 1.1 – Updated September 2019.

Clark, PF (1986) North-east Atlantic crabs: an atlas of distribution. Marine Conservation Society, Ross-on-Wye, 252 pp.

Clarke R. and Gorley R.N. (2006) PRIMER version 6: user manual/tutorial. PRIMER-E, Plymouth, UK, p192.

Clarke, K.R. and Warwick, R.M. (2001) Change in Marine Communities: An Approach to Statistical Analysis and Interpretation. Second Edition, PRIMER-E, Plymouth.

CMACS (2005a) *Burbo Banks Offshore Wind Farm Pre-construction Contaminants Investigation*.

CMACS (2005b) *Gwynt y Môr offshore wind farm Marine Benthic Characterisation Survey*. A report to NPower renewables (Gwynt y Môr offshore wind farm Environmental Impact Assessment).

CMACS (2009) *Walney and Ormonde Offshore Windfarm Benthic Survey Report.*

CMACS (2011) *Gwynt y Môr Offshore Wind Farm baseline pre-construction benthic survey report (2010 survey)*. Report to Gwynt y Môr OWF Ltd. July 2011.

CMACS (2012a) *Ormonde Offshore Wind Farm Year 1 post-construction benthic monitoring technical survey report (2012 survey).* Report to RPS Energy.

CMACS (2012b) *Walney Offshore Wind Farm Year 1 postconstruction benthic monitoring technical survey report (2012 survey).* Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy. July 2012.

CMACS (2012c) *Walney Offshore Wind Farm November Post-Construction Survey*. Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy. November 2012.

CMACS (2013) *Walney Offshore Wind Farm Year 1 postconstruction benthic monitoring technical survey report (2013 survey).* Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy.

CMACS (2014) *Walney Offshore Wind Farm Year 3 postconstruction benthic monitoring technical survey report (2014 survey).* Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy.

CMACS (2015) *Benthic and Annex I Habitat Pre-construction Survey Field Report*, Report to Burbo Bank Offshore Wind Farms (UK) Ltd/DONG Energy.

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. and Reker, J.B. (2004) The Marine Habitat Classification for Britain and Ireland. Version 04.05, JNCC, Peterborough.

Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F, and Sanderson, W.G. (1997) *Marine biotope classification for Britain and Ireland*. Vol 2. Sublittoral biotopes. Version 97.06. JNCC Report No 230. Joint Nature Conservation Committee, Peterborough.

Countryside Council for Wales (CCW) (2002) SITE OF SPECIAL SCIENTIFIC INTEREST CITATION CONWY CREIGIAU RHIWLEDYN/LITTLE ORMES HEAD, Available at [redacted]

Countryside Council for Wales (CCW) (2003) SITE OF SPECIAL SCIENTIFIC INTEREST CITATION CONWY ABER AFON CONWY, Available at [redacted] Accessed September 2023.

Countryside Council for Wales (CCW) (2004) '*Phase I- Intertidal Survey- Standard Report*', 11.55.2 Arfon Clwyd to Llanddulas.

Countryside Council for Wales (CCW) (2013) Great Ormes Head - Pen Y Gogarth ACA management plan, Available at [redacted].pdf, Accessed September 2023.

Welsh Government (2023) DataMapWales, Available at: https://datamap.gov.wales/, Accessed September 2023.

Davison D.M. and Hughes D. J. (1998) Zostera Biotopes (volume I). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project). 95pp.

De-Bastos and Hill (2016) *Amphiura filiformis, Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 11-04-2023].[redacted]

DEFA (2022a) Langness Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376789/langness-mnr-guide.pdf, Accessed September 2023.

DEFA (2022b) Little Ness Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376793/little-ness-mnr-guide.pdf, Accessed September 2023.

DEFA (2022c) Douglas Bay Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1366090/douglas-bay-guide.pdf, Accessed September 2023.

DEFA (2022d) Laxey Bay Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376791/laxey-bay-mnr-guide.pdf, Accessed September 2023.

DEFA (2022e) Ramsey Bay Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376799/ramsey-bay-mnr-guide.pdf, Accessed September 2023.

DEFA (2022f) Baie y Carrickey Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376783/baie-ny-carrickey-mnr-guide.pdf, Accessed September 2023.

DEFA (2022g) Calf of Man and Wart Bank Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376785/calf-wart-bank-mnr-guide.pdf, Accessed September 2023.

DEFA (2022h) Niarbyl Bay Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376796/niarbyl-bay-mnr-spotter-sheet.pdf, Accessed September 2023.

DEFA (2022i) Port Erin Bay Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376797/port-erin-bay-mnr-guide.pdf, Accessed September 2023.

DEFA (2022j) West Coast Marine Nature Reserve Guide, Available at: https://www.gov.im/media/1376801/west-coast-mnr-guide.pdf, Accessed September 2023.

Defra (2013) *Fylde Marine Conservation Zone Fact Sheet*. Available at: Marine conservation zone 2013 designation: Fylde - GOV.UK (www.gov.uk), Accessed September 2023.

Defra (2016a) West of Walney Marine Conservation Zone – Factsheet, A Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492471/mcz-west-walney-factsheet.pdf, Accessed September 2023.

Defra (2016b) Allonby Bay Marine Conservation Zone, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492326/mcz-allonby-bay-factsheet.pdf, Accessed September 2023.

Defra (2019a) West of Copeland Marine Conservation Zone – Factsheet, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915435/mcz-west-copeland-2019.pdf, Accessed September 2023.

Defra (2019b) Cumbria Coast Marine Conservation Zone, Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915627/mcz-cumbria-2019.pdf, Accessed September 2023.

DNV (2013). Monitoring of drilling activities in areas with presence of cold-water corals. [pdf] Norske Olie Og Gas (01).

Dong Energy Ltd (2013a) *Environmental Statement Volume 2 – Chapter 12: Subtidal and Intertidal Benthic Ecology*, Report to Burbo Bank Extension Offshore Wind Farms (UK) Ltd/DONG Energy.

Dong Energy Ltd (2013b) *Volume 1 Environmental Statement Walney Extension, Chapter 10: Benthic Ecology*, Report to Walney Offshore Wind Farms (UK) Ltd/DONG Energy.

Environment Agency (2015) Fylde MCZ Environment Agency Baseline survey PSA analysis 2015: Environment Agency (EA).

Envision Mapping Ltd. (2015) Shell Flat and Lune Deep Sensitive Special Area of Conservation & Fylde Marine Conservation Zone Interpretation and Mapping 2015, Available at: [redacted], Accessed September 2023.

European Marine Observation Data Network (EMODnet) (2019) Seabed Habitats Initiative. Financed by the European Union under Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund. Available at: [redacted] Accessed September 2023.

Folk, R.L. (1954) The distinction between grain size and mineral composition in sedimentary rock nomenclature. Journal of Geology, 62, 344-59.

Folk, R.L. and Ward, W.C. (1957) Brazos river bar: a study of the significance of grain size parameters. Journal of Sedimentary Petrology, 27, 3-26.

Frühe, L., Dully, V., Forster, D., Keeley, N.B., Laroche, O., Pochon, X., Robinson, S., Wilding, T.A. and Thorsten, S., (2021) Global Trends of Benthic Bacterial Diversity and Community Composition Along Organic Enrichment Gradients of Salmon Farms.

Golding, N., Albrecht, J. and McBreen, F. (2020) Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef. JNCC Report No. 656.

Gubbay, S. (2007) *Defining and Managing Sabellaria spinulosa Reefs*; Report of an interagency workshop. JNCC report No.405.

Henry, L.A. and Roberts, J.M. (2014) Applying the OSPAR habitat definition of deep-sea sponge aggregations to verify suspected records of the habitat in UK Waters. JNCC Report No. 508.

Holt, T.J., Shalla, S.H.A., and Brand, A.R. (1997) *Broadscale seabed survey to the east of the Isle of Man.* A report to British Petroleum, Exploration Team.

Horton, D.J., Theis, K.R., Uzarski, D.G. and Learman, D.R., 2019. Microbial community structure and microbial networks correspond to nutrient gradients within coastal wetlands of the Laurentian Great Lakes. FEMS Microbiology Ecology, 95(4).

Howe, V.L. (2018a) *Subtidal Ecology. In: Manx Marine Environmental Assessment (2nd Ed).* Isle of Man Government. pp 48.

Howe, V.L. (2018b) *Coastal Ecology. In: Manx Marine Environmental Assessment (2nd Ed).* Isle of Man Government. pp 24.

Hughes, D.J. (1998a) *Subtidal brittlestar beds (volume IV). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project). 78 Pages.

Hughes, D. J. (1998b). Sea pens and burrowing megafauna (Volume III). An overview of dynamics and sensitivity characteristics for conservation management of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project): Scottish Association for Marine Science (SAMS).

ICES (2011) Protocols for Assessing the Status of Sea-pen and Burrowing Megafauna Communities. Available at: [redacted].

Innogy (2002) North Hoyle offshore windfarm environmental statement, 2002. Innogy NWP offshore Ltd.

Irving, R. (2009) *The identification of the main characteristics of stony reef habitats under the Habitats Directive.* Summary report of an inter-agency workshop 26-27 March 2008.

Jenkins, C., Eggleton, J., Albrecht, J., Barry, J., Duncan, G., Golding, N. and O'Connor, J. (2015) North Norfolk Sandbank and Saturn Reef cSAC/SCI Management Investigation Report. JNCC/Cefas Partnership Report Series No. 7, JNCC, Peterborough, ISSN 2051-6711.

JNCC (2008) *UK BAP Priority Habitat Descriptions (Sublittoral Rock) (2008).* Available at: https://hub.jncc.gov.uk/assets/0a9b6b43-4827-44a4-ab06-0f94d5ad6b93, Accessed September 2023.

JNCC (2013) *SACFOR abundance scale used for both littoral and sublittoral taxa from 1990 onwards.* Available at: https://mhc.jncc.gov.uk/media/1009/sacfor.pdf, Accessed September 2023.

JNCC (2014) *Monitoring, assessment and reporting of UK benthic habitats: A rationalised list.* Available at: https://hub.jncc.gov.uk/assets/fb82e7cc-8ee2-494b-8af7-2360d809dee9, Accessed September 2023.

JNCC (2015) *The Marine Habitat Classification for Britain and Ireland Version 22.04.* Available at: https://mhc.jncc.gov.uk/. Accessed September 2023.

JNCC (2018). West of Walney MPA. Available at: https://jncc.gov.uk/our-work/west-of-walney-mpa/#activities-and-management, Accessed September 2023.

JNCC (2022a) Morecambe Bay SAC, Available at: https://sac.jncc.gov.uk/site/UK0013027, Accessed September 2023.

JNCC (2022b) Y Fenai a Bae Conwy/ Menai Strait and Conwy Bay SAC, Available at: https://sac.jncc.gov.uk/site/UK0030202, Accessed September 2023.

JNCC (2022c) Luce Bay and Sands SAC, Available at: https://sac.jncc.gov.uk/site/UK0013039, Accessed September 2023.

JNCC (2022d) Aber Dyfrdwy / Dee Estuary SAC, Available at: https://sac.jncc.gov.uk/site/UK0030131, Accessed September 2023.

JNCC (2022e) Solway Firth SAC, Available at: https://sac.jncc.gov.uk/site/UK0013025, Accessed September 2023.

Jones LA, Irving R, Cork M, Coyle MD, Evans D Gilliland PM & Murray AR (2004a). South Western Peninsula Marine Natural Area Profile: A contribution to regional planning and management of the seas around England. English Nature, Peterborough, UK, 109pp.

Jones LA, Irving R, Coyle MD, Evans D, Gilliland, PM & Murray AR (2004b). Western Approaches Marine Natural Area Profile: A contribution to regional planning and management of the seas around England. English Nature, Peterborough, UK, 76pp.

Jones LA, Coyle MD, Evans D, Gilliland PM & Murray AR (2004c). Southern North Sea Marine Natural Area Profile: A contribution to regional planning and management of the seas around England. English Nature, Peterborough, UK, 102pp.

Jones LA, Coyle MD, Gilliland PM, Larwood JG & Murray AR (2004d). Irish Sea Marine Natural Area Profile: A contribution to regional planning and management of the seas around England. English Nature, Peterborough, UK, 101pp.

Jones LA, Davies H, Coyle MD, Evans D, Gilliland PM, Irving R & Murray AR (2004e). Mid North Sea Marine Natural Area Profile: A contribution to regional planning and management of the seas around England. English Nature, Peterborough, UK.

Jones LA, Irving R, Cosgrove ARP, Coyle MD, Gilliland PM & Murray AR (2004f). Eastern Channel Marine Natural Area Profile: A contribution to regional planning and management of the seas around England. English Nature, Peterborough, UK, 106pp.

Kaiser, M.J., Galanidi, M., Showler, D.A., Elliott, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A., Sutherland, W.J. (2006) Distribution and behaviour of Common Scoter Melanitta nigra relative to prey resources and environmental parameters. Ibis 148, pp 110-128.

Leah, R.T., Collings, S.E., Johnson, M.S. and Evans, S.J. (1993) *Mercury in plaice (Pleuronectes platessa) from the sludge disposal ground of Liverpool Bay*. Marine Pollution Bulletin, 26 (8), pp 436 – 439.

Limpenny, D.S., Foster-Smith, R.L., Edwards, T.M., Hendrick, V.J., Diesing, M., Eggleton, J.D., Meadows, W.J., Crutchfield, Z., Pfeifer, S. and Reach, I.S. (2010) *Best methods for identifying and evaluating Sabellaria spinulosa and cobble reef.* Accessed September 2023.

Long (2006) *BGS detailed explanation of seabed sediment modified Folk classification*. Available from: https://webarchive.nationalarchives.gov.uk/20101014090013/[redacted].

Mackie, A.S.Y. (1990) *Offshore benthic communities of the Irish Sea*. In The Irish Sea: an environmental review. Part 1. Nature conservation, ed. Irish Sea Study Group, Liverpool University Press, pp 169 – 218.

MarLIN (2015) Habitats listed as Features of Conservation Interest. Available at: https://www.marlin.ac.uk/habitats/hoc, Accessed September 2023.

Mason, C. (2016) NMBAQC's Best Practice Guidance Particle Size Analysis (PSA) for Supporting Biological Analysis. Available at: [redacted]

MESH (2005). North Western Shelf Consortium survey. Mapping European Seabed Habitats.

MESH (2006). North Western Shelf Consortium survey. Mapping European Seabed Habitats.

MESH (2008). The MESH Blue Book. A summary of achievements of the MESH Project. ISBN-13: 978 1 86107 602 1.

Miller, C., and Green, B. (2017). Fylde Marine Conservation Zones Baseline Survey Report 2015. Environment Agency, Natural England.

Mitchell, P., McIlwaine, P., Arosio, R., Hogg, O. and Clare, D. (2023) West of Walney Marine Conservation Zone Monitoring Report 2018. NERC464. Natural England.

MMEA (2018) Manx Marine Environmental Assessment: Ecology/Biodiversity- Subtidal Ecology, Available at: DRAFT_Subtidal.Ecology_v3_27072012_finalisingLH (gov.im), Accessed September 2023.

Mona Offshore Wind Ltd. (2024) Mona Offshore Wind Project. Environmental Statement. Volume 6, Annex 2.1: Benthic subtidal and intertidal ecology technical report.

Moore, J. (2002) *An atlas of marine biodiversity action plan species and habitats and species of conservation concern in Wales*. 2nd Edition. CCW contract science report no 509.

Morecambe Offshore Windfarm (2023) Preliminary Environmental Information Report, Volume 1, Chapter 9 Benthic Ecology, Accessed June 2023, Available at FLO-MOR-REP-0006-09 Chapter 9 Benthic Ecology.pdf, Accessed September 2023.

Morecambe Offshore Windfarm Ltd and Morgan Offshore Wind Ltd (2023) Preliminary Environmental Information Report, Volume 1, Chapter 2: Benthic subtidal and intertidal ecology. Available https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN020032/EN020032-000032-EN020028%20-%20Scoping%20Report.pdf. Accessed September 2023.

National Biodiversity Network (2023) National Biodiversity Network Atlas, Available at: https://nbnatlas.org/, Accessed September 2023.

Natural England (2012) *Shell Flat & Lune Deep candidate Special Area of Conservation - Formal advice under Regulation 35(3) of The Conservation of Habitats and Species Regulations 2010*, Available at: h[redacted]Accessed September 2023.

Natural England (2015) *Ribble Estuary SSSI / Ribble & Alt SPA Intertidal sediments condition monitoring*. Available at: [redacted]3.

Natural England (2016a) Fylde Marine Conservation Zone Fact Sheet, Available at: [redacted]

Natural England (2008) Ribble Estuary SSSI – Salters Bank Unit 010. Available at: [redacted]

Natural Resources Wales (2018) Y Fenai a Bae Conwy / Menai Strait and Conwy Bay Special Area of Conservation, Indicative site level feature condition assessments 2018, Available at [redacted]

Neff, J.M. (2004). Bioaccumulation in Marine Organisms: Effect of Contaminants from Oil Well.

Okoro, H.K., Fatoki, O.S., Adekola, F.A., Ximba, B.J., Snyman, R.G. (2014) Organotin Compounds, Editor(s): Philip Wexler, Encyclopedia of Toxicology (Third Edition), Academic Press, pp. 720-

725,ISBN 9780123864550, Available at: [redacted]

Parry, M.E.V. (2019) Guidance on Assigning Benthic Biotopes using EUNIS or the Marine Habitat Classification of Britain and Ireland (Revised 2019). JNCC Report No. 546. ISSN 0963-8091. Peterborough, UK: JNCC.

Ramsar (2012) Information Sheet on Ramsar Wetlands(RIS) 2009-2012 version: The Dee Estuary, Available at: [redacted] October 2023.

Rees, E.I.S., Walker, A.J.M., and Ward, A.R. (1972) *Benthic fauna in relation to sludge disposal. In Out of Sight: Out of mind. Report of a working party on the disposal of sludge in Liverpool Bay,* Volume 2: Appendices. Department of the Environment, London, pp 229 – 343.

Rees, E.I.S (2001) *Habitat specialization by Thia scutellata (Decapoda: Brachyura) off Wales*. Journal of the marine Biological Association of the United Kingdom. 81, pp 697-698. Accessed on: 09 March 2022.

Robson, L. (2014) JNCC clarifications on the habitat definitions of two habitat Features of Conservation Importance: Mud habitats in deep water, and Sea-pen and burrowing megafauna communities.

Rowlatt, S. M. and Lovell, D. R. (1994) *Lead, zinc and chromium in sediment around England and Wales*. Marine Pollution Bulletin. 28:828-830.

RWE (2022) Awel y Môr Environmental Impact Assessment, Volume 2, Chapter 5: Benthic Subtidal and Intertidal Ecology, Available at https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010112/EN010112-000191-6.2.5_AyM_ES_Volume2_Chapter5_Benthic_Ecology_vFinal.pdf, Accessed October 2023.

Department for Energy Security and Net Zero, Offshore Petroleum Regulator for Environment and Decommissioning, and Department for Business, Energy & Industrial Strategy (2023) Offshore Energy Strategic Environmental Assessment (SEA): An overview of the SEA process, Available at: https://www.gov.uk/guidance/offshore-energy-strategic-environmental-assessment-sea-an-overview-of-the-sea-process, Accessed September 2023.

Seascape Energy Ltd. (2002) Burbo offshore wind farm Environmental Statement. 324pp.

SeaScape Energy (2011) *Burbo offshore wind farm, third post-construction benthic grab survey report (2009 survey)*. Report prepared by Centre for Marine and Coastal Studies Ltd (CMACS).

The Centre for Environment, Fisheries and Aquaculture Science (2007). Report to the Department of Trade and Industry - Fish and Fish Assemblages of the British Isles: The Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

Thornton, I. and Farago, M. (1997) *The geochemistry of arsenic.* In: Abernathy C.O., Calderon R.L., Chappell W.R. (eds) Arsenic. Springer, Dordrecht.

Titan environmental surveys (2005). Walney Offshore Windfarm Project Benthic Baseline Survey: Titan environmental surveys.

Unicomarine Ltd (2005) *Results of benthic sampling (macrofauna and sediment composition) at the proposed Ormonde Development Project windfarm site and cable route, in the vicinity of Morecambe Bay.*

Wentworth, C. K. (1922) A Scale of Grade and Class Terms for Clastic Sediments. *The Journal of Geology*. 30 (5): 377–392.

White, S. (2011) Biotope distribution and susceptibility to fishing pressure. MSc Thesis, Bangor University.

Williams, K.P., Gillespie, J.J., Sobral, B.W.S., Nordburg, E.K., Snyder, E.E., Shallom, J.M. and Dickerson, A.W. (2010) Phylogeny of Gammaproteobacteria. Journal of Bacteriology, 192(9), pp.2305-14.

Worsfold and Hall (2010) Guidelines for processing marine microbenthic invertebrate samples: a Processing Requirements Protocol, National Marine Biological Analytical Quality Control Scheme, Version 1, Available at: [redacted].

Appendix A: Seabed sediments

A.1. Results of particle size analysis (Morgan 2021 site specific survey)

Station number	Folk classification	BGS sediment classification (Based on Folk)	Sorting	Major sediment fractions % Fines	% Sand	% Gravel	THC from GC-FID	THC from ultra-violet fluorescence spectroscopy	Total organic carbon
2021 Survey									
ENV01	Gravelly muddy sand	Slightly gravelly sand	Very poor	10.67	78.68	10.65	NC	NC	NC
ENV02	Gravelly sand	Gravelly sand	Poor	7.36	85.32	7.32	NC	NC	NC
ENV03	Gravelly muddy sand	Gravelly sand	Very poor	9.83	79.99	10.19	NC	NC	NC
ENV04	Gravelly muddy sand	Sandy gravel	Very poor	14.12	64.12	21.76	NC	NC	NC
ENV05	Muddy sandy gravel	Sandy gravel	Very poor	6.94	55.89	37.17	4.7	1.5	0.23
ENV06	Gravelly muddy sand	Sandy gravel	Very poor	12.08	77.90	10.03	4.7	1.5	0.24
ENV07	Gravelly sand	Slightly gravelly sand	Poor	2.59	84.46	12.95	NC	NC	NC
ENV08	Gravelly sand	Gravelly sand	Very poor	7.83	78.11	14.06	NC	NC	NC
ENV09	Gravelly muddy sand	Gravelly sand	Poor	10.42	83.54	6.05	NC	NC	NC
ENV10	Gravelly muddy sand	Gravelly sand	Very poor	12.55	62.54	24.91	NC	NC	NC
ENV11	Sand	Slightly gravelly sand	Poor	9.13	90.77	0.10	NC	NC	NC
ENV12	Slightly gravelly sand	Gravelly sand	Poor	6.65	90.36	2.99	3.6	2.1	0.17

Station number	Folk classification	BGS sediment classification (Based on Folk)	Sorting	Major sediment fractions			THC from GC-FID	THC from ultra-violet fluorescence spectroscopy	Total organic carbon
				% Fines	% Sand	% Gravel			
ENV13	Gravelly sand	Gravelly sand	Poor	8.96	84.02	7.02	3.8	2.0	0.18
ENV14	Gravelly sand	Gravelly sand	Poor	8.79	85.55	5.65	4.4	3.7	0.24
ENV15	Gravelly muddy sand	Gravelly sand	Very poor	9.25	67.43	23.31	NC	NC	NC
ENV16	Sand	Sand	Moderate	3.85	95.66	0.48	5.0	2.1	NC
ENV17	Gravelly sand	Slightly gravelly sand	Poor	7.67	84.40	7.93	NC	NC	0.22
ENV18	Gravelly muddy sand	Sandy gravel	Very poor	10.38	72.98	16.64	NC	NC	NC
ENV19	Gravelly muddy sand	Sandy gravel	Very poor	9.00	65.15	25.85	NC	NC	NC
ENV20	Gravelly sand	Muddy sandy gravel	Poor	3.13	83.66	13.21	12.8	<1	0.14
ENV21	Sand	Sand	Poor	9.15	90.79	0.06	8.9	3.7	0.15
ENV22	Sand	Muddy sand	Moderate	2.44	97.25	0.32	NC	NC	NC
ENV23	Slightly gravelly sand	Muddy sand	Poor	3.90	94.35	1.75	NC	NC	NC
ENV24	Gravelly sand	Slightly gravelly sand	Very poor	6.88	77.12	16.00	NC	NC	NC
ENV25	Sand	Sand	Poor	9.23	90.66	0.11	NC	NC	NC
ENV26	Sand	Sand	Moderately well	0.00	99.92	0.08	NC	NC	NC
ENV27	Gravelly muddy sand	Gravelly sand	Very poor	11.45	62.53	26.02	NC	NC	NC
ENV28	Gravelly sand	Slightly gravelly sand	Very poor	4.05	71.09	24.86	NC	NC	NC
ENV29	Gravelly muddy sand	Gravelly sand	Very poor	13.79	76.33	9.88	7.4	2.5	0.28

Station number	Folk classification	BGS sediment classification (Based on Folk)	Sorting	Major sediment fractions % Fines	% Sand	% Gravel	THC from GC-FID	THC from ultra-violet fluorescence spectroscopy	Total organic carbon
ENV30	Sand	Sand	Moderately well	0.00	99.77	0.23	NC	NC	NC
ENV63	Gravelly sand	Muddy sand	Very poor	7.52	73.36	19.12	3.6	2.3	0.18
ENV64	Muddy sandy gravel	Sandy gravel	Very poor	9.81	55.94	34.26	3.7	<1	NC
ENV65	Gravelly muddy sand	Gravelly muddy sand	Very poor	9.65	65.17	25.18	NC	NC	NC
ENV90	Gravelly muddy sand	Gravelly sand	Very poor	11.07	66.13	11.07	NC	NC	NC
ENV91	Gravelly muddy sand	Slightly gravelly sand	Very poor	10.19	84.65	10.19	NC	NC	NC
ENV92	Gravelly muddy sand	Gravelly sand	Very poor	10.30	62.14	10.30	NC	NC	NC
ENV93	Gravelly sand	Slightly gravelly sand	Poor	0.90	85.86	0.90	NC	NC	NC
ENV94	Gravelly sand	Sand	Very poor	7.25	68.73	7.25	NC	NC	NC
2022 Survey									
ENV11	Sand	Slightly gravelly sand	Moderately well	0.47	99.37	0.16	3.8	2.50	0.12
ENV13	Gravelly muddy sand	Gravelly sand	Poor	10.14	84.57	5.29	5.1	5.70	0.21
ENV09	Gravelly sand	Gravelly sand	Poor	4.72	89.51	5.77	NC	NC	NC
22ENV05	Gravelly muddy sand		Very poor	11.15	68.67	20.18	NC	NC	NC
22ENV06	Gravelly sand		Very poor	8.51	78.75	12.73	5.8	4.59	0.22
22ENV07	Gravelly sand		Very poor	6.45	67.40	26.15	NC	NC	NC
ENV23	Gravelly sand	Muddy sand	Poor	1.70	91.64	6.67	1.5	<1	0.19

Station number	Folk classification	BGS sediment classification (Based on Folk)	Sorting	Major sediment fractions % Fines	% Sand	% Gravel	THC from GC-FID	THC from ultra-violet fluorescence spectroscopy	Total organic carbon
22ENV09	Gravelly sand		Very poor	7.59	77.40	15.00	5.6	5.15	0.18
22ENV10	Gravelly sand		Poor	5.86	85.18	8.96	NC	NC	NC
22ENV11	Gravelly sand		Poor	1.79	84.05	14.16	NC	NC	NC
22ENV12	Sand		Poor	6.55	93.37	0.07	NC	NC	NC
ENV02	Slightly gravelly sand	Gravelly sand	Poor	6.83	88.86	4.31	NC	NC	NC
ZOI14	Muddy sand	Slightly gravelly sand	Poor	10.96	89.04	0.00	9.9	5.69	0.22
ZOI15	Muddy sand	Muddy sand	Poor	25.07	74.93	0.00	16.8	37.70	0.36
ZOI16	Sand	Sand	Poor	9.23	90.58	0.19	6.4	3.96	0.14
ZOI17	Gravelly sand	Muddy sandy gravel	Poor	6.35	81.36	12.29	4.0	4.48	0.18
ZOI18	Gravelly muddy sand	Sandy gravel	Very poor	13.89	61.35	24.76	NC	NC	NC
ZOI19	Gravelly sand	Slightly gravelly sand	Poor	0.00	93.50	6.50	NC	NC	NC
ZOI20	Sand	Slightly gravelly sand	Poor	8.43	91.54	0.04	5.1	2.50	0.16
ZOI21	Muddy sandy gravel	Sandy gravel	Extremely poor	14.39	53.55	32.06	4.8	5.36	0.28
ZOI22	Sand	Sand	Poor	7.66	92.27	0.07	4.5	3.22	0.17
ZOI23	Gravelly muddy sand	Muddy sand	Very poor	9.32	75.62	15.06	4.3	5.47	0.24
ZOI24	Slightly gravelly sand	Slightly gravelly sand	Moderate	1.76	93.68	4.56	NC	NC	NC

Station number	Folk classification	BGS sediment classification (Based on Folk)	Sorting	Major sediment fractions			THC from GC-FID	THC from ultra-violet fluorescence spectroscopy	Total organic carbon
				% Fines	% Sand	% Gravel			
ZOI25	Gravelly sand	Gravelly sand	Very poor	6.60	67.12	26.28	4.3	2.06	0.17
ZOI26	Sand	Sand	Poor	9.28	90.62	0.10	NC	NC	NC

A.2. Full PSA analysis results for 2021 survey in Morgan benthic subtidal ecology study area (part 1)

Sample	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV 01	430333	5993745	-1.91	-1.10	-0.35	0.35	1.26	1.96	2.56	4.62	7.00	449.21	1.15	Medium sand	2.1	Very poor	0.09	Symmetrical	2.28	Very leptokurtic
ENV 02	428608	5991267	-1.32	-0.71	-0.05	0.42	1.22	1.83	2.20	2.91	6.15	458.59	1.12	Medium sand	1.7	Poor	0.09	Symmetrical	2.16	Very leptokurtic
ENV 03	427451	5989645	-1.67	-1.02	-0.53	0.09	1.17	2.16	2.83	3.93	6.97	448.58	1.16	Medium sand	2.2	Very poor	0.16	Fine	1.71	Very leptokurtic
ENV 04	424030	5987160	-3.19	-2.55	-1.72	-0.60	1.44	2.34	3.33	6.32	7.87	493.91	1.02	Medium sand	2.9	Very poor	-0.04	Symmetrical	1.54	Very leptokurtic
ENV 05	424020	5984718	-3.36	-3.16	-2.84	-2.03	0.24	1.64	2.06	2.62	6.15	1133.06	-0.18	Very coarse sand	2.7	Very poor	-0.01	Symmetrical	1.06	Mesokurtic
ENV 06	433590	5991426	-2.16	-1.01	0.00	0.41	1.42	2.21	2.87	5.54	7.40	371.36	1.43	Medium sand	2.2	Very poor	0.13	Fine	2.17	Very leptokurtic
ENV 07	431893	5988908	-1.74	-1.24	-0.82	-0.27	0.71	1.57	1.87	2.17	2.70	666.66	0.58	Coarse sand	1.3	Poor	-0.12	Coarse	0.99	Mesokurtic
ENV 08	429063	5988475	-2.20	-1.44	-0.79	0.12	1.11	1.86	2.39	3.13	6.47	535.29	0.90	Coarse sand	2.1	Very poor	0.02	Symmetrical	2.04	Very leptokurtic

Sample	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV 09	432398	5986201	-1.23	-0.21	0.25	0.69	1.46	2.09	2.58	4.43	7.21	371.19	1.43	Medium sand	1.9	Poor	0.16	Fine	2.47	Very leptokurtic
ENV 10	426400	5981162	-3.37	-2.77	-2.07	-0.99	1.10	2.13	2.79	5.71	7.52	655.10	0.61	Coarse sand	2.9	Very poor	-0.06	Symmetrical	1.43	Leptokurtic
ENV 11	436576	5988729	0.61	1.02	1.30	1.57	1.95	2.41	2.81	3.58	6.73	246.75	2.02	Fine sand	1.3	Poor	0.35	Very fine	2.97	Very leptokurtic
ENV 12	434849	5986265	-0.64	0.05	0.36	0.78	1.47	1.99	2.41	2.94	5.69	375.73	1.41	Medium sand	1.5	Poor	0.13	Fine	2.14	Very leptokurtic
ENV 13	434800	5984481	-1.36	-0.56	0.11	0.55	1.39	2.09	2.50	3.44	6.88	396.79	1.33	Medium sand	1.8	Poor	0.13	Fine	2.19	Very leptokurtic
ENV 14	430639	5983733	-1.15	-0.07	0.29	0.70	1.46	2.14	2.59	3.35	6.75	367.38	1.44	Medium sand	1.8	Poor	0.16	Fine	2.25	Very leptokurtic
ENV 15	430556	5980121	-3.25	-2.71	-1.97	-0.72	1.08	2.02	2.49	3.42	7.02	690.33	0.53	Coarse sand	2.7	Very poor	-0.10	Coarse	1.54	Very leptokurtic
ENV 16	442096	5986107	0.40	0.81	1.10	1.36	1.77	2.17	2.37	2.50	3.19	298.58	1.74	Medium sand	0.7	Moderate	-0.02	Symmetrical	1.42	Leptokurtic
ENV 17	439762	5982810	-1.75	-0.64	0.04	0.30	1.04	1.93	2.37	2.92	6.32	450.09	1.15	Medium sand	1.8	Poor	0.23	Fine	2.04	Very leptokurtic
ENV 18	437760	5979963	-2.42	-1.64	-1.06	-0.22	1.36	2.13	2.57	4.39	7.03	515.99	0.95	Coarse sand	2.3	Very poor	-0.07	Symmetrical	1.65	Very leptokurtic

Sample	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV 19	436609	5978328	-3.17	-2.74	-2.15	-1.10	1.15	2.03	2.45	3.30	6.99	713.61	0.49	Coarse sand	2.7	Very poor	-0.14	Coarse	1.33	Leptokurtic
ENV 20	434864	5975849	-2.01	-1.28	-0.86	-0.44	0.25	0.91	1.62	2.18	2.74	791.60	0.34	Coarse sand	1.3	Poor	0.07	Symmetrical	1.44	Leptokurtic
ENV 21	445657	5984166	0.72	1.12	1.47	1.64	2.03	2.42	2.75	3.51	6.80	235.77	2.08	Fine sand	1.2	Poor	0.34	Very fine	3.17	Extremely leptokurtic
ENV 22	443326	5980948	0.13	0.30	0.51	0.73	1.31	1.83	2.04	2.30	2.59	410.74	1.28	Medium sand	0.8	Moderate	0.00	Symmetrical	0.92	Mesokurtic
ENV 23	441270	5978119	-0.46	-0.12	0.07	0.21	0.69	1.69	2.13	2.42	3.00	513.17	0.96	Coarse sand	1.0	Poor	0.37	Very fine	0.96	Mesokurtic
ENV 24	439904	5976028	-3.46	-2.16	-1.00	0.19	1.24	2.07	2.37	2.77	6.17	548.00	0.87	Coarse sand	2.3	Very poor	-0.15	Coarse	2.10	Very leptokurtic
ENV 25	447757	5980285	1.16	1.53	1.63	1.78	2.15	2.46	2.78	3.44	6.83	219.53	2.19	Fine sand	1.1	Poor	0.37	Very fine	3.45	Extremely leptokurtic
ENV 26	446613	5978646	0.68	1.08	1.33	1.56	1.88	2.23	2.35	2.44	2.57	276.01	1.86	Medium sand	0.5	Moderately well	-0.18	Coarse	1.17	Leptokurtic
ENV 27	426335	5988006	-3.22	-2.57	-1.97	-1.10	1.10	2.16	2.88	5.15	7.41	628.40	0.67	Coarse sand	2.8	Very poor	-0.04	Symmetrical	1.34	Leptokurtic
ENV 28	436806	5985536	-3.52	-3.09	-2.21	-0.98	0.83	1.71	1.98	2.33	3.04	871.20	0.20	Coarse sand	2.0	Very poor	-0.39	Very coarse	1.00	Mesokurtic

Sample	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV 29	433347	5980618	-1.80	-0.99	-0.19	0.41	1.60	2.47	3.21	6.17	7.74	343.87	1.54	Medium sand	2.3	Very poor	0.12	Fine	1.90	Very leptokurtic
ENV 30	440271	5986893	0.31	0.65	1.02	1.25	1.68	1.97	2.16	2.31	2.43	325.22	1.62	Medium sand	0.6	Moderately well	-0.22	Coarse	1.19	Leptokurtic
ENV 63	433183	5973412	-3.13	-2.45	-1.50	-0.05	1.52	2.10	2.39	2.87	6.31	573.03	0.80	Coarse sand	2.4	Very poor	-0.27	Coarse	1.79	Very leptokurtic
ENV 64	429880	5975699	-3.35	-3.09	-2.67	-1.82	0.56	2.01	2.44	3.82	6.92	927.55	0.11	Coarse sand	2.8	Very poor	-0.01	Symmetrical	1.10	Mesokurtic
ENV 65	432045	5971748	-3.28	-2.73	-1.90	-1.02	1.25	2.13	2.47	3.72	6.95	656.99	0.61	Coarse sand	2.6	Very poor	-0.16	Coarse	1.33	Leptokurtic
ENV 66	433146	5958808	-1.13	-0.61	-0.29	0.02	0.31	0.66	0.84	0.96	1.26	821.18	0.28	Coarse sand	0.6	Moderately well	-0.13	Coarse	1.54	Very leptokurtic
ENV 67	449859	5947111	-0.80	-0.01	0.10	0.24	0.64	1.06	1.33	1.53	1.86	619.41	0.69	Coarse sand	0.7	Moderate	0.01	Symmetrical	1.33	Leptokurtic
ENV 68	452816	5942556	0.06	0.33	0.62	1.01	1.59	1.99	2.31	2.67	6.04	351.82	1.51	Medium sand	1.3	Poor	0.17	Fine	2.50	Very leptokurtic
ENV 69	445014	5945647	-3.21	-2.53	-2.05	-1.23	0.53	1.27	1.98	5.57	7.28	898.07	0.16	Coarse sand	2.6	Very poor	0.00	Symmetrical	1.72	Very leptokurtic
ENV 90	429245	5985927	-3.07	-2.44	-1.84	-0.61	0.80	1.58	2.18	5.06	7.24	768.45	0.38	Coarse sand	2.6	Very poor	-0.03	Symmetrical	1.93	Very leptokurtic

Sample	Easting	Northing	Percentile Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Folk and Ward Graphic Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness description	Kurtosis value	Kurtosis description
ENV 91	436564	5987302	-1.06	0.05	0.36	0.81	1.55	2.09	2.44	4.18	7.05	366.15	1.45	Medium sand	1.7	Poor	0.11	Fine	2.58	Very leptokurtic
ENV 92	432717	5984307	-4.29	-4.07	-3.41	-1.53	1.02	1.91	2.44	4.25	7.15	987.06	0.02	Coarse sand	3.2	Very poor	-0.22	Coarse	1.36	Leptokurtic
ENV 93	430337	5991128	-1.51	-1.20	-0.91	-0.62	0.09	0.60	0.86	1.06	1.38	992.51	0.01	Coarse sand	0.9	Moderate	-0.12	Coarse	0.97	Mesokurtic
ENV 94	439711	5986142	-3.19	-2.64	-1.94	-0.83	1.18	1.90	2.25	2.69	6.40	706.62	0.50	Coarse sand	2.5	Very poor	-0.20	Coarse	1.44	Leptokurtic

A.3. Full PSA analysis results for 2021 survey in Morgan benthic subtidal ecology study area (part 2)

Station	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness description	Kurtosis value	Kurtosis description	Fines	Sands	Gravels	Modified	Eunis
ENV01	354.40	1.50	Medium sand	2.43	Very poor	1.41	Very fine	6.42	Leptokurtic	10.67	78.68	10.65	Gravelly muddy sand	Mixed sediments
ENV02	384.28	1.38	Medium sand	2.03	Very poor	1.87	Very fine	8.96	Very leptokurtic	7.36	85.32	7.32	Gravelly sand	Coarse sediments
ENV03	365.17	1.45	Medium sand	2.42	Very poor	1.49	Very fine	6.51	Leptokurtic	9.83	79.99	10.19	Gravelly muddy sand	Mixed sediments
ENV04	364.56	1.46	Medium sand	3.12	Very poor	0.87	Fine	4.19	Leptokurtic	14.12	64.12	21.76	Gravelly muddy sand	Mixed sediments
ENV05	878.60	0.19	Coarse sand	2.78	Very poor	1.14	Fine	5.20	Leptokurtic	6.94	55.89	37.17	Muddy sandy gravel	Mixed sediments
ENV06	310.20	1.69	Medium sand	2.57	Very poor	1.32	Very fine	5.86	Leptokurtic	12.08	77.90	10.03	Gravelly muddy sand	Mixed sediments
ENV07	612.53	0.71	Coarse sand	1.66	Poor	1.62	Very fine	11.06	Very leptokurtic	2.59	84.46	12.95	Gravelly sand	Coarse sediments
ENV08	437.85	1.19	Medium sand	2.33	Very poor	1.36	Very fine	7.00	Leptokurtic	7.83	78.11	14.06	Gravelly sand	Coarse sediments
ENV09	290.67	1.78	Medium sand	2.28	Very poor	1.80	Very fine	7.59	Very leptokurtic	10.42	83.54	6.05	Gravelly muddy sand	Mixed sediments

Station	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness description	Kurtosis value	Kurtosis description	Fines	Sands	Gravels	Modified	Eunis
ENV10	469.64	1.09	Medium sand	3.07	Very poor	0.95	Fine	4.37	Leptokurtic	12.55	62.54	24.91	Gravelly muddy sand	Mixed sediments
ENV11	197.22	2.34	Fine sand	1.76	Poor	2.73	Very fine	11.78	Very leptokurtic	9.13	90.77	0.10	Sand	Sand and muddy sand
ENV12	318.97	1.65	Medium sand	1.82	Poor	2.21	Very fine	10.92	Very leptokurtic	6.65	90.36	2.99	Slightly gravelly sand	Sand and muddy sand
ENV13	322.92	1.63	Medium sand	2.23	Very poor	1.74	Very fine	7.93	Very leptokurtic	8.96	84.02	7.02	Gravelly sand	Coarse sediments
ENV14	303.45	1.72	Medium sand	2.15	Very poor	1.86	Very fine	8.71	Very leptokurtic	8.79	85.55	5.65	Gravelly sand	Coarse sediments
ENV15	502.98	0.99	Coarse sand	2.80	Very poor	0.97	Fine	5.11	Leptokurtic	9.25	67.43	23.31	Gravelly muddy sand	Mixed sediments
ENV16	269.50	1.89	Medium sand	1.37	Poor	3.34	Very fine	21.94	Very leptokurtic	3.85	95.66	0.48	Sand	Sand and muddy sand
ENV17	399.79	1.32	Medium sand	2.16	Very poor	1.68	Very fine	8.34	Very leptokurtic	7.67	84.40	7.93	Gravelly sand	Coarse sediments
ENV18	393.60	1.35	Medium sand	2.60	Very poor	1.17	Fine	5.62	Leptokurtic	10.38	72.98	16.64	Gravelly muddy sand	Mixed sediments
ENV19	522.33	0.94	Coarse sand	2.80	Very poor	0.96	Fine	4.91	Leptokurtic	9.00	65.15	25.85	Gravelly muddy sand	Mixed sediments
ENV20	754.27	0.41	Coarse sand	1.74	Poor	1.92	Very fine	11.55	Very leptokurtic	3.13	83.66	13.21	Gravelly sand	Coarse sediments

Station	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness description	Kurtosis value	Kurtosis description	Fines	Sands	Gravels	Modified	Eunis
ENV21	189.44	2.40	Fine sand	1.74	Poor	2.81	Very fine	12.12	Very leptokurtic	9.15	90.79	0.06	Sand	Sand and muddy sand
ENV22	373.60	1.42	Medium sand	1.26	Poor	4.04	Very fine	28.90	Very leptokurtic	2.44	97.25	0.32	Sand	Sand and muddy sand
ENV23	470.16	1.09	Medium sand	1.57	Poor	2.80	Very fine	14.75	Very leptokurtic	3.90	94.35	1.75	Slightly gravelly sand	Sand and muddy sand
ENV24	463.48	1.11	Medium sand	2.44	Very poor	0.83	Fine	6.20	Leptokurtic	6.88	77.12	16.00	Gravelly sand	Coarse sediments
ENV25	172.90	2.53	Fine sand	1.69	Poor	3.00	Very fine	13.11	Very leptokurtic	9.23	90.66	0.11	Sand	Sand and muddy sand
ENV26	281.87	1.83	Medium sand	0.55	Moderately well	-0.99	Coarse	4.99	Leptokurtic	0.00	99.92	0.08	Sand	Sand and muddy sand
ENV27	480.60	1.06	Medium sand	3.00	Very poor	0.99	Fine	4.50	Leptokurtic	11.45	62.53	26.02	Gravelly muddy sand	Mixed sediments
ENV28	731.76	0.45	Coarse sand	2.33	Very poor	0.60	Fine	5.61	Leptokurtic	4.05	71.09	24.86	Gravelly sand	Coarse sediments
ENV29	270.79	1.88	Medium sand	2.70	Very poor	1.21	Fine	5.27	Leptokurtic	13.79	76.33	9.88	Gravelly muddy sand	Mixed sediments
ENV30	334.62	1.58	Medium sand	0.62	Moderately well	-0.96	Coarse	5.31	Leptokurtic	0.00	99.77	0.23	Sand	Sand and muddy sand
ENV63	453.30	1.14	Medium sand	2.52	Very poor	0.75	Fine	5.46	Leptokurtic	7.52	73.36	19.12	Gravelly sand	Coarse sediments

Station	Mean µm	Mean Phi	Wentworth	Sorting value	Sorting description	Skewness value	Skewness description	Kurtosis value	Kurtosis description	Fines	Sands	Gravels	Modified	Eunis
ENV64	678.44	0.56	Coarse sand	2.99	Very poor	0.98	Fine	4.38	Leptokurtic	9.81	55.94	34.26	Muddy sandy gravel	Mixed sediments
ENV65	502.91	0.99	Coarse sand	2.83	Very poor	0.88	Fine	4.71	Leptokurtic	9.65	65.17	25.18	Gravelly muddy sand	Mixed sediments
ENV90	524.07	0.93	Coarse sand	2.83	Very poor	1.23	Fine	5.36	Leptokurtic	11.07	66.13	22.80	Gravelly muddy sand	Mixed sediments
ENV91	288.15	1.80	Medium sand	2.23	Very poor	1.63	Very fine	7.71	Very leptokurtic	10.19	84.65	5.16	Gravelly muddy sand	Mixed sediments
ENV92	645.24	0.63	Coarse sand	3.23	Very poor	0.60	Fine	3.97	Leptokurtic	10.30	62.14	27.56	Gravelly muddy sand	Mixed sediments
ENV93	962.18	0.06	Coarse sand	1.15	Poor	3.35	Very fine	31.46	Very leptokurtic	0.90	85.86	13.24	Gravelly sand	Coarse sediments
ENV94	541.83	0.88	Coarse sand	2.63	Very poor	0.97	Fine	5.74	Leptokurtic	7.25	68.73	24.01	Gravelly sand	Coarse sediments

A.4. Full PSA analysis results for 2021 survey in Morgan benthic subtidal ecology study area (part 3)[4]

Sample	Other central tendency measures						
	Median	Description	1st Local maxima (Mode)	Description	2nd Local maxima	Description	3rd Local maxima	Description
ENV01	1.26	Medium sand	1.50	Medium sand	-0.50	Very coarse sand	7.00	Fine silt
ENV02	1.22	Medium sand	1.50	Medium sand	-0.50	Very coarse sand		
ENV03	1.17	Medium sand	1.50	Medium sand	-3.00	Pebble	7.00	Fine silt
ENV04	1.44	Medium sand	2.00	Medium sand	-3.00	Pebble	-1.00	Granule
ENV05	0.24	Coarse sand	-3.00	Pebble	2.00	Medium sand	-1.50	Granule
ENV06	1.42	Medium sand	2.00	Medium sand	0.50	Coarse sand	-0.50	Very coarse sand
ENV07	0.71	Coarse sand	0.50	Coarse sand	-0.50	Very coarse sand		
ENV08	1.11	Medium sand	1.50	Medium sand	-0.50	Very coarse sand	-3.00	Pebble
ENV09	1.46	Medium sand	2.00	Medium sand	7.00	Fine silt		
ENV10	1.10	Medium sand	2.00	Medium sand	-2.50	Pebble	-0.50	Very coarse sand
ENV11	1.95	Medium sand	2.00	Medium sand	7.00	Fine silt		
ENV12	1.47	Medium sand	2.00	Medium sand				
ENV13	1.39	Medium sand	2.00	Medium sand	-0.50	Very coarse sand	7.00	Fine silt
ENV14	1.46	Medium sand	2.00	Medium sand	-0.50	Very coarse sand	7.50	Very fine silt

[4] The other central tendancy measures is a statistical representation of the sediment size disribution. Some samples will only have a 1st local maximum indicating one sediment size dominstated the sample. The more local maximums which are established the more mixed the sediment at this station will be.

Sample	Other central tendency measures							
	Median	Description	1st Local maxima (Mode)	Description	2nd Local maxima	Description	3rd Local maxima	Description
ENV15	1.08	Medium sand	1.50	Medium sand	-2.50	Pebble	7.00	Fine silt
ENV16	1.77	Medium sand	2.00	Medium sand				
ENV17	1.04	Medium sand	0.50	Coarse sand	-2.50	Pebble		
ENV18	1.36	Medium sand	2.00	Medium sand	0.50	Coarse sand	-0.50	Very coarse sand
ENV19	1.15	Medium sand	2.00	Medium sand	-3.00	Pebble	7.50	Very fine silt
ENV20	0.25	Coarse sand	0.50	Coarse sand	2.50	Fine sand	-3.00	Pebble
ENV21	2.03	Fine sand	2.50	Fine sand	7.00	Fine silt		
ENV22	1.31	Medium sand	2.00	Medium sand				
ENV23	0.69	Coarse sand	0.50	Coarse sand	2.50	Fine sand		
ENV24	1.24	Medium sand	2.00	Medium sand	1.00	Coarse sand	-3.50	Pebble
ENV25	2.15	Fine sand	2.50	Fine sand	7.00	Fine silt		
ENV26	1.88	Medium sand	2.00	Medium sand				
ENV27	1.10	Medium sand	2.00	Medium sand	-1.50	Granule	7.50	Very fine silt
ENV28	0.83	Coarse sand	2.00	Medium sand	0.50	Coarse sand	-3.00	Pebble
ENV29	1.60	Medium sand	2.00	Medium sand	0.50	Coarse sand	-0.50	Very coarse sand
ENV30	1.68	Medium sand	2.00	Medium sand				
ENV63	1.52	Medium sand	2.00	Medium sand	-3.00	Pebble		
ENV64	0.56	Coarse sand	2.00	Medium sand	-3.00	Pebble	0.50	Coarse sand
ENV65	1.25	Medium sand	2.00	Medium sand	0.50	Coarse sand	-3.00	Pebble

Sample	Other central tendency measures							
	Median	Description	1st Local maxima (Mode)	Description	2nd Local maxima	Description	3rd Local maxima	Description
ENV90	0.80	Coarse sand	1.50	Medium sand	-1.50	Granule	7.00	Fine silt
ENV91	1.55	Medium sand	2.00	Medium sand	-0.50	Very coarse sand	7.00	Fine silt
ENV92	1.02	Medium sand	2.00	Medium sand	-4.00	Pebble	0.50	Coarse sand
ENV93	0.09	Coarse sand	0.50	Coarse sand				
ENV94	1.18	Medium sand	2.00	Medium sand	-2.50	Pebble		

A.5. Full PSA analysis results for 2022 survey in Morgan benthic subtidal ecology study area (part 1)

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm (Folk and Ward)	Mean Phi (Folk and Ward)	Wentworth (Folk and Ward)	Sorting value (Folk and Ward)	Sorting description (Folk and Ward)
ENV11	436576	5988729	0.51	0.84	1.12	1.42	1.80	2.18	2.35	2.46	2.78	295.96	1.76	Medium sand	0.65	Moderately well
ENV72	430769	5982471	-1.92	-1.64	-1.40	-1.13	-0.42	0.79	1.16	1.42	1.87	1164.82	-0.22	Very coarse sand	1.22	Poor
ENV13	434800	5984487	-1.07	-0.26	0.31	0.77	1.48	2.14	2.57	4.09	7.17	365.32	1.45	Medium sand	1.81	Poor
ENV09	432396	5986200	-1.17	-0.26	0.23	0.66	1.32	1.83	2.05	2.41	3.62	434.47	1.20	Medium sand	1.18	Poor
22ENV 05	435141	5977322	-3.03	-2.29	-1.55	-0.21	1.28	2.19	2.55	4.92	7.26	590.24	0.76	Coarse sand	2.58	Very poor
22ENV 06	431274	5992764	-2.40	-1.50	-0.44	0.62	1.52	1.98	2.38	2.96	6.66	449.05	1.16	Medium sand	2.08	Very poor
22ENV 07	426470	5985608	-3.22	-2.74	-2.06	-1.12	1.07	1.87	2.26	2.69	5.64	745.32	0.42	Coarse sand	2.42	Very poor
ENV23	441260	5978234	-1.22	-0.76	-0.38	0.04	0.78	1.51	1.87	2.17	2.49	592.42	0.76	Coarse sand	1.13	Poor
22ENV 09	444561	5980579	-2.92	-2.14	-0.64	1.06	1.84	2.33	2.52	2.92	6.16	422.46	1.24	Medium sand	2.17	Very poor

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm (Folk and Ward)	Mean Phi (Folk and Ward)	Wentworth (Folk and Ward)	Sorting value (Folk and Ward)	Sorting description (Folk and Ward)
22ENV 10	438070	5981684	-1.67	-0.91	-0.39	0.24	1.26	1.98	2.33	2.67	5.04	477.97	1.07	Medium sand	1.69	Poor
22ENV 11	430574	5987585	-1.45	-1.20	-0.96	-0.75	-0.05	1.03	1.38	1.70	2.20	918.28	0.12	Coarse sand	1.14	Poor
22ENV 12	444219	5985259	0.78	1.13	1.38	1.58	1.93	2.34	2.49	2.92	5.64	261.91	1.93	Medium sand	1.01	Poor
ENV02	428608	5991267	-0.88	-0.07	0.38	0.81	1.42	1.94	2.33	2.91	5.67	385.29	1.38	Medium sand	1.48	Poor
ZOI14	445418	5992880	1.31	1.63	1.87	2.07	2.37	2.81	3.02	4.44	7.24	186.94	2.42	Fine sand	1.19	Poor
ZOI15	453173	5987872	2.14	2.28	2.44	2.59	2.91	4.01	6.41	7.53	8.60	66.00	3.92	Very fine sand	1.97	Poor
ZOI16	453192	5976521	1.16	1.53	1.63	1.79	2.15	2.44	2.71	3.48	6.82	223.01	2.16	Fine sand	1.13	Poor
ZOI17	433333	5973416	-2.63	-1.46	-0.34	0.77	1.66	2.17	2.40	2.73	5.43	423.23	1.24	Medium sand	1.91	Poor
ZOI18	418704	5984419	-4.10	-3.17	-2.27	-0.96	1.41	2.39	3.24	6.15	7.85	575.53	0.80	Coarse sand	3.19	Very poor
ZOI19	435333	5999183	-1.36	-0.40	0.31	0.89	1.56	1.96	2.16	2.32	2.45	393.10	1.35	Medium sand	1.04	Poor

Sample	Easting	Northing	Phi5	Phi10	Phi16	Phi25	Phi50	Phi75	Phi84	Phi90	Phi95	Mean µm (Folk and Ward)	Mean Phi (Folk and Ward)	Wentworth (Folk and Ward)	Sorting value (Folk and Ward)	Sorting description (Folk and Ward)
ZOI20	443708	5993601	0.95	1.20	1.45	1.67	2.14	2.52	2.85	3.36	6.56	225.47	2.15	Fine sand	1.20	Poor
ZOI21	420146	5981925	-5.87	-5.74	-5.58	-3.65	1.02	2.80	3.82	4.73	7.27	1186.36	-0.25	Very coarse sand	4.34	Extremely poor
ZOI22	444501	5988189	0.76	1.13	1.48	1.71	2.18	2.51	2.81	3.05	6.31	224.82	2.15	Fine sand	1.17	Poor
ZOI23	445008	5974394	-2.60	-1.86	-0.84	0.47	1.57	2.13	2.42	2.99	7.03	483.53	1.05	Medium sand	2.27	Very poor
ZOI24	428189	5995887	-0.93	-0.20	0.24	0.62	1.21	1.69	1.89	2.07	2.41	462.44	1.11	Medium sand	0.92	Moderate
ZOI25	427608	5975313	-3.00	-2.61	-2.02	-1.15	1.23	2.02	2.35	2.70	5.87	697.75	0.52	Coarse sand	2.44	Very poor
ZOI26	448470	5983030	1.03	1.46	1.67	1.95	2.28	2.65	2.89	3.54	6.80	206.00	2.28	Fine sand	1.18	Poor

A.6. Full PSA analysis results for 2022 survey in Morgan benthic subtidal ecology study area (part 2)

Sample	Skewness value (Folk and Ward)	Skewness description (Folk and Ward)	Kurtosis value (Folk and Ward)	Kurtosis Description (Folk and Ward)	Mean µm (Method of Moments)	Mean Phi (Method of Moments)	Wentworth (Method of Moments)
ENV11	-0.12	Coarse	1.23	Leptokurtic	295.97	1.76	Medium sand
ENV72	0.23	Fine	0.81	Platykurtic	1088.51	-0.12	Very coarse sand
ENV13	0.17	Fine	2.46	Very leptokurtic	289.76	1.79	Medium sand
ENV09	-0.12	Coarse	1.67	Very leptokurtic	389.34	1.36	Medium sand
22ENV05	-0.11	Coarse	1.75	Very leptokurtic	415.77	1.27	Medium sand
22ENV06	-0.13	Coarse	2.72	Very leptokurtic	367.10	1.45	Medium sand
22ENV07	-0.21	Coarse	1.21	Leptokurtic	621.14	0.69	Coarse sand
ENV23	-0.05	Symmetrical	1.04	Mesokurtic	570.69	0.81	Coarse sand
22ENV09	-0.31	Very coarse	2.93	Very leptokurtic	340.08	1.56	Medium sand
22ENV10	-0.04	Symmetrical	1.58	Very leptokurtic	418.86	1.26	Medium sand
22ENV11	0.23	Fine	0.84	Platykurtic	853.08	0.23	Coarse sand
22ENV12	0.26	Fine	2.65	Very leptokurtic	216.21	2.21	Fine sand
ENV02	0.12	Fine	2.36	Very leptokurtic	336.24	1.57	Medium sand
ZOI14	0.39	Very fine	3.30	Extremely leptokurtic	142.18	2.81	Fine sand
ZOI15	0.76	Very fine	1.86	Very leptokurtic	68.32	3.87	Very fine sand

Sample	Skewness value (Folk and Ward)	Skewness description (Folk and Ward)	Kurtosis value (Folk and Ward)	Kurtosis Description (Folk and Ward)	Mean µm (Method of Moments)	Mean Phi (Method of Moments)	Wentworth (Method of Moments)
ZOI16	0.35	Very fine	3.54	Extremely leptokurtic	176.11	2.51	Fine sand
ZOI17	-0.26	Coarse	2.35	Very leptokurtic	370.76	1.43	Medium sand
ZOI18	-0.13	Coarse	1.46	Leptokurtic	419.94	1.25	Medium sand
ZOI19	-0.44	Very coarse	1.46	Leptokurtic	428.97	1.22	Medium sand
ZOI20	0.29	Fine	2.73	Very leptokurtic	184.50	2.44	Fine sand
ZOI21	-0.23	Coarse	0.83	Platykurtic	820.12	0.29	Coarse sand
ZOI22	0.22	Fine	2.86	Very leptokurtic	188.15	2.41	Fine sand
ZOI23	-0.17	Coarse	2.39	Very leptokurtic	366.56	1.45	Medium sand
ZOI24	-0.23	Coarse	1.28	Leptokurtic	454.00	1.14	Medium sand
ZOI25	-0.22	Coarse	1.15	Leptokurtic	568.55	0.81	Coarse sand
ZOI26	0.29	Fine	3.35	Extremely leptokurtic	164.30	2.61	Fine sand

A.7. Full PSA analysis results for 2022 survey in Morgan benthic subtidal ecology study area (part 3)

Sample	Sorting value (Method of Moments)	Sorting description (Method of Moments)	Skewness value (Method of Moments)	Skewness description (Method of Moments)	Kurtosis value (Method of Moments)	Kurtosis description (Method of Moments)
ENV11	0.67	Moderately well	-0.28	Symmetrical	5.09	Leptokurtic
ENV72	1.49	Poor	2.07	Very fine	13.15	Very leptokurtic
ENV13	2.23	Very poor	1.79	Very fine	7.82	Very leptokurtic
ENV09	1.68	Poor	2.04	Very fine	12.36	Very leptokurtic
22ENV05	2.78	Very poor	0.99	Fine	5.00	Leptokurtic
22ENV06	2.29	Very poor	1.05	Fine	6.43	Leptokurtic
22ENV07	2.51	Very poor	0.79	Fine	5.05	Leptokurtic
ENV23	1.40	Poor	2.01	Very fine	15.98	Very leptokurtic
22ENV09	2.36	Very poor	0.42	Symmetrical	5.70	Leptokurtic
22ENV10	1.97	Poor	1.43	Very fine	8.16	Very leptokurtic
22ENV11	1.44	Poor	2.36	Very fine	14.91	Very leptokurtic
22ENV12	1.51	Poor	3.28	Very fine	16.27	Very leptokurtic
ENV02	1.82	Poor	1.73	Very fine	9.40	Very leptokurtic
ZOI14	1.72	Poor	2.71	Very fine	10.95	Very leptokurtic
ZOI15	2.19	Very poor	1.87	Very fine	5.89	Leptokurtic
ZOI16	1.65	Poor	2.93	Very fine	12.81	Very leptokurtic
ZOI17	2.14	Very poor	0.74	Fine	6.82	Leptokurtic

Sample	Sorting value (Method of Moments)	Sorting description (Method of Moments)	Skewness value (Method of Moments)	Skewness description (Method of Moments)	Kurtosis value (Method of Moments)	Kurtosis description (Method of Moments)
ZOI18	3.30	Very poor	0.66	Fine	3.86	Leptokurtic
ZOI19	1.19	Poor	-1.87	Very coarse	7.10	Leptokurtic
ZOI20	1.61	Poor	2.85	Very fine	12.57	Very leptokurtic
ZOI21	4.09	Extremely poor	0.09	Symmetrical	2.62	Mesokurtic
ZOI22	1.58	Poor	2.94	Very fine	13.85	Very leptokurtic
ZOI23	2.46	Very poor	1.04	Fine	5.90	Leptokurtic
ZOI24	1.35	Poor	2.19	Very fine	21.22	Very leptokurtic
ZOI25	2.54	Very poor	0.81	Fine	5.05	Leptokurtic
ZOI26	1.64	Poor	2.81	Very fine	12.37	Very leptokurtic

Appendix B: Habitat assessments

B.1. Seapens and burrowing megafauna assessment (Morgan 2021 site specific survey)

Station	Total images	Camera transect length (m)	Mean swathe width per image (m)	Estimated area investigated (m^2)	Number of burrows				Maximum density m^2	Size of burrows			Average size (cm)	Average SACFOR
					1 to 5	6 to 10	11+	Max total		0 - 1	1.1 - 3	3 +		
ENV01	126	270	0.59	160.65	40	55	20	970	6.04	97	18	0	1.2	F
ENV02	103	261	0.52	135.8	35	19	10	475	3.5	61	2	0	1.0	O
ENV03	77	267	0.64	170.17	27	29	19	634	3.73	71	4	0	1.0	F
ENV04	100	258	0.58	150.86	37	40	8	673	4.46	81	4	0	1.0	O
ENV05	84	278	0.67	184.97	52	30	2	582	3.15	78	6	0	1.0	F
ENV06	90	272	0.55	149.08	8	41	41	901	6.04	89	1	0	0.9	O
ENV07	97	273.2	0.76	208.27	3	1	14	179	0.86	18	0	0	0.9	R
ENV08	104	296	0.61	180.41	53	8	0	345	1.91	51	10	0	1.2	F
ENV09	94	268.9	0.67	178.96	36	32	21	731	4.08	21	67	0	2.4	F
ENV10	90	258	0.56	145.13	67	2	0	355	2.45	46	23	0	1.6	F
ENV11	109	330.7	0.66	217.96	0	0	0	0	0	0	0	0	0	N/A
ENV12	91	272	0.83	226.66	11	5	0	105	0.46	13	3	0	1.3	O
ENV13	94	281.1	0.77	215.18	43	37	14	739	3.43	42	52	0	2.0	F
ENV14	93	277.5	0.88	245.54	30	0	0	150	0.61	28	2	0	1.0	O
ENV15	106	292.1	0.61	177.55	79	3	0	425	2.39	69	14	0	1.2	F

Station	Total images	Camera transect length (m)	Mean swathe width per image (m)	Estimated area investigated (m^2)	Number of burrows				Maximum density m^2	Size of burrows			Average size (cm)	Average SACFOR
					1 to 5	6 to 10	11+	Max total		0 - 1	1.1 - 3	3 +		
ENV16	91	269.9	0.72	194.82	0	0	0	0	0	0	0	0	0	N/A
ENV17	96	275.3	0.67	185.09	23	36	37	882	4.77	48	48	0	1.9	F
ENV18	92	278.7	0.59	163.11	18	48	26	856	5.25	39	53	0	2.1	F
ENV19	81	272.8	0.67	182.01	51	28	2	557	3.06	56	25	0	1.5	F
ENV20	104	277.1	0.71	196.79	38	1	0	200	1.02	39	0	0	0.9	O
ENV21	101	314.1	0.69	215.35	0	0	0	0	0	0	0	0	0	N/A
ENV22	95	268.9	0.78	209.32	0	0	0	0	0	0	0	0	0	N/A
ENV23	82	271.3	0.62	169.3	0	0	0	0	0	0	0	0	0	N/A
ENV24	200	271.9	0.64	182.19	66	17	4	544	2.99	65	22	0	1.4	F
ENV25	74	278	0.61	169.82	0	0	0	0	0	0	0	0	0	N/A
ENV26	83	273.5	0.66	180.98	0	0	0	0	0	0	0	0	0	N/A
ENV27	84	265.7	0.56	149.91	81	1	0	415	2.77	79	1	0	0.9	O
ENV28	99	271.8	0.84	228.41	11	24	64	999	4.37	48	51	0	1.9	F
ENV29	78	273.6	0.70	190.5	24	39	15	675	3.54	28	50	0	2.2	F
ENV30	94	268.5	0.72	194.57	16	0	0	80	0.41	16	0	0	0.9	R
ENV90	96	270	0.79	213.2	6	7	81	991	4.65	35	59	0	2.2	F
ENV91	91	271.6	0.78	210.86	40	20	16	576	2.73	68	8	0	1.1	F
NV92	94	265.2	1.08	285.11	11	41	38	883	3.1	42	48	0	2.0	F
ENV93	94	284.1	0.97	274.4	34	23	14	554	2.02	69	1	1	1.0	O
ENV94	85	269.5	0.84	225.75	0	0	8	88	0.39	8	0	0	0.9	R

B.2. Seapens and burrowing megafauna assessment (Morgan 2022 site specific survey)

Station	Number of images assessed with visibility	Camera transect length (m)	Mean swathe width (m)	Estimated area investigated (m^2)	Number of burrows	Density (m^2)	Average size (cm)	Average SACFOR
ENV11	49	247	0.62	153.32	0	0	0	NA
ENV72	58	1842	0.80	1474.91	0	0	0	NA
ENV13	57	484	0.83	400.68	0	0	0	NA
ENV09	36	254	0.84	212.97	0	0	0	NA
22ENV05	56	374	0.47	174.63	0	0	0	NA
22ENV06	48	328	0.66	215.69	0	0	0	NA
22ENV07	57	479	0.78	375.17	0	0	0	NA
ENV23	33	332	0.86	286.64	0	0	0	NA
22ENV09	49	266	0.71	188.28	0	0	0	NA
22ENV10	48	225	0.64	142.89	0	0	0	NA
22ENV11	45	245	0.73	177.98	0	0	0	NA
22ENV12	42	216	0.68	147.67	0	0	0	NA
ENV02	49	277	0.81	223.81	0	0	0	NA
ZOI14	53	243	0.78	189.34	0	0	0	NA
ZOI15	41	271	0.67	180.40	16	0.09	2.0	R
ZOI16	61	1853	0.74	1377.79	0	0	0	NA
ENV63	48	1784	0.54	956.93	0	0	0	NA
ZOI18	55	428	0.60	255.37	0	0	0	NA
ZOI19	49	276	0.83	228.84	0	0	0	NA

Station	Number of images assessed with visibility	Camera transect length (m)	Mean swathe width (m)	Estimated area investigated (m^2)	Number of burrows	Density (m^2)	Average size (cm)	Average SACFOR
ZOI20	44	222	0.79	176.01	0	0	0	NA
ZOI21	54	308	0.84	257.51	0	0	0	NA
ZOI22	59	261	0.52	135.34	3	0.02	0.8	R
ZOI23	42	243	0.47	115.22	0	0	0	NA
ZOI24	56	341	0.72	246.05	0	0	0	NA
ZOI25	61	275	0.73	201.60	0	0	0	NA
ZOI26	48	214	11.32	2425.96	0	0	0	NA

B.3. Annex I stony reef assessment summary table (Morgan site specific survey 2021)

Station	Project	Total images	Camera transect length (m)	Mean swathe width per image (m^3)	Area investigated (m^2)	Number of images with stony features	Total reef area	Mean stony reef cover (%)	Max reef height (cm)	Resemblance to 'stony reef'
ENV01	Morgan	127	270.2	0.59	160.65	0	0	0	0	None
ENV02	Morgan	103	260.6	0.52	135.80	0	0	0	0	None
ENV03	Morgan	77	267.2	0.64	170.17	0	0	0	0	None
ENV04	Morgan	100	258.0	0.58	150.86	0	0	0	0	None
ENV05	Morgan	84	277.9	0.67	184.97	0	0	0	0	None
ENV06	Morgan	90	272.0	0.55	149.08	0	0	0	0	None
ENV07	Morgan	97	273.2	0.76	208.27	0	0	0	0	None
ENV08	Morgan	104	296.1	0.61	180.41	0	0	0	0	None
ENV09	Morgan	94	268.9	0.67	178.96	0	0	0	0	None
ENV10	Morgan	90	257.8	0.56	145.13	0	0	0	0	None
ENV11	Morgan	109	330.7	0.66	217.96	0	0	0	0	None
ENV12	Morgan	91	272.0	0.83	226.66	0	0	0	0	None
ENV13	Morgan	94	281.1	0.77	215.18	0	0	0	0	None
ENV14	Morgan	93	277.5	0.88	245.54	0	0	0	0	None
ENV15	Morgan	106	292.1	0.61	177.55	0	0	0	0	None
ENV16	Morgan	91	269.9	0.72	194.82	0	0	0	0	None
ENV17	Morgan	96	275.3	0.67	185.09	0	0	0	0	None
ENV18	Morgan	92	278.7	0.59	163.11	0	0	0	0	None
ENV19	Morgan	81	272.8	0.67	182.01	0	0	0	0	None

Station	Project	Total images	Camera transect length (m)	Mean swathe width per image (m^3)	Area investigated (m^2)	Number of images with stony features	Total reef area	Mean stony reef cover (%)	Max reef height (cm)	Resemblance to 'stony reef'
ENV20	Morgan	104	277.1	0.71	196.79	0	0	0	0	None
ENV21	Morgan	101	314.1	0.69	215.35	0	0	0	0	None
ENV22	Morgan	95	268.9	0.78	209.32	0	0	0	0	None
ENV23	Morgan	82	271.3	0.62	169.30	0	0	0	0	None
ENV24	Morgan	96	271.9	0.64	173.17	0	0	0	0	None
ENV25	Morgan	74	278.0	0.61	169.82	0	0	0	0	None
ENV26	Morgan	83	273.5	0.66	180.98	0	0	0	0	None
ENV27	Morgan	84	265.7	0.56	149.91	0	0	0	0	None
ENV28	Morgan	99	271.8	0.84	228.41	0	0	0	0	None
ENV29	Morgan	78	273.6	0.70	190.50	0	0	0	0	None
ENV30	Morgan	94	268.5	0.72	194.57	0	0	0	0	None
ENV90	Morgan	96	270.0	0.79	213.20	0	0	0	0	None
ENV91	Morgan	91	271.6	0.78	210.86	0	0	0	0	None
ENV92	Morgan	94	265.2	1.08	285.11	0	0	0	0	None
ENV93	Morgan	94	284.1	0.97	274.40	0	0	0	0	None
ENV94	Morgan	85	269.5	0.84	225.75	0	0	0	0	None

B.4. Annex I stony reef assessment full assessment

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	1.19	2.5	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B3 Cobble and Boulder Area	13.41	8.6	Low	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	6.44	3.3	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	3.95	1.9	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	0.52	2.4	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV76	None	B2 Scattered Cobbles	1.91	1.9	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	0.33	1.7	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	0.76	4.1	Low	NA	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	1.48	4.3	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

			Epifaunal presence															
Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	5.81	3.2	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	0.64	2.1	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	0.67	1.7	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B4 Boulder Area	6.95	6.1	Low	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	2.05	3.2	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	4.59	3.2	Low	1	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	1.53	2.6	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B3 Cobble and Boulder Area	23.93	5.6	Low	NA	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B3 Cobble and Boulder Area	24.69	4.5	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	10.88	4	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	13.75	4.9	Low	1	NA	1	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	4.39	4.5	Low	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	30.18	8.6	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV76	None	B2 Scattered Cobbles	7.82	3.5	Low	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	30.74	6.9	Low	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	18.32	3.8	Low	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	18.34	5.4	Low	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B3 Cobble and Boulder Area	15.99	6.4	Low	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	6.57	1.7	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	24.61	4	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	31.86	5.5	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	6.13	2.8	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	16.77	6.2	Low	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	8.78	3.4	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	19.44	5.1	Low	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	4.93	3.9	NA	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	6.62	4.9	Low	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	7.77	0.1	Low	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	0.85	3.1	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B2 Scattered Cobbles	6.42	4.7	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	0.72	2.7	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	0.61	2.2	Low	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV76	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	None	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	None	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	2.65	3.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	0.34	2.4	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B3 Cobble and Boulder Area	14.19	4.5	Low	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B3 Cobble and Boulder Area	7.64	8.5	Low	1	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	8.37	4.9	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	4.56	3.1	NA	1	NA	NA	1	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	6.99	5.2	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	5.52	4.2	NA	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	1.9	2.4	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	1.71	3.3	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	7.91	4	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Station	Sediment classification	Sediment classification	% Coverage of stony reef	Height of reef (cm)	Resemblance of stony reef	Epifaunal presence												
						Serpulidae msp0001	Metridium cf.	Nemertesia 01	Nemertesia 02	Tubularia msp0001	Faunal turf	Pachymati cf.	Polymastia sp.	Suberites cf.	Raspailia ramosa	Tethya sp.	Porifera 01	Porifera 02
ENV79	None	B2 Scattered Cobbles	4.71	2.5	Low	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	13.52	2.8	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B3 Cobble and Boulder Area	28.67	3.4	Low	1	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	27.31	4.8	Low	1	NA	NA	NA	1	1	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	16.66	3.5	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B3 Cobble and Boulder Area	25.22	6.4	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B3 Cobble and Boulder Area	41.27	9.3	Medium	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	7.96	2.3	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B2 Scattered Cobbles	2.42	2.1	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	0.55	3.2	Low	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENV79	None	B1 Gravel Area	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

B.5. Hard substrate porifera coverage summary table (Morgan 2021 site specific survey)

Station	Number of images assessed with visibility	Number of images with hard substrate porifera	Average % of hard substrate porifera	Max % of hard substrate porifera
ENV01	126	0	NA	NA
ENV02	102	6	0.12	0.32
ENV03	77	0	NA	NA
ENV04	100	0	NA	NA
ENV05	84	1	0.21	0.21
ENV06	90	0	NA	NA
ENV07	97	0	NA	NA
ENV08	104	0	NA	NA
ENV09	94	1	0.06	0.06
ENV10	90	0	NA	NA
ENV11	109	0	NA	NA
ENV12	91	0	NA	NA
ENV13	94	0	NA	NA
ENV14	93	1	0.55	0.55
ENV15	106	0	NA	NA
ENV16	91	0	NA	NA
ENV17	95	0	NA	NA
ENV18	92	0	NA	NA
ENV19	81	0	NA	NA
ENV20	104	2	0.30	0.49
ENV21	101	0	NA	NA

Station	Number of images assessed with visibility	Number of images with hard substrate porifera	Average % of hard substrate porifera	Max % of hard substrate porifera
ENV22	95	0	NA	NA
ENV23	82	1	0.65	0.65
ENV24	95	0	NA	NA
ENV25	73	0	NA	NA
ENV26	83	0	NA	NA
ENV27	84	0	NA	NA
ENV28	99	0	NA	NA
ENV29	78	0	NA	NA
ENV30	94	0	NA	NA
ENV63	84	0	NA	NA
ENV64	70	0	NA	NA
ENV65	75	0	NA	NA
ENV72	89	0	NA	NA
ENV73	143	0	NA	NA
ENV74	97	0	NA	NA
ENV75	91	0	NA	NA
ENV76	105	0	NA	NA
ENV77	98	0	NA	NA
ENV78	105	1	1.28	1.28
ENV79	77	1	0.09	0.09
ENV90	96	0	NA	NA
ENV91	91	0	NA	NA

Station	Number of images assessed with visibility	Number of images with hard substrate porifera	Average % of hard substrate porifera	Max % of hard substrate porifera
ENV92	94	0	NA	NA
ENV93	93	0	NA	NA
ENV94	85	0	NA	NA

B.6. Hard substrate porifera coverage summary table (Morgan 2021 site specific survey)

Station	Number of images assessed with visibility	Number of images with hard substrate porifera	Average % of hard substrate porifera	Max % of hard substrate porifera
ENV01	126	0	NA	NA
ENV02	102	6	0.12	0.32
ENV03	77	0	NA	NA
ENV04	100	0	NA	NA
ENV05	84	1	0.21	0.21
ENV06	90	0	NA	NA
ENV07	97	0	NA	NA
ENV08	104	0	NA	NA
ENV09	94	1	0.06	0.06
ENV10	90	0	NA	NA
ENV11	109	0	NA	NA
ENV12	91	0	NA	NA
ENV13	94	0	NA	NA
ENV14	93	1	0.55	0.55
ENV15	106	0	NA	NA
ENV16	91	0	NA	NA
ENV17	95	0	NA	NA
ENV18	92	0	NA	NA
ENV19	81	0	NA	NA
ENV20	104	2	0.30	0.49
ENV21	101	0	NA	NA

Station	Number of images assessed with visibility	Number of images with hard substrate porifera	Average % of hard substrate porifera	Max % of hard substrate porifera
ENV22	95	0	NA	NA
ENV23	82	1	0.65	0.65
ENV24	95	0	NA	NA
ENV25	73	0	NA	NA
ENV26	83	0	NA	NA
ENV27	84	0	NA	NA
ENV28	99	0	NA	NA
ENV29	78	0	NA	NA
ENV30	94	0	NA	NA
ENV63	84	0	NA	NA
ENV64	70	0	NA	NA
ENV65	75	0	NA	NA
ENV72	89	0	NA	NA
ENV73	143	0	NA	NA
ENV74	97	0	NA	NA
ENV75	91	0	NA	NA
ENV76	105	0	NA	NA
ENV77	98	0	NA	NA
ENV78	105	1	1.28	1.28
ENV79	77	1	0.09	0.09
ENV90	96	0	NA	NA
ENV91	91	0	NA	NA

Station	Number of images assessed with visibility	Number of images with hard substrate porifera	Average % of hard substrate porifera	Max % of hard substrate porifera
ENV92	94	0	NA	NA
ENV93	93	0	NA	NA
ENV94	85	0	NA	NA

B.7. Hard substrate porifera coverage full data (Morgan 2022 site specific survey)

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
ENV02	13	NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		0.42	NA	NA	NA	1	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		0.82	NA	NA	NA	1	NA	NA
ENV02		1.27	NA	NA	NA	1	NA	NA
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		1.3	NA	NA	NA	1	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		1.61	NA	NA	NA	1	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		1.01	NA	NA	NA	1	NA	NA
ENV02		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV02		NA	NA	NA	NA	NA	NA	1
ENV09	31	1.62	NA	NA	NA	1	NA	NA
ENV09		0.48	NA	NA	NA	1	NA	NA
ENV09		0.78	NA	NA	NA	1	NA	NA
ENV09		NA	NA	NA	NA	NA	NA	1
ENV09		NA	NA	NA	NA	NA	NA	1
ENV09		0.15	NA	1	NA	NA	NA	NA
ENV11	50	0.3	NA	NA	NA	1	NA	NA
ENV13	35	NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		1.04	NA	NA	NA	1	NA	NA
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		0.71	NA	NA	NA	1	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
ENV13		NA	NA	NA	NA	NA	NA	1
22ENV06	39	1.2	NA	NA	NA	1	NA	1
22ENV06		0.42	NA	NA	NA	1	NA	NA
22ENV06		0.53	NA	NA	NA	1	NA	NA
22ENV06		NA	NA	NA	NA	NA	NA	1
22ENV06		NA	NA	NA	NA	NA	NA	1
22ENV06		NA	NA	NA	NA	NA	NA	1
22ENV06		NA	NA	NA	NA	NA	NA	1
22ENV06		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
22ENV06		0.6	NA	NA	NA	1	NA	NA
22ENV06		NA	NA	NA	NA	NA	NA	1
22ENV06		NA	NA	NA	NA	NA	NA	1
22ENV06		1.09	NA	NA	NA	1	NA	NA
22ENV06		NA	NA	NA	NA	NA	NA	1
22ENV07	48	2.59	NA	NA	NA	1	NA	NA
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV07		NA	NA	NA	NA	NA	NA	1
22ENV10	42	NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
22ENV10		NA	NA	NA	NA	NA	NA	1
22ENV10		NA	NA	NA	NA	NA	NA	1
22ENV10		NA	NA	NA	NA	NA	NA	1
22ENV10		1.23	NA	NA	NA	1	NA	NA
22ENV10		NA	NA	NA	NA	NA	NA	1
ENV63	19	NA	NA	NA	NA	NA	NA	1
ENV63		0.96	NA	NA	NA	1	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		1.45	NA	NA	NA	1	NA	1
ENV63		0.95	NA	NA	NA	1	NA	NA
ENV63		0.42	NA	NA	NA	1	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		0.65	NA	NA	NA	1	NA	NA
ENV63		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
ENV63		NA	NA	NA	NA	NA	NA	1
22ENV05	14	NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		2.2	NA	NA	NA	1	NA	NA
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		0.05	NA	NA	1	NA	NA	NA
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		NA	NA	NA	NA	NA	NA	1
22ENV05		0.99	1	NA	NA	NA	NA	1
ZOI24	51	0.7	NA	NA	NA	1	NA	NA
ZOI24		NA	NA	NA	NA	NA	NA	1
ZOI24		1.28	NA	NA	NA	1	NA	1
ZOI24		0.68	NA	NA	NA	1	NA	NA
ZOI24		NA	NA	NA	NA	NA	NA	1
ZOI24		1.29	NA	NA	NA	1	NA	NA

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
ZOI24		0.45	NA	NA	NA	1	NA	NA
ZOI24		0.53	NA	NA	NA	1	NA	NA
ZOI25	33	NA	NA	NA	NA	NA	NA	1
ZOI25		1.73	NA	NA	NA	1	NA	NA
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		0.56	NA	NA	NA	1	NA	NA
ZOI25		0.59	NA	NA	NA	1	NA	NA
ZOI25		0.6	NA	NA	NA	1	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		0.29	NA	NA	NA	1	NA	NA
ZOI25		1.08	NA	NA	NA	1	NA	1
ZOI25		0.9	NA	NA	NA	1	NA	NA
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		0.93	NA	NA	NA	1	NA	NA
ZOI25		1.41	NA	NA	NA	1	NA	1
ZOI25		0.43	NA	NA	NA	1	NA	1

Station	Number of blank rows	% Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	Alcyonium digitatum
ZOI25		0.64	NA	NA	NA	1	NA	NA
ZOI25		1.28	NA	NA	NA	1	NA	1
ZOI25		0.54	NA	NA	NA	1	NA	NA
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1
ZOI25		NA	NA	NA	NA	NA	NA	1

Appendix C: Benthic multivariate analysis results

C.1. Morgan site specific survey simper analysis (infauna)

SIMPER
Similarity Percentages - species contributions

One-Way Analysis

Data worksheet
Name: Data3
Data type: Abundance
Sample selection: All
Variable selection: All

Parameters
Resemblance: S17 Bray-Curtis similarity
Cut off for low contributions: 70.00%

Factor Groups

Sample	Simprof Group
22ENV05	af
22ENV06	af
ZOI17	af
ZOI25	af
22ENV07	ag
ZOI18	ag
22ENV09	e
ZOI23	e
22ENV10	ae
22ENV11	ad
ZOI24	ad
22ENV12	j
ZOI14	d
ZOI15	d
ZOI16	b
ZOI20	b
ZOI26	b
ZOI19	a
ENV22	a
ENV28	a
ZOI21	h
ZOI22	c
ENV01	u
ENV04	u
ENV05	u

ENV10	u
ENV14	u
ENV15	u
ENV19	u
ENV27	u
ENV59	u
ENV63	u
ENV64	u
ENV02	ac
ENV03	ac
ENV06	ac
ENV08	ac
ENV17	ac
ENV20	ac
ENV24	ac
ENV90	ac
ENV07	f
ENV09	l
ENV11	m
ENV18	m
ENV23	m
ENV30	m
ENV91	m
ENV94	m
ENV12	r
ENV13	r
ENV16	k
ENV21	k
ENV25	k
ENV26	k
ENV29	ab
ENV62	ab
ENV95	ab
ENV31	y
ENV36	y
ENV37	y
ENV41	y
ENV47	y
ENV97	y
ENV32	v
ENV33	s
ENV34	s
ENV35	s
ENV38	aa
ENV48	aa
ENV49	aa
ENV51	aa
ENV52	aa
ENV54	aa
ENV55	aa
ENV56	aa

ENV71	aa
ENV86	aa
ENV88	aa
ENV39	w
ENV42	w
ENV40	t
ENV45	t
ENV43	g
ENV44	g
ENV57	g
ENV66	g
ENV67A	g
ENV70	g
ENV83	g
ENV89	g
ENV93	g
ENV96	g
ENV50	i
ENV53	x
ENV60	z
ENV61	z
ENV65	z
ENV68	q
ENV69	o
ENV84	o
ENV82	p
ENV92	n

Group af
Average similarity: 48.62

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nemertea	3.61	2.23	6.83	4.59	4.59
Paradoneis lyra	2.81	1.88	7.99	3.86	8.45
Ascidiacea	3.11	1.68	3.08	3.46	11.91
Sipuncula	2.72	1.67	3.85	3.43	15.34
Syllis armillaris	2.43	1.45	4.87	2.98	18.32
Echinocyamus pusillus	2.54	1.44	3.08	2.96	21.28
Leiochone	2.16	1.41	5.22	2.91	24.19
Lysidice unicornis	2.37	1.41	7.12	2.89	27.08
Spisula	2.27	1.33	3.83	2.73	29.81
Pseudopolydora pulchra	2.04	1.32	6.55	2.72	32.52
Gnathiid indet.	1.85	1.25	4.05	2.57	35.09
Cirrophorus branchiatus	2.13	1.02	2.37	2.09	37.19
Aonides paucibranchiata	2.01	0.99	2.62	2.05	39.23
Grania	2.12	0.99	3.59	2.03	41.26
Obtusella intersecta	2.31	0.98	3.81	2.02	43.28
Pholoe inornata	1.95	0.97	2.97	2	45.27
Kurtiella bidentata	3.53	0.96	1.63	1.97	47.24
Tharyx killariensis	1.46	0.88	4.05	1.82	49.06
Abra	1.52	0.87	6.31	1.79	50.85

Pholoe baltica	1.43	0.82	3.29	1.68	52.53
Urothoe elegans	2.55	0.81	4.2	1.66	54.2
Glycera	1.21	0.77	8.44	1.59	55.78
Pista lornensis	1.29	0.77	8.44	1.59	57.37
Ampelisca spinipes	1.72	0.75	0.91	1.55	58.92
Praxillella affinis	1.77	0.75	0.91	1.55	60.47
Spiophanes bombyx	1.1	0.73	15.34	1.49	61.96
Hydroides norvegica	1.25	0.73	15.34	1.49	63.46
Sphaerosyllis hystrix	1.59	0.7	0.91	1.43	64.89
Phoronis	1.49	0.64	0.91	1.31	66.2
Parexogone hebes	1.37	0.63	0.91	1.3	67.49
Spirobranchus triqueter	1.91	0.61	0.72	1.26	68.75
Polycirrus	1.06	0.54	0.91	1.11	69.86
Leptochiton	1.76	0.53	0.79	1.09	70.95

Group ag
Average similarity: 38.03

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Lumbrineris aniara	3.92	3.5	SD=0!	9.21	9.21
Pholoe inornata	2.22	1.94	SD=0!	5.11	14.32
Syllis armillaris	2.22	1.94	SD=0!	5.11	19.43
Ampelisca spinipes	2	1.94	SD=0!	5.11	24.54
Nemertea	3.18	1.94	SD=0!	5.11	29.65
Lysidice unicornis	2.28	1.68	SD=0!	4.43	34.08
Leptochiton asellus	1.98	1.68	SD=0!	4.43	38.5
Glycera lapidum	1.57	1.37	SD=0!	3.61	42.11
Caulleriella alata	1.71	1.37	SD=0!	3.61	45.73
Dialychone dunerificta	1.41	1.37	SD=0!	3.61	49.34
Anomiidae	1.41	1.37	SD=0!	3.61	52.95
Echinocyamus pusillus	1.71	1.37	SD=0!	3.61	56.57
Sphaerosyllis hystrix	1.5	0.97	SD=0!	2.55	59.12
Sphaerosyllis taylori	1.91	0.97	SD=0!	2.55	61.68
Eulalia bilineata	1	0.97	SD=0!	2.55	64.23
Eumida	1	0.97	SD=0!	2.55	66.79
Mediomastus fragilis	1.62	0.97	SD=0!	2.55	69.34
Notomastus	1.21	0.97	SD=0!	2.55	71.9

Group e
Average similarity: 43.71

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Pectinariidae	3.81	3.9	SD=0!	8.92	8.92
Scalibregma inflatum	5.3	3.46	SD=0!	7.91	16.84
Kurtiella bidentata	4	3.46	SD=0!	7.91	24.75
Scoloplos armiger	2.91	2.95	SD=0!	6.75	31.49
Pholoe baltica	2.72	2.55	SD=0!	5.84	37.34
Pseudopolydora pulchra	2.55	2.55	SD=0!	5.84	43.18
Amphiura filiformis	2.44	2.33	SD=0!	5.33	48.51
Echinocyamus pusillus	2	2.09	SD=0!	4.77	53.28
Lumbrineris aniara	1.98	1.81	SD=0!	4.13	57.42

Spiophanes bombyx	2.09	1.81	SD=0!	4.13	61.55
Owenia	2.99	1.81	SD=0!	4.13	65.68
Nemertea	2.19	1.81	SD=0!	4.13	69.81
Malmgrenia	1.57	1.47	SD=0!	3.37	73.18

Group ae
Less than 2 samples in group

Group ad
Average similarity: 41.92

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Grania	3.82	2.96	SD=0!	7.06	7.06
Goniadella gracilis	3.56	2.81	SD=0!	6.7	13.76
Aonides paucibranchiata	4.05	2.81	SD=0!	6.7	20.46
Echinocyamus pusillus	3.07	2.65	SD=0!	6.32	26.78
Goniadidae	2.82	2.48	SD=0!	5.91	32.69
Pisione remota	4.14	2.29	SD=0!	5.47	38.16
Nemertea	2.64	2.29	SD=0!	5.47	43.63
Obtusella intersecta	2.32	1.87	SD=0!	4.47	48.09
Spisula	2.73	1.87	SD=0!	4.47	52.56
Caulleriella alata	1.41	1.32	SD=0!	3.16	55.72
Abra	1.71	1.32	SD=0!	3.16	58.88
Thracioidea	2.29	1.32	SD=0!	3.16	62.03
Nereididae	1.21	0.94	SD=0!	2.23	64.27
Palposyllis prosostoma	1	0.94	SD=0!	2.23	66.5
Sphaerosyllis bulbosa	1.37	0.94	SD=0!	2.23	68.73
Hesionura elongata	2.16	0.94	SD=0!	2.23	70.97

Group j
Less than 2 samples in group

Group d
Average similarity: 46.20

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Kurtiella bidentata	4.46	5.42	SD=0!	11.73	11.73
Lumbrineris aniara	2.19	3.13	SD=0!	6.77	18.5
Pectinariidae	2.99	3.13	SD=0!	6.77	25.27
Tellimya ferruginosa	2.09	3.13	SD=0!	6.77	32.03
Amphiura filiformis	2.28	3.13	SD=0!	6.77	38.8
Sthenelais limicola	1.57	2.55	SD=0!	5.53	44.33
Nucula	1.57	2.55	SD=0!	5.53	49.86
Echinocardium cordatum	1.41	2.55	SD=0!	5.53	55.39
Ophiuroidea (Juvenile)	1.57	2.55	SD=0!	5.53	60.91
Pholoe baltica	1.37	1.81	SD=0!	3.91	64.82
Ophelina acuminata	1	1.81	SD=0!	3.91	68.73
Chaetozone christiei	1	1.81	SD=0!	3.91	72.64

Group b
Average similarity: 36.99

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Sthenelais limicola	3.98	6.28	9.15	16.97	16.97
Tellimya ferruginosa	2.67	2.83	4.6	7.66	24.63
Kurtiella bidentata	1.88	2.78	2.94	7.53	32.16
Phoronis	1.28	1.97	2.94	5.32	37.48
Bathyporeia tenuipes	1.55	1.92	6.34	5.18	42.67
Nephtys	1.14	1.7	8.2	4.6	47.27
Pectinariidae	1.55	1.29	0.58	3.5	50.76
Poecilochaetus serpens	1.32	1.12	0.58	3.03	53.79
Abra alba	1.24	1.12	0.58	3.03	56.82
Nucula nitidosa	1.41	1.07	0.58	2.89	59.71
Scalibregma inflatum	1.55	1.04	0.58	2.81	62.52
Pharidae	1.15	0.9	0.58	2.44	64.96
Aricidea (Aricidea) minuta	1.05	0.76	0.58	2.04	67
Phaxas pellucidus	1.05	0.76	0.58	2.04	69.05
Chaetozone christiei	1.41	0.74	0.58	1.99	71.03

Group a
Average similarity: 21.80

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Abra	1.82	6.04	6.02	27.7	27.7
Scoloplos armiger	1.66	4.28	3.3	19.64	47.34
Echinocyamus pusillus	1.61	3.49	6.02	15.99	63.34
Spio	0.67	1.38	0.58	6.34	69.68
Bivalvia	0.67	1.38	0.58	6.34	76.01

Group h
Less than 2 samples in group

Group c
Less than 2 samples in group

Group u
Average similarity: 45.15

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Poecilochaetus serpens	2.51	2.19	4.54	4.84	4.84
Nemertea	2.57	2.09	2.02	4.63	9.47
Urothoe elegans	2.1	1.82	3.16	4.04	13.51
Scalibregma inflatum	2.17	1.56	2.33	3.45	16.96
Lysidice unicornis	1.79	1.45	1.94	3.21	20.18
Lagis koreni	1.87	1.33	1.55	2.94	23.12
Pholoe baltica	1.61	1.24	1.94	2.75	25.87
Pholoe inornata	1.57	1.17	1.7	2.6	28.47
Ampharete lindstroemi agg.	1.82	1.16	1.53	2.58	31.05
Phoronis	1.71	1.14	1.31	2.53	33.57
Spiophanes bombyx	1.57	1.14	1.73	2.52	36.09
Chaetozone zetlandica	1.67	1.12	1.25	2.47	38.56
Ampelisca	1.38	0.99	1.25	2.19	40.75

Ophelina acuminata	1.23	0.92	1.29	2.05	42.79
Pista lornensis	1.21	0.85	1.24	1.88	44.67
Cirrophorus branchiatus	1.28	0.78	0.95	1.72	46.39
Ampelisca spinipes	1.32	0.77	0.96	1.71	48.1
Pseudopolydora pulchra	1.06	0.77	1.27	1.7	49.8
Urothoe	1.52	0.76	0.94	1.68	51.48
Golfingiidae	1.19	0.71	1.29	1.56	53.05
Ampelisca typica	1.14	0.7	0.97	1.56	54.6
Sabellidae	0.96	0.69	1.32	1.52	56.12
Aonides paucibranchiata	1.08	0.68	0.97	1.5	57.62
Leptochiton asellus	1.14	0.63	0.94	1.4	59.02
Spirobranchus triqueter	1.09	0.62	0.93	1.37	60.39
Lumbrineris aniara agg.	1.16	0.61	0.93	1.34	61.73
Echinocyamus pusillus	1.33	0.61	0.72	1.34	63.07
Paradoneis lyra	1.21	0.58	0.77	1.29	64.37
Owenia	0.96	0.58	0.96	1.29	65.66
Glycera lapidum	0.94	0.58	0.96	1.29	66.94
Kurtiella bidentata	1.28	0.57	0.73	1.26	68.2
Syllis armillaris agg.	0.99	0.54	0.75	1.19	69.4
Caulleriella alata	0.84	0.53	0.98	1.18	70.58

Group ac
Average similarity: 36.44

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nemertea	2.02	1.92	4.59	5.27	5.27
Echinocyamus pusillus	2.28	1.88	1.6	5.15	10.42
Goniadella gracilis	1.86	1.58	1.66	4.33	14.75
Poecilochaetus serpens	1.94	1.49	2.92	4.1	18.84
Scalibregma inflatum	2.01	1.44	1.44	3.95	22.79
Owenia	1.62	1.43	3.13	3.92	26.71
Pholoe baltica	2.01	1.34	1.26	3.69	30.39
Polynoidae	1.5	1.28	4.51	3.51	33.91
Golfingiidae	1.97	1.2	0.93	3.29	37.19
Kurtiella bidentata	2.43	1.2	0.85	3.28	40.47
Bivalvia	1.69	1.19	1.5	3.26	43.73
Pholoe inornata	1.54	1.01	1.54	2.78	46.51
Aonides paucibranchiata	1.26	0.74	0.99	2.03	48.54
Nereididae	1.11	0.69	0.99	1.89	50.44
Glycera lapidum	1.18	0.68	1	1.87	52.31
Phoronis	1.1	0.67	1.01	1.84	54.14
Thracioidea	1.11	0.64	1.01	1.76	55.9
Phascolion (Phascolion) strombus strombus	1.2	0.64	0.72	1.75	57.66
Syllis	1.16	0.62	1.02	1.71	59.37
Asclerocheilus	0.84	0.56	1.04	1.53	60.9
Abra	1.13	0.52	0.68	1.44	62.33
Lagis koreni	1.52	0.5	0.62	1.37	63.71
Amphipoda	0.87	0.45	0.71	1.24	64.95
Ampelisca spinipes	0.78	0.43	0.7	1.19	66.14
Lysidice unicornis	0.82	0.43	0.72	1.17	67.31
Timoclea ovata	1.05	0.43	0.66	1.17	68.47

Moerella donacina	0.84	0.4	0.71	1.1	69.57
Ampelisca	0.75	0.4	0.73	1.09	70.67

Group f
Less than 2 samples in group

Group l
Less than 2 samples in group

Group m
Average similarity: 40.39

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Poecilochaetus serpens	5.53	5.23	2.7	12.95	12.95
Lagis koreni	4.05	4.1	2.08	10.14	23.09
Scalibregma inflatum	3.59	3.53	7.98	8.74	31.83
Owenia	2.56	2.69	3.78	6.67	38.5
Scoloplos armiger	2.69	2.53	2.1	6.27	44.77
Sthenelais limicola	1.81	2.19	9.2	5.42	50.19
Spiophanes bombyx	2.35	1.95	1.2	4.84	55.03
Nemertea	2.02	1.61	1.15	3.99	59.02
Pseudopolydora pulchra	1.3	1.46	4.74	3.61	62.63
Pholoe baltica	1.5	1.18	1.12	2.93	65.56
Abra	1.35	1.13	1.25	2.79	68.34
Echinocyamus pusillus	1.7	1.09	0.7	2.7	71.04

Group r
Average similarity: 49.97

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Lagis koreni	3.87	3.41	SD=0!	6.82	6.82
Scalibregma inflatum	3.37	3.23	SD=0!	6.47	13.29
Ampharete lindstroemi agg.	2.72	2.64	SD=0!	5.28	18.58
Owenia	2.34	2.41	SD=0!	4.82	23.4
Abra	2.12	2.16	SD=0!	4.31	27.71
Echinocyamus pusillus	2.58	2.16	SD=0!	4.31	32.03
Nemertea	2.73	2.16	SD=0!	4.31	36.34
Spio symphyta	2.09	1.87	SD=0!	3.74	40.08
Aoridae	2.74	1.87	SD=0!	3.74	43.82
Phoronis	1.98	1.87	SD=0!	3.74	47.55
Pholoe baltica	1.71	1.52	SD=0!	3.05	50.6
Goniadella gracilis	1.41	1.52	SD=0!	3.05	53.65
Lysidice unicornis	1.41	1.52	SD=0!	3.05	56.7
Paradoneis lyra	1.57	1.52	SD=0!	3.05	59.75
Aonides paucibranchiata	1.41	1.52	SD=0!	3.05	62.81
Spiophanes bombyx	1.93	1.52	SD=0!	3.05	65.86
Lysilla nivea	1.41	1.52	SD=0!	3.05	68.91
Ampelisca typica	1.83	1.52	SD=0!	3.05	71.96

Group k
Average similarity: 51.44

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spiophanes bombyx	2.99	5.17	12.7	10.05	10.05
Scoloplos armiger	2.93	5.12	8.07	9.96	20.01
Lagis koreni	3.26	5.06	10.84	9.84	29.85
Poecilochaetus serpens	2.98	4.32	2.23	8.39	38.24
Sthenelais limicola	2.21	3.8	7.26	7.39	45.63
Amphiuridae	2.44	3.46	2.18	6.72	52.35
Nephtys cirrosa	1.8	2.88	2.48	5.6	57.95
Scolelepis bonnieri	1.46	2.38	4.3	4.63	62.58
Gari fervensis	1.79	2.36	6.18	4.58	67.16
Nemertea	1.21	2.09	6.55	4.07	71.23

Group ab
Average similarity: 39.03

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nemertea	2.82	3.75	9.36	9.62	9.62
Ampharete lindstroemi agg.	2.82	3.35	3.01	8.58	18.2
Phascolion (Phascolion) strombus strombus	1.79	2.14	44.95	5.48	23.69
Parexogone hebes	1.61	2.01	9.36	5.14	28.83
Syllis	1.41	2.01	9.36	5.14	33.97
Golfingiidae	2.49	1.93	2.6	4.95	38.92
Poecilochaetus serpens	1.94	1.93	1.94	4.95	43.87
Cirrophorus branchiatus	1.66	1.72	4.53	4.42	48.29
Podarkeopsis	1.28	1.63	3.39	4.18	52.47
Cheirocratus	1.28	1.62	3.82	4.16	56.62
Lumbrineris aniara agg.	1.62	1.59	10.39	4.08	60.7
Pholoe baltica	1.14	1.42	9.36	3.64	64.34
Pholoe inornata	1.14	1.42	9.36	3.64	67.98
Scoloplos armiger	1.14	1.42	9.36	3.64	71.61

Group y
Average similarity: 53.39

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nemertea	3.73	2.42	15.23	4.53	4.53
Scalibregma inflatum	3.53	2.18	6.82	4.08	8.61
Aonides paucibranchiata	3	1.74	3.26	3.27	11.87
Ampharete lindstroemi agg.	2.61	1.65	5.39	3.08	14.96
Leptochiton asellus	3.1	1.6	1.98	3	17.96
Dialychone	2.59	1.52	3.52	2.85	20.81
Pholoe inornata	2.57	1.45	3.36	2.72	23.53
Golfingiidae	2.29	1.41	5.01	2.64	26.17
Pholoe baltica	2.38	1.3	4.99	2.43	28.6
Leiochone	2.2	1.24	4.17	2.32	30.92
Glycera lapidum	1.92	1.2	5.51	2.24	33.17
Laonice bahusiensis agg.	2.39	1.15	2.46	2.15	35.32
Goniadella gracilis	1.97	1.07	2.92	2	37.32
Serpulidae	1.76	1.05	9.43	1.96	39.29
Lysidice unicornis	1.76	0.96	2.7	1.8	41.09

Eulalia mustela	1.69	0.93	3.37	1.75	42.83
Notomastus	1.4	0.91	5.53	1.7	44.53
Jasmineira caudata	1.6	0.89	3.21	1.67	46.2
Owenia	1.48	0.88	3.49	1.64	47.84
Paraonidae	1.84	0.87	1.25	1.63	49.48
Syllis garciai/mauretanica	1.68	0.85	1.35	1.6	51.08
Chaetozone zetlandica	1.38	0.85	3.71	1.59	52.67
Megamphopus cornutus	1.67	0.84	3.15	1.57	54.24
Ampelisca	1.56	0.84	2.8	1.56	55.8
Echinocyamus pusillus	1.81	0.82	1.29	1.54	57.34
Lumbrineris aniara agg.	1.43	0.78	6.01	1.46	58.8
Grania	1.68	0.77	1.25	1.44	60.24
Syllis	1.57	0.75	1.27	1.4	61.63
Poecilochaetus serpens	1.19	0.73	9.71	1.36	63
Cirrophorus branchiatus	1.64	0.7	1.18	1.32	64.32
Phoronis	1.68	0.68	1.12	1.27	65.59
Syllis armillaris agg.	1.48	0.64	1.31	1.2	66.79
Nototropis vedlomensis	1.52	0.62	1.24	1.15	67.94
Ophelina acuminata	1.22	0.61	1.27	1.14	69.08
Spirobranchus triqueter	1.4	0.59	1.23	1.1	70.18

Group v
Less than 2 samples in group

Group s
Average similarity: 58.04

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ampharete lindstroemi agg.	6.6	3.36	4.57	5.79	5.79
Poecilochaetus serpens	4.15	2.49	13.08	4.29	10.08
Ampelisca provincialis	4.98	2.44	3.31	4.2	14.28
Phoronis	4.45	2.44	8.86	4.2	18.48
Nemertea	4.03	2.42	37.69	4.16	22.64
Pholoe baltica	4.92	2.18	1.96	3.75	26.39
Owenia	3.74	2	61.31	3.44	29.83
Scalibregma inflatum	3.79	1.99	14.04	3.43	33.26
Cerianthus lloydii	2.94	1.75	11.18	3.01	36.27
Spiophanes bombyx	3.08	1.73	5.03	2.98	39.26
Chaetozone zetlandica	2.87	1.66	9.38	2.86	42.12
Photis longicaudata	3.01	1.63	9.96	2.8	44.92
Cirrophorus branchiatus	2.91	1.63	11.71	2.8	47.73
Leiochone	2.76	1.63	14.04	2.8	50.53
Lagis koreni	3.6	1.55	1.92	2.67	53.2
Praxillella affinis	2.9	1.46	18.26	2.51	55.71
Aonides paucibranchiata	2.37	1.41	61.31	2.43	58.14
Paradoneis lyra	2.58	1.26	61.31	2.18	60.32
Ampelisca spinipes	2.13	1.15	9.96	1.98	62.3
Kurtiella bidentata	2.41	1.15	2.67	1.98	64.28
Caulleriella alata	1.73	1.09	61.31	1.88	66.17
Eteone cf. longa	1.9	1.09	61.31	1.88	68.05
Parexogone hebes	1.52	0.89	61.31	1.54	69.59

Podarkeopsis	1.67	0.84	2.31	1.45	71.04

Group aa
Average similarity: 54.57

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Scalibregma inflatum	4.67	2.45	4.1	4.48	4.48
Nemertea	4.12	2.38	5.97	4.37	8.85
Ampharete lindstroemi agg.	4.05	2.13	3	3.9	12.75
Pholoe baltica	3.25	1.66	3.67	3.04	15.79
Aonides paucibranchiata	2.88	1.66	4.55	3.04	18.83
Phoronis	2.97	1.39	3.28	2.55	21.37
Cirrophorus branchiatus	2.39	1.26	3.51	2.32	23.69
Lysidice unicornis	2.19	1.25	5.32	2.29	25.98
Leptochiton asellus	2.61	1.24	1.91	2.27	28.26
Ophelina acuminata	2.18	1.16	3.1	2.12	30.38
Polycirrus	2.22	1.15	3.27	2.1	32.48
Ampelisca	2.46	1.13	2.59	2.07	34.55
Poecilochaetus serpens	2.21	1.06	2.42	1.93	36.48
Paradoneis ilvana	1.99	1.02	3.56	1.86	38.35
Chaetozone zetlandica	1.77	0.94	3.12	1.71	40.06
Urothoe marina	1.79	0.89	2.79	1.62	41.69
Urothoe	1.81	0.88	1.96	1.61	43.3
Laonice bahusiensis agg.	1.92	0.88	1.67	1.61	44.91
Dialychone	2.01	0.84	1.2	1.53	46.44
Lagis koreni	1.66	0.84	3.44	1.53	47.97
Nototropis vedlomensis	1.57	0.83	4.16	1.52	49.49
Aricidea (Acmira) cerrutii	1.78	0.81	1.81	1.49	50.98
Praxillella affinis	1.74	0.81	1.67	1.48	52.46
Glycera lapidum	1.54	0.8	1.71	1.47	53.93
Owenia	1.39	0.74	1.89	1.36	55.29
Terebellides	1.43	0.69	1.91	1.27	56.56
Cerianthus lloydii	1.66	0.69	1.27	1.26	57.83
Pholoe inornata	1.43	0.67	1.88	1.22	59.05
Serpulidae	1.35	0.67	1.76	1.22	60.27
Kurtiella bidentata	1.78	0.62	1.06	1.14	61.41
Dipolydora caulleryi agg.	1.18	0.61	1.9	1.12	62.53
Polynoidae	1.23	0.56	1.27	1.03	63.56
Echinocyamus pusillus	1.4	0.56	1.23	1.02	64.58
Ampelisca typica	1.29	0.53	0.97	0.97	65.55
Paradoneis lyra	1.54	0.53	0.91	0.96	66.51
Goniadella gracilis	1.1	0.51	1.27	0.94	67.45
Amphipoda	1.1	0.5	1.29	0.92	68.37
Leiochone	1.16	0.5	1.27	0.91	69.27
Mediomastus fragilis	1.09	0.48	1.31	0.88	70.16

Group w
Average similarity: 52.36

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Scalibregma inflatum	4.85	2.27	SD=0!	4.34	4.34

Golfingia (Golfingia) elongata	3.07	2.14	SD=0!	4.09	8.44
Unciola planipes	2.82	2.01	SD=0!	3.83	12.27
Owenia	2.72	1.86	SD=0!	3.55	15.81
Echinocyamus pusillus	2.64	1.86	SD=0!	3.55	19.36
Syllis garciai/mauretanica	2.64	1.86	SD=0!	3.55	22.91
Phoronis	2.92	1.69	SD=0!	3.24	26.14
Nereididae	2	1.52	SD=0!	2.9	29.04
Nemertea	2.87	1.52	SD=0!	2.9	31.93
Golfingiidae	2.5	1.52	SD=0!	2.9	34.83
Ampharete lindstroemi agg.	2.8	1.52	SD=0!	2.9	37.72
Syllis	2.93	1.31	SD=0!	2.51	40.23
Lagis koreni	1.73	1.31	SD=0!	2.51	42.74
Eulalia mustela	1.57	1.07	SD=0!	2.05	44.78
Mediomastus fragilis	1.83	1.07	SD=0!	2.05	46.83
Paraonidae	1.71	1.07	SD=0!	2.05	48.88
Paradoneis ilvana	1.83	1.07	SD=0!	2.05	50.93
Poecilochaetus serpens	2.12	1.07	SD=0!	2.05	52.97
Aonides paucibranchiata	2.89	1.07	SD=0!	2.05	55.02
Ampelisca typica	1.57	1.07	SD=0!	2.05	57.07
Urothoe marina	1.57	1.07	SD=0!	2.05	59.12
Nucula hanleyi	1.83	1.07	SD=0!	2.05	61.16
Eteone cf. longa	1.41	1.07	SD=0!	2.05	63.21
Dialychone	1.71	1.07	SD=0!	2.05	65.26
Pholoe baltica	3.1	0.76	SD=0!	1.45	66.7
Pholoe inornata	1	0.76	SD=0!	1.45	68.15
Malmgrenia thomsonae	1.72	0.76	SD=0!	1.45	69.6
Glycera lapidum	1.62	0.76	SD=0!	1.45	71.05

Group t
Average similarity: 54.61

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ampharete lindstroemi agg.	3.92	3.22	SD=0!	5.89	5.89
Nemertea	3.59	2.96	SD=0!	5.42	11.32
Scalibregma inflatum	4.13	2.82	SD=0!	5.17	16.49
Kurtiella bidentata	3.79	2.68	SD=0!	4.9	21.39
Lagis koreni	3.35	2.53	SD=0!	4.62	26.01
Pholoe baltica	3.19	2.36	SD=0!	4.33	30.34
Polycirrus	2	1.79	SD=0!	3.27	33.61
Paradoneis lyra	2.28	1.55	SD=0!	2.83	36.44
Owenia	1.98	1.55	SD=0!	2.83	39.27
Photis longicaudata	1.87	1.55	SD=0!	2.83	42.1
Tanaopsis graciloides	1.87	1.55	SD=0!	2.83	44.94
Platyhelminthes	2.09	1.55	SD=0!	2.83	47.77
Eteone cf. longa	1.87	1.55	SD=0!	2.83	50.6
Urothoe	3.46	1.55	SD=0!	2.83	53.43
Poecilochaetus serpens	2.83	1.26	SD=0!	2.31	55.74
Urothoe elegans	1.41	1.26	SD=0!	2.31	58.06
Megamphopus cornutus	1.57	1.26	SD=0!	2.31	60.37
Aoridae	3.05	1.26	SD=0!	2.31	62.68
Bivalvia	1.71	1.26	SD=0!	2.31	64.99

Cerianthus lloydii	1.71	1.26	SD=0!	2.31	67.3
Glycinde nordmanni	1	0.89	SD=0!	1.63	68.94
Schistomeringos rudolphi	1.21	0.89	SD=0!	1.63	70.57

Group g
Average similarity: 32.41

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Pisione remota	3.55	4.87	1.17	15.02	15.02
Hesionura elongata	2.4	3.07	2.3	9.46	24.48
Polygordius	2.81	2.69	1.26	8.29	32.78
Aonides paucibranchiata	2.29	2.59	1.76	8	40.78
Grania	1.9	2.38	1.62	7.34	48.11
Nemertea	1.77	2.23	1.61	6.87	54.98
Goniadella gracilis	1.75	1.73	0.78	5.35	60.33
Unciola planipes	1.88	1.4	0.86	4.33	64.67
Glycera lapidum	1.31	1.4	1.13	4.32	68.99
Eurydice truncata	1.07	1.09	0.62	3.37	72.35

Group i
Less than 2 samples in group

Group x
Less than 2 samples in group

Group z
Average similarity: 55.82

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ampharete lindstroemi agg.	4.07	3.16	19.43	5.67	5.67
Nemertea	3.36	2.36	13.84	4.24	9.9
Leptochiton asellus	3.53	2.27	6.28	4.06	13.97
Aonides paucibranchiata	2.55	1.86	5.02	3.33	17.3
Pholoe inornata	2.3	1.76	8.3	3.15	20.45
Cirrophorus branchiatus	2.69	1.76	8.3	3.15	23.6
Lysidice unicornis	2.29	1.44	3.1	2.57	26.18
Phoronis	2.44	1.42	3.53	2.55	28.73
Ophelina acuminata	1.9	1.42	13.36	2.54	31.27
Praxillella affinis	1.95	1.32	5.02	2.36	33.63
Chaetozone zetlandica	1.88	1.31	6.28	2.35	35.97
Golfingiidae	1.72	1.25	5.06	2.25	38.22
Pholoe baltica	1.79	1.24	8.3	2.23	40.45
Euchone pararosea	1.72	1.24	8.3	2.23	42.68
Scoloplos armiger	1.79	1.24	12.29	2.22	44.9
Eteone cf. longa	1.63	1.24	12.29	2.22	47.12
Parexogone hebes	1.52	1.16	13.36	2.08	49.2
Terebellides	1.41	1.16	13.36	2.08	51.28
Dipolydora caulleryi agg.	1.41	1.16	13.36	2.08	53.35
Leiochone	1.75	1.09	2.41	1.95	55.3
Lagis koreni	1.49	1.04	2.38	1.86	57.16
Glycera lapidum	1.58	1.02	3.1	1.82	58.97

Poecilochaetus serpens	1.28	0.94	3.46	1.69	60.66
Nototropis vedlomensis	1.38	0.94	3.46	1.69	62.35
Laonice bahusiensis agg.	1.47	0.94	3.46	1.69	64.04
Schistomeringos rudolphi	1.28	0.93	5.02	1.67	65.7
Scalibregma inflatum	1.55	0.93	5.02	1.67	67.37
Owenia	1.47	0.93	5.02	1.67	69.04
Paradoneis lyra	1.24	0.82	13.36	1.47	70.51

Group q
Less than 2 samples in group

Group o
Average similarity: 47.36

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Scalibregma inflatum	7.26	4.05	SD=0!	8.55	8.55
Pholoe baltica	3.15	2.16	SD=0!	4.57	13.12
Urothoe marina	2.9	2.02	SD=0!	4.27	17.39
Paradoneis lyra	3.29	1.87	SD=0!	3.96	21.35
Notomastus	2.44	1.71	SD=0!	3.61	24.96
Aonides paucibranchiata	2.44	1.71	SD=0!	3.61	28.57
Goniadella gracilis	2.22	1.53	SD=0!	3.23	31.8
Leptocheirus hirsutimanus	2.12	1.53	SD=0!	3.23	35.03
Kurtiella bidentata	3.6	1.53	SD=0!	3.23	38.26
Nemertea	2.66	1.53	SD=0!	3.23	41.5
Glycera lapidum	1.87	1.33	SD=0!	2.8	44.29
Lysilla nivea	2.6	1.33	SD=0!	2.8	47.09
Owenia	1.87	1.33	SD=0!	2.8	49.89
Ericthonius punctatus	2.09	1.33	SD=0!	2.8	52.69
Tanaopsis graciloides	2.09	1.33	SD=0!	2.8	55.49
Polynoidae	1.93	1.08	SD=0!	2.28	57.77
Malmgrenia	1.57	1.08	SD=0!	2.28	60.05
Glycera	1.41	1.08	SD=0!	2.28	62.34
Syllis	1.41	1.08	SD=0!	2.28	64.62
Mediomastus fragilis	1.93	1.08	SD=0!	2.28	66.91
Spionidae	1.83	1.08	SD=0!	2.28	69.19
Polycirrus	2.29	1.08	SD=0!	2.28	71.48

Group p
Less than 2 samples in group

Group n
Less than 2 samples in group

C.2. Morgan 2021 site specific survey simper analysis (epifauna)

SIMPER
Similarity Percentages - species contributions

One-Way Analysis

Data worksheet
Name: Data3
Data type: Abundance
Sample selection: All
Variable selection: All

Parameters
Resemblance: S17 Bray-Curtis similarity
Cut off for low contributions: 70.00%

Factor Groups

Sample	Simprof Groups
22ENV05	q
22ENV06	p
22ENV07	s
22ENV11	s
22ENV09	t
22ENV10	t
ZOI23	t
ZOI24	t
22ENV12	u
ZOI14	u
ZOI15	u
ZOI16	u
ZOI19	u
ZOI20	u
ZOI22	u
ZOI26	u
ZOI17	r
ZOI25	r
ZOI18	o
ZOI21	o
ENV01	c
ENV08	c
ENV94	c
ENV96	c
ENV02	e
ENV03	e
ENV06	e
ENV12	e
ENV13	e
ENV17	e

ENV18	e
ENV19	e
ENV24	e
ENV39	e
ENV69	e
ENV04	d
ENV05	d
ENV10	d
ENV15	d
ENV20	d
ENV27	d
ENV29	d
ENV31	d
ENV32	d
ENV33	d
ENV34	d
ENV35	d
ENV36	d
ENV37	d
ENV38	d
ENV41	d
ENV42	d
ENV47	d
ENV48	d
ENV49	d
ENV50	d
ENV51	d
ENV52	d
ENV53	d
ENV54	d
ENV55	d
ENV56	d
ENV57	d
ENV59	d
ENV60	d
ENV61	d
ENV62	d
ENV63	d
ENV64	d
ENV65	d
ENV71	d
ENV82	d
ENV84	d
ENV86	d
ENV88	d
ENV90	d
ENV92	d
ENV97	d
ENV07	l
ENV93	l

ENV09	a
ENV23	a
ENV40	a
ENV43	a
ENV45	a
ENV67	a
ENV68	a
ENV70	a
ENV95	a
ENV11	m
ENV91	m
ENV14	b
ENV28	b
ENV16	n
ENV21	n
ENV22	n
ENV25	n
ENV26	n
ENV30	n
ENV44	n
ENV46	k
ENV80	k
ENV81	k
ENV85	k
ENV87	k
ENV58	i
ENV66	f
ENV83	f
ENV89	f
ENV72	g
ENV75	g
ENV77	g
ENV78	g
ENV73	h
ENV74	j
ENV76	j
ENV79	j

Group q
Less than 2 samples in group

Group p
Less than 2 samples in group

Group s
Average similarity: 48.35

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Serpulidae stet.	4.89	8.75	SD=0!	18.1	18.1
Alcyonium digitatum	3.94	7.4	SD=0!	15.3	33.4

Pectinidae stet.	3.03	4.68	SD=0!	9.67	43.07
Paguroidea stet.	2.12	3.82	SD=0!	7.9	50.97
Nematoda	1.41	2.7	SD=0!	5.59	56.55
Hydrozoa indet. 01	1.21	1.91	SD=0!	3.95	60.5
Tubularia indivisa inc.	2.44	1.91	SD=0!	3.95	64.45
Anomiidae indet. 01	1.21	1.91	SD=0!	3.95	68.4
Buccinium undatum inc.	1.37	1.91	SD=0!	3.95	72.35

Group t
Average similarity: 39.47

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Tubularia indivisa inc.	2.43	4.26	6.81	10.8	10.8
Alcyonium digitatum	2.01	4.07	6.32	10.31	21.11
Ophiura ophiura inc.	1.97	3.48	1.87	8.82	29.92
Paguroidea stet.	1.47	3.11	3.39	7.87	37.8
Serpulidae stet.	1.76	3.1	5.66	7.85	45.65
Psolus phantapus inc.	1.18	2.45	7.3	6.21	51.85
Sertulariidae	1	2.45	7.3	6.21	58.06
Nematoda	1.1	2.45	7.3	6.21	64.27
Pectinidae stet.	1.98	2.12	0.9	5.36	69.63
Asterias rubens	0.75	1.3	0.9	3.3	72.93

Group u
Average similarity: 26.52

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ophiura ophiura inc.	2.55	8	1.1	30.15	30.15
Astropecten irregularis	1.53	3.67	0.7	13.85	44
Nematoda	0.63	1.9	0.69	7.16	51.16
Paguroidea stet.	0.73	1.48	0.68	5.58	56.74
Leptothecata	0.5	1.08	0.5	4.09	60.83
Phoronis	0.5	1.08	0.5	4.08	64.91
Actiniaria indet. 01	0.85	0.91	0.49	3.45	68.36
Ceriantharia stet.	1	0.91	0.48	3.42	71.78

Group r
Average similarity: 67.84

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Serpulidae stet.	7.12	7.88	SD=0!	11.62	11.62
Alcyonium digitatum	5.04	5.7	SD=0!	8.4	20.02
Pectinidae stet.	4.89	4.6	SD=0!	6.78	26.8
Ophiura albida inc.	3.72	3.14	SD=0!	4.63	31.43
Echinoidea indet. GL0002	2.24	2.66	SD=0!	3.92	35.35
Suberites indet. 03	2.92	2.66	SD=0!	3.92	39.26
Psolus phantapus inc.	2.12	2.38	SD=0!	3.5	42.77
Asterias rubens	2.09	2.06	SD=0!	3.03	45.8
Ophiura ophiura inc.	1.73	2.06	SD=0!	3.03	48.83
Pecten maximus	1.98	2.06	SD=0!	3.03	51.87

Paguroidea stet.	2.03	1.68	SD=0!	2.48	54.34
Actiniaria indet. 01	1.71	1.68	SD=0!	2.48	56.82
Spatangus purpureus	1.41	1.68	SD=0!	2.48	59.3
Aporrhais pespelecani	1.57	1.68	SD=0!	2.48	61.77
Buccinium undatum inc.	2.29	1.68	SD=0!	2.48	64.25
Scaphopoda stet.	1.71	1.68	SD=0!	2.48	66.73
Myxicola stet.	1.5	1.19	SD=0!	1.75	68.48
Cirripedia stet.	2.3	1.19	SD=0!	1.75	70.23

Group o
Average similarity: 60.49

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Serpulidae stet.	7.21	8.39	SD=0!	13.87	13.87
Alcyonium digitatum	6.12	6.85	SD=0!	11.33	25.2
Ophiura albida inc.	5.87	6.75	SD=0!	11.16	36.36
Ophiothrix fragilis inc.	5.51	6.11	SD=0!	10.1	46.46
Ceriantharia stet.	4.9	3.9	SD=0!	6.44	52.9
Actiniaria indet. 01	1.57	1.66	SD=0!	2.75	55.65
Nemertesia antennina inc.	1.93	1.66	SD=0!	2.75	58.4
Sertulariidae indet. 01	1.93	1.66	SD=0!	2.75	61.14
Paguroidea stet.	1.37	1.18	SD=0!	1.94	63.09
Ascidiacea indet. 01	1	1.18	SD=0!	1.94	65.03
Actiniaria indet. 03	1.21	1.18	SD=0!	1.94	66.97
Asterias rubens	1.5	1.18	SD=0!	1.94	68.92
Buccinium undatum inc.	1.21	1.18	SD=0!	1.94	70.86

Group c
Average similarity: 49.76

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Burrows	1.53	4.68	3.41	9.41	9.41
Sertulariidae	1	4.45	6.99	8.94	18.35
Hydrallmania falcata	1.1	4.45	6.99	8.94	27.29
Copepoda	1	4.45	6.99	8.94	36.23
Schizomavella	1	4.45	6.99	8.94	45.17
Faunalturf	0.69	2.69	2.83	5.4	50.57
Annelida_Serpulidaemsp0001	0.66	2.4	3.5	4.82	55.39
Nematoda	0.85	2.39	0.9	4.81	60.2
Animaliatubes	0.59	2.17	3.91	4.36	64.56
Mollusca_Pectinidae01	0.45	1.64	1.96	3.29	67.85
Cnidaria_Tubulariamsp0001	0.42	1.37	3.36	2.75	70.6

Group e
Average similarity: 49.65

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	1.38	6.01	6.61	12.1	12.1
Copepoda	1	4.51	7.93	9.08	21.18
Decapoda	1.01	3.37	1.32	6.78	27.96

Penetrantia	0.89	2.94	1.33	5.92	33.88
Cnidaria_Alcyoniumdigitatum	0.63	2.48	3.51	5	38.88
Amphipoda	0.8	2.3	1	4.63	43.52
Faunalturf	0.57	2.28	4.69	4.59	48.11
Annelida_Serpulidaemsp0001	0.58	1.98	2.73	4	52.11
Euclymeninae	0.71	1.79	0.76	3.6	55.71
Cnidaria_Tubulariamsp0001	0.44	1.56	1.72	3.14	58.85
Animaliatubes	0.4	1.54	3.56	3.1	61.95
Mollusca_Pectinidae01	0.33	1.26	4.36	2.54	64.49
Echinodermata_Ophiurasp	0.29	1.17	4.42	2.35	66.84
Sertulariidae	0.55	1.15	0.6	2.33	69.16
Mollusca_Scaphopoda01	0.26	0.8	1.61	1.61	70.77

Group d
Average similarity: 51.04

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	1.35	5.22	5.59	10.23	10.23
Annelida_Serpulidaemsp0001	0.91	3.49	6.09	6.83	17.06
Sertulariidae	1.07	3.37	1.58	6.61	23.66
Hydrallmania falcata	1.02	2.97	1.31	5.81	29.47
Copepoda	0.86	2.82	1.48	5.52	35
Cnidaria_Alcyoniumdigitatum	0.63	2.03	2.44	3.97	38.97
Echinodermata_Ophiurasp	0.63	2	2.99	3.91	42.88
Mollusca_Pectinidae01	0.57	1.94	3.83	3.8	46.67
Decapoda	0.77	1.91	0.95	3.74	50.42
Schizomavella	0.67	1.79	0.89	3.5	53.92
Porella concinna	0.67	1.79	0.89	3.5	57.42
Euclymeninae	0.7	1.45	0.69	2.85	60.26
Amphipoda	0.62	1.21	0.65	2.38	62.64
Cnidaria_Ceriantharia01	0.43	1.13	1.24	2.22	64.87
Faunalturf	0.4	1.09	1.85	2.14	67.01
Penetrantia	0.6	1.03	0.58	2.03	69.04
Echinodermata_Asteriasrubens	0.24	0.82	3.73	1.61	70.65

Group l
Average similarity: 57.62

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Burrows	1.85	11.4	SD=0!	19.79	19.79
Nematoda	1.41	9.77	SD=0!	16.96	36.75
Polygordius	1.21	6.91	SD=0!	11.99	48.74
Annelida_Serpulidaemsp0001	0.74	4.76	SD=0!	8.26	57
Cnidaria_Alcyoniumdigitatum	0.47	3.06	SD=0!	5.31	62.31
Faunalturf	0.4	2.33	SD=0!	4.04	66.35
Mollusca_Pectinidae01	0.33	2.02	SD=0!	3.5	69.85
Echinodermata_Ophiurasp	0.27	1.86	SD=0!	3.22	73.07

Group a
Average similarity: 43.14

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	1.23	7.2	5.23	16.68	16.68
Copepoda	0.89	5.06	1.79	11.72	28.4
Faunalturf	0.55	2.76	3.06	6.4	34.8
Echinodermata_Ophiurasp	0.35	1.9	5.8	4.4	39.21
Annelida_Serpulidaemsp0001	0.42	1.78	1.65	4.12	43.33
Amphipoda	0.6	1.72	0.61	3.98	47.31
Arthropoda_Paguroideaindet	0.31	1.68	5.21	3.9	51.21
Animaliatubes	0.28	1.32	3.28	3.06	54.28
Mollusca_Pectinidae01	0.28	1.27	2.07	2.95	57.22
Cnidaria_Tubulariamsp0001	0.31	1.23	1.4	2.86	60.08
Cnidaria_Alcyoniumdigitatum	0.27	1.14	1.51	2.65	62.74
Mollusca_Scaphopoda01	0.25	1.1	1.42	2.56	65.3
Nemertea	0.44	1.03	0.44	2.39	67.68
Annelida_Terebellidae01	0.23	0.99	1.28	2.3	69.99
Arthropoda_cfPagurusbernhardus	0.18	0.74	1.39	1.72	71.71

Group m
Average similarity: 50.06

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	1.21	6.13	SD=0!	12.24	12.24
Decapoda	1.21	6.13	SD=0!	12.24	24.47
Sertularella	1	6.13	SD=0!	12.24	36.71
Faunalturf	0.52	3.01	SD=0!	6.02	42.73
Chordata_Actinopterygii01	0.38	2.22	SD=0!	4.44	47.17
Echinodermata_Ophiurasp	0.43	2.12	SD=0!	4.23	51.4
Cnidaria_Actiniaria03	0.32	1.95	SD=0!	3.89	55.28
Cnidaria_Actiniaria01	0.32	1.55	SD=0!	3.1	58.39
Echinodermata_Ophiuroideaindet	0.27	1.44	SD=0!	2.87	61.26
Arthropoda_Paguruspridеaux	0.31	1.44	SD=0!	2.87	64.12
Cnidaria_Adamsiapalliata	0.31	1.44	SD=0!	2.87	66.99
Cnidaria_Alcyoniumdigitatum	0.28	1.17	SD=0!	2.34	69.34
Cnidaria_Ceriantharia01	0.35	1.17	SD=0!	2.34	71.68

Group b
Average similarity: 49.14

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Euclymeninae	1.41	6.39	SD=0!	12.99	12.99
Nematoda	1	4.52	SD=0!	9.19	22.18
Scoloplos armiger	1	4.52	SD=0!	9.19	31.37
Decapoda	1	4.52	SD=0!	9.19	40.56
Penetrantia	1.21	4.52	SD=0!	9.19	49.74
Cnidaria_Alcyoniumdigitatum	0.8	3.6	SD=0!	7.32	57.06
Echinodermata_Ophiurasp	0.45	1.87	SD=0!	3.81	60.87
Annelida_Serpulidaemsp0001	0.56	1.82	SD=0!	3.69	64.57
Cnidaria_Tubulariamsp0001	0.44	1.55	SD=0!	3.16	67.73
Mollusca_Pectinidae01	0.46	1.51	SD=0!	3.06	70.79

Group n
Average similarity: 35.13

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Faunalturf	0.48	4.26	3.19	12.14	12.14
Echinodermata_Ophiurasp	0.42	3.69	2.28	10.5	22.64
Phoronis	0.57	3.02	0.61	8.59	31.23
Arthropoda_Paguroideaindet	0.33	2.83	2.82	8.06	39.29
Amphipoda	0.57	2.59	0.61	7.36	46.66
Echinodermata_Astropectenirregularis	0.21	1.71	1.83	4.86	51.52
Cnidaria_Alcyoniumdigitatum	0.15	1.38	3.24	3.93	55.45
Nemertea	0.43	1.3	0.39	3.7	59.15
Cnidaria_Actiniaria01	0.18	1.27	1.24	3.62	62.77
Arthropoda_Paguruspriedeaux	0.22	1.26	1.07	3.6	66.37
Cnidaria_Adamsiapalliata	0.22	1.26	1.07	3.6	69.96
Cnidaria_Ceriantharia01	0.15	1.2	1.39	3.41	73.37

Group k
Average similarity: 68.93

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Annelida_Serpulidaemsp0001	0.97	7.98	40.5	11.57	11.57
Cnidaria_Alcyoniumdigitatum	0.82	6.22	9.08	9.02	20.59
Echinodermata_cfOphiothrixfragilis	0.65	4.57	16.43	6.63	27.22
Echinodermata_Ophiurasp	0.62	4.46	3.97	6.47	33.68
Faunalturf	0.53	3.84	6.37	5.58	39.26
Mollusca_Pectinidae01	0.44	3.32	6.67	4.81	44.08
Cnidaria_Actiniaria01	0.36	2.67	6.58	3.87	47.94
Arthropoda_cfPagurusbernhardus	0.32	2.6	34.49	3.77	51.71
Cnidaria_Hydrozoaindet	0.29	2.05	10.48	2.98	54.69
Cnidaria_Tubulariamsp0001	0.26	1.92	4.52	2.78	57.47
Arthropoda_Cirripedia	0.29	1.83	3.45	2.65	60.12
Mollusca_Buccinidae01	0.24	1.76	7.92	2.55	62.67
Arthropoda_Ebaliasp	0.23	1.74	11.59	2.53	65.2
Echinodermata_Asteriasrubens	0.23	1.63	5.34	2.36	67.57
Echinodermata_cfOphiocominanigra	0.33	1.48	1.16	2.15	69.72
Chordata_Ascidiacea01	0.2	1.39	3.63	2.01	71.73

Group i
Less than 2 samples in group

Group f
Average similarity: 39.33

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	1.14	10.29	6.69	26.17	26.17
Annelida_Serpulidaemsp0001	0.65	6.23	6.92	15.85	42.02
Faunalturf	0.39	3.09	8.18	7.87	49.89
Animaliatubes	0.29	2.99	6.28	7.6	57.49

Echinodermata_Ophiurasp	0.24	2.36	6.28	6.01	63.5
Mollusca_Pectinidae01	0.35	2.34	1.74	5.94	69.44
Arthropoda_cfPagurusbernhardus	0.24	2.11	5.23	5.35	74.8

Group g
Average similarity: 66.20

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Annelida_Serpulidaemsp0001	0.62	7.56	5.78	11.41	11.41
Cnidaria_Tubulariamsp0001	0.5	6.7	17.67	10.12	21.53
Cnidaria_Alcyoniumdigitatum	0.47	5.55	13.6	8.38	29.91
Mollusca_Pectinidae01	0.35	4.48	24.54	6.76	36.67
Echinodermata_Echinoidea01	0.34	4.05	4.04	6.11	42.79
Arthropoda_cfPagurusbernhardus	0.28	3.68	11.02	5.56	48.35
Faunalturf	0.32	3.52	3.05	5.32	53.67
Animaliatubes	0.27	3.02	3.6	4.57	58.24
Echinodermata_Ophiurasp	0.26	2.93	3.24	4.42	62.66
Mollusca_Buccinidae01	0.19	2.66	13.84	4.02	66.68
Echinodermata_cfSpatanguspurpureus	0.23	2.62	2.05	3.96	70.65

Group h
Less than 2 samples in group

Group j
Average similarity: 78.17

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Annelida_Serpulidaemsp0001	0.93	10.11	41.45	12.93	12.93
Cnidaria_Alcyoniumdigitatum	0.88	9.49	16.28	12.14	25.07
Echinodermata_Ophiurasp	0.55	6	22.66	7.67	32.75
Echinodermata_Echinoidea01	0.61	5.81	6.32	7.43	40.18
Mollusca_Pectinidae01	0.51	5.26	12.65	6.73	46.9
Faunalturf	0.36	3.58	31.73	4.58	51.48
Cnidaria_Tubulariamsp0001	0.35	3.19	2.77	4.08	55.56
Mollusca_Bivalviaindet	0.35	3.1	6.34	3.97	59.53
Mollusca_Buccinidae01	0.31	3.02	8.53	3.87	63.4
Arthropoda_cfPagurusbernhardus	0.26	2.66	5.7	3.41	66.81
Echinodermata_Asteriasrubens	0.28	2.64	4.53	3.38	70.18

Appendix D: Benthic infaunal data univariate analysis results

D.1. Raw data results of benthic infaunal univariate analysis (2021 and 2022 site specific survey data

S = number of species; N = abundance; B = Biomass (wet mass in grams); d = Margalef's index of Richness; J' = Pielou's Evenness index; H' = Shannon-Wiener Diversity index; I = Simpson's index of Dominance.

Station	Preliminary Infaunal Biotope	S	N	Biomass (g)	d	J'	H'	I
ENV01	SS.SMx.OMx.PoVen	67	187	3.56	12.62	0.89	3.76	0.97
ENV02	SS.SMx.OMx.PoVen	70	146	10.39	13.85	0.92	3.91	0.98
ENV03	SS.SMx.OMx.PoVen	66	185	58.97	12.45	0.90	3.77	0.97
ENV04	SS.SMx.OMx.PoVen	49	119	2.56	10.04	0.94	3.65	0.98
ENV05	SS.SMx.OMx.PoVen	71	158	15.70	13.83	0.94	3.99	0.98
ENV06	SS.SMx.OMx.PoVen	77	284	21.97	13.45	0.87	3.77	0.97
ENV07	SS.SCS.CCS	17	23	0.20	5.10	0.95	2.69	0.96
ENV08	SS.SMx.OMx.PoVen	57	133	5.64	11.45	0.93	3.76	0.98
ENV09	SS.SMx.OMx	36	53	39.38	8.82	0.96	3.43	0.98
ENV10	SS.SMx.OMx.PoVen	78	200	5.05	14.53	0.94	4.09	0.98
ENV11	SS.SMu.CSaMu.LkorPpel	32	137	2.13	6.30	0.79	2.72	0.89
ENV12	SS.SCS.CCS	54	196	1.87	10.04	0.88	3.52	0.96
ENV13	SS.SCS.CCS	63	179	2.49	11.95	0.87	3.60	0.96
ENV14	SS.SMx.OMx.PoVen	61	124	62.98	12.45	0.95	3.92	0.98
ENV15	SS.SMx.OMx.PoVen	74	156	4.90	14.46	0.91	3.90	0.97
ENV16	SS.SMu.CSaMu.LkorPpel	26	112	0.98	5.30	0.82	2.67	0.90
ENV17	SS.SMx.OMx.PoVen	52	273	1.41	9.09	0.60	2.36	0.73
ENV18	SS.SMx.OMx.PoVen	53	128	3.43	10.72	0.88	3.49	0.96
ENV19	SS.SMx.OMx.PoVen	74	196	1.92	13.83	0.92	3.96	0.98
ENV20	SS.SMx.OMx.PoVen	66	151	0.77	12.96	0.94	3.92	0.98
ENV21	SS.SMu.CSaMu.LkorPpel	28	101	0.88	5.85	0.90	3.01	0.95
ENV22	SS.SCS.CCS	18	30	0.22	5.00	0.93	2.68	0.95
ENV23	SS.SMu.CSaMu.LkorPpel	38	115	0.83	7.80	0.89	3.22	0.95
ENV24	SS.SMx.OMx.PoVen	54	135	16.21	10.80	0.90	3.57	0.97
ENV25	SS.SMu.CSaMu.LkorPpel	33	128	0.98	6.60	0.86	3.02	0.94
ENV26	SS.SMu.CSaMu.LkorPpel	29	110	0.56	5.96	0.89	3.00	0.94
ENV27	SS.SMx.OMx.PoVen	73	195	3.30	13.65	0.92	3.97	0.98

Station	Preliminary Infaunal Biotope	S	N	Biomass (g)	d	J'	H'	I
ENV28	SS.SCS.CCS	24	30	0.65	6.76	0.96	3.06	0.98
ENV29	SS.SMx.OMx.PoVen	52	136	1.16	10.38	0.92	3.62	0.97
ENV30	SS.SMu.CSaMu.LkorPpel	36	223	2.60	6.47	0.82	2.93	0.92
ENV31	SS.SMx.OMx.PoVen	71	193	14.97	13.30	0.91	3.86	0.97
ENV32	SS.SMx.OMx.PoVen	60	161	5.47	11.61	0.91	3.71	0.97
ENV33	SS.SMx.OMx.PoVen	97	364	4.88	16.28	0.88	4.01	0.97
ENV34	SS.SMx.OMx.PoVen	81	468	5.22	13.01	0.81	3.56	0.95
ENV35	SS.SMx.OMx.PoVen	82	434	4.18	13.34	0.81	3.58	0.95
ENV36	SS.SMx.OMx.PoVen	98	281	4.32	17.20	0.91	4.16	0.98
ENV37	SS.SMx.OMx.PoVen	86	293	5.83	14.96	0.90	4.02	0.98
ENV38	SS.SMx.OMx.PoVen	87	349	4.01	14.69	0.88	3.93	0.97
ENV39	SS.SMx.OMx.PoVen	86	346	7.00	14.54	0.86	3.82	0.96
ENV40	SS.SMx.CMx.KurThyMx	65	193	5.44	12.16	0.88	3.69	0.97
ENV41	SS.SMx.OMx.PoVen	102	291	17.31	17.80	0.92	4.26	0.98
ENV42	SS.SMx.OMx.PoVen	75	213	2.33	13.80	0.92	3.96	0.98
ENV43	SS.SCS.CCS	22	90	23.14	4.67	0.73	2.25	0.83
ENV44	SS.SCS.CCS	29	65	0.12	6.71	0.95	3.18	0.97
ENV45	SS.SMx.CMx.KurThyMx	69	306	21.70	11.88	0.85	3.61	0.96
ENV47	SS.SMx.OMx.PoVen	98	292	13.03	17.09	0.90	4.14	0.98
ENV48	SS.SMx.OMx.PoVen	92	437	4.15	14.97	0.87	3.91	0.97
ENV49	SS.SMx.OMx.PoVen	91	320	25.10	15.60	0.85	3.85	0.96
ENV50	SS.SMx.OMx.PoVen	23	38	0.48	6.05	0.95	2.99	0.97
ENV51	SS.SMx.OMx.PoVen	87	226	6.75	15.87	0.93	4.16	0.98
ENV52	SS.SMx.OMx.PoVen	91	367	6.01	15.24	0.87	3.91	0.97
ENV53	SS.SMx.OMx.PoVen	80	193	4.11	15.01	0.92	4.04	0.98
ENV54	SS.SMx.OMx.PoVen	98	331	14.96	16.72	0.90	4.15	0.98
ENV55	SS.SMx.OMx.PoVen	95	340	3.37	16.13	0.87	3.97	0.97
ENV56	SS.SMx.OMx.PoVen	115	428	27.96	18.81	0.89	4.24	0.98
ENV57	SS.SCS.CCS	53	129	1.39	10.70	0.90	3.57	0.97
ENV59	SS.SMx.OMx.PoVen	71	145	88.08	14.07	0.94	4.01	0.98
ENV60	SS.SMx.OMx.PoVen	70	194	7.08	13.10	0.92	3.92	0.98
ENV61	SS.SMx.OMx.PoVen	91	277	1.30	16.00	0.90	4.04	0.98
ENV62	SS.SMx.OMx.PoVen	57	144	0.42	11.27	0.90	3.66	0.97
ENV63	SS.SMx.OMx.PoVen	63	158	4.67	12.25	0.93	3.85	0.98

Station	Preliminary Infaunal Biotope	S	N	Biomass (g)	d	J'	H'	I
ENV64	SS.SMx.OMx.PoVen	64	181	11.05	12.12	0.90	3.76	0.97
ENV65	SS.SMx.OMx.PoVen	80	209	4.91	14.79	0.91	3.98	0.98
ENV66	SS.SCS.CCS	19	148	0.16	3.60	0.64	1.89	0.72
ENV67	SS.SCS.CCS	42	149	0.42	8.19	0.77	2.88	0.89
ENV68	SS.SCS.CCS	52	466	2.17	8.30	0.58	2.30	0.75
ENV69	SS.SMx.OMx.PoVen	69	249	7.78	12.32	0.88	3.72	0.96
ENV70	SS.SCS.CCS	42	140	0.51	8.30	0.84	3.14	0.94
ENV71	SS.SMx.OMx.PoVen	78	221	9.31	14.26	0.92	4.00	0.98
ENV82	SS.SMx.CMx	59	216	41.46	10.79	0.83	3.39	0.94
ENV83	SS.SCS.CCS	43	85	3.65	9.45	0.93	3.51	0.97
ENV84	SS.SMx.OMx.PoVen	77	393	29.87	12.72	0.82	3.56	0.94
ENV86	SS.SMx.OMx.PoVen	104	330	2.92	17.76	0.89	4.11	0.98
ENV88	SS.SMx.OMx.PoVen	88	247	7.95	15.79	0.90	4.02	0.98
ENV89	SS.SCS.CCS	15	68	0.13	3.32	0.81	2.19	0.85
ENV90	SS.SMx.OMx.PoVen	65	146	24.66	12.84	0.91	3.78	0.97
ENV91	SS.SMu.CSaMu.LkorPpel	59	258	4.98	10.44	0.79	3.21	0.92
ENV92	SS.SMu.CSaMu.LkorPpel	64	190	26.49	12.01	0.88	3.64	0.96
ENV93	SS.SCS.CCS	15	122	0.13	2.91	0.67	1.82	0.73
ENV94	SS.SMu.CSaMu.LkorPpel	53	230	2.59	9.56	0.73	2.91	0.86
ENV95	SS.SMx.OMx.PoVen	39	83	1.73	8.60	0.91	3.35	0.96
ENV96	SS.SCS.CCS	53	219	1.73	9.65	0.79	3.15	0.92
ENV97	SS.SMx.OMx.PoVen	87	297	10.06	15.10	0.89	3.96	0.97
ZOI14	SS.SMu.CSaMu.AfilKurAnit	29	105	11.5505	6.02	0.85	2.88	0.93
ZOI15	SS.SMu.CSaMu.AfilKurAnit	36	141	11.35	7.07	0.83	2.98	0.91
ZOI16	SS.SSa.CMuSa	35	87	8.90	7.61	0.87	3.10	0.93
ZOI17	SS.SMx.OMx.PoVen	79	272	2.05	13.91	0.88	3.83	0.96
ZOI18	SS.SMx.OMx.PoVen	67	157	18.07	13.05	0.92	3.86	0.97
ZOI19	SS.SSa.CFiSa.EpusOborApri	28	63	5.35	6.52	0.92	3.06	0.96
ZOI20	SS.SSa.CMuSa	38	93	4.15	8.16	0.91	3.31	0.96
ZOI21	SS.SMx.CMx.OphMx	74	412	33.60	12.12	0.77	3.31	0.93
ZOI22	SS.SSa.CMuSa	30	55	144.00	7.24	0.91	3.08	0.95
ZOI23	SS.SMx.OMx.PoVen	62	191	2.51	11.61	0.89	3.68	0.97
ZOI24	SS.SSa.CFiSa.EpusOborApri	61	175	6.69	11.62	0.88	3.60	0.96
ZOI25	SS.SMx.OMx.PoVen	99	333	0.86	16.87	0.89	4.10	0.98

Station	Preliminary Infaunal Biotope	S	N	Biomass (g)	d	J’	H’	I
ZOI26	SS.SSa.CMuSa	46	165	14.01	8.81	0.83	3.16	0.92
22ENV05	SS.SMx.OMx.PoVen	78	284	2.27	14	0.79	3.42	0.90
22ENV06	SS.SMx.OMx.PoVen	90	269	3.73	16	0.90	4.06	0.98
22ENV07	SS.SMx.OMx.PoVen	78	193	15.36	15	0.91	3.97	0.98
22ENV09	SS.SCS.CCS	51	249	10.37	9	0.81	3.20	0.93
22ENV10	SS.SMx.OMx	65	204	6.11	12	0.83	3.48	0.94
22ENV11	SS.SMx.OMx.PoVen	70	288	34.77	12	0.86	3.65	0.96
22ENV12	SS.SSa.CFiSa.EpusOborApri	22	36	0.21	6	0.94	2.91	0.96

Appendix E: Benthic epifaunal data multivariate analysis results

E.1. Raw data results of benthic epifaunal univariate analysis

S = number of species; N = abundance; B = Biomass (ash free dry mass in grams); d = Margalef's index of Richness; J' = Pielou's Evenness index; H' = Shannon-Wiener Diversity index; I = Simpson's index of Dominance

Station	Biotope	S	N	d	J'	H'	Lambda
ENV01	SS.SMx.CMx	60	23.65	18.65	0.69	2.82	0.93
ENV02	SS.SMx.CMx	59	25.74	17.86	0.77	3.15	0.98
ENV03	SS.SMx.CMx	42	21.51	13.36	0.65	2.42	0.88
ENV04	SS.SMx.CMx	56	25.84	16.91	0.73	2.93	0.96
ENV05	SS.SMx.CMx	55	31.85	15.60	0.79	3.16	0.97
ENV06	SS.SMx.CMx	58	30.67	16.65	0.68	2.78	0.90
ENV07	SS.SCS.CCS	34	12.49	13.07	0.65	2.28	0.94
ENV08	SS.SMx.CMx	46	18.72	15.36	0.83	3.19	1.01
ENV09	SS.SMx.CMx	43	11.46	17.22	0.69	2.61	0.98
ENV10	SS.SMx.CMx	58	24.59	17.80	0.79	3.21	0.99
ENV11	SS.SSa.CMuSa	43	6.95	21.66	0.69	2.61	1.04
ENV12	SS.SSa.CMuSa	49	12.49	19.01	0.76	2.96	1.02
ENV13	SS.SCS.CCS	47	18.88	15.66	0.73	2.83	0.98
ENV14	SS.SCS.CCS	41	15.88	14.47	0.75	2.78	0.98
ENV15	SS.SMx.CMx	52	18.53	17.47	0.78	3.09	1.00
ENV16	SS.SSa.CMuSa	26	5.87	14.13	0.66	2.15	1.03
ENV17	SS.SCS.CCS	41	12.32	15.93	0.71	2.65	0.98
ENV18	SS.SMx.CMx	35	18.52	11.65	0.78	2.76	0.97
ENV19	SS.SMx.CMx	40	19.26	13.18	0.78	2.86	0.98
ENV20	SS.SMx.CMx	46	18.96	15.29	0.79	3.04	0.99
ENV21	SS.SSa.CMuSa	25	2.89	22.61	0.58	1.88	1.15
ENV22	SS.SSa.CMuSa	28	4.73	17.38	0.68	2.27	1.08
ENV23	SS.SMx.CMx	36	13.05	13.63	0.74	2.66	0.98
ENV24	SS.SMx.CMx	43	15.57	15.30	0.75	2.80	0.98
ENV25	SS.SSa.CMuSa	23	7.19	11.15	0.68	2.13	0.98
ENV26	SS.SSa.CMuSa	19	6.00	10.05	0.65	1.93	0.96
ENV27	SS.SMx.CMx	42	19.13	13.89	0.83	3.09	1.00
ENV28	SS.SCS.CCS	54	21.11	17.38	0.78	3.11	0.99
ENV29	SS.SMx.CMx	51	13.31	19.32	0.73	2.86	1.00

Station	Biotope	S	N	d	J'	H'	Lambda
ENV30	SS.SSa.CMuSa	37	7.67	17.67	0.73	2.63	1.04
ENV31	SS.SMx.CMx	50	18.67	16.74	0.78	3.03	0.99
ENV32	SS.SMx.CMx	43	20.26	13.96	0.78	2.93	0.98
ENV33	SS.SMx.CMx	53	29.33	15.39	0.81	3.23	0.99
ENV34	SS.SMx.CMx	55	26.45	16.49	0.80	3.21	0.99
ENV35	SS.SMx.CMx	61	26.37	18.34	0.80	3.29	0.99
ENV36	SS.SMx.CMx	46	23.94	14.17	0.81	3.12	0.99
ENV37	SS.SMx.CMx	46	20.35	14.94	0.79	3.04	0.99
ENV38	SS.SMx.CMx	60	33.01	16.87	0.83	3.41	0.99
ENV39	SS.SMx.CMx	47	20.14	15.32	0.81	3.10	1.00
ENV40	SS.SMx.CMx	38	16.61	13.17	0.76	2.76	0.98
ENV41	SS.SMx.CMx	49	24.28	15.05	0.82	3.18	0.99
ENV42	SS.SMx.CMx	49	22.60	15.39	0.80	3.13	0.99
ENV43	SS.SMx.CMx	48	12.86	18.40	0.73	2.82	1.00
ENV44	SS.SMx.CMx	44	11.94	17.34	0.69	2.61	0.99
ENV45	SS.SMx.CMx	44	14.03	16.28	0.72	2.74	0.99
ENV46	SS.SMx.CMx	48	5.10	28.86	0.75	2.92	1.13
ENV47	SS.SMx.CMx	47	22.97	14.68	0.79	3.03	0.98
ENV48	SS.SMx.CMx	55	23.48	17.11	0.81	3.26	1.00
ENV49/1	SS.SMx.CMx	43	19.32	14.18	0.79	2.96	0.99
ENV50	SS.SMx.CMx	48	17.06	16.57	0.76	2.95	0.99
ENV51	SS.SMx.CMx	51	21.63	16.27	0.80	3.13	0.99
ENV52	SS.SMx.CMx	46	20.75	14.84	0.79	3.01	0.99
ENV53	SS.SMx.CMx	46	13.02	17.53	0.74	2.83	0.99
ENV54	SS.SMx.CMx	46	19.27	15.21	0.78	2.98	0.99
ENV55	SS.SMx.CMx	41	15.06	14.75	0.78	2.91	1.00
ENV56	SS.SMx.CMx	52	21.26	16.68	0.78	3.08	0.99
ENV57	SS.SMx.CMx	44	16.14	15.46	0.76	2.89	0.99
ENV58	SS.SMx.CMx	49	4.41	32.33	0.77	3.01	1.18
ENV59	SS.SMx.CMx	53	21.27	17.01	0.80	3.17	1.00
ENV60	SS.SMx.CMx	49	19.59	16.14	0.81	3.16	1.00
ENV61	SS.SMx.CMx	53	23.73	16.42	0.80	3.19	0.99
ENV62	SS.SMx.CMx	44	18.93	14.62	0.80	3.01	0.99
ENV63	SS.SMx.CMx	46	17.02	15.88	0.78	2.98	0.99
ENV64	SS.SMx.CMx	40	18.54	13.36	0.75	2.77	0.97

Station	Biotope	S	N	d	J'	H'	Lambda
ENV65	SS.SMx.CMx	42	17.93	14.20	0.82	3.05	1.00
ENV66	SS.SCS.CCS	31	5.03	18.57	0.60	2.05	0.97
ENV67/1	SS.SMx.CMx	50	7.82	23.83	0.68	2.68	1.03
ENV68	SS.SMx.CMx	45	5.59	25.57	0.59	2.24	0.98
ENV69	SS.SMx.CMx	52	21.47	16.63	0.77	3.04	0.99
ENV70	SS.SMx.CMx	40	9.90	17.01	0.69	2.55	0.99
ENV71	SS.SMx.CMx	50	16.85	17.35	0.75	2.94	0.99
ENV72	SS.SMx.CMx	29	2.64	28.84	0.78	2.61	1.43
ENV73	SS.SMx.CMx	47	3.38	37.79	0.74	2.86	1.29
ENV74	SS.SMx.CMx	32	3.47	24.89	0.74	2.55	1.22
ENV75	SS.SMx.CMx	30	1.32	104.83	0.85	2.89	3.82
ENV76	SS.SMx.CMx	36	4.27	24.12	0.73	2.63	1.16
ENV77	SS.SMx.CMx	32	2.49	33.97	0.80	2.76	1.50
ENV78	SS.SCS.CCS	31	1.90	46.56	0.84	2.88	1.94
ENV79	SS.SMx.CMx	37	3.81	26.94	0.73	2.63	1.20
ENV80	SS.SMx.CMx	45	4.37	29.82	0.77	2.91	1.18
ENV81	SS.SMx.CMx	48	4.36	31.92	0.76	2.95	1.18
ENV82	SS.SMx.CMx	45	16.49	15.70	0.75	2.84	0.98
ENV83	SS.SMx.CMx	34	8.99	15.03	0.74	2.60	1.02
ENV84	SS.SMx.CMx	39	12.04	15.27	0.74	2.71	0.99
ENV85	SS.SMx.CMx	45	6.11	24.31	0.73	2.76	1.08
ENV86	SS.SMx.CMx	60	20.12	19.66	0.79	3.22	1.00
ENV87	SS.SMx.CMx	48	4.78	30.04	0.77	2.99	1.16
ENV88	SS.SMx.CMx	52	21.03	16.74	0.80	3.17	1.00
ENV89	SS.SCS.CCS	23	5.33	13.15	0.62	1.95	0.96
ENV90	SS.SMx.CMx	67	25.11	20.47	0.77	3.25	0.99
ENV91	SS.SCS.CCS	59	14.03	21.96	0.70	2.86	0.98
ENV92	SS.SMx.CMx	64	22.86	20.13	0.80	3.33	1.00
ENV93	SS.SCS.CCS	52	9.98	22.17	0.53	2.10	0.85
ENV94	SS.SCS.CCS	55	24.00	16.99	0.79	3.17	0.99
ENV95	SS.SMx.CMx	42	9.10	18.56	0.74	2.76	1.03
ENV96	SS.SMx.CMx	42	9.25	18.43	0.72	2.68	1.02
ENV97	SS.SMx.CMx	67	23.88	20.80	0.78	3.27	0.99
ZOI14	SS.SSa.CMuSa	22	58	5.172	0.8616	2.663	0.9165
ZOI15	SS.SSa.CMuSa	11	35	2.813	0.6383	1.531	0.6353

Station	Biotope	S	N	d	J'	H'	Lambda
ZOI16	SS.SSa.CMuSa	9	32	2.308	0.6986	1.535	0.7137
ZOI17	SS.SMx.CMx	45	182	8.455	0.7755	2.952	0.9039
ZOI18	SS.SMx.CMx	58	261	10.24	0.6842	2.778	0.8903
ZOI19	SS.SSa.CMuSa	32	79	7.095	0.7781	2.697	0.8695
ZOI20	SS.SSa.CMuSa	24	41	6.193	0.9091	2.889	0.9451
ZOI21	SS.SMx.CMx	49	244	8.732	0.6849	2.665	0.8827
ZOI22	SS.SSa.CMuSa	14	21	4.27	0.9084	2.397	0.9238
ZOI23	SS.SMx.CMx	30	86	6.51	0.7691	2.616	0.8714
ZOI24	SS.SMx.CMx	32	96	6.792	0.8081	2.801	0.9037
ZOI25	SS.SMx.CMx	58	252	10.31	0.7422	3.014	0.9058
ZOI26	SS.SSa.CMuSa	16	38	4.124	0.78	2.162	0.8236
22ENV05	SS.SMx.CMx	39	147	8	0.72	2.64	0.86
22ENV06	SS.SMx.CMx	51	180	10	0.86	3.39	0.96
22ENV07	SS.SMx.CMx	46	102	10	0.81	3.12	0.92
22ENV09	SS.SMx.CMx	22	37	6	0.90	2.78	0.93
22ENV10	SS.SMx.CMx	39	71	9	0.93	3.39	0.97
22ENV11	SS.SMx.CMx	30	102	6	0.77	2.62	0.88
22ENV12	SS.SSa.CMuSa	12	21	4	0.84	2.10	0.85
22ENV05	SS.SMx.CMx	39	147	8	0.72	2.64	0.86

Appendix F: Sediment contamination results

F.1. Concentration of PCBs recorded in sediments within the Morgan benthic subtidal ecology study area (part 1)

Description (PCBs)	28	52	101	118	138	153	180	Sum of ICES 7
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Cefas AL1 (mg/kg)	-	-	-	-	-	-	-	0.01
Cefas AL2 (mg/kg)	-	-	-	-	-	-	-	-
Sample no.								
2021 Site Specific Survey								
ENV05	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	0.00013	0.00195
ENV06	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV12	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV13	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV14	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV17	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV20	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV21	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV29	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV63	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV65	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
2022 Site Specific Survey								
ENV11	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV72	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV13	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
22ENV06	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV23	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
22ENV09	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI14	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI15	<0.00008	0.00009	0.00009	0.00008	0.0001	<0.00008	<0.00008	0.0004
ZOI16	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI17	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI20	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ

Description (PCBs)	28	52	101	118	138	153	180	Sum of ICES 7
ZOI21	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI22	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI23	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI25	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ

F.2. Concentration of PCBs recorded in sediments within the Morgan benthic subtidal ecology study area (Part 2)

Description (PCBs)	18	31	44	47	49	66	105	110	128	141	149	151	156	158	170	183	187	194	Total PCBs
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Cefas AL1 (mg/kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02
Cefas AL2 (mg/kg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2
2021 Site Specific Survey																			
ENV05	0.00014	0.00037	0.00021	0.00027	0.00018	0.0004	<0.0008	0.00034	<0.0008	<0.0008	0.0003	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	0.00022	0.0004	0.00439
ENV06	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	NQ
ENV12	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	NQ
ENV13	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	NQ
ENV14	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	NQ
ENV17	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	NQ
ENV20	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	NQ

Description (PCBs)	18	31	44	47	49	66	105	110	128	141	149	151	156	158	170	183	187	194	Total PCBs
ENV21	<0.00008	0.0001	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.0001
ENV29	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV63	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
ENV65	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
2022 Site Specific Survey																			
ENV11	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV72	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV13	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
22ENV06	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ENV23	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
22ENV09	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI14	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI15	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00012	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.0005
ZOI16	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ

Description (PCBs)	18	31	44	47	49	66	105	110	128	141	149	151	156	158	170	183	187	194	Total PCBs
ZOI17	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI20	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI21	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI22	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI23	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ
ZOI25	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	NQ

F.3. Concentration of PAHs recorded in sediments within the Morgan benthic subtidal ecology study area (Part 1)

Description (PAH)	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(a)pyrene	Dibenzo(a,h)anthracene
Units	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**	**ug/kg**
Canadian TEL	**34.6**	**5.87**	**6.71**	**20.2**	**86.7**	**46.9**	**113**	**53**	**74.8**	**108**	**88.8**	**6.22**
Canadian PEL	**391**	**128**	**88.9**	**144**	**544**	**245**	**1494**	**875**	**693**	**846**	**763**	**135**
2021 Site Specific Survey												
ENV05	3	<1	<1	1	5	<1	4	4	3	4	3	1
ENV06	3	<1	<1	1	5	<1	5	5	3	5	4	2
ENV12	2	<1	<1	<1	3	<1	4	3	2	3	3	1
ENV13	3	<1	<1	<1	4	<1	5	5	3	4	4	1
ENV14	3	<1	<1	1	5	<1	5	5	3	5	4	1
ENV17	3	<1	<1	1	6	<1	6	6	4	5	5	2
ENV20	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	1	<1
ENV21	2	<1	<1	<1	4	<1	5	5	3	4	4	1
ENV29	3	<1	<1	1	7	<1	7	6	4	6	5	2
ENV36	3	<1	<1	1	6	<1	5	5	3	5	4	1
ENV37	3	<1	<1	1	5	<1	5	4	3	4	4	1

Description (PAH)	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(a(pyrene	Dibenzo(a,h)anthracene
ENV38	3	<1	<1	1	6	<1	7	6	4	5	5	2
ENV39	3	<1	<1	1	6	<1	7	6	4	6	6	2
ENV40	5	<1	<1	2	9	1	10	10	6	8	8	3
ENV47	2	<1	<1	<1	3	<1	3	3	2	3	2	<1
ENV50	3	<1	<1	2	7	<1	6	5	3	6	4	2
ENV51	3	<1	<1	1	6	<1	7	6	4	5	5	2
ENV52	3	<1	<1	1	5	<1	6	6	4	5	5	2
ENV57	1	<1	<1	<1	8	<1	3	3	2	3	1	<1
ENV59	1	<1	<1	<1	3	<1	3	3	2	3	2	<1
ENV63	3	<1	<1	<1	4	<1	3	3	2	3	3	<1
ENV65	2	<1	<1	<1	4	<1	4	3	2	3	3	<1
2022 Site Specific Survey												
ENV11	1	<1	<1	<1	4	<1	4	<1	2	3	3	<1
ENV72	<1	<1	<1	<1	3	<1	2	<1	1	1	1	<1
ENV13	3	<1	<1	2	8	1	8	2	4	6	5	2
22ENV06	3	<1	<1	2	7	<1	6	2	4	5	4	1
ENV23	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
22ENV09	3	<1	<1	1	6	<1	6	2	3	5	5	1
ZOI14	3	<1	<1	2	7	1	8	2	4	5	6	2

Description (PAH)	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(a(pyrene	Dibenzo(a,h)anthracene
ZOI15	7	2	2	4	20	4	25	6	14	15	20	5
ZOI16	2	<1	<1	<1	4	<1	5	1	3	4	4	1
ZOI17	3	<1	<1	1	7	<1	5	1	3	4	3	1
ZOI20	2	<1	<1	<1	4	<1	4	1	2	3	3	1
ZOI21	3	<1	<1	1	7	<1	6	2	3	4	4	1
ZOI22	2	<1	<1	1	4	<1	4	1	2	3	3	<1
ZOI23	3	<1	<1	1	8	<1	5	1	3	4	3	<1
ZOI25	2	<1	<1	1	7	<1	5	<1	3	3	3	<1

F.4. Concentration of PAHs recorded in sediments within the Morgan benthic subtidal ecology study area (Part 2)

Description (PAH)	Benzo[b]fluoranthene	Benzo[e]pyrene	Benzo[ghi]perylene	Benzo[k]fluoranthene	C1-naphthalenes	C1-phenanthrene	C2-naphthalenes	C3-naphthalenes	Indeno[1,2,3-cd]pyrene	Perylene	Total
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Canadian TEL	-	-	-	-	-	-	-	-	-	-	-
Canadian PEL	-	-	-	-	-	-	-	-	-	-	-
2021 Site Specific Survey											
ENV05	7	6	6	2	7	7	6	5	7	1	82
ENV06	9	7	7	3	7	7	6	5	9	2	97
ENV12	5	5	4	2	5	4	4	3	6	1	60
ENV13	7	6	6	3	7	6	5	4	8	2	83
ENV14	8	7	7	3	7	7	6	5	8	2	91
ENV17	9	8	8	4	8	8	7	7	9	2	108
ENV20	1	<1	<1	<1	1	2	2	2	1	<1	11
ENV21	8	7	6	3	6	6	6	5	8	1	86
ENV29	11	8	8	4	9	10	10	9	10	2	121
ENV63	5	4	4	2	10	6	8	6	5	<1	72
ENV65	6	4	4	3	6	6	5	5	5	<1	65

Description (PAH)	Benzo[b]fluoranthene	Benzo[e]pyrene	Benzo[ghi]perylene	Benzo[k]fluoranthene	C1-naphthalenes	C1-phenanthrene	C2-naphthalenes	C3-naphthalenes	Indeno[1,2,3-cd]pyrene	Perylene	Total
2022 Site Specific Survey											
ENV11	5	4	4	2	4	5	5	4	4	<1	57
ENV72	2	1	2	<1	3	4	4	4	1	<1	32
ENV13	10	8	8	4	9	11	11	9	9	2	125
22ENV06	8	7	7	3	9	9	10	8	7	2	107
ENV23	<1	<1	<1	<1	1	<1	1	<1	<1	<1	2
22ENV09	8	7	7	3	7	10	10	9	7	2	107
ZOI14	10	9	9	4	9	10	17	10	10	2	136
ZOI15	30	27	26	12	19	24	26	23	28	6	363
ZOI16	6	6	5	2	5	5	7	5	6	1	77
ZOI17	7	6	6	2	8	9	11	9	6	1	98
ZOI20	6	5	5	3	5	5	6	4	6	1	69
ZOI21	8	7	7	3	9	10	12	10	7	2	110
ZOI22	5	5	4	2	6	5	8	6	4	1	71
ZOI23	6	5	5	3	16	11	18	13	5	1	114
ZOI25	5	4	4	2	5	7	7	6	4	<1	71

Appendix G: Species scientific, common names and biotopes

G.1.1.1.1 The below table contains all common names for the latin species which have been referred to in the main text of this benthic subtidal ecology technical report.

G.2. Latin and common names.

Scientific name	Common name
Abra alba	White furrow shell
Abra nitida	Glossy furrow shell
Acanthocardia aculeata	Spiny cockle
Acanthocardia echinata	European prickly cockle
Acteon tornatilis	lathe acteon
Actinia equina	Beadlet anenome
Adamsia palliata	Cloak anenome
Alcyonidium diaphanum	Deadman's fingers anenome
Ammophila arenaria	Marram grass
Ampharete lindstroemi	No known common name
Amphiura chiajei	Heart urchin
Amphiura filiformis	Bristle worm
Aonides paucibranchiata	No known common name
Arctica islandica	Ocean quahog
Arenicola defodiens	Black lug worm
Arenicola marina	Lug worm
Asarte sulcata	Furrowed asarte
Ascophyllum nodosum	Knotted wrack
Asterias rubens	Common starfish
Asterina gibbosa	Cushion star
Austrominius modestus	Modest barnacle
Balanus crenatus	Wrinkled barnacle
Barnea candida	White piddock
Bathyporeia pelagica	Sand digger shrimp
Bathyporeia pilosa	Sand digger shrimp
Bathyporeia tenuipes	No known common name
Branchiostoma lanceolatum	Common lancet
Brissopsis lyrifera	Heart urchin

Scientific name	Common name
Callianassa subterranean	Mud shrimp/Ghost shrimp
Cancer pagurus	Brown crab
Carcinus maenas	Green shore crab
Cerastoderma edule	Common cockle
Cerianthus lloydii	North Sea tube anenome
Chamelea gallina	Striped venus clam
Chamelea striatula	No known common name
Cirrophorus branchiatus	No known common name
Chondrus crispus	Irish moss
Corallina officinalis	Coral weed
Corophium arenarium	No known common name
Corystes cassivelaunus	Masked crab
Dendrodoa grossularia	Baked bean ascidian
Donax vittatus	Banded wedge shell
Dosinia lupinus	Smooth artemis
Dumontia contorta	No known common name
Echinocardium cordatum	Sea potato
Echinocyamus pusillus	Pea urchin
Edwardsia timida	Worm anenome
Elminius modestus	Common rock barnacle
Ennucula tenuis	Smooth nutclam
Ensis magnus	Razor clam
Ensis siliqua	Pod razor
Euspira catena	Large necklace shell
Euspira nitida	Common necklace shell
Eurydice pulchra	Speckled sea louse
Fabulina fabula	Bean-like tellin
Fucus serratus	Toothed wrack
Fucus spiralis	Spiral wrack
Fucus vesiculosus	Bladder wrack
Glauco-Puccinellietalia maritimae	Atlantic salt meadow
Glycera lapidum	No known common name
Glycera tridactyla	No known common name
Glycimeris	Bittersweet clam
Golfingia (Golfingia) elongata	No known common name

Scientific name	Common name
Golfingia (Golfingia) vulgaris	Peanut worm
Goneplax rhomboides	Angular crab
Halidrys siliquosa	Sea-oak
Hediste diversicolor	Rag worm
Hymeniacidon perleve	Crumb-of-bread sponge
Kurtiella bidentata	Two-toothed Mantagu shell
Laevicardium crissum	Norwegian egg cockle
Lagis koreni	Trumpet worm
Laminaria digitata	Oar weed
Laminaria hyperborea	Cuvie
Lanice conchilega	Sand mason worm
Laonice bahusiensis	No known common name
Leptochiton asellus	No known common name
Limaria hians	Flame shell
Lipophrys pholis	Common blenny
Littorina littorea	Common periwinkle
Loripes lucinalis	No known common name
Lutraria oblonga	Oblong otter shell
Leymus arenarius	Lyme grass
Macoma balthica	Baltic tellin
Macomangulus tenuis	Thin tellin
Mactra stultorum	Edible salt water clam
Magelona mirabilis	Bristle worm
Mastocarpus stellatus	False irish moss
Maxmuelleria lankesteri	Volcano worm
Modiolus modiolus	Northern horse mussel
Mysella bidentata	No known common name
Mytilus edulis	Common blue mussel
Nephasoma (Nephasoma) minutum	Peanut worm
Nephrops norvegicus	Norway lobster
Nephtys cirrosa	White catworm
Nephtys hombergii	Catworm
Nucella lapillus	Dog whelk
Nucula nitidosa	Shiny nut clam
Obelia bidentata	Double toothed sea fir

Scientific name	Common name
Ophiocomina nigra	Black brittlestar
Ophiothrix fragilis	Common brittlestar
Ostrea edulis	European flat oyster
Owenia fusiformis	Tube worm
Pagurus prideaux	Prideaux's hermit crab
Pagurus bernhardus	Common hermit crab
Patella vulgata	Common limpet
Pennatula phosphorea	Phosphorescent sea pen
Pharus legumen	Razor shell
Phascolion (Phascolion) strombus strombus	Peanut worm
Phaxas pellucidus	Transparent razor shell
Petromyzon marinus	Sea lamprey
Phorcus lineatus	Lined top shell
Pleuronectes platessa	European plaice
Poecilochaetus serpens	No known common name
Pomacea canaliculata	Golden apple snail
Pomatoceros triqueter	Keel worm
Porcellana platycheles	Broad clawed porcelain crab
Porphyra purpurea	Purple laver
Priapulus caudatus	Cactus worm
Pygospio elegans	No known common name
Sabellaria alveolata	Honeycomb worm
Sabellaria spinulosa	Ross worm
Sagartia troglodytes	Cave-dwelling anenome
Salicornia	Glasswort
Scalibregma inflatum	T-headed worm
Scolelepis foliosa	No known common name
Scolelepis squamata	No known common name
Scoloplos armiger	Armoured bristle worm
Scrobicularia plana	Peppery furrow shell
Semibalanus balanoides	Common rock barnacle
Spatangus purpureus	Purple heart urchin
Spio martinensis	No known common name
Spirobranchus triqueter	Tube worm
Solea solea	Dover sole

Scientific name	Common name
Stauromedusae	Stalked jellyfish
Steromphala cineraria	Grey top shell
Steromphala umbilicalis	Flat top shell
Sthenelais limicola	No known common name
Syllis armillaris	No known common name
Thia scutellata	Thumbnail crab
Thysanocardia procera	Peanut worm
Ulva intestinalis	Sea lettuce
Urticina feline	Dahlia anemone
Verrucaria maura	Tar lichen
Zostera marina	Eel grass

G.2.1.1.1 The below table includes all the biotope codes referred to in the main body of the text as well as their full biotope names.

G.3. Biotope code.

Biotope Code	Biotope full name
CR.MCR	Moderate energy circalittoral rock
CR.MCR.CSab.Sspi	Sabellaria spinulosa encrusted circalittoral rock
CR.MCR.EcCr.FaAlCr	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
CR.MCR.SfR.Pid	Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
CR.HCR.XFa.ByErSp	Bryozoan turf and erect sponges on tide-swept circalittoral rock
CR.HCR.XFa.SpNemAdia	Sparse sponges, Nemertesia spp. and Alcyonidium diaphanum on circalittoral mixed substrata
ELR.MB.Bpat	Barnacles and Patella spp. on exposed or moderately exposed, or vertical sheltered eulittoral rock
ELR.MB.BPat.Sem	Semibalanus balanoides, Patella vulgata and Littorina spp. on exposed to moderately exposed or vertical sheltered eulittoral rock
ELR.MB.MytB	Mytilus edulis and barnacles on very exposed eulittoral rock
LGS.S.AEur	Eurydice pulchra in littoral mobile sand
LGS.S.AP.P	Amphipods and Scolelepis spp. in littoral medium-fine sand
LGS.S.Lan	Lanice conchilega in littoral sand
LGS.Sh.BarSh	Barren littoral shingle
LR.L.YG	Yellow and grey lichens on supralittoral rock
LR.R	Littoral rock

Biotope Code	Biotope full name
LR.FLR.Eph.BLitX	Barnacles and Littorina sp. on unstable eulittoral mixed substrata
LR.FLR.Eph.EphX	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata
LR.FLR.Eph.UlvPor	Porphyra purpurea and Ulva sp. on sand-scoured mid or lower eulittoral rock
LR.FLR.Lic.Ver	Verrucaria maura on littoral fringe rock
LR.HLR.MusB.Sem	Semibalanus balanoides on exposed to moderately exposed or vertical sheltered eulittoral rock
LR.HLR.MusB.Sem.LitX	Semibalanus balanoides and Littorina spp. on exposed to moderately exposed eulittoral boulders and cobbles
LR.LLR.F.Fspi	Fucus spiralis on sheltered upper eulittoral rock
LR.Rkp.H	Hydroids, ephemeral seaweeds and Littorina littorea in shallow eulittoral mixed substrata pools
LS.LBR.LMus.Myt.Mx	Mytilus edulis beds on littoral mixed substrata
LS.LBR.Sab.Salv	Sabellaria alveolata reefs on sand-abraded eulittoral rock
LS.LCS.Sh.BarSh	Barren littoral shingle
LS.LSa.FiSa	Polychaete/amphipod-dominated fine sand shores
LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores
LS.LSa.MuSa	Polychaete/bivalve-dominated muddy sand shores
LS.LSa.MuSa.Lan	Lanice conchilega in littoral sand
LS.LSa.MuSa.MacAre	Macoma balthica and Arenicola marina in littoral muddy sand
LS.LSa.St.Tal	Talitrids on the upper shore and strand-line
MLR.Eph.Ent	Ulva spp. on freshwater-influenced and/or unstable upper eulittoral rock
MLR.Eph.EntPor	Porphyra purpurea and Ulva spp. on sand-scoured mid or lower eulittoral rock
SLR.FX.BLlit	Barnacles and Littorina spp. on unstable eulittoral mixed substrata
SS.SBR.PoR.SspiMx	Sabellaria spinulosa on stable circalittoral mixed sediment
SS.SBR.Smus	Sublittoral mussel beds (on sublittoral sediment)
SS.SCS.CCS	Circalittoral coarse sediment
SS.SCS.CCS.Blan	Branchiostoma lanceolatum in circalittoral coarse sand with shell gravel
SS.SCS.ICS.MoeVen	Moerella sp. with venerid bivalves in infralittoral gravelly sand
SS.SCS.ICS.Glap	Glycera lapidum in impoverished infralittoral mobile gravel and sand
SS.SCS.ICS.SLan	Dense Lanice conchilega and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand
SS.SCS.OCS	Offshore circalittoral coarse sediment
SS.SCS.CCS.PomB	Pomatoceros triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
SLR.MX.MytX	Mytilus edulis beds on littoral mixed substrata

Biotope Code	Biotope full name
SS.SMu.CFiMu.BlyrAchi	Brissopsis lyrifera and Amphiura chiajei in circalittoral mud
SS.SMu.CfiMu.MegMax	Burrowing megafauna and Maxmuelleria lankesteri in circalittoral mud
SS.SSa.CmuSa.AalbNuc	Abra alba and Nucula nitidosa in circalittoral muddy sand or slightly mixed sediment
SS.SMu.CSaMu	Circalittoral sandy mud
SS.SMu.CSaMu.AfilKurAnit	Amphiura filiformis, Kurtiella bidentata and Abra nitida in circalittoral sandy mud
SS.SMu.CSaMu. LkorPpel	Lagis koreni and Phaxas pellucidus in circalittoral sandy mud
SS.SMu.CSaMu.ThyEten	Thyasira sp. and Ennucula tenuis in circalittoral sandy mud
SS.SMu.CSaMu.ThyNten	Thyasira spp. and Ennucula tenuis in circalittoral sandy mud
SS.SMx	Sublittoral mixed sediment
SS.SMx.CMx	Circalittoral mixed sediment
SS.SMx.CMx.ClloMx.Nem	Cerianthus lloydii with the Nemertesia spp. and other hydroids in circalittoral muddy mixed sediment
SS.SMx.CMx.FluHyd	Flustra foliacea and Hydrallmania falcata on tide-swept circalittoral mixed sediment
SS.SMx.CMx.KurThyMx	Kurtiella bidentata and Thyasira spp. in circalittoral muddy mixed sediment
SS.SMx.CMx.OphMx	Ophiothrix fragilis and/or Ophiocomina nigra brittlestar beds on sublittoral mixed sediment
SS.SMx.CMx.MysThyMx	Kurtiella bidentata and Thyasira spp. in circalittoral muddy mixed sediment
SS.SMx.OMx	Offshore circalittoral mixed sediment
SS.SMx.OMx.PoVen	Polychaete-rich deep Venus community in offshore mixed sediments
SS.SSa.CFiSa	Circalittoral fine sand
SS.SSa.CFiSa.EpusOborApri	Echinocyamus pusillus, Ophelia borealis and Abra prismatica in circalittoral fine sand
SS.SSa.CMuSa.AalbNuc	Abra alba and Nucula nitidosa in circalittoral muddy sand or slightly mixed sediment
SS.SSa.IFiSa.NcirBat	Nephtys cirrosa and Bathyporeia spp. in infralittoral sand
SS.SSa.IMuSa.Ecor.Ens	Echinocardium cordatum and Ensis spp. in lower shore and shallow sublittoral slightly muddy fine sand
SS.SSa.IMuSa.FfabMag	Fabulina fabula and Magelona mirabilis with venerid bivalves and amphipods in infralittoral compacted fine muddy sand
SS.SMu.ISaMu.AmpPlor	Ampelisca spp., Photis longicaudata and other tube-building amphipods and polychaetes in infralittoral sandy mud

Appendix H: Sediment metabarcoding

H.1. Sediment metabarcoding results (2021 survey)

H.1.1 Overview

H.1.1.1.1 Two samples were collected from 35 sample stations within the Morgan Array Area with one being analysed in the laboratory and the second retained as a spare. During the site-specific surveys, samples were also collected from 48 stations within the Mona Array Area.

H.1.2 Summary statistics

H.1.2.1.1 A total of 2,211 operational taxonomic units (OTUs) were detected across from the site-specific surveys as detailed in Table H.1. Of the 2211 detected OTUs (bacterial and infaunal), a greater percentage of infaunal OTUs were identified to species level (9%) compared to the bacterial OTUs (1%) possibly related to a larger pool of reference material for infaunal OTUs.

Table H.1: OTU detections per target and percentage successfully classified.

Target	Number of OTUs	Phylum (%)	Class (%)	Order (%)	Family (%)	Genus (%)	Species (%)
Bacteria	1582	72	53	31	21	6	1
Infauna	629	100	82	89	78	33	9

H.1.2.1.2 From the 1,582 bacterial OTUs detected in the sediment samples, 1,315 (83%) were detected in the Morgan sample stations whilst 1352 (85%) were detected in the Mona sample stations. Bacteria OTUs were similar between both survey areas with 69% (1085) shared across both survey areas. In terms of all the bacterial OTUs, 17% (230) were unique to the Morgan benthic subtidal ecology study area while 20% (267) were unique to Mona benthic subtidal ecology study area. A total of 35 bacterial OTUs (3%) were present in all Morgan sediment samples compared to 32 (2%) across the Mona samples. Generally, the proportion of bacterial OTUs occurring in a single sample only were similar between both survey areas with 27% of OTUs (n=355) in the Morgan sediment samples and 24% (n=326) in the Mona sediment samples. The relatively high numbers of widespread taxa and lone taxa across the Morgan and Mona benthic subtidal ecology study areas suggested that the community has been subjected to relatively little disturbance.

H.1.2.1.3 Overall, 629 infaunal OTUs were detected across both survey areas with a higher percentage of faunal OTUs detected at the Mona benthic subtidal ecology study area (73%; n=461) compared to the Morgan benthic subtidal ecology study area (71%; n=447). A total of 199 (45%) infaunal OTUs were present in a single sample across the Morgan samples, similar to the 198 (43%) infaunal OTUs across the Mona samples. However, in contrast to the bacterial data set no OTUs were detected in every sample. The absence of consistent community as well as the high proportion

(>40%) of rare OTUs suggest the community heterogeneity across the survey area may have been under sampled for the infaunal size class. This may be improved by analysis of the second samples acquired at each station though it's not certain that it will fill all community gaps.

H.1.2.1.4 The bacterial data sets identified 40 taxonomic groups based on class with the proportional contributions of these taxonomic groups to the overall structure of the Morgan and Mona benthic subtidal ecology study areas detailed in Table H.2. The 'Other' category comprised OTUs which could not be identified to class.

H.1.2.1.5 The most abundant taxonomic group across the Morgan and Mona benthic subtidal ecology study areas (n=599 and n=622) was the 'Other' which accounted for 45.6% and 46.0% of OTUs, respectively. The second most abundant taxonomic group was the Gammaproteobacteria class (n=239 and n=247 OTUs) and accounted for 18.2% and 18.3% of OTUs, respectively. As previously mentioned, Gammaproteobacteria dominance is likely given it is one of the richest classes within the bacterial phyla (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.

Table H.2: Contribution of Gross Sediment Bacterial OTU Taxonomic Groups.

Group	Morgan Survey Area		Mona Survey Area	
	Abundance	Proportional Contribution	Abundance	Proportional Contribution
Acidobacteriae	45	3.4%	46	3.4%
Aminicenantia	4	0.3%	4	0.3%
Acidimicrobiia	3	0.2%	2	0.1%
Actinomycetia	28	2.1%	26	1.9%
Bacteroidia	80	6.1%	82	6.1%
Ignavibacteria	1	0.1%	2	0.1%
Rhodothermia	1	0.1%	1	0.1%
Bacteriovoracia	1	0.1%	1	0.1%
Campylobacteria	3	0.2%	3	0.2%
Anaerolineae	16	1.2%	20	1.5%
Dehalococcoidia	1	0.1%	2	0.1%
Cyanobacteriia	1	0.1%	1	0.1%
Vampirovibrionia	1	0.1%	1	0.1%
Deferribacteres	2	0.2%	1	0.1%
Deinococci	1	0.1%	1	0.1%
Babeliae	1	0.1%	0	0.0%
Desulfobacteria	3	0.2%	5	0.4%
Desulfobulbia	1	0.1%	2	0.1%
Desulfovibrionia	0	0.0%	1	0.1%

Group	Morgan Survey Area		Mona Survey Area	
	Abundance	Proportional Contribution	Abundance	Proportional Contribution
Desulfuromonadia	2	0.2%	2	0.1%
Syntrophobacteria	1	0.1%	1	0.1%
Chitinivibrionia	0	0.0%	1	0.1%
Clostridia	3	0.2%	2	0.1%
Fusobacteriia	1	0.1%	1	0.1%
Gemmatimonadetes	4	0.3%	4	0.3%
Moduliflexia	1	0.1%	0	0.0%
Myxococcia	0	0.0%	1	0.1%
Polyangia	4	0.3%	3	0.2%
Nitrospiria	14	1.1%	15	1.1%
Thermodesulfovibrionia	3	0.2%	4	0.3%
Gracilibacteria	1	0.1%	3	0.2%
Phycisphaerae	4	0.3%	5	0.4%
Planctomycetes	92	7.0%	93	6.9%
Alphaproteobacteria	105	8.0%	100	7.4%
Gammaproteobacteria	239	18.2%	247	18.3%
Spirochaetia	6	0.5%	9	0.7%
Sumerlaeia	0	0.0%	1	0.1%
Chlamydiia	1	0.1%	0	0.0%
Kiritimatiellae	9	0.7%	10	0.7%
Verrucomicrobiae	33	2.5%	27	2.0%
Other	599	45.6%	622	46.0%
Total	**1315**	**100%**	**1352**	**100%**

H.1.2.1.6 A total of 26 taxonomic groups based on class were identified from the sediment infaunal data sets with the proportional contributions of these taxonomic groups to the overall structure of both the Morgan benthic subtidal ecology study area and Mona benthic subtidal and intertidal ecology study area detailed in Table H.3. The ‘Other’ category comprised the OTUs which could not be identified to class.

H.1.2.1.7 *Adenophorea* (n=189 and n=175 OTUs) was the most abundant taxonomic group across both the Morgan benthic subtidal ecology study area and Mona benthic subtidal and intertidal ecology study area and accounted for 51.9% and 44.4% of OTUs, respectively. The second most abundant group across the Morgan benthic subtidal ecology study area was the ‘Others group (n=83, 18.6%) while across the Mona benthic subtidal and intertidal ecology study area the second most abundant group was Hexanauplia (n=76, 19.3%). Four taxonomic groups were represented by a single

OTU across the Morgan benthic subtidal ecology study area while five represented by a single OTU across the Mona benthic subtidal and intertidal ecology study area. One taxonomic group was unique to the Morgan data set (*Asteroidea*) whilst three were unique to the Mona data set (*Staurozoa*, *Polyplacophora*, *Hoplonemertea*).

Table H.3: Contribution of gross sediment infaunal OUT taxonomic groups.

Group	Morgan survey area		Mona survey area	
	Abundance	Proportional contribution	Abundance	Proportional contribution
Clitellata	1	0.3%	2	0.5%
Polychaeta	53	14.6%	65	16.5%
Arachnida	6	1.6%	7	1.8%
Hexanauplia	58	15.9%	76	19.3%
Malacostraca	3	0.8%	4	1.0%
Ostracoda	4	1.1%	3	0.8%
Appendicularia	1	0.3%	1	0.3%
Ascidiacea	7	1.9%	6	1.5%
Anthozoa	4	1.1%	2	0.5%
Hydrozoa	7	1.9%	12	3.0%
Scyphozoa	1	0.3%	1	0.3%
Staurozoa	0	0.0%	1	0.3%
Asteroidea	1	0.3%	0	0.0%
Echinoidea	2	0.5%	2	0.5%
Holothuroidea	2	0.5%	3	0.8%
Ophiuroidea	1	0.3%	3	0.8%
Enteropneusta	2	0.5%	1	0.3%
Bivalvia	6	1.6%	6	1.5%
Gastropoda	6	1.6%	5	1.3%
Polyplacophora	0	0.0%	1	0.3%
Adenophorea	189	51.9%	175	44.4%
Hoplonemertea	0	0.0%	2	0.5%
Pilidiophora	4	1.1%	7	1.8%
Eurotatoria	6	1.6%	5	1.3%
Sipunculidea	0	0.0%	4	1.0%
Other	83	18.6%	67	14.5%
Total	364	100%	394	100%

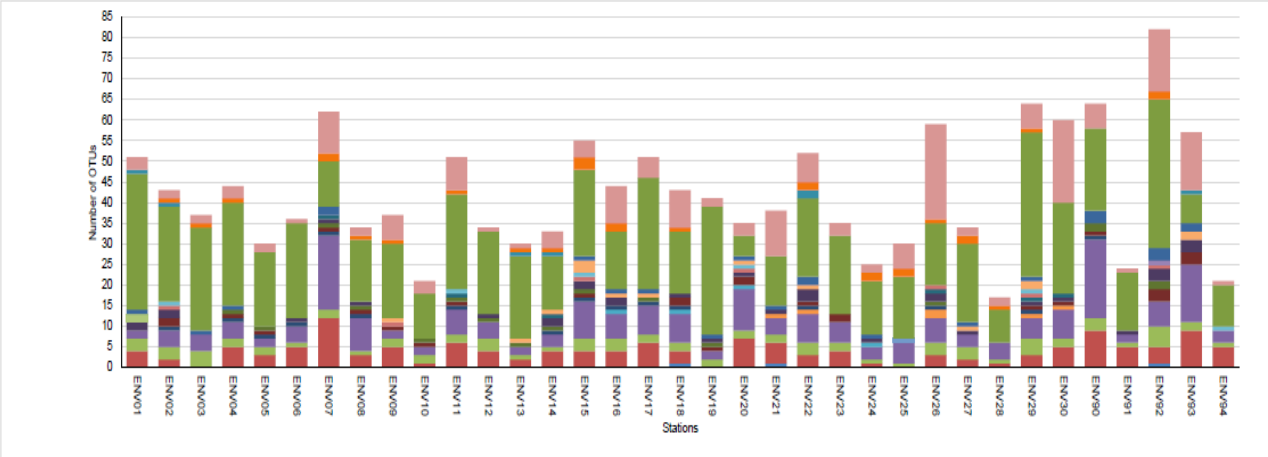


Figure H.1: Contributions of gross sediment infaunal OTU taxonomic groups by samples – Morgan benthic subtidal ecology study area.

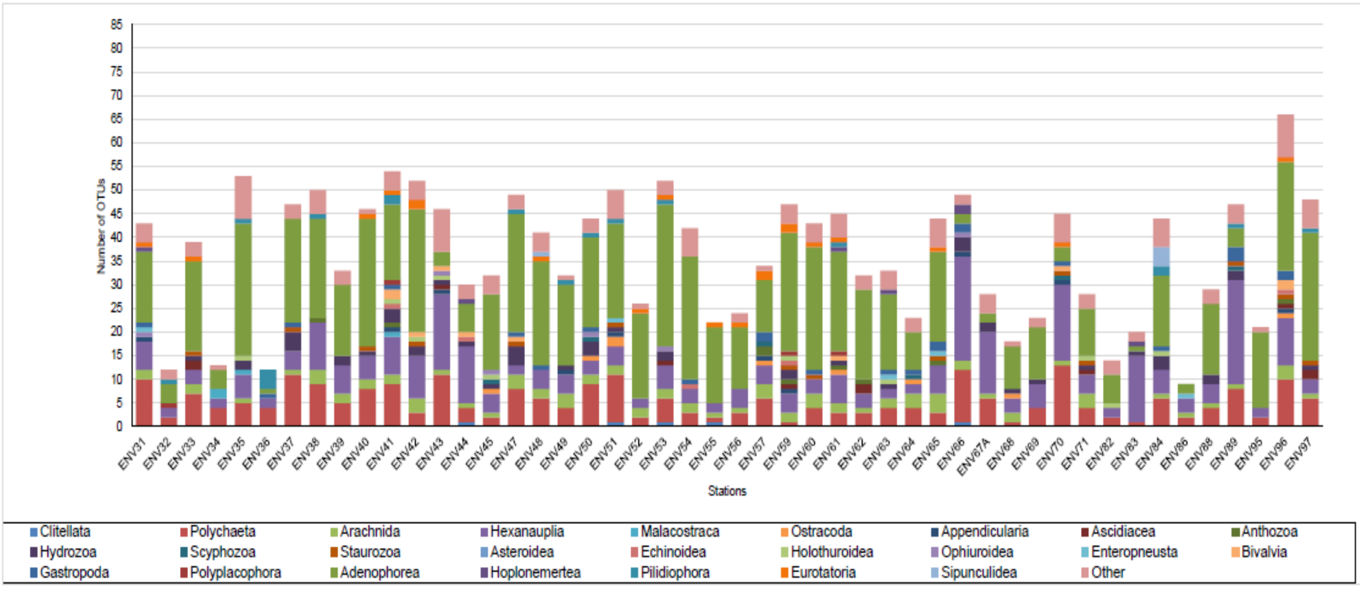


Figure H.2: Contributions of gross sediment infaunal OTU taxonomic groups by samples – Mona benthic subtidal ecology study area.

H.1.2.1.8 Comparative taxonomic heat trees detailing the number of OTUs across the Morgan and Mona benthic subtidal ecology study areas from bacterial taxa down to the order rank are presented in Figure H.3 while the taxonomic heat trees detailing the discrete faunal taxa OTUs down to the order rank are presented in Figure H.4. The nodes (circles) represent a 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 in the combined dataset for each survey area. Labels without nodes represent missing taxa. Summary statistics for the sediment bacterial and infaunal richness are detailed in Table H.4.

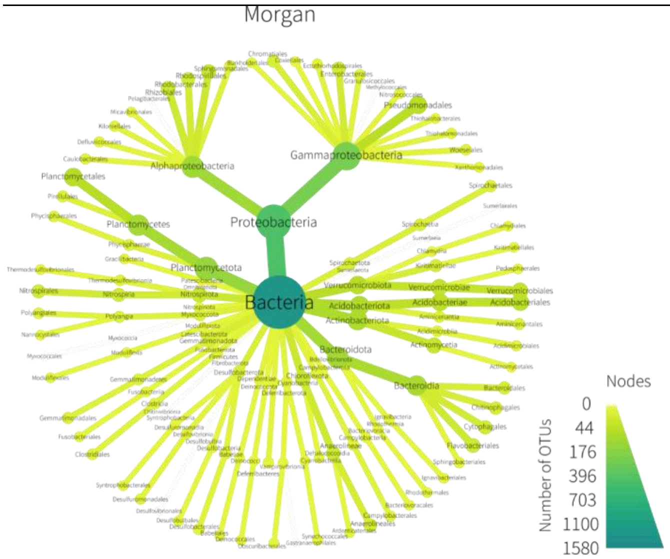


Figure H.3: Sediment bacterial taxonomic heat trees of the number of OTUs per benthic subtidal ecology study area.

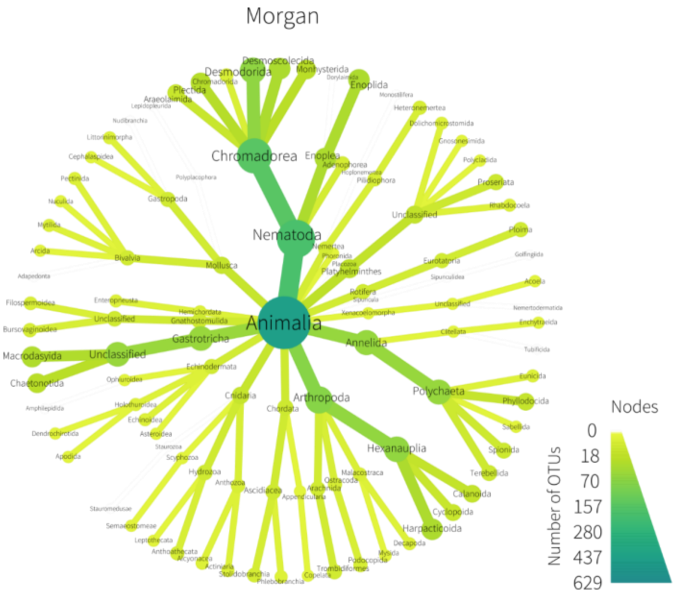


Figure H.4: Sediment infaunal taxonomic heat trees of the number of OTUs per benthic subtidal ecology study area.

Table H.4: Summary of sediment bacterial and infaunal richness.

	Bacterial		Faunal	
	Morgan survey area	Mona survey area	Morgan survey area	Mona survey area
Minimum	298	324	17	9
Maximum	415	424	82	66
Mean	371.4	382.3	42.1	36.1
±SD	31.6	23.0	14.7	13.6

H.1.2.1.9 Accumulation plots of OTUs for the sediment bacterial and infaunal data sets for both the Morgan and Mona benthic subtidal ecology study areas are presented in Figure H.5, Figure H.6, Figure H.7 and Figure H.8, respectively. Sharp changes in the slope of the species in order of observation (Sobs) curve reflect notable changes in community between stations. Further, the relation of the Sobs curve to that of the permutated average of samples (such as the UGE curve generated average after 999 random sample combinations) can reflect number of OTUs versus expectations.

H.1.2.1.10 The Sobs curve for the Morgan sediment bacterial data set (Figure H.5) steeply increased with the addition of ENV02. The curve steepened again with the addition of ENV07. Following this the Sobs curve closely matches that of the UGE curve. It also reveals that Stations ENV04 to ENV06 form a similar group with a low quantity of OTUs with comparatively little changes in community between them, though still notably below the expected rate of change in community.

H.1.2.1.11 Considering the Mona bacterial data set (Figure H.6), the Sobs curve steadily increased with addition of samples there where two steep increases with the addition of ENV43 and ENV59. Following this the Sobs curve closely matched that of the UGE curve until the addition of ENV95 when the Sobs curve rose above the UGE curve indicating a greater number of OTUs were present that was expected. There are several plateaus (including ENV44 to ENV53 and ENV57 to ENV61) within the Mona dataset indicating groups of stations with more similar OTUs than the rate of change indicated by the UGE curve.

H.1.2.1.12 The Sobs and UGE curves of the sediment bacterial data OTU accumulation plots for both the Morgan and Mona benthic subtidal ecology study areas continued to rise with the addition of the last samples. This reflected that further samples across the Morgan and Mona benthic subtidal ecology study areas may elicit additional OTUs to those reported during the current sampling campaign though the rate of increases were low (<8 OTUs in Morgan and <16 OTUS in Mona added with the last UGE stations).

H.1.2.1.13 The Sobs curve for the Morgan sediment infaunal data set (Figure H.7) initially began above the UGE which indicated that a greater number of OTUs were present in ENV01 than was to be expected. Following the addition of ENV03 the Sobs curve falls below the UGE and steadily increased with the addition of samples. This suggested that the number of OTUs reported for subsequent samples were in line with the wider area and no shift in the community was present.

H.1.2.1.14 The Sobs curve for the Mona sediment infaunal data set (Figure H.8) initially began above the UGE which indicated that a greater number of OTUs were present in ENV31 than was to be expected. Following the addition of ENV32 the Sobs curve falls below the UGE and steadily increased with the addition of samples. This suggested that the number of OTUs reported for subsequent samples were in line with the wider area and no shift in the community was present.

H.1.2.1.15 The Sobs and UGE curves of the sediment infaunal data OTU accumulation plots for both the Morgan and Mona benthic subtidal ecology study areas continued to rise with the addition of the last samples This reflected that further samples across the Morgan and Mona benthic subtidal ecology study areas may elicit additional OTUs to those reported during the current sampling campaign. Rates of increase towards the end were low with <6 OTUs added to UGE in the Morgan benthic subtidal ecology study area and <5 in the Mona benthic subtidal ecology study area.

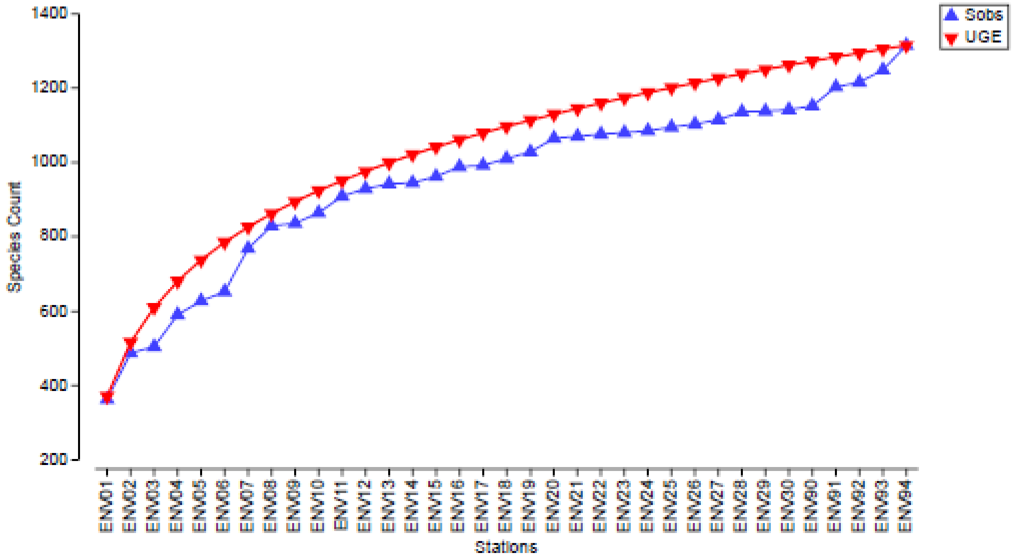


Figure H.5: Sediment bacterial OTU accumulation curve – Morgan benthic subtidal ecology study area.

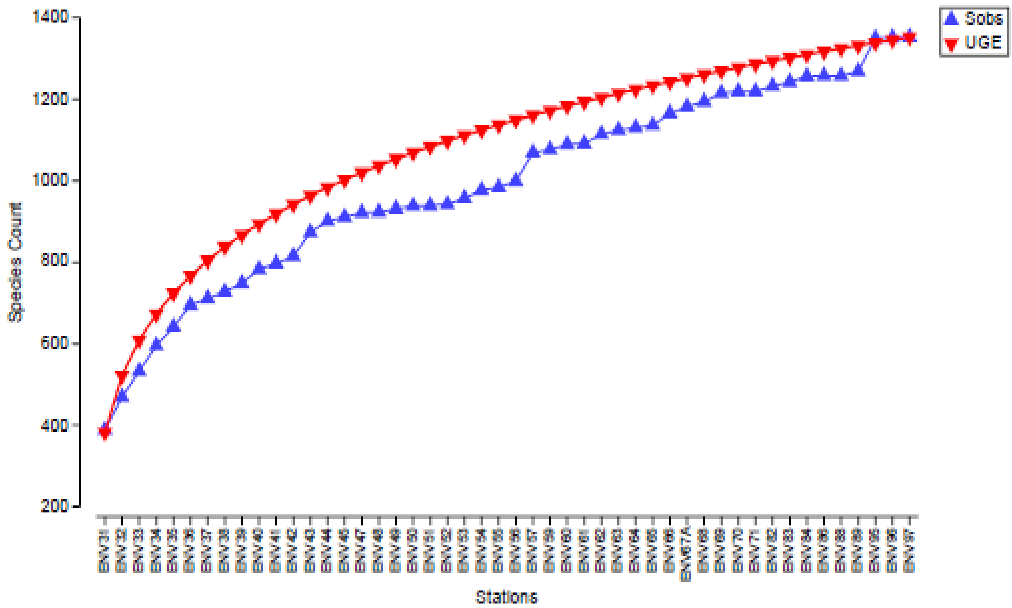


Figure H.6: Sediment bacterial OTU accumulation curve – Mona benthic subtidal ecology study area.

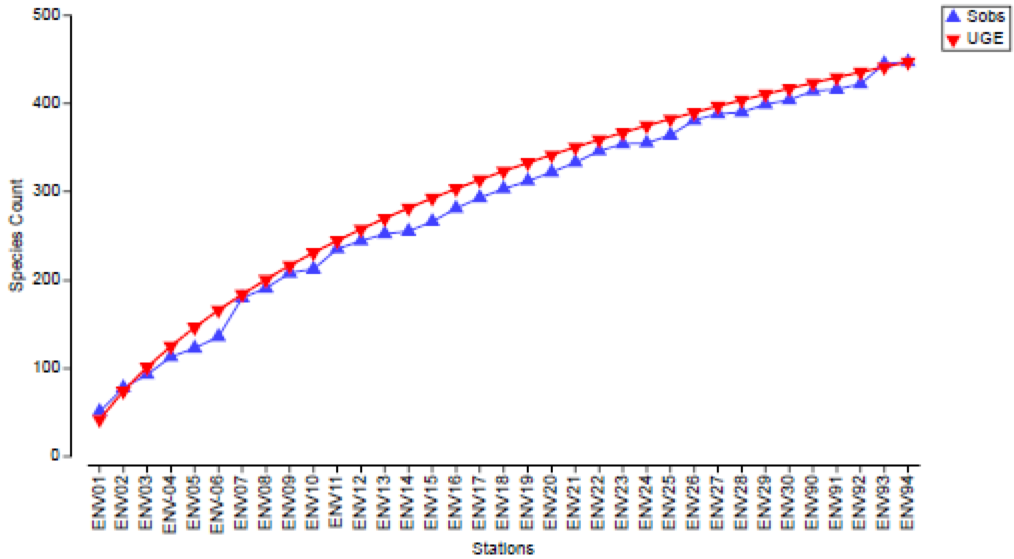


Figure H.7: Sediment infaunal OTU accumulation curve – Morgan benthic subtidal ecology study area.

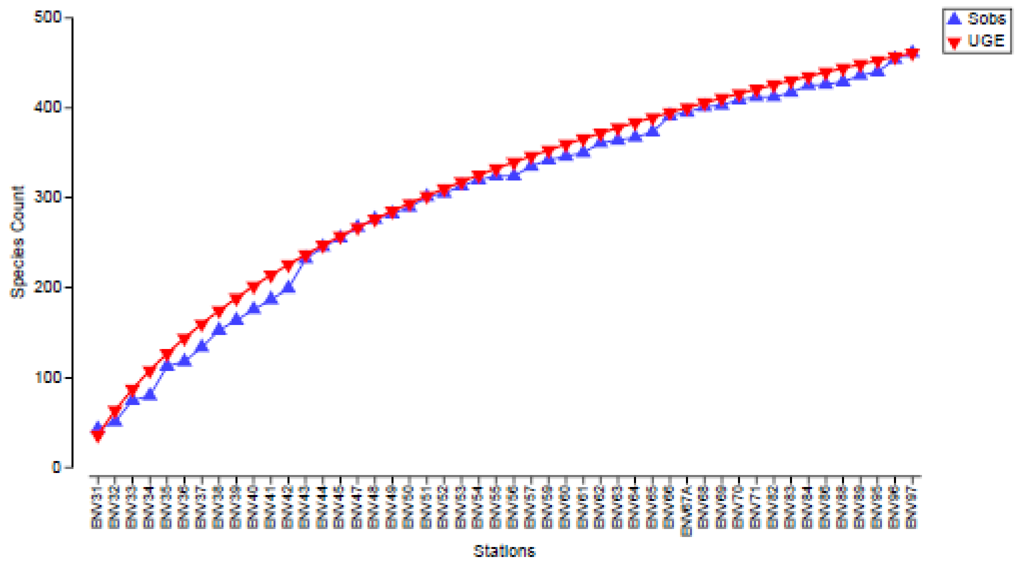


Figure H.8: Sediment infaunal OTU accumulation curve – Mona benthic subtidal ecology study area.

H.1.3 OTU Community Structure using Multivariate Analyses

H.1.3.1.1 The results of the CLUSTER analysis including SIMPROF analysis in the form of a Bray-Curtis similarity dendrogram and nMDS plot based upon standardised data for the sediment bacterial samples are displayed in Figure H.9 and Figure H.10 for the Morgan benthic subtidal ecology study area and in Figure H.11 and Figure H.12 for the Mona benthic subtidal ecology study area. Similarly results of the same analyses on the standardised infauna data are presented in Figure H.13 for the Morgan benthic subtidal ecology study area and in Figure H.14 for the Mona benthic subtidal ecology study area.

H.1.3.1.2 The CLUSTER analysis and resulting dendrogram for the Morgan benthic subtidal ecology study area sediment bacterial OTU data set (Figure H.9) identified 23 groups which comprised 12 outliers (SIMPROF a, b, g, i, l, m, n, o, q, s, t and u), 10 closely associated pairs (SIMPROF c, d, e, f, h, j, k, p, r and w) and a single cluster (SIMPROF v). All samples were considered more dissimilar than similar to one another and grouped at c.21% similarity.

H.1.3.1.3 The Mona benthic subtidal ecology study area identified 29 SIMPROF groups (Figure H.11) including 16 outliers (SIMPROF a, b, c, d, g, j, m, o, p, q, r, t, w, y, z and aa) 7 closely associated groups (SIMPROF h, i, k, s, u, v and ab) and 6 clusters (SIMPROF e, f, l, n, x and ac). Like the Morgan benthic subtidal ecology study area, all samples were more dissimilar than similar to one another grouping at c.16%. The generally low similarities are potentially relating to the bacterial communities are far richer than equivalent larger metazoan communities and also less discriminately bound to the sediment given their established variation with both overlying water quality along with direct sediment physico-chemistry (Allison and Martiny, 2008; Frühe et al., 2021). However, they still provide a suitable sensitive receptor to environmental pressures for monitoring impacts (Horton et al., 2019).

H.1.3.1.4 The nMDS ordination of the Morgan and Mona sediment bacterial sample data sets (Figure H.10 and Figure H.12) revealed a similar pattern to the cluster analysis, with a stress level of 0.14 and 0.12 respectively, the ordinations can be considered a useful two-dimensional representation of rank dis(similarities) and overall pattern observed in the data sets.

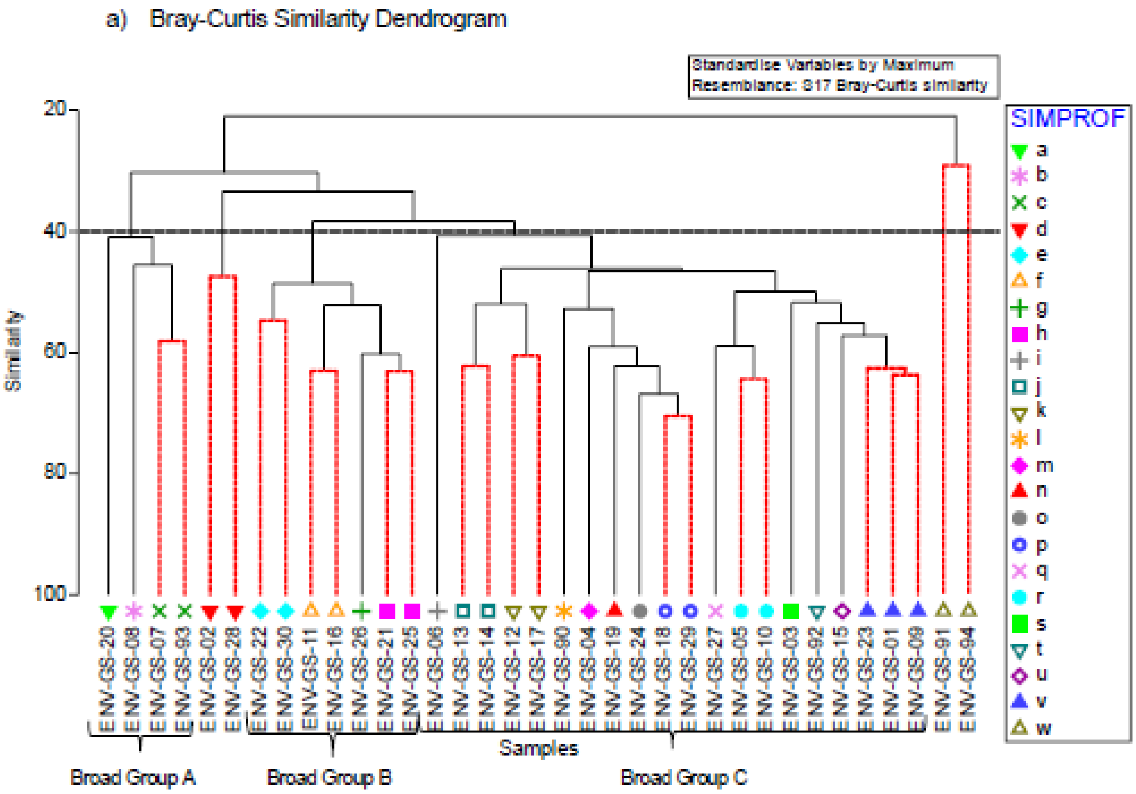


Figure H.9: Multivariate analysis of sediment bacterial OTU data by sample – Morgan benthic subtidal ecology study area.

b) MDS Ordination

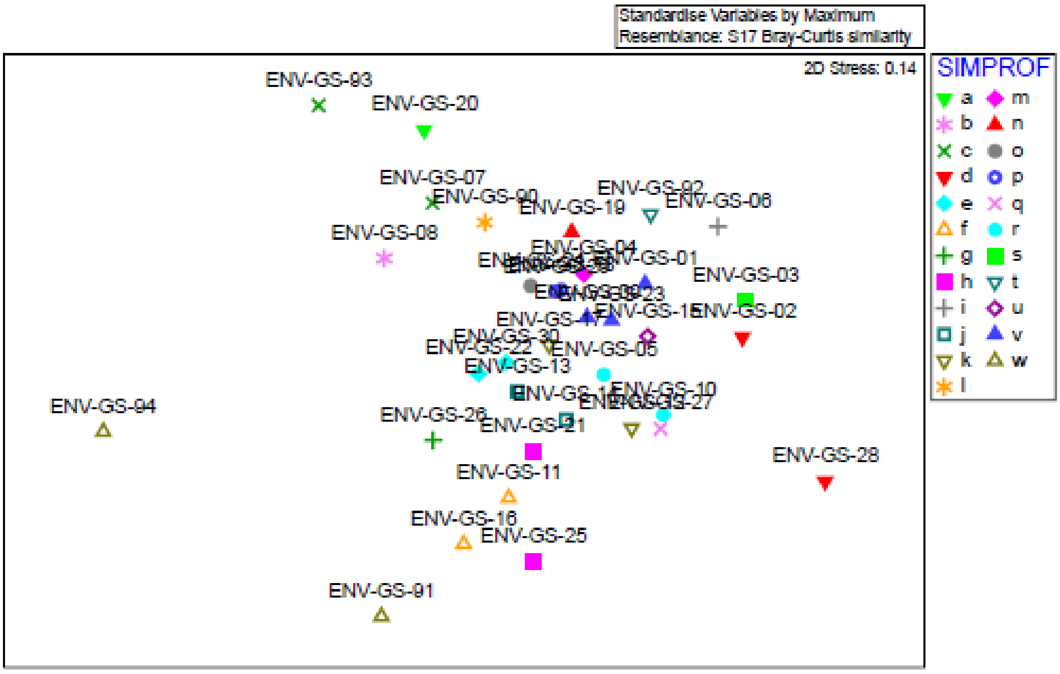


Figure H.10: Multivariate analysis of sediment bacterial OTU data by sample – Morgan benthic subtidal ecology study area.

a) Bray-Curtis Similarity Dendrogram

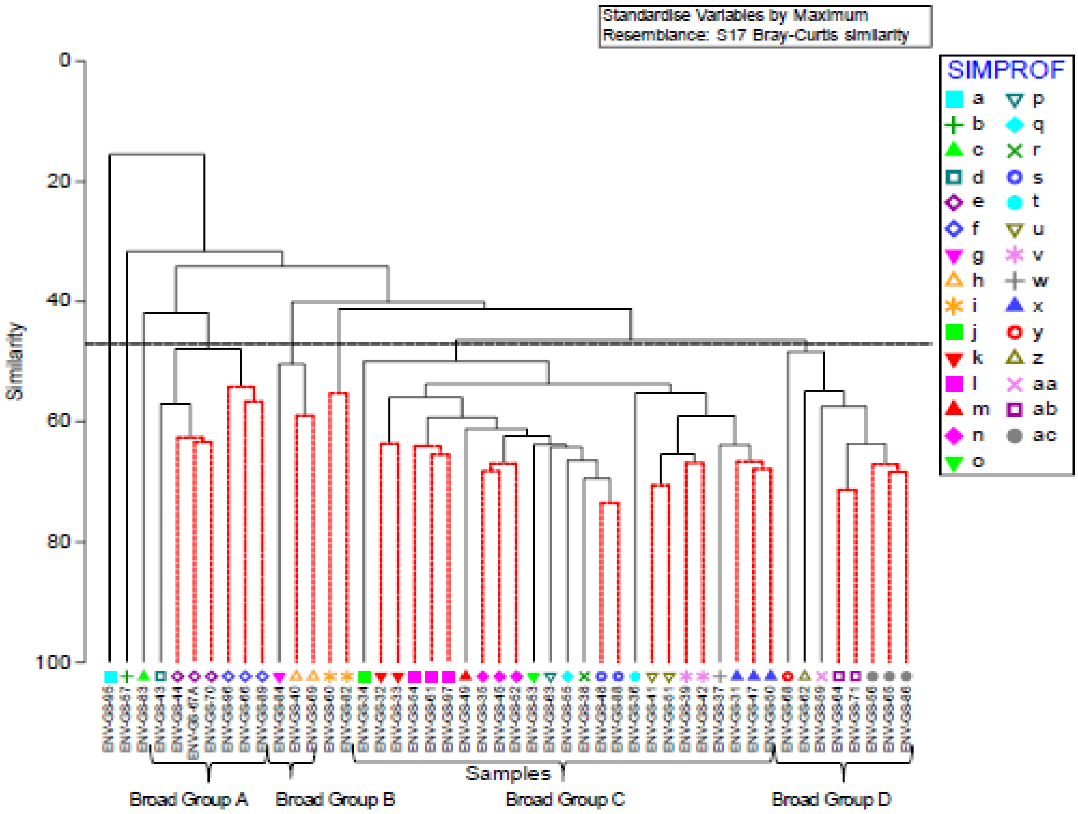


Figure H.11: Multivariate analysis of sediment bacterial OTU data by sample – Mona benthic subtidal ecology study area.

b) MDS Ordination

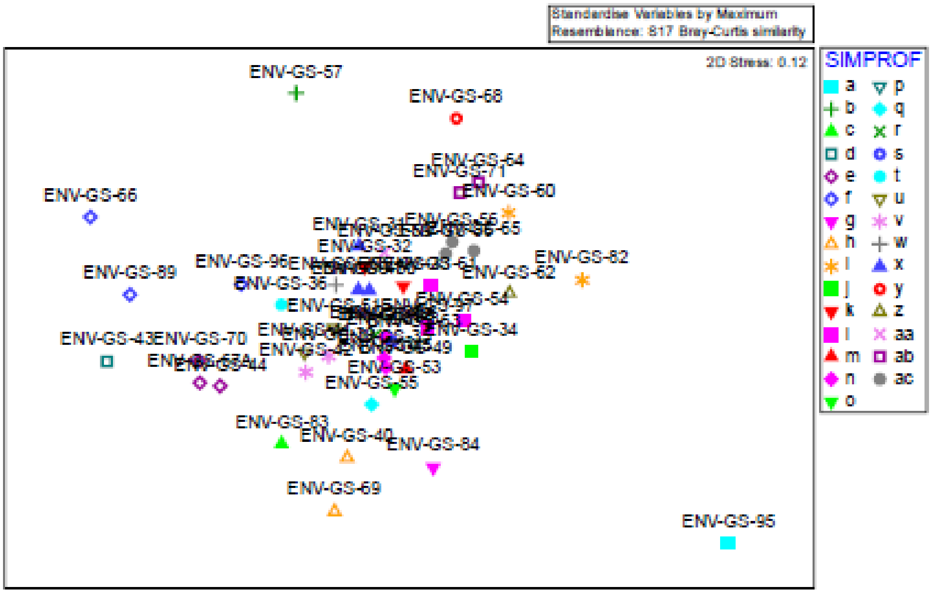


Figure H.12: Multivariate analysis of sediment bacterial OTU data by sample – Mona benthic subtidal ecology study area.

H.1.3.1.5 Examination of the Morgan sediment bacterial sample data set together with results of SIMPER analyses at a group level is presented in Table H.5. This was restricted to explaining the separations where similarity was less than 40% for conciseness and includes the principal contributors to the grouping and separation of the samples. The analysis suggested that differences in SIMPROF groups and further the broad groups were largely due to the variations in abundances/absences of the OTUs from the dominant groups particularly from Gammaproteobacteria Alphaproteobacteria and Planctomycetes.

Table H.5: Taxa influencing sediment bacteria OTU SIMPROF variation – Morgan benthic subtidal ecology study area.

SIMPROF	Dissimilarity (%)	Groups Influencing Sample Separation
SIMPROF w vs a-v	79	51 Indeterminate Bacteria OTUs were unique to SIMPROF w (c.10.2% of the dissimilarity) whilst 44 were more abundant in SIMPROF w (c.8.8% of the dissimilarity). 18 Proteobacteria OTUs were unique to SIMPROF w (c.3.4% of the dissimilarity) whilst 13 were more abundant in SIMPROF w (c.2.6% of the dissimilarity). 10 Gammaproteobacteria OTUs were unique to SIMPROF w (c.1.9% of the dissimilarity) whilst 6 were more abundant in SIMPROF w (c.1.1% of the dissimilarity) and 10 were more abundant in SIMPROF groups a-v (c.1.7% of the dissimilarity).
Broad Group A vs SIMPROF groups d-v	70	12 Indeterminate Bacteria OTUs were unique to Broad Group A (c.2.3% of the dissimilarity) whilst 46 were more abundant in Broad Group A (c.7.8% of the dissimilarity). 10 Gammaproteobacteria OTUs were unique to Broad Group A (c.1.7% of the dissimilarity) whilst 52 were more abundant in Broad Group A (c.9.1% of the dissimilarity) and 12 were more abundant in SIMPROF groups d-v (c.1.7% of the dissimilarity).

SIMPROF	Dissimilarity (%)	Groups Influencing Sample Separation
		25 Alphaproteobacteria were more abundant in SIMPROF groups a-c (c.4.2% of the dissimilarity).
SIMPROF d vs Broad Group B and C	67	23 Planctomycetes OTUs were more abundant in SIMPROF d (c.7.5% of the dissimilarity) 8 Indeterminate Bacteria OTUs were unique to SIMPROF d (c.1.8% of the dissimilarity) whilst 27 were more abundant in SIMPROF d (c.5.9% of the dissimilarity). 23 Alphaproteobacteria OTUs were more abundant in SIMPROF d (c.5.6% of the dissimilarity) 7 Gammaproteobacteria OTUs were unique to SIMPROF d (c.1.5% of the dissimilarity) whilst 23 were more abundant in SIMPROF d (c.5.4% of the dissimilarity)
Broad Group B vs Broad Group C	62	44 Indeterminate Bacteria OTUs were more abundant in Broad Group B (c.9.0% of the dissimilarity) whilst 16 were more abundant in Broad Group C (c.3.0% of the dissimilarity). 22 Indeterminate Bacteria OTUs were more abundant in Broad Group B (c.4.3% of the dissimilarity) whilst 31 were more abundant in Broad Group C (c.5.6% of the dissimilarity). 12 Planctomycetes OTUs were more abundant in SIMPROF d (c.2.8% of the dissimilarity)

H.1.3.1.6 Examination of the Mona bacterial sample data set, together with the results of SIMPER analyses at a group level is presented in Table H.6. This was restricted to explaining separations where similarity was less than 47% for conciseness. SIMPROF groups a, b and c were outliers due to the occurrence of several bacterial taxa not present in the other groups. The broad groups identified showed differences due to subtle variations in taxa community structure within particular SIMPROF groups.

Table H.6: Taxa influencing sediment bacteria OTU SIMPROF variation – Mona benthic subtidal ecology study area.

SIMPROF	Dissimilarity (%)	Taxa Influencing Sample Separation
SIMPROF a vs rest	85	41 Indeterminate Bacteria OTUs were unique to SIMPROF a (c.13.1% of the dissimilarity) whilst 31 were more abundant in SIMPROF a (c.8.6% of the dissimilarity). 6 Proteobacteria OTUs were unique to SIMPROF a (c.1.9% of the dissimilarity) whilst 10 were more abundant in SIMPROF a (c.3.0% of the dissimilarity). Anaerolineae OTUs were unique to SIMPROF a (c.2.9% of the dissimilarity) whilst 5 were more abundant in SIMPROF a (c.1.1% of the dissimilarity).
SIMPROF b vs Broad Groups A, B, C, D and SIMPROF i and c	68	12 Gammaproteobacteria OTUs were unique to SIMPROF b (c.4.3% of the dissimilarity) whilst 29 were more abundant in SIMPROF b (c.8.4% of the dissimilarity). 9 Indeterminate Bacteria OTUs were unique to SIMPROF b (c.3.2% of the dissimilarity) whilst 26 were more abundant in SIMPROF b (c.7.7% of the dissimilarity). 4 Planctomycetes OTUs were unique to SIMPROF b (c.1.4% of the dissimilarity) whilst 11 were more abundant in SIMPROF b (c.3.2% of the dissimilarity).
SIMPROF c and Broad Group A vs Broad Groups B, C, D and SIMPROF i	67	24 Alphaproteobacteria OTUs were more abundant in Group cA (c.4.3% of the dissimilarity) and 8 were more abundant in Group BCDi (c.1.1% of the dissimilarity) 34 Gammaproteobacteria were more abundant in Group cA (c.5.7% of the dissimilarity) and 34 were more abundant in Group BCDi (c.5.1% of the dissimilarity) 44 Indeterminate Bacteria OTUs were more abundant in Group cA (c.7.7% of the dissimilarity) and 23 were more abundant in Group BCDi (c.3.5% of the dissimilarity) 16 Planctomycetes OTUs were more abundant in Group cA (c.3.1% of the dissimilarity)
SIMPROF c vs Broad Group A	58	9 Indeterminate Bacteria OTUs were unique to SIMPROF c (c.3.2% of the dissimilarity) whilst 21 were more abundant in SIMPROF c (c.5.4% of the dissimilarity). 5 Alphaproteobacteria OTUs were unique to SIMPROF c (c.2.2% of the dissimilarity) whilst 8 were more abundant in SIMPROF c (c.2.2% of the dissimilarity). 10 Gammaproteobacteria OTUs were unique to SIMPROF c (c.4.1% of the dissimilarity) whilst 29 were more abundant in SIMPROF c (c.9.0% of the dissimilarity).
Broad Group B vs SIMPROF i and Broad Groups C and D	61	6 Gammaproteobacteria OTUs were unique to Group B (c.1.0% of the dissimilarity) whilst 54 were more abundant in Group B (c.11.4% of the dissimilarity) 12 Indeterminate Bacteria OTUs were unique to Group B (c.2.0% of the dissimilarity) whilst 39 were more abundant in Group B (c.8.2% of the dissimilarity). 13 Verrucomicrobiae were more abundant in Group B (c.0.7% of the dissimilarity).
SIMPROF i vs Broad Groups C and D	60	22 Gammaproteobacteria OTUs were more abundant to SIMPROF i (c.4.8% of the dissimilarity) whilst 14 were more abundant in Group CD (c.2.7% of the dissimilarity)

SIMPROF	Dissimilarity (%)	Taxa Influencing Sample Separation
		4 Indeterminate Bacteria OTUs were unique to SIMPROF i (c.1.2% of the dissimilarity) whilst 36 were more abundant in SIMPROF i (c.9.8% of the dissimilarity). 13 Bacteroidia were more abundant in SIMPROF i (c.3.3% of the dissimilarity).
Broad Group C vs D	55	25 Gammaproteobacteria OTUs were more abundant in Group D (c.4.6% of the dissimilarity) whilst 28 were more abundant in Group C (c.5.2% of the dissimilarity) 42 Indeterminate Bacteria OTUs were more abundant in Group D (c.8.5% of the dissimilarity) whilst 21 were more abundant in Group C (c.3.9% of the dissimilarity) 15 Alphaproteobacteria were more abundant in SIMPROF i (c.2.8% of the dissimilarity). 13 Planctomycetes were more abundant in SIMPROF i (c.2.4% of the dissimilarity).

H.1.3.1.7 CLUSTER analysis and resulting dendrograms for the Morgan sediment infauna OTU data set (Figure H.13) identified seven groups; which comprised two closely associated pairs (SIMPROF d and e) and five clusters (SIMPROF a, b, c, f and g). All samples were more dissimilar than similar to one another and grouped at c.2.7% similarity.

H.1.3.1.8 The Mona benthic subtidal ecology study area (Figure H.14) identified eleven SIMPROF groups comprising three outliers (SIMPROF a, c and f), four closely associated groups (SIMPROF b, d, e, and g) and four clusters (SIMPROF h, i, j and k). Similar to the Morgan survey area, all samples were more dissimilar than similar to one another; grouping together at c.2% similarity.

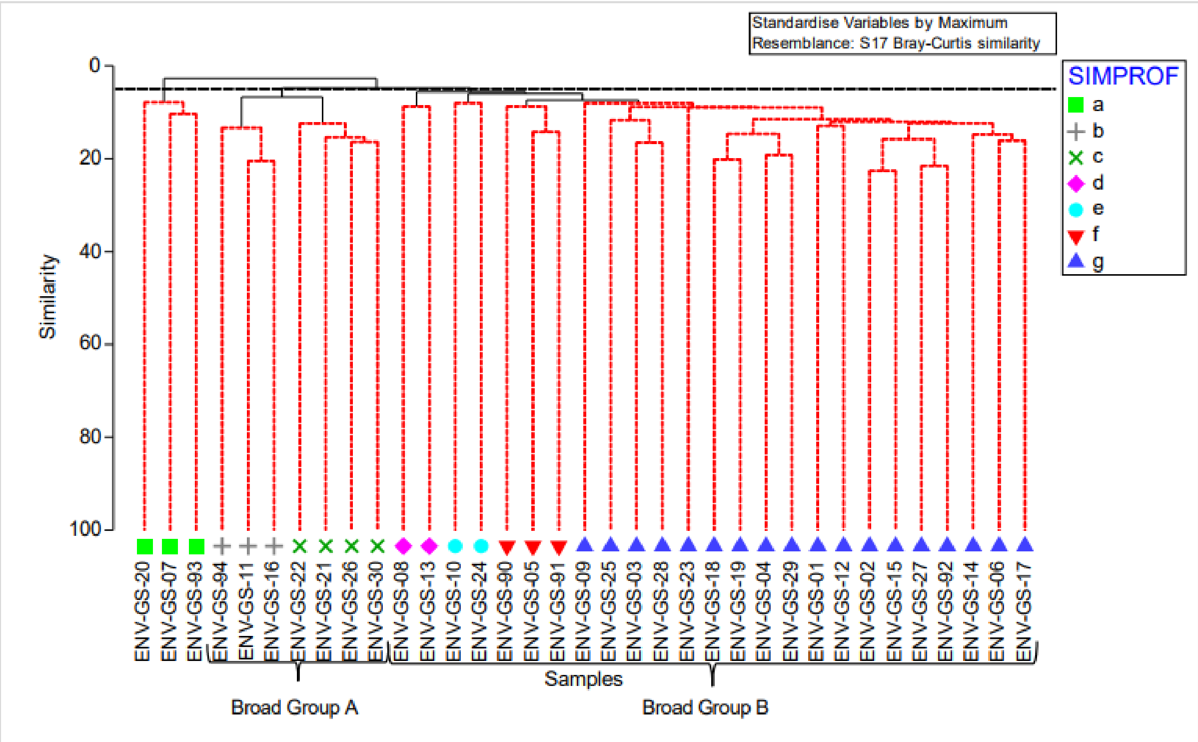


Figure H.13: Bray-Curtis similarity dendrogram of sediment infaunal OTU data by sample – Morgan benthic subtidal ecology study area.

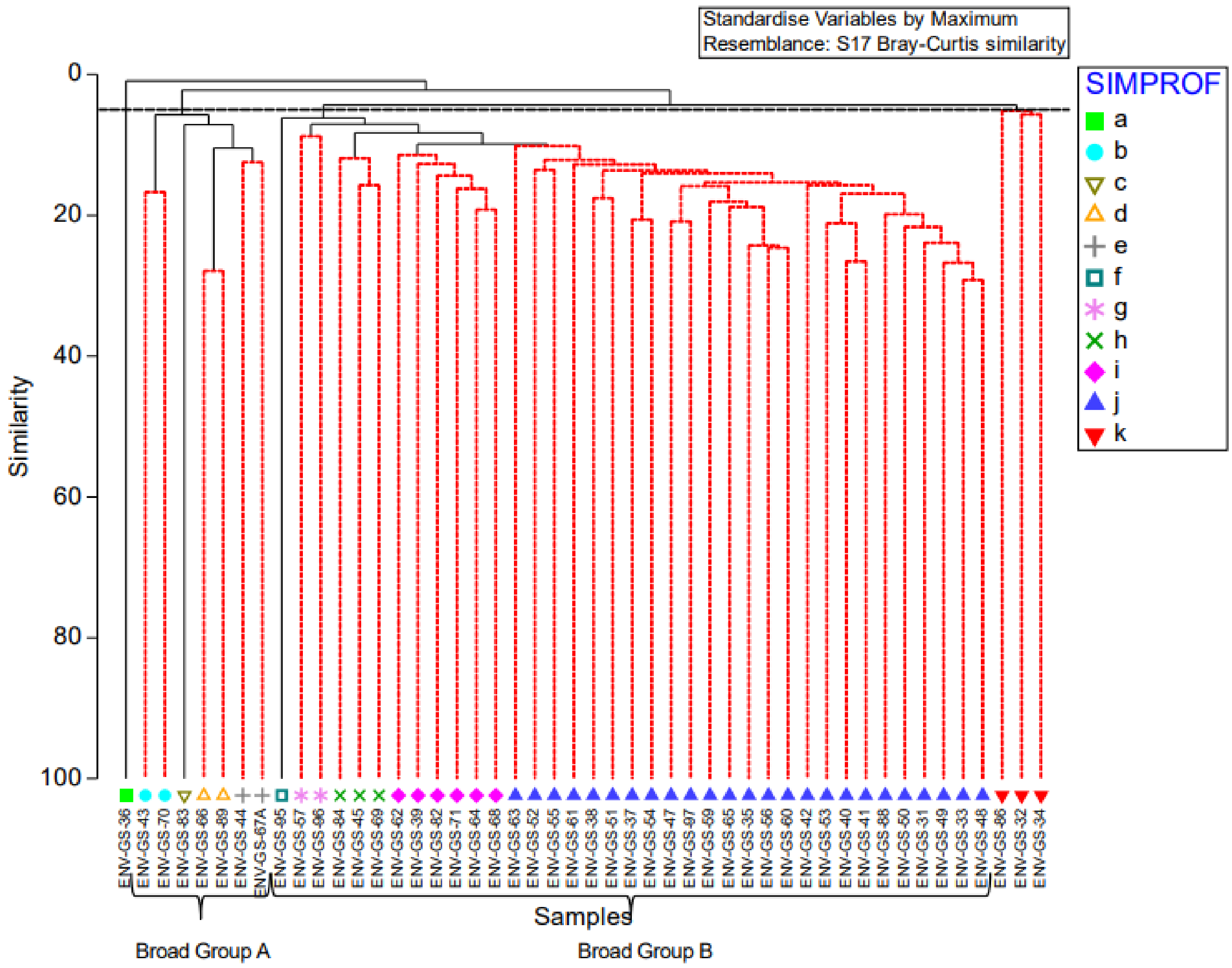


Figure H.14: Bray-Curtis similarity dendrogram of sediment infaunal OTU data by sample – Morgan benthic subtidal ecology study area.

H.1.3.1.9 Examinations of the Morgan sediment infaunal sample data set together with results of SIMPER analysis; presented in Table H.7, along with the principal contributors to the grouping and separation of the samples. The analysis suggested that differences in SIMPROF groups and the Broad Groups were largely due to the subtle differences in the infaunal community.

Table H.7: Taxa influencing sediment infauna OTU SIMPROF variation – Morgan benthic subtidal ecology study area.

SIMPROF	Dissimilarity (%)	Taxa Influencing Sample Separation
SIMPROF a vs Broad Group A and B	98	Mesonerilla_IM-211R6N, Mytilidae_IM-P18O8Y, Cyclopoida_IM- 45PX6J and Harpacticoida_IM-9BK8SI were more abundant in SIMPROF a (c.4.9% of the dissimilarity) whilst Nerillidium gracile and Spio_IM-6W06R6 were unique to Groups A and B (c.2.0% of the dissimilarity).

SIMPROF	Dissimilarity (%)	Taxa Influencing Sample Separation
Broad Group A vs Broad Group B	95	Ixonema_IM-J3RK8Q, Spio_IM-X7S00O, and Lauratonematidae_IM- 8TAQB0 were unique to Group A (c.3.0% of the dissimilarity) whilst Harpacticoida_IM-98G22P and Laxus_IM-2NM2IQ were more abundant in Group A (c.2.1% of the dissimilarity) Temora longicornis was less abundant at Group A (c.1.1% of the dissimilarity)

H.1.3.1.10 Results of the SIMPER analysis (Table H.8) for the Mona infaunal sample data set highlighted that SIMPROF a were outliers due to the presence of taxa not present in the other SIMPROF groups. Differences between Broad Groups A, B and SIMPROF k were similarly due to higher abundances and presence of several taxa. The broad groups identified showed differences due to subtle changes in the infaunal taxa contributions and presences and absences within particular SIMPROF groups.

Table H.8: Taxa influencing sediment infauna OTU SIMPROF variation – Morgan benthic subtidal ecology study area.

SIMPROF	Dissimilarity (%)	Taxa Influencing Sample Separation
SIMPROF a vs SIMPROF b-k	99	Odontosyllis fulgurans, Lineidae_IM-A93VO3, Lineidae_IM-197QT8 and Lineidae_IM-V6NR6Z were unique to SIMPROF a (c.21.3% of the dissimilarity) whilst Aricidea_IM-1L75U0 was more abundant in SIMPROF a (c.3.1% of the dissimilarity) Calanoida_IM-J7MI8C and Temora longicornis were more abundance in SIMPROF b-k (c.2.4% of the dissimilarity) whilst Desmoscolecidae_IM-04EB95 was unique to SIMPROF b-k (c.0.8% of the dissimilarity).
Broad Group A vs Broad Group B and SIMPROF k	98	Harpacticoida_IM-9BK8SI, Parameiropsidae_IM-3WL810, Harpacticoida_IM-Q1XWI6 and Argestidae_IM-43AS6P were unique to Group A (c.4.4% of the dissimilarity) whilst Ameira_IM-QY3076 was more abundant in Group A (c.1.0% of the dissimilarity) Calanoida_IM-J7MI8C and Temora longicornis were more abundant in Group B (c.2.7% of the dissimilarity)
Broad Group B vs SIMPROF k	96	Desmodorida_IM-2TWXL3, Dorvilleidae_IM-4BCCG8 and Haplognathiidae_IM-1M0V63 were unique to SIMPROF k (c.5.5% of the dissimilarity) whilst Terebellidae_IM-2QCW27 was more abundant in SIMPROF k (c.2.0% of the dissimilarity) Calanoida_IM-J7MI8C and Temora longicornis were more abundant in Group B

H.1.4 Multivariate comparison of metabarcoding results to physico-chemical data

H.1.4.1.1 The bacterial and infaunal OTUs detected throughout both Morgan and Mona benthic subtidal ecology study areas were compared to the physico-chemical data to determine if any patterns correlated.

H.1.4.1.2 A RELATE analysis identified a 48.5% significant correlation between the sediment bacterial OTUs and physico-chemical variables. BV STEP analyses further identified nine bacterial taxa groups (Acidobacteriaceae_IM-A38G3N, Actinobacteriota_IM-4S9D5Q, Flavobacteriaceae_IM-W54D7S, Planctomycetales_IM-MM63P0, Spongiibacteraceae_IM-RY386Z, Gammaproteobacteria_IM-496PWF, Gammaproteobacteria_IM-3FM60Y, Bacteria_IM-T842VS, Bacteria_IM-U76S04) which best explained the correlation. Figure H.15 illustrates the distribution patterns of these taxa across the benthic subtidal ecology study areas in relation to the physico-chemical SIMPROF clusters identified. Their geographic distribution in relation to the physico-chemical SIMPROF clusters indicates a potential overlap linking to the environmental driver defining those cluster discussed in Section 2.8.1. Bacteria_IM-T842VS for example, is predominantly distributed within the sandwave areas indicating a possible association with SIMPROF groups I and j.

H.1.4.1.3 A RELATE analysis between the infaunal I data set and the physico-chemical variables identified a 41% significant correlation. Sixteen taxa (Sabellariidae_IM-WO1H6H, Nerillidae_IM-P7281C, Halacaridae_IM-854J7R, Halacaridae_IM-863YQ3, Leptosynapta_IM-471WYT, Chaetonotidae_IM-66HBWK, Microlaimus honestus, Desmodorida_IM-7Z5D37, Oxystominidae_IM-84F6F2, Calyptronema_IM-QS27I8, Terschellingia longicaudata, Xyalidae_IM-JC228M, Lineidae_IM-97F94L, Lumbrineridae_IM-KH2BT9, Capitellidae_IM-0GX3E3 and Argestidae_IM-V085H7) which best explains the correlation were identified with a BV STEP analysis. Of the sixteen taxa, four (Xyalidae_IM-JC228M, Halacaridae_IM-854J7R, Halacaridae_IM-863YQ3 and Chaetonotidae_IM-66HBWK) best illustrate this correlation through their geographic distribution in relation to the physico-chemical SIMPROF clusters identified (Figure H.16). Xyalidae_IM-JC228M and Halacaridae_IM-854J7R both had a broad distribution across the survey area, whilst the distributions of Halacaridae_IM-863YQ3 and Chaetonotidae_IM-66HBWK indicated potential association with the SIMPROF groups I and j in the shallower sandwave areas.

H.1.4.1.4 Further investigation into the relationship between bacterial and infaunal OTUs and physico-chemical variables would require further sampling, however, no further sampling will be undertaken in the Morgan and Mona Array Area. This is because the results of this analysis are considered to be sufficient for the purposes of baseline characterisation.

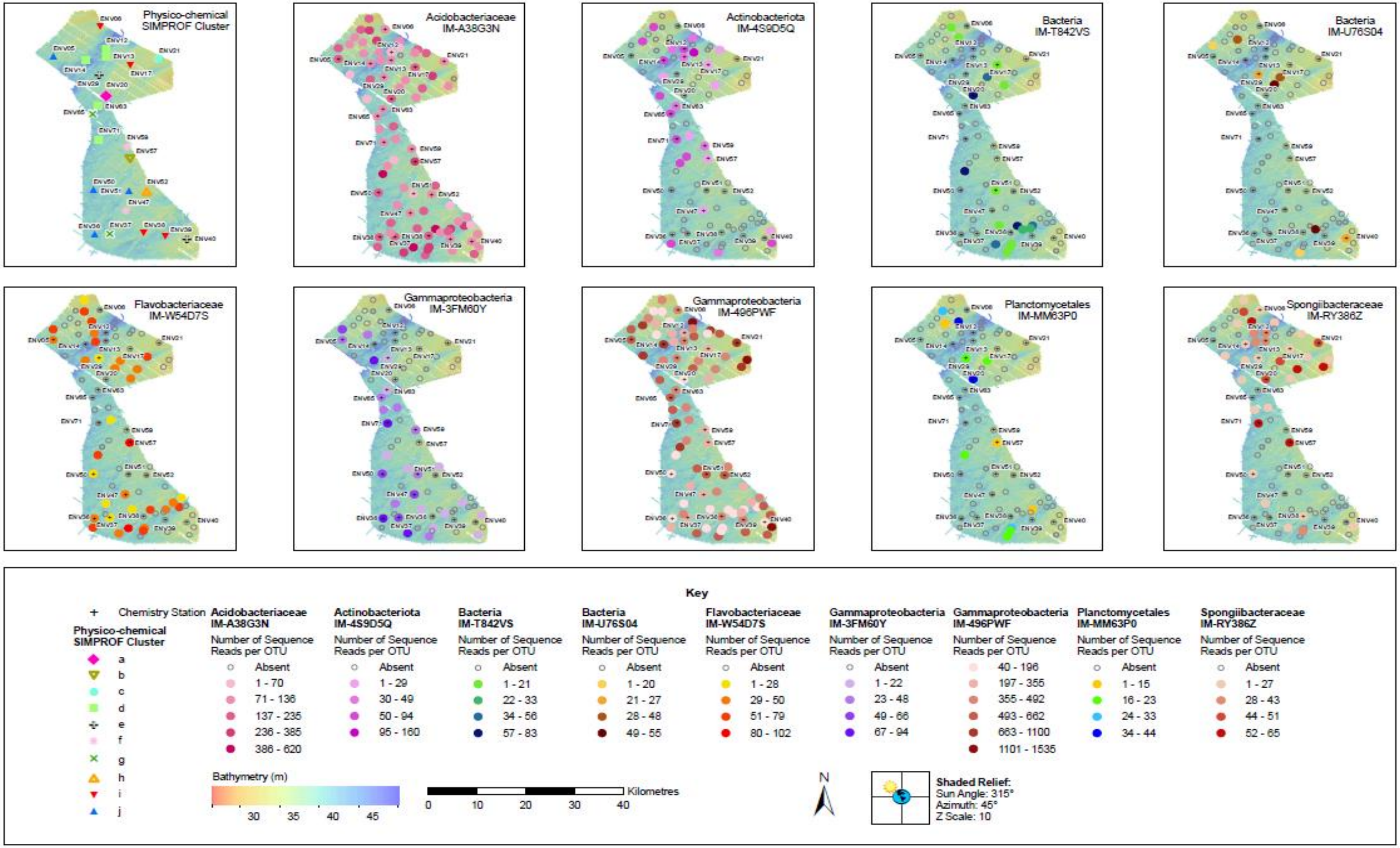


Figure H.15: Geographical overview of bacterial taxa in relation to physico-chemical SIMPROF groups.

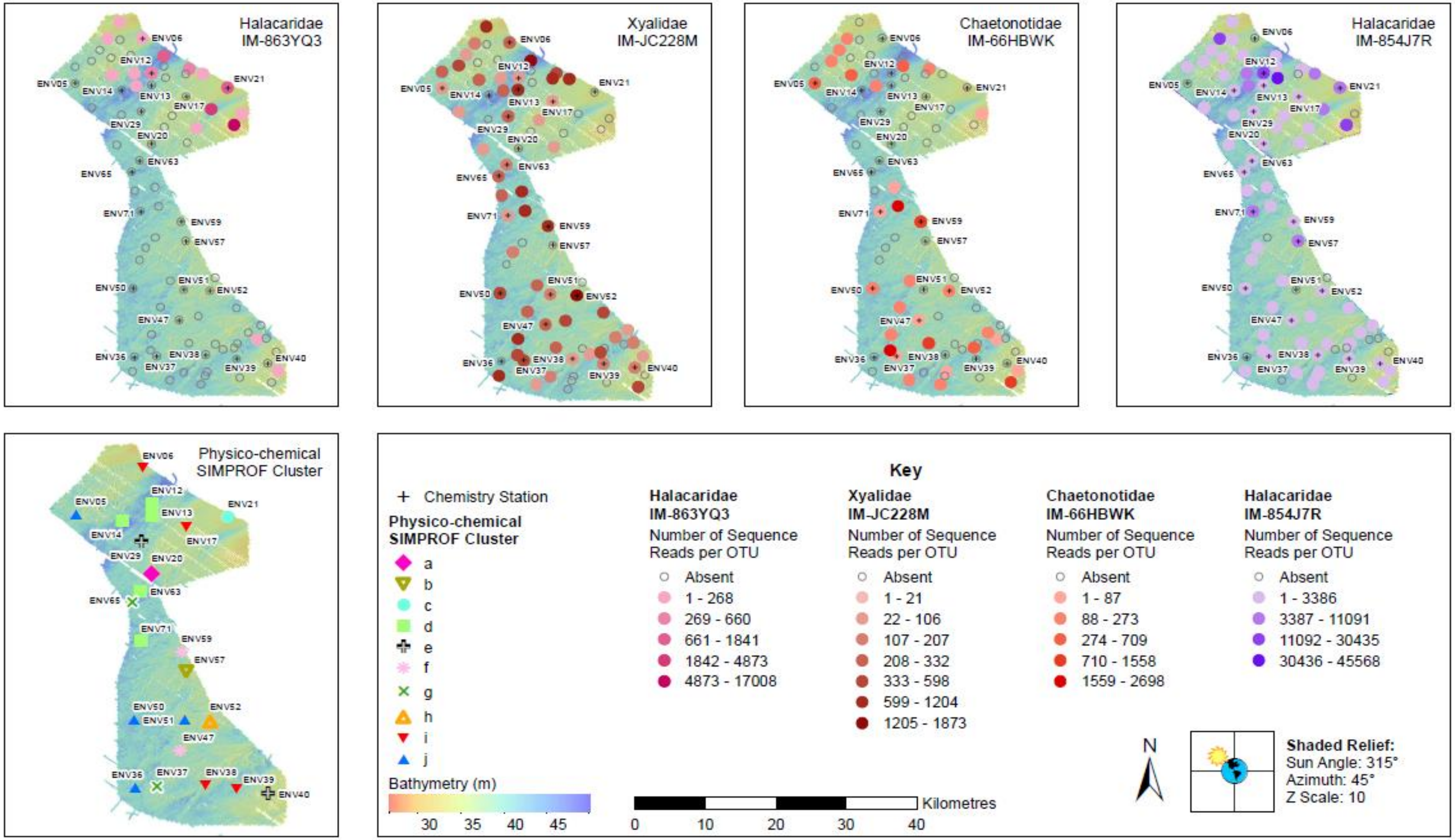


Figure H.16: Geographical overview of bacterial taxa in relation to physico-chemical SIMPROF groups.

H.1.5 Multivariate Comparison of Macrofaunal and Metabarcoding Data Sets

H.1.5.1.1 The sediment bacterial and infaunal OTU data sets, from the combined survey areas, were compared to the adult macrofaunal abundance and biomass data to determine if there was any correlation. As expected, a RELATE analysis identified a significant correlation of 50% for bacterial OTUs and 52% for infaunal OTUs when comparted to the adult macrofauna abundance data. Similar results were found for biomass data, indicating a 40% significant correlation for bacteria OTUs and 44% for infaunal OTUs.

H.1.5.1.2 It is important to note that despite the significant correlations found, only one macrofauna replicate sample was used for metabarcoding of bacteria and infauna. This is, however, considered to be sufficient for the purposes of baseline characterisation for the Morgan and Mona Array Areas.

H.2. Sediment metabarcoding results (2022 survey)

H.2.1 Overview

H.2.1.1.1 Two samples were collected from 103 stations within the survey area; of which a subset of 52 stations were sent to the laboratory for bacterial and infaunal DNA analysis. The remaining samples were retained as spares.

H.2.2 Summary statistics

H.2.2.1.1 A total of 1906 operational taxonomic units (OTUs) were detected across the survey area, as detailed in Table H.9. Of the 1906 detected OTUs (bacterial and infaunal), a greater percentage of infaunal OTUs were identified to species level (10%) compared to the bacterial OTUs (1%), which may be due to a larger pool of reference material for infaunal OTUs.

Table H.9: OTU detections per target and percentage successfully classified.

Target	Number of OTUs	Percentage of OTUs classified to					
		Phylum	Class	Order	Family	Genus	Species
Bacteria	1409	69%	51%	30%	23%	6%	1%
Infauna	497	100%	81%	88%	75%	35%	10%

H.2.2.1.2 A total of 14 bacterial OTUs (1%) were present in all the sediment samples, while 31% (n=443) occurred in a single sediment sample. The relatively high numbers of widespread taxa and lone taxa across the survey area suggested that the community has been exposed to relatively little disturbance.

H.2.2.1.3 A total of 443 (31%) bacterial OTUs and 225 (45%) infaunal OTUs were present in a single sample across the survey area, with no OTUs either bacterial or infaunal present across all stations, The absence of a consistent community across the survey area, as well as the high proportion (>30%) of rare OTUs suggest the community heterogeneity across the survey area may have been under sampled for the bacterial and infaunal size class. This may be improved by analysis of additional samples or analysis of the second samples acquired at each of the stations, though it is not certain that this would fill all gaps within the community.

H.2.2.1.4 The bacterial data set identified 34 taxonomic groups based on class, with the proportional contributions of these groups to the overall community structure of the survey areas detailed in Table H.10 and graphically presented in Figure 2.6. Bacterial OTUs which could not be successfully identified to class were grouped into the 'Other' category.

H.2.2.1.5 The 'Other' taxonomic group was recorded as the richest within the bacterial data set, accounting for 48.7% (n=686) of OTUs. The second most abundant taxonomic group was the Gammaproteobacteria, 16.4% of OTUs across the survey area. The relative Gammaproteobacteria dominance is likely given it is one of the richest classes within the bacterial phyla (Williams *et al.*, 2010). The dominance of 'Other' within the proportional contributions was partly due to the inability to determine these OTUs further than phylum. When compared with the previous Gardline (2022b) survey, these two classes were also the top two most abundant. Additional classes also showed proportional contributions to that of the previous survey.

Table H.10: Contribution of sediment bacterial taxonomic groups.

NR Not reported

Group	This Study		Gardline (2022b)	
	Abundance	Proportional contribution %	Abundance	Proportional contribution %
Acidobacteriae	46	3.3%	45	3.4%
Aminicenantia	4	0.3%	4	0.3%
Acidimicrobiia	2	0.1%	3	0.2%
Actinomycetia	27	1.9%	28	2.1%
Bacteroidia	81	5.7%	80	6.1%
Ignavibacteria	2	0.1%	1	0.1%
Rhodothermia	1	0.1%	1	0.1%
Calditrichia	3	0.2%	NR	NR
Campylobacteria	4	0.3%	3	0.2%
Anaerolineae	35	2.5%	16	1.2%
Chloroflexia	3	0.2%	NR	NR
Dehalococcoidia	7	0.5%	1	0.1%
Cyanobacteriia	1	0.1%	1	0.1%
Deinococci	1	0.1%	1	0.1%
Babeliae	2	0.1%	1	0.1%
Desulfobacteria	5	0.4%	3	0.2%
Desulfobulbia	1	0.1%	1	0.1%
Fibrobacteria	1	0.1%	NR	NR
Bacilli	2	0.1%	NR	NR

Group	This Study		Gardline (2022b)	
	Abundance	Proportional contribution %	Abundance	Proportional contribution %
Clostridia	9	0.6%	3	0.2%
Fusobacteriia	1	0.1%	1	0.1%
Gemmatimonadetes	4	0.3%	4	0.3%
Latescibacteria	1	0.1%	NR	NR
Moduliflexia	3	0.2%	1	0.1%
Nitrospiria	12	0.9%	14	1.1%
Thermodesulfovibrionia	1	0.1%	3	0.2%
Gracilibacteria	1	0.1%	1	0.1%
Phycisphaerae	11	0.8%	4	0.3%
Planctomycetes	77	5.5%	92	7.0%
Alphaproteobacteria	97	6.9%	105	8.0%
Gammaproteobacteria	231	16.4%	239	18.2%
Spirochaetia	12	0.9%	6	0.5%
Kiritimatiellae	8	0.6%	9	0.7%
Verrucomicrobiae	27	1.9%	33	2.5%
Other	686	48.7%	599	45.6%
Total	**1409**	**100%**	1303	100%

H.2.2.1.6 A total of 27 taxonomic groups based on class were identified from the sediment infaunal data sets with the proportional contribution of these taxonomic groups to the overall structure of the survey area detailed in Table H.11 and graphically presented in Figure H.17. OTUs which could not be identified to class were grouped into an 'Other' category.

H.2.2.1.7 Adenophorea (n=188) was the most abundant taxonomic group across the survey area, accounting for 37.8% of OTUs. The next most abundant groups were 'Other' (n=94, 18.9%) and Hexanaulia (n=71, 14.3%). Seven taxonomic groups (Appendicularia, Asteroidea, Branchiopoda, Enteropneusta, Maxilopoda, Scyphozoa and Trematoda) were represented by a single OTU. When comparing with the previous Gardline (2022b) survey, Adenophorea and Hexanauplia were the two most abundant groups. Branchiopoda and Trematoda were also represented by a single OTU within the comparison survey.

H.2.2.1.8 A greater number of bacterial and infaunal taxonomic groups and individual OTUs were recorded within the current survey than the previous (Gardline, 2022b); however, this cannot be used to conclude that the bacterial or infaunal community within the current survey was more diverse, due to continuing advancements in metabarcoding and additions to the pool of reference material.

Table H.11: Contributions of sediment faunal OTU taxonomic groups.

NR Not reported

Group	This Study		Gardline (2022b)	
	Abundance	Proportional Contribution %	Abundance	Proportional Contribution %
Adenophorea	188	37.8%	189	42.3%
Anthozoa	4	0.8%	4	0.9%
Appendicularia	1	0.2%	1	0.2%
Arachnida	5	1.0%	6	1.3%
Ascidiacea	9	1.8%	7	1.6%
Asteroidea	1	0.2%	1	0.2%
Bivalvia	5	1.0%	6	1.3%
Branchiopoda	1	0.2%	NR	NR
Clitellata	5	1.0%	1	0.2%
Echinoidea	2	0.4%	2	0.4%
Enteropneusta	1	0.2%	2	0.4%
Eurotatoria	7	1.4%	6	1.3%
Gastropoda	7	1.4%	6	1.3%
Hexanauplia	71	14.3%	58	13.0%
Holothuroidea	2	0.4%	2	0.4%
Hoplonemertea	4	0.8%	0	0.0%
Hydrozoa	9	1.8%	7	1.6%
Malacostraca	2	0.4%	3	0.7%
Maxillopoda	1	0.2%	NR	NR
Ophiuroidea	3	0.6%	1	0.2%
Ostracoda	4	0.8%	4	0.9%
Palaeonemertea	2	0.4%	NR	NR
Pilidiophora	4	0.8%	4	0.9%
Polychaeta	60	12.1%	53	11.9%
Scyphozoa	1	0.2%	1	0.2%
Secernentea	3	0.6%	NR	NR
Trematoda	1	0.2%	NR	NR
Other	94	18.9%	83	18.6%
Total	**497**	**100%**	447	100%

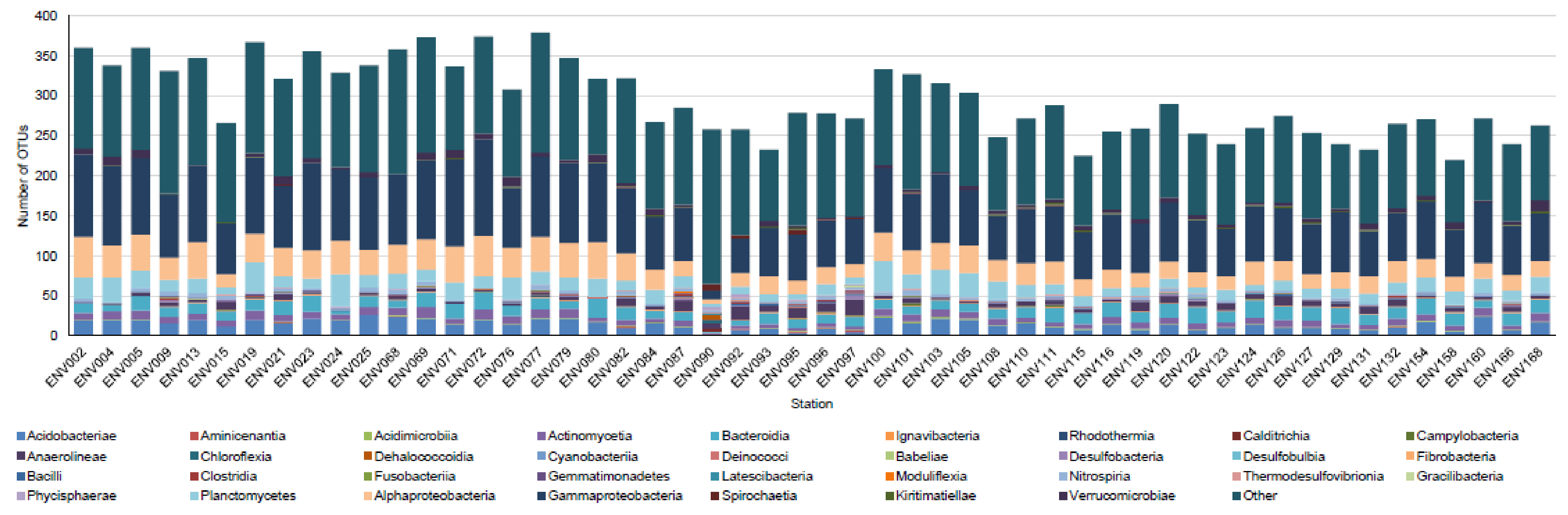


Figure H.17: Contributions of gross sediment bacterial OTU taxonomic groups by samples.

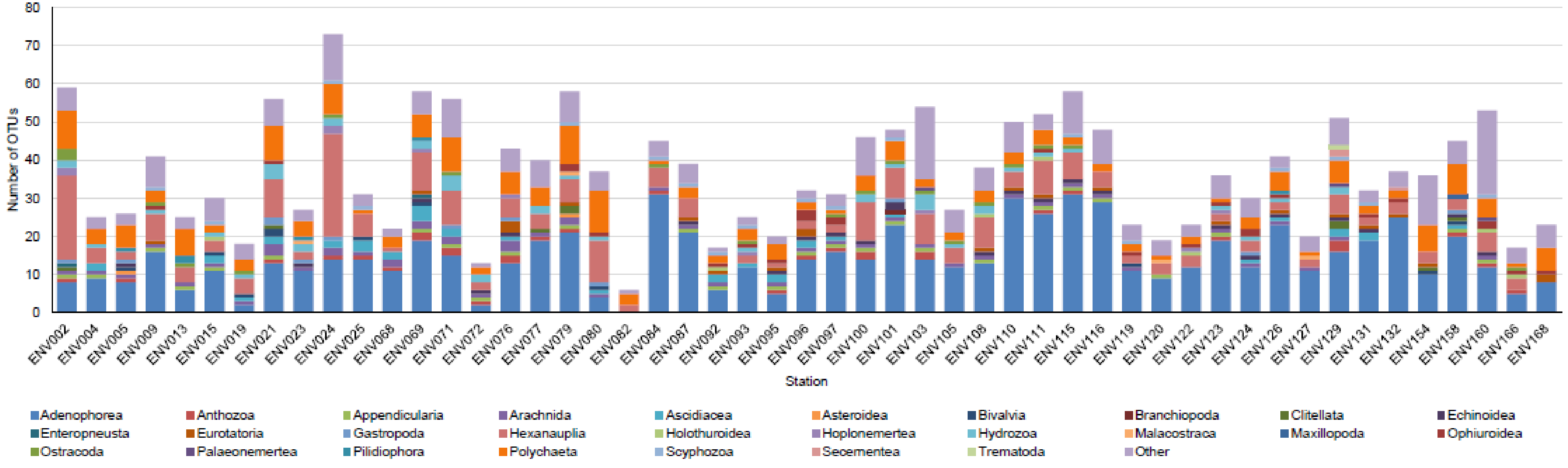


Figure H.18: Contributions of gross sediment infaunal OTU taxonomic groups by samples.

H.2.2.1.9 Comparative taxonomic heat trees detailing the number of OTUs across the survey from bacterial taxa, down to the order rank are presented in Figure H.19 while the taxonomic heat trees detailing the discrete infaunal taxa OTUs down to the order rank are presented in Figure H.20. The nodes (circles) represent a 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 H.12.

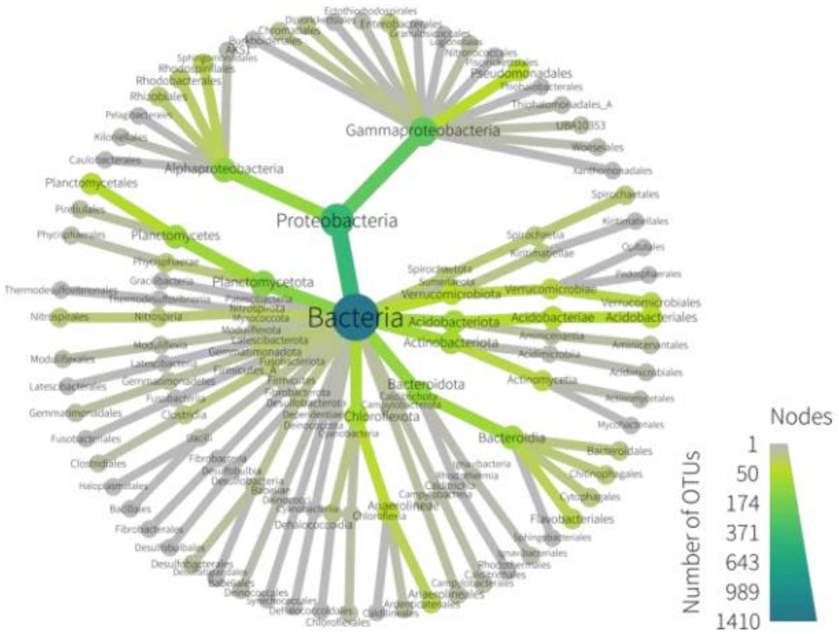


Figure H.19: Sediment bacterial taxonomic heat trees of the number of OTUs.

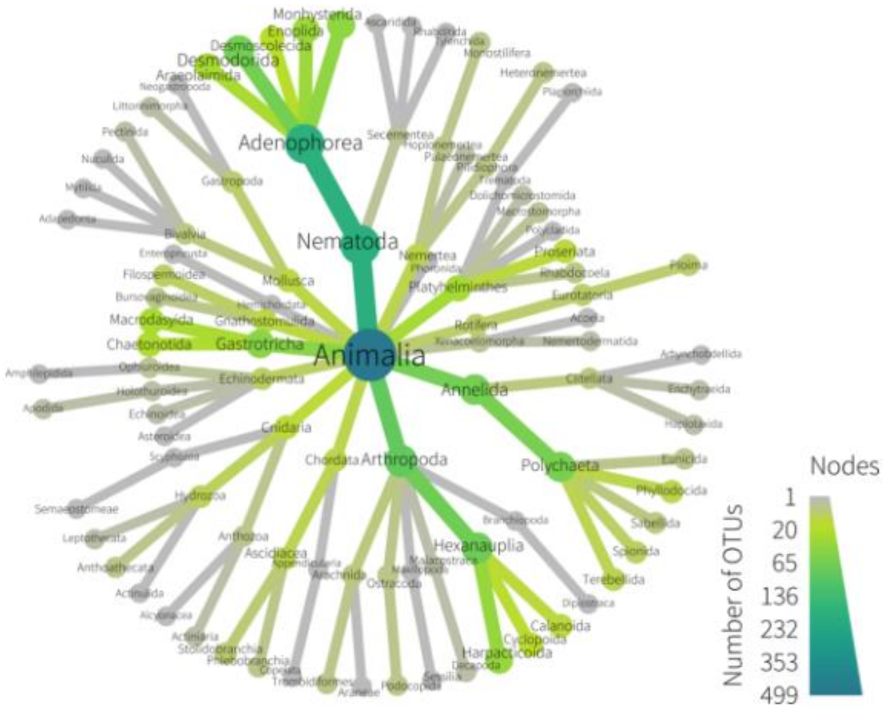


Figure H.20: Sediment infaunal taxonomic heat trees of the number of OTUs.

Table H.12: Summary of sediment OTU richness.

	Bacterial OTUs		Faunal OTUs	
	This Study	Gardline (2022b)	This Study	Gardline (2022b)
Minimum	220	298	6	17
Maximum	379	415	73	82
Mean	295.5	371.4	36.5	42.1
±SD	45.6	31.6	14.7	14.7

H.2.2.1.10 Accumulation plots of OTUs for the sediment bacterial and infaunal data sets for the survey are presented in Figure H.21. Two lines are plotted; the first (plotted in blue and often referred to as a 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 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). Sharp changes in the slope of the species in order of observation (Sobs) curve reflect notable changes in community between stations. Further, the relation of the Sobs curve to that of the permutated average of samples (such as the UGE curve generated average after 999 random sample combinations) can reflect the number of OTUs versus expectations.

H.2.2.1.11 The Sobs curve for the sediment bacterial data set (Figure H.21) initially began above the UGE curve indicating that a greater number of OTUs were present than was to be expected, the Sobs curve then continued to follow the curve of the UGE curve until the addition of Station ENV025 where the Sobs curve plateaued. Upon the addition of Station ENV090 the Sobs curve steeply increased where the Sobs curve increased above the UGE curve. Station additions after this followed the curve of the UGE curve.

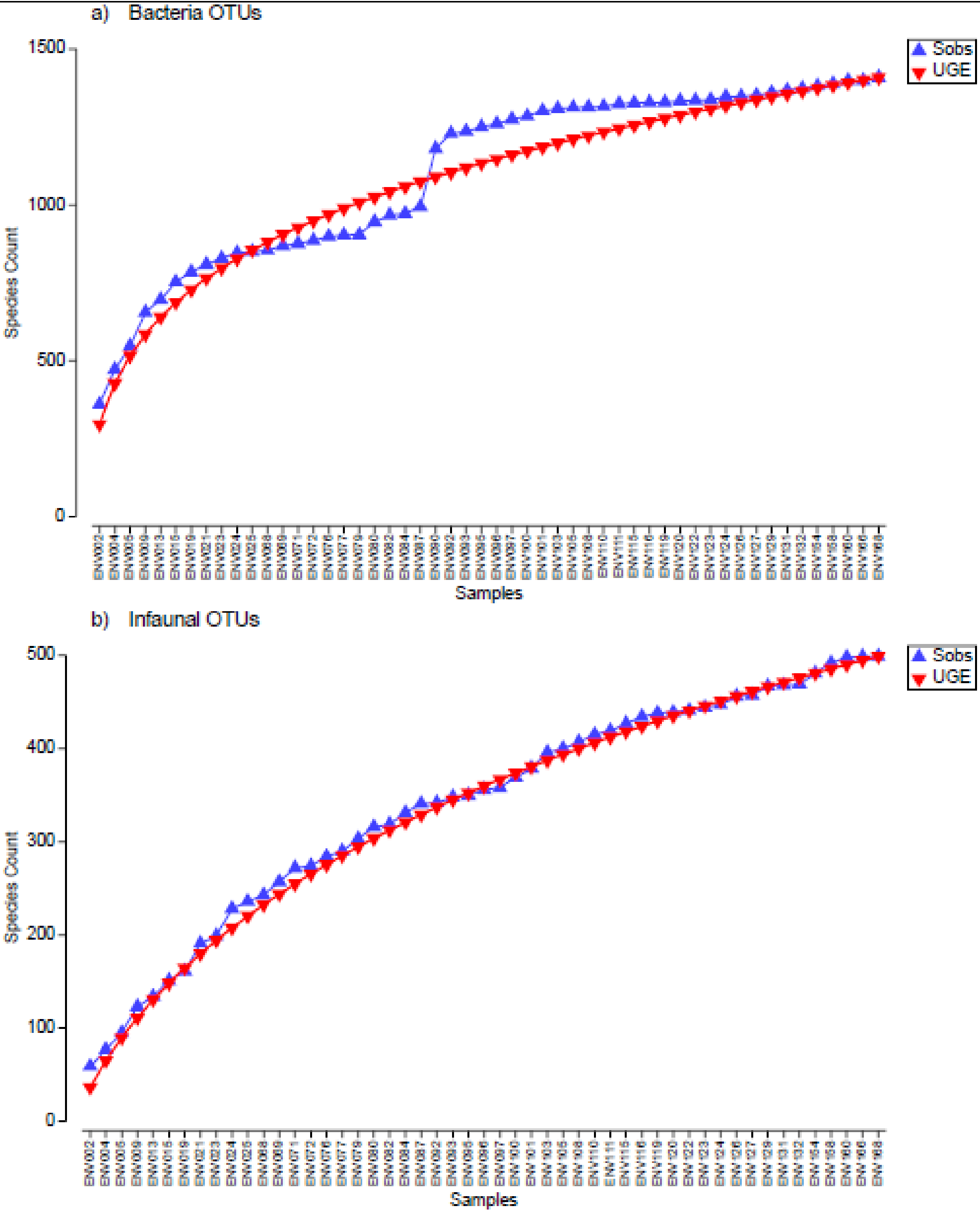


Figure H.21: OTU accumulation curves.

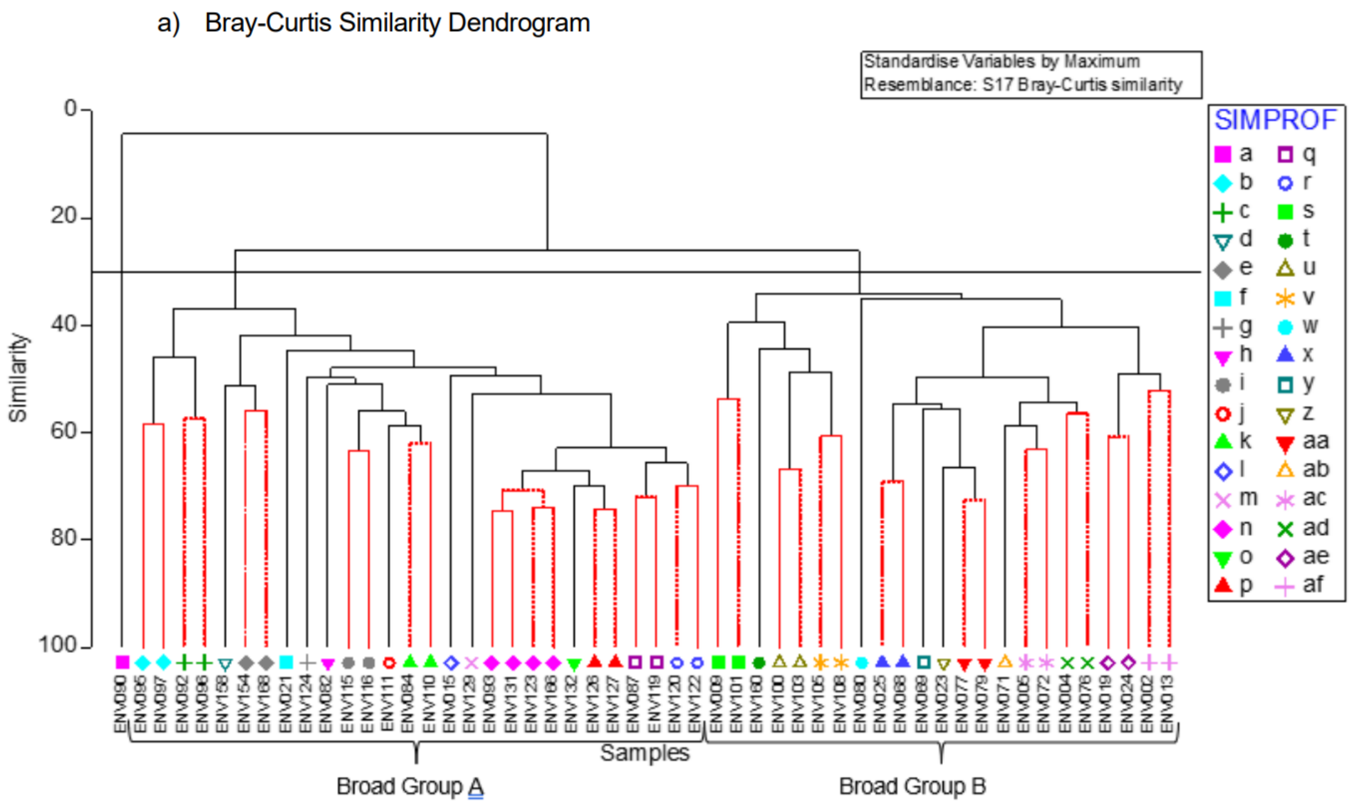
H.2.2.2 OTU community structure using multivariate statistics

H.2.2.2.1 The results of the CLUSTER analysis including SIMPROF analysis in the form of a Bray-Curtis similarity dendrogram and nMDS plot based upon standardised data for the sediment bacteria samples are displayed in Figure H.22 for the survey area. Similarly results of the same analysis on the standardised infaunal data are presented in Figure H.23.

H.2.2.2.2 The CLUSTER analysis and resulting dendrogram for the sediment bacterial OTU data set (Figure 2.11a) identified 32 groups which comprised 14 outliers (SIMPROF *a, d, f, g, h, j, l, m, o, t, w, y, z* and *ab*), 17 closely associated pairs (SIMPROF *b, c, e, i, k, p, q, r, s, u, v, x, aa, ac, ad, ae* and *af*) and a single cluster (SIMPROF *n*). All samples were considered more dissimilar than similar to one another and grouped at *c.*4% similarity. The generally low similarities are potentially due to the bacterial communities being far richer than equivalent metazoan communities and are 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).

H.2.2.2.3 The nMDS ordination of the sediment bacterial data set (Figure H.22) revealed a similar pattern to the cluster analysis with a stress level of 0.1, which can be considered a good two-dimensional representation of rank dis (similarities) and overall pattern observed in the data set.

H.2.2.2.4 Examination of the sediment bacterial data set together with results of SIMPER analyses at a group level is presented in Table H.13. This was restricted to explaining separations where similarity was less than 30% for conciseness. The broad groups identified showed differences due to subtle variations in taxa community structure within a particular SIMPROF groups.



b) MDS Ordination

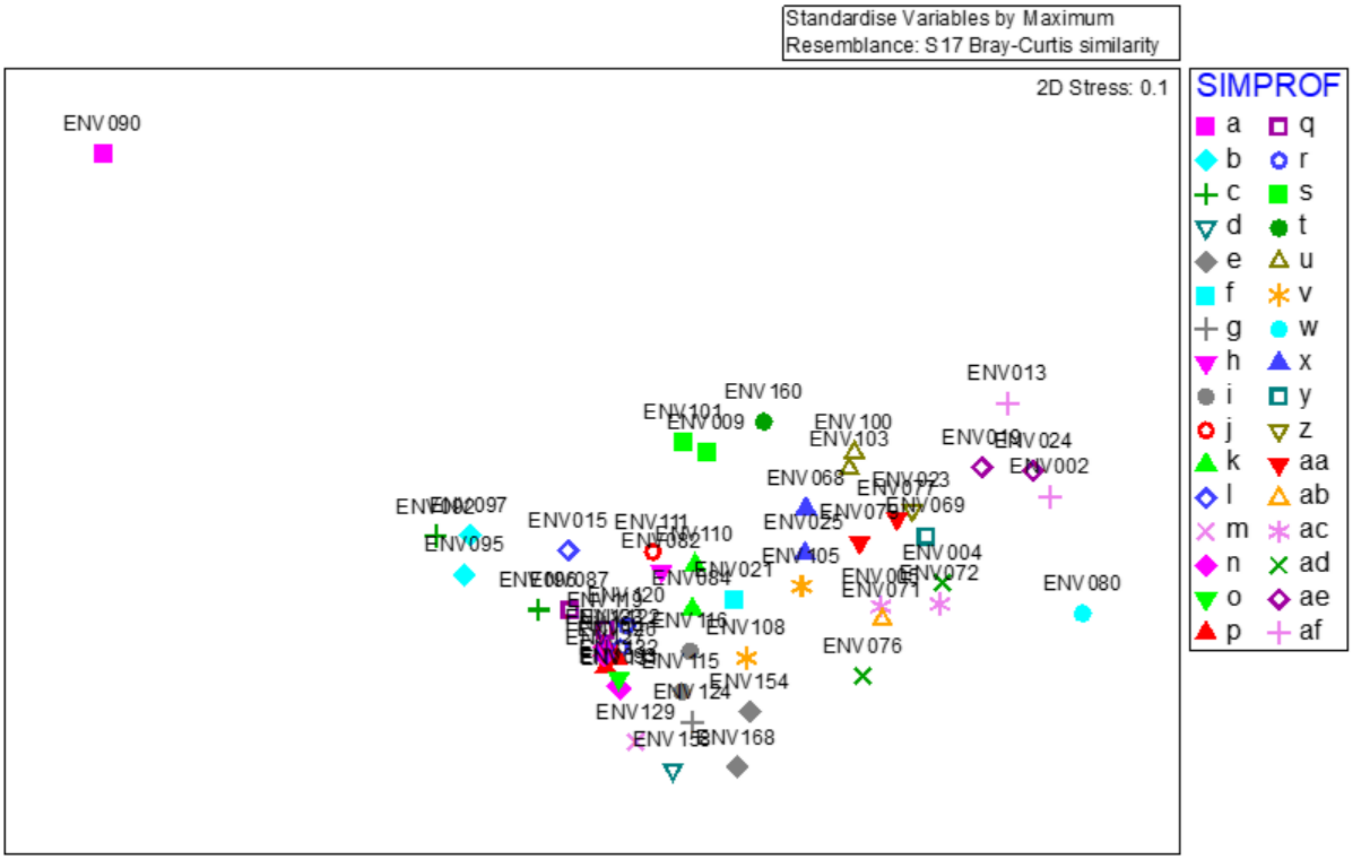


Figure H.22: Multivariate analysis of sediment bacterial OTU data by sample.

Table H.13: Taxa influencing sediment bacteria OTU SIMPROF variation.

Groupings	Dissimilarity (%)	Groups Influencing Separation
SIMPROF a vs remaining	96	• 42 Indeterminate Bacteria OTUs were more abundant in SIMPROF *a* • (*c.* 11.4% of the dissimilarity) • 19 Gammaproteobacteria OTUs were absent from SIMPROF *a* (*c.* 2.2% of the dissimilarity).
Broad Group A vs Broad Group B	74	• 44 Indeterminate Bacteria OTUs were more abundant in Broad Group B (*c.* 6.8% of the dissimilarity) • 34 Gammaproteobacteria OTUs were more abundant in Broad Group B (*c.* 5% of the dissimilarity) • 12 Alphaproteobacteria OTUs were more abundant in Broad Group B (*c.* 1.8% of the dissimilarity) • 12 Bacteroidia OTUs were more abundant in Broad Group B (*c.* 1.7% of the dissimilarity).

H.2.2.2.5 CLUSTER analysis and the resulting dendrograms for the sediment infaunal OTU data set (Figure H.23) identified 22 groups; 7 outliers (SIMPROF *a, b, c, d, i, j* and *u*), 8 closely associated pairs (SIMPROF *g, h, m, n, p, q, r* and *v*) and 7 clusters (SIMPROF *e, f, j, k, l, o* and *s*). All samples were more dissimilar than similar to one another, joining together at c.0.3% similarity.

H.2.2.2.6 Examinations of the sediment infaunal data together with results of SIMPER analyses; presented in Table H.14 highlighted the principal contributors to the grouping and separation of stations. This was restricted to explaining separations where similarity was less than 2.5% for conciseness.

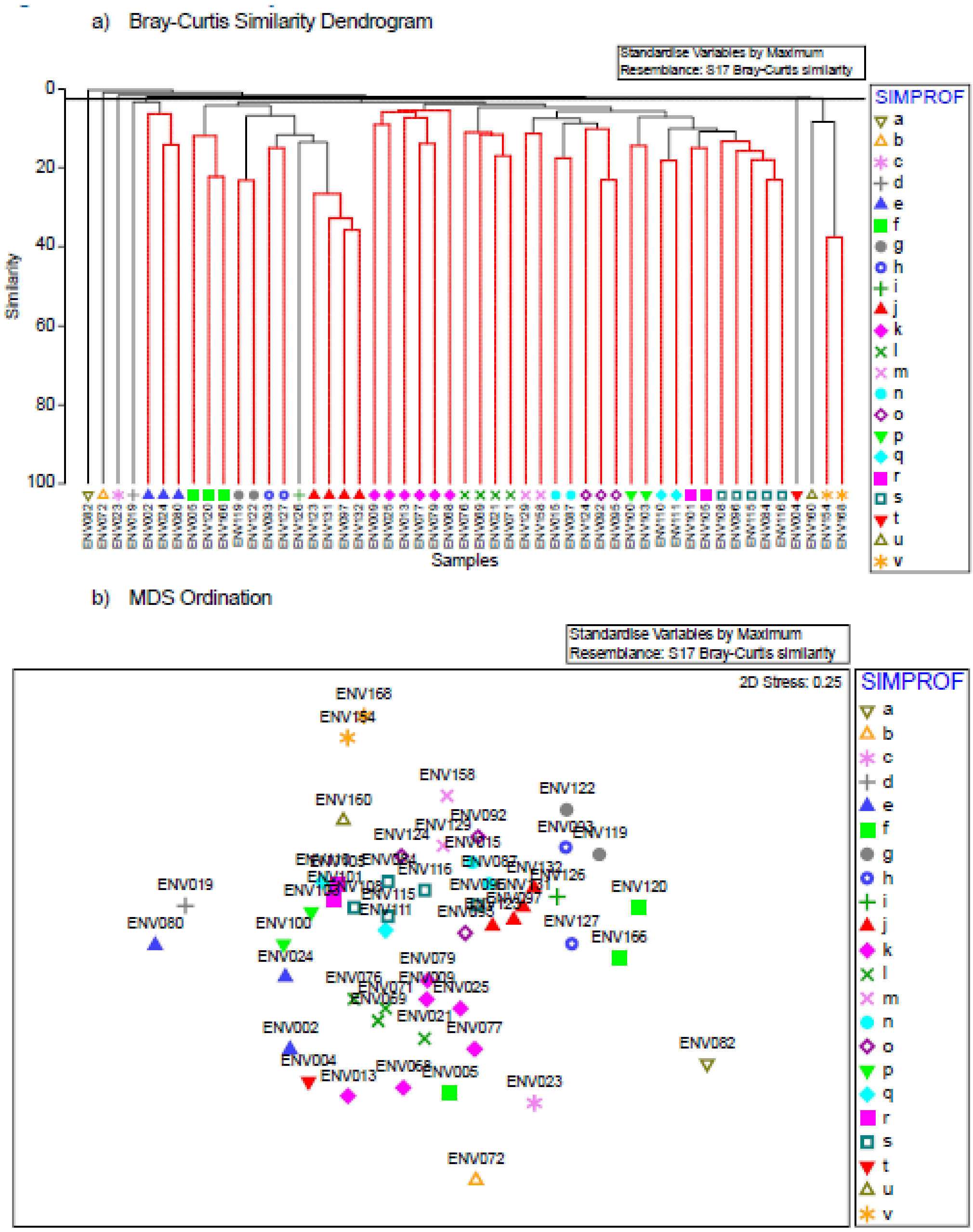


Figure H.23: Multivariate analysis of sediment infaunal OTU data.

Table H.14: Taxa influencing sediment infaunal OTU SIMPROF variation.

SIMPROF	Dissimilarity (%)	Taxa Influencing Separation
SIMPROF *a* vs remaining	99.7	• *Phyllodoce* IM-19H88I was more abundant in SIMPROF *a* (*c*. 9.0% of the dissimilarity) • The absence of 188 infaunal OTUs from SIMPROF *a* contributed *c*. 57.6% of the dissimilarity.
SIMPROF *b* vs SIMPROF *c*, Broad Groups A-C	99.2	• Onuphidae IM-I2992I was unique to SIMPROF b (*c* 7.5% of the dissimilarity) • Acanthogorgiidae IM-6HNE0Q was more abundant in SIMPROF *b* (*c*. 7.5% of the dissimilarity) • The absence of 174 infaunal OTUs from SIMPROF *b* contributed *c*. 49.6% of the dissimilarity.
SIMPROF c vs Broad Groups A-C	98.3	• Callianassidae IM-32VZ5A, Oncholaimidae IM-ELM9Z5 and Oncholaimidae IM-W4UI46 were unique to SIMPROF *c* (*c*. 16.1% of the dissimilarity) • The absence of 129 infaunal OTUs from SIMPROF *c* contributed c. 30.8% of the dissimilarity. • Eight infaunal OTUs were more abundant in SIMPROF *c* (*c*. 17.5% of the dissimilarity) • A total of 16 infaunal OTUs were more abundant in Broad Groups A-C which contributed • *c*. 5.7% of the dissimilarity.
Broad Group A vs Broad Groups B, C	98	• A total of 40 infaunal OTUs were more abundance in Broad Group A which contributed • *c*. 22.7% of the dissimilarity. • The absence of 56 infaunal OTUs from Broad Groups B and C contributed *c*. 38.4% of the dissimilarity. • The absence of 22 infaunal OTUs from Broad Group A contributed *c*. 5.4% of the dissimilarity.
Broad Group C vs Broad Group B	97.9	• A total of 43 infaunal OTUs were more abundance in Broad Group C which contributed • *c*. 29.9% of the dissimilarity. • The absence of 22 infaunal OTUs from Broad Group B contributed *c*. 22.5% of the dissimilarity.

H.2.2.3 Multivariate Comparison of Metabarcoding and Physico-chemical Data Sets

H.2.2.3.1 The bacterial and infaunal OTUs detected throughout the Morgan and Morecambe survey areas were compared to the physico-chemical data to determine if any patterns in the metabarcoding correlated with the environmental factors assessed.

H.2.2.3.2 A RELATE analysis identified no correlation between the sediment bacterial OTUs and physico-chemical variables ($r=0.042$, $p>0.05$). BIOENV analyses identified a 26% correlation between the bacterial multivariate pattern and As concentrations, with the inclusion of additional variables having little impact on correlations.

H.2.2.3.3 A RELATE analysis identified no correlation between the sediment infaunal OTUs and physico-chemical variables ($r=-0.013$, $p>0.05$). BIOENV analyses identified a 22%

correlation between the infaunal multivariate pattern and mean particle diameter, with the inclusion of additional variables having little impact on correlations.

H.2.2.3.4 Further sampling, including additional stations and replication is required to further investigate the relationship between bacterial and infaunal OTU data and the physico-chemical variables. As a result of the single replication per station the statistical robustness of the analysis patterns is limited, and patterns may be obscured.

H.2.2.4 Multivariate Comparison of Macrofaunal and Metabarcoding Data Sets

H.2.2.4.1 The sediment bacterial and infaunal OTU data sets were compared to the adult macrofaunal abundance and biomass data to determine if there was any correlation. As expected, a RELATE analysis identified a significant correlation of 61% for bacterial OTUs and 45% for infaunal OTUs when compared to the adult abundance data. Similar results were found when comparing to the adult biomass data, with a RELATE analysis identifying a significant correlation of 54% for bacterial OTUs and 42% for infaunal OTUs.

H.2.2.4.2 It is important to note that despite the significant correlations found, only one replicate sample was analysed for macrofauna abundance and biomass and only one replicate sample was used for metabarcoding of bacteria and infauna. In order to better utilise this approach for monitoring and avoid missing taxa present in the environment, more replicate eDNA samples associated with each sample (*i.e.* MFA and MFB) are needed. Additional sample replication would allow for better comparison between data sets, further aid in a more comprehensive characterisation of the macrofaunal communities across the survey area.

H.3. References

Ugland, K.I., Gray, J.S. and Ellingsen, K.E. (2003) The species-accumulation curve and estimation of species richness. Journal of Animal Ecology, 72, pp.888-97.

Appendix B: Morecambe Offshore Windfarm: Generation Assets benthic characterisation survey report

Morecambe Offshore Windfarm: Generation Assets

Environmental Statement

Volume 5

Appendix 9.1 Benthic Characterisation Survey

PINS Document Reference: 5.2.9.1

APFP Regulation: 5(2)(a)

Rev 01

MORECAMBE

Document History

Doc No	MOR001-FLO-CON-ENV-RPT-1091	**Rev**	01
Alt Doc No	OEL_FLOMOR0222_TCR		
Document Status	Approved for Use	**Doc Date**	May 2024
PINS Doc Ref	5.2.9.1	**APFP Ref**	5(2)(a)

Rev	Date	Doc Status	Originator	Reviewer	Approver	Modifications
01	May 2024	Approved for Use	Ocean Ecology Limited	Morecambe Offshore Windfarm Ltd	Morecambe Offshore Windfarm Ltd	n/a

Ocean Ecology

Marine Surveys, Analysis & Consultancy

Morecambe Offshore Wind Farm Benthic Characterisation Survey Technical Report 2022

REF: OEL_FLOMOR0222_TCR

FLO-MOR-REP-0010

T: +44 (0) 1452 740697 E: info@ocean-ecology.com W: www.ocean-ecology.com Tw: @Ocean_Ecology

Details

Version	Date	Description	Author(s)	Reviewed By
V03	11/10/2022	Updated following client review	Samuel Holmes, Elena Cappelli	Ross Griffin

Updates

Section	Description	Page
7.7	Removed reference to shapefile appendix	65
-	Added Appendix XIX to list	6

Contents

List of Figures

List of Tables

List of Appendices

Appendix XI - Macrobenthic raw data

Appendix XII - Macrobenthic Biomass Ash Free Dry Weight

Appendix XIII - Dendrogram resulting from cluster analysis

Appendix XIV - Results of SIMPER analysis

Appendix XV - Seabed Imagery still logs

Appendix XVI - Seabed Imagery video logs

Appendix XVII - Seapen and burrowing megafauna assessment

Appendix XVIII – Biotoping

Appendix XIX – Response to NE?MMO comments

List of Abbreviations

AIS	Automatic Identification System
BSH	Broadscale Habitat
DDC	Drop Down Camera
EB	Environmental Baseline
EBS	Environmental Baseline Survey
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation and Data Network
EUNIS	European Nature Information System
EQS	Environmental Quality Standards
FLOW	Floating Offshore Wind Farm
FOCI	Features of Conservation Interest
GPS	Global Positioning System
HA	Habitat Assessment
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
MBES	Multibeam Echosounder
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MNCR	Marine Habitat Classification for Britain and Ireland
MOWF	Morecambe Offshore Wind Farm
NMBAQC	NE Atlantic Marine Biological Quality Control
OEL	Ocean Ecology Limited
OWL	Offshore Wind Limited

PAH	Polycyclic Aromatic Hydrocarbon
PEP	Project Execution Plan
PSA	Particle Size Analysis
PSD	Particle Size Distribution
SAC	Special Area of Conservation
SBE	Simply Blue Energy
SPA	Special Protection Area
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
THC	Total Hydrocarbons Content
TOC	Total Organic Carbon
TOM	Total Organic Matter
TPH	Total Petroleum Hydrocarbons
WTGs	Wind Turbines Generators

Non-Technical Summary

Introduction

Morecambe Offshore Windfarm is a proposed offshore windfarm located in the Northeast Irish Sea with an expected nominal capacity of 480 megawatts. Offshore Wind Ltd (OWL): a joint venture between Cobra Instalaciones y Servicios, S.A., and Flotation Energy plc, contracted Ocean Ecology Limited (OEL) to undertake a benthic characterisation survey of the Morecambe Offshore Windfarm site as there is a requirement for baseline information on the sediment quality and benthic habitats from within the proposed wind farm site to be collected to inform project design and the Environmental Impact Assessment.

Survey Strategy

50 stations were sampled first with Drop-Down Camera methods before sediment grab sampling using a $0.1m^2$ Day Grab. Sediment samples were collected for particle size and macrobenthic analyses at all 50 stations, with a subset of 20 stations sampled for sediment contaminants. All survey work was conducted onboard the dedicated survey vessel *Seren Las*. An Ultra-Short Baseline System was used to provide accurate subsea positioning of sampling locations.

Sediments

Most sampling stations (27 of 50) were classified as Muddy Sand, however some variation in sediment type was observed between sampling stations whereby stations located towards the west and southwest of the windfarm site were characterised by slightly coarser sediments. Mean sediment grain size across the windfarm site ranged from 35.5 µm to 536.1 µm.

Relatively high Total Organic Carbon and Total Organic Matter content, by comparison to other stations sampled within this survey, was observed at stations located to the east of the windfarm site. Trace and heavy metal concentrations were overall low across the windfarm site with none of the metals analysed exceeding any of the reference level. In general metal concentrations were relatively higher to the east, closer to land than at stations further offshore, as seen for TOC and TOM. Among all Polycyclic Aromatic Hydrocarbons (PAHs), Naphthalene, Pyrene, Anthracene and Benzo[a]anthracene were the ones found to exceed reference levels at 5 to 6 stations. No other PAHs exceeded any reference levels. Stations with relatively elevated PAH concentrations also had relatively high TOC, TOM and metals concentrations. Total hydrocarbon concentration was also found to be relatively higher to the east of the survey area.

Macrobenthos

Macrobenthic assemblages identified across the Morecambe Offshore Windfarm site were made up of a total of 8,127 individuals and 189 different taxa. Most stations were characterised by the presence of *K. bidentata* which occurred in 88 % of samples. Other key taxa included the brittle star A*mphiura filiformis*, the polychaetes *Sthenelais limicola* and *Scalibregma inflatum*.

Macrobenthic abundance and diversity varied across the windfarm site however no obvious pattern was observed across stations.

EUNIS Habitats/Biotopes

Sediment particle size distribution and macrobenthic data clearly indicated the presence of two biotopes across the survey area: A5.252 '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' in the middle and to the east of the windfarm site, and A5.351 '*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida*' in circalittoral sandy mud' to the west of the windfarm site.

Annex I Habitats

No Annex I habitats were identified within the windfarm site.

Other Features of Interest

Large areas of the OSPAR threatened and/ or declining habitat 'Sea-pens and burrowing megafauna' were identified across the windfarm site within the EUNIS habitat A5.26. Sea-pens and burrowing megafauna is considered a priority habitat listed under Section 41 of the Natural Environment and Rural Communities Act 2006, as well as a Marine Conservation Zone Feature of Conservation Interest.

1. Introduction

1.1. Project Overview

Morecambe Offshore Windfarm (the Project) is a proposed offshore windfarm (OWF) located in the Northeast Irish Sea (Figure 1) with an expected nominal capacity of 480 megawatts (MW). The Project is being developed by Offshore Wind Limited (OWL): a joint venture between Cobra Instalaciones y Servicios, S.A., and Flotation Energy plc. The windfarm site is located approximately 30 km from the Lancashire coast, with water depths in the windfarm site ranging between 18 and 40 m.

1.2. Background Information

OWL contracted Ocean Ecology Limited (OEL) to undertake a benthic characterisation survey of the Project windfarm site as there is a requirement for baseline information on the sediment quality and benthic habitats from within the proposed windfarm site to be collected to inform project design and the Environmental Impact Assessment (EIA).

The Project export cable route is not included in this report and will be subject to a separate survey and consent process in association with the Project transmission assets. Therefore, all survey works covered in this report were located within the windfarm site.

1.3. Aims and Objectives

The key focus of the benthic characterisation survey was to provide accurate ground truthing to the geophysical data collected within the windfarm site in 2021 (provided to OEL by OWL) using a combination of Drop-Down Camera (DDC) and sediment grab sampling. As well as ground truthing the geophysical data, this survey will be used to characterise the environmental baseline and assign habitats across the site for the purpose of Environmental Impact Assessment (EIA).

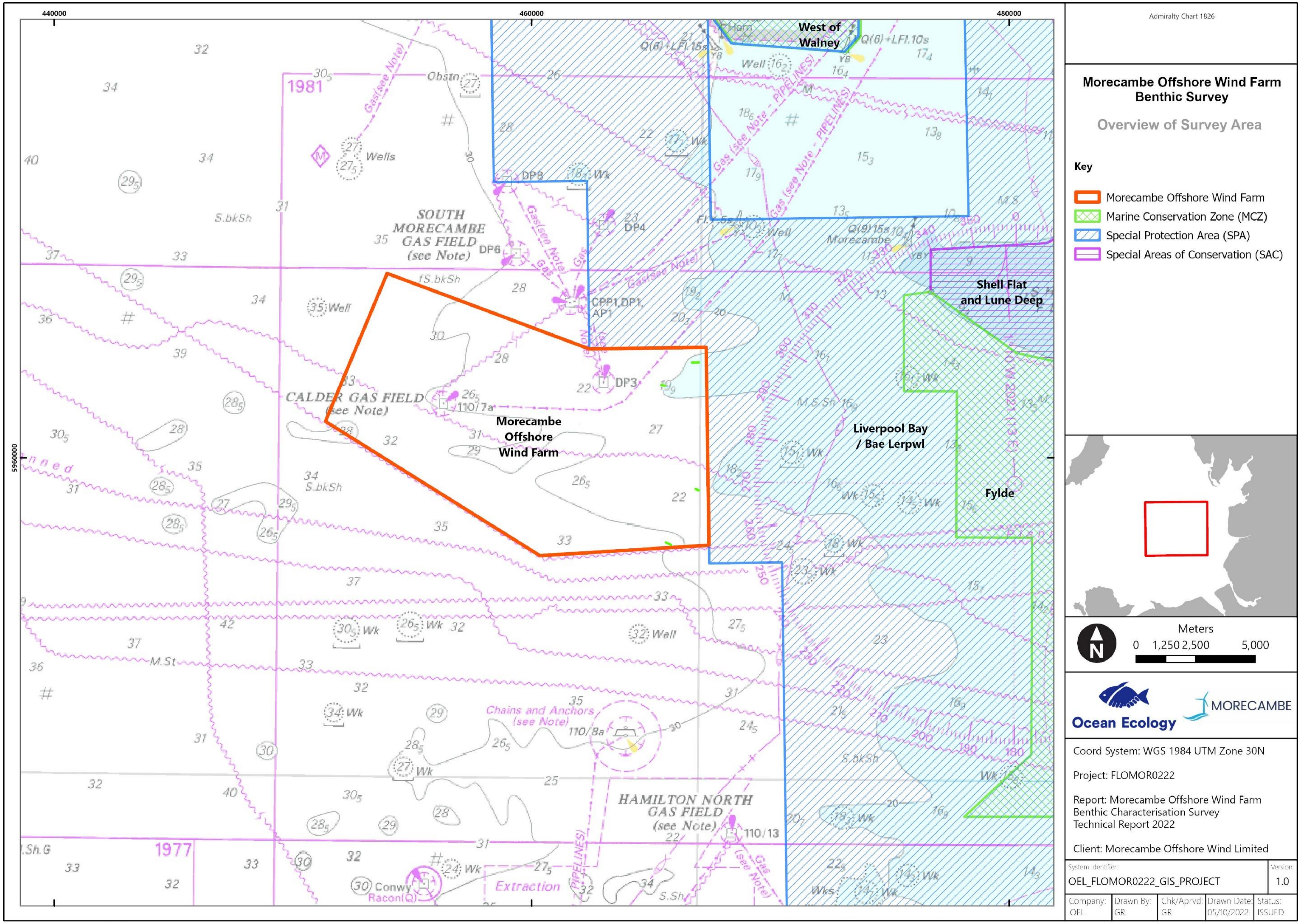


Figure 1 The location of the proposed Morecambe OWF site in the Northeast Irish Sea.

2. Designated Sites

The windfarm site is located to the immediate west of the Liverpool Bay / Bae Lerpwl Special Protection Area (SPA) with its northern and eastern boundaries adjoining but not intersecting that of the SPA (Figure 1). Liverpool Bay / Bae Lerpwl SPA is in the east of the Irish Sea, bordering the coastlines of north-west England and north Wales. The boundary of Liverpool Bay / Bae Lerpwl SPA extends beyond 12 nautical miles and therefore lies partly in Welsh and English territorial waters and partly in offshore waters.

The Liverpool Bay / Bae Lerpwl SPA is designated for the protection of red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra*), and little gull (*Hydrocoloeus minutus*) in the non-breeding season; common tern (*Sterna hirundo*) and little tern (*Sterna albifrons*) in the breeding season, and as an internationally important waterbird assemblage.

Further to the east of the windfarm site are the Fylde Marine Conservation Zone (MCZ), and the Shell Flat and Lune Deep Special Area of Conservation (SAC) (Figure 1).

3. Existing Data

3.1. EMODnet Habitat Mapping

The EMODnet broad-scale seabed habitat map (EMODnet 2021) for Europe is a comprehensive, free and ready-to-use broad-scale map of physical habitats, harmonising mapping procedures and fostering a common understanding among seabed mappers in Europe. This indicates that the windfarm site is dominated by the following sediment habitats including European Nature Information System (EUNIS) classifications A5.25/A5.26 'Circalittoral fine sand' / 'Circalittoral muddy sand', A5.27 'Deep circalittoral sand', A5.35 'Circalittoral sand mud' and A5.37 'Deep circalittoral mud' (Figure 2).

3.2. Geophysical Data

Full coverage acoustic data was collected across the windfarm site during a geophysical survey campaign in 2021 and was provided to OEL in processed format for consideration during the survey design (see PEP, Appendix I). This included side-scan sonar (SSS) and multi-beam echosounder (MBES) bathymetry at 1 m resolution (Figure 3).

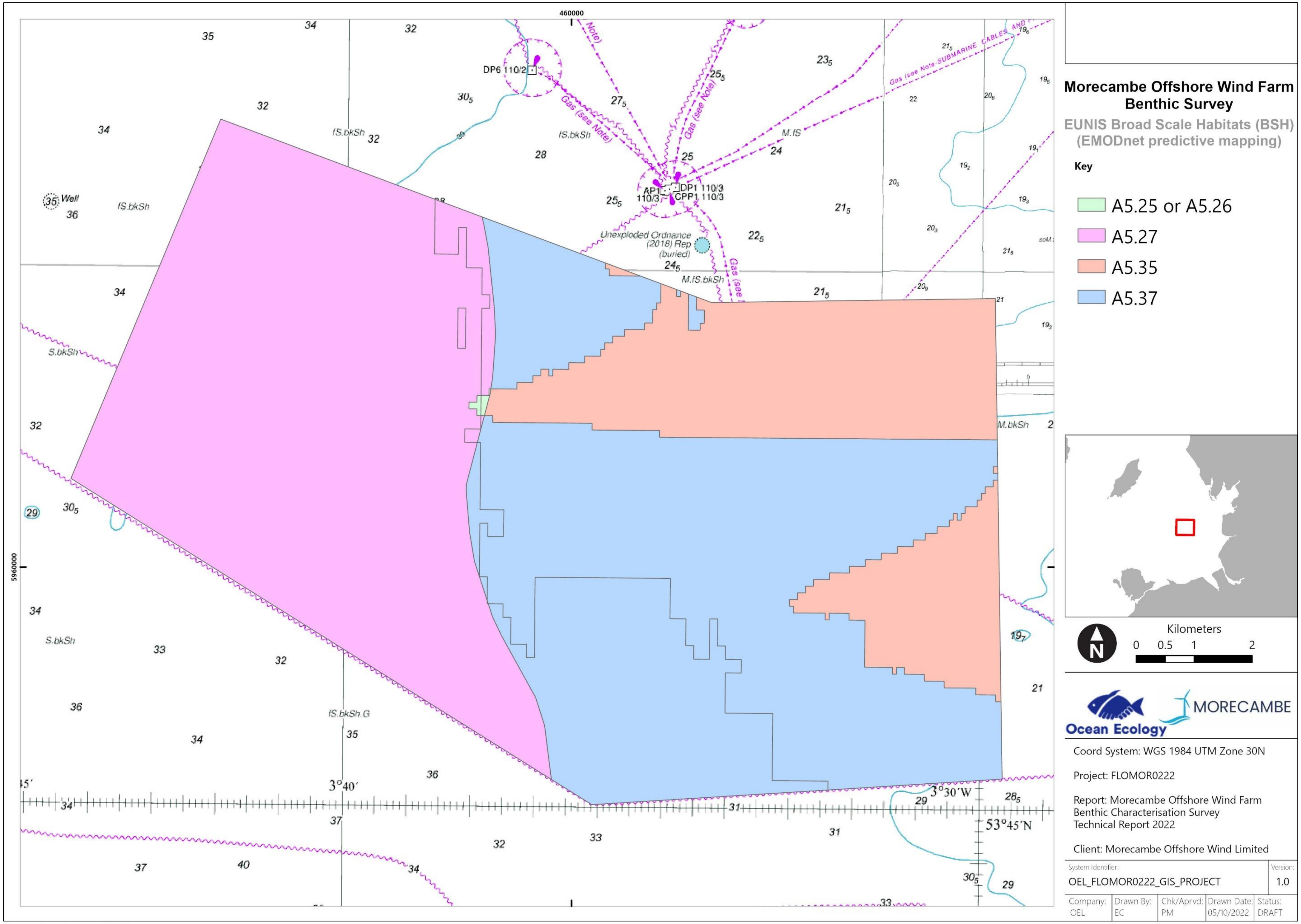


Figure 2 EMODnet predictive habitat mapping showing EUNIS BSH for the Morecambe OWF site.

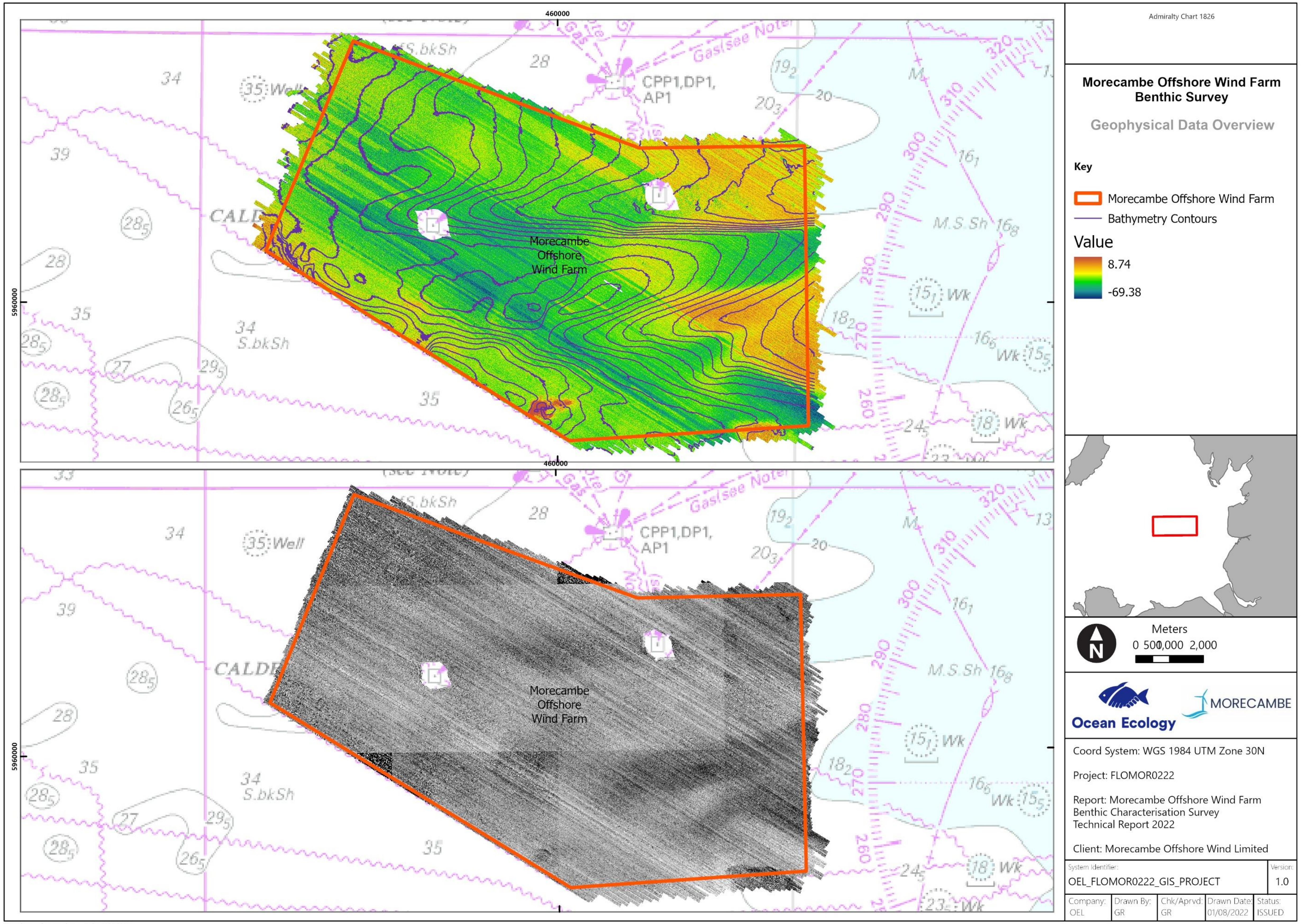


Figure 3 Overview of the Morecambe OWF site, results of the 2021 geophysical survey campaign (MBES and SSS) used to inform sampling design and identify features of interest for the DDC investigations.

4. Survey Design

4.1. Sampling Rationale

The benthic sampling plan was developed in line with Phase I of Natural England's (NE) "Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards" (Natural England 2021a) to provide maximum geographic coverage of the proposed windfarm site, whilst also ensuring that all key habitats and communities likely to be encountered across the windfarm site were adequately targeted. The key principles underpinning the survey design were therefore to:

- Provide adequate spatial coverage of the windfarm site.
- Ensure representative sampling of all main sediment types was undertaken.
- Ensure representative examples of all potential features of conservation interest (e.g., Annex I reef) were adequately ground-truthed.

The sampling plan was produced based on a stratified sampling approach across the windfarm site with micrositing of sampling stations informed by a detailed review and interpretation of the outputs of the 2021 geophysical campaign and consideration for all surface, subsurface and subsea hazards and their respective exclusion / buffer zones. Table 1 lists sediment types present across the windfarm site as per EMODnet predicted Broad Scale Habitat (BSH) and targeted during the environmental survey.

Table 1 Overview of grab locations by predicted Broad Scale Habitat (BSH) and contaminant samples across the windfarm site.

Predicted BSH	No. of Grab Locations	No. of Contaminant Samples
A5.1 - Sublittoral Coarse Sediment	12	4
A5.2 - Sublittoral Sand	38	16
A5.2 - Sublittoral Sand / A5.1 - Sublittoral Coarse Sediment	1	1

The sampling plan was issued to and approved by OWL in the form of a Project Execution Plan (PEP) prior to the commencement of the survey (Appendix I). This PEP was also shared with regulatory stakeholders including NE and The Marine Management Organisation (MMO). Return comments were provided by NE however no comments were received from the MMO prior to the survey. Full details of the procedure and rationale for the design of the final sampling array is set out in the PEP, provided as Appendix I, and not repeated here. Responses to the NE and MMO comments received on the PEP and incorporated in this report are provided in Appendix XIX.

4.2. Summary of Sampling

In summary, the sampling array included:

- 50 stations sampled with a $0.1m^2$ Day grab with prior investigation by DDC. Samples collected were to be suitable for Particle-size distribution (PSD) and macrobenthic analyses. Only single PSD and faunal samples were required from each site.
- Contaminant samples taken at 20 selected sampling locations.
- DDC deployments undertaken at each grab location to: i) determine the suitability of the station for grab samples (i.e., no hazards or sensitive habitat) and ii) provide an indication of the epibenthos at each location.
- Four DDC transects across the site to ground truth geophysical data and identify any features of interest.

A summary of sampling stations is provided in Table 2 and presented spatially in Figure 4, Figure 5.

Table 2 Summary of sampling stations surveyed during the Morecambe OWF survey.

Station I.D.	Target Easting	Target Northing	Notes
ST01	459526.752	5956923.006	
ST02	461209.685	5957188.416	
ST03	462611.030	5957149.039	
ST04	464111.030	5957149.039	
ST05	465611.030	5957149.039	
ST06	466873.419	5956911.428	
ST07	455127.525	5959655.225	
ST08	456611.030	5959649.039	
ST09	464135.247	5964444.396	
ST10	459611.030	5959649.039	
ST11	461377.879	5958604.849	
ST12	462611.030	5959649.039	
ST13	464297.252	5959542.956	
ST14	465582.517	5958537.019	
ST15	466517.251	5959273.583	
ST16	452111.030	5962149.039	
ST17	453611.030	5962149.039	
ST18	455563.417	5961670.060	
ST19	458092.235	5961650.961	
ST20	459648.621	5961622.767	
ST21	461120.428	5961571.479	
ST22	462287.113	5963151.507	
ST23	464161.071	5962091.300	
ST24	465663.487	5962198.327	
ST25	467111.030	5962149.039	
ST26	453370.566	5964598.521	
ST27	455111.030	5964649.039	
ST28	456611.030	5964649.039	
ST29	458003.250	5964768.367	
ST30	459884.226	5964483.519	
ST31	461111.030	5964649.039	
ST32	455111.030	5967149.039	
ST33	-	-	DDC only – no permission to sample
ST34	463263.110	5958542.026	
ST35	462097.091	5956369.826	
ST36	453971.505	5966373.181	
ST37	456155.158	5965962.777	
ST38	463257.635	5961074.951	
ST39	459657.190	5963366.583	
ST40	466977.917	5962892.013	

Station I.D.	Target Easting	Target Northing	Notes
ST41	458167.160	5959119.766	
ST42	458536.783	5958351.464	
ST43	453474.193	5960836.048	
ST44	455242.801	5963558.811	
ST45	466045.552	5960487.933	
ST46	466787.669	5963994.446	
ST47	465505.971	5963037.928	
ST48	455363.366	5962442.488	
ST49	463631.928	5963230.410	
ST50	465249.064	5956469.728	
ST51	466934.211	5958665.120	Backup contaminant samples also taken at ST51 but not required for analysis.
TR01	465613.196	5956461.600	
TR02	467011.285	5964000.584	
TR03	465580.148	5963024.434	
TR04	459422.455	5956927.820	

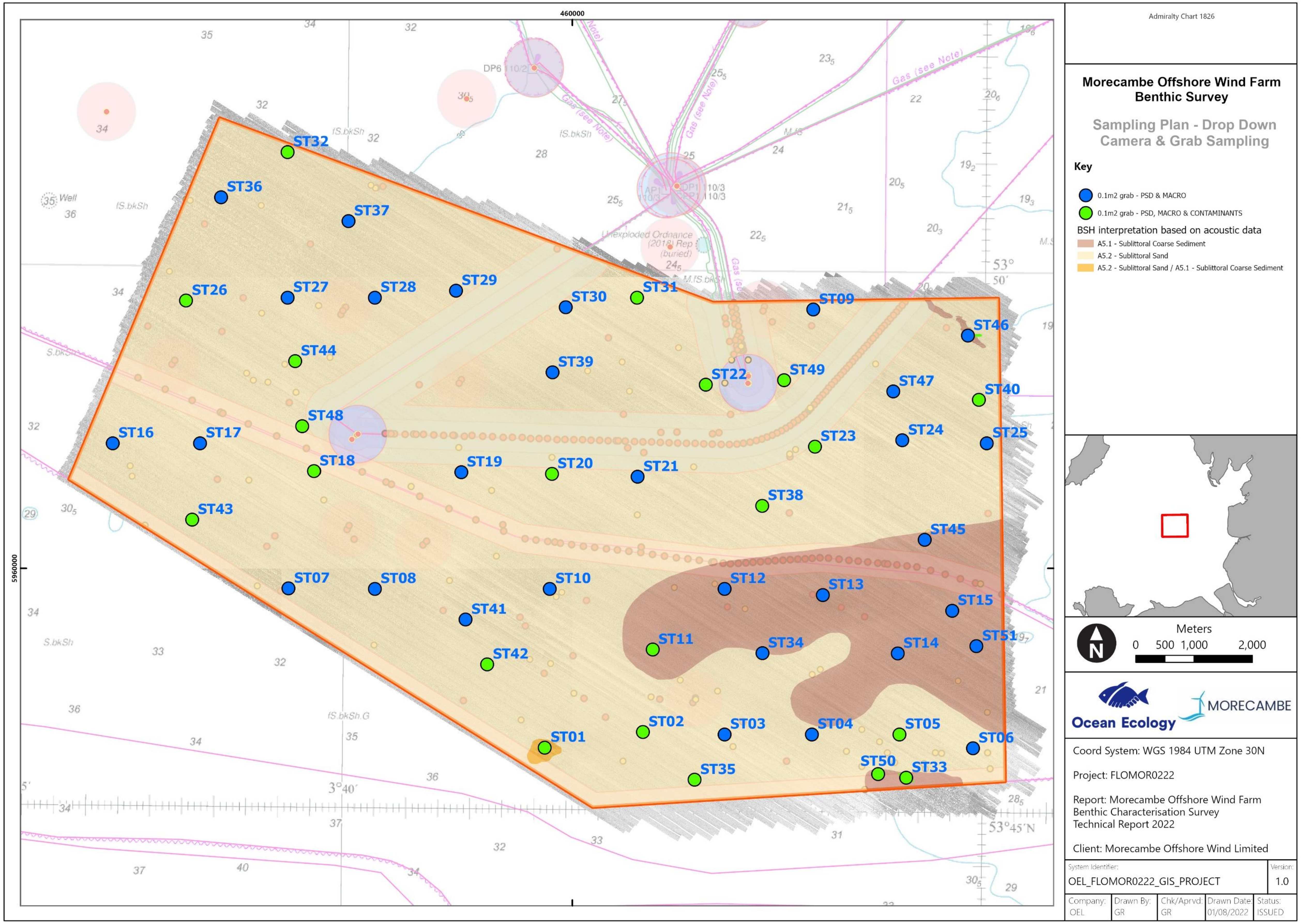


Figure 4 Locations of Morecambe OWF site DDC and grab sampling stations.

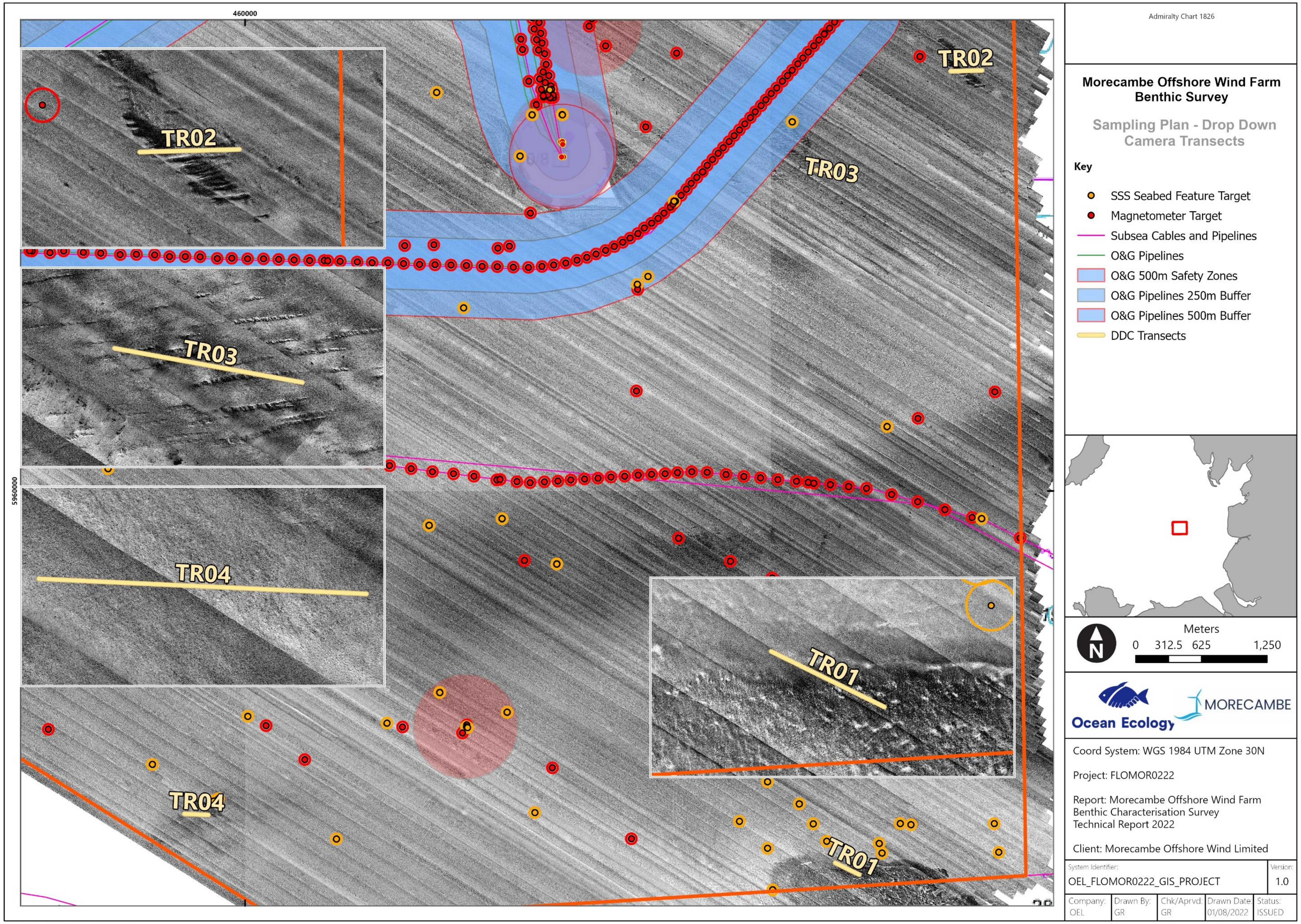


Figure 5 Locations of Morecambe OWF site DDC transects.

5. Field Methods

5.1. Survey Vessel

All sampling was conducted aboard OEL's dedicated 10.4 m Marine and Coastal Agency (MCA) category 2 coded survey vessel '*Seren Las*' (Plate 1). The vessel was equipped with a Hemisphere V104s GPS Compass system that provided a Global Positioning System (GPS) feed to a dedicated survey navigation PC operating EIVA NaviPac and TimeZero Navigator v4 marine navigation with routing module and SeaTraceR Class B AIS.

Plate 1 Nearshore survey vessel '*Seren Las*'.

5.2. Geodetic Parameters

All coordinates were based on World Geodetic System 1984 (WGS 1984) with projected grid coordinates based on Universal Transverse Mercator (UTM) zone 30N with a Central Meridian of 03˚W. A summary of geodetic and projection parameters is provided in Table 3.

Table 3 Geodetic parameters used during the survey.

Local geodetic Datum Parameters	
Datum	World Geodetic System 1984 (WGS 1984)
Spheroid	WGS 1984
Project Projection Parameters	
Grid Projection	Universal Transverse Mercator, Northern Hemisphere
UTM Zone	30 N
Central Meridian	03˚ 00′ 00″ West
Latitude of Origin	00˚ 00′ 00″ North
False Easting	500000.0 m
False Northing	0 m
Scale factor on Central Meridian	0.9996
Units	Metres

5.3. Survey Equipment

Table 4 Equipment utilised onboard the *Seren Las*.

Equipment	Model
Camera System	OEL's Rayfin PLE Camera System with freshwater housing
Grab System	OEL's 0.1 m^2 Day Grab
dGPS	Hemisphere V104s GPS Compass
Gyro Compass	Hemisphere V104s GPS Compass
Navigation Software	EIVA NaviPac V4.5
Subsea Positioning	Ultra-Short Baseline System (USBL) – AAE Nexus 2 Lite

5.3.1. Subsea Positioning

A vessel-based positioning system was employed utilizing EIVA NaviPac V4.5 software to ensure the accurate positioning of the vessel and subsea positioning of the sampling equipment. A navigation screen, displaying EIVA Helmsman Display was provided at the helm position of the vessel for the Vessel Skipper as well as for the ecologist/surveyor in the wheelhouse. An Ultra-Short Baseline (USBL) system was required due to deep water depths meaning the camera system was offset from the vessel's stern (i.e., the deployment point). The position of the sampling equipment was determined using a subsea beacon attached to the camera and grab frames when deployed from the stern A frame of *Seren Las*.

5.3.2. Drop-Down Camera Systems

Seabed imagery (simultaneous video and stills) were acquired along the DDC transects and stations using OEL's Rayfin PLE Camera System to collect High Definition (HD) video and high-resolution (up to 21 megapixels (MP)) still images. OEL's Rayfin PLE Camera System (Plate 2) consisted of a SubC Imaging Rayfin PLE camera, seabed frame equipped with freshwater housing (Jones et al. 2021), two LED strip lights, two 5kW green dot lasers (set to 10cm distance for scale), a 300m umbilical and topside computer. The camera was powered with the use of an Uninterruptable Power Supply (UPS) to ensure no damage was caused should the vessel lose power or cause a power surge. The freshwater housing was height and angle adjustable providing a variety of options for view, lighting, and focal length to maximise data quality with respect to prevailing conditions (e.g., high turbidity).

Plate 2 OEL's bespoke drop-down camera and deployment frame.

All DDC stations and transects were sampled in consideration of the Joint Nature Conservation Committee (JNCC) epibiota remote monitoring operational guidelines (Hitchin et al. 2015). At each screening DDC location, a minimum of two minutes of video footage and five seabed still images (of between 0.5m^2 to 1m^2 of seabed coverage depending on visibility) were obtained. Along each DDC transect, the camera was slowly 'flown' just above the seabed to ensure representative imagery was collected along the full transect with still images taken every 5-10 m along with continuous video recording. Where visibility was restricted, the camera was lowered gently on to the seabed. All footage underwent a preliminary review onboard by the OEL's marine ecologists.

5.3.3. Benthic Grab Sampling

A $0.1m^2$ Day grab was used to obtain macrobenthic and PSD at each of the proposed grab sampling locations.

To ensure consistency in sampling, all grab samples were screened by the lead marine ecologist and considered unacceptable if:

- The sample was less than 5L. i.e., the sample represents less than half the 10L capacity of the grab used.
- The jaws failed to close completely or were jammed open by an obstruction, allowing fines to pass through (washout or partial washout).
- The sample was taken at an unacceptable distance from the target location (beyond 20m).
- There was obvious contamination of the sample from survey equipment, paint chips etc.

Samples with a volume less than 5L in muds or 2.5L in hard-packed sands were rejected and sampling at the location reattempted up to a maximum of three times. Attempts were made to obtain as much sample as possible by adjusting the amount of weight on the grab sampler. Under no circumstances was pooling of samples undertaken.

Grab Sample Processing (macrobenthos and PSA samples)

Initial grab sample processing was undertaken onboard the *Seren Las* in line with the following methodology:

- Initial visual assessment of sample size and acceptability made.
- Photograph of the unprocessed sample in sample hopper with station details and scale bar taken.
- Sub-sample removed for PSD analysis and transferred to a labelled tray.
- Remaining sample emptied onto 1.0 mm sieve net laid over 4.0 mm sieve table and washed through using gentle rinsing with seawater hose.
- Photograph of the sieved sample on 1.0 mm sieve net taken.
- Remaining sample for faunal sorting and identification backwashed into a suitable sized sample container and diluted 10 % formalin solution added to fix the sample prior to laboratory analysis.
- Sample containers clearly labelled internally and externally with date, sample ID and project name.

Grab Sample Processing (contaminant samples)

A separate grab was taken at a subset of 20 sampling stations for contaminant analysis using the following methodology:

- Inspection cover lifted and general assessment of sample size and acceptability made ensuring sediment surface is undisturbed and no obvious sign of contamination. NB ensure no grease, oils or lubes enter the sample once the inspection cover is open.
- pH / Redox probe placed into sediment sample and allowed to settle for 2 minutes before taking readings in field logs.
- Sediment samples were sub-sampled and decanted into the recommended sample containers provided by Société de Contrôles Techniques (SOCOTEC), the contaminant laboratory specialists, to undertake the MMO suite analysis for disposal at sea along with additional analyses, as summarised below:

    - Additional Metals: Ag, Te, Ba, Be, Ti, U, Mn, Sb, Co, Mo, Sn, Se, Tl, V
    - Total Organic Matter by Loss on Ignition (LOI)
    - Moisture Content

6. Laboratory and Analytical Methods

On arrival to the laboratory, all samples were logged in and entered into the project database created in OEL's web-based data management application ABACUS in line with in-house Standard Operating Procedures (SOPs) and OEL's Quality Management System (QMS).

6.1. Particle Size Distribution (PSD) Analysis

PSD analysis of sediment samples was undertaken by in-house laboratory technicians at OEL's MMO Validated laboratory.

6.1.1. Sample Preparation

Frozen sediment samples were first transferred to a drying oven and thawed at 80°C for at least 6 hours prior to visual assessment of sediment type. Before any further processing (e.g., sieving or sub-sample removal), samples were mixed thoroughly with a spatula and all conspicuous fauna (>1 mm) which appeared to have been alive at the time of sampling removed from the sample. A representative sub-sample of the whole sample was then removed for laser diffraction analysis before the remaining sample wet screened over a 1mm sieve to sort coarse and fine fractions. Care was taken so as not to overload the sieve and allow continual flow of <1mm sediment through until the water run clear.

6.1.2. Dry Sieving

The >1 mm fraction was then returned to a drying oven and dried at 80°C for at least 24 hours prior to dry sieving. Once dry, the sediment sample was run through a series of Endecott BS 410 test sieves (nested at 0.5 φ intervals) using a Retsch AS200 sieve shaker to fractionate the samples into particle size classes. The dry sieve mesh apertures used are given in Table 5.

Table 5. Sieve series employed for Particle Size Distribution (PSD) analysis by dry sieving (mesh size in mm).

Sieve aperture (mm)												
63	45	32	22.5	16	11.2	8	5.6	4	2.8	2	1.4	1

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

6.1.3. Laser Diffraction

The fine fraction residue (<1 mm sediments) was transferred to a suitable container and allowed to settle for 24 hours before excess water syphoned from above the sediment surface until a paste texture was achieved. The fine fraction was then analysed by laser diffraction using a Beckman Coulter LS13 320. For silty sediments, ultrasound was used to agitate particles and prevent aggregation of fines.

6.1.4. Data Merging

The dry sieve and laser data were then merged for each sample with the results expressed as a percentage of the whole sample at 0.5 φ intervals from -5.5 (45 mm) to >14.5 (<0.04 µm). Once data was merged, size classifications were presented in the MMO Template and PSD statistics and sediment classifications were generated from the percentages of the sediment determined for each sediment fraction using Gradistat v9.1 software.

Sediments were also described by their size class based on the Wentworth classification system (Wentworth 1922) (Table 6). Statistics such as mean and median grain size, sorting coefficient, skewness and bulk sediment classes (percentage silt, sand and gravel) were also derived in accordance with the Folk classification (Folk 1954).

Table 6. Classification used for defining sediment type based on the Wentworth Classification System (Wentworth 1922).

Wentworth Scale	Phi Units (φ)	Sediment Types
>64 mm	<-6	Cobble and boulders
32 – 64 mm	-5 to -6	Pebble
16 – 32 mm	-4 to -5	Pebble
8 – 16 mm	-3 to -4	Pebble
4 - 8 mm	-3 to -2	Pebble
2 - 4 mm	-2 to -1	Granule
1 - 2 mm	-1 to 0	Very coarse sand
0.5 - 1 mm	0 – 1	Coarse sand
250 - 500 µm	1 – 2	Medium sand
125 - 250 µm	2 – 3	Fine sand
63 - 125 µm	3 – 4	Very fine sand
31.25 – 63 µm	4 – 5	Very coarse silt
15.63 – 31.25 µm	5 – 6	Coarse silt
7.813 – 15.63 µm	6 – 7	Medium silt
3.91 – 7.81 µm	7 – 8	Fine silt
1.95 – 3.91 µm	8 – 9	Very fine silt
<1.95 µm	<9	Clay

6.2. Sediment Chemical Analysis

All sediment chemistry analysis was undertaken by UKAS accredited and MMO Validated laboratory SOCOTEC UK Limited. A full description of the methods used to test for each chemical determined is provided as Appendix II.

6.2.1. Hydrocarbons

Indices and ratios were calculated to assess source origin of hydrocarbons in the sediment sampled across the Morecambe OWF site (Ines et al. 2013, Aly Salem et al. 2014, Al-hejuje et al. 2015). Generally, there are three sources of hydrocarbons depending on their origin: biogenic, petrogenic and pyrogenic. Hydrocarbons of biogenic origin are the produce of biological processes or early diagenesis in marine sediments (e.g., perylene) (Venkatesan 1988, Junttila et al. 2015). Hydrocarbons of petrogenic origin are the compounds present in oil and some oil products following low to moderate temperature diagenesis of organic matter in sediments resulting in fossil fuels. Hydrocarbons of pyrogenic origin are the product of incomplete combustion of organic material (Page et al. 1999, Junttila et al. 2015), such as forest fires and incomplete combustion of fossil fuels.

Based on polycyclic aromatic hydrocarbon (PAH) compounds the following ratios were calculated as follows:

The ratio between light (LMW) and heavy molecular weight (HMW) PAHs is typically used as a proxy to determine the origin source of PAH compounds in sediments, ratios above 1 indicate a petrogenic source while ratios below 1 indicate a pyrogenic source. LMW PAHs include compounds with 2-3 rings while HMW PAHs include compounds with more than 4 rings (Edokpayi et al. 2016).

Phenanthrene / Anthracene ratio: values lower than 10 indicate a pyrogenic source origin for the hydrocarbons; while values higher than ten account for hydrocarbons of petrogenic origin (Kafilzadeh et al. 2011).

Fluoranthene / Pyrene ratio: for values higher than one, the hydrocarbons are pyrogenic in origin, for values below one, the hydrocarbons are petrogenic in origin (Kafilzadeh et al. 2011).

6.2.2. Heavy and Trace Metals

A total of eight main heavy and trace metals were analysed from sediments taken at each of the 20 stations sampled. These were Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn). An additional 14 heavy and trace metals were analysed in support of the above measurements.

Where available, mean metal concentrations were compared to the OSPAR Background Assessment Concentration (BAC) (OSPAR et al. 2009), the USA Environmental Protection Agency (EPA) Effect Range Low (ERL) (NJDEP 2009), (DEFRA 2003) Action Level (AL) 1 and AL 2, and the Canadian sediment quality guideline (CSQG) Threshold Effect Level (TEL) and Probable Effect Level (PEL) (CCME 2001). To note that ERL, TEL and PEL are based on field research programmes based on North American data that have demonstrated associations between chemicals and biological effects by establishing cause and effect relationships in particular organisms (CCME 2001). This means they provide a measure of environmental toxicity compared to the other reference levels which instead provide information on the degree of contamination of the sediments. At levels above the TEL, adverse effects may occasionally occur, whilst at levels above the PEL, adverse effects may occur frequently; concentrations below the ERL rarely cause adverse effects in marine organisms. Additionally, the TEL has been adopted as the International Sediment Quality Guideline (ISQG) (CCME 2001), while ERL has been adopted by OSPAR to assess the ecological significance of contaminant concentrations in sediments, where concentrations below the ERL rarely cause adverse effects in marine organisms. For these reasons ERL, TEL and PEL are presented here as reference values despite being based on North American data.

BACs were developed to assess the status of contaminant concentrations in sediment within the OSPAR framework with concentrations significantly below the BAC considered to be near background levels for the North-East Atlantic. Cefas ALs are used as part of a ‘weight of evidence’ approach to assessing dredged material and its suitability for disposal to sea ((DEFRA 2003).

Contaminant levels in dredged material which fall below AL1 are of no concern and are unlikely to influence decision-making, while contaminant levels above AL2 are generally considered unsuitable for at-sea disposal.

6.3. Macrobenthic Analysis

All elutriation, extraction, identification and enumeration was undertaken at OEL's NMBAQC scheme participating laboratory in line with the NMBAQC Processing Requirement Protocol (PRP) (Worsfold & Hall 2010a). All processing information and macrobenthic records were recorded using OEL's cloud-based data management application 'ABACUS' that employs MEDIN[1] validated controlled vocabularies ensuring all sample information, nomenclature, qualifiers and metadata are recorded in line with international data standards.

For each macrobenthic sample, the excess formalin was drained off into a labelled container over a 1 mm mesh sieve in a well-ventilated area. The samples were then re-sieved over a 1 mm mesh sieve to remove all remaining fine sediment and fixative. The low-density fauna was then separated by elutriation with fresh water, poured over a 1 mm mesh sieve, transferred into a Nalgene and preserved in 70 % Industrial Denatured Alcohol (IDA). The remaining sediment from each sample was subsequently separated into 1 mm, 2 mm and 4 mm fractions and sorted under a stereomicroscope to extract any remaining fauna (e.g., high-density bivalves not 'floated' off during elutriation). All macrobenthos present was identified to species level, where possible, and enumerated by trained benthic taxonomists using the most up to date taxonomic literature and checks against existing reference collections. Nomenclature utilised the live link within ABACUS to the WoRMS[2] REST webservice, to ensure the most up to date taxonomic classifications were recorded. Colonial fauna (e.g., hydroids and bryozoans) were recorded as present (P). For the purposes of subsequent data analysis, taxa recorded as P were given the numerical value of 1.

Following identification, all specimens from each sample were pooled into five major groups (Annelida, Crustacea, Mollusca, Echinodermata and Miscellaneous taxa) in order to measure blotted wet weight major group biomass to 0.0001g. As a standard, the conventional conversion factors as defined by (Eleftheriou & Basford 1989) were applied to biomass data to provide equivalent dry weight biomass (Ash Free Dry Weight, AFDW). The conversion factors applied are as follows:

- Annelida = 15.5 %
- Crustacea = 22.5 %
- Mollusca = 8.5 %
- Echinodermata = 8.0 %
- Miscellaneous = 15.5 %

[1] Marine Environmental Data and Information Network
[2] http://www.marinespecies.org

6.4. Macrobenthic Data Analysis

6.4.1. Data Truncation and Standardisation

The macrobenthic species list was checked using the R package '*worms*' (Holstein 2018) to check against WoRMS taxon lists and standardise species nomenclature. Once the species nomenclature was standardised in accordance with WoRMS accepted species names, the species list was examined carefully by a senior taxonomist to truncate the data, combining species records where differences in taxonomic resolution were identified.

6.4.2. Pre-Analysis Data Treatment

All data were collated in excel spreadsheets and made suitable for statistical analysis. All data processing and statistical analysis was undertaken using R v 1.2 1335 (R Core Team 2020) and PRIMER v7 (Clarke & Gorley 2015) software packages.

In accordance with the OSPAR Commission guidelines (OSPAR 2004) records of colonial, meiofaunal, parasitic, egg and pelagic taxa (e.g. epitokes and larvae) were recorded, but were excluded when calculating diversity indices and conducting multivariate analysis of community structure. Newly settled juveniles of macrobenthic species may at times dominate the macrobenthos, however the OSPAR (2004) guidelines suggest they should be considered an ephemeral component due to heavy post-settlement mortality and not therefore representative of prevailing bottom conditions (OSPAR 2004). OSPAR (2004) further states that "Should juveniles appear among the ten most dominant organisms in the data set, then statistical analyses should be conducted both with and without these in order to evaluate their importance". As juveniles of Amphiuridae and Pectinariidae appeared in the top ten most dominant taxa across the windfarm site, a 2STAGE analysis was conducted to compare the two data sets (with and without juveniles) which revealed a high level of similarity (~98.7 %) between the two and therefore juveniles were retained in the dataset for all further analyses and discussion.

In accordance with NMBAQC PRP (Worsfold & Hall 2010b), Nematoda were recorded during the macrobenthic analysis and included in all datasets for all further analyses and discussion.

6.4.3. Univariate Statistics

The '*diverse*' function in PRIMER was used to calculate species diversity indices for macrobenthic data. These univariate indices enable the reduction of large datasets into useful metrics which can be used to describe and compare community structures:

- Number of Species (S): the number of species present in a sample, with no indication of relative abundances.
- Number of individuals (N): total number of individuals counted.

6.4.4. Multivariate Statistics

Multivariate analysis was undertaken in consideration of best practice guidance (Noble-James et al. 2018) and NE's (2021) Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards - Phase I (Natural England 2021b). Prior to multivariate analyses data were displayed as a shade plot with linear grey-scale intensity proportional to macrobenthic abundance (Clarke et al. 2014) to determine the most efficient pre-treatment method. Macrobenthic abundance data from grab samples was square root transformed to prevent taxa with intermediate abundances from being discounted from the analysis.

The PRIMER v7 software package (Clarke & Gorley 2015) was utilised to undertake the multivariate statistical analysis on the biotic macrobenthic dataset. To fully investigate the multivariate patterns in the biotic data, macrobenthic assemblages were characterised based on their community composition, with hierarchical clustering used to identify groupings of sampling stations that could be grouped together as a habitat type or community. SIMPER analysis was then applied to identify which taxa contributed most to the similarity within that habitat type or community. A detailed description of analytical routines is provided in Appendix III.

6.5. Determining EUNIS Classifications

Macrobenthic assemblages were characterised based on their community composition, with hierarchical clustering used to identify groupings of sampling stations that could be grouped together as a habitat type or community. Setting these groupings as factors within PRIMER, SIMPER analysis was then applied to identify which taxa contributed the most to the similarity within that community. EUNIS classifications were then assigned based on the latest JNCC guidance (Parry 2019).

6.6. Seabed Imagery Analysis

Digital photographic stills and video footage were successfully obtained at all DDC stations and along all DDC transects and subsequently analysed to aid in the identification and delineation of EUNIS habitats and potential Annex I habitats and other features of interest within the windfarm site.

All seabed imagery analysis was undertaken using the Bio-Image Indexing and Graphical Labelling Environment (BIIGLE) annotation platform (Langenkämper et al. 2017) and in line with JNCC epibiota remote monitoring interpretation guidelines (Turner et al. 2016) with consideration of the latest NMBAQC/JNCC Epibiota Quality Assurance Framework (QAF) guidance and identification protocols.

Analysis of still images was undertaken in two stages. The first stage, "Tier 1", consisted of labels that referred to the whole image being assigned, providing appropriate metadata for the image. Depending on the reef type, this included:

- Extent: As it is not possible to fully determine the extent of reef habitats from a single image alone this label was used to identify areas that were highly unlikely to constitute reef habitats. An example being an image that shows a large boulder being preceded and succeeded by images of unconsolidated sandy sediments.
- Biota: Labels assigned to determine whether epifauna dominate the biological community observed.
- Elevation: Labels assigned depending on reef type. Laser points were used to assist in the assignment of categories.

The second stage, "Tier 2", was used to assign percentage cover of 'reef' types by drawing polygons to inform the habitat assessment process.

6.6.1. Annex I Habitat Assessment

A full reef habitat assessment was conducted on all images to determine whether habitats met the definitions of Annex I geogenic and biogenic *Sabellaria spinulosa* reef habitats as detailed in Table 7 and Table 8 and in consideration of the JNCC guidance for Annex I low resemblance stony reef (Golding et al. 2020). The annotation label tree used during analysis had major headings for each of reef type. Under each reef type labels were assigned for each of the categories required to determine whether reef habitat was present.

There are currently no guidelines for assessing the quality ('reefiness') of bedrock reef habitats, however extent and cover were used to determine areas of bedrock reef as suggested by (Golding et al. 2020). The annotation label tree in BIIGLE was assigned major headings for each reef type: stony reef, bedrock reef and biogenic reef. Under each reef type, labels were assigned for each of the categories required to determine whether reef habitat was present as per the tables below.

Table 7 Characteristics of stony reef (Irving 2009).

Characteristic	'Reefiness'			
	Not a Reef	Low	Medium	High
Composition (proportion of boulders/cobbles (>64 mm))	<10 %	10-40 % matrix supported	40-95 %	>95 % clast-supported
Elevation	Flat seabed	<64 mm	64 mm - 5 m	>5 m
Extent	<25 m^2	>25 m^2		
Biota	Dominated by infaunal species	>80 % of species present composed of epibiotal species		

Table 8 Characteristics of *Sabellaria* spinulosa reef (Gubbay 2007).

Characteristic	'Reefiness'			
	Not a Reef	Low	Medium	High
Elevation (cm)	< 2	2 - 5	5 – 10	> 10
Extent (m^2)	< 25	25 – 10,000	10,000 – 1,000,000	> 1,000,000
Patchiness (% Cover)	< 10	10 - 20	20 – 30	> 30

6.6.2. Seapen and Burrowing Megafauna Assessment

Areas deemed to meet the criteria of the FOCI/OSPAR Seapens and burrowing megafauna, as per Robson (Robson 2014), were further assessed to determine the density of burrows, burrowing megafauna and seapens (if present). Burrows, megafauna and seapens were annotated using point annotations, with burrows being split based on width. Field of view was used to determine density per m^2, which was calculated for each image using BIIGLEs in built field of view calculation function.

6.7. Habitat/Biotope Mapping

All mapping processes was conducted in ESRI ArcPro Version 2.9. All seabed imagery assigned a EUNIS habitat in BIIGLE based on the latest JNCC guidance (Parry 2019) was utilised alongside the acoustic information and ground-truthed data from the grab samples to manually delineate the boundaries (polygons) of the various habitats and biotopes encountered across the survey area. Confidence scores were assigned to each polygon to give an indication of their accuracy. A value of 1 (low confidence) or 2 (high confidence) was assigned depending on the following:

- Whether ground-truth data was available within the polygon
- Whether multiple data sources confirmed/suggested the presence of the same habitat/biotope within a polygon
- Whether the boundaries of the habitat/biotope were clearly defined either by seabed imagery, ground-truth or acoustic data

Highest scores were given to polygons where all data sources identified the same habitat/biotope, with distinct boundaries. Lower scores were assigned to polygons where ground-truth data was limited, and boundaries not obvious. In these cases, polygons were drawn based upon expert judgement, given the information available.

7. Results

A total of 50 successful grab samples were collected during the survey. ST33, a proposed DDC and grab location was located within 250m of the LANIS I subsea cable for which permission to sample was not received by the asset owner in time for the survey. Therefore, only seabed imagery was obtained at ST033 and a pre-determined backup grab location (ST51) was sampled for both DDC and grab. Full DDC and grab field logs are provided in Appendices IV, V and VI. Grab images are provided in Appendix VII.

7.1. Particle Size Distribution Data

7.1.1. Sediment Type

Full raw PSD data for each sampling station is provided in Appendix VIII. Sediment types at each sampling station as classified by the (Folk 1954) classification are summarised in Appendix IX and illustrated in Figure 6. Some variation in sediment type was observed between sampling stations, with stations located towards the west and southwest of the array having slightly coarser sediments. Specifically, 27 sediment samples consisted of Muddy Sand (mS), seven of Sand (S) and seven of Slightly Gravelly Sand ((g)S), six of Slightly Gravelly Muddy Sand ((g)mS), and one each of Gravelly Muddy Sand (gmS) and Sandy Mud (sM). Figure 7 maps the distribution of these sediment types across the Morecambe OWF site.

Most of the sediments recorded were classified as very poorly to poorly sorted (78 % of stations) due to the mixed composition of different size fractions of all three principal sediment types (gravel, sand, and mud). However, 11 of the samples made of Sand and Slightly Gravelly Sand were classified as moderately to moderately well sorted.

7.1.2. Sediment Composition

Mean sediment grain size (µm) across the windfarm site ranged between 35.5 µm at station ST45 and 536.1 µm at station ST01 (Figure 9). A clear spatial pattern was evident in the distribution of mean grain size across the windfarm site with finer sediment characterising the eastern portion of the windfarm site and coarser sediment characterising the western part of the windfarm site.

Percentage contribution of gravel (> 2 mm), sand (> 63 µm < 2 mm), and mud (< 63 µm) are presented by station in Figure 9. Sand dominated across all stations but station ST45 where mud dominated. Other stations with notable mud contributions were stations ST25 and ST38, while gravel content was relatively high at station ST01. The mean (± SE) proportion of sand across all survey stations was 81.01 ± 2.03 %, mean (± SE) gravel content was 0.51 ± 0.41 % and mean (± SE) mud content was 18.46 ± 2.05 %.

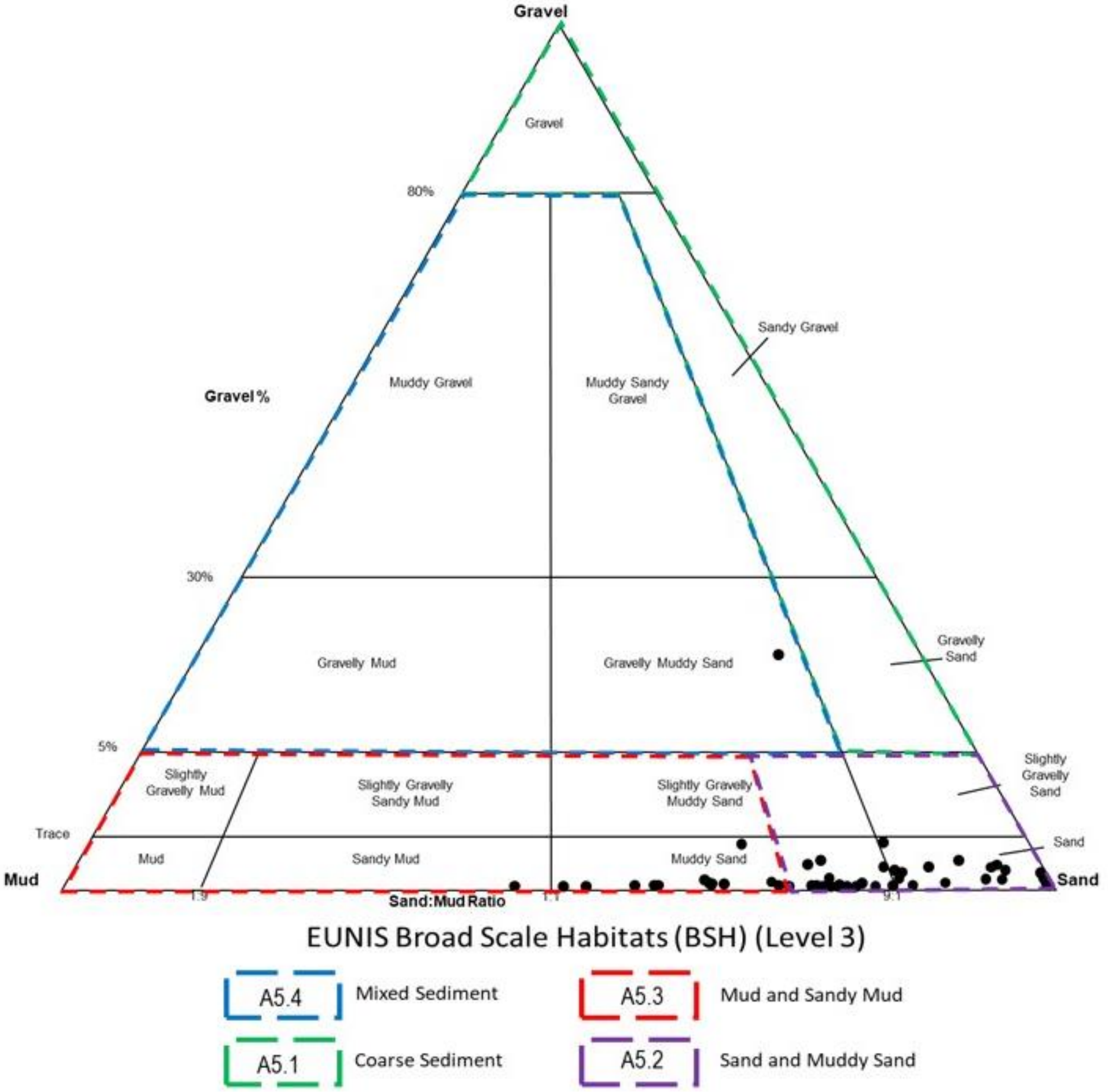


Figure 6 (Folk 1954) triangle classifications of sediment gravel percentage and sand to mud ratio of samples collected across the Morecambe OWF site.

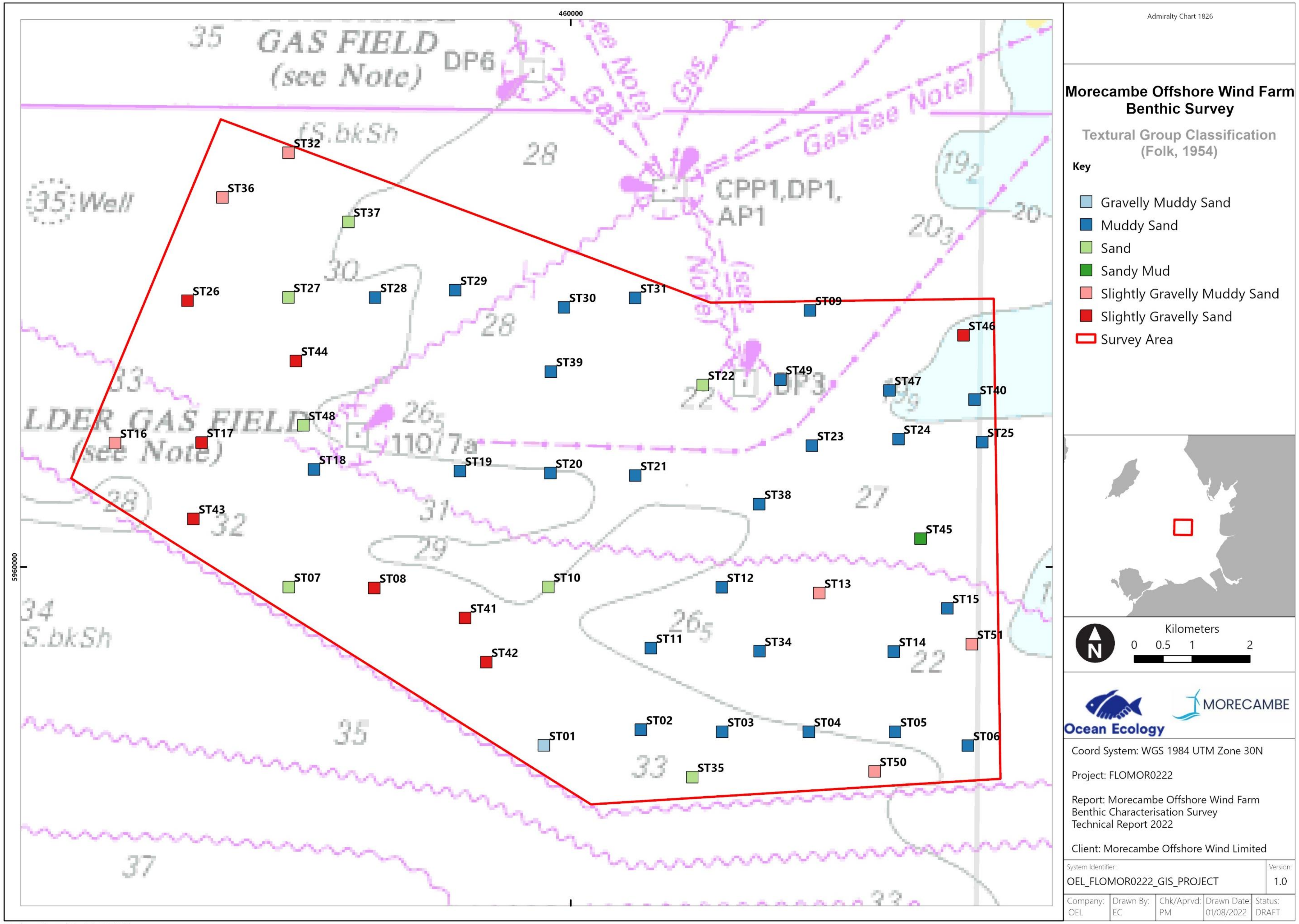


Figure 7 (Folk 1954) sediment types as determined from PSD analysis of samples.

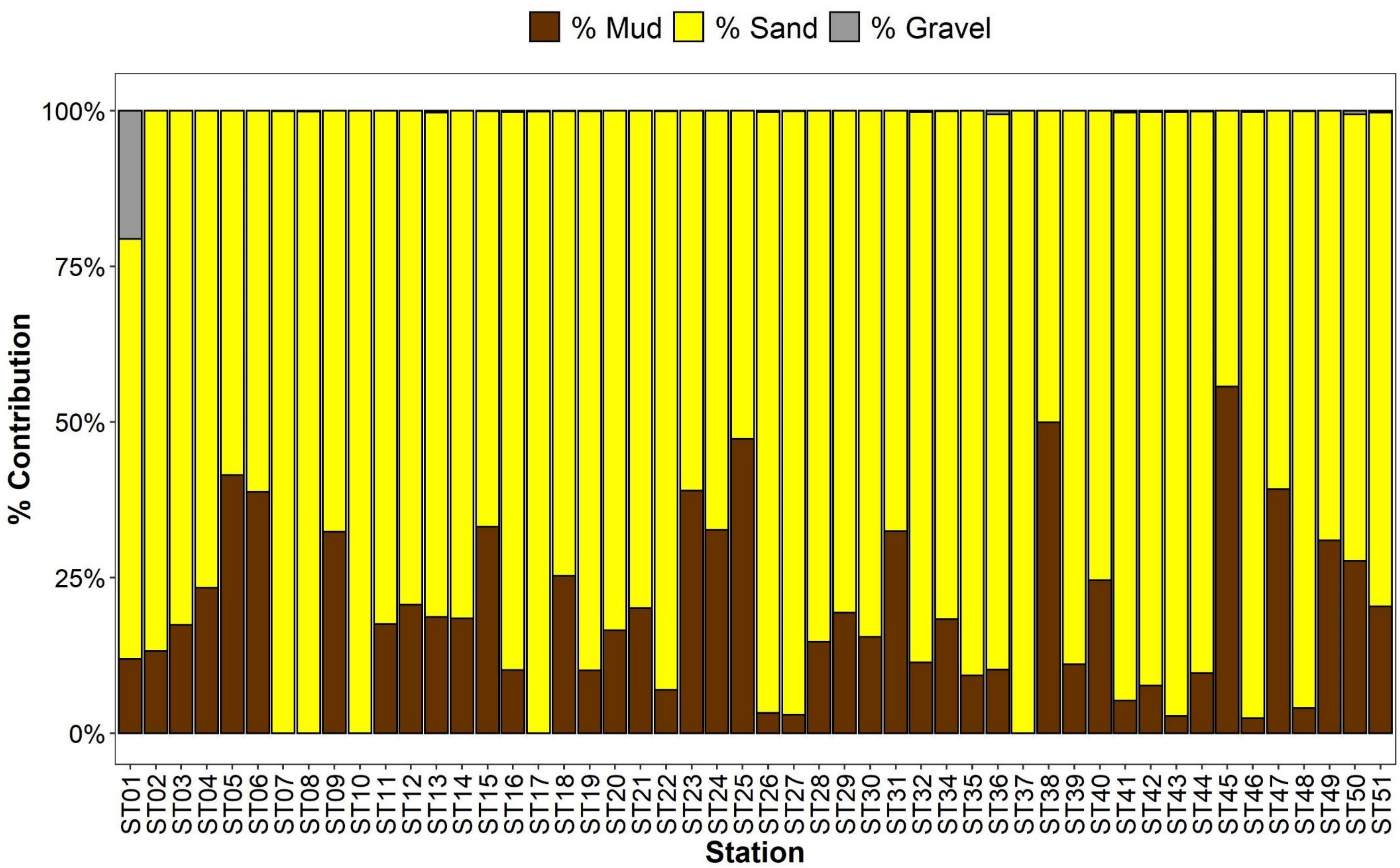


Figure 8 Principal sediment components (Gravel, Sand, Mud) as determined from PSD analysis of stations sampled across the Morecambe OWF site.

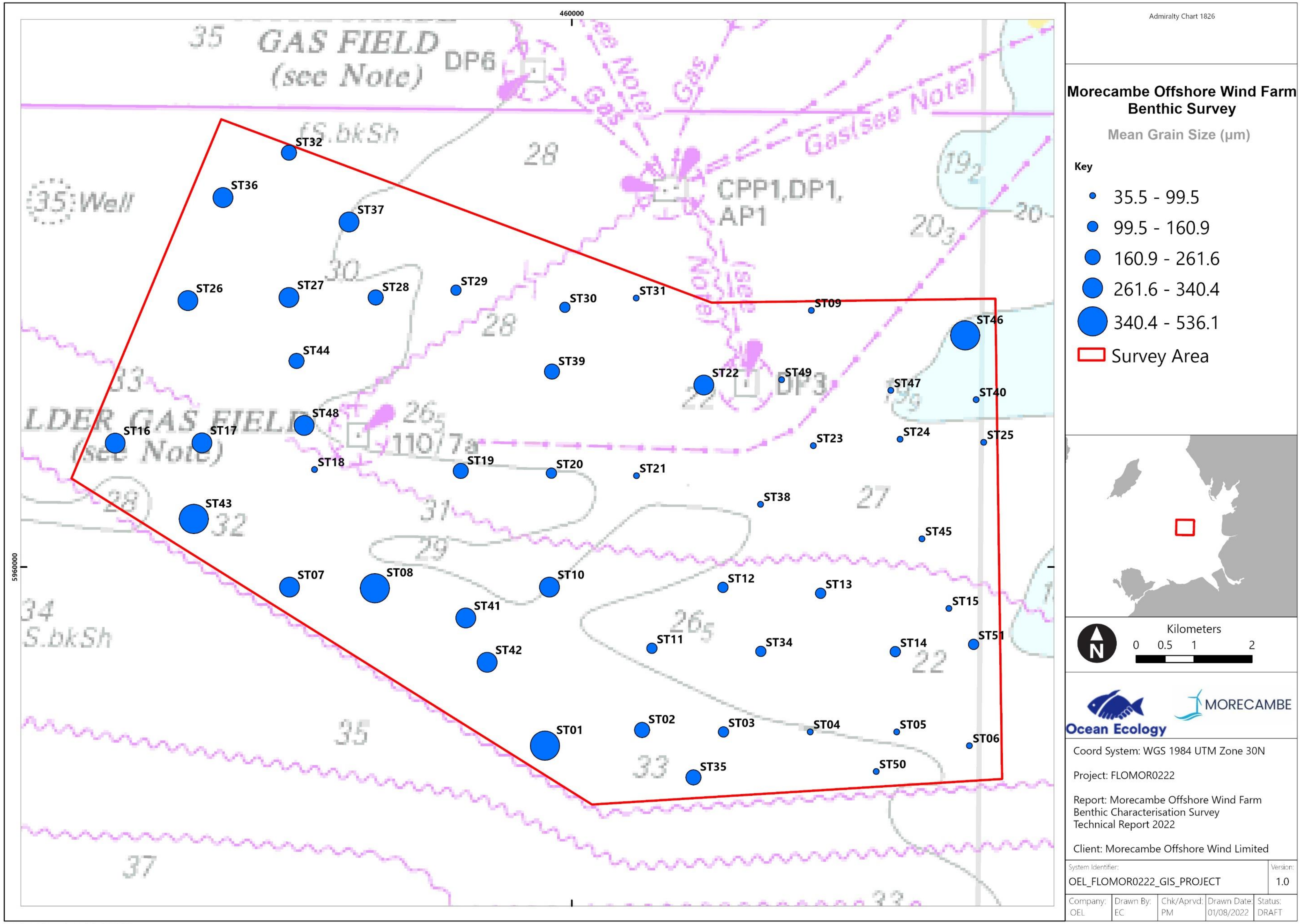


Figure 9 Comparison of mean sediment grain size (µm) of sediment samples.

7.2. Sediment Chemistry

Sediment samples for chemical analysis were collected from 20 stations sampled across the windfarm site. Grab samples taken for chemical analyses were analysed for Total Organic Carbon (TOC) and Total Organic Matter (TOM) (Section 7.2.1), heavy and trace metals (Section 7.2.2), Polycyclic Aromatic Hydrocarbon (PAH) and Total Hydrocarbon Content (THC) (Section 7.2.3), Organotins (Section 7.2.4) and Polychlorinated Biphenyls (PCBs) (Section 7.2.5). Raw sediment chemistry data are provided in Appendix X.

7.2.1. Total Organic Carbon (TOC) and Total Organic Matter (TOM)

TOC concentrations ranged from 0.07 % at ST43 to 0.46 % at ST38 with an average value (± SE) of 0.20 ± 0.03 % across the windfarm site (Figure 10). In general, relatively higher TOC values were recorded at stations located in the eastern reaches of the windfarm site, compared to the stations located to the west and more offshore.

TOM content in sediment varied between 0.7 % at stations ST26 and ST49 and 2.53 % at ST38, with an average value (± SD) of 1.36 ± 0.12 % across the windfarm site (Figure 11). A pattern like that observed for TOC was also seen for TOM with the highest TOM content at stations located in the eastern reaches of windfarm site.

No trend was observed between mud content in the sediment and percentage contribution of TOC or TOM.

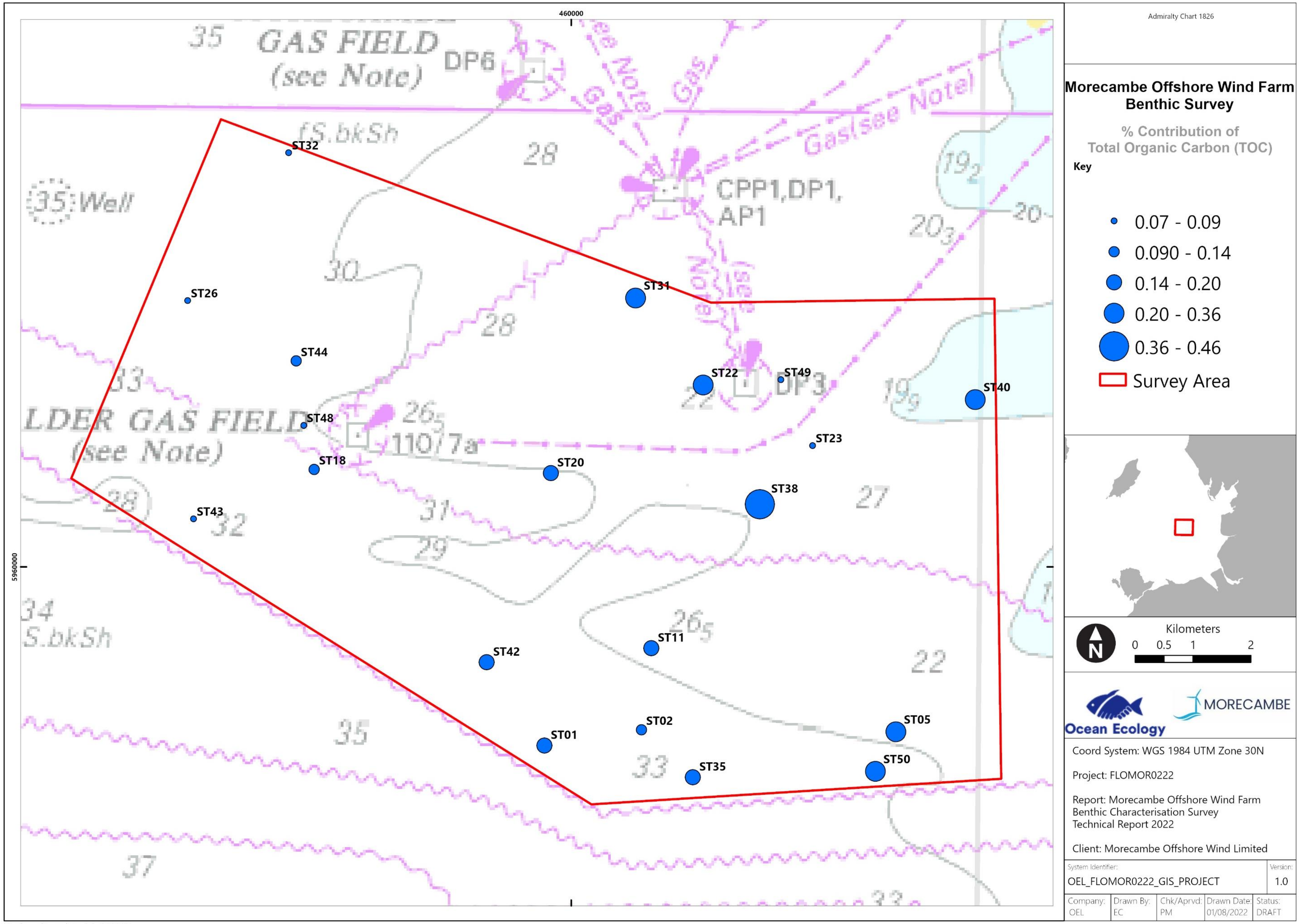


Figure 10 Percentage contribution of TOC across the Morecambe OWF site.

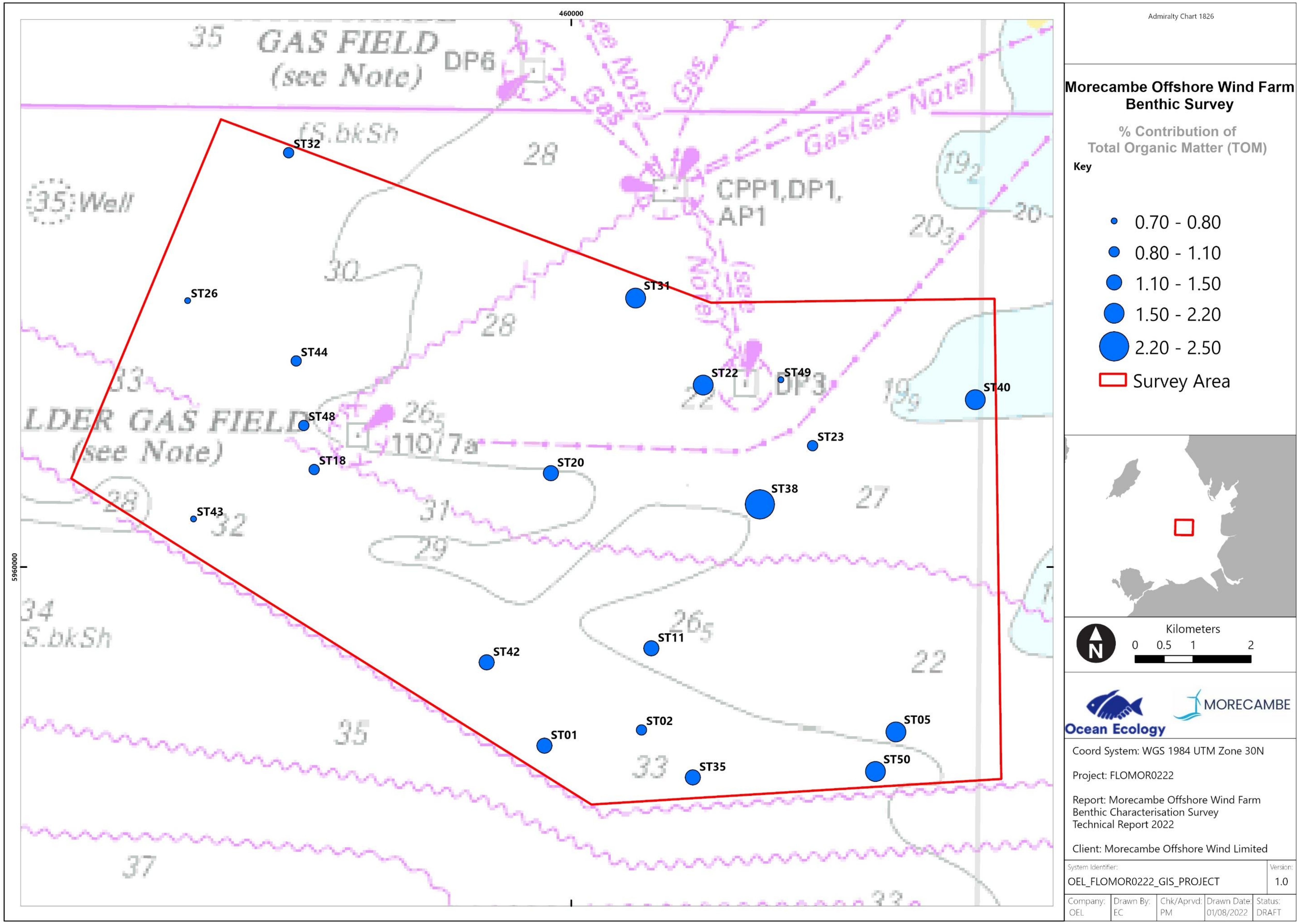


Figure 11 Percentage contribution of TOM across the Morecambe OWF site

7.2.2. Heavy and Trace Metals

A total of eight main heavy and trace metals were analysed from sediments taken at each of the 20 sampling stations. These were: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn). In addition, 14 secondary heavy and trace metals were analysed to provide a more in-depth picture of potential sediment contamination. These were: Antimony (Sb), Cobalt (Co), Manganese (Mn), Molybdenum (Mo), Selenium (Se), Thallium (Tl), Tin (Sn), Uranium (U), Vanadium (V), Barium (Ba), Beryllium (Be), Titanium (Ti), Silver (Ag) and Tellurium (Te). Raw data for these secondary metals are provided in Appendix X.

Raw data for the eight main heavy and trace metals (dry-weight concentration, mg kg^{-1}) are shown in Table 9 together with available reference levels (see Section 6.2.2 for details on national and international reference levels). None of the main heavy and trace metals exceeded reference levels with the exception of As which was above the TEL (7.24 mg kg^{-1}) at three stations: ST01, ST26 and ST43. However, As concentrations were well below Cefas AL 1, the national reference level. Of notice, Cd was below detection limit (0.04 mg kg^{-1}) at 12 of the 20 stations sampled.

The most abundant metal was Zn which ranged from 21 mg kg^{-1} at ST48 to 52.2 mg kg^{-1} at ST38, however, it was always recorded well below any of the reference levels (Table 9). Pb was also recorded in relatively high concentrations, ranging between 6.4 mg kg^{-1} at ST43 and 18.2 mg kg^{-1} at ST38, again well below any of the reference levels. The third most abundant metal was Cr which varied from 6.2 mg kg^{-1} at ST43 and 16.8 mg kg^{-1} at ST38, once again never exceeding reference levels. The only metal exceeding reference levels was As, which was generally recorded in low concentrations, with an average concentration across the windfarm site of 6.14 mg kg^{-1}, but exceeded the TEL at three stations. Figure 12 illustrates the spatial distribution of these four metals across the windfarm site. Typically, Zn, Pb and Cr had higher concentrations at stations located closer to land than in stations further offshore, displaying an east-west gradient with higher concentrations to the east. Conversely, As did not show a concentration gradient as most stations had comparable and relatively low As concentrations with stations ST01 and ST42 located to the south west of the windfarm site and station ST26 located in the north west of the windfarm site reporting As concentrations exceeding the TEL (Figure 12).

No trend was observed between the concentration of heavy and trace metals and the amount of mud in the sediments.

Table 9 Main Heavy and trace metals (mg kg^{-1}) in sediments. Shading indicates values above AL1.

Analyte	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Mercury (Hg)	Nickel (Ni)	Lead (Pb)	Zinc (Zn)
ST01	8.7	<0.04	12.2	6.5	0.06	10.4	12.2	32.3
ST02	5.0	<0.04	8.4	5.2	0.05	6.5	8.8	28.6
ST05	5.9	0.08	14.7	8.7	0.11	11.2	15.4	47.8
ST11	4.6	<0.04	8.7	6.0	0.06	6.3	9.3	28.8
ST18	5.7	<0.04	8.1	5.7	0.05	6.0	8.0	24.3
ST20	5.0	0.06	9.2	6.8	0.06	7.3	10.0	29.8
ST22	5.8	0.08	13.5	9.0	0.15	10.8	15.4	47.1
ST23	4.9	0.05	7.8	11.4	0.06	5.8	7.9	22.4
ST26	8.3	0.05	6.6	4.7	0.04	5.3	8.6	27.2
ST31	6.7	<0.04	14.7	7.0	0.12	10.8	16.5	47.4
ST32	7.1	<0.04	7.1	3.9	0.03	5.1	8.1	26.0
ST35	5.8	<0.04	9.8	6.3	0.05	7.2	11.5	32.8
ST38	6.0	0.07	16.8	10.2	0.12	12.7	18.2	52.2
ST40	6.4	<0.04	15.9	9.5	0.12	11.5	16.1	46.5
ST43	9.2	<0.04	6.2	3.7	0.01	5.3	6.4	21.3
ST44	6.5	<0.04	6.4	3.9	0.03	5.0	8.5	25.0
ST48	6.0	<0.04	6.8	4.0	0.05	4.8	7.6	21.0
ST49	4.6	0.05	7.5	5.1	0.05	5.4	8.3	23.8
ST50	6.1	0.07	14.8	7.9	0.10	10.3	15.7	44.1
ST42	4.6	<0.04	7.2	5.5	0.02	5.6	7.3	22.1
Min	*4.6*	*0.05*	*6.2*	*3.7*	*0.01*	*4.8*	*6.4*	*21*
Max	*9.2*	*0.08*	*16.8*	*11.4*	*0.15*	*12.7*	*18.2*	*52.2*
Mean	**6.14**	**0.06**	**10.12**	**6.55**	**0.07**	**7.66**	**10.99**	**32.52**
Standard Error	*0.30*	*0.00*	*0.81*	*0.50*	*0.01*	*0.60*	*0.85*	*2.39*
CEFAS AL1	20	0.4	40	40	0.3	20	50	130
CEFAS AL2	100	5	400	400	3	200	500	800
OSPAR BAC	25	0.31	81	27	0.07	36	38	122
ERL	8.2*	1.2	81	34	0.15	21*	47	150
TEL	7.24	0.7	52.3	18.7	0.1	-	30.2	124
PEL	41.6	4.2	160	108	0.7	-	112	271

*The ERLs for As and Ni are below the BACs therefore As and Ni concentrations are usually assessed only against the BAC.

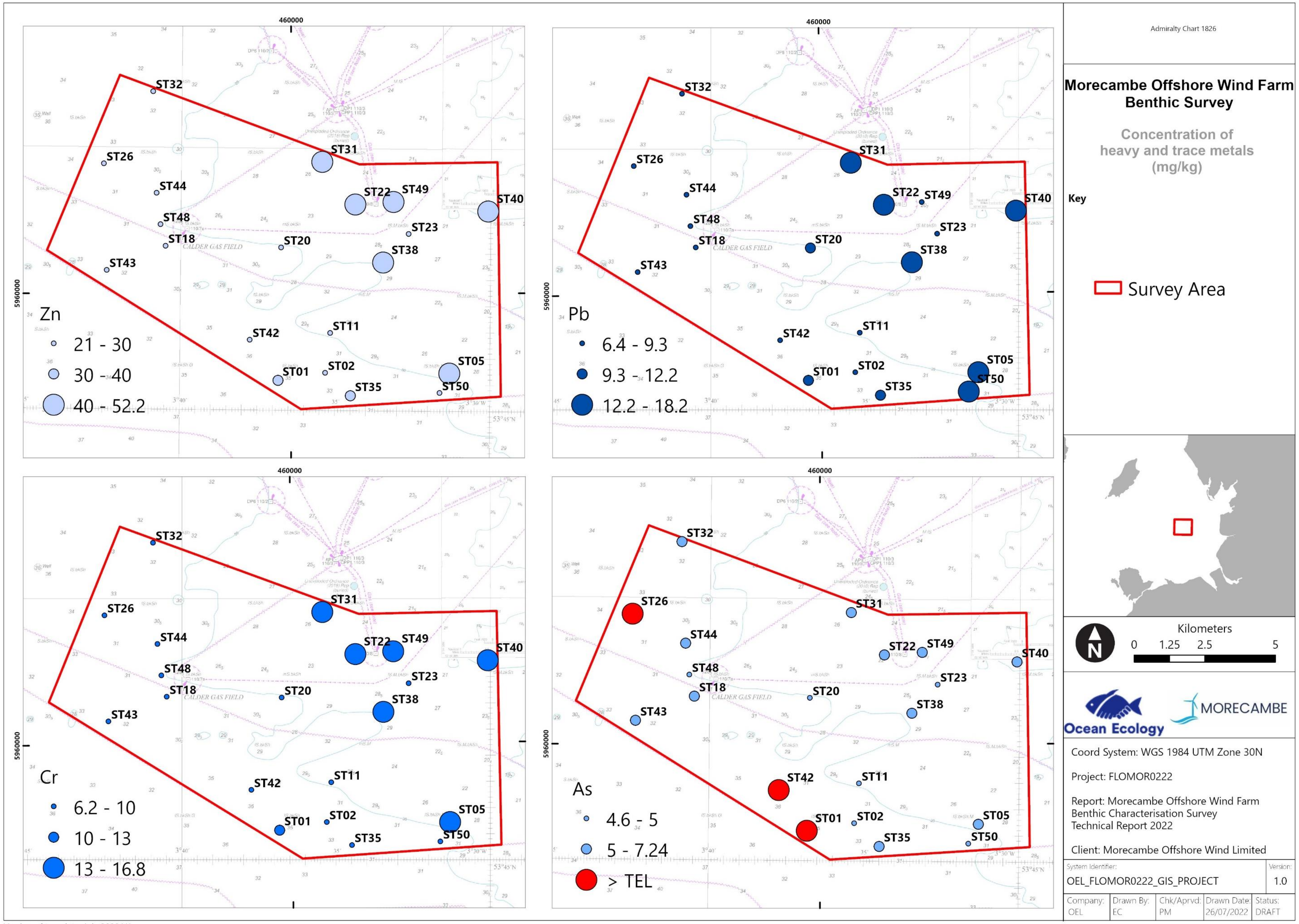


Figure 12 Concentration of the key heavy and trace metals sampled across the Morecambe OWF site. Note different scales

7.2.3. Polycyclic Aromatic Hydrocarbons (PAHs) and Total Hydrocarbons (THC)

The full range of PAHs as specified in the Department of Trade and Industry (DTI) regulations (DTI 1993) as well as by the EPA was tested for all 20 contaminant sub-samples collected.

The results of the PAHs analysis undertaken are reported in Appendix X. PAH concentrations were compared to Cefas AL1 (no Cefas AL2 available for PAHs), OSPAR BAC levels and ERLs, and TEL and PEL where possible (Table 10). The only reference level to be exceeded was the BAC, with Pyrene and Naphthalene being above reference levels at six of the 20 stations sampled. However, when averaged across the windfarm site, none of the PAH concentrations exceeded any of the reference levels.

The most abundant PAHs were: Pyrene with a mean concentration across the windfarm site of 14.27 μg kg^{-1} and a maximum concentration of 40.00 μg kg^{-1} at ST38, Benzo[b]fluoranthene with a mean concentration across the windfarm site of 14.05 μg kg^{-1} and a maximum concentration of 40.00 μg kg^{-1} at ST38 and Fluoranthene with a mean concentration across the windfarm site of 13.94 μg kg^{-1} and a maximum concentration of 40.10 μg kg^{-1} at ST38. Reference levels were available only for Pyrene and Fluoranthene with the former exceeding the BAC at six stations and the latter exceeding the BAC only at one station ST38 (Table 10).

The PAHs recorded in elevated concentrations at more stations were Naphthalene and Pyrene, followed by Anthracene and Benzo[a]anthracene (Table 10 and Figure 13). Naphthalene ranged from 1.06 μg kg^{-1} at ST26 to a maximum of 16.60 μg kg^{-1} at ST40 with six stations exceeding the BAC (Table 10 and Figure 13). Pyrene ranged from 1.23 μg kg^{-1} at ST43 to a maximum of 40.00 μg kg^{-1} at ST38 with six stations exceeding the BAC (Table 10 and Figure 13). Anthracene ranged from below detection limit (1 μg kg^{-1}) to a maximum of 6.64 μg kg^{-1} at ST38 with five stations exceeding the BAC (Table 10 and Figure 13). Benzo[a]anthracene ranged from below detection limit (1 μg kg^{-1}) to a maximum of 20.80 μg kg^{-1} at ST38 with five stations exceeding the BAC (Table 10 and Figure 13). In general PAHs showed higher concentrations at the nearshore stations compared to stations located further offshore, similar to what observed for trace metals.

To determine the origin source of PAH compounds in sediments, the ratio between Low Molecular Weight (LMW) and High Molecular Weight (HMW) PAHs was calculated. Based on this ratio all stations were characterised by PAHs of pyrogenic origin (LMW/HMW < 1). Similarly, the ratios of Phenanthrene / Anthracene (Ph/Ant) indicated a pyrogenic origin of PAHs as this ratio was below 10 at all stations. However, it should be noted that Anthracene concentrations were below detection limit at six stations and therefore it was not possible to calculate Ph/Ant at these locations. In contrast, the Fluoranthene / Pyrene ratio (Fl/Py) was lower than one at most stations (16 out of 20) indicating a petrogenic origin source of PAHs across the windfarm site (Figure 14). Given the contrasting results, average values across the windfarm site (± SE) were calculated to assess the robustness of the measurements and it followed that mean (± SE) LMW/HMW was 0.22 ± 0.023, mean (± SE) Ph/Ant was 5.05 ± 0.165 and mean (± SE) Fl/Py was 0.96 ± 0.010 suggesting a mix source of PAHs, most likely of pyrogenic origin as two of the three indices indicated that.

Table 10 Number of stations across the Morecambe OWF site exhibiting elevated PAHs levels in comparison with OSPAR and Canadian Sediment Quality Guidelines (CSQG). No PAHs exceeded Cefas AL1 or CSQG levels.

Analyte	Cefas	OSPAR		CSQG	
	AL1	BAC	ERL	TEL	PEL
Acenaphthene	0	-	-	0	0
Acenaphthylene	0	-	-	0	0
Anthracene	0	5	0	0	0
Benzo[a]anthracene	0	5	0	0	0
Benzo[a]pyrene	0	1	0	0	0
Benzo[b]fluoranthene	0	-	-	-	-
Benzo[ghi]perylene	0	0	0	-	-
Benzo[e]pyrene	0	-	-	-	-
Benzo[k]fluoranthene	0	-	-	-	-
Chrysene	0	3	0	0	0
Dibenzo[ah]anthracene	0	-	-	0	0
Fluoranthene	0	1	0	0	0
Fluorene	0	-	-	0	0
Indeno[1,2,3-cd]pyrene	0	0	0	-	-
Naphthalene	0	6	0	0	0
Perylene	0	-	-	-	-
Phenanthrene	0	1	0	0	0
Pyrene	0	6	0	0	0

THC in sediment samples ranged from 1.00 mg kg^{-1} at ST43 to 33.70 mg kg^{-1} at ST22, with an average value (± SE) for the whole of the windfarm site of 9.84 ± 2.17 mg kg^{-1} (Figure 14). As seen for trace metals and PAHs, also THC was relatively higher at easternmost stations compared to stations located further offshore.

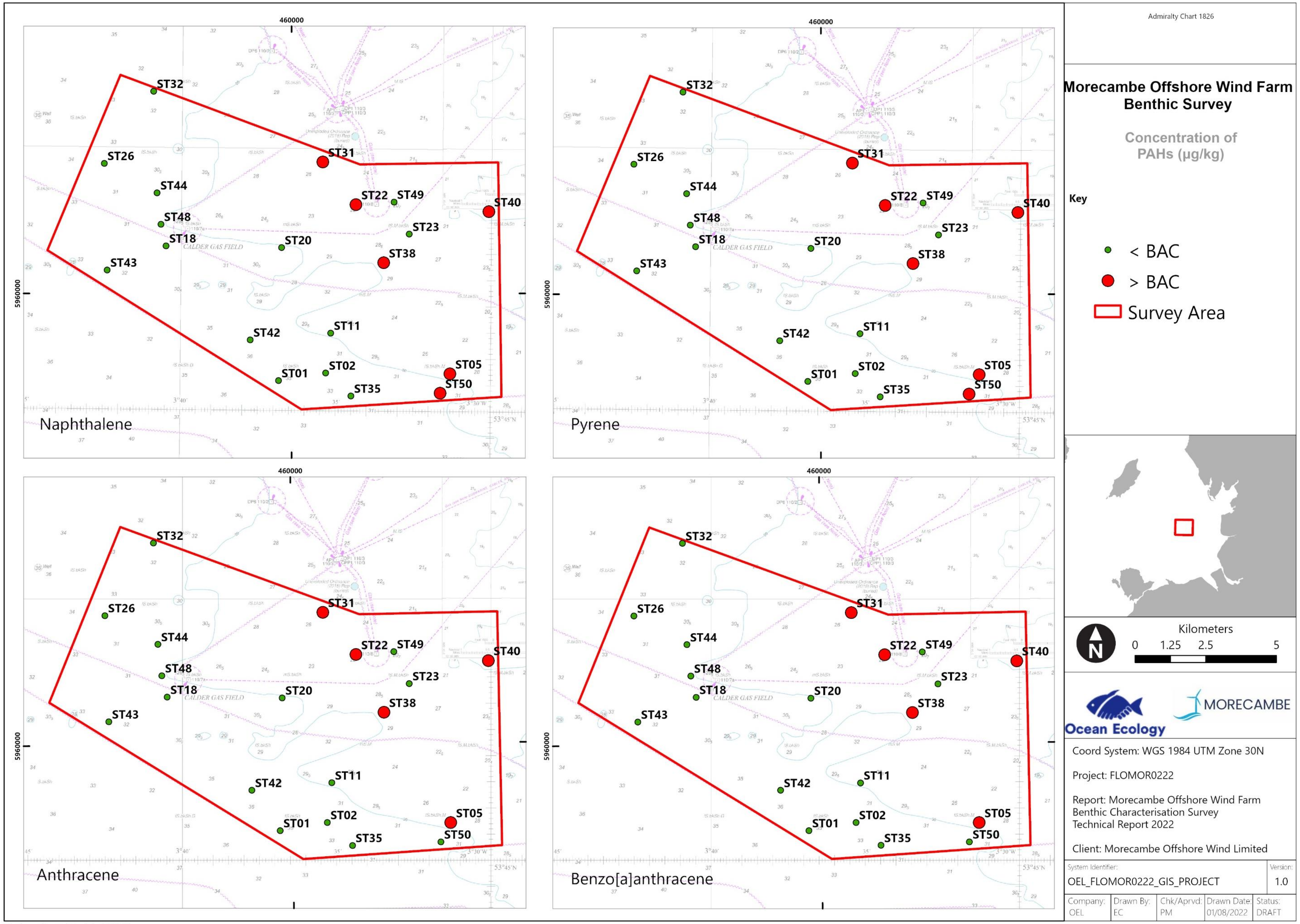


Figure 13 Concentration (µg kg^{-1}) of key PAHs against BAC across the Morecambe OWF site.

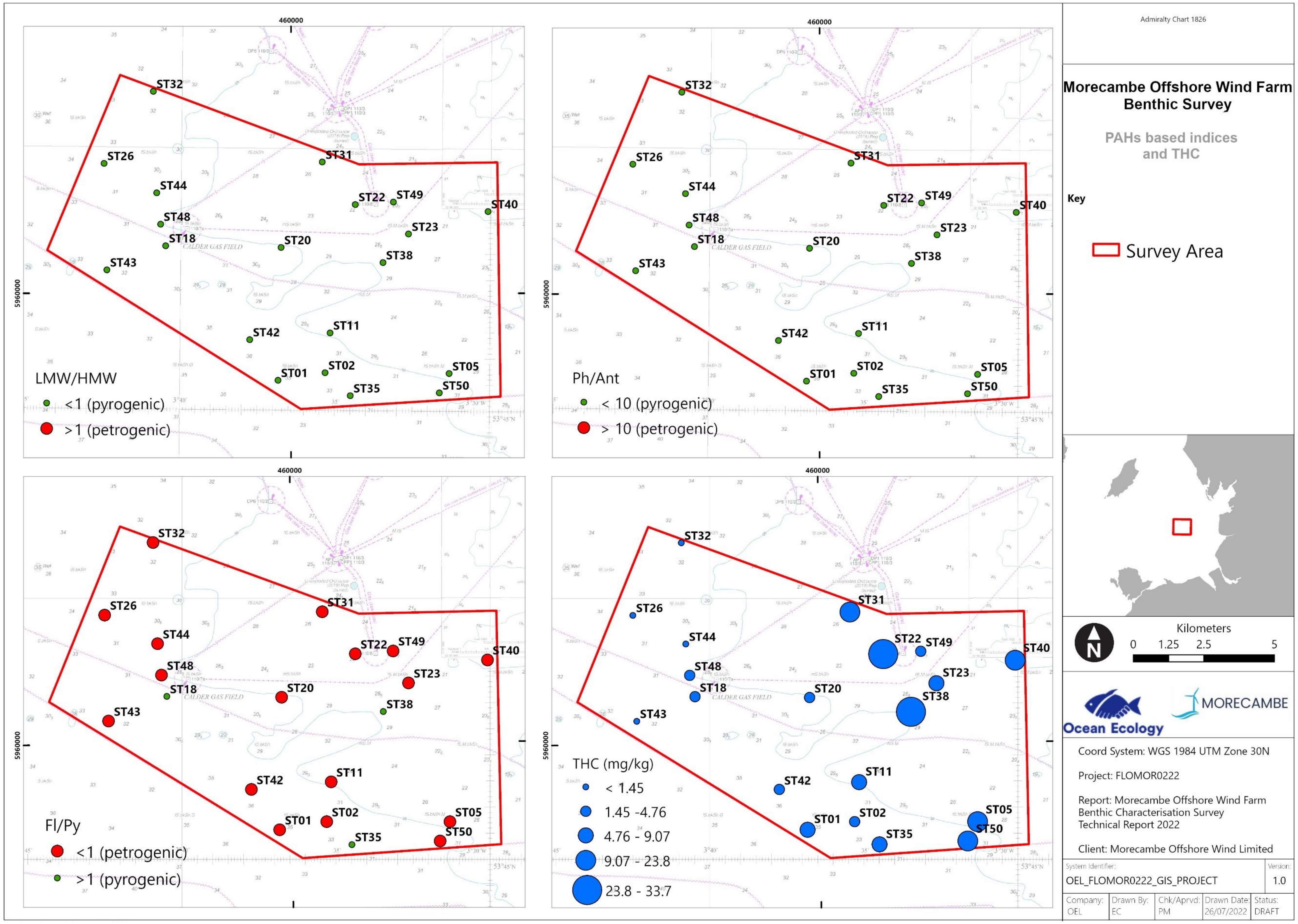


Figure 14 PAHs based indices and THC across the Morecambe OWF site.

7.2.4. Organotins

The concentrations of two organotins (Dibutyltin (DBT) and Tributyltin (TBT)) were analysed from the sediment taken at each of the 20 stations and reported in Appendix X.

All stations had organotin concentrations below the detection limit of 0.005 mg kg^{-1}. To provide some context, Cefas AL1 for organotins is 0.1 mg kg^{-1} and AL2 is 1 mg kg^{-1}.

7.2.5. Polychlorinated Biphenyls (PCBs)

All 25 PCBs congeners were analysed from the sediments taken at each of the 20 stations and reported in Appendix X.

No Cefas Action Levels exist for each individual PCBs, however most PCBs had concentrations below the detection limit of 0.00008 mg kg^{-1}. Cefas Action Levels do exist for the sum of all 25 PCBs congeners (Σ25PCBs). At all stations Σ25PCBs was below Cefas AL1 (0.02 mg kg^{-1}), ranging from below detection limit to 0.0009 mg kg^{-1}.

7.3. Macrobenthos

7.3.1. Macrobenthic Composition

The macrobenthic assemblage identified across the Morecambe OWF site from the 50 macrobenthic samples collected was made up of a total of 8,127 individuals and 154 different taxa. The mean (± SE) number of taxa was 24 ± 1 per station. Mean (± SE) abundance per station was 162 ± 19 with a mean (± SE) biomass per station of 0.9504 ± 0.1573 gAFDW.

The full abundance matrix is provided in Appendix XI. The biomass (gAFDW) of each major taxonomic group (Annelida, Crustacea, Mollusca, Echinodermata and Miscellaneous) in each sample collected is presented in Appendix XII.

As shown in Figure 15, the two-toothed Montagu shell (*Kurtiella bidentata*) was the most abundant taxon sampled accounting for 33 % of all individuals recorded. It was also the most frequently occurring as it was recorded in 88 % of samples and it accounted for the maximum abundance in a sample and greatest average density per sample (Figure 15). Other key taxa included the brittle star A*mphiura filiformis*, the polychaetes *Sthenelais limicola* and *Scalibregma inflatum* (Figure 15).

Figure 16 illustrates the relative contributions to total abundance, diversity, and biomass of the major taxonomic groups in the macrobenthic community sampled across the windfarm site. Mollusca taxa contributed most to abundance as they accounted for approximately 40 % of all individuals recorded, followed by Echinodermata taxa accounting for 33% (Figure 16). Annelida taxa contributed the most to the overall diversity of the macrobenthic assemblages at 38 %, while Echinodermata taxa dominated the biomass and accounted for 67 % of the total biomass (Figure 16).

Compared to abundance and diversity, biomass showed a much higher variability across the Morecambe OWF site (Figure 17) with the highest biomass recorded at station ST24 due to the presence of large molluscs and crustaceans, followed by station ST38 dominated by large echinoderms.

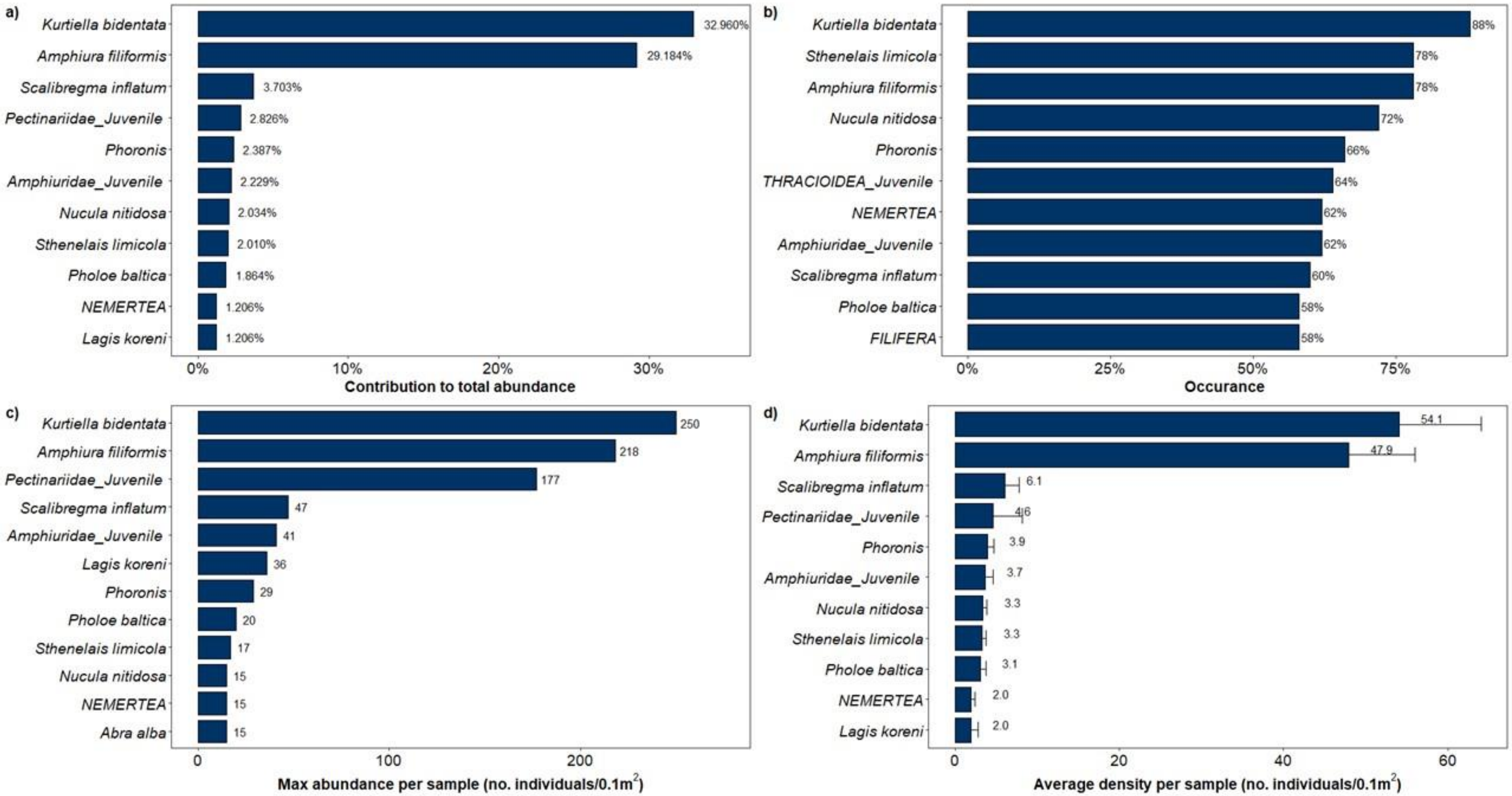


Figure 15 Percentage contributions of the top 10 macrobenthic taxa to total abundance (a) and occurrence (b) from samples collected across the Morecambe OWF site. Also shown are the maximum densities of the top 10 taxa per sample (c) and average densities of the top 10 taxa per sample (d).

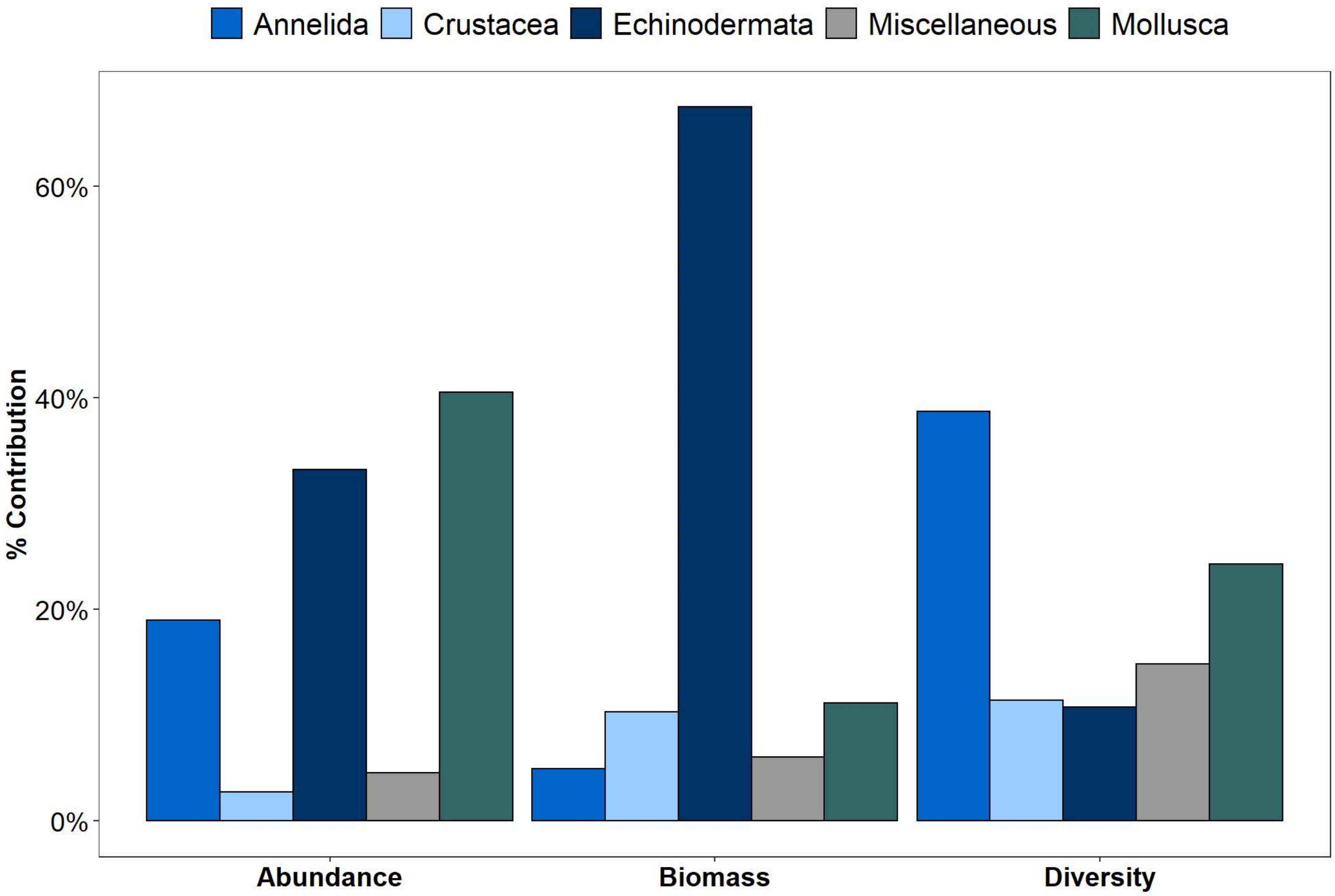


Figure 16 Relative contribution of the major taxonomic groups to the total abundance, diversity and biomass of the macrobenthos sampled across the Morecambe OWF site.

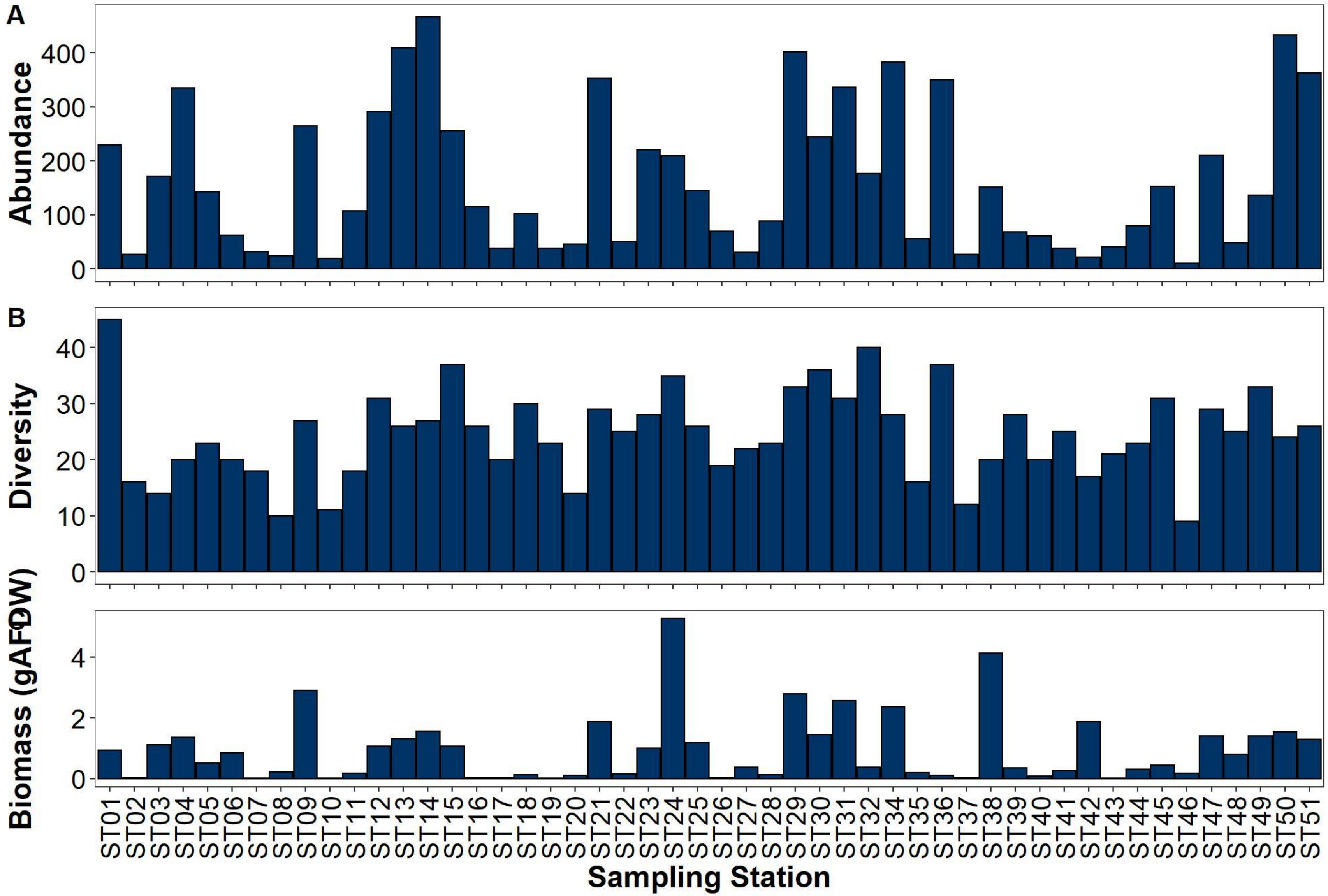


Figure 17 Abundance, diversity and biomass (gAFDW) per station across the Morecambe OWF site .

7.3.2. Notable Taxa

No notable taxa (e.g., non-native or commercially important species) were recorded across the Morecambe OWF site .

7.4. Macrobenthic Faunal Groupings

Multivariate analysis was undertaken on the square-root transformed macrobenthic abundance data to identify spatial distribution patterns in infaunal assemblages across the windfarm site and identify characterising taxa present.

Cluster analysis of the macrobenthic data was performed on a Bray-Curtis similarity matrix to analyse the spatial similarities in macrobenthic communities recorded across all sampled stations. The dendrogram resulting from the cluster analysis and associated Type 1 SIMPROF (similarity profile routine) permutation test of all nodes within the dendrogram identified 10 statistically significantly similar groups ($p > 0.05$). To enable a broad interpretation of the community present across the windfarm site, a similarity slice at 31 % was used to amalgamate the 10 SIMPROF groups into four broader Macrobenthic Groups, with one station not belonging to any group (outlier station ST46). The dendrogram resulting from the cluster analysis and associated Type 1 SIMPROF permutation test is provided in Appendix XIII.

To visualise the relationships between the sampled macrobenthic assemblages, a non-metric multi-dimensional scaling (nMDS) plot was generated on macrobenthic abundance data (Figure 18). The nMDS represents the relationships between the communities sampled, based on the distance between sample (station) points. The stress value of the nMDS ordination plot (0.17) indicates that the two-dimensional plot provides an adequate representation of the similarity between stations. The degree of clustering of intra-group sample points demonstrates the level of within group similarity (e.g., points within Macrobenthic Group A show distinct clustering), whilst the degree of overlap of inter-group sample points is indicative of the level of similarity between different Macrobenthic Groups (e.g., Macrobenthic Groups B, C and D).

The spatial distribution of the four broader Macrobenthic Groups and outlier is mapped in Figure 19. SIMPER (similarity percentage analysis) was used to identify the key taxa contributing to the within group similarity (see Appendix XIV for SIMPER results).

Macrobenthic Group A – was the largest group observed including 38 of the 50 stations sampled (average similarity 41.79). Characterising taxa of this group were the bivalves *Kurtiella bidentata* and *Nucula nitidosa* and the brittle star *Amphiura filiformis,* together accounting for 50 % of the total assemblage.

Macrobenthic Group B – four stations belonged to this group ST07, ST08, ST17 and ST43 all located in the southwestern reaches of the windfarm site (average similarity 37.80). The taxa characterising this group were the ribbon worms Nemertea and the polychaete *Spiophanes bombyx* together accounting for 54 % of the total assemblage.

Macrobenthic Group C – Only two stations fell into this group: ST10 and ST27 (average similarity 45.33). Key taxa in this group were the polychaetes *Sthenelais limicola* and *Nephtys cirrosa* and the amphipod *Bathyporeia gracilis* all together accounting for the 53 % of the total assemblage.

Macrobenthic Group D – five stations belonged to this group: ST26, ST37, ST41, ST42 and ST48 (average similarity 34.11). The taxa characterising this group were the polychaetes *Scalibregma inflatum, S. limicola, N. cirrosa* and *Scoloplos armiger*, all together accounting for 54 % of the total assemblage.

7.4.1. Biotope Assignment

For each of the four Macrobenthic Groups determined using cluster analysis, biotopes were assigned according to the JNCC classification tool (JNCC 2015) based upon their faunal and physical characteristics. Correlation of EUNIS/MNCR (Marine Nature Conservation Review) biotopes was undertaken using the JNCC correlation table (JNCC 2018).

Macrobenthic Group A - The biotope that most closely aligned with the community observed in this group was "A5.351 *Amphiura filiformis, Mysella bidentata* and *Abra nitida* in circalittoral sandy mud", which is consistent with the finer sediments recorded in at these locations characterised by notable mud contributions (Figure 9).

Macrobenthic Group B, **Macrobenthic Group C** and **Macrobenthic Group D** were characterised by the polychaetes *N. cirrosa, S. limicola, S. bombyx* and *S. armiger,* amphipods of the genus *Bathyporeia* with variable abundances of the bivalve *Abra alba*. The biotope that most closely aligned with this assemblage was "A5.252 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand", which is consistent with sediments being sandier at these locations compared the Macrobenthic Group A and representative of the textural groups Sand and Slightly Gravelly Sand.

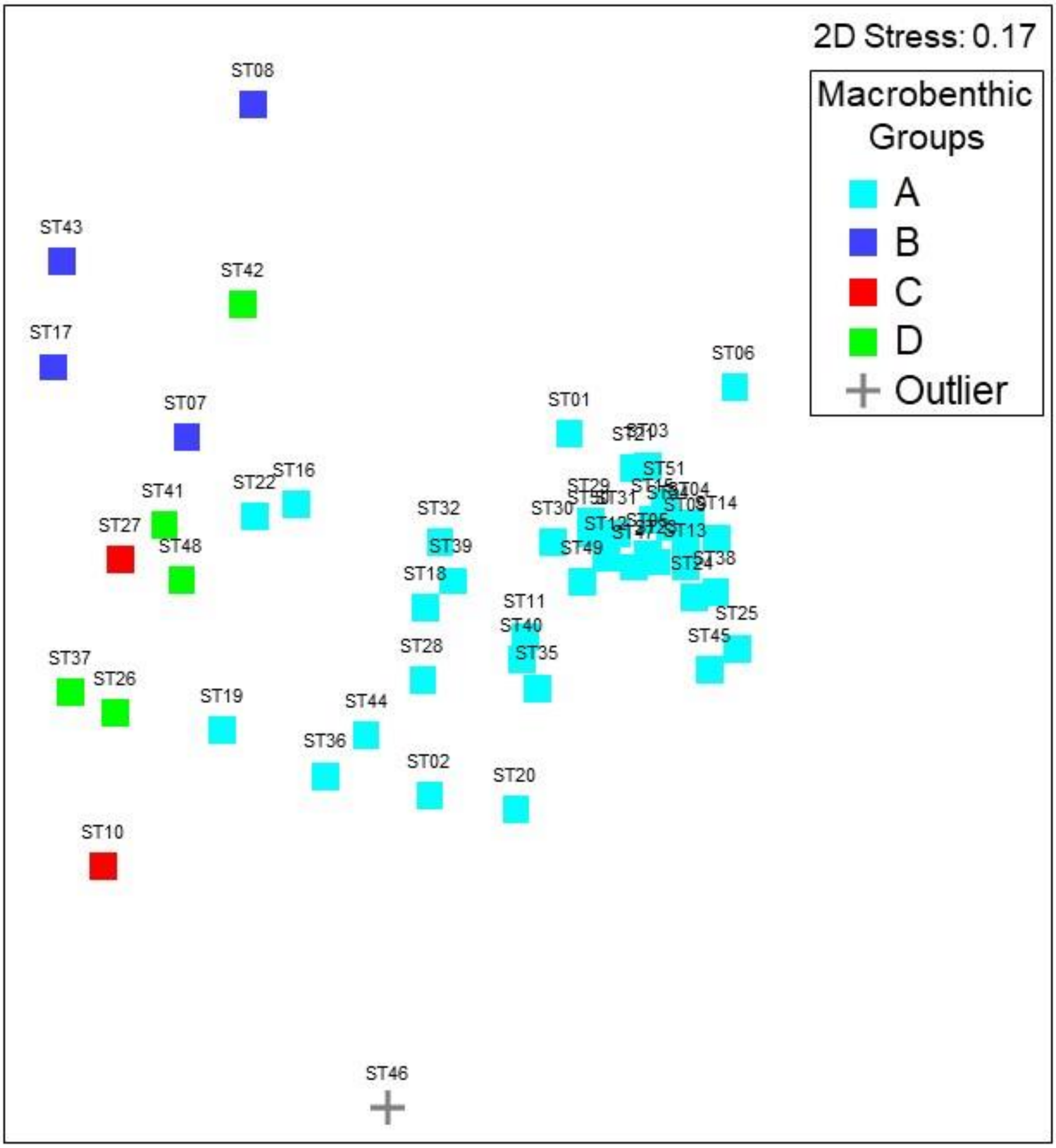


Figure 18 Two-dimensional nMDS ordination of macrobenthic communities sampled across the Morecambe OWF site, based on square root transformed and Bray-Curtis similarity abundance data. Macrobenthic Groups were identified at 31 % similarity.

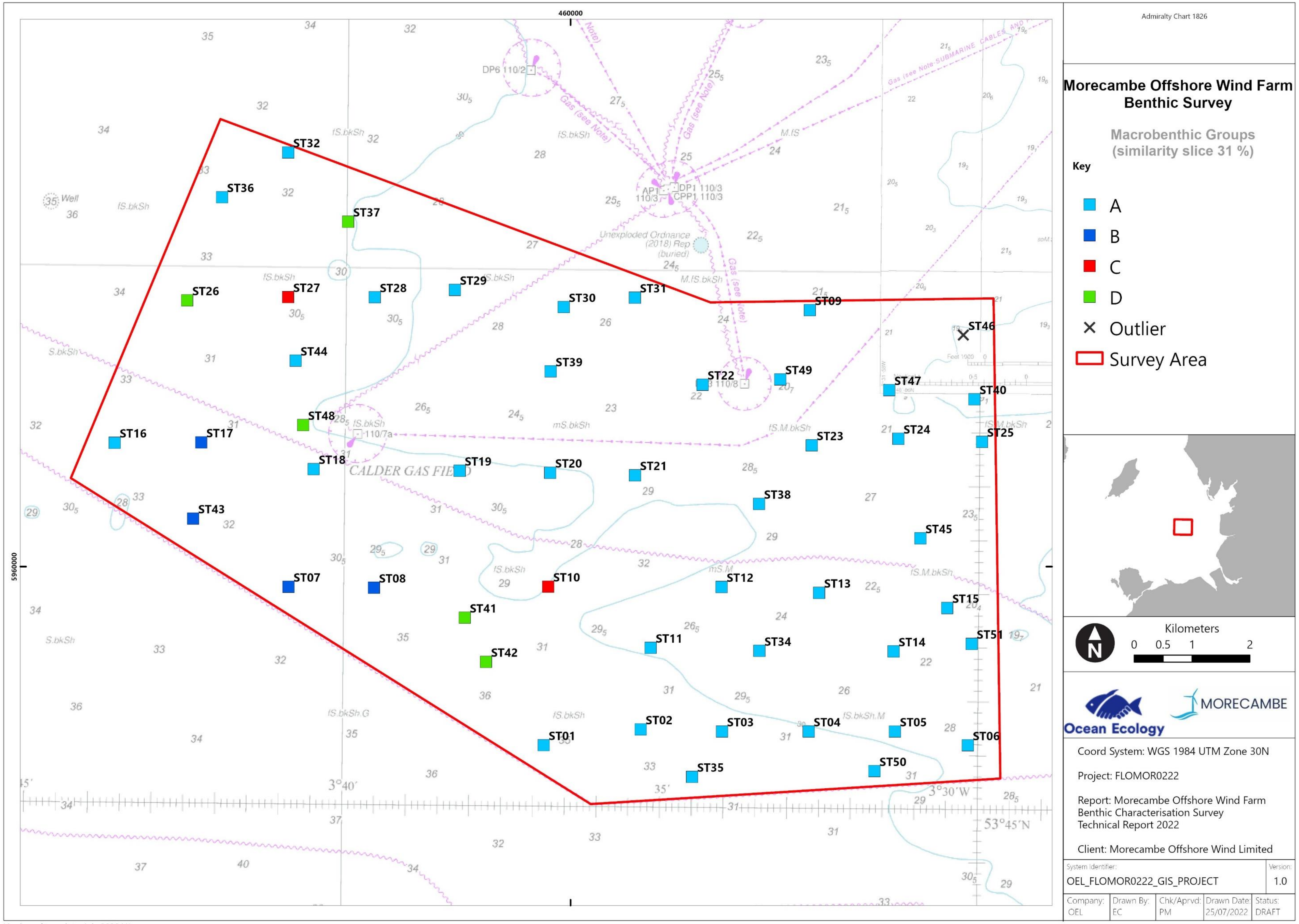


Figure 19 Spatial distribution of macrobenthic groups as determined from cluster analysis of abundance data.

7.5. Seabed Imagery

A total of 47 DDC stations and four DDC transects were sampled throughout the duration of the survey resulting in the collection of 404 still images. Of these, 18 were duplicates images, therefore a total of 386 images were analysed for this report.

The sampling logs for all seabed imagery collected during this survey are presented in Appendices XV and XVI. An overview of all EUNIS BSH and EUNIS level 4 categories identified is presented in Table 11. Example imagery of each EUNIS habitat encountered is presented in Plate 3.

Table 11 EUNIS classifications (both 2012 and 2022 codes) identified within the Morecambe Bay OWF Benthic Survey area.

EUNIS BSH (2012)	EUNIS Level 4 (2012)	EUNIS Description	EUNIS Code (2022)
A5.2 – Subtidal Sand	A5.25	Circalittoral fine sand	MC52
	A5.26	Circalittoral muddy sand	
A5.3 – Subtidal Mud	A5.35	Circalittoral sandy mud	MC62
A5.4 – Subtidal Mixed Sediment	A5.44	Circalittoral mixed sediments	MC42

Four EUNIS habitat types were encountered across the windfarm site: A5.25 'Circalittoral fine sand'; A5.26 'Circalittoral muddy sand'; A5.35 'Circalittoral sandy mud'; and A5.44 'Circalittoral mixed sediment' (Table 11). A5.26 was the most frequently encountered habitat type, having been assigned to 265 of the 386 analysed images. A5.25 was identified in 63 images, A5.44 in 47 images and A.35 in 11 images. The spatial distribution of habitat types within the windfarm site is presented in Figure 20. Areas to the west of the windfarm site were found to be dominated by circalittoral fine sands (A5.25), with circalittoral muddy sand (A5.26) dominating the majority of the windfarm site. Circalittoral sandy muds (A5.35) and circalittoral mixed sediments (A5.44) were largely interspersed within large areas of circalittoral muddy sand (A5.26), with the exception of transects 01 and 04 where there was a prevalence of the circalittoral mixed sediment (A5.44) habitat.

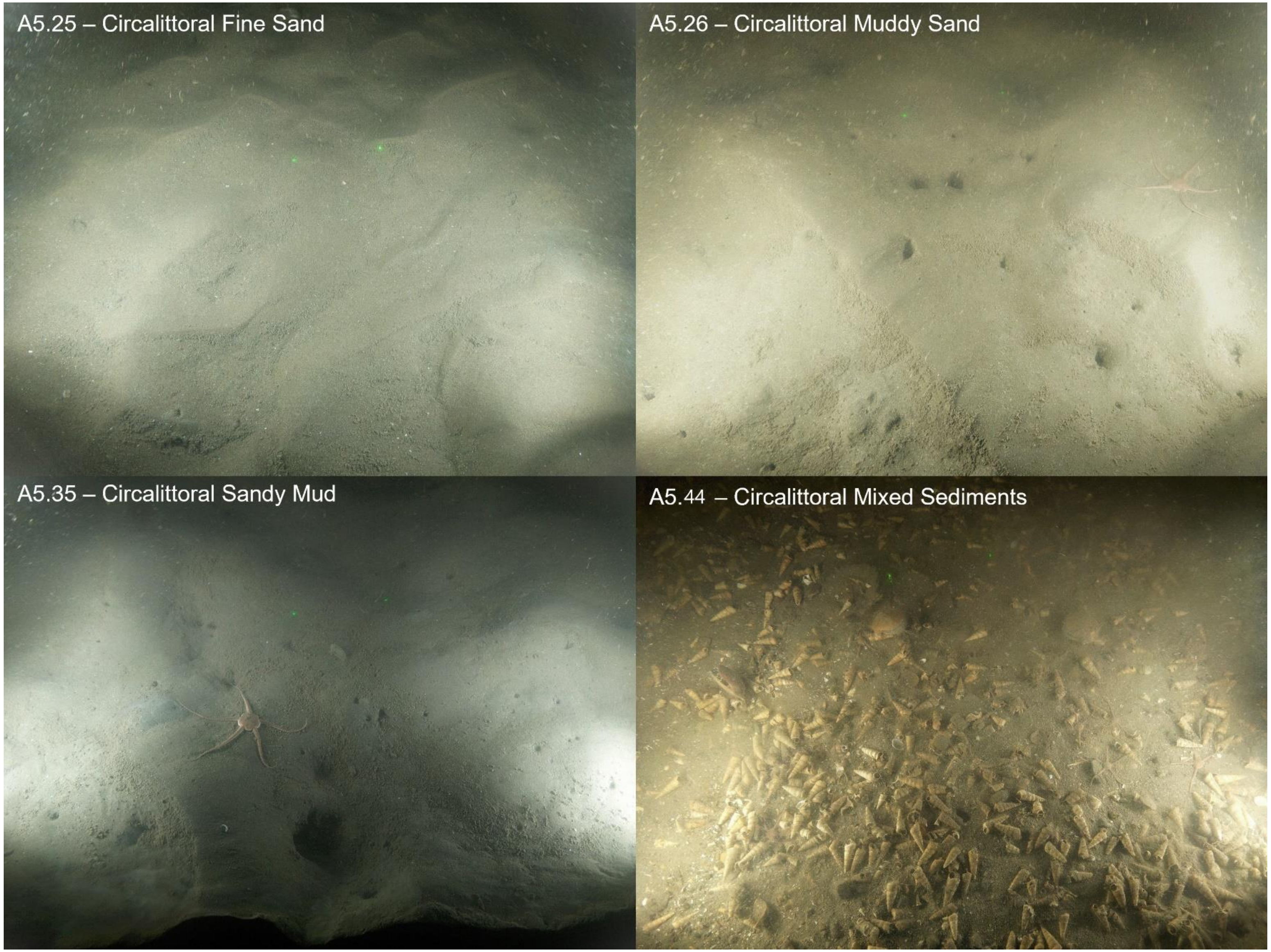


Plate 3 Example imagery of EUNIS classifications identified within the Morecambe OWF site..

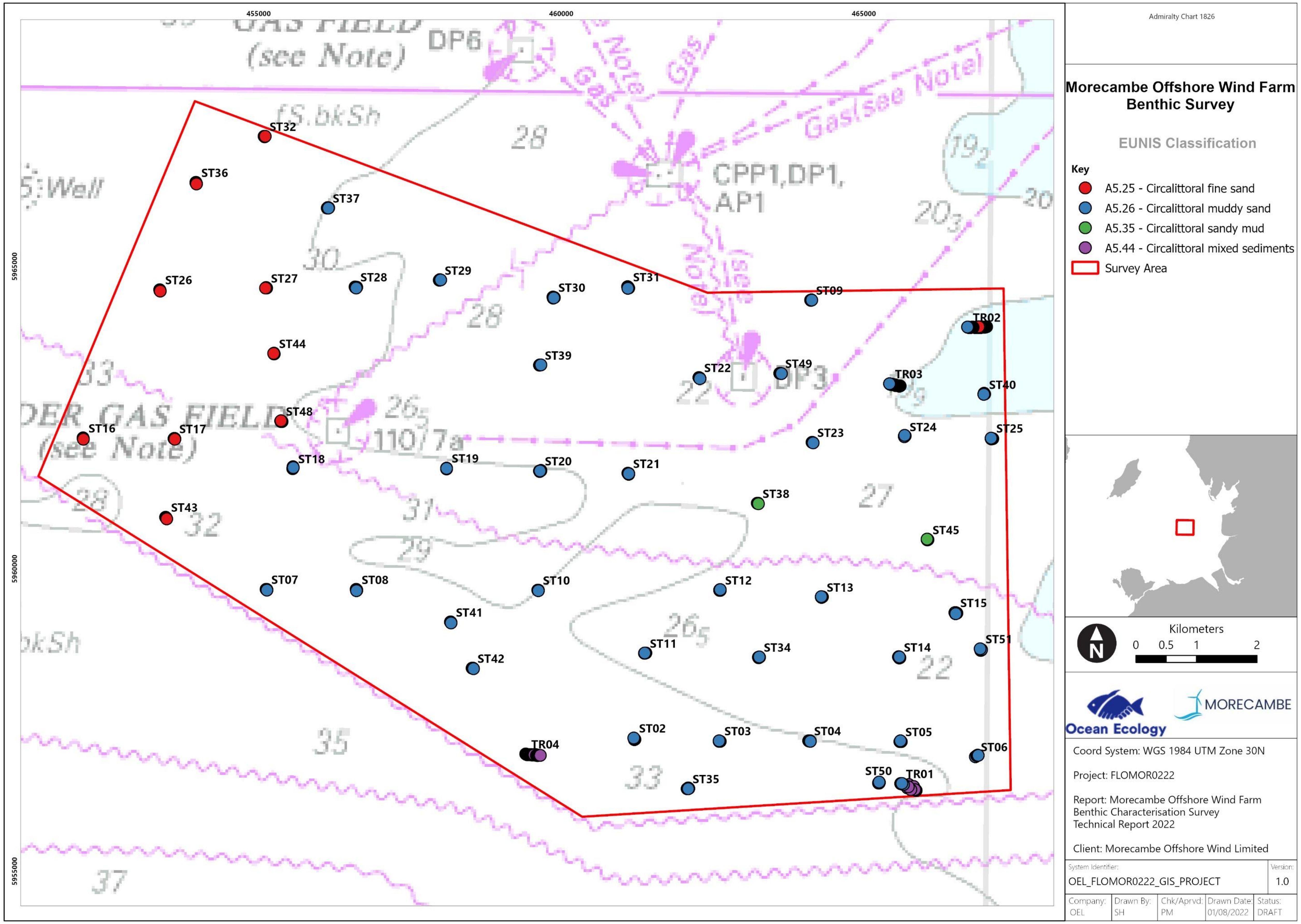


Figure 20 EUNIS habitats encountered across the Morecambe OWF site .

7.6. Habitats of Conservation Value

Areas of burrowed mud were identified across the windfarm site within areas of EUNIS habitat A5.26 'Circalittoral muddy sand'. Areas where megafaunal burrows were present matched the criteria required to be classified as the OSPAR/FOCI habitat 'Sea-pens and burrowing megafauna'. Whilst no sea-pens were identified in DDC imagery collected, the presence of sea-pens is not required to meet this habitat classification based on JNCC's interpretation of the OSPAR habitat definition (Robson 2014). Two individuals of the burrowing crab *Corystes cassivelaunus* were identified in DDC imagery, one from ST02 and one from ST30. The spatial distribution of megafaunal burrow density and burrowing megafauna is presented in Figure 21. A maximum average density of 43 m^2 of megafaunal burrows was recorded at ST24, with a minimum of 8 m^2 recorded at ST25. No clear pattern in the distribution of burrow density was identified in the data, with areas of higher and lower burrow density interspersed throughout the windfarm site. A full sea-pen and burrowing megafauna (SPBM) assessment can be found in Appendix XVII.

No areas of potential Annex I reef were identified in DDC imagery and therefore no formal reef assessments were conducted.

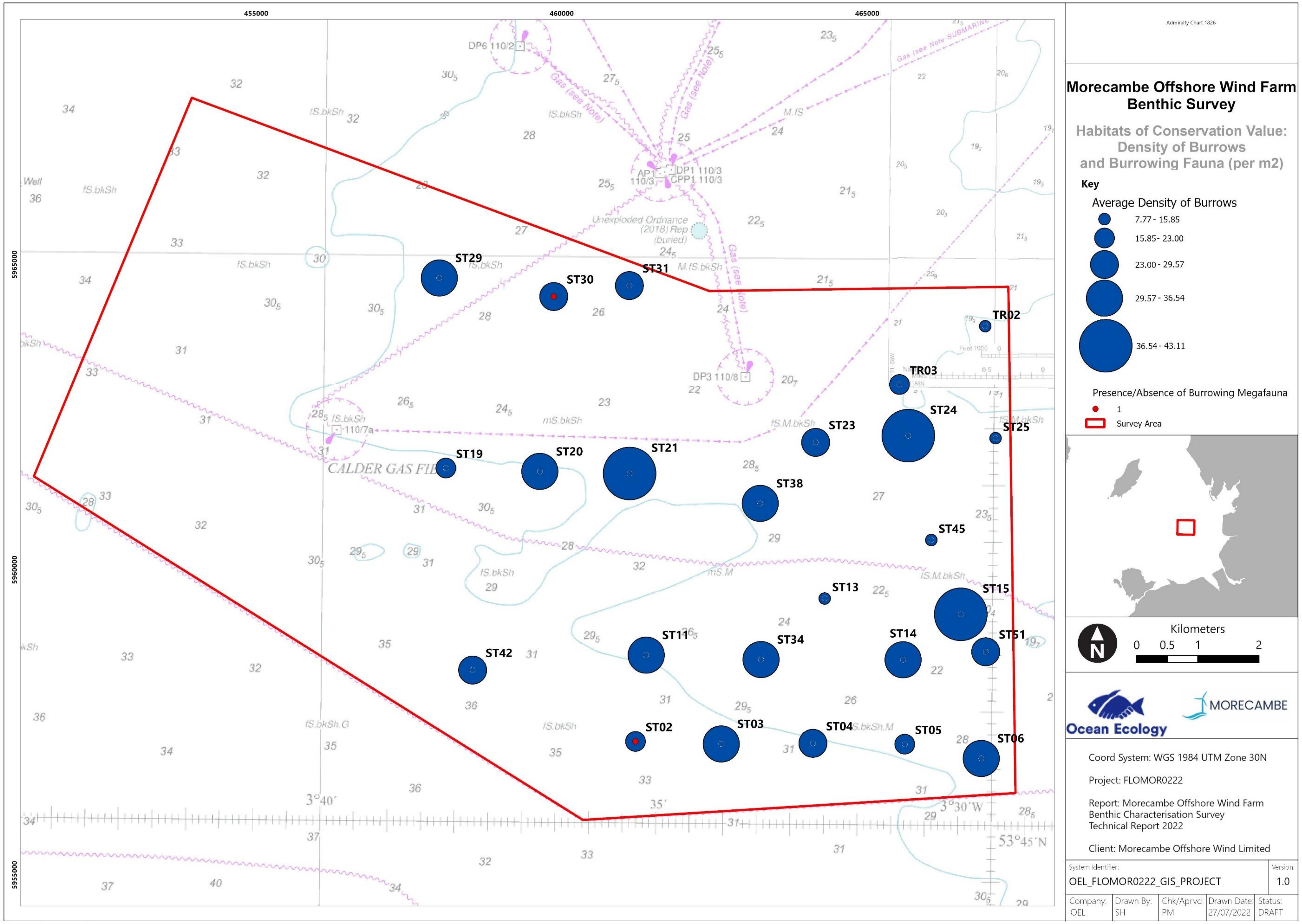


Figure 21 Density of burrows (per m²) and abundance of burrowing megafauna across the Morecambe OWF site.

7.7. Habitat/Biotope Mapping

To map the principal habitats that occurred throughout the Morecambe OWF site, a full interrogation of available geophysical data in combination with grab sample data (PSD and macrobenthos) was undertaken. As the two habitats identified across the windfarm site consisted of soft sediments, A5.25 and A5.35, seabed imagery was only used to corroborate PSD and macrobenthic data as it is limited in discriminating between soft substrates (i.e., habitats A5.25 and A5.26 look very similar in seabed imagery). Similarly, the acoustic data did not indicate any major anomalies between these two soft substrates which in turn hindered the delineation of polygons on the map as confidence in assessing their boundaries was low. Nevertheless, PSD and macrobenthic data clearly indicated the presence of two biotopes across the windfarm site: A5.252 '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' in the middle and to the east of the windfarm site and A5.351 '*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud' to the west of the windfarm site as illustrated in Figure 22. Keeping into account the low confidence associated to the polygons encompassing the biotopes observed across the Morecambe OWF site, the area covered by A5.252 was estimated to be 21.38 km^2 in total, while the area covered by A5.351 was estimated at 107.21 km^2 in total (Figure 23).

Rationale for the designated biotopes is provided in Appendix XVIII.

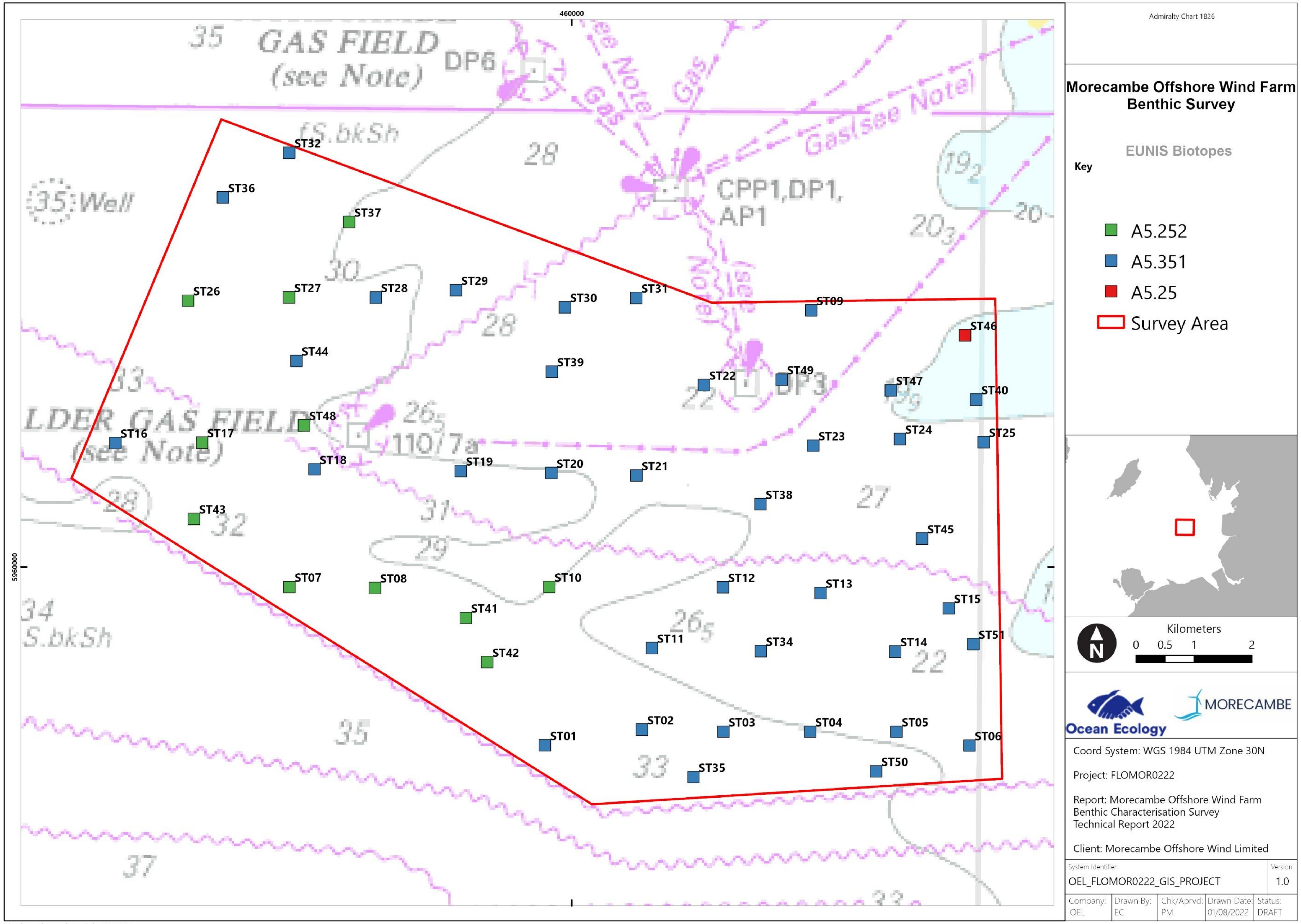


Figure 22 EUNIS Biotopes as determined from interrogation of sediment and macrobenthic data.

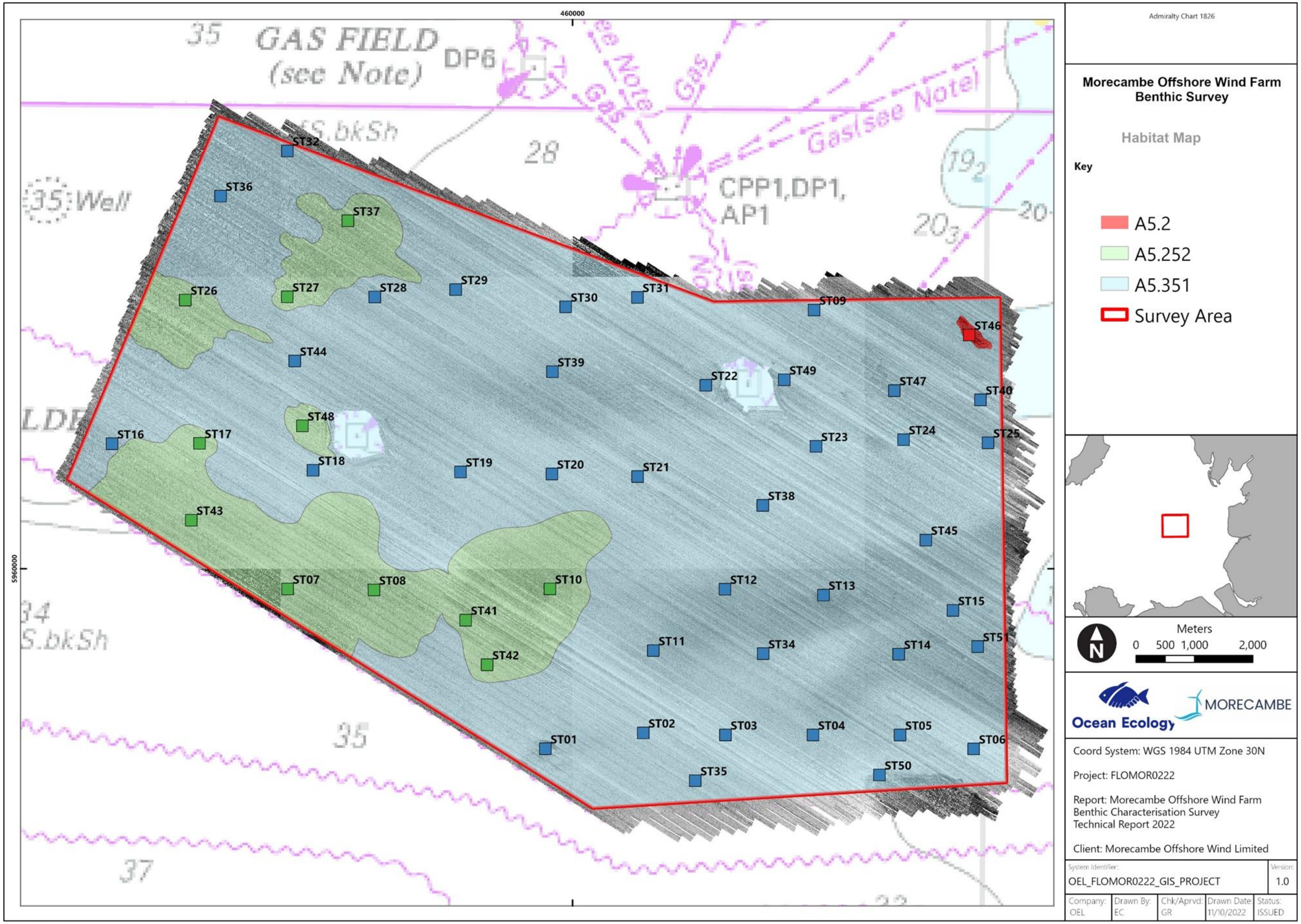


Figure 23 Habitat map based on the interrogation of all available data.

8. Discussion

This report presents the results of the macrobenthic and sediment analysis with the aim to set out the environmental baseline conditions across the proposed Morecambe OWF site to inform final engineering design and the installation process of the proposed windfarm as well as providing a robust dataset for future comparison if required.

8.1. Sediments

Some variation in sediment types was observed across the windfarm site; however, most stations were dominated by sand (Figure 8). Mud content was higher in the middle and to the east of the windfarm site, while gravel content was higher (albeit it low) moving offshore and to the west of the windfarm site. This was reflected in the Textural Groups recorded across the windfarm site with muddier stations classified as Muddy Sand and coarser stations classified as Sand and Slightly Gravelly Sand. These types of sediment are among the most common habitats found in subtidal settings across the UK coast and fall in the list of habitats of principal importance under Section 7 of the Environment (Wales) Act 2016 'Subtidal sands and gravels' and 'Subtidal mixed muddy sediments' and under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 as 'Subtidal sands and gravels' and 'Mud habitats in deep water.

No pattern was observed between stations with higher mud (> 20 %) and TOM content despite studies based on the coastal ocean and marine environment having found a positive relationship between organic matter content and proportions of finer sediment grain size (Winterwerp & van Kesteren 2004, McBreen et al. 2008, Hunt et al. 2020). Relatively high TOC and TOM content was observed at stations located to the east of the windfarm site, closer to land. This could suggest runoff from land as a potential source of the organic matter found at these locations. Average TOC compares well with global sediment average TOC content for the deep ocean (0.5 %) (Seiter et al. 2004).

Several guidelines exist to assess the degree of contamination and likely ecological impacts of contaminants in marine sediments. These regulations defined the levels below which effects are of no concern and/or rarely occur (AL1, BAC, TEL) and the levels above which adverse biological effects are considerable and/or occur frequently (AL2, ERL, PEL). *Ad hoc* decisions need to be made when contaminant concentrations fall between these levels. To note that Cefas ALs1 are typically the most conservative measures to assess sediment contamination and often result in "false positives" meaning that non-toxic sediment samples fail to pass this screening test. Conversely, ALs2 tend to be rather permissive allowing samples with relatively high contaminant concentrations to fall between AL1 and AL2 and thus requiring expert judgment to further assess their potential toxicity (MMO 2015, Mason et al. 2020). Recent studies have been revising these ALs with the goal of reducing the range of concentrations falling between AL1 and AL2 and minimise the number of samples requiring an *ad hoc* treatment; however, no policy has been made yet based on these recommendations and suggestions (MMO 2015, Mason et al. 2020).

Trace and heavy metal concentrations were overall low across the windfarm site with none of the metals analysed exceeding any of the reference level. In general metal concentrations were relatively higher to the east, closer to land than stations located further offshore, as seen for TOC and TOM. As was an exception to this trend as it exceeded the TEL at three stations ST01, ST26 and ST42 all located to the west of the windfarm site (Figure 12). However, As concentrations never exceeded Cefas AL1 which is the national reference level. As concentrations exceeding the TEL has possibly to do with the TEL being based on North American data and as such it may not be representative of UK conditions (Section 6.2.2) (MMO 2015, Mason et al. 2020). In comparison OSPAR BAC and Cefas ALs are based on UK data and therefore are more suitable for the current assessment. No pattern emerged when comparing stations with elevated As concentrations with the correspondent TOC, TOM and mud content, which could have been related to transportation and deposition of As across the windfarm site. Elevated metal sediment concentrations do not necessarily imply toxicity to benthic communities (Rees et al. 2007) as the bioavailability of these metals is more important than simply concentration levels. Despite the elevated As levels at these three stations, no macrobenthic anomalies were identified at these locations to suggest any adverse effects were present.

Among all PAHs, Naphthalene, Pyrene, Anthracene and Benzo[a]anthracene were the ones found to exceed BAC reference levels at 5 to 6 stations (Table 10). None of the other reference levels was exceeded by any of the analysed PAHs. Stations with elevated PAHs concentrations also had relatively high TOC, TOM and metals concentrations which could be related to transportation and deposition across the windfarm site; however, no macrobenthic anomalies were identified at these locations to suggest any adverse effects were present. When assessing the origin source of PAH compounds in sediments, the ratio between LMW and HMW PAHs was found to be lower than 1 at all stations indicating a pyrogenic origin, similarly the Ph/Ant ratio was lower than 10 at all stations also indicating a pyrogenic source of PAHs (Figure 14). PAHs of pyrogenic origin can derive from various activities which ultimately involve the combustion of organic substances at high temperatures under low oxygen conditions. These may include incomplete combustion of motor fuels, or products derived from the foundry and steel industries. In contrast the Fl/Py ratio indicated a petrogenic source of PAHs at most stations (Figure 14). Petrogenic PAHs typically include crude oil and refined crude oil products such as gasoline, heating oil, asphalt, and coal. It is not uncommon to find a mixture of petrogenic and pyrogenic PAHs sources in marine sediment (EPRI 2008, Aly Salem et al. 2014).

As already seen for TOC, TOM, metals and PAHs, also THC was higher to the east of the windfarm site, closer to land than stations located further offshore (Figure 14), suggesting that the proximity to urban settings can result in additional sources of contaminants that can potentially become stored in coastal sediments. No macrobenthic anomalies were identified at locations with high THC suggesting no adverse effects were present.

Comparison between the concentrations of determinands measured in the sediments of the Liverpool Bay as part of the OSPAR "Levels and trends in marine contaminants and their biological effects monitoring programme" (OSPAR 2020) to those across the windfarm site showed that concentrations were consistently lower across the windfarm site than those recorded in the Liverpool Bay (Table 12).

Table 12 Comparison of mean concentrations of key metals (mgkg^{-1}) and PAHs (μgkg^{-1}) sampled across the Morecambe OWF site with previous records from (OSPAR 2020).

Analyte	Liverpool Bay (OSPAR)	Morecambe OWF site
As (mg kg^{-1})	18.92	6.14
Naphthalene (μg kg^{-1})	35.25	5.56
Pyrene (μg kg^{-1})	60.25	14.27
Anthracene (μg kg^{-1})	8.15	3.39
Benzo[a]anthracene (μg kg^{-1})	47.69	8.05

8.2. Macrobenthos

The macrobenthic assemblage identified across the Morecambe OWF site was made up of a total of 8,127 individuals and 189 different taxa. However, most stations were characterised by the presence of *K. bidentata* which occurred in 88 % of samples. Other key taxa included the brittle star A*mphiura filiformis*, the polychaetes *Sthenelais limicola* and *Scalibregma inflatum* (Figure 15).

Macrobenthic communities can be highly heterogenous as they are heavily influenced by ambient environmental conditions such as sediment composition (Cooper et al. 2011), hydrodynamic forces and physical disturbance (Hall 1994), depth (Ellingsen 2002) and salinity (Thorson 1966). Macrobenthic abundance and diversity varied across the windfarm site however no obvious pattern was observed across stations (Figure 17). Conversely, the four Macrobenthic Groups identified by the multivariate cluster analysis (Section 7.4) did show a clear distinction between stations located in the middle and to the east of the windfarm site and stations located more offshore and to the west. Macrobenthic Group A covered most of the windfarm site and was characterised by high abundances of *K. bidentata* and *A. filiformis.* In contrast macrobenthic groups B, C and D were dominated by polychaetes and amphipods and covered the more offshore and western part of the windfarm site. Sediment composition is a key factor in determining macrobenthic community structure (Hall 1994, Cooper et al. 2011), itself defined by ambient conditions. This was clearly reflected in the Macrobenthic Groups detected across the windfarm site with Macrobenthic Group A indicating an affinity for muddier substrates compared to the other macrobenthic groups more typical of sandy substrates with little to no mud. Two biotopes were identified across the windfarm site based on a combination of macrobenthic and sediment data, these were "A5.351 *Amphiura filiformis, Mysella bidentata* and *Abra nitida* in circalittoral sandy mud" corresponding to the stations belonging to Macrobenthic Group A, and "A5.252 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand" including all other stations.

8.3. Seabed Imagery

Four EUNIS habitats were recorded across the Morecambe OWF site: A5.25, A5.26, A5.35, and A5.44 (Table 11). Whilst the BSHs of A5.2 and A5.3 are present in existing EMODnet predictive mapping (Figure 2), the level 4 EUNIS habitats predicted by EMODnet do not align well with the imagery collected in this survey (Figure 20). Circalittoral muddy sand (A5.26) was the dominant habitat type identified here across the majority of the windfarm site, with areas to the west dominated by circalittoral fine sand (A5.25). Isolated areas of the habitats circalittoral sandy mud (A5.35) and circalittoral mixed sediments (A5.44) were also identified.

8.4. Habitats of Conservation Value

JNCC's interpretation of the OSPAR habitat definition for 'sea-pens and burrowing megafauna', whereby no sea-pens need be present and that this habitat can be present in muddy sands (Robson 2014), means that large areas of the OSPAR/FOCI habitat 'Sea-pens and burrowing megafauna' were identified across the windfarm site within the EUNIS habitat A5.26. Sea-pens and burrowing megafauna is as priority habitat listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 as well as an MCZ FOCI. As there is currently no MPA designated within this area, there is no legislative protection afforded to the observed sea-pen and burrowing megafauna habitats observed within this survey. The identification of this habitat should, however, be acknowledged going forward.

No Annex I habitats were identified within the windfarm site.

8.5. Habitat/Biotope Mapping

PSD and macrobenthic data clearly indicated the presence of two biotopes across the windfarm site: A5.252 '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' in the middle and to the east of the windfarm site, and A5.351 '*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral sandy mud' to the west (Figure 22). Seabed imagery and acoustic data was used sparingly in the determination of these biotopes due to the similarity in the appearance of soft substrate habitats (i.e., A5.25 and A5.26) in these types of data. It follows that it is difficult to confidently identify strict boundaries between the two biotopes based on acoustic and imagery data, however a habitat map has been presented based on the interrogation of all available data and low confidence scores have been assigned to the polygons delineating each habitat/biotope to reflect these limitations.

9. References

Al-hejuje MM, Hussain NA, Al-saad HT (2015) Total Petroleum Hydrocarbons (TPHs) , n-alkanes and Polynuclear Aromatic Hydrocarbons (PAHs) in water of Shatt Al-Arab River – part 1. Global Journal of Biology, Agriculture and Health Sciences.

Aly Salem DMS, Morsy FAEM, El Nemr A, El-Sikaily A, Khaled A (2014) The monitoring and risk assessment of aliphatic and aromatic hydrocarbons in sediments of the Red Sea, Egypt. Egyptian Journal of Aquatic Research.

CCME (2001) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Environmental Protection.

Clarke KR, Gorley RN (2015) PRIMER v7: User Manual/Tutorial.

Clarke KR, Tweedley JR, Valesini FJ (2014) Simple shade plots aid better long-term choices of data pre-treatment in multivariate assemblage studies. Journal of the Marine Biological Association of the United Kingdom 94:1–16.

Cooper KM, Curtis M, Wan Hussin WMR, Barrio Froján CRS, Defew EC, Nye V, Paterson DM (2011) Implications of dredging induced changes in sediment particle size composition for the structure and function of marine benthic macrofaunal communities. Marine Pollution Bulletin 62:2087–2094.

DEFRA (2003) The use of Action Levels in the Assessment of Dredged Material Placement at Sea and in Estuarine Areas under FEPA (II), Final Project Report.

Edokpayi JN, Odiyo JO, Popoola OE, Msagati TAM (2016) Determination and distribution of polycyclic aromatic hydrocarbons in rivers, sediments and wastewater effluents in Vhembe District, South Africa. International Journal of Environmental Research and Public Health.

Eleftheriou A, Basford DJ (1989) The macrobenthic infauna of the offshore northern North Sea. Journal of the Marine Biological Association 69:123–143.

Ellingsen K (2002) Soft-sediment benthic biodiversity on the continental shelf in relation to environmental variability. Marine Ecology Progress Series 232:15–27.

EMODnet (2021) EMODnet Seabed Habitats - Homepage

EPRI (2008) Examination of the Sources of Polycyclic Aromatic Hydrocarbon (PAH) in Urban Background Soil. Palo Alto, CA.

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

Golding N, Albrecht J, McBreen F (2020) Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef. JNCC Report No 656.

Gubbay S (2007) Defining and managing Sabellaria spinulosa reefs: Report of an inter-agency workshop 1-2 May, 2007. JNCC Report No405 44:22.

Hall SJ (1994) Physical disturbance and marine benthic communities: life in unconsolidated sediments. Oceanograohy and Marine Biology: An Annual Review 32:179–239.

Hitchin R, Turner, Verling (2015) Epibiota Remote Monitoring from Digital Imagery: Operational Guidelines.

Holstein J (2018) Worms: Retriving Aphia Information from World Register of Marine Species. package ve.

Hunt C, Demšar U, Dove D, Smeaton C, Cooper R, Austin WEN (2020) Quantifying Marine Sedimentary Carbon: A New Spatial Analysis Approach Using Seafloor Acoustics, Imagery, and Ground-Truthing Data in Scotland. Frontiers in Marine Science.

Ines Z, Amina B, Mahmoud R, Dalila S-M (2013) Aliphatic and Aromatic Biomarkers for Petroleum Hydrocarbon Monitoring in Khniss Tunisian-Coast, (Mediterranean Sea). Procedia Environmental Sciences.

Irving R (2009) The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-27 March 2008. JNCC Rep No 432:44.

JNCC (2018) Marine habitat correlation tables version 201801

JNCC (2015) The Marine Habitat Classification for Britain and Ireland Version 15.03.

Jones R, Unsworth R, Hawes J, Griffin R (2021) Improving benthic biodiversity assessments in turbid aquatic environments. Aquatic Conservation: Marine and Freshwater Ecosystems 31:1379–1391.

Junttila J, Carroll J, Dijkstra N (2015) Variability of present and past PAH (Polyaromatic hydrocarbons) concentrations in sediments of the SW Barents Sea. Norsk Geologisk Tidsskrift.

Kafilzadeh F, Shiva AH, Malekpour R (2011) Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Water and Sediments of the Kor River, Iran. Middle-East Journal of Scientific Research.

Langenkämper D, Zurowietz M, Schoening T, Nattkemper TW (2017) BIIGLE 2.0 - Browsing and Annotating Large Marine Image Collections. Frontiers in Marine Science 4:83.

Mason C, Lonsdale J, Vivian C, Griffith A, Warford L (2020) Review of Action Levels used for assessing dredging and disposal marine licences.

McBreen F, Wilson JG, Mackie ASY, Nic Aonghusa C (2008) Seabed mapping in the southern Irish Sea: Predicting benthic biological communities based on sediment characteristics. In: *Hydrobiologia*.

MMO (2015) High Level Review of Current UK Action Level Guidance. A report produced for the Marine Management Organisation. MMO Project No: 1053.

Natural England (2021a) Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards - Phase I: Expectations for pre-application baseline data for designated nature conservation and landscape receptors to support offshore wind application.

Natural England (2021b) Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards - Phase I: Expectations for pre-application baseline data for designated nature conservation and landscape receptors to support offshore wind application.

NJDEP (2009) Ecological Screening Criteria (ESC).

Noble-James T, Jesus A, Fionnuala M (2018) Monitoring guidance for marine benthic habitats (Revised 2018).

OSPAR (2020) Levels and trends in marine contaminants and their biological effects – CEMP Assessment report 2019 – 2020.

OSPAR (2004) OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities - Reference number: 2004-11. 19.

OSPAR, Webster L, Fryer R, Davies I, Roose P, Moffat C (2009) Background Document on CEMP Assessment Criteria for QSR 2010. Monitoring and Assessment Series.

Page DS, Boehm PD, Douglas GS, Bence AE, Burns WA, Mankiewicz PJ (1999) Pyrogenic polycyclic aromatic hydrocarbons in sediments record past human activity: A case study in Prince William Sound, Alaska. Marine Pollution Bulletin.

Parry ME V (2019) Guidance on Assigning Benthic Biotopes using EUNIS or the Marine Habitat Classification of Britain and Ireland (Revised 2019).

R Core Team (2020) R: A Language and Environment for Statistical Computing.

Rees HL, Eggleton JD, Rachor E, Vanden Berghe E (2007) Structure and Dynamics of the North Sea Benthos. ICES Cooperative Research report no 288:258.

Robson L (2014) JNCC clarifications on the habitat definitions of two habitat Features of Conservation Importance: Mud habitats in deep water, and Sea-pen and burrowing megafauna communities.

Seiter K, Hensen C, Schröter J, Zabel M (2004) Organic carbon content in surface sediments - Defining regional provinces. Deep-Sea Research Part I: Oceanographic Research Papers.

Thorson G (1966) Some factors influencing the recruitment and establishment of marine benthic communities. Netherlands Journal of Sea Research.

Turner JA, Hitchin R, Verling E, van Rein H (2016) Epibiota remote monitoring from digital imagery: Interpretation guidelines.

Venkatesan MI (1988) Occurrence and possible sources of perylene in marine sediments-a review. Marine Chemistry.

Wentworth CK (1922) A scale of grade and class terms for clastic sediments. J Geol 30:377–392.

Winterwerp JC, van Kesteren WGM (2004) Introduction to the Physics of Cohesive Sediment Dynamics in the Marine Environment.

Worsfold T, Hall D (2010a) Guidelines for processing marine macrobenthic invertebrate samples: a Processing Requirements Protocol.

Worsfold T, Hall D (2010b) National Marine Biological Analytical Quality Control Scheme Guidelines for processing marine macrobenthic invertebrate samples: a Processing Requirements Protocol.

Appendix I - Project Execution Plan

Ocean Ecology

Marine Surveys, Analysis & Consultancy

Morecambe Offshore Wind Farm

Project Execution Plan

REF: OEL_FLOMOR0222_PEP_V02

T: +44 (0) 1452 740697 E: info@ocean-ecology.com W: www.ocean-ecology.com Tw: @Ocean_Ecology

Details

Version	Date	Description	Author(s)	Reviewed By
01	20/04/2022	Draft	Gary Robinson	Elena Lo Giudice Cappelli
02	22/04/2022	Revised following client review	-	Gary Robinson
03	16/05/2022	Revised following NE comments	-	Ross Griffin

Updates

Section	Description	Page
1.3	Reference to NE best practice guidelines now included	8
1.3	Figure 1 updated – indicative turbine locations removed	9
4.2	Figure 2 updated – indicative turbine locations removed	13
4.2	Figure 3 updated – indicative turbine locations removed	14
4.3	Additional detail relating to geophysical interpretation and spatial layout of sampling array included	15
4.3	Table 1 updated to reflect updated sampling plan	15
4.3	Table 2 updated to reflect updated sampling plan	16
4.4	Table 2 updated to reflect TR04 relocated to BSH A5.2 / A5.1	16
4.5	Figure 4 updated to reflect updated sampling plan	18
4.5	Figure 5 updated to reflect updated sampling plan	19
5.3.1	Additional text on combined DDC and grab locations	21
5.4	Clarification detail provided on MMO validated methods and determinands for testing.	23-24
6.3.1 / 6.3.2	Addition of text relating to INNS now added	31 / 32
6.4.2	Table 12 – added detail on technical reporting	33
1.3	Update to reference to NE best practice guidance	8
4.1	Inclusion of reference to NE best practice guidance	12
6.4.2	Inclusion of reference to NE best practice guidance	34

Contents

List of Figures

List of Tables

List of Plates

Abbreviations

BIIGLE	Bio-Image Indexing and Graphical Labelling Environment
BSH	Broadscale Habitat
DDC	Drop-Down Camera
dGPS	Differential Global Positioning System
ECR	Export Cable Route
EUNIS	European Nature Information System
FOCI	Feature of Conservation Importance
GPS	Global Positioning System
HA	Habitat Assessment
HD	High Definition
HOCI	Habitat of Conservation Importance
INNS	Invasive Non-Native Species
JNCC	Joint Nature Conservation Committee
KP	Kilometre Point
LED	Light-Emitting Diode
MBES	Multibeam Echosounder
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MOWF	Morecambe Offshore Windfarm
MP	Megapixel
MSFD	Marine Strategy Framework Directive
MW	Megawatt
NE	Natural England
NMBAQC	NE Atlantic Marine Biological Analytical Quality Control
OEL	Ocean Ecology Ltd
OWF	Offshore Windfarm
PEP	Project Execution Plan
PSD	Particle Size Distribution
QAF	Quality Assurance Framework
RAMS	Risk Assessment Method Statement
SAC	Special Area of Conservation
SBAS	Satellite-based Augmentation System
SoW	Scope of Work
SPA	Special Protection Area
SSS	Side-Scan Sonar
UPS	Uninterruptable Power Supply
USBL	Ultra-Short Baseline
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
WTG	Wind Turbine Generator

1. Introduction

1.1. Project Overview

Morecambe Offshore Windfarm (MOWF) is a proposed offshore windfarm (OWF) located in the Irish Sea (Figure 1) with an expected nominal capacity of 480 megawatts (MW). The Project is being developed by Offshore Wind Ltd: a joint venture between Cobra Instalaciones y Servicios, S.A., and Flotation Energy plc. The Morecambe OWF site is located in the Northeast Irish Sea with water depths in the array area ranging between 20 and 35 m.

There is a requirement for baseline information on the sediment quality, environment and benthic habitats from within the proposed wind farm site and Floatation Energy have contracted OEL to undertake a benthic characterisation survey of the site. The key focus of the benthic characterisation survey will be to provide accurate ground truthing to the geophysical data using a Drop-Down Camera (DDC) and sediment grab sampling and to form a baseline for future monitoring of the survey area upon which any changes to the sediment characteristics, macrobenthic communities and seabed physico-chemical properties can be monitored.

1.2. Site Information

1.2.1. Site Location

The MOWF site is located in the Northeast Irish Sea, approximately 20 nautical miles due East of Blackpool on the North West coast of England. There is no Export Cable Route (ECR) currently proposed for the development and therefore all survey works are located within the consented array boundary.

Water depths in the array area range between 20 and 35 m.

1.2.2. Designated Sites

The MOWF site is located to the immediate west of the Liverpool Bay / Bae Lerpwl Special Protection Area (SPA) with its northern and eastern boundaries adjoining but not intersecting that of the SPA (Figure 1). Liverpool Bay / Bae Lerpwl SPA is in the east of the Irish Sea, bordering the coastlines of north-west England and north Wales. The boundary of Liverpool Bay / Bae Lerpwl SPA extends beyond 12 nautical miles and therefore lies partly in Welsh and English territorial waters and partly in offshore waters.

It is classified for the protection of red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra*), and little gull (*Hydrocoloeus minutus*) in the non-breeding season; common tern (*Sterna hirundo*) and little tern (*Sterna albifrons*) in the breeding season, and as an internationally important waterbird assemblage.

Further to the east of the survey area are the Fylde Marine Conservation Zone (MCZ), the Shell Flat and Lune Deep Special Area of Conservation (SAC) (Figure 1).

1.3. Document Overview

This document sets out the Project Execution Plan (PEP) for an offshore environmental camera and benthic grab survey to be undertaken in May 2022 by Ocean Ecology Limited (OEL) onboard their dedicated survey vessel, *Seren Las* as part of the wider pre-construction site characterisation programme.

This PEP has been produced to ensure that this characterisation benthic survey is aligned to Natural England's (NE) "Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards" (Natural England 2021a b).

The objective of this PEP is to detail the following aspects of the project:

- Scope of Work (SoW)
- Sampling Plan
- Project Plan of Work (Timeline)
- Equipment and Vessel summary
- Project personnel summary
- Processing and Reporting deliverables
- Quality processes and procedures relevant to this work scope

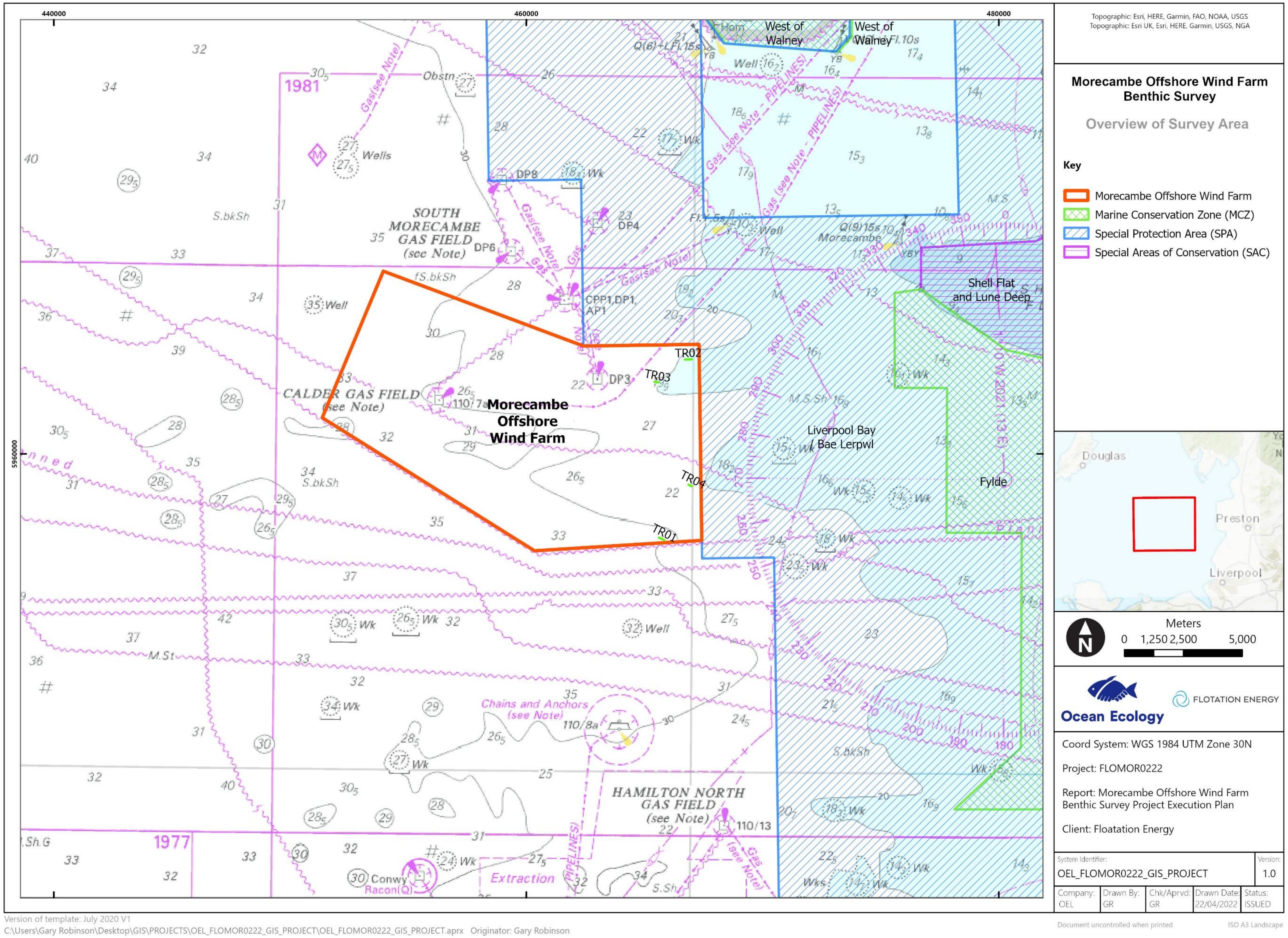


Figure 1 The location and project layout of the MOWF in the Northeast Irish Sea.

2. Health and Safety

2.1. Risk Assessment

A project specific Risk Assessment Method Statement (RAMS) (OEL_HSE_RAM_FLOMOR0222_V01) has been produced and will be reviewed on-board and adjusted as appropriate during mobilisation. All personnel joining the project must read, understand and sign this document prior to sailing.

2.2. Health, Safety and Environmental Plan

A project specific Health, Safety & Environment Plan (OEL_HSE_HSP_FLOMOR0222_V01) including Emergency Response Procedures has been produced and will be reviewed on-board and adjusted as appropriate during mobilisation. All personnel joining the project must read, understand and sign this document prior to sailing.

2.3. Hazard Identification and Risk Assessment

A Hazard Identification and Risk Assessment meeting is scheduled on Friday 29th April prior to environmental operations commencing. This meeting will aim to discuss the presented RAMS (OEL_HSE_RAM_FLOMOR0222_V01) for the environmental SoW and ensure that all potential hazards are both identified, and suitably and sufficiently mitigated.

3. Overview of Scope

3.1. Overview

The benthic survey will collect benthic grab samples for subsequent macrobenthic and Particle Size Distribution (PSD) analyses at a total of 50 sampling stations across the proposed array area, while contaminant analysis will be done on a subset of 20 stations. Seabed imagery will be collected with a Drop-Down Camera (DDC) system at each of the 50 grab sampling stations prior to grab deployment to ensure the target location is clear of any obstructions or protected habitats (e.g., Annex I).

In addition, seabed imagery will be collected along three DDC transects which have been located over features of interest within the array area to aid in the description of the seabed, identify Annex I habitats, archaeological finds and ground truth the geophysical data collected through November and December 2021.

3.2. Outline of Scope

The benthic survey design includes the following:

- 50 stations to be sampled with a 0.1 m^2 grab sampler with prior investigation by DDC. Samples collected are to be suitable for PSD and macrobenthic analyses. Only single PSD and faunal samples are required from each site
- Contaminant samples to be taken at up to 20 of the sampling locations.
- DDC deployments will be undertaken at each grab location.
- Three DDC transects across the site to ground truth geophysical data and identify any features of interest

3.3. Outline of Methods

Detailed method statements for both camera and grab operations including sampling, processing, analysis and reporting are provided in Sections 5 and 6 of this PEP.

4. Sampling Plan

4.1. Overview

The benthic sampling plan has been developed in line with Phase I of Natural England's "Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards" (Natural England 2021a) to provide maximum geographic coverage of the proposed survey area, whilst also ensuring that all key habitats and communities likely to be encountered across the survey area are adequately targeted. The key principles underpinning the survey design were therefore to:

- Provide adequate spatial coverage of the array area;
- Ensure representative sampling of all main sediment types is undertaken; and
- Ensure representative examples of all potential features of conservation interest (e.g., Annex I reefs) are adequately ground-truthed.

4.2. Sampling Plan Procedure

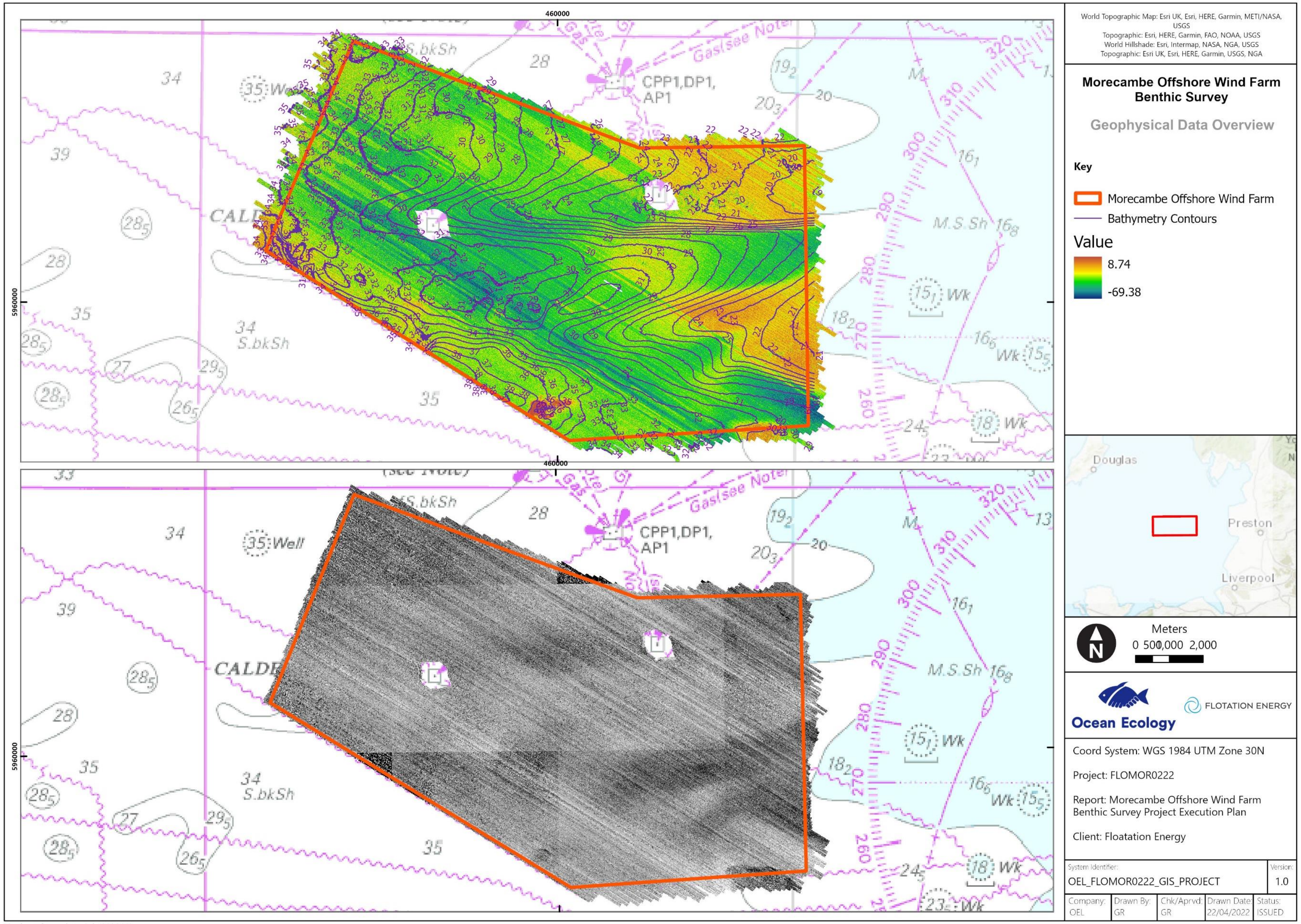
The sampling plan was produced based on a stratified sampling approach across the proposed MOWF array area with micrositing of sampling stations informed by a detailed review and interpretation of the outputs of the 2021 geophysical campaign and consideration for all surface, subsurface and subsea hazards and their respective exclusion / buffer zones.

The following components, provided by the client Floatation Energy, were assessed in the development of the sampling plan:

- 2021 geophysical campaign processed multibeam echosounder (MBES) bathymetry and side scan sonar (SSS) imagery in mosaiced geotiff format (Figure 2);
- 2021 geophysical campaign processed magnetometer and SSS feature analysis to identify potential subsea hazards and Unexploded Ordnance (UXO) (Figure 3);
- Interpreted seabed classification from 2021 geophysical campaign (Figure 3);
- All available GIS shapefiles and rasters in ESRI format including: scoping boundaries and design of the Wind Turbine Generator (WTG) locations for the array, planned and existing infrastructure to include all oil and gas surface and subsurface infrastructure within the MOWF boundary or within close proximity to it; the latest relevant Marine Protected Area (MPA) boundaries, admiralty charts for the survey area (if available);
- All previous survey and/or technical reports available for the area.

The sampling plan consists of two elements: DDC and grab sampling locations, and DDC Transects. Details on each is provided in Sections 4.3 and 4.4 below. A detailed sampling plan is provided in Appendix 1 and sampling plan shapefiles are provided in Appendix 2.

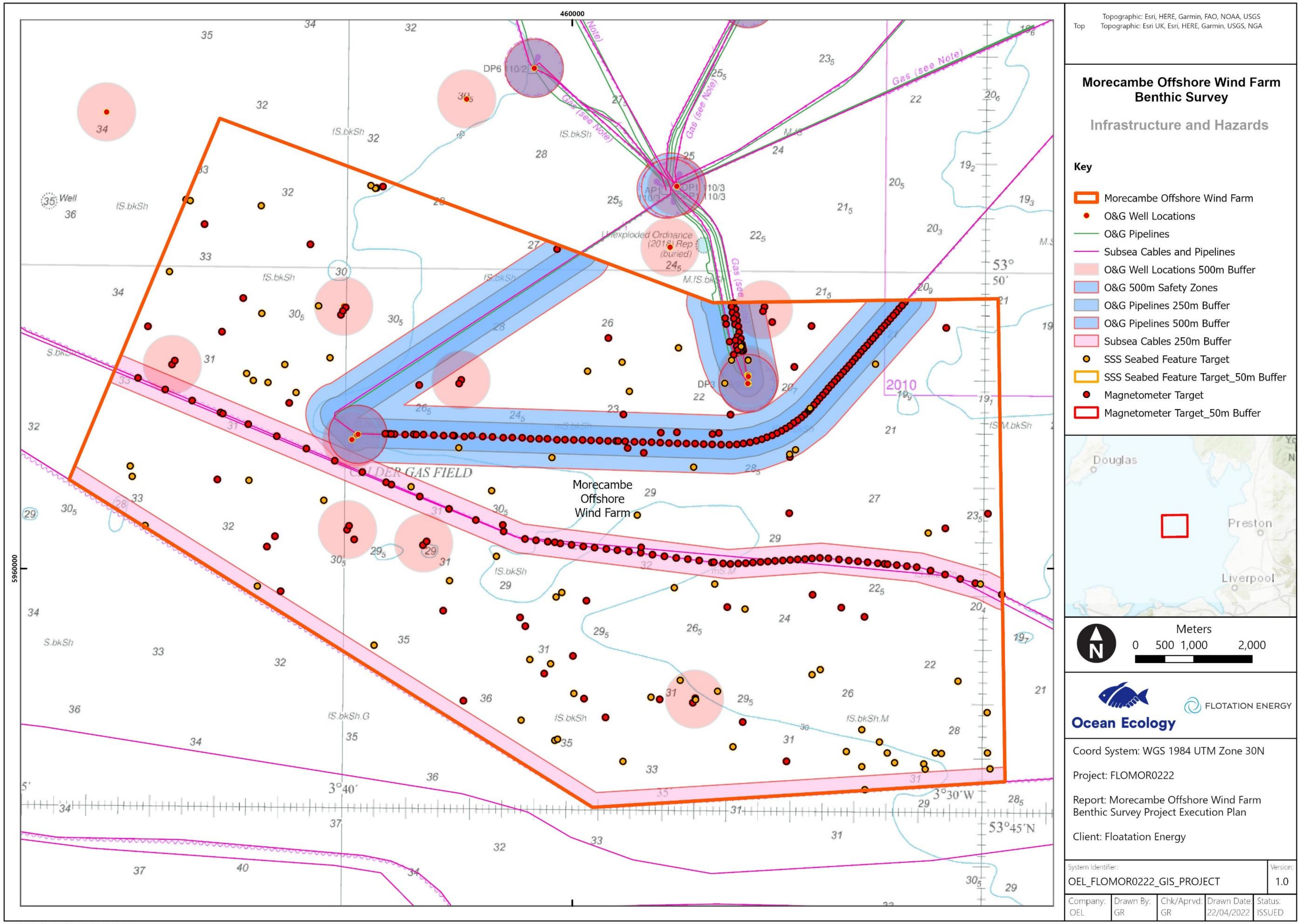
An overview of the proposed sampling stations is also presented spatially in Figure 4 and Figure 5.



Version of template: July 2020 V1
C:\Users\Gary Robinson\Desktop\GIS\PROJECTS\OEL_FLOMOR0222_GIS_PROJECT\OEL_FLOMOR0222_GIS_PROJECT.aprx Originator: Gary Robinson

Document uncontrolled when printed ISO A3 Landscape

Figure 2 Overview of the MOWF site, results of 2021 geophysical survey campaign (MBES and SSS) used to inform spatial distribution of sampling locations and identify features of interest for investigation with DDC Transects.



Version of template: July 2020 V1
C:\Users\Gary Robinson\Desktop\GIS\PROJECTS\OEL_FLOMOR0222_GIS_PROJECT\OEL_FLOMOR0222_GIS_PROJECT.aprx Originator: Gary Robinson

Document uncontrolled when printed ISO A3 Landscape

Figure 3 Overview of the MOWF site and associated surface and sub-surface hazards used to microsite sampling locations.

4.3. Drop Down Camera and Grab Locations

There are up to 50 stations to be sampled with a 0.1 m^2 grab sampler with prior investigation by DDC across the MOWF array area.

The sampling plan was developed to ensure sampling is representative of the varying depths and habitats across the array area in a stratified design whilst also considering the surface and subsurface infrastructures and hazards, design WTG locations and any other notable features identified from the geophysical data review (e.g., areas of seabed scouring and trawl marks).

The DDC investigation prior to grab sampling is to provide additional information on the sediment / substrate surface and to determine suitability to collect grab samples (i.e., confirm the absence of subsea hazards and protected habitats not identified during the geophysical data review).

MBES and SSS was reviewed simultaneously to microsite samples around a stratified grid which was initially overlain on the MOWF array area. SSS and MBES was reviewed manually to identify areas of differing sediment type and seabed elevation. Sediment / substrate type was inferred from SSS based on the reflectivity (coarser sediments providing showing greater reflectivity) and seabed elevation was determined by review of MBES which presents water depth. A representative number of stations was attributed to each of the main Broadscale Habitats (BSH) (Table 1) to ensure coverage of the array area was proportional to the dominant BSH present whilst also considering adequate spatial coverage. Sample locations were further microsited to consider contaminant sampling which was predominantly focused on areas of finer sediment and in proximity to infrastructure which are likely to represent areas of higher contaminant levels.

An overview of the distribution of grab samples and contaminant stations by predicted BSH is provided below in Table 1.

Table 1 Overview of proposed grab locations by predicted Broad Scale Habitat (BSH) and contaminant samples to be sampled across the MOWF array area.

Predicted BSH	No. of Grab Locations	No. of Contaminant Samples
A5.1 - Sublittoral Coarse Sediment	12	4
A5.2 - Sublittoral Sand	38	16
A5.2 - Sublittoral Sand / A5.1 - Sublittoral Coarse Sediment	1	1

Proposed sampling plan for grab sampling is presented visually in Figure 4 and detailed with rationale for each sample location in Appendix 1 – Tab 1: V02 Sampling Plan – DDC & GRAB.

4.3.1. Approach

Sampling will be conducted using OEL's 0.1m^2 Day grab and sediment samples will be collected within 20 m of the target sampling location. Single grab samples will be collected at each station to collect approximately 10L of sediment. Where a suitable sample cannot be collected after three attempts within a 20 m radius of the target location, the sample location will be moved by up to 50 m away. Should none of these attempts be successful, the largest of the three samples should be taken and the volume noted.

Detailed field methods are provided in Section 5.

4.4. Drop Down Camera Transects

There are three targeted transects identified to be sampled with DDC. The main objective of the monitoring focused on characterising any features of interest identified in the geophysical review and assessing for the presence of biogenic/geogenic reef habitats within the MOWF array.

A full interrogation of available geophysical data was undertaken by an experienced ecologist to identify and microsite for reef features or areas of interest that required the collection of additional data (e.g., to better ground truth the geophysical data or aid in the delineation of boundaries between sediment / substrate type). Acoustic data was assessed for any topographically complex area of seabed in the MBES and for any hard return or areas of mottled returns in the SSS data as well as for any distinctness against the surrounding seabed to delineate potential boundaries in reef structures.

Transects have been positioned to ensure they intersect the boundaries of any feature identified to aid in the identification of reef features and delineate the extent of such features. Transects range from 150-300 m in length depending on the feature targeted.

TR01 targets an elevated reef-like feature, distinct from the surrounding seabed, in the southeast corner of the site. TR02 targets an area of pronounced scouring within coarse sediment whereby the SSS signature is distinct from the surrounding seabed in the northeast corner of the site. TR03 targets an area of sandy sediments with narrow scour marks aligned to the prevailing current.

An overview of the proposed DDC Transects by predicted BSH is provided below in Table 2.

Table 2 Overview of proposed DDC Transects by predicted Broad Scale Habitat (BSH) and contaminant samples to be sampled across the MOWF array area.

Predicted BSH	No. of DDC Transects
A5.1 - Sublittoral Coarse Sediment	2
A5.2 - Sublittoral Sand	1
A5.2 - Sublittoral Sand / A5.1 - Sublittoral Coarse Sediment	1

The complete DDC Transect sampling plan is presented visually in Figure 5 and detailed with rationale for each transect location in Appendix 1 – Tab 2: V02 Sampling Plan - Transects.

4.4.1. Approach

Seabed imagery (simultaneous video and stills) will be acquired along the DDC transects using OEL's Rayfin PLE Camera System with freshwater housing to collect 4K video and high-resolution (up to 21 megapixels (MP)) still images. The transects have been orientated to intersect the features of interest and are of length sufficient to delineate the feature boundaries whilst also considering the prevailing currents in the area which run east to west.

Along each DDC transect, a 'bed-hopping' approach will be employed to ensure representative imagery is collected along the full transect with still images to be taken every 5-10 m along with continuous video recording.

Detailed field methods are provided in Section 5.

4.5. Timing

The survey will be undertaken during May 2022 following the sign off of this PEP by Floatation Energy.

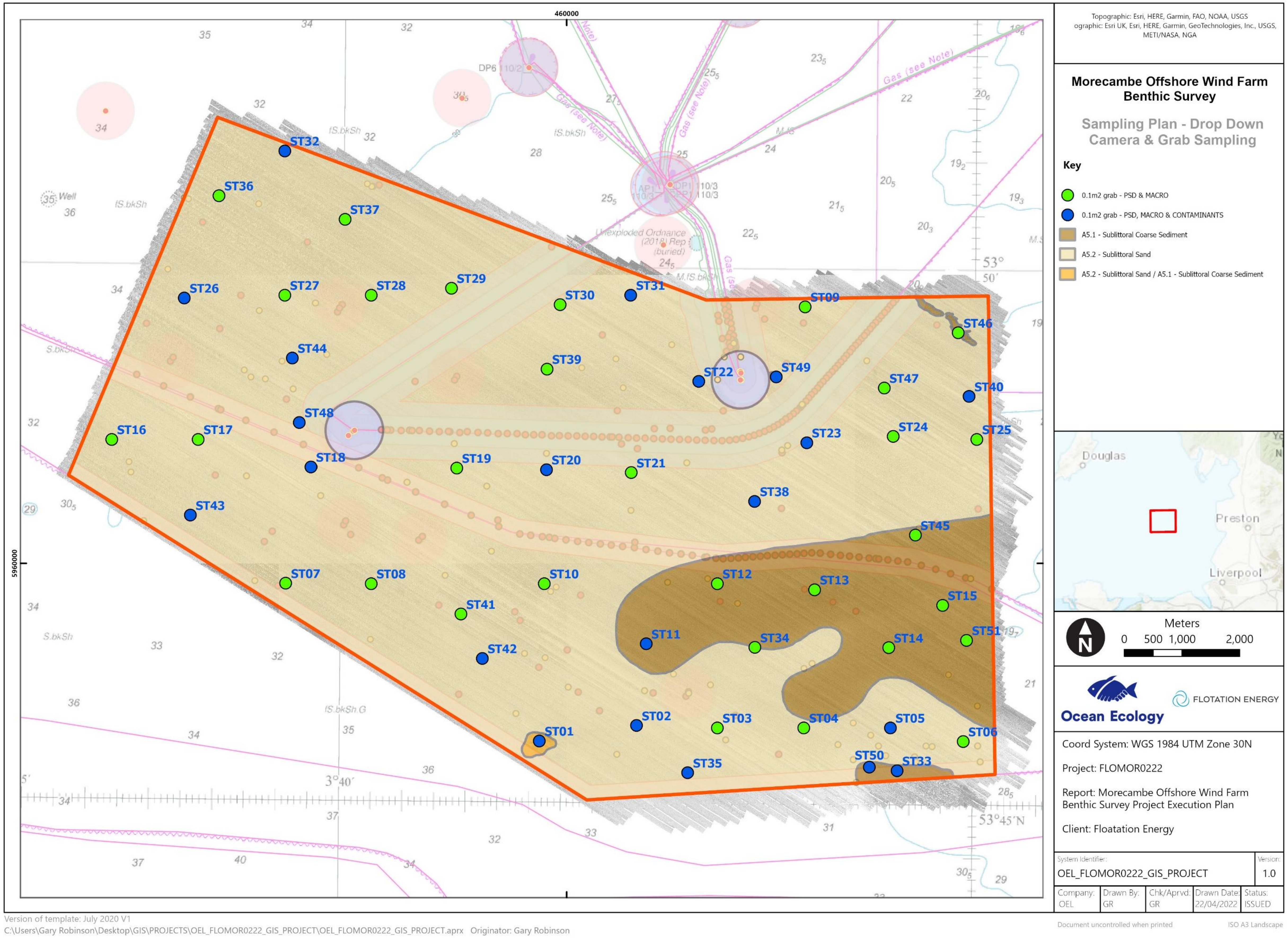


Figure 4 Locations of MOWF DDC and grab sampling stations.

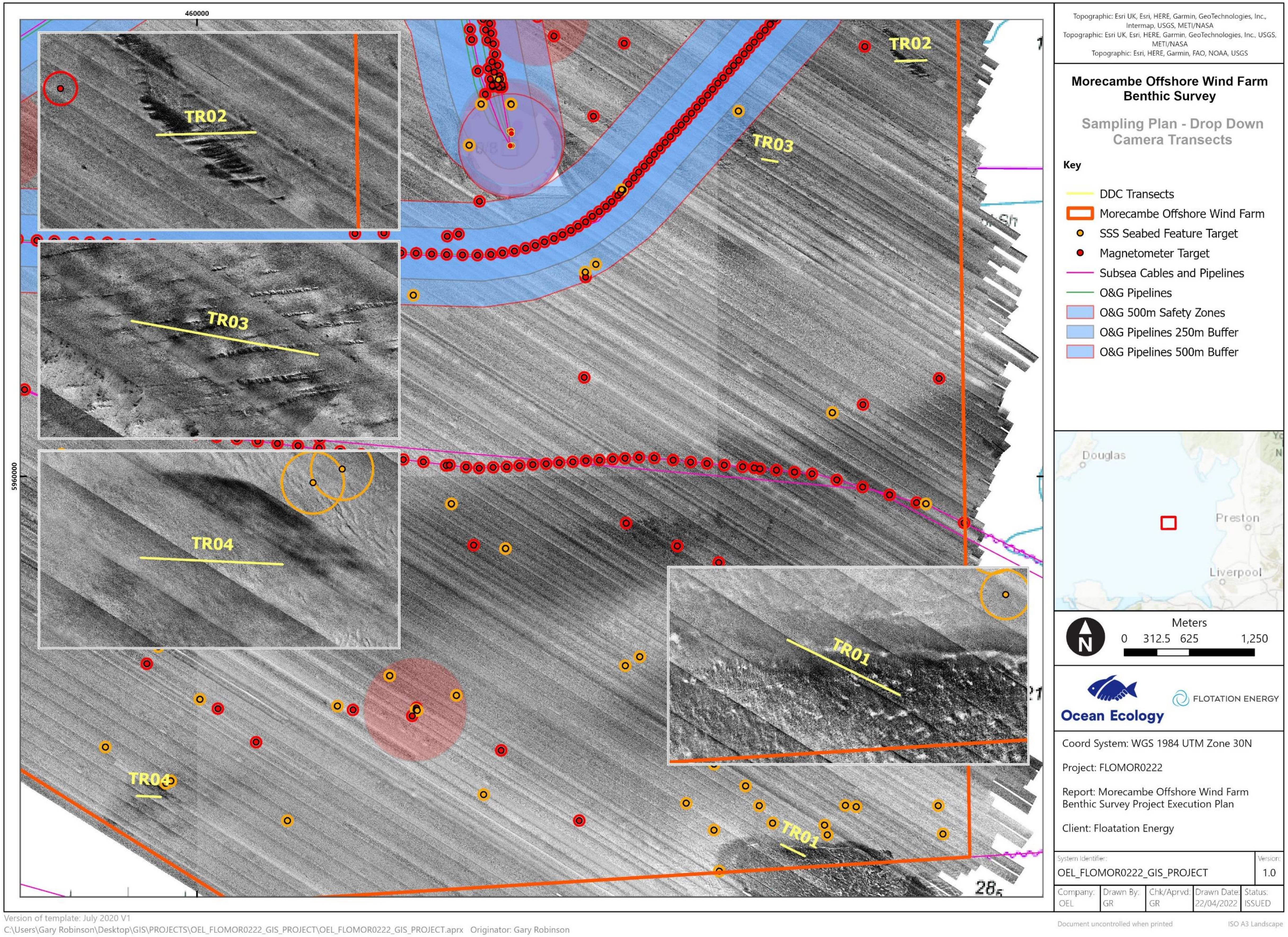


Figure 5 Locations of MOWF DDC transects.

5. Survey Methods

5.1. Survey Vessel

The Marine and Coastal Agency (MCA) Category 2, 10 m dedicated survey vessel *Seren Las*. (Plate 1), operated by OEL, will undertake the benthic surveys, operating out of either Fleetwood or Barrow-in-Furness. *Seren Las* has been specifically designed for the collection of benthic grab samples and deployment of DDC and due to its shallow draft, it is an ideal platform for shallow subtidal surveying.

Table 3 Vessel details.

Vessel Name	Seren Las
Call Sign	MDAH2
MMSI	235087047
Mobilisation Port	TBC – one of Fleetwood or Barrow-in-Furness
Length	10.4 m
Beam	3.5 m
Draft	1.5 m

Plate 1 OEL's dedicated survey vessel, 'Seren Las'.

5.2. Equipment

Table 4 Equipment list to be utilised onboard the Seren Las.

Equipment	Model
Camera System	OEL freshwater housing with HD video and high-resolution stills camera
dGPS	Hemisphere V104s GPS Compass
Gyro Compass	Hemisphere V104s GPS Compass
USBL	Easytrak Nexus 2 Lite
Navigation Software	EIVA NaviPac V4.5

5.3. Seabed Imagery Collection

5.3.1. Drop-Down Video System

Seabed imagery (simultaneous video and stills) will be acquired along the DDC transects using OEL's Rayfin PLE Camera System to collect 4K video and high-resolution (up to 21 megapixels (MP)) still images. The camera system (Plate 2) consists of a SubC Imaging Rayfin PLE camera, seabed frame equipped with freshwater housing (Jones et al. 2020), two LED strip lights, two 5 kW green dot lasers (set to 10 cm distance for scale), a 300 m umbilical and topside computer. The camera is powered with the use of an Uninterruptable Power Supply (UPS) to ensure no damage is caused should the vessel lose power or cause a power surge. The freshwater housing is height and angle adjustable providing a variety of options for view, lighting, and focal length to maximise data quality with respect to prevailing conditions (e.g., high turbidity).

Videos will be digitally overlaid retrospectively with information including project, date, time and Differential Global Positioning System (dGPS) position and recorded in a digital format.

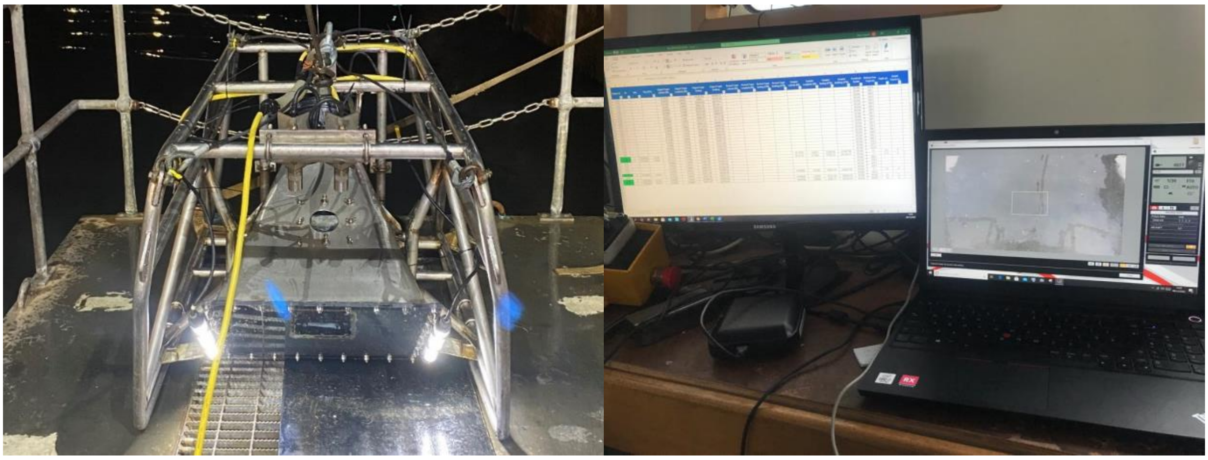


Plate 2 Left: OEL freshwater housing camera system. Right: The camera system topside setup.

All DDC stations (co-located with grab sample locations for prior investigation) and DDC transects will be sampled in line with the JNCC epibiota remote monitoring operational guidelines (Hitchin et al. 2015). Along each DDC transect, a 'bed-hopping' approach will be employed to ensure representative imagery is collected along the full transect with still images to be taken every 5-10 m along with continuous video recording. All footage will undergo a preliminary review *in situ* by the OEL's marine ecologists.

The camera system will be deployed as follows:

- Vessel approach target location and alerts deck personnel to prepare camera and umbilical.
- Sea fastening on camera frame to be released to allow deployment from the deck.
- Umbilical released overboard with sufficient length paid out to cover water depth.

- Camera to be raised and lowered into the water column to within 5 m of the seabed.
- Ecologist switches on video recording and the camera lowered until gently landing on the seabed at which point a positional fix will be taken.
- The ecologist waits for any suspended sediments in the field of view to disperse before taking an image and confirming with the skipper to move on.
- The camera will then be raised from the seabed and moved along the transect 5-10 m. Where possible the seabed will be maintained in view at all times.
- Following the capture of the final image, the camera will be lifted, video recording stopped, and the camera retrieved to the surface.
- The winch operator will then take the tension on the winch cable whilst the ecologist ensures the camera umbilical is free for recovery.
- Once the camera was on the surface, the vessel will be positioned to minimise pitch and roll (e.g., into wind/tide).
- The vessel skipper will then confirm that sea conditions are suitable for retrieval and the camera system recovered aboard.
- The camera frame will then be lowered onto the deck and the tension released.

5.4. Benthic Grab Sampling

Sampling will be conducted using OEL's 0.1m^2 Day grab and samples will be collected within 20 m of the target sampling location. Single grab samples will be collected at each station to collect approximately 10L of sediment from each grab from which a sub-sample of the sediment (a volume of 500 – 750 ml dependent on the nature of the sediment) will be removed for characterisation of the physical nature of the substrate (via PSD analysis). From a subset of 20 stations, contaminant sub-samples will be collected for analysis of various determinants including hydrocarbons and metals.

OEL's 0.1m^2 Day Grab is ideal for sampling medium to fine sediments, benthic macrofauna and for when contaminant sampling is required and is crucial to obtain undisturbed sediment surface samples. Upon contact with the seabed, the tension from the wire is released which causes the sampling bucket to pivot through 90º, pushing seabed sediment into the bucket which closes, forming a tight seal to avoid sediment/sample loss.

A 0.1m^2 mini Hamon Grab will be available as backup to sample coarser sediments should there be issues with recovery using the Day Grab. The Hamon Grab is designed to sample coarse sands and gravels.

The grab will be deployed from the A-frame on the aft deck of the *Seren Las*.

5.4.1. Sample Collection

To ensure consistency in sampling, grab samples will be screened by the lead marine ecologist and considered unacceptable if:

- The sample is less than 5L. i.e., the sample represents less than approx. a half of the 10L capacity of the grab used.
- The jaws fail to close completely or are jammed open by an obstruction, allowing fines to pass through (washout or partial washout).
- The sample is taken at an unacceptable distance from the target location (beyond 20 m).
- There is obvious contamination of the sample from survey equipment, paint chips etc.

Where a suitable sample cannot be collected after three attempts within a 20 m radius of the target location, the sample location will be moved by up to 50 m away. Where samples of less than 5L are continually achieved, these samples will be assessed on site to establish if the sample volume is acceptable to allow subsequent analysis. No pooling of samples will take place.

5.4.2. Grab Sample Processing (PSD & MACRO)

Initial grab sample processing will be undertaken onboard the *Seren Las* in line with the following methodology:

- Initial visual assessment of sample size and acceptability made.
- Photograph of the sample with station details and scale bar to be taken.
- Sub-sample removed for PSD analysis and transferred to a labelled tray.
- Remaining sample emptied onto 1.0 mm sieve net laid over 4.0 mm sieve table and washed through using gentle rinsing with seawater hose.
- Remaining sample for faunal sorting and identification backwashed into a suitable sized sample container and diluted 10% formalin solution added to fix the sample prior to laboratory analysis.
- Sample containers will be clearly labelled internally and externally with date, sample ID and project name.

Detailed field notes will be taken including station number, fix number, number of attempts, sample volume, sediment type, conspicuous fauna, any sign of protected features and water depth.

5.4.3. Grab Sample Processing (CONTAMINANTS)

A separate grab will be taken at a subset of up to 20 sample stations. Detailed notes will be taken of visible sediment conditions and seabed features, obvious fauna and habitat-related features whilst in the field, prior to detailed analysis at the MMO validated laboratories, SOCOTEC (contaminant analyses) and OEL (PSD). Sample processing will be undertaken onboard the survey vessel using the following methodology:

- Inspection cover lifted and general assessment of sample size and acceptability made ensuring sediment surface is undisturbed and no obvious sign of contamination. NB ensure no grease, oils or lubes enter the sample once the inspection cover is open.
- pH / Redox probe placed into sediment sample and allowed to settle for 2 minutes before taking readings in field logs.
- Sediment samples will be sub-sampled and decanted into the recommended sample containers provided by SOCOTEC, the contaminant laboratory specialists for the required analyses as below:
    - Moisture Content
    - Total organic matter (by loss on ignition)
    - Total Organic Carbon (TOC)
    - Total content and the content of the labile form of heavy metals (Pb, Cu, Zn, Ni, Cd, Cr, As, Hg);
    - Organotins (DBT, TBT)
    - Polycyclic aromatic hydrocarbons (PAHs) - Acenaphthene, Acenaphthylene, Anthracene, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[b]fluoranthene, Benzo[ghi]perylene, Benzo[e]pyrene, Benzo[k]fluoranthene, Chrysene, Dibenzo[a,h]anthracene, Fluoranthene, Fluorene, Indeno[123,cd]pyrene, Naphthalene, Perylene, Phenanthrene, Pyrene
    - Total Hydrocarbon Content (THC)
    - Polychlorinated biphenyls (PCBs 25 including the ICES 7); -

All samples taken for physico-chemical analysis will be stored frozen at -20°C in amber glass containers, up to a maximum of 3 months[1]. These containers will be acid cleaned and solvent-rinsed before use, sealed with a foil liner and tightened appropriately to avoid potential loss of determinands, contamination of samples, or both. A temperature of 25°C will not be exceeded at any stage of storage or transportation.

Two replicates (A and B Reps) will be collected at each contaminant sampling location. The B replicates will be stored frozen in line with MMO requirements in case of requirement for re-analysis or in the event of any A replicates becoming compromised during transit / storage prior to analysis.

5.5. Navigation Equipment

The vessel is equipped with a Hemisphere V104s Global Positioning System (GPS) compass system. The Hemisphere V104s's internal GPS receiver automatically searches for and uses a minimum of 4 GPS satellites and manages the navigation information required for position to

[1] Samples will be delivered to SOCOTEC immediately for analysis and processed within 30 days of receipt.

within 3 m (95% accuracy). Since there is some error in the GPS data calculations, the V104s also automatically tracks a Satellite-Based Augmentation System (SBAS) differential correction to improve its position accuracy to better than 1.0 m 95%.

The V104s has an integrated gyro and two tilt sensors to provide an accurate heading for the navigation software.

5.6. Subsea Positioning

The vessel will be fitted with an Easytrak Nexus 2 Lite Ultra-Short Baseline (USBL) system and 1329A Omni-directional +/-90° Micro Beacons for subsea positioning of the camera and grab. The Easytrak Nexus 2 Lite is an advanced USBL positioning and tracking system that determines the position of dynamic subsea targets through the transmission and reception of acoustic signals between the submerged transceiver and a target beacon.

5.6.1. Positional Checks

The GPS has an internal precision calculation to give a graphical representation of horizontal accuracy and displays numerical precision in easting and northing. To verify the reference systems are operating correctly, transformation parameters and a test point shall be agreed upon with the Client prior to the commencement of operations. Vessel heading will be checked in reference to a known point for accuracy on mobilisation.

5.7. Navigation Software

A vessel-based positioning system will be employed utilizing EIVA NaviPac V4.2 software to ensure the accurate positioning of the vessel and survey equipment via the USBL system. A navigation screen, displaying EIVA Helmsman Display will be provided at the helm position of the vessel for the Officer on Watch as well as for the ecologist/surveyor in the wheelhouse.

5.8. Project Parameters

5.8.1. Horizontal Reference systems

Table 5 Project horizontal geodetic parameters.

Parameter	Value
Datum	World Geodetic System 1984
Ellipsoid	World Geodetic System 1984
Spheroid	World Geodetic System 1984
Semi Major Axis (m)	6378137.0
Semi Minor Axis (m)	6356752.314245719
Inverse Flattening (1/f)	298.257223563
Angular unit	Degree

Table 6 Project horizontal projection parameters.

Parameter	Value
Projection	Universal Transverse Mercator (UTM) Zone 30N
Longitude at Central Meridian	003° 00.000000′ E

Latitude of Origin	000° 00.000000′ N
False Northing and Easting (m)	0; 500,000
Scale Factor	0.9996
Linear Unit	Metre
Time Datum	Universal Time Coordinated (UTC)

5.8.2. Unit Format and Conversions

The following units will be used throughout this project and are expressed using the following conventions.

Table 7 Project unit format and convention details.

Unit Formats and Conventions	
Geographical Coordinates	Latitude N DD˚MM.mmmmmm' to 6 decimal places. Longitude E/W DD˚MM.mmmmmm' to 6 decimal places.
Grid Coordinates	Meters in the following format: Easting EEE EEE.eee m to 3 decimal places. Northing NNN NNN.nnn m to 3 decimal places.
Linear distances	Meters to 1 decimal places.
Kilometre Point (KP) distances	Kilometres to 2 decimal places.
Offset measurement sign conventions	Meters in the following format: 'Y' is positive forward 'X' is positive to starboard 'Z' values are positives upwards from the waterline
Time	Local unless otherwise stated.

6. Post-Survey Analysis & Reporting

6.1. Benthic Grab Sample Analysis

All elutriation, extraction, identification, and enumeration will be undertaken at OEL's NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme participating laboratory in line with the NMBAQC Processing Requirement Protocol (Worsfold & Hall 2010). All processing information and macrobenthic records will be recorded using OEL's cloud-based data management application ABACUS that employs MEDIN validated, controlled vocabularies ensuring all sample information, nomenclature, qualifiers, and metadata are recorded in line with international data standards.

For each macrobenthic sample, the excess formalin will be drained off into a labelled container over a 1 mm mesh sieve in a well-ventilated area. The samples will then be re-sieved over a 1 mm mesh sieve to remove all remaining fine sediment and fixative. The low-density fauna will then be separated by elutriation with freshwater, poured over a 1 mm mesh sieve, transferred into a Nalgene and preserved in 70 % Industrial Denatured Alcohol (IDA). The remaining sediment from each sample will subsequently be separated into 1 mm, 2 mm and 4 mm fractions and sorted under a stereomicroscope to extract any remaining fauna (e.g., high-density bivalves not 'floated' off during elutriation).

All fauna present will be identified to species level, where possible, and enumerated by trained benthic taxonomists using the most up to date taxonomic literature and checks against existing reference collections. Nomenclature will utilise the live link within ABACUS to the WoRMS web services to ensure the most up to date taxonomic classifications are recorded. Colonial fauna (e.g., hydroids and bryozoans) will be identified to species level where possible and recorded as present (P). For subsequent data analysis, taxa recorded as P will be given the numerical value of 1. A full reference collection will be retained including at least one example specimen of each taxon.

Biomass will be measured as blotted wet weight in grams to at least 4 decimal places for all countable taxa (i.e., at species level where possible). As a standard, the conventional conversion factors as defined by Eleftheriou & Basford (1989) will be applied to biomass data to provide equivalent dry weight biomass (Ash Free Dry Weight).

The conversion factors applied are as follows:

- Annelida = 15.5%
- Crustacea = 22.5%
- Mollusca = 8.5%
- Echinodermata = 8.0%
- Miscellaneous = 15.5%

In addition to OEL's standard quality control procedures, the macrobenthic sample processing will be subject to external quality control checks by an independent, competent benthic laboratory participant in the NMBAQC scheme as per the RSMP protocol(Ware et al. 2011, Cooper & Mason 2019).

6.2. Particle Size Distribution (PSD) Analysis

PSD analysis of the sediment samples will be undertaken by in-house laboratory technicians at OEL's NMBAQC participating laboratory in line with NMBAQC best practice guidance (Mason 2016).

Frozen sediment samples will first be transferred to a drying oven and thawed at 80°C for at least 6 hours before visual assessment of sediment type. Before any further processing (e.g., sieving or sub-sample removal), samples will be mixed thoroughly with a spatula and all conspicuous fauna (>1 mm) which appeared to have been alive at the time of sampling removed from the sample. A representative sub-sample of the whole sample will then be removed for laser diffraction analysis before the remaining sample screened over a 1 mm sieve to sort coarse and fine fractions. The >1 mm fraction will then be returned to a drying oven and dried at 80°C for at least 24 hours before dry sieving. Once dry, the sediment sample will be run through a series of Endecott BS 410 test sieves (nested at 0.5 φ intervals) using a Retsch AS200 sieve shaker to fractionate the samples into particle size classes. The dry sieve mesh apertures to be used are given in Table 8.

Table 8 Sieve series employed for PSD analysis by dry sieving.

Sieve aperture (mm)												
63	45	32	22.5	16	11.2	8	5.6	4	2.8	2	1.4	1

The sample will then be transferred onto the coarsest sieve at the top of the sieve stack and shaken for a standardised period of 20 minutes. The sieve stack will be checked to ensure the components of the sample had been fractioned as far down the sieve stack as their diameter would allow. A further 10 minutes of shaking may be undertaken if there is evidence that particles had not been properly sorted.

The sub-sample for laser diffraction will be first screened over a 1 mm sieve and the fine fraction residue (<1 mm sediments) transferred to a suitable container and allowed to settle for 24 hours before excess water syphoned from above the sediment surface until a paste texture is achieved. The fine fraction will then be analysed by laser diffraction using a Beckman Coulter LS13 320. For silty sediments, ultrasound will be used to agitate particles and prevent aggregation of fines.

The dry sieve and laser data will then be merged for each sample with the results expressed as a percentage of the whole sample. Once data is merged, PSD statistics and sediment classifications will be generated from the percentages of the sediment determined for each sediment fraction using Gradistat v8 software.

Sediment descriptions will be defined by their size class based on the Wentworth classification system (Wentworth 1922) (Table 9). Statistics such as mean and median grain size, sorting coefficient, skewness and bulk sediment classes (percentage silt, sand and gravel) will also be derived following the Folk classification (Folk 1954).

Table 9 The classification used for defining sediment type based on the Wentworth Classification System (Wentworth 1922).

Wentworth Scale	Phi Units (φ)	Sediment Types
>64 mm	<-6	Cobble and boulders
32 – 64 mm	-5 to -6	Pebble
16 – 32 mm	-4 to -5	Pebble
8 – 16 mm	-3 to -4	Pebble
4 - 8 mm	-3 to -2	Pebble
2 - 4 mm	-2 to -1	Granule
1 - 2 mm	-1 to 0	Very coarse sand
0.5 - 1 mm	0 – 1	Coarse sand
250 - 500 µm	1 – 2	Medium sand
125 - 250 µm	2 – 3	Fine sand
63 - 125 µm	3 – 4	Very fine sand
31.25 – 63 µm	4 – 5	Very coarse silt
15.63 – 31.25 µm	5 – 6	Coarse silt
7.813 – 15.63 µm	6 – 7	Medium silt
3.91 – 7.81 µm	7 – 8	Fine silt
1.95 – 3.91 µm	8 – 9	Very fine silt
<1.95 µm	<9	Clay

In addition to OEL's standard quality control procedures, the PSD sample processing will be subject to external quality control checks by an independent, competent benthic laboratory participant in the NMBAQC scheme as per the RSMP protocol (Ware et al. 2011, Cooper & Mason 2019).

6.3. Seabed Imagery Analysis

All seabed imagery analysis collected by DDC will be undertaken in consideration of the latest NMBAQC/JNCC Epibiota Quality Assurance Framework (QAF) guidance and identification protocols available on the NMBAQC website. Final datasets will be presented using the latest NMBAQC/JNCC epibiota monitoring proformas available for stills and video footage and will be quality assured using the Quality Assurance Framework (QAF) form check and comparison tools.

The seabed imagery analysis Bio-Image Indexing and Graphical Labelling Environment (BIIGLE) annotation platform (Langenkämper et al. 2017) and Analysis of still images will be undertaken in two stages. The first stage, "Tier 1", will consist of labels that refer to the whole image being assigned providing appropriate metadata for the image including European Nature Information System (EUNIS) habitat classifications assigned in line with Parry (2019). The second stage, "Tier 2", will be used for enumerating epibiotal abundance and cover within each image and to assign percentage cover of reef types.

A full reef habitat assessment (HA) will be conducted on all DDC imagery to determine whether habitats meet the definitions of Annex I reef habitats as detailed in (Table 10 and Table 11). The latest JNCC guidance on the characterisation of 'low resemblance' Annex I stony reef will also be considered (Golding et al. 2020).

The annotation label tree to be used during analysis will have major headings for each of the reef types. Under each reef type, labels will be assigned for each of the categories required to determine whether Annex I reef habitat is present (Table 10 and Table 11).

Table 10 Characteristics of stony reef (Irving 2009).

Characteristic	'Reefiness'			
	Not a Reef	Low	Medium	High
Composition (proportion of boulders/cobbles (>64 mm))	<10 %	10-40 % matrix supported	40-95 %	>95 % clast-supported
Elevation	Flat seabed	<64 mm	64 mm - 5 m	>5 m
Extent	<25 m^2	>25 m^2		
Biota	Dominated by infaunal species	>80 % of species present composed of epibiotal species		

Table 11 Characteristics of *Sabellaria spinulosa* reef (Gubbay 2007).

Characteristic	'Reefiness'			
	Not a Reef	Low	Medium	High
Elevation (cm)	< 2	2 - 5	5 – 10	> 10
Extent (m^2)	< 25	25 – 10,000	10,000 – 1,000,000	> 1,000,000
Patchiness (% Cover)	< 10	10 - 20	20 – 30	> 30

6.3.1. Tier 1 Analysis

The first stage, "Tier 1", will consist of assigning labels that referred to the whole image, providing appropriate metadata for the image. Metadata "Image Labels" include:

- Broadscale Habitat (BSH) type.
- Substrate type (and percentage cover in 10% intervals).
- Bedforms present.

- The presence of any Annex I habitats, Features of Conservation Importance (FOCI),Habitats of Conservation Importance (HOCI) and Invasive Non-Native Species (INNS).
- The presence of any visible impacts or other modifiers (such as discarded fishing gear or marine litter (as per the Marine Strategy Framework Directive (MSFD) categories), visible physical damage to the seabed, evidence of strong currents, non-native species, etc.).
- Image quality categories (including "Not Analysable" category).

Depending on the presence of reef, this will also include:

- Extent: As it is not possible to fully determine the extent of reef habitats from a single image alone this label will be used to identify areas that are highly unlikely to constitute reef habitats. An example is an image that shows a large boulder being preceded and succeeded by images of unconsolidated sandy sediments.
- Biota: Labels assigned to determine whether epifauna dominate the biological community observed.
- Elevation: Labels assigned depending on reef type. Laser points will be used to assist in the assignment of categories.

6.3.2. Tier 2 Analysis

The second stage, "Tier 2", will be used to assess epibiotal abundance data as "annotations" within each image for all visible flora and fauna. This will be undertaken as follows:

- Using the BIIGLE Annotation Platform, (detailed below) enumeration of all visible taxa will be undertaken using points for enumerable "count" taxa and polygons for ground-covering taxa; to enable calculation of percentage cover for these taxa.
- Where an individual of a "count" taxon overlay a ground-cover taxon, then this individual is still counted (i.e., a point annotation will be added for the count taxa over the polygon of the ground-cover taxon).
- Identification of any invasive non-native species (INNS) and species non-native to UK waters. Information will also be included on species non-native to the local habitat types (e.g. hard-substrate specialists in a wider sedimentary habitat).

The substratum observed in each still image will be recorded as a percentage cover of CATAMI (Althaus et al. 2015) substratum types where possible. Determination of sediment type (such as coarse, mixed, sand etc.) will be facilitated using the adapted Folk sediment trigon (Long 2006) incorporated into a sediment category correlation table. Percentage cover of the different substrate types will be used to determine and assign EUNIS codes and BSH.

6.4. Reporting

6.4.1. Field Report

Within five working days of demobilisation of the survey, a field report will be issued by OEL to Floatation Energy providing a summary of the work completed. This report will summarise sampling progress, any problems encountered and provide final field logs and sample images.

6.4.2. Technical Report

All of the raw data derived from the characterisation survey will undergo detailed analysis and interpretation in line with Phase III of NE's "Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards" (Natural England 2021b). Following the completion of all data analysis, OEL will provide a detailed technical report to provide a description of the baseline environment, including a narrative of the seabed type across the project area, the range of habitats and biotopes present and the presence of any habitats/species of conservation importance. Data will be collated using Excel spreadsheets conforming to the relevant Marine Environmental Data and Information Network (MEDIN) data guidelines and with all site locations recorded. All electronic data will be provided in addition to the report. An outline contents table for the report is set out in Table 12.

Table 12 Outline of the offshore benthic baseline technical report contents.

Section	Description
Introduction	• Project background • Existing environment • Aims and objectives
Methods	• Sampling design and rationale including methods of geophysical interpretation • Field methods • Seabed imagery analysis methods including Annex I assessment methodology • Benthic grab sampling analysis methods • Statistical analysis • GIS Habitat Mapping Procedures
Results	• Summary of progress • Sediment analysis and mapping • Macrobenthic analysis and mapping • Seabed imagery analysis and mapping (with Annex I assessment) • Mapping of benthic habitats • Assessment of any Annex I habitats encountered
Discussion	• Contextualisation of results • Limitations of the study • Conclusion
References	• List of references used

Appendices	• Sampling logs • Data matrices • Benthic grab sample image examples • Seabed imagery examples • GIS data package

7. References

Althaus F, Hill N, Ferrari R, Edwards L, Przeslawski R, Schönberg CHL, Stuart-Smith R, Barrett N, Edgar G, Colquhoun J, Tran M, Jordan A, Rees T, Gowlett-Holmes K (2015) A Standardised Vocabulary for Identifying Benthic Biota and Substrata from Underwater Imagery: The CATAMI Classification Scheme. PLoS One 10.

Cooper K, Mason C (2019) Regional Seabed Monitoring Programme (RSMP) Protocal for Sample Collection and Processing. Version 7.0.

Eleftheriou A, Basford D. (1989) The macrobenthic infauna of the offshore northern North Sea. J Mar Biol Assoc 69:123–143.

Folk R. (1954) The distribution between grain size and mineral composition in sedimentary rock nomenclature. J Geol 62:344–359.

Golding N, Albrecht J, McBreen F (2020) Refining criteria for defining areas with a 'low resemblance' to Annex I stony reef: Workshop Report.

Gubbay S (2007) Defining and managing Sabellaria spinulosa reefs: Report of an inter-agency 1-2 May, 2007.

Hitchin R, Turner, Verling (2015) Epibiota Remote Monitoring from Digital Imagery: Operational Guidelines.

Irving R (2009) The identification of the main characteristics of stony reef habitats under the Habitats Directive. JNCC Rep No 432:44.

Jones RE, Unsworth RKF, Hawes J, Griffin RA (2020) Improving benthic biodiversity assessments in turbid aquatic environments. Aquat Conserv Mar Freshw Ecosyst:aqc.3509.

Langenkämper D, Zurowietz M, Schoening T, Nattkemper TW (2017) BIIGLE 2.0 - Browsing and Annotating Large Marine Image Collections. Front Mar Sci 4:1–10.

Long D (2006) BGS detailed explanation of seabed sediment modified folk classification. Folk.

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

Natural England (2021a) Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards - Phase I: Expectations for pre-application baseline data for designated nature conservation and landscape receptors to support offshore wind application.

Natural England (2021b) Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards - Phase III: Expectations for data analysis and presentation at examination for offshore wind applications.

Parry ME V (2019) Guidance on Assigning Benthic Biotopes using EUNIS or the Marine Habitat Classification of Britain and Ireland (Revised 2019).

Ware SJ, Kenny AJ, Curtis M, Froján CB, Cooper K, Reach I, Bussell J, Service M, Boyd A, Sotheran I, Egerton J, Pearce LSB (2011) Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites. Mar Aggreg Levy Sustain Fund 2:80.

Wentworth C. (1922) A scale of grade and class terms for clastic sediments. J Geol 30:377–392.

Worsfold T, Hall D (2010) Guidelines for processing marine macrobenthic invertebrate samples: a Processing Requirements Protocol.

Appendix II - Methods for the analysis of sediment chemistry

Method	Sample and Fraction Size	Method Summary
Total Organic Carbon (TOC)	Air dried	Carbonate removal and sulphurous acid/combustion at 1600°C/NDIR.
Metals	Air dried	Aqua-regia extraction followed by ICP analysis.
Silver & Tellurium	Air dried	Nitric acid extraction followed by ICP analysis.
Organotins	Wet Sediment	Solvent extraction and derivatisation followed by GC-MS analysis.
Polyaromatic Hydrocarbons (PAH)	Wet Sediment	Solvent extraction and clean up followed by GC-MS analysis.
Total Hydrocarbon Content (THC)	Wet Sediment	Ultra-violet fluorescence spectroscopy
Polychlorinated Biphenyls (PCBs)	Air dried and seived to <2mm	Solvent extraction and clean up followed by GC-MS-MS analysis.

Appendix III - Analytical routines

Hierarchical Cluster Analysis & SIMPROF

Cluster analysis is used to establish groups of samples which show multivariate similarity using an agglomerative hierarchical clustering method. When applied to between-sample similarity matrices based on Bray-Curtis similarities (Bray & Curtis, 1957) results can be represented in a dendrogram where samples are displayed on the x-axis and the level of similarity is displayed on the y-axis. Similarity profile permutation (SIMPROF) tests can be undertaken to test for the presence of statistically significant sample groups in a priori unstructured set of samples (Clarke et al. 2008) separated in the dendrogram.

Multidimensional Scaling (MDS)

MDS ordination plots can be used to represent the similarity of samples based on their multivariate structure by arranging them graphically in a multidimensional plot. This plot can be configured to display the sample points in two dimensions and provides a stress value that indicates the degree to which the plot is providing a representative interpretation of the similarity between the samples.

Similarity Percentage (SIMPER)

Using the Bray-Curtis measure of similarity the SIMPER routine identifies the variables primarily providing the discrimination between two observed sample clusters. This analysis breaks down the contribution of each variable to the observed similarity between samples effectively meaning the key characterising variables of identified groups can be identified.

Shade Plots

PRIMER v7 now allows shade plots to be plotted showing simple visual representations of abundance matrices from multivariate species assemblage studies and have been shown to be an effective aid in choosing overall transformation (or other pre-treatment) of quantifiative data (Clarke et al. 2014). Shade plots with linear grey-scale intensity proportional species abundance data can therefore be plotted and species can be clustered using the standard agglomerative method, based on the 'index of association' resemblances computed on species-standardised abundance. Resulting dendograms can be rotated to maximise the seriation statistic p, non-parametrically correlating their resemblances on the distance structure of a linear sequence to present the data in a form where general trends are most easily distinguished.

Appendix IV - Morecambe OWF drop-down camera video survey logs.

Station	Date	Video Start Time (UTC)	Video Length	Video End Time (UTC)	GPS to Camera Time Offset	No. of Videos	No. of Images Per Video	Video File Name	Depth (m)	Camera System	Freshwater Housing Height Setting	Distance Between Laser Points (cm)	FOCI/OSPAR present (excluding reef)	Potential Annex I reef?
ST01	Station not sampled due to being covered by TR04													
ST02	29/05/2022	16:55:45	00:03:51	16:59:36	00:00:03	1	6	FLOMOR0322_ST02_2022_05_29_165543	35.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST03	29/05/2022	17:34:15	00:03:30	17:37:45	00:00:02	1	5	FLOMOR0322_ST03_2022_05_29_173413	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST04	01/06/2022	04:20:45	00:04:05	04:24:50	00:00:00	1	8	FLOMOR0322_ST04_2022_06_01_042045	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST05	01/06/2022	05:48:30	00:06:30	05:55:00	00:00:01	1	8	FLOMOR0322_ST05_2022_06_01_054829	32.0	SubC Rayfin PLE System	Top - Plan View	10	Y	N
ST06	01/06/2022	06:12:00	00:04:40	06:16:40	00:00:00	1	6	FLOMOR0322_ST06_2022_06_01_061200	30.0	SubC Rayfin PLE System	Top - Plan View	10	Y	N
ST07	29/05/2022	14:43:45	00:02:22	14:46:07	00:00:01	1	5	FLOMOR0322_ST07_2022_05_29_144344	30.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST08	29/05/2022	15:03:08	00:03:19	15:06:27	00:00:03	1	6	FLOMOR0322_ST08_2022_05_29_130305	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST09	28/05/2022	12:39:47	00:02:52	12:42:39	00:00:04	1	5	FLOMOR0322_ST09_2022_05_28_123943	27.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST10	29/05/2022	15:43:10	00:02:07	15:45:17	00:00:03	1	5	FLOMOR0322_ST10_2022_05_29_154307	32.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST11	29/05/2022	17:59:10	00:02:59	18:02:09	00:00:03	1	5	FLOMOR0322_ST11_2022_05_29_175907	31.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST12	29/05/2022	18:20:30	00:03:58	18:24:28	00:00:02	1	5	FLOMOR0322_ST12_2022_05_29_182028	29.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST13	01/06/2022	07:53:35	00:04:43	07:58:18	00:00:01	1	6	FLOMOR0322_ST13_2022_06_01_075334	25.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST14	01/06/2022	07:27:35	00:05:24	07:32:59	00:00:01	1	6	FLOMOR0322_ST14_2022_06_01_072734	24.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST15	01/06/2022	07:03:20	00:10:00	07:13:20	00:00:01	2	5	FLOMOR0322_ST15_2022_06_01_070319	22.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
		07:13:20	00:01:23	07:14:43	00:00:01		3	FLOMOR0322_ST15_2022_06_01_071321						
ST16	29/05/2022	13:46:30	00:02:42	13:49:12	00:00:02	1	5	FLOMOR0322_ST16_2022_05_29_134628	37.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST17	29/05/2022	14:07:00	00:02:36	14:09:36	00:00:03	1	5	FLOMOR0322_ST17_2022_05_29_140657	35.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST18	28/05/2022	17:01:40	00:03:32	17:05:12	00:00:03	1	6	FLOMOR0322_ST18_2022_05_28_170137	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST19	28/05/2022	16:33:15	00:02:28	16:35:43	00:00:05	1	5	FLOMOR0322_ST19_2022_05_28_163310	32.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST20	28/05/2022	16:07:11	00:06:16	16:13:27	00:00:04	1	5	FLOMOR0322_ST20_2022_05_28_060707	32.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST21	28/05/2022	14:02:30	00:04:21	14:06:51	00:00:05	1	6	FLOMOR0322_ST21_2022_05_28_140225	32.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST22	28/05/2022	14:35:20	00:03:24	14:38:44	00:00:03	1	5	FLOMOR0322_ST22_2022_05_28_143517	25.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST23	28/05/2022	13:19:40	00:03:09	13:22:49	00:00:04	1	5	FLOMOR0322_ST23_2022_05_28_131936	29.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST24	01/06/2022	08:35:20	00:04:27	08:39:47	00:00:00	1	6	FLOMOR0322_ST24_2022_06_01_083520	26.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST25	01/06/2022	10:23:20	00:04:55	10:28:15	00:00:01	1	6	FLOMOR0322_ST25_2022_06_01_102319	30.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST26	29/05/2022	13:22:55	00:02:37	13:25:32	00:00:02	1	5	FLOMOR0322_ST26_2022_05_29_132253	38.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST27	28/05/2022	17:51:55	00:03:33	17:55:28	00:00:04	1	7	FLOMOR0322_ST27_2022_05_28_175151	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST28	29/05/2022	12:08:55	00:03:47	12:12:42	00:00:01	1	6	FLOMOR0322_ST28_2022_05_29_120854	37.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST29	29/05/2022	11:50:22	00:03:00	11:53:22	00:00:01	1	5	FLOMOR0322_ST29_2022_05_29_115021	35.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST30	28/05/2022	15:27:15	00:07:44	15:34:59	00:00:03	1	8	FLOMOR0322_ST30_2022_05_28_152712	29.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST31	28/05/2022	15:03:52	00:07:45	15:11:37	00:00:06	1	5	FLOMOR0322_ST31_2022_05_28_150346	27.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST32	29/05/2022	12:47:00	00:04:06	12:51:06	00:00:03	1	5	FLOMOR0322_ST32_2022_05_29_124657	38.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST33	Station not sampled due to being covered by TR01													
ST34	29/05/2022	18:39:00	00:03:45	18:42:45	00:00:09	1	5	FLOMOR0322_ST34_2022_05_29_183851	30.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST35	29/05/2022	17:14:00	00:07:18	17:21:18	00:00:04	1	5	FLOMOR0322_ST35_2022_05_29_171356	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST36	29/05/2022	13:04:45	00:02:38	13:07:23	00:00:02	1	5	FLOMOR0322_ST36_2022_05_29_130443	38.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST37	29/05/2022	12:28:50	00:02:59	12:31:49	00:00:02	1	5	FLOMOR0322_ST37_2022_05_29_122848	36.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST38	28/05/2022	13:36:37	00:03:37	13:40:14	00:00:04	1	5	FLOMOR0322_ST38_2022_05_28_133633	35.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST39	28/05/2022	15:47:15	00:03:29	15:50:44	00:00:03	1	7	FLOMOR0322_ST39_2022_05_28_154712	27.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST40	01/06/2022	10:09:10	00:03:25	10:12:35	00:00:01	1	6	FLOMOR0322_ST40_2022_06_01_100909	25.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST41	29/05/2022	15:23:00	00:02:51	15:25:51	00:00:02	1	5	FLOMOR0322_ST41_2022_05_29_152258	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST42	29/05/2022	15:58:45	00:02:52	16:01:37	00:00:03	1	5	FLOMOR0322_ST42_2022_05_29_155842	38.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST43	29/05/2022	14:21:20	00:03:45	14:25:05	00:00:03	1	6	FLOMOR0322_ST43_2022_05_29_142117	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST44	28/05/2022	17:33:30	00:03:15	17:36:45	00:00:04	1	5	FLOMOR0322_ST44_2022_05_28_173326	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST45	01/06/2022	08:15:55	00:04:54	08:20:49	00:00:00	1	6	FLOMOR0322_ST45_2022_06_01_081555	27.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST46	Station not sampled due to being covered by TR02													
ST47	Station not sampled due to being covered by TR03													
ST48	28/05/2022	17:16:45	00:03:00	17:19:45	00:00:04	1	8	FLOMOR0322_ST48_2022_05_28_171641	32.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST49	28/05/2022	13:00:27	00:02:26	13:02:53	00:00:04	1	6	FLOMOR0322_ST49_2022_05_28_130024	26.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST50	01/06/2022	04:46:45	00:04:40	04:51:25	00:00:00	1	7	FLOMOR0322_ST50_2022_06_01_044645	34.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
ST51	01/06/2022	06:41:30	00:10:00	06:51:30	00:00:00	2	4	FLOMOR0322_ST51_2022_06_01_064130	22.0	SubC Rayfin PLE System	Top - Plan View	10	N	N
		06:51:30	00:00:32	06:52:02	00:00:01		1	FLOMOR0322_ST51_2022_06_01_0656131						
TR01	01/06/2022	05:02:50	00:10:00	05:12:50	00:00:01	3	28	FLOMOR0322_TR01_2022_06_01_050249	33	SubC Rayfin PLE System	Top - Plan View	10	N	N
		05:12:50	00:10:00	05:22:50	00:00:01		9	FLOMOR0322_TR01_2022_06_01_052252						
		05:22:10	00:01:12	05:23:22	00:00:01		1	FLOMOR0322_TR01_2022_06_01_053235						
TR02	01/06/2022	09:29:55	00:10:00	09:39:55	00:00:01	3	12	FLOMOR0322_TR02_2022_06_01_092954	24	SubC Rayfin PLE System	Top - Plan View	10	N	N
		09:39:55	00:10:00	09:49:55	00:00:01		16	FLOMOR0322_TR02_2022_06_01_093955						
		09:49:55	00:10:00	09:59:55	00:00:01		10	FLOMOR0322_TR02_2022_06_01_094956						
TR03	01/06/2022	08:55:15	00:10:00	09:05:15	00:00:02	2	16	FLOMOR0322_TR03_2022_06_01_085513	23	SubC Rayfin PLE System	Top - Plan View	10	N	N
		09:05:15	00:07:02	09:12:17	00:00:01		12	FLOMOR0322_TR03_2022_06_01_090514						
TR04	29/05/2022	16:21:10	00:10:00	16:31:10	00:00:03	2	18	FLOMOR0322_TR04_2022_05_29_162107	38	SubC Rayfin PLE System	Top - Plan View	10	N	N
		17:31:10	00:07:10	17:38:20	00:00:03		13	FLOMOR0322_TR04_2022_05_29_163109						

Appendix V - Morecambe OWF drop-down camera stills survey logs.

Station	Image File Name	Fix Time (UTC)	Date	Target Easting	Target Northing	Sampled Easting	Sampled Northing	Distance from Target (m)
ST02	FLOMOR0222_ST02_2022_05_29_165557.jpg	16:56:01	29/05/2022	461209.685	5957188.416	461207.659	5957174.598	14.0
ST02	FLOMOR0222_ST02_2022_05_29_165623.jpg	16:56:26	29/05/2022	461209.685	5957188.416	461212.824	5957177.337	11.5
ST02	FLOMOR0222_ST02_2022_05_29_165706.jpg	16:57:10	29/05/2022	461209.685	5957188.416	461217.719	5957179.410	12.1
ST02	FLOMOR0222_ST02_2022_05_29_165757.jpg	16:58:00	29/05/2022	461209.685	5957188.416	461208.357	5957187.276	1.8
ST02	FLOMOR0222_ST02_2022_05_29_165844.jpg	16:58:47	29/05/2022	461209.685	5957188.416	461204.327	5957194.208	7.9
ST02	FLOMOR0222_ST02_2022_05_29_165927.jpg	16:59:31	29/05/2022	461209.685	5957188.416	461198.585	5957201.376	17.1
ST03	FLOMOR0222_ST03_2022_05_29_173503.jpg	17:35:06	29/05/2022	462611.030	5957149.039	462627.952	5957146.247	17.1
ST03	FLOMOR0222_ST03_2022_05_29_173546.jpg	17:35:49	29/05/2022	462611.030	5957149.039	462620.893	5957145.636	10.4
ST03	FLOMOR0222_ST03_2022_05_29_173621.jpg	17:36:24	29/05/2022	462611.030	5957149.039	462610.930	5957144.714	4.3
ST03	FLOMOR0222_ST03_2022_05_29_173701.jpg	17:37:05	29/05/2022	462611.030	5957149.039	462607.700	5957144.740	5.4
ST03	FLOMOR0222_ST03_2022_05_29_173738.jpg	17:37:41	29/05/2022	462611.030	5957149.039	462607.586	5957155.199	7.1
ST04	FLOMOR0222_ST04_2022_06_01_042114.jpg	04:21:15	01/06/2022	464111.030	5957149.039	464090.187	5957156.328	22.1
ST04	FLOMOR0222_ST04_2022_06_01_042155.jpg	04:21:57	01/06/2022	464111.030	5957149.039	464094.303	5957152.725	17.1
ST04	FLOMOR0222_ST04_2022_06_01_042227.jpg	04:22:29	01/06/2022	464111.030	5957149.039	464099.191	5957153.776	12.8
ST04	FLOMOR0222_ST04_2022_06_01_042241.jpg	04:22:43	01/06/2022	464111.030	5957149.039	464101.913	5957151.043	9.3
ST04	FLOMOR0222_ST04_2022_06_01_042306.jpg	04:23:08	01/06/2022	464111.030	5957149.039	464106.959	5957156.406	8.4
ST04	FLOMOR0222_ST04_2022_06_01_042330.jpg	04:23:31	01/06/2022	464111.030	5957149.039	464112.263	5957154.053	5.2
ST04	FLOMOR0222_ST04_2022_06_01_042350.jpg	04:23:51	01/06/2022	464111.030	5957149.039	464118.288	5957151.262	7.6
ST04	FLOMOR0222_ST04_2022_06_01_042441.jpg	04:24:44	01/06/2022	464111.030	5957149.039	464118.176	5957145.499	8.0
ST05	FLOMOR0222_ST05_2022_06_01_054919.jpg	05:49:15	01/06/2022	465611.030	5957149.039	465597.998	5957141.733	14.9
ST05	FLOMOR0222_ST05_2022_06_01_055046.jpg	05:50:42	01/06/2022	465611.030	5957149.039	465612.529	5957140.959	8.2
ST05	FLOMOR0222_ST05_2022_06_01_055151.jpg	05:51:47	01/06/2022	465611.030	5957149.039	465616.019	5957140.377	10.0
ST05	FLOMOR0222_ST05_2022_06_01_055229.jpg	05:52:26	01/06/2022	465611.030	5957149.039	465620.827	5957139.785	13.5
ST05	FLOMOR0222_ST05_2022_06_01_055303.jpg	05:52:59	01/06/2022	465611.030	5957149.039	465615.261	5957144.944	5.9
ST05	FLOMOR0222_ST05_2022_06_01_055340.jpg	05:53:37	01/06/2022	465611.030	5957149.039	465611.673	5957150.088	1.2
ST05	FLOMOR0222_ST05_2022_06_01_055413.jpg	05:54:10	01/06/2022	465611.030	5957149.039	465610.174	5957152.491	3.6
ST05	FLOMOR0222_ST05_2022_06_01_055453.jpg	05:54:50	01/06/2022	465611.030	5957149.039	465605.384	5957155.475	8.6
ST06	FLOMOR0222_ST06_2022_06_01_061209.jpg	06:12:06	01/06/2022	466873.419	5956911.428	466844.381	5956893.421	34.2
ST06	FLOMOR0222_ST06_2022_06_01_061244.jpg	06:12:40	01/06/2022	466873.419	5956911.428	466866.799	5956907.782	7.6
ST06	FLOMOR0222_ST06_2022_06_01_061349.jpg	06:13:46	01/06/2022	466873.419	5956911.428	466873.178	5956910.129	1.3
ST06	FLOMOR0222_ST06_2022_06_01_061446.jpg	06:14:42	01/06/2022	466873.419	5956911.428	466881.665	5956916.967	9.9
ST06	FLOMOR0222_ST06_2022_06_01_061555.jpg	06:15:51	01/06/2022	466873.419	5956911.428	466889.182	5956912.408	15.8
ST06	FLOMOR0222_ST06_2022_06_01_061635.jpg	06:16:31	01/06/2022	466873.419	5956911.428	466889.174	5956915.913	16.4
ST07	FLOMOR0222_ST07_2022_05_29_144401.jpg	14:44:04	29/05/2022	455127.525	5959655.225	455122.433	5959659.749	6.8
ST07	FLOMOR0222_ST07_2022_05_29_144425.jpg	14:44:28	29/05/2022	455127.525	5959655.225	455124.684	5959660.840	6.3
ST07	FLOMOR0222_ST07_2022_05_29_144457.jpg	14:45:00	29/05/2022	455127.525	5959655.225	455131.712	5959658.548	5.3
ST07	FLOMOR0222_ST07_2022_05_29_144533.jpg	14:45:37	29/05/2022	455127.525	5959655.225	455136.442	5959657.056	9.1
ST07	FLOMOR0222_ST07_2022_05_29_144558.jpg	14:46:01	29/05/2022	455127.525	5959655.225	455135.281	5959645.829	12.2
ST08	FLOMOR0222_ST08_2022_05_29_150332.jpg	15:03:35	29/05/2022	456611.030	5959649.039	456613.848	5959657.921	9.3
ST08	FLOMOR0222_ST08_2022_05_29_150408.jpg	15:04:11	29/05/2022	456611.030	5959649.039	456617.649	5959648.540	6.6
ST08	FLOMOR0222_ST08_2022_05_29_150447.jpg	15:04:50	29/05/2022	456611.030	5959649.039	456620.558	5959649.626	9.5
ST08	FLOMOR0222_ST08_2022_05_29_150531.jpg	15:05:34	29/05/2022	456611.030	5959649.039	456621.558	5959643.719	11.8
ST08	FLOMOR0222_ST08_2022_05_29_150601.jpg	15:06:04	29/05/2022	456611.030	5959649.039	456618.558	5959632.843	17.9
ST08	FLOMOR0222_ST08_2022_05_29_150613.jpg	15:06:16	29/05/2022	456611.030	5959649.039	456619.240	5959635.396	15.9
ST09	FLOMOR0222_ST09_2022_05_28_124008.jpg	12:40:11	28/06/2022	464135.247	5964444.396	464122.273	5964441.337	13.3
ST09	FLOMOR0222_ST09_2022_05_28_124036.jpg	12:40:40	28/06/2022	464135.247	5964444.396	464125.269	5964437.197	12.3
ST09	FLOMOR0222_ST09_2022_05_28_124117.jpg	12:41:20	28/06/2022	464135.247	5964444.396	464133.398	5964441.474	3.5
ST09	FLOMOR0222_ST09_2022_05_28_124144.jpg	12:41:47	28/06/2022	464135.247	5964444.396	464136.189	5964444.902	1.1
ST09	FLOMOR0222_ST09_2022_05_28_124218.jpg	12:42:21	28/06/2022	464135.247	5964444.396	464140.304	5964440.642	6.3
ST10	FLOMOR0222_ST10_2022_05_29_154322.jpg	15:43:25	29/06/2022	459611.030	5959649.039	459611.088	5959647.556	1.5
ST10	FLOMOR0222_ST10_2022_05_29_154347.jpg	15:43:50	29/06/2022	459611.030	5959649.039	459614.439	5959646.415	4.3
ST10	FLOMOR0222_ST10_2022_05_29_154432.jpg	15:44:35	29/06/2022	459611.030	5959649.039	459621.142	5959644.354	11.1
ST10	FLOMOR0222_ST10_2022_05_29_154457.jpg	15:45:00	29/06/2022	459611.030	5959649.039	459624.699	5959636.646	18.5
ST10	FLOMOR0222_ST10_2022_05_29_154508.jpg	15:45:11	29/06/2022	459611.030	5959649.039	459623.629	5959634.764	19.0
ST11	FLOMOR0222_ST11_2022_05_29_175924.jpg	17:59:28	29/06/2022	461377.879	5958604.849	461396.669	5958605.311	18.8
ST11	FLOMOR0222_ST11_2022_05_29_180012.jpg	18:00:15	29/06/2022	461377.879	5958604.849	461390.077	5958605.143	12.2
ST11	FLOMOR0222_ST11_2022_05_29_180037.jpg	18:00:40	29/06/2022	461377.879	5958604.849	461382.660	5958600.865	6.2
ST11	FLOMOR0222_ST11_2022_05_29_180118.jpg	18:01:21	29/06/2022	461377.879	5958604.849	461377.417	5958604.469	0.6
ST11	FLOMOR0222_ST11_2022_05_29_180200.jpg	18:02:03	29/06/2022	461377.879	5958604.849	461379.423	5958607.901	3.4
ST12	FLOMOR0222_ST12_2022_05_29_182109.jpg	18:21:12	29/06/2022	462611.030	5959649.039	462627.519	5959640.264	18.7
ST12	FLOMOR0222_ST12_2022_05_29_182151.jpg	18:21:54	29/06/2022	462611.030	5959649.039	462619.814	5959643.470	10.4
ST12	FLOMOR0222_ST12_2022_05_29_182229.jpg	18:22:32	29/06/2022	462611.030	5959649.039	462618.416	5959649.934	7.4
ST12	FLOMOR0222_ST12_2022_05_29_182310.jpg	18:23:14	29/06/2022	462611.030	5959649.039	462623.534	5959655.456	14.1
ST12	FLOMOR0222_ST12_2022_05_29_182419.jpg	18:24:23	29/06/2022	462611.030	5959649.039	462626.960	5959655.429	17.2
ST13	FLOMOR0222_ST13_2022_06_01_075355.jpg	07:53:51	01/06/2022	464297.252	5959542.956	464315.705	5959537.103	19.4
ST13	FLOMOR0222_ST13_2022_06_01_075439.jpg	07:54:35	01/06/2022	464297.252	5959542.956	464308.577	5959535.600	13.5

Appendix VI - Morecambe OWF grab survey logs

Station Details				Sampling Details			Metadata					Positional Data											
Station I.D.	Attempt No.	Sample Type (as per SoW)	Sampled Type (Post-Survey)	Method	Vessel	Personnel (Initials)	Wind Direction	Wind Force (Beaufort)	Tide Direction	Tide Rate (knots)	Water Depth (m)	Fix Number	Date	Time (UTC)	Target Latitude (DD)	Target Longitude (DD)	Target Easting	Target Northing	Sampled Latitude (DD)	Sampled Longitude (DD)	Sampled Easting	Sampled Northing	Coordinate System
ST01	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.3	37	3074	06/06/2022	09:46:50	53.759357	-3.613913	459526.752	5956923.006	53.759304	-3.613803	459534.014	5956917.060	WGS 84 / UTM Zone 30N
ST01	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.3	37	3075	06/06/2022	09:53:05	53.759357	-3.613913	459526.752	5956923.006	53.759344	-3.613876	459529.217	5956921.522	WGS 84 / UTM Zone 30N
ST02	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.5	36	3071	06/06/2022	09:23:05	53.761870	-3.588421	461209.685	5957188.416	53.761874	-3.588412	461210.296	5957188.867	WGS 84 / UTM Zone 30N
ST02	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.5	36	3072	06/06/2022	09:29:59	53.761870	-3.588421	461209.685	5957188.416	53.761852	-3.588389	461211.800	5957186.369	WGS 84 / UTM Zone 30N
ST03	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.9	34	3038	02/06/2022	06:07:48	53.761619	-3.567160	462611.030	5957149.039	53.761656	-3.567073	462616.772	5957153.161	WGS 84 / UTM Zone 30N
ST04	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.9	33	3035	02/06/2022	05:25:08	53.761724	-3.544407	464111.030	5957149.039	53.761759	-3.544359	464114.242	5957152.832	WGS 84 / UTM Zone 30N
ST05	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	1.3	33	3031	02/06/2022	04:30:15	53.761826	-3.521655	465611.030	5957149.039	53.761960	-3.521688	465608.928	5957163.974	WGS 84 / UTM Zone 30N
ST05	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	1.1	33	3032	02/06/2022	04:49:59	53.761826	-3.521655	465611.030	5957149.039	53.761856	-3.521741	465605.363	5957152.496	WGS 84 / UTM Zone 30N
ST06	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	1.3	33	3030	02/06/2022	04:12:12	53.759772	-3.502480	466873.419	5956911.428	53.759793	-3.502608	466865.056	5956913.891	WGS 84 / UTM Zone 30N
ST07	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F2 - 4-6 knots (Light breeze)	E	0.8	37	3081	06/06/2022	11:11:28	53.783553	-3.681035	455127.525	5959655.225	53.783527	-3.681098	455123.350	5959652.413	WGS 84 / UTM Zone 30N
ST08	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	E	0.6	34	3080	06/06/2022	10:55:05	53.783623	-3.658521	456611.030	5959649.039	53.783508	-3.658678	456600.557	5959636.344	WGS 84 / UTM Zone 30N
ST09	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	1.1	27	3055	06/06/2022	05:34:04	53.827295	-3.544889	464135.247	5964444.396	53.827169	-3.544904	464134.196	5964430.292	WGS 84 / UTM Zone 30N
ST10	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.6	33	3066	06/06/2022	08:00:17	53.783864	-3.612992	459611.030	5959649.039	53.783911	-3.612980	459611.850	5959654.219	WGS 84 / UTM Zone 30N
ST11	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.6	31	3067	06/06/2022	08:21:37	53.774613	-3.586047	461377.879	5958604.849	53.774553	-3.585970	461382.877	5958598.062	WGS 84 / UTM Zone 30N
ST11	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.6	31	3068	06/06/2022	08:28:49	53.774613	-3.586047	461377.879	5958604.849	53.774565	-3.585945	461384.575	5958599.396	WGS 84 / UTM Zone 30N
ST12	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.6	28	3069	06/06/2022	08:46:46	53.784088	-3.567463	462611.030	5959649.039	53.784084	-3.567493	462609.078	5959648.520	WGS 84 / UTM Zone 30N
ST13	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.5	26	3043	02/06/2022	07:17:30	53.783253	-3.541860	464297.252	5959542.956	53.783301	-3.541898	464294.746	5959548.265	WGS 84 / UTM Zone 30N
ST14	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.9	24	3039	02/06/2022	06:25:43	53.774299	-3.522242	465582.517	5958537.019	53.774294	-3.522241	465582.571	5958536.525	WGS 84 / UTM Zone 30N
ST15	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.7	22	3042	02/06/2022	06:57:42	53.780980	-3.508139	466517.251	5959273.583	53.781083	-3.508254	466509.741	5959285.119	WGS 84 / UTM Zone 30N
ST16	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F2 - 4-6 knots (Light breeze)	E	1.2	37	3084	06/06/2022	11:57:51	53.805697	-3.727200	452111.030	5962149.039	53.805621	-3.727088	452118.354	5962140.503	WGS 84 / UTM Zone 30N
ST17	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F2 - 4-6 knots (Light breeze)	E	1.2	35	3085	06/06/2022	12:13:31	53.805833	-3.704425	453611.030	5962149.039	53.805812	-3.704357	453615.431	5962146.618	WGS 84 / UTM Zone 30N
ST18	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F2 - 4-6 knots (Light breeze)	E	1.4	37	3086	06/06/2022	12:32:42	53.801699	-3.674711	455563.417	5961670.060	53.801836	-3.674799	455557.767	5961685.359	WGS 84 / UTM Zone 30N
ST18	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F2 - 4-6 knots (Light breeze)	E	1.4	37	3087	06/06/2022	12:39:13	53.801699	-3.674711	455563.417	5961670.060	53.801669	-3.674566	455572.934	5961666.635	WGS 84 / UTM Zone 30N
ST19	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.8	33	3065	06/06/2022	07:32:30	53.801737	-3.636314	458092.235	5961650.961	53.801793	-3.636472	458081.880	5961657.323	WGS 84 / UTM Zone 30N
ST20	2	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.8	33	3063	06/06/2022	07:09:48	53.801607	-3.612680	459648.621	5961622.767	53.801598	-3.612716	459646.223	5961621.884	WGS 84 / UTM Zone 30N
ST20	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.8	33	3064	06/06/2022	07:17:29	53.801607	-3.612680	459648.621	5961622.767	53.801597	-3.612799	459640.788	5961621.739	WGS 84 / UTM Zone 30N
ST21	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	1.0	31	3061	06/06/2022	06:50:36	53.801258	-3.590328	461120.428	5961571.479	53.801321	-3.590440	461113.065	5961578.599	WGS 84 / UTM Zone 30N
ST22	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	1.0	25	3058	06/06/2022	06:20:43	53.815544	-3.572808	462287.113	5963151.507	53.815461	-3.572905	462280.667	5963142.330	WGS 84 / UTM Zone 30N
ST22	2	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	1.0	25	3060	06/06/2022	06:32:36	53.815544	-3.572808	462287.113	5963151.507	53.815569	-3.572854	462284.091	5963154.249	WGS 84 / UTM Zone 30N
ST23	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	E	0.1	28	3046	02/06/2022	07:56:11	53.806148	-3.544223	464161.071	5962091.300	53.806187	-3.544127	464167.405	5962095.542	WGS 84 / UTM Zone 30N
ST23	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	E	0.1	28	3047	02/06/2022	08:01:19	53.806148	-3.544223	464161.071	5962091.300	53.806230	-3.544240	464160.002	5962100.416	WGS 84 / UTM Zone 30N
ST24	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	E	0.1	25	3048	02/06/2022	08:17:52	53.807211	-3.521421	465663.487	5962198.327	53.807311	-3.521396	465665.257	5962209.349	WGS 84 / UTM Zone 30N
ST25	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	w	1.3	25	3050	02/06/2022	09:11:47	53.806862	-3.499435	467111.030	5962149.039	53.806922	-3.499428	467111.566	5962155.677	WGS 84 / UTM Zone 30N
ST26	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.5	36	3099	07/06/2022	09:01:44	53.827826	-3.708447	453370.566	5964598.521	53.827841	-3.708422	453372.205	5964600.170	WGS 84 / UTM Zone 30N
ST26	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.5	36	3100	07/06/2022	09:07:29	53.827826	-3.708447	453370.566	5964598.521	53.827830	-3.708401	453373.619	5964598.898	WGS 84 / UTM Zone 30N
ST27	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.6	34	3101	07/06/2022	09:28:09	53.828434	-3.682013	455111.030	5964649.039	53.828498	-3.681926	455116.869	5964656.171	WGS 84 / UTM Zone 30N
ST28	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.8	34	3093	07/06/2022	07:50:44	53.828561	-3.659225	456611.030	5964649.039	53.828598	-3.659170	456614.664	5964653.124	WGS 84 / UTM Zone 30N
ST29	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.8	32	3092	07/06/2022	07:37:26	53.829748	-3.638090	458003.250	5964768.347	53.829856	-3.638155	457999.094	5964780.482	WGS 84 / UTM Zone 30N
ST30	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	1.1	31	3090	07/06/2022	07:02:55	53.827336	-3.609476	459884.226	5964483.519	53.827344	-3.609522	459881.227	5964484.349	WGS 84 / UTM Zone 30N
ST31	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	1.1	30	3088	07/06/2022	06:41:28	53.828917	-3.590859	461111.030	5964649.039	53.828894	-3.590863	461110.737	5964646.436	WGS 84 / UTM Zone 30N
ST31	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	1.1	30	3089	07/06/2022	06:49:30	53.828917	-3.590859	461111.030	5964649.039	53.828997	-3.590891	461108.988	5964657.926	WGS 84 / UTM Zone 30N
ST32	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.5	36	3095	07/06/2022	08:19:48	53.850902	-3.682379	455111.030	5967149.039	53.850952	-3.682267	455118.434	5967154.527	WGS 84 / UTM Zone 30N
ST32	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.5	36	3096	07/06/2022	08:26:13	53.850902	-3.682379	455111.030	5967149.039	53.850913	-3.682381	455110.918	5967150.245	WGS 84 / UTM Zone 30N
ST33	-	PSD & MACRO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ST33	-	CONTAMINANTS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ST34	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.5	30	3070	06/06/2022	09:00:51	53.774185	-3.557435	463263.110	5958542.026	53.774219	-3.557447	463262.310	5958545.807	WGS 84 / UTM Zone 30N
ST35	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.7	34	3036	02/06/2022	05:47:50	53.754578	-3.574860	462097.091	5956369.826	53.754577	-3.574825	462099.420	5956369.610	WGS 84 / UTM Zone 30N
ST35	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.7	34	3037	02/06/2022	05:54:31	53.754578	-3.574860	462097.091	5956369.826	53.754611	-3.574834	462098.863	5956373.457	WGS 84 / UTM Zone 30N
ST36	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.5	36	3097	07/06/2022	08:41:40	53.843830	-3.699583	453971.505	5966373.181	53.843904	-3.699529	453975.187	5966381.368	WGS 84 / UTM Zone 30N
ST37	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.6	34	3094	07/06/2022	08:04:47	53.840330	-3.666338	456155.158	5965962.777	53.840292	-3.666346	456154.618	5965958.520	WGS 84 / UTM Zone 30N
ST38	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.4	31	3044	02/06/2022	07:34:13	53.796950	-3.557820	463257.635	5961074.951	53.797032	-3.557845	463256.054	5961084.075	WGS 84 / UTM Zone 30N
ST38	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	W	0.4	31	3045	02/06/2022	07:40:18	53.796950	-3.557820	463257.635	5961074.951	53.796984	-3.557926	463250.667	5961078.782	WGS 84 / UTM Zone 30N
ST39	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	1.1	30	3091	07/06/2022	07:16:42	53.817280	-3.612778	459657.190	5963366.583	53.817340	-3.612816	459654.797	5963373.254	WGS 84 / UTM Zone 30N
ST40	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F3 - 7-10 knots (Gentle breeze)	W	1.4	22	3051	02/06/2022	09:20:41	53.813531	-3.501536	466977.917	5962892.013	53.813522	-3.501498	466980.429	5962891.009	WGS 84 / UTM Zone 30N
ST40	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	ER / KK	NE	F3 - 7-10 knots (Gentle breeze)	W	2.4	22	3052	02/06/2022	09:27:24	53.813531	-3.501536	466977.917	5962892.013	53.813566	-3.501554	466976.772	5962895.912	WGS 84 / UTM Zone 30N
ST41	2	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	E	0.2	35	3079	06/06/2022	10:37:22	53.778993	-3.634833	458167.160	5959119.766	53.778987	-3.634789	458170.012	5959119.084	WGS 84 / UTM Zone 30N
ST42	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.0	38	3076	06/06/2022	10:13:06	53.772118	-3.629121	458536.783	5958351.464	53.772150	-3.629112	458537.406	5958355.045	WGS 84 / UTM Zone 30N
ST42	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	0.0	38	3077	06/06/2022	10:20:03	53.772118	-3.629121	458536.783	5958351.464	53.772082	-3.628966	458546.946	5958347.439	WGS 84 / UTM Zone 30N
ST43	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F2 - 4-6 knots (Light breeze)	E	0.8	34	3082	06/06/2022	11:29:52	53.794020	-3.706304	453474.193	5960836.048	53.793970	-3.706298	453474.558	5960830.465	WGS 84 / UTM Zone 30N
ST43	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F2 - 4-6 knots (Light breeze)	E	0.8	34	3083	06/06/2022	11:36:22	53.794020	-3.706304	453474.193	5960836.048	53.794099	-3.706240	453478.488	5960844.798	WGS 84 / UTM Zone 30N
ST44	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.6	35	3102	07/06/2022	09:41:56	53.818647	-3.679853	455242.801	5963558.811	53.818640	-3.679814	455245.347	5963558.038	WGS 84 / UTM Zone 30N
ST44	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.6	35	3103	07/06/2022	09:48:01	53.818647	-3.679853	455242.801	5963558.811	53.818660	-3.679755	455249.290	5963560.245	WGS 84 / UTM Zone 30N
ST45	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F1 - 1-3 knots (Light air)	E	0.9	27	3049	02/06/2022	08:54:55	53.791864	-3.515431	466045.552	5960487.933	53.791874	-3.515421	466046.255	5960489.078	WGS 84 / UTM Zone 30N
ST46	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F3 - 7-10 knots (Gentle breeze)	E	1.4	22	3053	02/06/2022	09:44:17	53.823428	-3.504545	466787.669	5963994.446	53.823486	-3.504538	466788.125	5964000.980	WGS 84 / UTM Zone 30N
ST47	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NE	F3 - 7-10 knots (Gentle breeze)	E	1.9	25	3054	02/06/2022	10:14:02	53.814747	-3.523907	465505.971	5963037.928	53.814850	-3.523885	465507.546	5963049.400	WGS 84 / UTM Zone 30N
ST48	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.6	33	3104	07/06/2022	10:04:12	53.808624	-3.677860	455363.366	5962442.488	53.808661	-3.677672	455375.793	5962446.451	WGS 84 / UTM Zone 30N
ST48	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	W	F2 - 4-6 knots (Light breeze)	W	0.6	33	3105	07/06/2022	10:10:59	53.808624	-3.677860	455363.366	5962442.488	53.808585	-3.677801	455367.214	5962438.184	WGS 84 / UTM Zone 30N
ST49	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	1.1	25	3056	06/06/2022	05:55:12	53.816349	-3.552392	463631.928	5963230.410	53.816385	-3.552527	463623.071	5963234.429	WGS 84 / UTM Zone 30N
ST49	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	AK / SA	NE	F3 - 7-10 knots (Gentle breeze)	W	1.1	25	3057	06/06/2022	06:03:56	53.816349	-3.552392	463631.928	5963230.410	53.816389	-3.552551	463621.494	5963234.930	WGS 84 / UTM Zone 30N
ST50	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NW	F1 - 1-3 knots (Light air)	W	1.1	34	3033	02/06/2022	05:01:22	53.755696	-3.527069	465249.064	5956469.728	53.755689	-3.527025	465251.924	5956468.987	WGS 84 / UTM Zone 30N
ST50	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	ER / KK	NW	F1 - 1-3 knots (Light air)	W	1.1	34	3034	02/06/2022	05:09:32	53.755696	-3.527069	465249.064	5956469.728	53.755651	-3.527082	465248.130	5956464.700	WGS 84 / UTM Zone 30N
ST51	1	PSD & MACRO	PSD & MACRO	Day Grab	Seren Las	ER / KK	NW	F1 - 1-3 knots (Light air)	W	0.7	22	3040	02/06/2022	06:42:32	53.775538	-3.501746	466934.211	5958665.120	53.775545	-3.501759	466933.351	5958665.936	WGS 84 / UTM Zone 30N
ST51	1	CONTAMINANTS	CONTAMINANTS	Day Grab	Seren Las	ER / KK	NW	F1 - 1-3 knots (Light air)	W	0.7	22	3041	02/06/2022	06:48:15	53.775538	-3.501746	466934.211	5958665.120	53.775568	-3.501789	466931.389	5958668.482	WGS 84 / UTM Zone 30N

Appendix VII(a) - Morecambe OWF grab sample photos (Unreleased).

FLOMOR0222_ST01_MMO SAMPLES | FLOMOR0222_ST01_PSA MACRO | FLOMOR0222_ST02_MMO SAMPLES | FLOMOR0222_ST02_PSA MACRO | FLOMOR0222_ST07_PSA MACRO | FLOMOR0222_ST08_PSA MACRO

FLOMOR0222_ST09_PSA MACRO | FLOMOR0222_ST10_PSA MACRO | FLOMOR0222_ST11_MMO SAMPLES | FLOMOR0222_ST11_PSA MACRO | FLOMOR0222_ST12_PSA MACRO | FLOMOR0222_ST16_PSA MACRO

FLOMOR0222_ST17_PSA MACRO | FLOMOR0222_ST18_MMO SAMPLES | FLOMOR0222_ST18_PSA MACRO | FLOMOR0222_ST19_PSA MACRO | FLOMOR0222_ST20_MMO SAMPLES | FLOMOR0222_ST20_PSA MACRO

FLOMOR0222_ST21_PSA MACRO | FLOMOR0222_ST22_MMO SAMPLES | FLOMOR0222_ST22_PSA MACRO | FLOMOR0222_ST26_MMO SAMPLES | FLOMOR0222_ST26_PSA MACRO | FLOMOR0222_ST27_PSA MACRO

FLOMOR0222_ST28_PSA MACRO | FLOMOR0222_ST29_PSA MACRO | FLOMOR0222_ST30_PSA MACRO | FLOMOR0222_ST31_MMO SAMPLES | FLOMOR0222_ST31_PSA MACRO | FLOMOR0222_ST32_MMO SAMPLES

FLOMOR0222_ST32_PSA MACRO | FLOMOR0222_ST34_PSA MACRO | FLOMOR0222_ST36_PSA MACRO | FLOMOR0222_ST37_PSA MACRO | FLOMOR0222_ST39_PSA MACRO | FLOMOR0222_ST41_PSA MACRO

FLOMOR0222_ST42_MMO SAMPLES | FLOMOR0222_ST42_PSA MACRO | FLOMOR0222_ST43_MMO SAMPLES | FLOMOR0222_ST43_PSA MACRO | FLOMOR0222_ST44_MMO SAMPLES | FLOMOR0222_ST44_PSA MACRO

FLOMOR0222_ST48_MMO SAMPLES | FLOMOR0222_ST48_PSA MACRO | FLOMOR0222_ST49_MMO SAMPLES | FLOMOR0222_ST49_PSA MACRO

Appendix VII(b) - Morecambe OWF grab sample photos (released)


FLOMOR0222_ST01_RELEASED


FLOMOR0222_ST02_RELEASED


FLOMOR0222_ST07_RELEASED


FLOMOR0222_ST08_RELEASED


FLOMOR0222_ST09_RELEASED


FLOMOR0222_ST10_RELEASED


FLOMOR0222_ST11_RELEASED


FLOMOR0222_ST12_RELEASED


FLOMOR0222_ST16_RELEASED


FLOMOR0222_ST17_RELEASED


FLOMOR0222_ST18_RELEASED


FLOMOR0222_ST19_RELEASED


FLOMOR0222_ST20_RELEASED


FLOMOR0222_ST21_RELEASED


FLOMOR0222_ST22_RELEASED


FLOMOR0222_ST26_RELEASED


FLOMOR0222_ST27_RELEASED


FLOMOR0222_ST28_RELEASED


FLOMOR0222_ST29_RELEASED


FLOMOR0222_ST30_RELEASED


FLOMOR0222_ST31_RELEASED


FLOMOR0222_ST32_RELEASED


FLOMOR0222_ST34_RELEASED


FLOMOR0222_ST36_RELEASED


FLOMOR0222_ST37_RELEASED


FLOMOR0222_ST39_RELEASED


FLOMOR0222_ST41_RELEASED


FLOMOR0222_ST42_RELEASED


FLOMOR0222_ST43_RELEASED


FLOMOR0222_ST44_RELEASED


FLOMOR0222_ST48_RELEASED

Appendix VII(c) - Morecambe OWF grab sample photos (sieved)


FLOMOR0222_ST01_SIEVED


FLOMOR0222_ST02_SIEVED


FLOMOR0222_ST07_SIEVED


FLOMOR0222_ST08_SIEVED


FLOMOR0222_ST10_SIEVED


FLOMOR0222_ST11_SIEVED


FLOMOR0222_ST12_SIEVED


FLOMOR0222_ST16_SIEVED


FLOMOR0222_ST17_SIEVED


FLOMOR0222_ST18_SIEVED


FLOMOR0222_ST19_SIEVED


FLOMOR0222_ST20_SIEVED


FLOMOR0222_ST21_SIEVED


FLOMOR0222_ST22_SIEVED


FLOMOR0222_ST26_SIEVED


FLOMOR0222_ST27_SIEVED


FLOMOR0222_ST28_SIEVED


FLOMOR0222_ST29_SIEVED


FLOMOR0222_ST30_SIEVED


FLOMOR0222_ST31_SIEVED


FLOMOR0222_ST32_SIEVED


FLOMOR0222_ST34_SIEVED


FLOMOR0222_ST36_SIEVED


FLOMOR0222_ST37_SIEVED


FLOMOR0222_ST39_SIEVED


FLOMOR0222_ST41_SIEVED


FLOMOR0222_ST42_SIEVED


FLOMOR0222_ST43_SIEVED


FLOMOR0222_ST44_SIEVED


FLOMOR0222_ST48_SIEVED


FLOMOR0222_ST49_SIEVED

Appendix VIII - PSD raw data

Aperture (μm)	ST01	ST02	ST03	ST04	ST05	ST06	ST07	ST08	ST09	ST10	ST11	ST12	ST13	ST14	ST15	ST16	ST17	ST18	ST19	ST20	ST21	ST22	ST23	ST24	ST25
63000.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45000.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31500.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22400.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16000.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11200.000	4.135	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8000.000	3.796	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080	0.000	0.000	0.000	0.000	0.000	0.056	0.000	0.000	0.000	0.000	0.028	0.000
5600.000	3.832	0.000	0.001	0.000	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.020	0.000	0.022	0.029	0.000	0.024	0.000	0.000	0.009	0.014	0.000	0.000	0.000
4000.000	3.303	0.000	0.013	0.002	0.006	0.018	0.042	0.088	0.007	0.000	0.000	0.000	0.040	0.000	0.022	0.052	0.061	0.005	0.012	0.004	0.004	0.010	0.003	0.000	0.000
2800.000	2.912	0.003	0.004	0.002	0.004	0.000	0.015	0.028	0.018	0.000	0.002	0.011	0.068	0.003	0.020	0.054	0.057	0.014	0.015	0.002	0.002	0.016	0.002	0.006	0.002
2000.000	2.624	0.006	0.006	0.002	0.004	0.002	0.023	0.039	0.015	0.013	0.002	0.004	0.108	0.003	0.020	0.061	0.051	0.016	0.017	0.006	0.002	0.010	0.006	0.008	0.002
1400.000	3.264	0.014	0.010	0.004	0.016	0.007	0.063	0.049	0.029	0.007	0.006	0.017	0.196	0.010	0.031	0.100	0.067	0.011	0.012	0.015	0.006	0.019	0.006	0.013	0.007
1000.000	2.122	0.030	0.043	0.022	0.018	0.027	0.341	0.209	0.044	0.016	0.043	0.056	0.148	0.016	0.034	0.192	0.084	0.022	0.023	0.015	0.013	0.042	0.016	0.024	0.022
707.000	2.622	2.208	0.447	0.001	0.219	0.000	5.251	7.176	0.000	1.440	0.358	0.353	0.594	0.003	0.000	4.985	4.365	0.914	1.897	0.504	0.000	1.255	0.000	0.000	0.000
500.000	4.862	6.412	5.370	2.404	0.125	0.007	10.522	18.535	0.017	8.736	6.032	6.771	5.413	1.044	0.006	9.299	14.225	5.117	3.438	2.332	1.827	7.368	0.012	0.355	0.006
353.600	7.947	15.531	10.237	8.257	1.322	2.424	20.459	28.507	6.115	25.208	15.538	18.241	23.094	8.158	4.487	17.203	25.276	8.572	6.037	6.005	7.034	28.037	3.963	12.958	3.743
250.000	16.722	20.858	17.000	7.348	8.205	5.274	35.584	28.462	24.886	33.367	14.148	18.385	24.375	26.637	23.748	31.928	32.484	22.210	16.124	8.387	5.920	34.356	10.823	25.768	11.227
176.800	21.438	30.403	31.742	30.082	17.642	15.663	24.762	14.971	23.754	25.016	28.576	19.271	14.937	28.716	24.000	21.794	20.753	29.055	43.396	38.373	32.257	16.442	17.113	13.627	7.811
125.000	7.979	10.638	16.696	24.967	22.206	26.720	2.911	1.933	11.487	6.127	16.430	14.026	10.227	14.025	11.898	3.488	2.575	8.183	17.440	25.027	28.938	5.105	22.706	9.178	14.757
88.390	0.297	0.708	1.035	2.886	6.531	8.201	0.002	0.002	1.204	0.070	1.324	1.808	1.470	2.134	1.948	0.379	0.002	0.141	0.924	2.259	3.302	0.293	5.518	3.677	9.417
62.500	0.231	0.005	0.011	0.653	2.220	2.932	0.000	0.000	0.095	0.000	0.010	0.415	0.590	0.804	0.636	0.276	0.000	0.429	0.567	0.535	0.587	0.069	0.873	1.686	5.749
44.190	0.806	0.753	0.863	2.081	4.623	4.627	0.000	0.000	1.559	0.000	1.087	1.539	1.370	1.649	2.570	0.861	0.000	1.760	0.921	1.149	1.599	0.442	3.117	2.615	5.780
31.250	0.846	0.777	1.280	1.357	3.445	3.200	0.000	0.000	1.975	0.000	0.862	1.582	1.497	1.141	2.129	0.772	0.000	1.745	0.566	0.884	1.175	0.389	2.826	2.293	4.238
22.097	0.776	0.902	1.137	1.358	3.034	2.729	0.000	0.000	2.055	0.000	1.009	1.617	1.579	1.260	2.247	0.833	0.000	1.760	0.770	0.859	1.168	0.429	2.822	2.230	3.647
15.625	0.902	1.130	1.285	1.948	2.807	2.480	0.000	0.000	2.282	0.000	1.337	1.829	1.781	1.641	2.462	0.919	0.000	2.284	0.843	1.254	1.641	0.539	3.256	2.672	3.752
11.049	1.263	1.324	1.821	2.180	3.274	3.060	0.000	0.000	2.832	0.000	1.498	2.164	2.025	1.635	2.886	1.019	0.000	2.826	0.918	1.501	1.821	0.733	3.919	3.256	4.154
7.813	1.523	1.748	2.348	2.609	4.455	4.124	0.000	0.000	3.975	0.000	2.029	2.431	2.239	2.105	3.774	1.208	0.000	3.153	1.253	1.704	2.401	0.954	4.735	3.894	5.088
5.524	1.547	1.894	2.403	3.317	5.010	4.592	0.000	0.000	4.425	0.000	2.520	2.468	2.282	2.527	4.241	1.274	0.000	3.190	1.341	2.313	2.901	0.997	4.994	4.161	5.533
3.906	1.293	1.524	1.954	2.944	4.354	4.011	0.000	0.000	3.818	0.000	2.304	2.084	1.875	2.143	3.744	1.021	0.000	2.650	1.055	2.240	2.475	0.775	4.158	3.548	4.674
2.762	0.911	0.878	1.285	1.615	2.983	2.821	0.000	0.000	2.657	0.000	1.367	1.465	1.199	1.219	2.645	0.606	0.000	1.782	0.634	1.353	1.394	0.450	2.744	2.403	3.076
1.953	0.543	0.476	0.751	0.806	1.749	1.686	0.000	0.000	1.576	0.000	0.738	0.857	0.668	0.651	1.552	0.338	0.000	0.969	0.366	0.694	0.736	0.237	1.522	1.328	1.724
1.381	0.315	0.411	0.502	0.764	1.144	1.069	0.000	0.000	0.996	0.000	0.675	0.493	0.446	0.587	0.937	0.289	0.000	0.528	0.306	0.602	0.677	0.193	0.931	0.768	1.109
0.977	0.217	0.371	0.379	0.674	0.926	0.835	0.000	0.000	0.785	0.000	0.584	0.354	0.349	0.523	0.712	0.275	0.000	0.397	0.290	0.556	0.601	0.199	0.743	0.599	0.905
0.691	0.188	0.265	0.291	0.403	0.823	0.747	0.000	0.000	0.714	0.000	0.362	0.326	0.277	0.344	0.652	0.216	0.000	0.396	0.237	0.384	0.382	0.180	0.682	0.575	0.803
0.488	0.178	0.176	0.239	0.231	0.734	0.682	0.000	0.000	0.662	0.000	0.223	0.320	0.232	0.212	0.618	0.153	0.000	0.409	0.173	0.239	0.222	0.143	0.629	0.559	0.713
0.345	0.165	0.136	0.214	0.210	0.636	0.603	0.000	0.000	0.591	0.000	0.202	0.303	0.211	0.172	0.562	0.110	0.000	0.393	0.123	0.181	0.177	0.107	0.556	0.513	0.616
0.244	0.146	0.122	0.196	0.238	0.526	0.507	0.000	0.000	0.498	0.000	0.215	0.269	0.193	0.174	0.481	0.086	0.000	0.350	0.088	0.172	0.186	0.077	0.465	0.438	0.510
0.173	0.118	0.107	0.167	0.231	0.399	0.391	0.000	0.000	0.382	0.000	0.197	0.217	0.162	0.165	0.374	0.067	0.000	0.280	0.063	0.160	0.186	0.052	0.355	0.338	0.387
0.122	0.092	0.089	0.134	0.194	0.294	0.293	0.000	0.000	0.285	0.000	0.158	0.168	0.129	0.142	0.281	0.054	0.000	0.215	0.046	0.138	0.165	0.036	0.263	0.253	0.286
0.086	0.060	0.063	0.090	0.133	0.184	0.185	0.000	0.000	0.179	0.000	0.105	0.108	0.085	0.100	0.177	0.037	0.000	0.137	0.030	0.098	0.120	0.022	0.165	0.159	0.178
0.061	0.025	0.031	0.041	0.065	0.075	0.076	0.000	0.000	0.073	0.000	0.050	0.044	0.037	0.050	0.072	0.018	0.000	0.056	0.014	0.049	0.061	0.010	0.067	0.064	0.072
0.043	0.003	0.005	0.006	0.010	0.009	0.009	0.000	0.000	0.009	0.000	0.008	0.005	0.005	0.008	0.009	0.003	0.000	0.007	0.002	0.007	0.010	0.002	0.008	0.008	0.009
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Aperture (μm)	ST26	ST27	ST28	ST29	ST30	ST31	ST32	ST34	ST35	ST36	ST37	ST38	ST39	ST40	ST41	ST42	ST43	ST44	ST45	ST46	ST47	ST48	ST49	ST50	ST51
63000.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45000.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31500.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22400.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16000.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.240	0.000
11200.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.039	0.000	0.000	0.000	0.000	0.000
8000.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.143	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.000	0.000	0.000	0.000	0.000
5600.000	0.066	0.015	0.011	0.000	0.000	0.000	0.033	0.065	0.000	0.183	0.000	0.000	0.004	0.000	0.028	0.017	0.045	0.031	0.000	0.024	0.000	0.000	0.000	0.000	0.099
4000.000	0.066	0.046	0.005	0.000	0.000	0.005	0.168	0.013	0.011	0.173	0.011	0.002	0.000	0.003	0.094	0.152	0.093	0.052	0.002	0.012	0.004	0.021	0.006	0.032	0.007
2800.000	0.050	0.011	0.020	0.004	0.005	0.005	0.016	0.015	0.008	0.045	0.025	0.002	0.004	0.002	0.081	0.030	0.051	0.048	0.002	0.021	0.008	0.046	0.017	0.073	0.022
2000.000	0.050	0.017	0.007	0.006	0.003	0.005	0.022	0.013	0.002	0.063	0.008	0.004	0.011	0.009	0.115	0.040	0.071	0.044	0.007	0.026	0.010	0.025	0.014	0.202	0.136
1400.000	0.081	0.013	0.005	0.006	0.008	0.010	0.008	0.018	0.022	0.060	0.011	0.006	0.014	0.014	0.253	0.043	0.045	0.042	0.004	0.082	0.018	0.061	0.013	0.482	0.029
1000.000	0.078	0.036	0.016	0.013	0.014	0.023	0.022	0.030	0.233	0.065	0.099	0.006	0.097	0.024	1.084	0.225	0.379	0.040	0.020	0.645	0.024	0.167	0.044	0.938	0.020
707.000	2.167	1.167	0.033	0.001	0.000	0.000	1.482	0.235	2.712	2.331	1.686	0.000	1.909	0.000	3.923	2.509	7.731	2.339	0.000	12.431	0.000	2.623	0.000	0.202	0.005
500.000	5.500	4.774	2.743	2.053	1.234	0.122	3.992	3.437	8.693	4.964	4.407	0.000	4.466	0.053	8.863	7.579	22.118	5.618	0.010	29.717	0.015	8.830	0.258	3.919	2.639
353.600	20.068	18.366	6.454	7.278	5.659	2.051	13.009	10.033	18.163	19.154	13.105	0.635	11.149	13.382	20.252	14.944	26.715	11.839	3.110	32.959	5.083	16.165	9.389	6.738	15.062
250.000	39.191	39.471	22.222	10.862	6.796	6.008	35.807	8.664	19.644	37.568	36.193	5.181	19.170	37.119	31.110	26.862	22.712	31.217	6.195	16.756	21.201	30.736	22.529	8.720	32.815
176.800	25.841	29.379	42.590	41.432	38.565	27.173	27.848	26.823	30.332	20.715	36.969	13.764	35.496	20.086	23.645	31.351	14.772	33.043	8.169	3.799	21.018	31.252	23.638	24.998	21.264
125.000	3.108	3.725	10.506	17.653	29.551	28.083	5.295	27.908	9.932	3.649	7.475	20.615	15.581	3.931	5.016	8.361	2.174	5.462	13.667	0.782	11.007	5.641	12.231	21.702	6.155
88.390	0.326	0.003	0.743	1.323	2.655	3.923	0.652	3.730	0.529	0.680	0.012	6.729	1.002	0.798	0.154	0.141	0.179	0.425	7.383	0.155	1.547	0.168	0.841	2.791	1.387
62.500	0.171	0.057	0.001	0.001	0.021	0.131	0.328	0.713	0.444	0.035	0.000	3.124	0.009	0.028	0.123	0.134	0.149	0.188	5.803	0.113	0.878	0.218	0.083	1.258	0.019
44.190	0.248	0.249	0.549	0.887	1.095	1.659	0.957	1.561	0.769	0.799	0.000	5.116	0.658	1.746	0.401	0.579	0.241	0.669	6.256	0.213	3.007	0.244	1.608	2.655	1.374
31.250	0.194	0.189	0.871	1.154	0.903	2.409	0.745	1.109	0.619	0.672	0.000	4.399	0.634	1.389	0.337	0.473	0.185	0.549	5.239	0.141	2.850	0.234	1.985	2.277	1.142
22.097	0.210	0.194	0.905	1.189	0.995	2.039	0.764	1.070	0.677	0.736	0.000	4.286	0.683	1.365	0.365	0.529	0.199	0.616	4.676	0.184	2.869	0.258	1.882	2.076	1.186
15.625	0.232	0.184	1.082	1.523	1.014	2.406	0.973	1.488	0.803	0.811	0.000	4.436	0.805	2.082	0.367	0.570	0.195	0.792	4.950	0.212	3.359	0.333	2.342	2.083	1.731
11.049	0.304	0.283	1.307	1.690	1.202	3.347	1.109	1.630	0.966	0.945	0.000	5.075	0.960	2.132	0.530	0.742	0.274	0.981	5.406	0.272	3.897	0.412	2.821	2.693	1.810
7.813	0.406	0.370	1.860	2.420	1.907	4.207	1.383	2.161	1.190	1.250	0.000	5.817	1.393	2.866	0.694	1.001	0.346	1.229	5.934	0.291	4.641	0.494	3.750	3.280	2.431
5.524	0.416	0.360	2.115	2.826	2.197	4.342	1.539	2.608	1.231	1.334	0.000	5.835	1.608	3.591	0.678	1.039	0.333	1.345	6.207	0.246	5.018	0.509	4.192	3.383	3.040
3.906	0.316	0.274	1.808	2.431	1.864	3.609	1.246	2.205	0.963	1.068	0.000	4.718	1.354	3.155	0.510	0.805	0.249	1.097	5.280	0.163	4.266	0.401	3.644	2.831	2.614
2.762	0.189	0.173	1.115	1.444	1.167	2.477	0.715	1.244	0.558	0.645	0.000	3.087	0.820	1.747	0.311	0.486	0.152	0.652	3.537	0.090	2.823	0.245	2.529	1.956	1.423
1.953	0.111	0.107	0.638	0.810	0.684	1.437	0.385	0.670	0.302	0.379	0.000	1.702	0.456	0.961	0.185	0.279	0.094	0.348	1.909	0.054	1.533	0.139	1.472	1.123	0.756
1.381	0.099	0.088	0.546	0.723	0.577	0.856	0.337	0.618	0.257	0.334	0.000	1.020	0.387	0.935	0.155	0.227	0.084	0.281	1.088	0.053	0.913	0.113	0.903	0.636	0.725
0.977	0.105	0.088	0.487	0.613	0.506	0.643	0.321	0.548	0.252	0.312	0.000	0.812	0.359	0.735	0.156	0.219	0.087	0.275	0.861	0.064	0.736	0.121	0.702	0.453	0.602
0.691	0.100	0.084	0.349	0.386	0.359	0.592	0.245	0.351	0.206	0.242	0.000	0.761	0.271	0.382	0.145	0.190	0.082	0.230	0.841	0.070	0.693	0.120	0.644	0.415	0.342
0.488	0.086	0.074	0.239	0.247	0.240	0.567	0.167	0.208	0.149	0.174	0.000	0.716	0.187	0.245	0.122	0.150	0.070	0.172	0.826	0.069	0.651	0.109	0.604	0.408	0.205
0.345	0.070	0.062	0.192	0.225	0.185	0.522	0.121	0.168	0.106	0.132	0.000	0.638	0.138	0.302	0.097	0.111	0.056	0.125	0.759	0.064	0.580	0.093	0.544	0.386	0.210
0.244	0.054	0.050	0.175	0.236	0.168	0.453	0.097	0.175	0.078	0.108	0.000	0.533	0.115	0.346	0.074	0.081	0.043	0.091	0.648	0.056	0.482	0.076	0.460	0.345	0.237
0.173	0.039	0.037	0.151	0.213	0.151	0.358	0.080	0.171	0.058	0.087	0.000	0.406	0.096	0.275	0.053	0.055	0.031	0.065	0.500	0.045	0.363	0.057	0.353	0.280	0.209
0.122	0.029	0.028	0.123	0.171	0.129	0.273	0.065	0.150	0.044	0.069	0.000	0.301	0.078	0.175	0.038	0.039	0.022	0.048	0.373	0.036	0.266	0.043	0.262	0.218	0.158
0.086	0.019	0.018	0.084	0.114	0.092	0.175	0.045	0.107	0.029	0.047	0.000	0.188	0.055	0.086	0.025	0.024	0.014	0.031	0.234	0.025	0.164	0.028	0.164	0.141	0.097
0.061	0.009	0.009	0.041	0.055	0.047	0.073	0.022	0.054	0.014	0.023	0.000	0.077	0.027	0.031	0.012	0.011	0.007	0.015	0.094	0.012	0.066	0.014	0.067	0.059	0.044
0.043	0.001	0.001	0.007	0.009	0.008	0.009	0.004	0.009	0.002	0.004	0.000	0.009	0.004	0.004	0.002	0.002	0.001	0.002	0.011	0.002	0.008	0.002	0.008	0.007	0.007
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Appendix IX - PSD summary data

Station	Treatment	Textural Group Classification	Folk and Ward Description	Folk and Ward Sorting	Mean µm	Mean phi	Sorting Coefficient	Skewness	Kurtosis	Major Sediment Fractions		
										% Gravel	% Sand	% Mud
ST01	Sediment	Gravelly Muddy Sand	Coarse Sand	Very Poorly Sorted	536.1	0.900	6.794	0.261	1.664	20.6%	67.5%	11.9%
ST02	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	237.7	2.073	2.696	-0.288	2.819	0.0%	86.8%	13.2%
ST03	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	141.5	2.821	3.601	-0.564	2.714	0.0%	82.6%	17.4%
ST04	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	87.54	3.514	4.391	-0.645	2.369	0.0%	76.6%	23.4%
ST05	Sediment	Muddy Sand	Very Coarse Silt	Very Poorly Sorted	54.74	4.191	5.496	-0.665	0.788	0.0%	58.5%	41.5%
ST06	Sediment	Muddy Sand	Very Coarse Silt	Very Poorly Sorted	55.26	4.178	5.208	-0.684	0.852	0.0%	61.3%	38.7%
ST07	Sediment	Sand	Medium Sand	Moderately Well Sorted	321.7	1.636	1.537	0.180	0.989	0.1%	99.9%	0.0%
ST08	Sediment	Slightly Gravelly Sand	Medium Sand	Moderately Well Sorted	381.0	1.392	1.559	0.060	0.959	0.2%	99.8%	0.0%
ST09	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	73.82	3.760	5.807	-0.742	0.787	0.0%	67.6%	32.3%
ST10	Sediment	Sand	Medium Sand	Moderately Well Sorted	305.2	1.712	1.500	0.044	0.935	0.0%	100.0%	0.0%
ST11	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	146.7	2.769	3.831	-0.537	2.410	0.0%	82.5%	17.5%
ST12	Sediment	Muddy Sand	Fine Sand	Very Poorly Sorted	128.8	2.957	4.408	-0.598	2.039	0.0%	79.3%	20.6%
ST13	Sediment	Slightly Gravelly Muddy Sand	Fine Sand	Poorly Sorted	156.0	2.681	3.928	-0.653	2.026	0.3%	81.0%	18.6%
ST14	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	133.3	2.907	3.499	-0.656	2.518	0.0%	81.5%	18.4%
ST15	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	73.24	3.771	5.562	-0.741	0.801	0.1%	66.8%	33.1%
ST16	Sediment	Slightly Gravelly Muddy Sand	Medium Sand	Poorly Sorted	295.3	1.760	2.496	-0.267	2.722	0.2%	89.6%	10.2%
ST17	Sediment	Slightly Gravelly Sand	Medium Sand	Moderately Well Sorted	340.4	1.555	1.529	0.099	0.926	0.2%	99.8%	0.0%
ST18	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	97.80	3.354	4.962	-0.673	1.285	0.1%	74.7%	25.3%
ST19	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	209.3	2.256	2.319	-0.276	3.522	0.1%	89.9%	10.0%
ST20	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	137.6	2.861	3.029	-0.597	3.515	0.0%	83.5%	16.5%
ST21	Sediment	Muddy Sand	Very Fine Sand	Poorly Sorted	96.58	3.372	3.749	-0.653	3.359	0.0%	79.9%	20.1%
ST22	Sediment	Sand	Medium Sand	Poorly Sorted	299.8	1.738	2.186	-0.378	2.656	0.1%	93.0%	7.0%
ST23	Sediment	Muddy Sand	Very Coarse Silt	Very Poorly Sorted	60.23	4.053	5.357	-0.651	0.769	0.0%	61.0%	39.0%
ST24	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	80.38	3.637	5.646	-0.682	0.799	0.0%	67.3%	32.7%
ST25	Sediment	Muddy Sand	Very Coarse Silt	Very Poorly Sorted	46.93	4.413	5.682	-0.397	0.791	0.0%	52.7%	47.3%
ST26	Sediment	Slightly Gravelly Sand	Medium Sand	Moderately Well Sorted	293.9	1.766	1.511	0.026	1.170	0.2%	96.5%	3.2%
ST27	Sediment	Sand	Medium Sand	Moderately Well Sorted	284.8	1.812	1.461	0.025	1.107	0.1%	97.0%	2.9%
ST28	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	206.0	2.279	2.513	-0.412	3.924	0.0%	85.3%	14.6%
ST29	Sediment	Muddy Sand	Very Fine Sand	Poorly Sorted	106.1	3.237	3.940	-0.684	3.440	0.0%	80.6%	19.4%
ST30	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	160.9	2.636	2.509	-0.504	3.601	0.0%	84.5%	15.5%
ST31	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	63.28	3.982	4.930	-0.729	0.839	0.0%	67.5%	32.5%
ST32	Sediment	Slightly Gravelly Muddy Sand	Medium Sand	Poorly Sorted	251.1	1.994	2.389	-0.403	3.269	0.2%	88.4%	11.3%
ST34	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	125.9	2.990	3.572	-0.510	3.061	0.1%	81.6%	18.3%
ST35	Sediment	Sand	Medium Sand	Poorly Sorted	259.6	1.946	2.492	-0.212	2.360	0.0%	90.7%	9.3%
ST36	Sediment	Slightly Gravelly Muddy Sand	Medium Sand	Poorly Sorted	282.2	1.825	2.406	-0.350	3.204	0.6%	89.2%	10.2%
ST37	Sediment	Sand	Medium Sand	Moderately Well Sorted	269.2	1.893	1.441	0.134	1.081	0.0%	100.0%	0.0%
ST38	Sediment	Muddy Sand	Very Coarse Silt	Very Poorly Sorted	41.52	4.590	5.162	-0.395	0.747	0.0%	50.1%	49.9%
ST39	Sediment	Muddy Sand	Fine Sand	Poorly Sorted	223.4	2.162	2.535	-0.266	2.963	0.0%	88.9%	11.1%
ST40	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	99.50	3.329	4.987	-0.794	1.858	0.0%	75.4%	24.6%
ST41	Sediment	Slightly Gravelly Sand	Medium Sand	Moderately Sorted	302.9	1.723	1.901	-0.136	1.710	0.3%	94.4%	5.3%
ST42	Sediment	Slightly Gravelly Sand	Medium Sand	Poorly Sorted	271.0	1.884	2.288	-0.186	2.650	0.2%	92.1%	7.6%
ST43	Sediment	Slightly Gravelly Sand	Medium Sand	Moderately Sorted	381.4	1.391	1.638	-0.052	0.921	0.3%	97.0%	2.8%
ST44	Sediment	Slightly Gravelly Sand	Medium Sand	Poorly Sorted	261.6	1.934	2.346	-0.238	3.256	0.2%	90.2%	9.6%
ST45	Sediment	Sandy Mud	Very Coarse Silt	Very Poorly Sorted	35.50	4.816	5.651	-0.253	0.799	0.0%	44.4%	55.6%
ST46	Sediment	Slightly Gravelly Sand	Medium Sand	Moderately Well Sorted	457.2	1.129	1.537	-0.088	1.106	0.2%	97.4%	2.4%
ST47	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	68.08	3.877	5.696	-0.692	0.714	0.0%	60.8%	39.2%
ST48	Sediment	Sand	Medium Sand	Moderately Well Sorted	287.5	1.798	1.593	0.104	1.122	0.1%	95.9%	4.0%
ST49	Sediment	Muddy Sand	Very Fine Sand	Very Poorly Sorted	77.32	3.693	5.722	-0.717	0.834	0.0%	69.0%	30.9%
ST50	Sediment	Slightly Gravelly Muddy Sand	Very Fine Sand	Very Poorly Sorted	83.49	3.582	5.055	-0.584	1.259	0.5%	71.7%	27.7%
ST51	Sediment	Slightly Gravelly Muddy Sand	Very Fine Sand	Very Poorly Sorted	122.0	3.035	4.329	-0.737	2.517	0.3%	79.4%	20.3%

Appendix X - Raw PCBs

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008
		Accreditation	MMO*	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB 101**	**PCB 105**	**PCB 110**	**PCB 118**	**PCB 128**	**PCB 138**	**PCB 141**	**PCB 149**	**PCB 151**	**PCB 153**	**PCB 156**
FLOMOR0222 - 01 (A)	MAR01453.001	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 02 (A)	MAR01453.002	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 05 (A)	MAR01453.003	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00012	<0.00008
FLOMOR0222 - 11 (A)	MAR01453.004	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 18 (A)	MAR01453.005	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 20 (A)	MAR01453.006	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 22 (A)	MAR01453.007	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 23 (A)	MAR01453.008	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
tified Reference Material Quasimeme QOR149MS (% Recovery)			72	72	83	84	88	102	112	73	65	93	91
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 26 (A)	MAR01453.009	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 31 (A)	MAR01453.010	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00009	<0.00008
FLOMOR0222 - 32 (A)	MAR01453.011	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 35 (A)	MAR01453.012	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 38 (A)	MAR01453.013	Sediment	<0.00008	<0.00008	<0.00008	0.00013	<0.00008	0.00014	<0.00008	<0.00008	<0.00008	0.00015	<0.00008
FLOMOR0222 - 40 (A)	MAR01453.014	Sediment	<0.00008	<0.00008	<0.00008	0.00011	<0.00008	0.00008	<0.00008	<0.00008	<0.00008	0.00012	<0.00008
FLOMOR0222 - 43 (A)	MAR01453.015	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 44 (A)	MAR01453.016	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 48 (A)	MAR01453.017	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 49 (A)	MAR01453.018	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
tified Reference Material Quasimeme QOR149MS (% Recovery)			87	79	98	103	96	99	123~	98	93	102	77
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 50 (A)	MAR01453.019	Sediment	<0.00008	<0.00008	<0.00008	0.00009	<0.00008	0.00009	<0.00008	<0.00008	<0.00008	0.00011	<0.00008
tified Reference Material Quasimeme QOR149MS (% Recovery)			81	89	91	93	90	104	120~	95	80	98	84
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 42 (B)	MAR01456.001	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
tified Reference Material Quasimeme QOR149MS (% Recovery)			81	89	91	93	90	104	120~	95	80	98	84
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008

		Units	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)	mg/Kg (Dry Weight)
		Method No	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302	ASC/SOP/302
		Limit of Detection	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008	0.00008
		Accreditation	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**PCB 158**	**PCB 170**	**PCB 18**	**PCB 180**	**PCB 183**	**PCB 187**	**PCB 194**	**PCB 28**	**PCB 31**	**PCB 44**	**PCB 47**	**PCB 49**	**PCB 52**	**PCB 66**
FLOMOR0222 - 01 (A)	MAR01453.001	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 02 (A)	MAR01453.002	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 05 (A)	MAR01453.003	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00010
FLOMOR0222 - 11 (A)	MAR01453.004	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 18 (A)	MAR01453.005	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 20 (A)	MAR01453.006	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 22 (A)	MAR01453.007	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00009
FLOMOR0222 - 23 (A)	MAR01453.008	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
tified Reference Material Quasimeme QOR149MS (% Recovery)			98	86	72	84	109	93	71	72	90	98	88	98	95	94
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 26 (A)	MAR01453.009	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 31 (A)	MAR01453.010	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00009	0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00010
FLOMOR0222 - 32 (A)	MAR01453.011	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 35 (A)	MAR01453.012	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 38 (A)	MAR01453.013	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00010	0.00009	<0.00008	0.00019	<0.00008	<0.00008	0.00010
FLOMOR0222 - 40 (A)	MAR01453.014	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00010	<0.00008	0.00009	0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00010
FLOMOR0222 - 43 (A)	MAR01453.015	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 44 (A)	MAR01453.016	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 48 (A)	MAR01453.017	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 49 (A)	MAR01453.018	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
tified Reference Material Quasimeme QOR149MS (% Recovery)			114	77	77	86	92	99	62	71	87	83	79	90	88	93
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 50 (A)	MAR01453.019	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	0.00009
tified Reference Material Quasimeme QOR149MS (% Recovery)			101	80	82	91	106	100	65	73	87	88	83	92	91	94
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
FLOMOR0222 - 42 (B)	MAR01456.001	Sediment	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
tified Reference Material Quasimeme QOR149MS (% Recovery)			101	80	82	91	106	100	65	73	87	88	83	92	91	94
		QC Blank	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008

Appendix X - Raw Physical Data

		Units	% M/M	% M/M
		Method No	WSLM59*	LOI(%MM)*
		Accreditation	UKAS/MMO	N
			Total Organic Carbon	**LOI @ 450**
Client Reference:	**SOCOTEC Ref:**	**Matrix**	–	–
FLOMOR0222 - 01 (A)	MAR01453.001	Sediment	0.17	1.3
FLOMOR0222 - 02 (A)	MAR01453.002	Sediment	0.11	1.0
FLOMOR0222 - 05 (A)	MAR01453.003	Sediment	0.33	1.9
FLOMOR0222 - 11 (A)	MAR01453.004	Sediment	0.18	1.2
FLOMOR0222 - 18 (A)	MAR01453.005	Sediment	0.12	1.0
FLOMOR0222 - 20 (A)	MAR01453.006	Sediment	0.20	1.3
FLOMOR0222 - 22 (A)	MAR01453.007	Sediment	0.36	2.2
FLOMOR0222 - 23 (A)	MAR01453.008	Sediment	0.09	0.9
FLOMOR0222 - 26 (A)	MAR01453.009	Sediment	0.07	0.7
FLOMOR0222 - 31 (A)	MAR01453.010	Sediment	0.32	1.9
FLOMOR0222 - 32 (A)	MAR01453.011	Sediment	0.08	0.9
FLOMOR0222 - 35 (A)	MAR01453.012	Sediment	0.19	1.3
FLOMOR0222 - 38 (A)	MAR01453.013	Sediment	0.46	2.5
FLOMOR0222 - 40 (A)	MAR01453.014	Sediment	0.36	2.1
FLOMOR0222 - 43 (A)	MAR01453.015	Sediment	0.07	0.8
FLOMOR0222 - 44 (A)	MAR01453.016	Sediment	0.14	1.1
FLOMOR0222 - 48 (A)	MAR01453.017	Sediment	0.09	0.9
FLOMOR0222 - 49 (A)	MAR01453.018	Sediment	0.08	0.7
FLOMOR0222 - 50 (A)	MAR01453.019	Sediment	0.34	2.0
FLOMOR0222 - 42 (B)	MAR01456.001	Sediment	0.19	1.5

Appendix X - Raw PAH & THC

		Units	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	µg/Kg (Dry Weight)	mg/Kg
		Method No	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/303/304	ASC/SOP/305
		Limit of Detection	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Accreditation	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	MMO	MMO	MMO	MMO	MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	MMO	UKAS/MMO	UKAS/MMO	MMO
Client Reference:	**SOCOTEC Ref:**	**Matrix**	**ACENAPTH**	**ACENAPHY**	**ANTHRACN**	**BAA**	**BAP**	**BBF**	**BENZGHIP**	**BEP**	**BKF**	**C1N**	**C1PHEN**	**C2N**	**C3N**	**CHRYSENE**	**DBENZAH**	**FLUORANT**	**FLUORENE**	**INDPYR**	**NAPTH**	**PERYLENE**	**PHENANT**	**PYRENE**	**THC**
FLOMOR0222 - 01 (A)	MAR01453.001	Sediment	<1	<1	1.40	4.34	5.97	8.61	7.38	8.05	3.93	9.20	12.3	17.5	11.1	5.44	1.24	8.10	1.58	6.75	4.11	1.91	8.32	8.14	9.07
FLOMOR0222 - 02 (A)	MAR01453.002	Sediment	<1	<1	<1	2.48	3.45	5.37	4.89	5.03	2.63	5.82	5.22	11.8	6.27	3.07	<1	4.86	1.11	3.34	2.46	1.12	4.10	5.10	3.41
FLOMOR0222 - 05 (A)	MAR01453.003	Sediment	1.94	2.62	6.05	16.9	24.3	31.6	28.6	29.1	15.4	25.6	34.0	31.6	25.2	19.5	4.60	32.7	4.79	26.3	8.98	9.06	30.0	32.7	18.3
FLOMOR0222 - 11 (A)	MAR01453.004	Sediment	<1	<1	1.68	4.69	6.63	9.43	8.42	9.38	4.47	9.58	12.7	13.7	11.2	6.35	1.43	8.67	1.57	7.50	3.68	2.23	8.80	9.09	6.52
FLOMOR0222 - 18 (A)	MAR01453.005	Sediment	<1	<1	<1	2.07	3.16	4.07	4.98	4.56	2.05	4.18	5.04	7.54	5.22	2.68	<1	4.43	<1	2.58	2.08	1.06	3.89	4.35	3.33
FLOMOR0222 - 20 (A)	MAR01453.006	Sediment	<1	<1	1.73	4.86	6.62	9.66	8.27	9.58	5.00	9.28	18.3	17.1	16.3	6.60	1.36	8.96	1.71	7.57	3.91	2.47	10.8	10.1	4.50
FLOMOR0222 - 22 (A)	MAR01453.007	Sediment	2.24	2.20	5.54	17.1	25.1	33.3	29.3	31.1	19.7	25.6	35.9	35.5	30.0	21.4	4.89	31.1	4.40	27.6	10.2	8.98	26.4	32.3	33.7
FLOMOR0222 - 23 (A)	MAR01453.008	Sediment	<1	<1	<1	2.85	4.23	5.69	4.82	5.79	3.74	5.14	5.40	11.1	5.57	3.53	<1	5.22	<1	4.93	2.36	1.58	4.50	5.46	7.22
FLOMOR0222 - 26 (A)	MAR01453.009	Sediment	<1	<1	<1	<1	<1	1.78	1.45	1.85	<1	2.05	2.49	6.05	2.10	1.15	<1	1.77	<1	1.24	1.06	<1	1.76	1.86	1.35
rtified Reference Material Quasimeme QPH106MS (% Recovery)			91	132	93	87	92	69	86	87	94	98	79	49	87	88	77	93	85	79	82	76	87	93	104~
		QC Blank	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
FLOMOR0222 - 31 (A)	MAR01453.010	Sediment	2.43	2.96	5.37	18.3	26.8	34.7	30.2	32.3	20.0	29.9	32.9	44.0	28.9	22.2	5.21	33.8	5.63	28.0	12.5	9.33	28.3	34.7	23.8
FLOMOR0222 - 32 (A)	MAR01453.011	Sediment	<1	<1	<1	1.08	1.49	2.21	1.71	2.40	1.29	2.43	3.65	5.06	3.62	1.52	<1	2.29	<1	1.54	1.27	<1	2.29	2.44	1.45
FLOMOR0222 - 35 (A)	MAR01453.012	Sediment	1.23	1.09	2.42	7.71	10.6	13.5	10.9	12.9	5.79	10.5	12.9	14.0	10.9	8.86	1.99	15.7	1.92	9.89	4.84	2.81	11.4	15.6	7.18
FLOMOR0222 - 38 (A)	MAR01453.013	Sediment	2.74	3.26	6.64	20.8	30.5	40.0	35.0	38.3	22.4	33.9	40.1	47.8	37.4	24.4	5.98	40.1	6.29	31.8	15.2	11.1	33.6	40.0	27.3
FLOMOR0222 - 40 (A)	MAR01453.014	Sediment	2.45	2.89	5.23	17.3	25.7	33.6	29.4	31.8	18.0	29.7	29.7	42.5	26.7	18.8	5.30	32.1	5.43	27.6	16.6	8.87	25.8	32.8	18.3
FLOMOR0222 - 43 (A)	MAR01453.015	Sediment	<1	<1	<1	<1	<1	1.11	<1	1.11	<1	1.62	1.34	2.81	1.26	<1	<1	1.02	<1	<1	1.11	<1	1.01	1.23	1.00
FLOMOR0222 - 44 (A)	MAR01453.016	Sediment	<1	<1	<1	1.05	1.70	2.66	2.05	2.53	1.10	2.80	2.93	8.50	2.81	1.45	<1	2.25	<1	1.92	2.90	<1	2.13	2.38	1.42
FLOMOR0222 - 48 (A)	MAR01453.017	Sediment	<1	<1	1.09	2.84	4.34	6.26	5.00	5.93	3.13	5.06	5.95	11.3	4.79	3.88	<1	5.85	1.08	4.02	2.57	1.37	4.86	5.88	4.76
FLOMOR0222 - 49 (A)	MAR01453.018	Sediment	<1	<1	1.21	3.33	4.81	6.30	5.03	6.29	3.01	5.41	6.29	8.05	4.82	4.06	<1	6.40	<1	4.42	2.36	1.94	5.04	6.56	3.62
FLOMOR0222 - 50 (A)	MAR01453.019	Sediment	2.10	2.08	4.69	14.1	20.3	25.3	22.0	24.3	15.0	22.4	23.0	30.3	20.6	17.6	3.73	27.3	4.37	20.2	10.3	6.94	20.8	28.3	16.6
rtified Reference Material Quasimeme QPH106MS (% Recovery)			72	132	85	74	74	74	82	80	80	91	71	56	96	79	74	83	81	67	79	73	77	86	104~
		QC Blank	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
FLOMOR0222 - 42 (B)	MAR01456.001	Sediment	<1	<1	1.01	3.03	4.39	5.93	4.80	5.93	3.36	5.29	6.63	13.9	5.30	4.77	1.14	6.24	<1	4.01	2.67	1.34	5.57	6.33	3.99
rtified Reference Material Quasimeme QPH106MS (% Recovery)			72	132	85	74	74	74	82	80	80	91	71	56	96	79	74	83	81	67	79	73	77	86	107~
		QC Blank	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Appendix X - Raw Trace Metals

		Units	mg/Kg (Dry Weight)							
		Method No	ICPMSS*							
		Limit of Detection	0.5	0.04	0.5	0.5	0.01	0.5	0.5	2
		Accreditation	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO	UKAS/MMO
Client Reference:	SOCOTEC Ref:	Matrix	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Mercury (Hg)	Nickel (Ni)	Lead (Pb)	Zinc (Zn)
FLOMOR0222 - 01 (A)	MAR01453.001	Sediment	8.7	<0.04	12.2	6.5	0.06	10.4	12.2	32.3
FLOMOR0222 - 02 (A)	MAR01453.002	Sediment	5.0	<0.04	8.4	5.2	0.05	6.5	8.8	28.6
FLOMOR0222 - 05 (A)	MAR01453.003	Sediment	5.9	0.08	14.7	8.7	0.11	11.2	15.4	47.8
FLOMOR0222 - 11 (A)	MAR01453.004	Sediment	4.6	<0.04	8.7	6.0	0.06	6.3	9.3	28.8
FLOMOR0222 - 18 (A)	MAR01453.005	Sediment	5.7	<0.04	8.1	5.7	0.05	6.0	8.0	24.3
FLOMOR0222 - 20 (A)	MAR01453.006	Sediment	5.0	0.06	9.2	6.8	0.06	7.3	10.0	29.8
FLOMOR0222 - 22 (A)	MAR01453.007	Sediment	5.8	0.08	13.5	9.0	0.15	10.8	15.4	47.1
FLOMOR0222 - 23 (A)	MAR01453.008	Sediment	4.9	0.05	7.8	11.4	0.06	5.8	7.9	22.4
FLOMOR0222 - 26 (A)	MAR01453.009	Sediment	8.3	0.05	6.6	4.7	0.04	5.3	8.6	27.2
FLOMOR0222 - 31 (A)	MAR01453.010	Sediment	6.7	<0.04	14.7	7.0	0.12	10.8	16.5	47.4
FLOMOR0222 - 32 (A)	MAR01453.011	Sediment	7.1	<0.04	7.1	3.9	0.03	5.1	8.1	26.0
FLOMOR0222 - 35 (A)	MAR01453.012	Sediment	5.8	<0.04	9.8	6.3	0.05	7.2	11.5	32.8
FLOMOR0222 - 38 (A)	MAR01453.013	Sediment	6.0	0.07	16.8	10.2	0.12	12.7	18.2	52.2
FLOMOR0222 - 40 (A)	MAR01453.014	Sediment	6.4	<0.04	15.9	9.5	0.12	11.5	16.1	46.5
FLOMOR0222 - 43 (A)	MAR01453.015	Sediment	9.2	<0.04	6.2	3.7	0.01	5.3	6.4	21.3
FLOMOR0222 - 44 (A)	MAR01453.016	Sediment	6.5	<0.04	6.4	3.9	0.03	5.0	8.5	25.0
FLOMOR0222 - 48 (A)	MAR01453.017	Sediment	6.0	<0.04	6.8	4.0	0.05	4.8	7.6	21.0
FLOMOR0222 - 49 (A)	MAR01453.018	Sediment	4.6	0.05	7.5	5.1	0.05	5.4	8.3	23.8
FLOMOR0222 - 50 (A)	MAR01453.019	Sediment	6.1	0.07	14.8	7.9	0.10	10.3	15.7	44.1
FLOMOR0222 - 42 (B)	MAR01456.001	Sediment	4.6	<0.04	7.2	5.5	0.02	5.6	7.3	22.1
Certified Reference Material SETOC 774 (% Recovery)			100	101	108	100	108	105	99	100
QC Blank			<0.5	<0.04	<0.5	<0.5	<0.01	<0.5	<0.5	<2

Appendix X - Raw Organotins

Client Reference:	OCOTEC Re	Matrix	Dibutyltin (DBT)	Tributyltin (TBT)
		Units	mg/Kg (Dry Weight)	
		Method No	ASC/SOP/301	
		Limit of Detection	0.001	0.001
		Accreditation	UKAS/MMO	UKAS/MMO
FLOMOR0222 - 01 (A)	MAR0145 3.001	Sediment	<0.005	<0.005
FLOMOR0222 - 02 (A)	MAR0145 3.002	Sediment	<0.005	<0.005
FLOMOR0222 - 05 (A)	MAR0145 3.003	Sediment	<0.005	<0.005
FLOMOR0222 - 11 (A)	MAR0145 3.004	Sediment	<0.005	<0.005
Certified Reference Material QSP077MS(% Recovery)			63	55
QC Blank			<0.001	<0.001
FLOMOR0222 - 18 (A)	MAR0145 3.005	Sediment	<0.005	<0.005
FLOMOR0222 - 20 (A)	MAR0145 3.006	Sediment	<0.005	<0.005
FLOMOR0222 - 22 (A)	MAR0145 3.007	Sediment	<0.005	<0.005
FLOMOR0222 - 23 (A)	MAR0145 3.008	Sediment	<0.005	<0.005
FLOMOR0222 - 26 (A)	MAR0145 3.009	Sediment	<0.005	<0.005
FLOMOR0222 - 31 (A)	MAR0145 3.010	Sediment	<0.005	<0.005
FLOMOR0222 - 32 (A)	MAR0145 3.011	Sediment	<0.005	<0.005
FLOMOR0222 - 35 (A)	MAR0145 3.012	Sediment	<0.005	<0.005
FLOMOR0222 - 38 (A)	MAR0145 3.013	Sediment	<0.005	<0.005
FLOMOR0222 - 40 (A)	MAR0145 3.014	Sediment	<0.005	<0.005
Certified Reference Material QSP077MS(% Recovery)			153	120
QC Blank			<0.001	<0.001
FLOMOR0222 - 43 (A)	MAR0145 3.015	Sediment	<0.005	<0.005
FLOMOR0222 - 44 (A)	MAR0145 3.016	Sediment	<0.005	<0.005
FLOMOR0222 - 48 (A)	MAR0145 3.017	Sediment	<0.005	<0.005
FLOMOR0222 - 49 (A)	MAR0145 3.018	Sediment	<0.005	<0.005
FLOMOR0222 - 50 (A)	MAR0145 3.019	Sediment	<0.005	<0.005
Certified Reference Material QSP077MS(% Recovery)			112	70
QC Blank			<0.001	<0.001
FLOMOR0222 - 42 (B)	MAR0145 6.001	Sediment	<0.005	<0.005
Certified Reference Material QSP077MS(% Recovery)			112	70
QC Blank			<0.001	<0.001

Appendix XI – Macrobenthic raw data

taxonName	matrixID	aphiaID	originalN	qualifier	abundanceUnits	ST01 MA	ST02 MA	ST03 MA	ST04 MA	ST05 MA	ST06 MA	ST07 MA	ST08 MA	ST09 MA	ST10 MA	ST11 MA	ST12 MA	ST13 MA	ST14 MA	ST15 MA	ST16 MA	ST17 MA	ST18 MA	ST19 MA	ST20 MA	ST21 MA	ST22 MA	ST23 MA	ST24 MA	ST25 MA	ST26 MA	ST27 MA	ST28 MA	ST29 MA	ST30 MA	ST31 MA	ST32 MA	ST33 MA	ST34 MA	ST35 MA	ST36 MA	ST37 MA	ST38 MA	ST39 MA	ST40 MA	ST41 MA	ST42 MA	ST43 MA	ST44 MA	ST45 MA	ST46 MA	ST47 MA	ST48 MA	ST49 MA	ST50 MA	ST51 MA
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

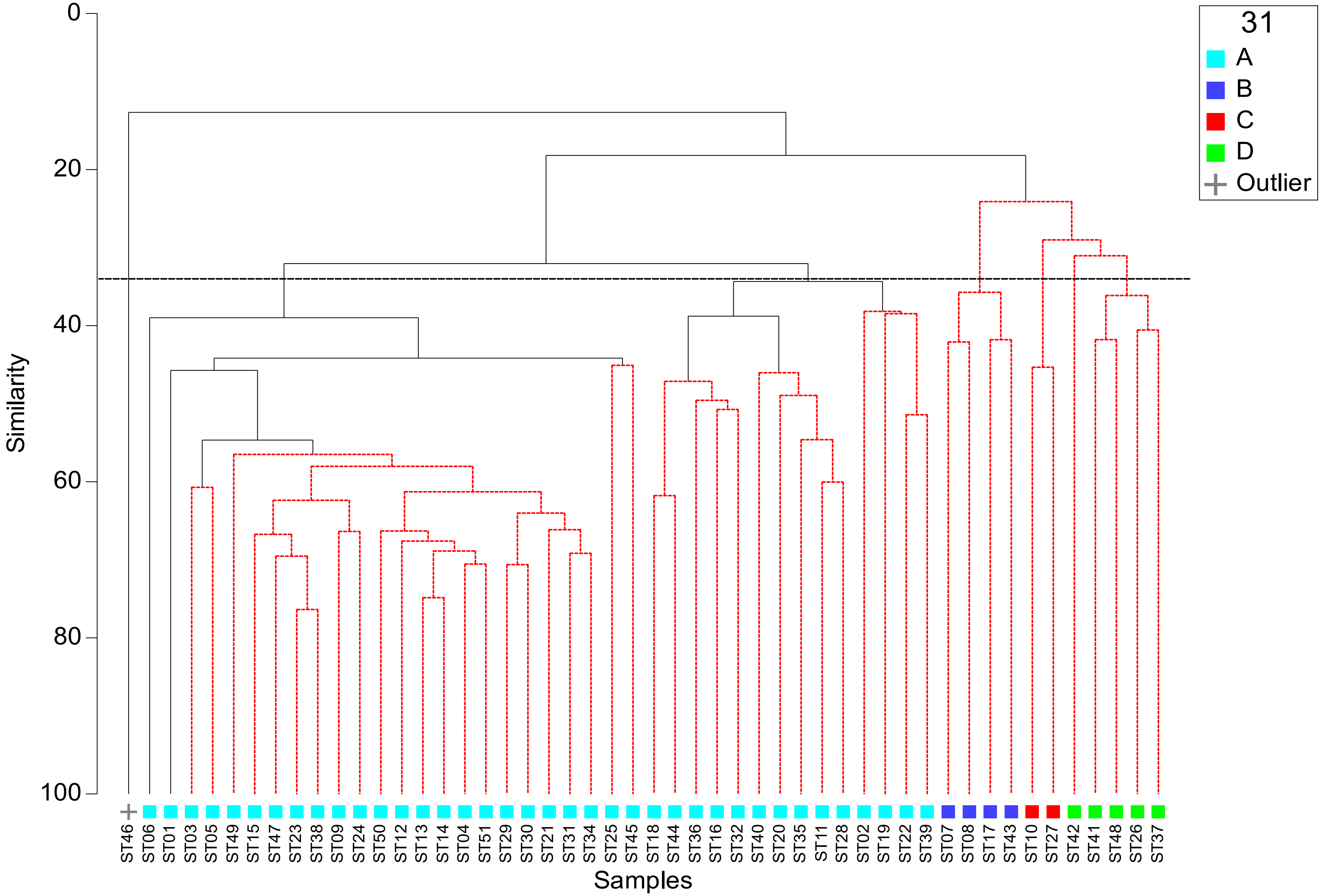
Appendix XII - Macrobenthic biomass presented as Ash Free Dry Weight (AFDW)

	ST01_MA	ST02_MA	ST03_MA	ST04_MA	ST05_MA	ST06_MA	ST07_MA	ST08_MA	ST09_MA	ST10_MA	ST11_MA	ST12_MA	ST13_MA	ST14_MA	ST15_MA	ST16_MA	ST17_MA
MISCELLANIA	0.022506	0.00076	0.035154	0.088025	0.002403	0.001256	0.000357	0.000326	0.248682	0	0.00076	0.133378	0.106888	0.188449	0.04123	0.010246	0.002124
ANNELIDA	0.108376	0.00324	0.003643	0.012509	0.047012	0.020398	0.011517	0.005999	0.04619	0.006572	0.004526	0.02742	0.070665	0.073207	0.0857	0.011424	0.010928
CRUSTACEA	0.037395	0.00315	0	0	0.009293	0.362633	0	0.000315	0.0099	0.001553	0.003465	0.001598	0.038768	0.001148	0.028215	0.001598	0.00072
ECHINODERMATA	0.709944	0.01912	1.053976	1.225504	0.451384	0.380808	0.002352	0.170408	2.579384	0.004648	0.126784	0.849056	1.048424	1.257432	0.908024	0.009728	0.024312
MOLLUSCA	0.052624	0.016108	0.0102	0.036899	0.00629	0.087848	0.007523	0.046963	0.022313	0.000493	0.028654	0.056704	0.049963	0.032326	0.010821	0.00278	0.00023

	ST18_MA	ST19_MA	ST20_MA	ST21_MA	ST22_MA	ST23_MA	ST24_MA	ST25_MA	ST26_MA	ST27_MA	ST28_MA	ST29_MA	ST30_MA	ST31_MA	ST32_MA	ST34_MA	ST35_MA
MISCELLANIA	0.000822	3.10E-05	0	0.329453	0.009316	0.026257	0.155636	0.162688	0.000155	0.342566	0.001147	0.029202	0.065736	0.051088	0.004805	0.048035	0.001845
ANNELIDA	0.092613	0.021871	0.051941	0.037774	0.080616	0.054188	0.039308	0.273575	0.011687	0.010773	0.020553	0.027606	0.075237	0.069797	0.137981	0.022537	0.064449
CRUSTACEA	0.00108	0.00216	0.001148	0.002588	0.001283	0.081068	2.531565	0.22752	0.008483	0.004478	0.000383	0.004838	0.011453	0.007403	0.095918	0.007673	0.000315
ECHINODERMATA	0.015368	0.000808	0.03412	1.352432	0.054736	0.814736	0.366656	0.486704	0.000104	0.003584	0.078904	2.643008	1.218296	2.267112	0.068888	1.301712	0.116992
MOLLUSCA	0.030677	0.003936	0.010838	0.155805	0.006358	0.034026	2.185724	0.036168	0.016601	0.021922	0.020953	0.075965	0.087678	0.173808	0.075455	0.975571	0.003783

	ST36_MA	ST37_MA	ST38_MA	ST39_MA	ST40_MA	ST41_MA	ST42_MA	ST43_MA	ST44_MA	ST45_MA	ST46_MA	ST47_MA	ST48_MA	ST49_MA	ST50_MA	ST51_MA
MISCELLANIA	0.002217	0	0.011703	0.007146	0.008742	0.006169	0.000543	0.00045	0.009037	0.022832	0	0.324012	0.003457	0.124651	0.168144	0.066666
ANNELIDA	0.056591	0.0175	0.005518	0.017996	0.014431	0.013981	0.213466	0.015237	0.008463	0.055583	0.003782	0.0527	0.145065	0.031155	0.029373	0.037975
CRUSTACEA	0.006008	0	0.001013	0.003128	0	0.001958	0.002408	0.001328	0.001485	0.140445	0	0.014423	0.653085	0.006998	0.574088	0.01728
ECHINODERMATA	0.01452	0.017608	4.082616	0.30776	0.040008	0.239096	1.631288	0.000392	0.022024	0.171208	0.00252	0.9846	0.000432	1.040488	0.734768	1.154224
MOLLUSCA	0.024557	0.007727	0.018301	0.010217	0.030498	0	0.020502	0.000536	0.261851	0.061736	0.178917	0.034714	0.002814	0.208344	0.030855	0.017901

Appendix XIII - Dendrogram resulting from cluster analysis



Appendix XIV - Results of SIMPER analysis

Group A
Average similarity: 41.79

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Kurtiella bidentata	7.19	9.31	1.72	22.28	22.28
Amphiura filiformis	6.82	8.82	1.48	21.12	43.4
Nucula nitidosa	1.83	2.55	1.58	6.1	49.5
Phoronis	1.77	1.96	1.05	4.69	54.19
Sthenelais limicola	1.52	1.93	1.16	4.63	58.82
Amphiuridae_Juvenile	1.57	1.54	0.87	3.68	62.5
Pholoe baltica	1.5	1.42	0.89	3.39	65.89
Scalibregma inflatum	1.66	1.23	0.57	2.94	68.82
THRACIOIDEA_Juvenile	0.95	1.04	0.84	2.5	71.32

Group B
Average similarity: 37.80

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
NEMERTEA	3.44	15.37	4.73	40.66	40.66
Spiophanes bombyx	1.29	5.14	7.85	13.61	54.27
THRACIOIDEA_Juvenile	1	2.62	0.9	6.92	61.19
Bathyporeia elegans	0.85	2.41	0.9	6.37	67.56
Nephtys cirrosa	0.96	2.39	0.9	6.33	73.89

Group C
Average similarity: 45.33

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Sthenelais limicola	1.87	9.17	SD=0!	20.23	20.23
Bathyporeia gracilis	1.57	7.49	SD=0!	16.52	36.75
Nephtys cirrosa	1.41	7.49	SD=0!	16.52	53.27
Aglaophamus agilis	1	5.3	SD=0!	11.68	64.96
Amphiuridae_Juvenile	1.21	5.3	SD=0!	11.68	76.64

Group D
Average similarity: 35.11

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Scalibregma inflatum	2.37	6.43	3.06	18.33	18.33
Sthenelais limicola	2.02	5.45	1.11	15.52	33.85
Nephtys cirrosa	1.28	4.33	4.64	12.34	46.2
Scoloplos armiger	1.11	2.86	1.07	8.14	54.33
Lagis koreni	1.29	2.26	1.15	6.43	60.76
THRACIOIDEA_Juvenile	1.04	1.69	0.61	4.81	65.57
Abra alba	0.89	1.41	0.61	4.02	69.59
Scolelepis bonnieri	0.77	1.37	0.59	3.91	73.5

Appendix XV - Seabed imagery still logs

Station	age File Na	Fix Time (UTC)	Date	Target Easting	Target Northing	Sampled Easting	Sampled Northing	Distance from Target (m)
ST02	T02_2022_0	16:56:01	29/05/2022	461209.685	5957188.416	461207.659	5957174.598	14.0
ST02	T02_2022_0	16:56:26	29/05/2022	461209.685	5957188.416	461212.824	5957177.337	11.5
ST02	T02_2022_0	16:57:10	29/05/2022	461209.685	5957188.416	461217.719	5957179.410	12.1
ST02	T02_2022_0	16:58:00	29/05/2022	461209.685	5957188.416	461208.357	5957187.276	1.8
ST02	T02_2022_0	16:58:47	29/05/2022	461209.685	5957188.416	461204.327	5957194.208	7.9
ST02	T02_2022_0	16:59:31	29/05/2022	461209.685	5957188.416	461198.585	5957201.376	17.1
ST03	T03_2022_0	17:35:06	29/05/2022	462611.030	5957149.039	462627.952	5957146.247	17.1
ST03	T03_2022_0	17:35:49	29/05/2022	462611.030	5957149.039	462620.893	5957145.636	10.4
ST03	T03_2022_0	17:36:24	29/05/2022	462611.030	5957149.039	462610.930	5957144.714	4.3
ST03	T03_2022_0	17:37:05	29/05/2022	462611.030	5957149.039	462607.700	5957144.740	5.4
ST03	T03_2022_0	17:37:41	29/05/2022	462611.030	5957149.039	462607.586	5957155.199	7.1
ST04	T04_2022_0	04:21:15	01/06/2022	464111.030	5957149.039	464090.187	5957156.328	22.1
ST04	T04_2022_0	04:21:57	01/06/2022	464111.030	5957149.039	464094.303	5957152.725	17.1
ST04	T04_2022_0	04:22:29	01/06/2022	464111.030	5957149.039	464099.191	5957153.776	12.8
ST04	T04_2022_0	04:22:43	01/06/2022	464111.030	5957149.039	464101.913	5957151.043	9.3
ST04	T04_2022_0	04:23:08	01/06/2022	464111.030	5957149.039	464106.959	5957156.406	8.4
ST04	T04_2022_0	04:23:31	01/06/2022	464111.030	5957149.039	464112.263	5957154.053	5.2
ST04	T04_2022_0	04:23:51	01/06/2022	464111.030	5957149.039	464118.288	5957151.262	7.6
ST04	T04_2022_0	04:24:44	01/06/2022	464111.030	5957149.039	464118.176	5957145.499	8.0
ST05	T05_2022_0	05:49:15	01/06/2022	465611.030	5957149.039	465597.998	5957141.733	14.9
ST05	T05_2022_0	05:50:42	01/06/2022	465611.030	5957149.039	465612.529	5957140.959	8.2
ST05	T05_2022_0	05:51:47	01/06/2022	465611.030	5957149.039	465616.019	5957140.377	10.0
ST05	T05_2022_0	05:52:26	01/06/2022	465611.030	5957149.039	465620.827	5957139.785	13.5
ST05	T05_2022_0	05:52:59	01/06/2022	465611.030	5957149.039	465615.261	5957144.944	5.9
ST05	T05_2022_0	05:53:37	01/06/2022	465611.030	5957149.039	465611.673	5957150.088	1.2
ST05	T05_2022_0	05:54:10	01/06/2022	465611.030	5957149.039	465610.174	5957152.491	3.6
ST05	T05_2022_0	05:54:50	01/06/2022	465611.030	5957149.039	465605.384	5957155.475	8.6
ST06	T06_2022_0	06:12:06	01/06/2022	466873.419	5956911.428	466844.381	5956893.421	34.2
ST06	T06_2022_0	06:12:40	01/06/2022	466873.419	5956911.428	466866.799	5956907.782	7.6
ST06	T06_2022_0	06:13:46	01/06/2022	466873.419	5956911.428	466873.178	5956910.129	1.3
ST06	T06_2022_0	06:14:42	01/06/2022	466873.419	5956911.428	466881.665	5956916.967	9.9
ST06	T06_2022_0	06:15:51	01/06/2022	466873.419	5956911.428	466889.182	5956912.408	15.8
ST06	T06_2022_0	06:16:31	01/06/2022	466873.419	5956911.428	466889.174	5956915.913	16.4
ST07	T07_2022_0	14:44:04	29/05/2022	455127.525	5959655.225	455122.433	5959659.749	6.8
ST07	T07_2022_0	14:44:28	29/05/2022	455127.525	5959655.225	455124.684	5959660.840	6.3
ST07	T07_2022_0	14:45:00	29/05/2022	455127.525	5959655.225	455131.712	5959658.548	5.3
ST07	T07_2022_0	14:45:37	29/05/2022	455127.525	5959655.225	455136.442	5959657.056	9.1
ST07	T07_2022_0	14:46:01	29/05/2022	455127.525	5959655.225	455135.281	5959645.829	12.2
ST08	T08_2022_0	15:03:35	29/05/2022	456611.030	5959649.039	456613.848	5959657.921	9.3
ST08	T08_2022_0	15:04:11	29/05/2022	456611.030	5959649.039	456617.649	5959648.540	6.6
ST08	T08_2022_0	15:04:50	29/05/2022	456611.030	5959649.039	456620.558	5959649.626	9.5
ST08	T08_2022_0	15:05:34	29/05/2022	456611.030	5959649.039	456621.558	5959643.719	11.8
ST08	T08_2022_0	15:06:04	29/05/2022	456611.030	5959649.039	456618.558	5959632.843	17.9
ST08	T08_2022_0	15:06:16	29/05/2022	456611.030	5959649.039	456619.240	5959635.396	15.9
ST09	T09_2022_0	12:40:11	28/06/2022	464135.247	5964444.396	464122.273	5964441.337	13.3
ST09	T09_2022_0	12:40:40	28/06/2022	464135.247	5964444.396	464125.269	5964437.197	12.3
ST09	T09_2022_0	12:41:20	28/06/2022	464135.247	5964444.396	464133.398	5964441.474	3.5
ST09	T09_2022_0	12:41:47	28/06/2022	464135.247	5964444.396	464136.189	5964444.902	1.1
ST09	T09_2022_0	12:42:21	28/06/2022	464135.247	5964444.396	464140.304	5964440.642	6.3
ST10	T10_2022_0	15:43:25	29/06/2022	459611.030	5959649.039	459611.088	5959647.556	1.5
ST10	T10_2022_0	15:43:50	29/06/2022	459611.030	5959649.039	459614.439	5959646.415	4.3
ST10	T10_2022_0	15:44:35	29/06/2022	459611.030	5959649.039	459621.142	5959644.354	11.1
ST10	T10_2022_0	15:45:00	29/06/2022	459611.030	5959649.039	459624.699	5959636.646	18.5
ST10	T10_2022_0	15:45:11	29/06/2022	459611.030	5959649.039	459623.629	5959634.764	19.0
ST11	T11_2022_0	17:59:28	29/06/2022	461377.879	5958604.849	461396.669	5958605.311	18.8
ST11	T11_2022_0	18:00:15	29/06/2022	461377.879	5958604.849	461390.077	5958605.143	12.2
ST11	T11_2022_0	18:00:40	29/06/2022	461377.879	5958604.849	461382.660	5958600.865	6.2
ST11	T11_2022_0	18:01:21	29/06/2022	461377.879	5958604.849	461377.417	5958604.469	0.6
ST11	T11_2022_0	18:02:03	29/06/2022	461377.879	5958604.849	461379.423	5958607.901	3.4
ST12	T12_2022_0	18:21:12	29/06/2022	462611.030	5959649.039	462627.519	5959640.264	18.7
ST12	T12_2022_0	18:21:54	29/06/2022	462611.030	5959649.039	462619.814	5959643.470	10.4
ST12	T12_2022_0	18:22:32	29/06/2022	462611.030	5959649.039	462618.416	5959649.934	7.4
ST12	T12_2022_0	18:23:14	29/06/2022	462611.030	5959649.039	462623.534	5959655.456	14.1
ST12	T12_2022_0	18:24:23	29/06/2022	462611.030	5959649.039	462626.960	5959655.429	17.2

Appendix XVI - Seabed imagery video logs

Station	Date	Video Start Time (UTC)	Video Length	Video End Time (UTC)	GPS to Camera Time Offset	No. of Videos	No. of Images Per Video	Video File Name	Depth (m)	Camera System	Freshwater Housing Height Setting	Distance Between Laser Points (cm)	FOCI/OSPAR present (excluding reef)	Potential Annex I reef?	Deployment Position Offset	Notes
ST01	Station not sampled due to being covered by TR04															
ST02	29/05/2022	16:55:45	00:03:51	16:59:36	00:00:03	1	6	ST02_2022	35.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST03	29/05/2022	17:34:15	00:03:30	17:37:45	00:00:02	1	5	ST03_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Mud with small burrows.
ST04	01/06/2022	04:20:45	00:04:05	04:24:50	00:00:00	1	8	ST04_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand. No positional log data.
ST05	01/06/2022	05:48:30	00:06:30	05:55:00	00:00:01	1	8	ST05_2022	32.0	Rayfin PLE Sp - Plan Vi		10	Y	N	USBL	Megafauna burrows in mud. Sandy mud.
ST06	01/06/2022	06:12:00	00:04:40	06:16:40	00:00:00	1	6	ST06_2022	30.0	Rayfin PLE Sp - Plan Vi		10	Y	N	USBL	Megafauna burrows in mud. Sandy mud.
ST07	29/05/2022	14:43:45	00:02:22	14:46:07	00:00:01	1	5	ST07_2022	30.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST08	29/05/2022	15:03:08	00:03:19	15:06:27	00:00:03	1	6	ST08_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST09	28/05/2022	12:39:47	00:02:52	12:42:39	00:00:04	1	5	ST09_2022	27.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST10	29/05/2022	15:43:10	00:02:07	15:45:17	00:00:03	1	5	ST10_2022	32.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST11	29/05/2022	17:59:10	00:02:59	18:02:09	00:00:03	1	5	ST11_2022	31.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST12	29/05/2022	18:20:30	00:03:58	18:24:28	00:00:02	1	5	ST12_2022	29.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Mud with small burrows.
ST13	01/06/2022	07:53:35	00:04:43	07:58:18	00:00:01	1	6	ST13_2022	25.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST14	01/06/2022	07:27:35	00:05:24	07:32:59	00:00:01	1	6	ST14_2022	24.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST15	01/06/2022	07:03:20	00:10:00	07:13:20	00:00:01	2	5	ST15_2022	22.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
		07:13:20	00:01:23	07:14:43	00:00:01		3	ST15_2022								
ST16	29/05/2022	13:46:30	00:02:42	13:49:12	00:00:02	1	5	ST16_2022	37.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST17	29/05/2022	14:07:00	00:02:36	14:09:36	00:00:03	1	5	ST17_2022	35.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST18	28/05/2022	17:01:40	00:03:32	17:05:12	00:00:03	1	6	ST18_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sandy mud.
ST19	28/05/2022	16:33:15	00:02:28	16:35:43	00:00:05	1	5	ST19_2022	32.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Mud with small burrows.
ST20	28/05/2022	16:07:11	00:06:16	16:13:27	00:00:04	1	5	ST20_2022	32.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST21	28/05/2022	14:02:30	00:04:21	14:06:51	00:00:05	1	6	ST21_2022	32.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Mud with small burrows.
ST22	28/05/2022	14:35:20	00:03:24	14:38:44	00:00:03	1	5	ST22_2022	25.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST23	28/05/2022	13:19:40	00:03:09	13:22:49	00:00:04	1	5	ST23_2022	29.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST24	01/06/2022	08:35:20	00:04:27	08:39:47	00:00:00	1	6	ST24_2022	26.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST25	01/06/2022	10:23:20	00:04:55	10:28:15	00:00:01	1	6	ST25_2022	30.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST26	29/05/2022	13:22:55	00:02:37	13:25:32	00:00:02	1	5	ST26_2022	38.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST27	28/05/2022	17:51:55	00:03:33	17:55:28	00:00:04	1	7	ST27_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST28	29/05/2022	12:08:55	00:03:47	12:12:42	00:00:01	1	6	ST28_2022	37.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST29	29/05/2022	11:50:22	00:03:00	11:53:22	00:00:01	1	5	ST29_2022	35.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST30	28/05/2022	15:27:15	00:07:44	15:34:59	00:00:03	1	8	ST30_2022	29.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Mud with small burrows.
ST31	28/05/2022	15:03:52	00:07:45	15:11:37	00:00:06	1	5	ST31_2022	27.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST32	29/05/2022	12:47:00	00:04:06	12:51:06	00:00:03	1	5	ST32_2022	38.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST33	Station not sampled due to being covered by TR01															
ST34	29/05/2022	18:39:00	00:03:45	18:42:45	00:00:09	1	5	ST34_2022	30.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST35	29/05/2022	17:14:00	00:07:18	17:21:18	00:00:04	1	5	ST35_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST36	29/05/2022	13:04:45	00:02:38	13:07:23	00:00:02	1	5	ST36_2022	38.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST37	29/05/2022	12:28:50	00:02:59	12:31:49	00:00:02	1	5	ST37_2022	36.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST38	28/05/2022	13:36:37	00:03:37	13:40:14	00:00:04	1	5	ST38_2022	35.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST39	28/05/2022	15:47:15	00:03:29	15:50:44	00:00:03	1	7	ST39_2022	27.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST40	01/06/2022	10:09:10	00:03:25	10:12:35	00:00:01	1	6	ST40_2022	25.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST41	29/05/2022	15:23:00	00:02:51	15:25:51	00:00:02	1	5	ST41_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST42	29/05/2022	15:58:45	00:02:52	16:01:37	00:00:03	1	5	ST42_2022	38.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST43	29/05/2022	14:21:20	00:03:45	14:25:05	00:00:03	1	6	ST43_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST44	28/05/2022	17:33:30	00:03:15	17:36:45	00:00:04	1	5	ST44_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST45	01/06/2022	08:15:55	00:04:54	08:20:49	00:00:00	1	6	ST45_2022	27.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand with burrows.
ST46	Station not sampled due to being covered by TR02															
ST47	Station not sampled due to being covered by TR03															
ST48	28/05/2022	17:16:45	00:03:00	17:19:45	00:00:04	1	8	ST48_2022	32.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST49	28/05/2022	13:00:27	00:02:26	13:02:53	00:00:04	1	6	ST49_2022	26.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Sand.
ST50	01/06/2022	04:46:45	00:04:40	04:51:25	00:00:00	1	7	ST50_2022	34.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy sand.
ST51	01/06/2022	06:41:30	00:10:00	06:51:30	00:00:00	2	4	ST51_2022	22.0	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Muddy san
		06:51:30	00:00:32	06:52:02	00:00:01		1	ST51_2022_								
TR01	01/06/2022	05:02:50	00:10:00	05:12:50	00:00:01	3	28	TR01_2022	33	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Covers ST33. Line re-run in
		05:12:50	00:10:00	05:22:50	00:00:01		9	TR01_2022								
		05:22:10	00:01:12	05:23:22	00:00:01		1	TR01_2022								
TR02	01/06/2022	09:29:55	00:10:00	09:39:55	00:00:01	3	12	TR02_2022	24	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Covers ST46. Muddy
		09:39:55	00:10:00	09:49:55	00:00:01		16	TR02_2022								
		09:49:55	00:10:00	09:59:55	00:00:01		10	TR02_2022								
TR03	01/06/2022	08:55:15	00:10:00	09:05:15	00:00:02	2	16	TR03_2022	23	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Covers ST47.
		09:05:15	00:07:02	09:12:17	00:00:01		12	TR03_2022								
TR04	29/05/2022	16:21:10	00:10:00	16:31:10	00:00:03	2	18	TR04_2022	38	Rayfin PLE Sp - Plan Vi		10	N	N	USBL	Covers ST01.
		17:31:10	00:07:10	17:38:20	00:00:03		13	TR04_2022								

Appendix XVII - Seapen and burrowing megafauna assessment

Filename	Field of View (m^2)	Burrow 1cm	Burrow 2cm	Burrow 3cm	Burrow 4cm	Burrow 5cm	Burrow 6cm	Burrow 7cm	Density of Burrows (m^2)	Average Burrow Density (m^2)	Density of 3+ cm Burrows (m^2)	Average Density of 3+ cm burrows (m^2)	Seapens	Density of Seapens (m^2)	Average Seapen Density (m^2)	Corystes cassivelaunus	Total burrowing fauna	Density of Burrowing fauna (m^2)	Average Density of burrowing fauna (m^2)
FLOMOR0222_ST02_2022_05_29_165623.jpg	0.35	0	1	1	0	0	0	0	6	23	3	2	0	0	0	0	0	0	1
FLOMOR0222_ST02_2022_05_29_165706.jpg	0.32	11	3	0	0	0	0	0	44		0		0	0		0	0	0	
FLOMOR0222_ST02_2022_05_29_165757.jpg	0.34	7	0	1	0	0	0	0	24		3		0	0		0	0	0	
FLOMOR0222_ST02_2022_05_29_165844.jpg	0.33*	9	0	1	0	0	0	0	30		3		0	0		0	0	0	
FLOMOR0222_ST02_2022_05_29_165927.jpg	0.33*	4	0	0	0	0	0	0	12		0		0	0		1	1	3	
FLOMOR0222_ST03_2022_05_29_173503.jpg	0.33*	8	5	0	0	0	0	0	39	33	0	4	0	0	0	0	0	0	0
FLOMOR0222_ST03_2022_05_29_173546.jpg	0.33*	6	3	1	0	1	0	0	33		6		0	0		0	0	0	
FLOMOR0222_ST03_2022_05_29_173621.jpg	0.33*	2	3	1	0	0	0	0	18		3		0	0		0	0	0	
FLOMOR0222_ST03_2022_05_29_173701.jpg	0.33*	14	1	1	0	0	0	0	48		3		0	0		0	0	0	
FLOMOR0222_ST03_2022_05_29_173738.jpg	0.33*	5	2	2	0	0	0	0	27		6		0	0		0	0	0	
FLOMOR0222_ST04_2022_06_01_042114.jpg	0.33*	4	1	0	3	1	0	0	27	26	12	6	0	0	0	0	0	0	0
FLOMOR0222_ST04_2022_06_01_042155.jpg	0.33*	4	0	2	0	0	0	0	18		6		0	0		0	0	0	
FLOMOR0222_ST04_2022_06_01_042241.jpg	0.33*	3	2	4	0	0	0	0	27		12		0	0		0	0	0	
FLOMOR0222_ST04_2022_06_01_042306.jpg	0.33*	6	0	1	0	0	0	0	21		3		0	0		0	0	0	
FLOMOR0222_ST04_2022_06_01_042330.jpg	0.33*	5	2	1	0	0	0	0	24		3		0	0		0	0	0	
FLOMOR0222_ST04_2022_06_01_042350.jpg	0.33*	5	2	0	0	1	0	0	24		3		0	0		0	0	0	
FLOMOR0222_ST04_2022_06_01_042441.jpg	0.33*	10	3	0	0	1	0	0	42		3		0	0		0	0	0	
FLOMOR0222_ST05_2022_06_01_054919.jpg	0.33*	9	0	1	0	4	0	0	42	23	15	8	0	0	0	0	0	0	0
FLOMOR0222_ST05_2022_06_01_055046.jpg	0.33*	1	0	4	0	0	0	0	15		12		0	0		0	0	0	
FLOMOR0222_ST05_2022_06_01_055151.jpg	0.33*	4	0	0	0	0	0	0	12		0		0	0		0	0	0	
FLOMOR0222_ST05_2022_06_01_055340.jpg	0.33*	5	1	0	2	0	0	0	24		6		0	0		0	0	0	
FLOMOR0222_ST05_2022_06_01_055453.jpg	0.33*	3	1	1	0	1	1	0	21		9		0	0		0	0	0	
FLOMOR0222_ST06_2022_06_01_061209.jpg	0.33*	10	2	1	0	2	0	0	45	33	9	6	0	0	0	0	0	0	0
FLOMOR0222_ST06_2022_06_01_061244.jpg	0.33*	9	4	1	0	0	0	0	42		3		0	0		0	0	0	
FLOMOR0222_ST06_2022_06_01_061349.jpg	0.33*	2	3	1	1	0	0	0	21		6		0	0		0	0	0	
FLOMOR0222_ST06_2022_06_01_061446.jpg	0.33*	7	1	4	0	0	0	0	36		12		0	0		0	0	0	
FLOMOR0222_ST06_2022_06_01_061555.jpg	0.33*	6	4	0	1	0	0	0	33		3		0	0		0	0	0	
FLOMOR0222_ST06_2022_06_01_061635.jpg	0.33*	5	0	1	1	0	0	0	21		6		0	0		0	0	0	
FLOMOR0222_ST11_2022_05_29_175924.jpg	0.35	6	2	3	0	0	0	0	31	37	9	4	0	0	0	0	0	0	0
FLOMOR0222_ST11_2022_05_29_180012.jpg	0.36	7	4	1	0	0	0	0	34		3		0	0		0	0	0	
FLOMOR0222_ST11_2022_05_29_180037.jpg	0.33*	2	0	0	0	0	0	0	6		0		0	0		0	0	0	
FLOMOR0222_ST11_2022_05_29_180118.jpg	0.33*	7	1	0	0	0	0	0	24		0		0	0		0	0	0	
FLOMOR0222_ST11_2022_05_29_180200.jpg	0.33*	8	1	1	0	3	0	0	39		12		0	0		0	0	0	
FLOMOR0222_ST12_2022_05_29_182109.jpg	0.30	8	4	1	0	0	0	0	43		3		0	0		0	0	0	
FLOMOR0222_ST12_2022_05_29_182151.jpg	0.33*	8	3	0	0	0	0	0	33		0		0	0		0	0	0	
FLOMOR0222_ST12_2022_05_29_182229.jpg	0.33*	12	7	0	0	0	0	0	57		0		0	0		0	0	0	
FLOMOR0222_ST12_2022_05_29_182310.jpg	0.33*	10	2	0	0	0	0	0	36		0		0	0		0	0	0	
FLOMOR0222_ST12_2022_05_29_182419.jpg	0.33*	11	7	3	0	0	0	0	63		9		0	0		0	0	0	
FLOMOR0222_ST13_2022_06_01_075355.jpg	0.34	4	1	1	0	0	0	0	18	16	3	1	0	0	0	0	0	0	0
FLOMOR0222_ST13_2022_06_01_075439.jpg	0.33*	8	0	0	0	0	0	0	24		0		0	0		0	0	0	
FLOMOR0222_ST13_2022_06_01_075517.jpg	0.31	2	2	0	0	0	0	0	13		0		0	0		0	0	0	
FLOMOR0222_ST13_2022_06_01_075614.jpg	0.33*	2	1	0	0	0	0	0	9		0		0	0		0	0	0	
FLOMOR0222_ST13_2022_06_01_075715.jpg	0.31	5	1	0	0	0	0	0	19		0		0	0		0	0	0	
FLOMOR0222_ST13_2022_06_01_075815.jpg	0.33*	2	1	1	0	0	0	0	12		3		0	0		0	0	0	
FLOMOR0222_ST14_2022_06_01_072812.jpg	0.34	7	2	1	0	0	0	0	30	35	3	5	0	0	0	0	0	0	0
FLOMOR0222_ST14_2022_06_01_072847.jpg	0.32	7	3	1	0	0	0	0	35		3		0	0		0	0	0	
FLOMOR0222_ST14_2022_06_01_072919.jpg	0.32	6	3	3	0	0	0	0	38		10		0	0		0	0	0	
FLOMOR0222_ST14_2022_06_01_073119.jpg	0.37	13	2	0	1	0	0	0	43		3		0	0		0	0	0	
FLOMOR0222_ST14_2022_06_01_073209.jpg	0.25	9	1	2	0	0	0	0	49		8		0	0		0	0	0	
FLOMOR0222_ST14_2022_06_01_073256.jpg	0.33*	3	0	2	0	0	0	0	15		6		0	0		0	0	0	
FLOMOR0222_ST15_2022_06_01_070345.jpg	0.30	7	0	0	0	0	0	0	23	39	0	5	0	0	0	0	0	0	0
FLOMOR0222_ST15_2022_06_01_070445.jpg	0.32	12	1	1	0	0	0	0	43		3		0	0		0	0	0	
FLOMOR0222_ST15_2022_06_01_070725.jpg	0.27	11	4	0	0	0	0	0	57		0		0	0		0	0	0	
FLOMOR0222_ST15_2022_06_01_071301.jpg	0.24	2	3	2	0	0	0	0	29		8		0	0		0	0	0	
FLOMOR0222_ST15_2022_06_01_071333.jpg	0.28	11	2	1	1	0	0	0	53		7		0	0		0	0	0	
FLOMOR0222_ST15_2022_06_01_071412.jpg	0.30	6	0	2	0	0	0	0	27		7		0	0		0	0	0	
FLOMOR0222_ST15_2022_06_01_071440.jpg	0.30	11	0	1	0	1	0	0	44		7		0	0		0	0	0	
FLOMOR0222_ST19_2022_05_28_163320.jpg	0.39	4	1	2	0	0	0	0	18	19	5	1	0	0	0	0	0	0	0
FLOMOR0222_ST19_2022_05_28_163337.jpg	0.43	3	1	0	0	0	0	0	9		0		0	0		0	0	0	
FLOMOR0222_ST19_2022_05_28_163424.jpg	0.43	12	0	0	0	0	0	0	28		0		0	0		0	0	0	
FLOMOR0222_ST19_2022_05_28_163448.jpg	0.44	11	0	1	0	0	0	0	28		2		0	0		0	0	0	
FLOMOR0222_ST19_2022_05_28_163531.jpg	0.38	5	0	0	0	0	0	0	13		0		0	0		0	0	0	
FLOMOR0222_ST20_2022_05_28_160824.jpg	0.37	10	2	0	0	0	0	0	32	34	0	2	0	0	0	0	0	0	0
FLOMOR0222_ST20_2022_05_28_160901.jpg	0.40	12	3	0	0	0	0	0	37		0		0	0		0	0	0	
FLOMOR0222_ST20_2022_05_28_161212.jpg	0.42	15	2	0	0	0	0	0	40		0		0	0		0	0	0	
FLOMOR0222_ST20_2022_05_28_161240.jpg	0.89	10	1	2	0	0	0	0	15		2		0	0		0	0	0	
FLOMOR0222_ST20_2022_05_28_161313.jpg	0.41	16	0	3	0	0	0	0	47		7		0	0		0	0	0	
FLOMOR0222_ST21_2022_05_28_140248.jpg	0.35	6	3	3	0	0	0	0	34	38	9	5	0	0	0	0	0	0	0
FLOMOR0222_ST21_2022_05_28_140334.jpg	0.40	16	1	4	0	0	0	0	53		10		0	0		0	0	0	
FLOMOR0222_ST21_2022_05_28_140414.jpg	0.39	15	5	0	0	0	0	0	52		0		0	0		0	0	0	
FLOMOR0222_ST21_2022_05_28_140511.jpg	0.43	7	1	1	0	0	0	0	21		2		0	0		0	0	0	
FLOMOR0222_ST21_2022_05_28_140553.jpg	0.40	6	2	0	0	0	0	0	20		0		0	0		0	0	0	
FLOMOR0222_ST21_2022_05_28_140638.jpg	0.40	14	1	3	0	0	0	0	45		8		0	0		0	0	0	
FLOMOR0222_ST23_2022_05_28_131952.jpg	0.36	11	1	0	0	0	0	0	33	30	0	3	0	0	0	0	0	0	0
FLOMOR0222_ST23_2022_05_28_132036.jpg	0.36	11	4	2	2	0	0	0	52		11		0	0		0	0	0	
FLOMOR0222_ST23_2022_05_28_132116.jpg	0.36	2	2	1	0	0	0	0	14		3		0	0		0	0	0	
FLOMOR0222_ST23_2022_05_28_132157.jpg	0.38	4	1	0	0	0	0	0	13		0		0	0		0	0	0	
FLOMOR0222_ST23_2022_05_28_132237.jpg	0.37	13	0	0	0	0	0	0	35		0		0	0		0	0	0	
FLOMOR0222_ST24_2022_06_01_083538.jpg	0.29	8	6	1	0	0	0	0	52	43	3	2	0	0	0	0	0	0	0
FLOMOR0222_ST24_2022_06_01_083615.jpg	0.28	8	4	0	0	0	0	0	43		0		0	0		0	0	0	
FLOMOR0222_ST24_2022_06_01_083702.jpg	0.25	10	4	1	0	0	0	0	59		4		0	0		0	0	0	
FLOMOR0222_ST24_2022_06_01_083739.jpg	0.29	6	1	0	0	0	0	0	24		0		0	0		0	0	0	
FLOMOR0222_ST24_2022_06_01_083836.jpg	0.33*	9	1	1	0	0	0	0	33		3		0	0		0	0	0	
FLOMOR0222_ST24_2022_06_01_083941.jpg	0.31	12	3	0	0	0	0	0	48		0		0	0		0	0	0	
FLOMOR0222_ST25_2022_06_01_102429.jpg	0.33*	0	0	0	1	0	0	0	3	8	3	2	0	0	0	0	0	0	0
FLOMOR0222_ST25_2022_06_01_102631.jpg	0.33*	0	0	1	1	0	0	0	6		6		0	0		0	0	0	
FLOMOR0222_ST25_2022_06_01_102709.jpg	0.33*	1	1	0	0	0	0	0	6		0		0	0		0	0	0	
FLOMOR0222_ST25_2022_06_01_102743.jpg	0.33*	3	1	0	0	0	0	0	12		0		0	0		0	0	0	
FLOMOR0222_ST25_2022_06_01_102810.jpg	0.33*	4	0	0	0	0	0	0	12		0		0	0		0	0	0	
FLOMOR0222_ST29_2022_05_29_115040.jpg	0.48	12	5	0	0	0	0	0	35	36	0	1	0	0	0	0	0	0	0
FLOMOR0222_ST29_2022_05_29_115108.jpg	0.43	13	4	1	0	0	0	0	42		2		0	0		0	0	0	
FLOMOR0222_ST29_2022_05_29_115157.jpg	0.44	13	1	1	0	0	0	0	34		2		0	0		0	0	0	
FLOMOR0222_ST29_2022_05_29_115233.jpg	0.43	14	5	1	0	0	0	0	46		2		0	0		0	0	0	
FLOMOR0222_ST29_2022_05_29_115334.jpg	0.44	8	1	0	0	0	0	0	20		0		0	0		0	0	0	
FLOMOR0222_ST30_2022_05_28_152738.jpg	0.38	9	1	1	0	0	0	0	29	30	3	2	0	0	0	0	0	0	1
FLOMOR0222_ST30_2022_05_28_152813.jpg	0.32	6	0	1	0	0	0	0	22		3		0	0		0	0	0	
FLOMOR0222_ST30_2022_05_28_152857.jpg	0.33*	8	2	0	0	0	0	0	30		0		0	0		0	0	0	
FLOMOR0222_ST30_2022_05_28_152933.jpg	0.38	13	1	0	0	0	0	0	37		0		0	0		1	1	3	
FLOMOR0222_ST30_2022_05_28_153451.jpg	0.33*	2	7	1	0	0	0	0	30		3		0	0		0	0	0	
FLOMOR0222_ST31_2022_05_28_150351.jpg	0.33*	3	4	1	0	0	0	0	24	29	3	3	0	0	0	0	0	0	0
FLOMOR0222_ST31_2022_05_28_150508.jpg	0.33*	5	5	3	0	0	0	0	39		9		0	0		0	0	0	
FLOMOR0222_ST31_2022_05_28_150523.jpg	0.33*	4	3	0	0	0	0	0	21		0		0	0		0	0	0	
FLOMOR0222_ST31_2022_05_28_150628.jpg	0.37	11	0	1	0	0	0	0	33		3		0	0		0	0	0	
FLOMOR0222_ST31_2022_05_28_151125.jpg	0.34	8	1	0	0	0	0	0	26		0		0	0		0	0	0	
FLOMOR0222_ST34_2022_05_29_183948.jpg	0.33*	4	5	3	0	0	0	0	36	33	9	6	0	0	0	0	0	0	0
FLOMOR0222_ST34_2022_05_29_184028.jpg	0.36	11	4	4	0	0	0	0	52		11		0	0		0	0	0	
FLOMOR0222_ST34_2022_05_29_184101.jpg	0.34	5	2	1	0	0	0	0	24		3		0	0		0	0	0	
FLOMOR0222_ST34_2022_05_29_184154.jpg	0.34	6	3	0	0	0	0	0	27		0		0	0		0	0	0	
FLOMOR0222_ST34_2022_05_29_184226.jpg	0.36	4	3	1	2	0	0	0	28		8		0	0		0	0	0	
FLOMOR0222_ST38_2022_05_28_133705.jpg	0.35	7	3	0	0	0	0	0	29	33	0	2	0	0	0	0	0	0	0
FLOMOR0222_ST38_2022_05_28_133745.jpg	0.37	2	1	0	0	1	0	0	11		3		0	0		0	0	0	
FLOMOR0222_ST38_2022_05_28_133829.jpg	0.35	11	2	1	0	0	0	0	41		3		0	0		0	0	0	
FLOMOR0222_ST38_2022_05_28_133926.jpg	0.32	5	2	1	0	0	0	0	25		3		0	0		0	0	0	
FLOMOR0222_ST38_2022_05_28_134001.jpg	0.33*	17	2	0	0	0	0	1	61		3		0	0		0	0	0	
FLOMOR0222_ST42_2022_05_29_155901.jpg	0.36	5	0	0	0	0	0	0	14	25	0	1	0	0	0	0	0	0	0
FLOMOR0222_ST42_2022_05_29_155930.jpg	0.32	6	1	0	0	0	0	0	22		0		0	0		0	0	0	
FLOMOR0222_ST42_2022_05_29_160011.jpg	0.35	4	0	1	0	0	0	0	14		3		0	0		0	0	0	
FLOMOR0222_ST42_2022_05_29_160046.jpg	0.37	11	1	1	0	0	0	0	35		3		0	0		0	0	0	
FLOMOR0222_ST42_2022_05_29_160125.jpg	0.37	15	0	0	0	0	0	0	41		0		0	0		0	0	0	
FLOMOR0222_ST45_2022_06_01_081724.jpg	0.27	2	0	0	0	0	0	0	7	10	0	4	0	0	0	0	0	0	0
FLOMOR0222_ST45_2022_06_01_081757.jpg	0.29	0	0	2	0	0	0	0	7		7		0	0		0	0	0	
FLOMOR0222_ST45_2022_06_01_081851.jpg	0.27	0	0	3	0	0	0	0	11		11		0	0		0	0	0	
FLOMOR0222_ST45_2022_06_01_081935.jpg	0.28	1	0	0	0	1	0	0	7		4		0	0		0	0	0	
FLOMOR0222_ST45_2022_06_01_082011.jpg	0.31	4	0	0	0	0	0	0	13		0		0	0		0	0	0	
FLOMOR0222_ST45_2022_06_01_082040.jpg	0.33*	5	0	0	0	0	0	0	15		0		0	0		0	0	0	
FLOMOR0222_ST51_2022_06_01_064348.jpg	0.29	8	0	0	0	0	0	0	28	28	0	3	0	0	0	0	0	0	0
FLOMOR0222_ST51_2022_06_01_064817.jpg	0.29	2	2	2	0	1	0	0	24		10		0	0		0	0	0	
FLOMOR0222_ST51_2022_06_01_064901.jpg	0.25	4	1	0	0	0	0	0	20		0		0	0		0	0	0	
FLOMOR0222_ST51_2022_06_01_064958.jpg	0.27	0	2	0	0	0	0	0	7		0		0	0		0	0	0	
FLOMOR0222_ST51_2022_06_01_065159.jpg	0.29	16	0	2	0	0	0	0	62		7		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093131.jpg	0.33*	11	0	0	0	0	0	0	33	15	0	1	0	0	0	0	0	0	0
FLOMOR0222_TR02_2022_06_01_093229.jpg	0.33*	2	2	0	0	0	0	0	12		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093323.jpg	0.33*	4	1	0	0	0	0	0	15		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093359.jpg	0.33*	4	1	0	0	0	0	0	15		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093440.jpg	0.33*	1	2	0	0	0	0	0	9		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093519.jpg	0.33*	4	0	1	0	0	0	0	15		3		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093553.jpg	0.33*	5	4	0	0	0	0	0	27		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093629.jpg	0.33*	6	0	0	1	0	0	0	21		3		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093750.jpg	0.28	0	0	0	0	0	0	0	0		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_093917.jpg	0.29	0	0	0	0	0	0	0	0		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_094004.jpg	0.31	8	1	0	0	0	0	0	29		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_094106.jpg	0.27	3	3	0	0	0	0	0	22		0		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_094449.jpg	0.26	1	0	0	0	0	1	0	8		4		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_095509.jpg	0.29	1	0	1	0	0	0	1	10		7		0	0		0	0	0	
FLOMOR0222_TR02_2022_06_01_095627.jpg	0.33*	1	2	0	0	0	0	0	9		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_085547.jpg	0.25	2	1	0	0	2	0	0	20	20	8	3	0	0	0	0	0	0	0
FLOMOR0222_TR03_2022_06_01_085625.jpg	0.27	7	1	0	0	0	0	0	29		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_085701.jpg	0.28	9	0	0	0	0	0	0	32		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_085739.jpg	0.34	2	1	0	0	0	0	0	9		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_085825.jpg	0.28	1	0	0	0	0	0	0	4		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_085912.jpg	0.29	7	1	1	0	1	0	0	34		7		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_085959.jpg	0.26	4	4	1	0	0	0	0	35		4		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090056.jpg	0.30	9	4	0	0	0	0	0	44		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090129.jpg	0.26	4	1	3	1	0	0	0	35		16		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090221.jpg	0.34	4	2	0	0	0	0	0	18		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090250.jpg	0.33*	0	0	0	0	0	0	0	0		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090316.jpg	0.31	4	1	0	0	0	0	0	16		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090348.jpg	0.29	7	1	1	0	0	0	0	31		3		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090424.jpg	0.28	7	2	1	1	1	0	0	43		11		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090501.jpg	0.29	0	0	0	0	0	0	0	0		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090534.jpg	0.32	0	0	0	0	0	0	0	0		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090616.jpg	0.30	0	0	0	0	0	0	0	0		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090653.jpg	0.30	4	2	0	0	0	0	0	20		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090718.jpg	0.30	7	1	3	1	0	0	0	40		13		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090756.jpg	0.32	4	0	0	0	0	0	0	13		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090831.jpg	0.33*	3	1	0	0	0	0	0	12		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090909.jpg	0.29	3	1	1	0	0	0	0	17		3		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_090945.jpg	0.30	8	0	0	0	0	0	0	27		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_091022.jpg	0.33*	1	0	0	0	0	0	0	3		0		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_091058.jpg	0.27	5	3	0	0	1	0	0	33		4		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_091134.jpg	0.28	4	0	0	1	0	0	0	18		4		0	0		0	0	0	
FLOMOR0222_TR03_2022_06_01_091210.jpg	0.31	3	1	0	0	0	0	0	13		0		0	0		0	0	0	

Appendix XVIII - Biotoping

Station	Sampled Lat	Sampled Long	Easting	Northing	Textural Group	Mean Grain Size	Macro Group	BSH EUNIS Level 3	EUNIS Level 4	EUNIS Level 5	EUNIS name 2007-11	JNCC 04.05 code	Physical Mismatch	Notes
ST01	53.759304	-3.613803	459534.014	5956917.06	Gravelly Muddy Sand	536.1	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	Whilst gravel content is high in this sample it is not seen to be driving the biological community. The driving factor here is the muddy sand content which aligns with the note on the biotope for all other mismatches of this nature below.
ST02	53.761874	-3.588412	461210.296	5957188.867	Muddy Sand	237.7	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST03	53.761656	-3.567073	462616.772	5957153.161	Muddy Sand	141.5	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	
ST04	53.761759	-3.544359	464114.242	5957152.832	Muddy Sand	87.54	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST05	53.761856	-3.521741	465605.363	5957152.496	Muddy Sand	54.74	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST06	53.759793	-3.502608	466865.056	5956913.891	Muddy Sand	55.26	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST07	53.783527	-3.681098	455123.35	5959652.413	Sand	321.7	B	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST08	53.783508	-3.658678	456600.557	5959636.344	Slightly Gravelly Sand	381	B	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST09	53.827169	-3.544904	464134.196	5964430.292	Muddy Sand	73.82	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST10	53.783911	-3.61298	459611.85	5959654.219	Sand	305.2	C	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST11	53.774553	-3.58597	461382.877	5958598.062	Muddy Sand	146.7	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	See comment in cell O3.
ST12	53.784084	-3.567493	462609.078	5959648.52	Muddy Sand	128.8	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST13	53.783301	-3.541898	464294.746	5959548.265	Slightly Gravelly Muddy Sand	156	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST14	53.774294	-3.522241	465582.571	5958536.525	Muddy Sand	133.3	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST15	53.781083	-3.508254	466509.741	5959285.119	Muddy Sand	73.24	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST16	53.805621	-3.727088	452118.354	5962140.503	Slightly Gravelly Muddy Sand	295.3	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST17	53.805812	-3.704357	453615.431	5962146.618	Slightly Gravelly Sand	340.4	B	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST18	53.801836	-3.674799	455557.767	5961685.359	Muddy Sand	97.8	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST19	53.801793	-3.636472	458081.88	5961657.323	Muddy Sand	209.3	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST20	53.801598	-3.612716	459646.223	5961621.884	Muddy Sand	137.6	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST21	53.801321	-3.59044	461113.065	5961578.599	Muddy Sand	96.58	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST22	53.815461	-3.572905	462280.667	5963142.33	Sand	299.8	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST23	53.806187	-3.544127	464167.405	5962095.542	Muddy Sand	60.23	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST24	53.807311	-3.521396	465665.257	5962209.349	Muddy Sand	80.38	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST25	53.806922	-3.499428	467111.566	5962155.677	Muddy Sand	46.93	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST26	53.827841	-3.708422	453372.205	5964600.17	Slightly Gravelly Sand	293.9	D	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST27	53.828498	-3.681926	455116.869	5964656.171	Sand	284.8	C	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST28	53.828598	-3.65917	456614.664	5964653.124	Muddy Sand	206	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST29	53.829856	-3.638155	457999.094	5964780.482	Muddy Sand	106.1	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST30	53.827344	-3.609522	459881.227	5964484.349	Muddy Sand	160.9	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST31	53.828894	-3.590863	461110.737	5964646.436	Muddy Sand	63.28	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST32	53.850952	-3.682267	455118.434	5967154.527	Slightly Gravelly Muddy Sand	251.1	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST34	53.774219	-3.557447	463262.31	5958545.807	Muddy Sand	125.9	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST35	53.754577	-3.574825	462099.42	5956369.61	Sand	259.6	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST36	53.843904	-3.699529	453975.187	5966381.368	Slightly Gravelly Muddy Sand	282.2	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST37	53.840292	-3.666346	456154.618	5965958.52	Sand	269.2	D	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST38	53.797032	-3.557845	463256.054	5961084.075	Muddy Sand	41.52	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST39	53.81734	-3.612816	459654.797	5963373.254	Muddy Sand	223.4	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	This community occurs in muddy sands in moderately deep water (Hiscock 1984; Picton et al. 1994) and may be related to the 'offshore muddy sand association' described by other workers (Jones 1951; Thorson 1957; Mackie 1990). Also note that a confirmed core record for this community has been recorded in proxmity to the Morecambe OWF site location previously (Source: https://mhc.jncc.gov.uk/biotopes/jnccmncr00000786)
ST40	53.813522	-3.501498	466980.429	5962891.009	Muddy Sand	99.5	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST41	53.778987	-3.634789	458170.012	5959119.084	Slightly Gravelly Sand	302.9	D	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST42	53.77215	-3.629112	458537.406	5958355.045	Slightly Gravelly Sand	271	D	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST43	53.79397	-3.706298	453474.558	5960830.465	Slightly Gravelly Sand	381.4	B	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST44	53.81864	-3.679814	455245.347	5963558.038	Slightly Gravelly Sand	261.6	A	A5.2	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	Yes	PSD data shows <0.5% gravel so this is essentially sand or muddy sand and therefore confident this aligns with the biotope description.
ST45	53.791874	-3.515421	466046.255	5960489.078	Sandy Mud	35.5	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST46	53.823486	-3.504538	466788.125	5964000.98	Slightly Gravelly Sand	457.2	Outlier	A5.2	A5.25	-	Circalittoral fine sand	SS.SSa.CFiSa	No	
ST47	53.81485	-3.523885	465507.546	5963049.4	Muddy Sand	68.08	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST48	53.808661	-3.677672	455375.793	5962446.451	Sand	287.5	D	A5.2	A5.25	A5.252	[Abra prismatica], [Bathyporeia elegans] and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo	No	
ST49	53.816385	-3.552527	463623.071	5963234.429	Muddy Sand	77.32	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST50	53.755689	-3.527025	465251.924	5956468.987	Slightly Gravelly Muddy Sand	83.49	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	
ST51	53.775545	-3.501759	466933.351	5958665.936	Slightly Gravelly Muddy Sand	122	A	A5.3	A5.35	A5.351	[Amphiura filiformis], [Mysella bidentata] and [Abra nitida] in circalittoral sandy mud	SS.SMu.CSaMu.AfilMysAnit	No	

Appendix XIX - Responses to NE and MMO comments on the PEP

Response to Natural England (NE) comments on OEL Project Execution Plan (OEL_FLOMOR0222_PEP_V02) for Morecambe Offshore Windfarm (NE comments received 06 May 2022)

Natural England Advice	Morecambe OWF response
General Overall, Natural England is content that the specified survey will produce data sufficient to undertake benthic characterisation of the site and ground truth previously collected geophysical data.	Noted.
General Natural England notes that the proposed survey is broadly in line with the requirements set out in the "Best Practice Advice for Evidence and Data Standards", although some detail on analysis is missing (see comment on technical report below).	Noted.
4.3.1 Approach	
Natural England advises that consideration should be given to taking replicate grabs at each station. Whilst basic characterisation of the benthic communities present may be achieved with a single sample per station, replicate samples would enable the communities present to be described with greater accuracy and confidence. Furthermore, replicates would allow for temporal comparisons to be made with future surveys, for example in the post-construction phase. Three to five replicates are recommended for these purposes, respectively.	The sampling plan is designed to characterise the baseline, to ground truth the geophysical data and to identify and assign habitats across the site for EIA purposes. For this purpose, we consider one sample is adequate and common practice. Samples have been placed to provide comprehensive coverage of the whole site, with numerous samples placed in each habitat. At this stage sensitive features have not been identified from the geophysical data and the need for monitoring has also not been established. Further, the project is developing its layout for turbines carefully with the owners of existing infrastructure which co-exist within the site which means that it is difficult at this stage to predict suitable monitoring sites where multiple samples would be of benefit. While we note that multiple samples can help accuracy and check homogeneity between samples at this stage single samples will be taken, with results used to help establish the need for further sampling and monitoring. Existing datasets that may be held within the site from owners of existing infrastructure, where available will also be used and assist with the evidence base for the project.
6.4.2 Technical Report Little detail has been provided beyond the contents of the Technical Report. There is no reference to indices that will be used in the analysis and interpretation of the grab sample data, so we are unable to confirm whether the planned analysis will be adequate. Natural England advises that the Best Practice Advice for Evidence and Data Standards is referred to for further guidance on the appropriate analyses to apply to the grab and DDC data. We would welcome further consultation following the completion of the survey and before the Technical Report is finalised to confirm the analysis will be sufficient	All of the raw data derived from the combined benthic characterisation works will undergo detailed analysis and interpretation in line with Phase III of NE's "Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards" (Natural England 2021b). Following the completion of all data analysis, OEL will provide a detailed technical report to provide a description of the baseline environment, including a narrative of the seabed type across the project area, the range of habitats and biotopes present and the presence of any habitats/species of conservation importance. As per best practice guidance (Noble-James et al. 2018) this will include the calculation of univariate and multimetric diversity indices to condense the full benthic community dataset into single metrics for use in univariate analyses. The indices to be calculated will include: abundance of individuals, richness (Margalef's species richness), evenness (Pielou's evenness), diversity (Simpson's index and Shannon-Wiener index) and the Infaunal Quality Index (IQI)). Data will be collated using Excel spreadsheets conforming to the relevant Marine Environmental Data and Information Network (MEDIN) data guidelines and with all site locations recorded.

Response to Marine Management Organisation (MMO) comments on OEL Project Execution Plan (OEL_FLOMOR0222_PEP_V03) for Morecambe Offshore Windfarm (MMO comments received 03 August 2022)

Reference	Topic	Comment	OEL Response
1	Project description	The proposed Morecambe OWF (OWF) is in water depths of 20-35 metres (m), approximately 30 kilometres (km) off the Lancashire coast in the Irish Sea. It is a 480 megawatt round four venture from Cobra Instalaciones SA and Floatation Energy plc. As a Nationally Significant Infrastructure Project (NSIP), an Environmental Impact Assessment (EIA) is required to determine the impact of the installation, operation and maintenance and subsequent decommissioning of Morecambe Bay OWF before a Development Consent Order (DCO) is granted (active DCO/2022/0001). Ocean Ecology have submitted a Project Execution Plan in support of this application on behalf of the developer to set out the offshore environmental survey methods (grab and camera) as part of the pre-construction site characterisation programme. Note, this has been received for review following completion of the survey work conducted in May 2022.	No action needed
2.1	Contaminant sampling	In total, 50 stations were sampled and 20 samples selected for contaminant analysis. Each benthic grab sample aimed to collect 10 litres (L) of sediment. The Project Execution Plan stated that the sample locations were developed to provide adequate spatial coverage of the array area and to represent all main sediment types and features of conservation interest	No action needed
2.2	Contaminant sampling	The Shapefiles submitted for review show that the samples are approximately 1- 2km apart. The 20 samples for contaminate analysis are adequately spaced and are shown in Figure 1 (Annex 1).	No action needed
2.3	Contaminant sampling	A Drop-Down camera (DDC) system was used prior to grab sampling to make sure the target location was free of obstructions or protected habitats and 4 DDC transects were completed.	No action needed
2.4	Contaminant sampling	Paragraph 5.4.3 of the Project Execution Plan provides details of the analysis to be carried out on the 20 contaminate samples stations which include Total Organic Carbon, Total Organic matter, Heavy metals including Arsenic, Organotin, PAHs, THC and PCBs. The analyses are to be carried out by SOCOTEC.	No action needed
2.5	Contaminant sampling	Whilst the number of sample stations collected appear to be appropriate as there is no dredge and disposal planned, the documentation provided does not state how many samples or sample volume will be taken at each of the 20 stations. It only states that there will be 10L of sediment collected from the 50 stations with a volume of 500-750ml removed for particle size distribution (PSD) analysis (paragraph 5.4 of Project Execution Plan).	In section 5.3.3 of the technical report, an explanation of how sub-samples for chemical analysis have been obtained has been included
2.6	Contaminant sampling	The documentation provided for review does not include the sample analysis data from the 20 stations sampled. The MMO are unable to provide further recommendations without reviewing the data	In section 5.3.3 of the technical report, a summary of the analysis to be done on the sediment chemistry samples is listed
3.1	Benthic Sampling	In total, 50 locations were planned for benthic sediment sample collection within the Morecambe OWF area (Figure 1 (Annex 1)). Seabed imagery (Drop down video (DDV)) was collected from each of these locations "to provide additional information on the sediment / substrate surface and to determine suitability to collect grab samples".	No action needed
3.2	Benthic Sampling	The distance between sediment sampling stations ranges approximately between 1 – 2 km. The MMO are satisfied that the sample density is sufficient to further our understanding of the baseline conditions at the site.	No action needed
3.3	Benthic Sampling	The MMO are unable to confirm if the benthic assemblages and sediment types present within the site have been sampled adequately (particularly from within the area marked as coarse sediment in Figure 1 (Annex 1). The MMO request that the rationale behind placement of sediment sample locations is made available and whether the acoustic datasets (Figure 2 (Annex 1)) were interpreted or analysed prior to arriving at the sample design. The MMO notes that best practice would be to segment the area based on the acoustics dataset in advance of the survey, and station locations (both grab and DDV) are based on interpretation of the resultant segmentation so that the range of sediment types identified are sampled adequately and can be classified accordingly. In the absence of this step, the location of the grab stations may not lie within the sediment boundaries ultimately identified within the site and therefore, the assemblages associated with some habitat types may not be sampled sufficiently.	This comment has been addressed in section 4.1 of the technical report. Geophysical data was reviewed prior to produce the sampling array for the project. Table 1 lists the type of substrated targeted during the survey and how many samples were collected for each substrate.
3.4	Benthic Sampling	The number of grab samples collected appears appropriate to characterise the Morecambe OWF area and identify regions of different sediment characteristics and infaunal assemblages.	No action needed
3.5	Benthic Sampling	The number of DDV station locations appears to be four (Figure 3 (Annex 1)). However, section 4.4. of the Project Execution Plan includes brief descriptions of only three of these features (TR01-03). The number of DDV transect should be clarified within the subsequent technical report. The report should also include the rationale of DDV station placement and detailed results of the seabed imagery analysis.	Section 4.2 of the technical report addresses this comment by providing table and maps illustrating where DDC stations were located and their rationale.
3.6	Benthic Sampling	The MMO recommend that benthic monitoring should be conducted to validate the predictions made in the Environmental Statement and to determine the scale and magnitude of the impacts on benthic assemblages and protected features as a result of the installation of the proposed Morecambe OWF. It would be beneficial to the benthic monitoring programme if the location of the Wind Turbine Generator (WTG) infrastructure is known in advance of the pre- construction monitoring survey so that station locations can be consistent throughout pre- and post-construction monitoring, and the impact of their installation can be assessed over time. A subset of WTGs, spatially spread within the site, could be monitored to assess the impact of the installation of WTGs more accurately.	Aims and objectives of the technical report are presented in Section 1.3.
3.7	Benthic Sampling	The MMO recommend post-construction monitoring of the benthic assemblage and any protected features is carried out over non-consecutive years e.g., 1, 3 and 5 or 1, 5 and 10 years, to evidence the long-term impacts of Morecambe OWF on the benthic environment.	No action needed
3.8	Benthic Sampling	The Project Execution Plan assures that sample processing will be in line with national guidelines and accepted methodologies. The MMO welcome this.	No action needed
3.9	Benthic Sampling	Analysis of the benthic grab data would be expected to include a multivariate assessment of the assemblage within the site using widely accepted methods, such as that used in Clarke et al., 2006 and Clarke et al., 2016, and an assessment of the biological relevance of any cluster groups identified in the context of temporal monitoring (e.g., location of monitoring stations).	All analyses carried out and presented in the technical report have been done in consideration of the most recent guidelines as per section 6 of the techncial report.
4.1	Conclusions	The Project Execution Plan provides details of an appropriate sample plan in support of their application. This data should allow for adequate characterisation of the sediment type and contaminate levels within the proposed OWF. The data available from the dedicated acoustic survey(s) (Multibeam Echosounder and associated back scatter); the sediment sampling survey (particle size distribution and benthic infaunal data); and seabed imagery survey (still images along features of interest and at each grab station) should also allow the benthic assemblage within the site to be characterised adequately.	No action needed
4.2	Conclusions	The MMO note that should any dredging or disposal activities become necessary, the MMO must be consulted to ensure the samples and analyses are adequate. This cannot be assessed currently without further information e.g., volume, depths.	Noted. No action needed.
4.3	Conclusions	The MMO are satisfied that the results of the baseline characterisation at Morecambe OWF should provide useful support to aid in future monitoring decisions.	Noted. No action needed.
4.4	Conclusions	The MMO recommend that the technical report produced includes the information highlighted in sections 3.6, 4.3, 4.5 alongside a detailed rationale behind the station location placement. The MMO also note that the outline of the report contents would facilitate this (Figure 5 (Annex 1)).	Please see responses above to relevant comments.

Appendix C: Transmission Assets site-specific survey data (excluding the Generation Assets)

C.1 Seabed sediments

Appendix Table 1: Summary of results of particle size analysis

Station number	Folk classification	Sorting	Fines (%)	Sands (%)	Gravels (%)	Total Hydrocarbons from GC-FID	Total Hydrocarbons from ultra-violet fluoresence spectroscopt	Total organic carbon (%)
ENV066	Gravelly muddy sand	Very poor	10.05	67.52	22.44	4.9	2.9	0.21
ENV067	Gravelly sand	Very poor	7.95	71.77	20.27	NA	NA	NA
ENV068	Gravelly sand	Very poor	7.71	70.43	21.86	3.1	2.1	0.20
ENV069	Gravelly muddy sand	Very poor	8.71	78.13	13.17	NA	NA	NA
ENV070	Gravelly sand	Very poor	7.95	76.57	15.48	3.8	2.7	0.18
ENV071	Gravelly muddy sand	Very poor	16.59	71.93	11.48	NA	NA	NA
ENV072	Gravelly sand	Poor	5.36	78.17	16.48	2.8	1.7	0.17
ENV073	Gravelly sand	Very poor	7.97	77.48	14.55	NA	NA	NA
ENV074	Gravelly muddy sand	Poor	9.81	83.07	7.12	3.7	3.6	0.19
ENV075	Gravelly muddy sand	Very poor	9.84	70.18	19.99	NA	NA	NA
ENV076	Gravelly sand	Very poor	6.54	78.53	14.92	4.7	5.9	0.19
ENV077	Gravelly muddy sand	Very poor	13.46	68.79	17.76	NA	NA	NA
ENV078	Gravelly muddy sand	Poor	10.28	84.36	5.36	7.5	6.7	0.19

Station number	Folk classification	Sorting	Fines (%)	Sands (%)	Gravels (%)	Total Hydrocarbons from GC-FID	Total Hydrocarbons from ultra-violet fluoresence spectroscopt	Total organic carbon (%)
ENV079	Gravelly muddy sand	Very poor	8.36	70.64	21.00	NA	NA	NA
ENV080	Sand	Moderately well	3.17	96.22	0.61	3.3	1.7	0.09
ENV081	Sand	Moderately well	0.00	99.62	0.38	NA	NA	NA
ENV082	Muddy sand	Very poor	19.60	80.33	0.07	14.2	7.3	0.23
ENV083	Muddy sand	Very poor	33.38	66.58	0.04	NA	NA	NA
ENV084	Sand	Poor	9.86	90.14	0.00	8.0	4.6	0.14
ENV085	Muddy sand	Poor	20.15	79.85	0.00	NA	NA	NA
ENV086	Muddy sand	Very poor	29.54	70.46	0.00	18.0	16.2	0.29
ENV087	Muddy sand	Very poor	34.71	65.29	0.00	NA	NA	NA
ENV088	Sandy mud	Very poor	50.49	49.51	0.00	31.3	17.5	0.46
ENV089	Muddy sand	Very poor	48.82	51.18	0.00	NA	NA	NA
ENV090	Muddy sand	Very poor	39.79	59.98	0.22	8.7	4.1	0.15
ENV091	Sandy mud	Very poor	65.06	34.80	0.13	NA	NA	NA
ENV092	Sand	Moderately well	3.21	96.44	0.35	4.8	3.9	0.06
ENV093	Muddy sand	Very poor	40.06	59.00	0.93	NA	NA	NA
ENV094	Sand	Moderately well	2.06	97.63	0.31	4.0	1.9	0.06
ENV095	Muddy sand	Very poor	44.33	55.27	0.40	NA	NA	NA

Station number	Folk classification	Sorting	Fines (%)	Sands (%)	Gravels (%)	Total Hydrocarbons from GC-FID	Total Hydrocarbons from ultra-violet fluoresence spectroscopt	Total organic carbon (%)
ENV096	Muddy sand	Very poor	42.57	57.38	0.04	41.2	17.0	0.35
ENV097	Sandy mud	Very poor	57.56	42.09	0.35	66.9	34.0	0.60
ENV098	Gravelly muddy sand	Very poor	12.08	80.36	7.56	NA	NA	NA
ENV099	Sand	Moderate	4.27	95.30	0.43	3.0	<1	0.10
ENV100	Slightly gravelly sand	Moderate	3.14	92.50	4.36	NA	NA	NA
ENV101	Sand	Poor	7.18	92.56	0.26	4.5	1.7	0.12
ENV102	Sand	Poor	8.25	91.47	0.28	NA	NA	NA
ENV103	Sand	Poor	8.29	91.64	0.07	5.8	3.0	0.12
ENV104	Muddy sand	Poor	10.57	89.39	0.04	NA	NA	NA
ENV105	Sand	Moderate	5.32	94.64	0.04	37.6	1.5	0.11
ENV106	Sand	Moderate	6.93	93.04	0.02	NA	NA	NA
ENV107	Sand	Well	1.07	98.85	0.08	4.6	1.2	0.11
ENV108	Muddy sand	Poor	10.62	89.26	0.13	NA	NA	NA
ENV109	Muddy sand	Poor	11.19	88.62	0.19	7.8	13.1	0.13
ENV110	Sand	Poor	8.41	91.50	0.10	NA	NA	NA
ENV111	Slightly gravelly sand	Moderately well	1.92	95.03	3.05	4.3	1.8	0.08
ENV112	Muddy sand	Poor	13.37	86.63	0.00	NA	NA	NA
ENV113	Slightly gravelly sand	Poor	7.38	90.57	2.05	5.1	2.9	0.10

Station number	Folk classification	Sorting	Fines (%)	Sands (%)	Gravels (%)	Total Hydrocarbons from GC-FID	Total Hydrocarbons from ultra-violet fluoresence spectroscopt	Total organic carbon (%)
ENV114	Sand	Moderately well	5.30	94.64	0.06	NA	NA	NA
ENV115	Muddy sand	Poor	15.63	84.37	0.00	14.8	8.2	0.15
ENV116	Muddy sand	Poor	17.78	82.22	0.00	NA	NA	NA
ENV117	Muddy sand	Poor	19.91	80.09	0.00	15.8	14.9	0.20
ENV118	Muddy sand	Very poor	33.28	66.72	0.00	NA	NA	NA
ENV119	Muddy sand	Very poor	38.48	61.52	0.00	26.0	17.3	0.42
ENV120	Muddy sand	Very poor	29.93	69.97	0.10	NA	NA	NA
ENV121	Muddy sand	Very poor	47.77	52.23	0.00	29.1	22.1	0.52
ENV122	Muddy sand	Very poor	47.67	52.33	0.00	NA	NA	NA
ENV123	Muddy sand	Very poor	33.38	66.62	0.00	24.4	24.8	0.34
ENV124	Muddy sand	Very poor	27.78	71.89	0.34	NA	NA	NA
ENV125	Sandy mud	Very poor	64.41	35.59	0.00	75.2	22.0	0.67
ENV126	Muddy sand	Very poor	42.70	57.15	0.15	NA	NA	NA
ENV127	Muddy sand	Very poor	46.14	53.50	0.36	45.1	22.5	0.43
ENV128	Slightly gravelly sand	Moderate	3.85	94.89	1.25	NA	NA	NA
ENV129	Sand	Moderately well	1.96	97.73	0.31	6.1	5.8	0.08
ENV130	Muddy sand	Very poor	39.08	60.61	0.31	NA	NA	NA

Station number	Folk classification	Sorting	Fines (%)	Sands (%)	Gravels (%)	Total Hydrocarbons from GC-FID	Total Hydrocarbons from ultra-violet fluoresence spectroscopt	Total organic carbon (%)
ENV131	Slightly gravelly muddy sand	Very poor	36.52	60.50	2.98	64.0	19.7	0.35
ENV132	Muddy sand	Very poor	35.69	63.53	0.78	NA	NA	NA
ENV154	Sand	Moderately well	4.00	95.73	0.26	9.6	7.6	0.09
ENV156	Slightly gravelly muddy sand	Poor	18.26	80.26	1.47	NA	NA	NA
ENV157	Muddy sand	Very poor	20.49	78.74	0.78	14.9	10.0	1.72
ENV158	Muddy sand	Very poor	19.27	80.61	0.12	NA	NA	NA
ENV160	Muddy sand	Poor	17.91	81.87	0.22	7.7	8.8	0.11
ENV162	Sand	Moderately well	4.68	95.15	0.17	NA	NA	NA
ENV164	Sand	Poor	8.96	90.75	0.29	7.9	11.3	0.10
ENV166	Muddy sand	Very poor	46.60	53.16	0.25	NA	NA	NA
ENV167	Sand	Moderate	5.11	94.58	0.31	NA	NA	NA
ENV168	Sand	Moderately well	3.30	96.30	0.40	5.5	7.2	0.10

Appendix Table 2: Full results of PSA (part 1)

Station number	Easting	Northing	Percentile									Folk and Ward Graphic									
			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
ENV066	424689	5982276	-3.17	-2.56	-1.81	-0.66	1.38	2.11	2.49	4.04	7.20	620.88	0.69	Coarse sand	2.65	Very poor	-0.18	Coarse	1.53	Very leptokurtic
ENV067	426240	5981012	-3.09	-2.30	-1.49	-0.45	1.32	2.03	2.40	2.88	6.60	598.43	0.74	Coarse sand	2.44	Very poor	-0.18	Coarse	1.60	Very leptokurtic
ENV068	427602	5979511	-2.85	-2.27	-1.62	-0.68	1.25	2.05	2.41	2.86	6.55	625.03	0.68	Coarse sand	2.43	Very poor	-0.15	Coarse	1.41	Leptokurtic
ENV069	429227	5978247	-2.08	-1.40	-0.63	0.23	1.19	1.95	2.35	2.89	6.78	509.62	0.97	Coarse sand	2.09	Very poor	0.02	Symmetrical	2.10	Very leptokurtic
ENV070	431035	5977337	-2.98	-1.92	-0.92	0.30	1.36	2.12	2.46	2.90	6.36	512.42	0.96	Coarse sand	2.26	Very poor	-0.14	Coarse	2.10	Very leptokurtic
ENV071	432895	5976552	-1.79	-1.17	-0.56	0.69	1.82	2.51	4.32	6.79	8.00	275.69	1.86	Medium sand	2.70	Very poor	0.14	Fine	2.21	Very leptokurtic
ENV072	434605	5975548	-2.76	-1.82	-1.06	0.18	1.29	1.96	2.28	2.49	4.36	560.17	0.84	Coarse sand	1.91	Poor	-0.27	Coarse	1.63	Very leptokurtic
ENV073	436288	5974562	-1.93	-1.42	-0.88	-0.02	1.57	2.22	2.46	2.89	6.50	483.12	1.05	Medium sand	2.11	Very poor	-0.15	Coarse	1.54	Very leptokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV074	437820	5973618	-1.52	-0.45	0.41	0.98	1.64	2.23	2.51	3.47	6.85	348.95	1.52	Medium sand	1.80	Poor	0.04	Symmetrical	2.75	Very leptokurtic
ENV075	439719	5973009	-2.82	-1.95	-1.36	-0.55	1.32	2.07	2.44	3.46	6.98	574.08	0.80	Coarse sand	2.44	Very poor	-0.13	Coarse	1.54	Very leptokurtic
ENV076	441920	5972300	-2.86	-1.79	-0.84	0.30	1.36	1.97	2.31	2.66	5.78	520.24	0.94	Coarse sand	2.10	Very poor	-0.19	Coarse	2.12	Very leptokurtic
ENV077	443757	5971503	-2.95	-2.13	-1.27	0.25	1.41	2.05	2.60	6.13	7.60	530.14	0.92	Coarse sand	2.57	Very poor	-0.11	Coarse	2.40	Very leptokurtic
ENV078	445641	5970909	-1.10	-0.06	0.43	0.86	1.54	2.04	2.42	4.21	6.96	363.11	1.46	Medium sand	1.72	Poor	0.11	Fine	2.81	Very leptokurtic
ENV079	447581	5970494	-3.13	-2.64	-1.83	0.09	1.45	1.94	2.27	2.77	6.47	645.84	0.63	Coarse sand	2.48	Very poor	-0.28	Coarse	2.13	Very leptokurtic
ENV080	449455	5969896	0.34	0.68	0.97	1.13	1.52	1.87	2.01	2.29	2.66	353.51	1.50	Medium sand	0.61	Moderately well	-0.03	Symmetrical	1.28	Leptokurtic
ENV081	451367	5969298	0.24	0.54	0.70	0.93	1.29	1.65	1.81	1.91	2.00	416.31	1.26	Medium sand	0.54	Moderately well	-0.13	Coarse	1.00	Mesokurtic
ENV082	453276	5968694	1.02	1.19	1.39	1.58	1.92	2.46	5.14	7.02	8.12	142.15	2.81	Fine sand	2.01	Very poor	0.73	Very fine	3.30	Extremely leptokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV083	455182	5968031	1.22	1.50	1.60	1.74	2.20	5.86	7.11	7.84	8.88	80.35	3.64	Very fine sand	2.54	Very poor	0.76	Very fine	0.76	Platykurtic
ENV084	457050	5967344	0.52	1.11	1.53	1.73	2.16	2.47	2.78	3.81	6.94	224.03	2.16	Fine sand	1.29	Poor	0.24	Fine	3.55	Extremely leptokurtic
ENV085	458985	5966624	1.23	1.57	1.83	2.06	2.37	2.89	5.38	6.89	7.92	109.41	3.19	Very fine sand	1.90	Poor	0.68	Very fine	3.33	Extremely leptokurtic
ENV086	463449	5965043	1.54	1.64	1.77	1.95	2.40	5.31	7.14	7.96	9.17	73.41	3.77	Very fine sand	2.50	Very poor	0.77	Very fine	0.93	Mesokurtic
ENV087	465430	5965644	1.26	1.51	1.61	1.76	2.34	6.09	7.39	8.17	9.45	72.79	3.78	Very fine sand	2.69	Very poor	0.74	Very fine	0.78	Platykurtic
ENV088	467520	5965830	1.63	1.92	2.23	2.61	4.05	7.05	7.81	8.53	9.92	38.56	4.70	Coarse silt	2.65	Very poor	0.38	Very fine	0.77	Platykurtic
ENV089	469079	5964557	1.13	1.37	1.60	1.86	3.58	6.96	7.73	8.39	9.74	50.73	4.30	Coarse silt	2.84	Very poor	0.39	Very fine	0.69	Platykurtic
ENV090	469789	5964064	1.45	1.61	1.76	1.99	3.30	5.67	7.37	8.44	10.01	56.54	4.14	Coarse silt	2.70	Very poor	0.51	Very fine	0.95	Mesokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV091	471428	5962677	1.29	1.62	1.90	2.99	5.16	7.47	8.24	9.15	10.55	29.13	5.10	Medium silt	2.99	Very poor	0.07	Symmetrical	0.85	Platykurtic
ENV092	473103	5961511	0.58	0.71	0.86	1.04	1.30	1.63	1.82	1.94	2.43	398.46	1.33	Medium sand	0.52	Moderately well	0.15	Fine	1.27	Leptokurtic
ENV093	474901	5960496	1.06	1.27	1.51	1.69	2.38	6.58	7.53	8.27	9.57	71.51	3.81	Very fine sand	2.79	Very poor	0.70	Very fine	0.71	Platykurtic
ENV094	476530	5959359	0.51	0.61	0.73	0.91	1.27	1.65	1.85	1.99	2.39	410.90	1.28	Medium sand	0.57	Moderately well	0.12	Fine	1.04	Mesokurtic
ENV095	478160	5958225	0.75	1.13	1.40	1.67	2.56	6.76	7.63	8.36	9.67	68.64	3.86	Very fine sand	2.91	Very poor	0.61	Very fine	0.72	Platykurtic
ENV096	479538	5956801	1.02	1.18	1.37	1.60	2.29	6.78	7.63	8.31	9.61	73.70	3.76	Very fine sand	2.87	Very poor	0.70	Very fine	0.68	Platykurtic
ENV097	481511	5955651	1.34	1.63	1.88	2.26	4.80	7.30	7.99	8.79	10.22	33.66	4.89	Coarse silt	2.87	Very poor	0.13	Fine	0.72	Platykurtic
ENV098	436002	5991262	-1.86	-0.48	0.22	0.71	1.51	2.26	2.77	5.46	7.42	353.12	1.50	Medium sand	2.04	Very poor	0.13	Fine	2.46	Very leptokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV099	438507	5990091	0.31	0.64	0.96	1.25	1.75	2.17	2.35	2.48	3.18	310.34	1.69	Medium sand	0.78	Moderate	-0.07	Symmetrical	1.28	Leptokurtic
ENV100	439281	5988212	0.02	0.55	1.04	1.31	1.75	2.13	2.31	2.44	2.89	307.25	1.70	Medium sand	0.75	Moderate	-0.16	Coarse	1.45	Leptokurtic
ENV101	441176	5987363	0.71	1.11	1.39	1.59	1.96	2.36	2.55	2.96	5.87	256.54	1.96	Medium sand	1.07	Poor	0.27	Fine	2.75	Very leptokurtic
ENV102	442460	5985881	0.59	1.03	1.22	1.51	1.86	2.31	2.49	2.97	6.55	275.66	1.86	Medium sand	1.22	Poor	0.28	Fine	3.04	Extremely leptokurtic
ENV103	446067	5984463	1.00	1.35	1.56	1.72	2.11	2.45	2.74	3.13	6.59	227.21	2.14	Fine sand	1.14	Poor	0.34	Very fine	3.13	Extremely leptokurtic
ENV104	447945	5983860	1.33	1.61	1.79	2.02	2.30	2.69	2.92	4.33	7.17	198.03	2.34	Fine sand	1.17	Poor	0.38	Very fine	3.56	Extremely leptokurtic
ENV105	448990	5980895	1.15	1.53	1.63	1.79	2.15	2.44	2.63	2.87	4.33	227.21	2.14	Fine sand	0.73	Moderate	0.17	Fine	2.03	Very leptokurtic
ENV106	450332	5979336	1.43	1.59	1.71	1.89	2.20	2.46	2.71	2.95	6.16	216.70	2.21	Fine sand	0.97	Moderate	0.35	Very fine	3.37	Extremely leptokurtic
ENV107	451223	5977553	1.18	1.52	1.60	1.72	2.05	2.34	2.44	2.53	2.80	244.97	2.03	Fine sand	0.45	Well	-0.08	Symmetrical	1.08	Mesokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV108	452500	5976008	1.11	1.50	1.59	1.72	2.08	2.42	2.70	4.40	7.14	229.46	2.12	Fine sand	1.19	Poor	0.40	Very fine	3.54	Extremely leptokurtic
ENV109	453699	5973866	1.07	1.38	1.55	1.67	2.00	2.38	2.63	4.85	7.25	239.95	2.06	Fine sand	1.21	Poor	0.43	Very fine	3.57	Extremely leptokurtic
ENV110	454487	5972116	1.02	1.26	1.52	1.64	1.98	2.36	2.50	2.98	6.59	250.53	2.00	Medium sand	1.09	Poor	0.36	Very fine	3.18	Extremely leptokurtic
ENV111	455076	5970187	0.52	1.04	1.25	1.52	1.86	2.22	2.36	2.46	2.72	282.82	1.82	Medium sand	0.61	Moderately well	-0.15	Coarse	1.28	Leptokurtic
ENV112	455948	5968868	0.21	0.95	1.31	1.60	2.03	2.43	2.86	5.85	7.60	238.84	2.07	Fine sand	1.51	Poor	0.28	Fine	3.62	Extremely leptokurtic
ENV113	452245	5978882	1.16	1.57	1.70	1.90	2.22	2.49	2.76	2.97	6.36	213.47	2.23	Fine sand	1.05	Poor	0.31	Very fine	3.63	Extremely leptokurtic
ENV114	454008	5977818	1.42	1.59	1.72	1.90	2.21	2.47	2.69	2.88	4.37	216.80	2.21	Fine sand	0.69	Moderately well	0.23	Fine	2.12	Very leptokurtic
ENV115	455707	5976790	1.38	1.65	1.89	2.07	2.36	2.82	3.57	6.46	7.71	163.97	2.61	Fine sand	1.38	Poor	0.56	Very fine	3.45	Extremely leptokurtic
ENV116	457540	5975924	1.44	1.88	2.06	2.18	2.51	2.95	4.58	6.94	8.02	120.65	3.05	Very fine sand	1.63	Poor	0.66	Very fine	3.51	Extremely leptokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV117	459256	5974895	1.64	2.04	2.13	2.27	2.64	3.06	5.32	7.10	8.13	96.86	3.37	Very fine sand	1.78	Poor	0.69	Very fine	3.35	Extremely leptokurtic
ENV118	460937	5973875	2.02	2.15	2.31	2.53	2.92	5.47	7.27	8.14	9.50	55.62	4.17	Coarse silt	2.37	Very poor	0.76	Very fine	1.04	Mesokurtic
ENV118	460937	5973875	2.02	2.15	2.31	2.53	2.92	5.47	7.27	8.14	9.50	55.62	4.17	Coarse silt	2.37	Very poor	0.76	Very fine	1.04	Mesokurtic
ENV119	462688	5972813	2.07	2.25	2.46	2.63	3.12	6.28	7.47	8.25	9.57	49.08	4.35	Coarse silt	2.39	Very poor	0.73	Very fine	0.84	Platykurtic
ENV120	464032	5970590	1.51	1.62	1.75	1.96	2.56	4.91	6.91	7.91	9.28	74.87	3.74	Very fine sand	2.47	Very poor	0.71	Very fine	1.08	Mesokurtic
ENV121	464946	5969283	2.50	2.62	2.76	2.97	3.87	6.81	7.84	8.82	10.36	35.31	4.82	Coarse silt	2.46	Very poor	0.61	Very fine	0.84	Platykurtic
ENV122	466125	5967962	2.52	2.64	2.78	2.99	3.88	6.73	7.87	8.90	10.39	34.85	4.84	Coarse silt	2.46	Very poor	0.61	Very fine	0.86	Platykurtic
ENV123	466742	5966720	1.41	1.57	1.67	1.83	2.37	5.50	7.22	8.24	9.80	74.11	3.75	Very fine sand	2.66	Very poor	0.76	Very fine	0.94	Mesokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV124	480790	5945988	0.60	1.01	1.17	1.41	1.94	4.37	6.13	7.50	9.11	118.38	3.08	Very fine sand	2.53	Very poor	0.69	Very fine	1.18	Leptokurtic
ENV125	467525	5961487	2.40	2.70	2.98	3.38	5.52	7.83	8.74	9.77	11.22	18.59	5.75	Medium silt	2.78	Very poor	0.20	Fine	0.81	Platykurtic
ENV126	469433	5961486	0.56	0.80	1.05	1.29	2.83	6.79	7.88	8.86	10.49	66.03	3.92	Very fine sand	3.21	Very poor	0.51	Very fine	0.74	Platykurtic
ENV127	471521	5961431	0.74	1.03	1.19	1.42	3.35	7.05	8.03	8.98	10.59	54.73	4.19	Coarse silt	3.20	Very poor	0.42	Very fine	0.72	Platykurtic
ENV128	472857	5960497	0.31	0.58	0.74	0.97	1.32	1.74	1.93	2.20	2.99	397.68	1.33	Medium sand	0.70	Moderate	0.13	Fine	1.43	Leptokurtic
ENV129	474710	5959202	0.17	0.37	0.55	0.71	1.14	1.55	1.79	1.95	2.32	447.74	1.16	Medium sand	0.63	Moderately well	0.07	Symmetrical	1.05	Mesokurtic
ENV130	476351	5958052	0.42	0.72	1.01	1.22	1.92	6.56	7.75	8.73	10.37	84.85	3.56	Very fine sand	3.19	Very poor	0.71	Very fine	0.76	Platykurtic
ENV131	476620	5956671	0.39	1.00	1.17	1.44	1.98	6.43	7.55	8.41	9.91	84.28	3.57	Very fine sand	3.04	Very poor	0.71	Very fine	0.78	Platykurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV132	477290	5955335	0.25	0.62	0.90	1.18	1.93	6.36	7.60	8.53	10.11	89.88	3.48	Very fine sand	3.17	Very poor	0.68	Very fine	0.78	Platykurtic
ENV154	492462	5955650	1.09	1.34	1.56	1.75	2.19	2.61	2.84	2.99	3.49	218.17	2.20	Fine sand	0.68	Moderately well	0.04	Symmetrical	1.14	Leptokurtic
ENV156	490985	5955536	1.05	1.46	1.64	1.88	2.35	2.95	5.01	6.96	8.28	124.95	3.00	Very fine sand	1.94	Poor	0.61	Very fine	2.77	Very leptokurtic
ENV157	489989	5955366	1.10	1.51	1.66	1.88	2.33	3.02	5.78	7.33	8.62	104.72	3.26	Very fine sand	2.17	Very poor	0.67	Very fine	2.69	Very leptokurtic
ENV158	488509	5955130	1.11	1.26	1.45	1.59	1.89	2.48	5.31	7.06	8.30	135.42	2.88	Fine sand	2.06	Very poor	0.78	Very fine	3.32	Extremely leptokurtic
ENV160	487047	5955655	1.22	1.50	1.57	1.67	1.95	2.46	4.56	6.65	7.97	154.49	2.69	Fine sand	1.77	Poor	0.76	Very fine	3.49	Extremely leptokurtic
ENV162	485549	5955516	1.09	1.21	1.36	1.54	1.82	2.20	2.39	2.59	3.86	276.03	1.86	Medium sand	0.68	Moderately well	0.28	Fine	1.72	Very leptokurtic
ENV164	484065	5955800	0.62	0.78	0.97	1.11	1.46	1.94	2.31	3.42	6.17	333.92	1.58	Medium sand	1.18	Poor	0.48	Very fine	2.75	Very leptokurtic

Station number	Easting	Northing	Percentile									Folk and Ward Graphic								
			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
ENV166	482724	5955260	1.14	1.54	1.75	2.06	3.41	7.14	8.18	9.25	10.93	45.91	4.45	Coarse silt	3.09	Very poor	0.51	Very fine	0.79	Platykurtic
ENV167	494315	5956106	1.20	1.52	1.69	1.94	2.36	2.80	2.97	3.28	4.10	197.68	2.34	Fine sand	0.76	Moderate	0.08	Symmetrical	1.39	Leptokurtic
ENV168	495216	5957174	1.34	1.64	1.89	2.12	2.56	2.93	3.13	3.34	3.57	173.24	2.53	Fine sand	0.65	Moderately well	-0.08	Symmetrical	1.13	Leptokurtic

Appendix Table 3: Full results of PSA (part 2)

Station number	Method of Moments								Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value					
ENV066	447.76	1.16	Medium sand	2.80	Very poor	0.91	Fine	4.94	Leptokurtic	10.05	67.52	22.44	Gravelly muddy sand

Station number	Method of Moments								Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean μm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value					
ENV067	469.35	1.09	Medium sand	2.54	Very poor	0.95	Fine	5.63	Leptokurtic	7.95	71.77	20.27	Gravelly sand
ENV068	492.85	1.02	Medium sand	2.53	Very poor	1.00	Fine	5.57	Leptokurtic	7.71	70.43	21.86	Gravelly sand
ENV069	405.77	1.30	Medium sand	2.36	Very poor	1.43	Very fine	7.05	Leptokurtic	8.71	78.13	13.17	Gravelly muddy sand
ENV070	420.45	1.25	Medium sand	2.39	Very poor	0.84	Fine	5.84	Leptokurtic	7.95	76.57	15.48	Gravelly sand
ENV071	232.86	2.10	Fine sand	2.83	Very poor	1.12	Fine	4.64	Leptokurtic	16.59	71.93	11.48	Gravelly muddy sand
ENV072	484.97	1.04	Medium sand	2.11	Very poor	0.70	Fine	6.52	Leptokurtic	5.36	78.17	16.48	Gravelly sand
ENV073	379.37	1.40	Medium sand	2.26	Very poor	1.18	Fine	6.27	Leptokurtic	7.97	77.48	14.55	Gravelly sand
ENV074	291.48	1.78	Medium sand	2.20	Very poor	1.33	Very fine	7.20	Leptokurtic	9.81	83.07	7.12	Gravelly muddy sand
ENV075	435.19	1.20	Medium sand	2.63	Very poor	1.05	Fine	5.40	Leptokurtic	9.84	70.18	19.99	Gravelly muddy sand

Station number	Method of Moments								Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value					
ENV076	441.24	1.18	Medium sand	2.25	Very poor	0.90	Fine	6.49	Leptokurtic	6.54	78.53	14.92	Gravelly sand
ENV077	353.83	1.50	Medium sand	2.86	Very poor	1.01	Fine	4.78	Leptokurtic	13.46	68.79	17.76	Gravelly muddy sand
ENV078	292.88	1.77	Medium sand	2.15	Very poor	1.67	Very fine	7.63	Very leptokurtic	10.28	84.36	5.36	Gravelly muddy sand
ENV079	468.96	1.09	Medium sand	2.53	Very poor	0.67	Fine	5.05	Leptokurtic	8.36	70.64	21.00	Gravelly muddy sand
ENV080	323.21	1.63	Medium sand	1.28	Poor	4.08	Very fine	28.49	Very leptokurtic	3.17	96.22	0.61	Sand
ENV081	421.90	1.25	Medium sand	0.55	Moderately well	-0.99	Coarse	5.90	Leptokurtic	0.00	99.62	0.38	Sand
ENV082	141.09	2.83	Fine sand	2.35	Very poor	1.94	Very fine	6.11	Leptokurtic	19.60	80.33	0.07	Muddy sand
ENV083	79.75	3.65	Very fine sand	2.75	Very poor	1.18	Fine	3.34	Mesokurtic	33.38	66.58	0.04	Muddy sand
ENV084	182.59	2.45	Fine sand	1.77	Poor	2.45	Very fine	10.53	Very leptokurtic	9.86	90.14	0.00	Sand

Station number	Method of Moments								Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value					
ENV085	112.42	3.15	Very fine sand	2.14	Very poor	1.93	Very fine	6.26	Leptokurtic	20.15	79.85	0.00	Muddy sand
ENV086	75.89	3.72	Very fine sand	2.67	Very poor	1.39	Very fine	3.88	Leptokurtic	29.54	70.46	0.00	Muddy sand
ENV087	69.60	3.84	Very fine sand	2.85	Very poor	1.14	Fine	3.20	Mesokurtic	34.71	65.29	0.00	Muddy sand
ENV088	34.79	4.85	Coarse silt	2.74	Very poor	0.74	Fine	2.67	Mesokurtic	50.49	49.51	0.00	Sandy mud
ENV089	44.71	4.48	Coarse silt	2.95	Very poor	0.64	Fine	2.41	Platykurtic	48.82	51.18	0.00	Muddy sand
ENV090	54.63	4.19	Coarse silt	2.79	Very poor	1.12	Fine	3.52	Mesokurtic	39.79	59.98	0.22	Muddy sand
ENV091	24.07	5.38	Medium silt	2.91	Very poor	0.33	Symmetrical	2.47	Platykurtic	65.06	34.80	0.13	Sandy mud
ENV092	360.22	1.47	Medium sand	1.15	Poor	4.46	Very fine	31.59	Very leptokurtic	3.21	96.44	0.35	Sand
ENV093	64.19	3.96	Very fine sand	3.02	Very poor	0.82	Fine	2.73	Mesokurtic	40.06	59.00	0.93	Muddy sand

Station number	Method of Moments									Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value						
ENV094	379.50	1.40	Medium sand	1.10	Poor	5.15	Very fine	42.81	Very leptokurtic	2.06	97.63	0.31	Sand	
ENV095	57.51	4.12	Coarse silt	3.08	Very poor	0.69	Fine	2.48	Platykurtic	44.33	55.27	0.40	Muddy sand	
ENV096	59.92	4.06	Coarse silt	3.07	Very poor	0.78	Fine	2.44	Platykurtic	42.57	57.38	0.04	Muddy sand	
ENV097	31.37	4.99	Coarse silt	2.97	Very poor	0.41	Symmetrical	2.38	Platykurtic	57.56	42.09	0.35	Sandy mud	
ENV098	284.48	1.81	Medium sand	2.48	Very poor	1.33	Very fine	6.27	Leptokurtic	12.08	80.36	7.56	Gravelly muddy sand	
ENV099	275.34	1.86	Medium sand	1.41	Poor	3.50	Very fine	21.43	Very leptokurtic	4.27	95.30	0.43	Sand	
ENV100	308.81	1.70	Medium sand	1.51	Poor	1.58	Very fine	17.38	Very leptokurtic	3.14	92.50	4.36	Slightly gravelly sand	
ENV101	212.79	2.23	Fine sand	1.55	Poor	3.03	Very fine	15.14	Very leptokurtic	7.18	92.56	0.26	Sand	
ENV102	217.46	2.20	Fine sand	1.69	Poor	2.87	Very fine	13.01	Very leptokurtic	8.25	91.47	0.28	Sand	
ENV103	186.41	2.42	Fine sand	1.60	Poor	3.03	Very fine	13.76	Very leptokurtic	8.29	91.64	0.07	Sand	

Station number	Method of Moments									Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value						
ENV104	151.05	2.73	Fine sand	1.70	Poor	2.77	Very fine	11.22	Very leptokurtic	10.57	89.39	0.04	Muddy sand	
ENV105	197.13	2.34	Fine sand	1.35	Poor	3.95	Very fine	22.70	Very leptokurtic	5.32	94.64	0.04	Sand	
ENV106	177.85	2.49	Fine sand	1.45	Poor	3.57	Very fine	17.35	Very leptokurtic	6.93	93.04	0.02	Sand	
ENV107	239.76	2.06	Fine sand	0.78	Moderately	5.62	Very fine	64.87	Very leptokurtic	1.07	98.85	0.08	Sand	
ENV108	174.02	2.52	Fine sand	1.77	Poor	2.76	Very fine	11.08	Very leptokurtic	10.62	89.26	0.13	Muddy sand	
ENV109	177.71	2.49	Fine sand	1.83	Poor	2.64	Very fine	10.36	Very leptokurtic	11.19	88.62	0.19	Muddy sand	
ENV110	197.91	2.34	Fine sand	1.62	Poor	3.06	Very fine	13.59	Very leptokurtic	8.41	91.50	0.10	Sand	
ENV111	284.86	1.81	Medium sand	1.20	Poor	1.68	Very fine	23.69	Very leptokurtic	1.92	95.03	3.05	Slightly gravelly sand	
ENV112	175.66	2.51	Fine sand	2.10	Very poor	2.16	Very fine	8.10	Very leptokurtic	13.37	86.63	0.00	Muddy sand	
ENV113	183.40	2.45	Fine sand	1.65	Poor	2.31	Very fine	13.46	Very leptokurtic	7.38	90.57	2.05	Slightly gravelly sand	

Station number	Method of Moments								Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value					
ENV114	187.38	2.42	Fine sand	1.34	Poor	4.10	Very fine	23.69	Very leptokurtic	5.30	94.64	0.06	Sand
ENV115	124.71	3.00	Very fine sand	1.96	Poor	2.28	Very fine	7.93	Very leptokurtic	15.63	84.37	0.00	Muddy sand
ENV116	106.30	3.23	Very fine sand	2.07	Very poor	2.16	Very fine	7.28	Leptokurtic	17.78	82.22	0.00	Muddy sand
ENV117	94.56	3.40	Very fine sand	2.11	Very poor	2.04	Very fine	6.73	Leptokurtic	19.91	80.09	0.00	Muddy sand
ENV118	55.23	4.18	Coarse silt	2.54	Very poor	1.40	Very fine	4.06	Leptokurtic	33.28	66.72	0.00	Muddy sand
ENV118	46.30	4.43	Coarse silt	2.55	Very poor	1.22	Fine	3.58	Mesokurtic	38.48	61.52	0.00	Muddy sand
ENV119	75.12	3.73	Very fine sand	2.62	Very poor	1.42	Very fine	4.21	Leptokurtic	29.93	69.97	0.10	Muddy sand
ENV120	31.67	4.98	Coarse silt	2.59	Very poor	1.12	Fine	3.38	Mesokurtic	47.77	52.23	0.00	Muddy sand
ENV121	31.59	4.98	Coarse silt	2.58	Very poor	1.15	Fine	3.42	Mesokurtic	47.67	52.33	0.00	Muddy sand

Station number	Method of Moments								Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value					
ENV122	70.57	3.82	Very fine sand	2.82	Very poor	1.30	Very fine	3.67	Mesokurtic	33.38	66.62	0.00	Muddy sand
ENV123	114.02	3.13	Very fine sand	2.74	Very poor	1.48	Very fine	4.53	Leptokurtic	27.78	71.89	0.34	Muddy sand
ENV124	17.16	5.86	Medium silt	2.80	Very poor	0.55	Fine	2.49	Platykurtic	64.41	35.59	0.00	Sandy mud
ENV125	58.88	4.09	Coarse silt	3.34	Very poor	0.75	Fine	2.48	Platykurtic	42.70	57.15	0.15	Muddy sand
ENV126	49.69	4.33	Coarse silt	3.34	Very poor	0.65	Fine	2.36	Platykurtic	46.14	53.50	0.36	Muddy sand
ENV127	352.16	1.51	Medium sand	1.40	Poor	3.62	Very fine	23.94	Very leptokurtic	3.85	94.89	1.25	Slightly gravelly sand
ENV128	418.83	1.26	Medium sand	1.11	Poor	4.91	Very fine	40.44	Very leptokurtic	1.96	97.73	0.31	Sand
ENV129	71.84	3.80	Very fine sand	3.36	Very poor	0.88	Fine	2.60	Mesokurtic	39.08	60.61	0.31	Muddy sand
ENV130	81.16	3.62	Very fine sand	3.40	Very poor	0.57	Fine	3.06	Mesokurtic	36.52	60.50	2.98	Slightly gravelly muddy sand

Station number	Method of Moments								Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value					
ENV131	82.00	3.61	Very fine sand	3.32	Very poor	0.94	Fine	2.78	Mesokurtic	35.69	63.53	0.78	Muddy sand
ENV132	197.73	2.34	Fine sand	1.32	Poor	3.90	Very fine	25.58	Very leptokurtic	4.00	95.73	0.26	Sand
ENV154	121.26	3.04	Very fine sand	2.38	Very poor	1.56	Very fine	6.36	Leptokurtic	18.26	80.26	1.47	Slightly gravelly muddy sand
ENV156	108.67	3.20	Very fine sand	2.46	Very poor	1.74	Very fine	5.77	Leptokurtic	20.49	78.74	0.78	Muddy sand
ENV157	136.07	2.88	Fine sand	2.40	Very poor	1.97	Very fine	6.14	Leptokurtic	19.27	80.61	0.12	Muddy sand
ENV158	139.95	2.84	Fine sand	2.23	Very poor	2.12	Very fine	7.09	Leptokurtic	17.91	81.87	0.22	Muddy sand
ENV160	238.69	2.07	Fine sand	1.30	Poor	4.46	Very fine	28.59	Very leptokurtic	4.68	95.15	0.17	Sand
ENV162	262.06	1.93	Medium sand	1.74	Poor	3.02	Very fine	13.66	Very leptokurtic	8.96	90.75	0.29	Sand
ENV164	39.59	4.66	Coarse silt	3.19	Very poor	0.73	Fine	2.51	Platykurtic	46.60	53.16	0.25	Muddy sand

Station number	Method of Moments									Fines%	Sands%	Gravels%	FolkModified	FolkEunis
	Mean µm	Mean Phi	Wentworth	Sorting Value	Sorting Description	Skewness Value	Skewness Description	Kurtosis Value						
ENV166	171.51	2.54	Fine sand	1.40	Poor	3.55	Very fine	20.99	Very leptokurtic	5.11	94.58	0.31	Sand	
ENV167	162.58	2.62	Fine sand	1.20	Poor	3.83	Very fine	29.48	Very leptokurtic	3.30	96.30	0.40	Sand	
ENV168	447.76	1.16	Medium sand	2.80	Very poor	0.91	Fine	4.94	Leptokurtic	10.05	67.52	22.44	Gravelly muddy sand	

Appendix Table 4: Full results of PSA (part 3)

Station number	Median	Description	1stLocalMaxima	Description	2ndLocalMaxima	Description	3rdLocalMaxima	Description
ENV066	1.38	Medium sand	2.00	Medium sand	-3.00	Pebble	-1.50	Granule
ENV067	1.32	Medium sand	2.00	Medium sand	-3.00	Pebble	-0.50	Very coarse sand
ENV068	1.25	Medium sand	2.00	Medium sand	-1.50	Granule	-2.50	Pebble
ENV069	1.19	Medium sand	1.50	Medium sand	-1.00	Granule	-3.00	Pebble
ENV070	1.36	Medium sand	2.00	Medium sand	-3.00	Pebble	-0.50	Very coarse sand
ENV071	1.82	Medium sand	2.50	Fine sand	-0.50	Very coarse sand	7.50	Very fine silt
ENV072	1.29	Medium sand	2.00	Medium sand	-1.50	Granule	-3.00	Pebble
ENV073	1.57	Medium sand	2.00	Medium sand	-0.50	Very coarse sand	7.50	Very fine silt
ENV074	1.64	Medium sand	2.00	Medium sand	7.00	Fine silt		
ENV075	1.32	Medium sand	2.00	Medium sand	-1.00	Granule	-3.00	Pebble
ENV076	1.36	Medium sand	2.00	Medium sand	-3.00	Pebble	-0.50	Very coarse sand
ENV077	1.41	Medium sand	2.00	Medium sand	-3.00	Pebble	-1.50	Granule
ENV078	1.54	Medium sand	2.00	Medium sand	7.50	Very fine silt		
ENV079	1.45	Medium sand	2.00	Medium sand	-2.50	Pebble	7.50	Very fine silt
ENV080	1.52	Medium sand	2.00	Medium sand				
ENV081	1.29	Medium sand	1.50	Medium sand				
ENV082	1.92	Medium sand	2.00	Medium sand	7.50	Very fine silt	4.50	Coarse silt

Station number	Median	Description	1stLocalMaxima	Description	2ndLocalMaxima	Description	3rdLocalMaxima	Description
ENV083	2.20	Fine sand	2.00	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV084	2.16	Fine sand	2.50	Fine sand	0.00	Very coarse sand	7.50	Very fine silt
ENV085	2.37	Fine sand	2.50	Fine sand	7.50	Very fine silt	4.50	Coarse silt
ENV086	2.40	Fine sand	2.50	Fine sand	7.50	Very fine silt	5.00	Coarse silt
ENV087	2.34	Fine sand	2.00	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV088	4.05	Coarse silt	3.00	Fine sand	7.50	Very fine silt		
ENV089	3.58	Very fine sand	2.00	Medium sand	7.50	Very fine silt	4.50	Coarse silt
ENV090	3.30	Very fine sand	2.00	Medium sand	7.50	Very fine silt		
ENV091	5.16	Medium silt	2.00	Medium sand	4.50	Coarse silt	7.50	Very fine silt
ENV092	1.30	Medium sand	1.50	Medium sand				
ENV093	2.38	Fine sand	2.00	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV094	1.27	Medium sand	1.50	Medium sand				
ENV095	2.56	Fine sand	2.00	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV096	2.29	Fine sand	2.00	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV097	4.80	Coarse silt	2.00	Medium sand	7.50	Very fine silt	4.50	Coarse silt
ENV098	1.51	Medium sand	2.00	Medium sand	-3.00	Pebble	7.50	Very fine silt
ENV099	1.75	Medium sand	2.00	Medium sand				
ENV100	1.75	Medium sand	2.00	Medium sand	-2.50	Pebble		
ENV101	1.96	Medium sand	2.00	Medium sand				
ENV102	1.86	Medium sand	2.00	Medium sand	7.50	Very fine silt		

Station number	Median	Description	1stLocalMaxima	Description	2ndLocalMaxima	Description	3rdLocalMaxima	Description
ENV103	2.11	Fine sand	2.50	Fine sand	7.50	Very fine silt		
ENV104	2.30	Fine sand	2.50	Fine sand	7.50	Very fine silt		
ENV105	2.15	Fine sand	2.50	Fine sand				
ENV106	2.20	Fine sand	2.50	Fine sand				
ENV107	2.05	Fine sand	2.50	Fine sand	0.50	Coarse sand		
ENV108	2.08	Fine sand	2.50	Fine sand	7.50	Very fine silt		
ENV109	2.00	Medium sand	2.00	Medium sand	7.50	Very fine silt		
ENV110	1.98	Medium sand	2.00	Medium sand	7.50	Very fine silt		
ENV111	1.86	Medium sand	2.00	Medium sand	-2.00	Pebble		
ENV112	2.03	Fine sand	2.50	Fine sand	0.00	Very coarse sand	7.50	Very fine silt
ENV113	2.22	Fine sand	2.50	Fine sand	-2.00	Pebble		
ENV114	2.21	Fine sand	2.50	Fine sand				
ENV115	2.36	Fine sand	2.50	Fine sand	7.50	Very fine silt		
ENV116	2.51	Fine sand	2.50	Fine sand	7.50	Very fine silt	6.00	Medium silt
ENV117	2.64	Fine sand	3.00	Fine sand	1.50	Medium sand	7.50	Very fine silt
ENV118	2.92	Fine sand	3.00	Fine sand	7.50	Very fine silt		
ENV119	3.12	Very fine sand	3.00	Fine sand	7.50	Very fine silt		
ENV120	2.56	Fine sand	2.00	Medium sand	7.50	Very fine silt		
ENV121	3.87	Very fine sand	3.00	Fine sand	7.50	Very fine silt		
ENV122	3.88	Very fine sand	3.00	Fine sand	7.50	Very fine silt		

Station number	Median	Description	1stLocalMaxima	Description	2ndLocalMaxima	Description	3rdLocalMaxima	Description
ENV123	2.37	Fine sand	2.00	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV124	1.94	Medium sand	2.00	Medium sand	4.50	Coarse silt	7.50	Very fine silt
ENV125	5.52	Medium silt	3.50	Very fine sand	7.50	Very fine silt	1.50	Medium sand
ENV126	2.83	Fine sand	1.50	Medium sand	7.50	Very fine silt	4.00	Very fine sand
ENV127	3.35	Very fine sand	1.50	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV128	1.32	Medium sand	1.50	Medium sand				
ENV129	1.14	Medium sand	1.50	Medium sand				
ENV130	1.92	Medium sand	1.50	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV131	1.98	Medium sand	2.00	Medium sand	7.50	Very fine silt	-4.00	Pebble
ENV132	1.93	Medium sand	1.50	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV154	2.19	Fine sand	2.50	Fine sand				
ENV156	2.35	Fine sand	2.50	Fine sand	7.50	Very fine silt	5.00	Coarse silt
ENV157	2.33	Fine sand	2.50	Fine sand	7.50	Very fine silt		
ENV158	1.89	Medium sand	2.00	Medium sand	7.50	Very fine silt	5.00	Coarse silt
ENV160	1.95	Medium sand	2.00	Medium sand	7.50	Very fine silt	4.50	Coarse silt
ENV162	1.82	Medium sand	2.00	Medium sand				
ENV164	1.46	Medium sand	1.50	Medium sand	4.50	Coarse silt		
ENV166	3.41	Very fine sand	2.50	Fine sand	7.50	Very fine silt	5.00	Coarse silt
ENV167	2.36	Fine sand	2.50	Fine sand				
ENV168	2.56	Fine sand	3.00	Fine sand				

C.2 Sediment contamination results

Appendix Table 5: Concentrations of metal contaminants within the survey area

Station	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Detection Limit	1	0.1	0.5	2	0.01	0.5	2	3
Cefas AL1 (mg/kg)	20	0.4	40	40	0.3	20	50	130
Cefas AL2 (mg/kg)	100	5	400	400	3	200	500	800
Canadian TEL (mg/kg)	7.2	0.7	52.3	18.7	0.13	-	30.2	124
Canadian PEL (mg/kg)	41.6	4.2	160	108	0.7	-	112	271
ENV066	12.2	0.05	18.7	7.9	0.02	16.5	9.9	33.8
ENV068	13.0	<0.04	18.6	8.2	<0.01	16.0	9.8	31.2
ENV070	10.1	0.05	12.4	7.0	<0.01	12.2	10.6	35.4
ENV072	12.8	<0.04	12.8	5.6	<0.01	10.2	9.1	28.4
ENV074	12.6	<0.04	10.7	6.8	<0.01	9.6	12.3	27.8
ENV076	11.9	0.06	11.5	6.6	<0.01	12.1	12.7	38.6
ENV078	13.2	<0.04	10.0	6.1	<0.01	8.5	13.4	30.8
ENV080	9.6	<0.04	7.3	6.6	0.03	6.1	8.1	30.1
ENV082	6.2	<0.04	10.1	7.3	0.06	7.3	11.4	43.7
ENV084	4.8	<0.04	7.9	5.2	0.05	5.9	8.7	44.3
ENV086	3.4	<0.04	10.5	7.8	0.09	7.8	11.7	49.3
ENV088	4.6	<0.04	16.2	9.0	0.14	11.6	17.6	82.8
ENV090	8.3	<0.04	9.3	5.9	0.04	8.3	7.8	50.7
ENV092	7.7	<0.04	6.3	4.4	0.03	5.8	7.5	40.4
ENV094	18.4	<0.04	7.9	5.8	0.03	7.9	14.3	42.8
ENV096	6.0	<0.04	13.8	9.0	0.12	10.4	16.8	62.8
ENV097	7.7	<0.04	24.5	14.4	0.27	16.2	29.4	87.0
ENV099	8.4	<0.04	7.7	5.3	0.03	5.9	9.1	36.0

Station	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
ENV101	5.9	<0.04	7.1	5.0	0.03	5.5	7.0	28.9
ENV103	4.8	<0.04	7.0	5.6	0.03	5.1	7.5	28.2
ENV105	4.5	<0.04	14.7	5.6	0.03	20.6	7.1	48.0
ENV107	5.9	<0.04	6.7	5.5	0.03	5.2	7.7	28.9
ENV109	5.8	<0.04	9.8	6.1	0.06	7.8	11.6	35.3
ENV111	5.2	<0.04	6.7	5.0	0.04	4.9	7.0	33.2
ENV113	4.8	<0.04	7.3	4.6	0.04	5.1	7.7	31.7
ENV115	4.3	<0.04	8.7	7.3	0.05	6.4	9.4	36.4
ENV117	4.2	<0.04	11.0	8.8	0.07	8.2	11.4	60.3
ENV119	4.9	<0.04	15.7	8.7	0.13	11.6	16.9	112.0
ENV121	4.4	<0.04	17.8	10.3	0.14	12.7	18.4	99.0
ENV123	4.5	<0.04	13.4	7.8	0.11	10.0	14.9	103.0
ENV125	7.0	0.23	25.3	13.0	0.20	18.2	27.2	96.8
ENV127	6.5	0.10	19.3	9.4	0.14	14.4	20.0	76.2
ENV129	15.7	0.07	7.9	4.8	0.03	8.8	10.1	35.4
ENV131	6.0	0.06	15.2	8.1	0.13	12.9	17.2	57.5
ENV154	6.7	<0.04	11.5	4.3	0.02	8.8	6.7	26.2
ENV157	8.0	<0.04	13.1	5.0	0.05	9.6	10.7	40.2
ENV160	19.4	<0.04	13.5	5.6	0.04	10.0	14.8	45.7
ENV164	13.6	<0.04	11.6	5.1	0.06	10.1	9.8	32.8
ENV168	6.0	<0.04	12.4	4.2	0.03	8.6	6.8	24.8

Green = exceeds Canadian TEL, Blue = exceeds Canadian PEL, Yellow = exceeds Cefas AL1, Orange = exceeds Cefas AL2

Appendix Table 6: Concentrations of PAHs within the survey area

Station	Acenaphthene	Acenaphthylene	Anthracene	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[e]pyrene	Benzo[ghi]perylene	Benzo[k]fluoranthene	C1-naphthalenes	C1-phenanthrene	C2-naphthalenes	C3-naphthalenes	Chrysene	Dibenzo[ah]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-cd]pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	Total PAH
Units	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	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Canadian TEL	6.71	5.87	46.9	74.9	88.8	-	-	-	-	-	-	-	-	108	6.22	113	21.2	-	34.6	-	86.7	153	-
Canadian PEL	88.9	128	245	693	763	-	-	-	-	-	-	-	-	846	135	1,494	144	-	391	-	544	1398	-
ERL	16	44	85.3	261	430	-	-	-	-	-	-	-	-	384	63.4	600	19	-	160	-	240	665	4022
Cefas AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	10	100	100	100	100	100	100	100	-
ENV066	<1	<1	<1	3	3	7	6	6	3	10	9	10	8	4	1	5	2	6	3	1	7	4	97
ENV068	<1	<1	<1	1	2	3	3	3	1	5	4	5	3	2	<1	3	<1	3	2	<1	3	2	47
ENV070	<1	<1	<1	2	2	4	4	4	2	6	5	6	4	3	<1	4	1	4	2	1	4	3	63
ENV072	<1	<1	<1	<1	1	2	2	2	1	3	3	5	3	2	<1	2	<1	2	1	<1	2	2	34
ENV074	<1	<1	<1	2	3	5	4	4	2	7	6	7	6	3	<1	4	1	4	3	<1	4	3	68
ENV076	<1	<1	<1	3	4	7	6	5	2	9	8	10	8	4	<1	5	1	6	3	1	6	5	91
ENV078	<1	<1	1	5	6	9	8	9	4	35	27	46	40	7	1	8	2	7	6	2	18	8	250
ENV080	<1	<1	<1	1	2	2	2	3	1	4	4	4	3	2	<1	2	<1	2	2	<1	4	3	41
ENV082	1	1	3	9	15	19	17	18	9	19	19	23	19	12	3	16	3	19	6	5	14	17	265
ENV084	<1	<1	<1	3	5	7	6	7	3	7	9	10	8	4	1	5	1	6	2	2	6	6	98

Station	Acenaphthene	Acenaphthylene	Anthracene	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[e]pyrene	Benzo[ghi]perylene	Benzo[k]fluoranthene	C1-naphthalenes	C1-phenanthrene	C2-naphthalenes	C3-naphthalenes	Chrysene	Dibenzo[ah]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-cd]pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	Total PAH
Units	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	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Canadian TEL	6.71	5.87	46.9	74.9	88.8	-	-	-	-	-	-	-	-	108	6.22	113	21.2	-	34.6	-	86.7	153	-
Canadian PEL	88.9	128	245	693	763	-	-	-	-	-	-	-	-	846	135	1,494	144	-	391	-	544	1398	-
ERL	16	44	85.3	261	430	-	-	-	-	-	-	-	-	384	63.4	600	19	-	160	-	240	665	4022
Cefas AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	10	100	100	100	100	100	100	100	-
ENV086	2	2	4	13	20	26	24	24	14	19	21	23	19	15	4	23	4	25	7	7	18	23	337
ENV088	3	3	7	23	36	46	42	42	25	31	34	35	28	25	8	39	6	46	11	12	30	40	569
ENV090	<1	<1	1	4	6	8	7	8	4	8	8	9	7	5	1	7	1	7	3	3	7	7	112
ENV092	<1	<1	<1	2	3	4	3	3	2	3	3	3	3	2	<1	3	<1	3	1	<1	3	3	45
ENV094	<1	<1	<1	1	2	2	2	2	1	2	2	2	2	1	<1	2	<1	2	<1	<1	2	2	26
ENV096	4	4	8	28	45	61	55	52	27	41	43	45	38	33	10	49	8	60	16	15	40	48	730
ENV097	6	8	13	43	73	89	84	79	39	53	57	62	50	45	16	65	11	93	19	21	51	75	1050
ENV099	<1	<1	<1	<1	1	2	2	2	<1	2	3	3	2	1	<1	2	<1	2	<1	<1	2	1	24
ENV101	<1	<1	<1	2	2	4	3	3	2	4	6	6	5	2	<1	3	<1	3	1	<1	4	3	53
ENV103	<1	<1	<1	3	4	6	5	6	3	7	8	9	7	4	<1	5	<1	5	2	1	6	5	85
ENV105	<1	<1	<1	1	2	3	3	3	2	4	4	5	4	2	<1	3	<1	3	1	<1	3	3	45

Station	Acenaphthene	Acenaphthylene	Anthracene	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[e]pyrene	Benzo[ghi]perylene	Benzo[k]fluoranthene	C1-naphthalenes	C1-phenanthrene	C2-naphthalenes	C3-naphthalenes	Chrysene	Dibenzo[ah]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-cd]pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	Total PAH
Units	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	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Canadian TEL	6.71	5.87	46.9	74.9	88.8	-	-	-	-	-	-	-	-	108	6.22	113	21.2	-	34.6	-	86.7	153	-
Canadian PEL	88.9	128	245	693	763	-	-	-	-	-	-	-	-	846	135	1,494	144	-	391	-	544	1398	-
ERL	16	44	85.3	261	430	-	-	-	-	-	-	-	-	384	63.4	600	19	-	160	-	240	665	4022
Cefas AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	10	100	100	100	100	100	100	100	-
ENV107	<1	<1	<1	1	2	2	3	3	1	3	4	4	4	2	<1	2	<1	3	<1	<1	3	2	37
ENV109	1	1	2	6	10	13	12	12	7	10	12	13	12	8	2	12	2	12	4	3	9	13	177
ENV111	<1	<1	<1	1	2	3	3	3	1	4	6	7	5	2	<1	3	<1	3	1	<1	4	3	50
ENV113	<1	<1	<1	2	3	4	4	4	2	3	5	5	3	2	<1	4	<1	4	1	<1	4	4	53
ENV115	<1	1	2	6	9	13	12	11	6	14	14	17	13	8	2	11	2	11	5	3	11	12	184
ENV117	1	2	3	9	13	19	17	17	9	20	23	26	22	11	3	17	3	17	7	4	17	18	278
ENV119	2	3	5	17	25	34	30	30	16	26	31	30	28	20	5	34	5	31	9	8	26	34	449
ENV121	4	3	7	21	30	42	36	36	18	32	38	37	31	23	7	39	6	38	12	10	32	40	542
ENV123	3	3	5	17	23	31	27	28	14	20	25	23	20	17	5	34	4	29	8	7	24	34	400
ENV125	10	7	11	38	60	82	66	65	66	77	78	74	60	57	10	84	13	58	26	22	63	84	1111
ENV127	4	5	10	24	39	44	39	39	29	46	56	43	39	37	5	54	8	35	17	10	43	56	684

Station	Acenaphthene	Acenaphthylene	Anthracene	Benzo[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[e]pyrene	Benzo[ghi]perylene	Benzo[k]fluoranthene	C1-naphthalenes	C1-phenanthrene	C2-naphthalenes	C3-naphthalenes	Chrysene	Dibenzo[ah]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-cd]pyrene	Naphthalene	Perylene	Phenanthrene	Pyrene	Total PAH
Units	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	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Canadian TEL	6.71	5.87	46.9	74.9	88.8	-	-	-	-	-	-	-	-	108	6.22	113	21.2	-	34.6	-	86.7	153	-
Canadian PEL	88.9	128	245	693	763	-	-	-	-	-	-	-	-	846	135	1,494	144	-	391	-	544	1398	-
ERL	16	44	85.3	261	430	-	-	-	-	-	-	-	-	384	63.4	600	19	-	160	-	240	665	4022
Cefas AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	10	100	100	100	100	100	100	100	-
ENV129	<1	<1	<1	3	4	4	4	4	4	5	4	4	4	4	<1	5	<1	4	2	1	4	5	65
ENV131	3	4	11	28	35	45	34	39	32	45	45	43	37	40	4	62	8	33	16	10	45	63	680
ENV154	<1	2	<1	3	4	4	4	3	4	2	3	5	2	3	<1	4	<1	4	1	1	2	3	55
ENV157	1	1	2	7	11	13	12	10	10	9	10	12	9	9	2	13	2	13	3	3	10	13	177
ENV160	<1	<1	1	5	7	9	8	7	6	6	6	6	5	6	2	9	1	8	2	2	6	9	112
ENV164	<1	<1	1	4	6	8	7	6	7	5	6	6	5	5	1	8	1	7	2	2	5	8	102
ENV168	<1	<1	<1	2	3	4	3	3	2	3	3	4	2	2	<1	3	<1	4	1	<1	2	3	45

Green = exceeds Canadian TEL, Blue = exceeds Canadian PEL, Yellow = exceeds ERL, Red = exceeds Cefas AL1

Appendix Table 7: Concentrations of PCBs within the survey area

Station	PCB101	PCB105	PCB110	PCB118	PCB128	PCB138	PCB141	PCB149	PCB151	PCB153	PCB156	PCB158	PCB170	PCB18	PCB180	PCB183	PCB187	PCB194	PCB28	PCB31	PCB44	PCB47	PCB49	PCB52	PCB66	Total PCBs	Total ICES-7 PCBs
Units	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	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	ng/g
AL1																										20	10
AL2																										200	
ENV 066	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ[1]	NQ
ENV 068	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 070	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.11	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.11	NQ
ENV 072	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 074	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 076	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 078	0.08	0.10	0.08	0.11	<0.08	0.10	0.09	0.08	0.09	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.08	0.12	0.93	0.37
ENV 080	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ

Station	PCB101	PCB105	PCB110	PCB118	PCB128	PCB138	PCB141	PCB149	PCB151	PCB153	PCB156	PCB158	PCB170	PCB18	PCB180	PCB183	PCB187	PCB194	PCB28	PCB31	PCB44	PCB47	PCB49	PCB52	PCB66	Total PCBs	Total ICES-7 PCBs
Units	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	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	ng/g
AL1																										20	10
AL2																										200	
ENV 082	0.26	0.39	0.33	0.44	0.40	0.43	0.30	0.37	0.31	0.42	0.40	0.37	0.40	<0.08	0.34	0.33	0.37	0.46	0.14	0.11	0.17	0.12	0.13	0.12	0.34	7.45	2.15
ENV 084	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 086	<0.08	<0.08	<0.08	0.13	<0.08	0.15	<0.08	<0.08	<0.08	0.10	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.10	<0.08	<0.08	<0.08	<0.08	<0.08	0.11	0.59	0.48
ENV 088	0.09	<0.08	0.09	0.18	<0.08	0.19	<0.08	0.10	<0.08	0.17	<0.08	<0.08	<0.08	<0.08	0.09	<0.08	0.10	<0.08	0.15	0.11	<0.08	<0.08	<0.08	<0.08	0.18	1.45	0.87
ENV 090	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 092	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 094	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 096	0.11	<0.08	<0.08	0.18	<0.08	0.10	<0.08	0.09	<0.08	0.13	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.14	0.11	<0.08	<0.08	<0.08	<0.08	0.14	1.00	0.66
ENV 097	0.21	0.11	0.17	0.34	0.11	0.36	<0.08	0.20	<0.08	0.40	<0.08	<0.08	0.08	<0.08	0.14	<0.08	0.16	0.08	0.26	0.20	0.12	<0.08	0.14	0.16	0.27	3.51	1.87

Station	PCB101	PCB105	PCB110	PCB118	PCB128	PCB138	PCB141	PCB149	PCB151	PCB153	PCB156	PCB158	PCB170	PCB18	PCB180	PCB183	PCB187	PCB194	PCB28	PCB31	PCB44	PCB47	PCB49	PCB52	PCB66	Total PCBs	Total ICES-7 PCBs
Units	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	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	ng/g
AL1																										20	10
AL2																										200	
ENV099	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV101	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV103	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV105	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV107	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV109	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV111	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV113	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV115	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ

Station	PCB101	PCB105	PCB110	PCB118	PCB128	PCB138	PCB141	PCB149	PCB151	PCB153	PCB156	PCB158	PCB170	PCB18	PCB180	PCB183	PCB187	PCB194	PCB28	PCB31	PCB44	PCB47	PCB49	PCB52	PCB66	Total PCBs	Total ICES-7 PCBs
Units	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	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	ng/g
AL1																										20	10
AL2																										200	
ENV 117	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 119	0.08	<0.08	<0.08	0.08	<0.08	0.11	<0.08	<0.08	<0.08	0.11	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.14	0.11	<0.08	<0.08	<0.08	0.09	0.13	0.85	0.61
ENV 121	0.11	<0.08	0.10	0.17	<0.08	0.21	<0.08	0.08	<0.08	0.19	<0.08	<0.08	<0.08	0.09	<0.08	<0.08	<0.08	<0.08	0.17	0.17	<0.08	0.09	0.10	0.11	0.17	1.76	0.96
ENV 123	<0.08	<0.08	<0.08	0.15	<0.08	0.10	<0.08	<0.08	<0.08	0.14	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.10	<0.08	<0.08	<0.08	<0.08	<0.08	0.12	0.61	0.49
ENV 125	0.20	0.14	0.23	0.35	0.09	0.24	<0.08	0.21	0.09	0.34	0.11	0.09	0.12	0.08	0.17	0.10	0.14	0.11	0.26	0.20	0.13	0.09	0.14	0.15	0.34	4.12	1.71
ENV 127	0.10	<0.08	0.11	0.22	<0.08	0.09	<0.08	0.09	<0.08	0.15	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.15	0.12	<0.08	<0.08	<0.08	<0.08	0.19	1.22	0.71
ENV 129	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 131	0.09	<0.08	0.13	0.19	<0.08	0.11	<0.08	0.09	<0.08	0.13	<0.08	<0.08	<0.08	<0.08	0.09	<0.08	<0.08	<0.08	0.15	0.14	<0.08	<0.08	<0.08	<0.08	0.18	1.30	0.76
ENV 154	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ

Station	PCB101	PCB105	PCB110	PCB118	PCB128	PCB138	PCB141	PCB149	PCB151	PCB153	PCB156	PCB158	PCB170	PCB18	PCB180	PCB183	PCB187	PCB194	PCB28	PCB31	PCB44	PCB47	PCB49	PCB52	PCB66	Total PCBs	Total ICES-7 PCBs
Units	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	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	ng/g
AL1																										20	10
AL2																										200	
ENV 157	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 160	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 164	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ
ENV 168	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	NQ	NQ

Grey shading shows where the PCB levels were either not quantified or below the limit of detection

C.3 Habitats assessment

Appendix Table 8: Fragile sponge and anthozoan communities on subtidal rocky habitats summary

Station	Number of images assessed with visibility	Number of Images with hard substrate porifera	Average % of hard substrate porifera	Maximum Coverage of hard substrate porifera in an image (%)
ENV066	49	8	0.13	2
ENV067	35	6	0.21	2.55
ENV068	41	4	0.08	0.98
ENV069	43	2	0.05	1.3
ENV070	38	3	0.08	1.4
ENV071	55	6	0.07	1.18
ENV072	46	2	0.01	0.32
ENV073	58	2	0.01	0.48
ENV075	30	1	0.02	0.45
ENV081	33	4	0.03	0.62
ENV082	36	1	0.02	0.61
ENV100	48	1	0.01	0.61

Appendix Table 9: Fragile sponge and anthozoan communities on subtidal rocky habitats assessment - presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV066	32	NA	NA	NA	NA	NA	NA	1
ENV066		NA	NA	NA	NA	NA	NA	1
ENV066		0.09	NA	NA	1	NA	NA	NA
ENV066		NA	NA	NA	NA	NA	NA	1
ENV066		1.68	NA	NA	NA	1	NA	NA
ENV066		0.2	NA	NA	1	NA	NA	NA
ENV066		NA	NA	NA	NA	NA	NA	1
ENV066		NA	NA	NA	NA	NA	NA	1
ENV066		0.55	NA	NA	NA	1	NA	NA
ENV066		0.06	NA	NA	1	NA	NA	NA
ENV066		2	NA	NA	NA	1	NA	NA
ENV066		0.53	NA	NA	NA	1	NA	NA
ENV066		NA	NA	NA	NA	NA	NA	1
ENV066		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV066		NA	NA	NA	NA	NA	NA	1
ENV066		NA	NA	NA	NA	NA	NA	1
ENV066		1.3	NA	NA	NA	1	NA	NA
ENV067	25	0.79	NA	NA	NA	1	NA	NA
ENV067		2.55	NA	NA	NA	1	NA	1
ENV067		NA	NA	NA	NA	NA	NA	1
ENV067		0.74	NA	NA	NA	1	NA	NA
ENV067		NA	NA	NA	NA	NA	NA	1
ENV067		0.85	NA	NA	NA	1	NA	1
ENV067		1.15	NA	NA	NA	1	NA	1
ENV067		NA	NA	NA	NA	NA	NA	1
ENV067		1.19	NA	NA	NA	1	NA	NA
ENV068	21	NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV068		0.97	NA	NA	NA	1	NA	NA
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		0.78	NA	NA	NA	1	NA	1
ENV068		0.71	NA	NA	NA	1	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		0.98	NA	NA	NA	1	NA	NA
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV068		NA	NA	NA	NA	NA	NA	1
ENV069	18	NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		0.75	NA	NA	NA	1	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		NA	NA	NA	NA	NA	NA	1
ENV069		1.3	NA	NA	NA	1	NA	NA
ENV069		NA	NA	NA	NA	NA	NA	1
ENV070	14	NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		1.4	NA	NA	NA	1	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		1.32	NA	NA	NA	1	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		NA	NA	NA	NA	NA	NA	1
ENV070		0.31	NA	NA	NA	NA	NA	1
ENV071	14	NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV071		0.76	NA	NA	NA	1	NA	NA
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		0.63	NA	NA	NA	1	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		0.32	NA	NA	NA	1	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		0.63	NA	NA	NA	1	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		1.18	NA	NA	NA	1	1	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		0.13	NA	NA	NA	NA	1	1
ENV071		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV071		NA	NA	NA	NA	NA	NA	1
ENV072	13	0.16	NA	NA	NA	1	NA	NA
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		0.32	NA	NA	NA	1	NA	NA
ENV072			NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV072		NA	NA	NA	NA	NA	NA	1
ENV073	21	NA	NA	NA	NA	NA	NA	1
ENV073		0.48	NA	NA	NA	1	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		0.26	NA	NA	NA	NA	1	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV073		NA	NA	NA	NA	NA	NA	1
ENV074	17	NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV074		NA	NA	NA	NA	NA	NA	1
ENV075	11	0.45	NA	NA	NA	1	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV075		NA	NA	NA	NA	NA	NA	1
ENV076	15	NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV076		NA	NA	NA	NA	NA	NA	1
ENV077	31	NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV077		NA	NA	NA	NA	NA	NA	1
ENV078	26	NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV078		NA	NA	NA	NA	NA	NA	1
ENV079	44	NA	NA	NA	NA	NA	NA	1
ENV079		NA	NA	NA	NA	NA	NA	11
ENV079		NA	NA	NA	NA	NA	NA	1
ENV079		NA	NA	NA	NA	NA	NA	1
ENV079		NA	NA	NA	NA	NA	NA	1
ENV079		NA	NA	NA	NA	NA	NA	1
ENV079		NA	NA	NA	NA	NA	NA	1
ENV079		NA	NA	NA	NA	NA	NA	1
ENV080	39	N/A	NA	NA	NA	NA	NA	1
ENV080		N/A	NA	NA	NA	NA	NA	1
ENV080		N/A	NA	NA	NA	NA	NA	1
ENV081	29	0.62	NA	NA	NA	1	NA	NA
ENV081		0.04	NA	NA	1	NA	NA	1
ENV081		0.29	NA	NA	NA	1	NA	NA

Station	Number of blank rows (photo transects at each station without this habitat present)[1]	Coverage of hard substrate porifera	Presence of epifaunal taxa associated with fragile sponge and anthozoan communities on subtidal rocky habitats					
			Antho dichotoma	Suberites indet. 01	Suberites indet. 02	Suberites indet. 03	Porifera indet. 01	*Alcyonium digitatum*
ENV081		0.14	NA	NA	NA	1	NA	NA
ENV082	35	0.61	NA	NA	NA	1	NA	NA
ENV100	46	N/A	NA	NA	NA	NA	NA	1
ENV100		0.61	NA	NA	NA	NA	1	NA

[1] Grey shading in the 'Number of blank rows' column is used as the column only applies once per station i.e. the number of photo transects at each station which do not show any fragile sponge or anthozoan communities on subtidal rocky habitats.

C.4 Benthic infaunal data multivariate analysis results

Appendix Table 10: Benthic infaunal data multivariate analysis results

SIMPER					
Similarity Percentages - species contributions					
One-Way Analysis					
Data worksheet					
Name: Data1					
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	Simprof Groups				
ENV066	e				
ENV067	e				
ENV068	e				
ENV069	e				
ENV070	e				
ENV071	e				
ENV072	e				
ENV074	e				
ENV073	c				
ENV075	d				
ENV076	d				
ENV077	d				
ENV078	d				
ENV079	b				
ENV098	b				
ENV080	a				
ENV081	a				
ENV082	i				
ENV110	i				
ENV111	i				
ENV083	m				
ENV084	m				
ENV112	m				
ENV085	k				
ENV116	k				
ENV086	t				
ENV088	t				

ENV117	t				
ENV118	t				
ENV119	t				
ENV120	t				
ENV121	t				
ENV122	t				
ENV087	s				
ENV089	s				
ENV092	s				
ENV093	s				
ENV095	s				
ENV096	s				
ENV097	s				
ENV126	s				
ENV090	p				
ENV091	o				
ENV094	x				
ENV124	x				
ENV129	x				
ENV099	j				
ENV101	j				
ENV102	j				
ENV100	h				
ENV103	n				
ENV105	n				
ENV106	n				
ENV107	n				
ENV108	n				
ENV109	n				
ENV104	l				
ENV113	l				
ENV114	l				
ENV115	l				
ENV123	r				
ENV127	r				
ENV128	r				
ENV130	r				
ENV131	r				
ENV132	r				
ENV125	q				
ENV154	g				
ENV156	g				
ENV157	v				
ENV158	w				
ENV160	w				
ENV162	u				
ENV164	u				
ENV166	u				

ENV167	f				
ENV168	f				
Group e					
Average similarity: 47.37					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nemertea	3.63	2.64	5.43	5.58	5.58
Lysidice unicornis	2.56	1.97	6.23	4.15	9.73
Syllis armillaris	2.86	1.7	5.4	3.59	13.32
Cirrophorus branchiatus	2.19	1.48	4.08	3.12	16.44
Sphaerosyllis hystrix	2.14	1.38	2.33	2.91	19.35
Phoronis	1.74	1.27	4.42	2.69	22.04
Paradoneis lyra	1.88	1.27	3.65	2.69	24.73
Parexogone hebes	2.16	1.25	2.72	2.64	27.37
Polycirrus	1.92	1.21	3.89	2.55	29.92
Echinocyamus pusillus	2.03	1.2	1.63	2.54	32.45
Pholoe inornata	2.29	1.17	1.54	2.48	34.93
Aonides paucibranchiata	1.74	1.11	2.81	2.34	37.27
Euclymene oerstedii	1.63	1.03	4.48	2.17	39.44
Dipolydora coeca	1.89	0.94	3.57	1.98	41.42
Ascidiacea	1.76	0.91	1.34	1.93	43.35
Spisula	1.65	0.89	1.03	1.89	45.23
Ampelisca	1.63	0.89	1.48	1.88	47.12
Urothoe elegans	1.95	0.89	1.22	1.87	48.99
Anomiidae	1.96	0.86	1.44	1.81	50.79
Pista lornensis	1.31	0.85	4.23	1.79	52.59
Eumida	1.46	0.82	1.43	1.74	54.32
Leiochone	1.33	0.74	1.61	1.57	55.89
Aricidea (Acmira) cerrutii	1.52	0.72	0.96	1.52	57.41
Spirobranchus triqueter	1.77	0.66	0.97	1.38	58.79
Grania	1.49	0.63	0.98	1.33	60.13
Glycinde nordmanni	1.02	0.62	1.64	1.31	61.43
Dialychone dunerificta	1.31	0.61	1.01	1.28	62.72
Lumbrineris aniara	1.34	0.56	0.94	1.18	63.9
Abra	1.12	0.55	1.02	1.17	65.06
Chaetozone zetlandica	1.12	0.54	1.01	1.15	66.21
Exogone naidina	1.26	0.53	0.99	1.12	67.33
Spiophanes bombyx	1.1	0.51	0.97	1.09	68.42
Pholoe baltica	0.98	0.51	1.01	1.09	69.5
Nototropis vedlomensis	0.91	0.51	1.02	1.07	70.57
Gnathia oxyuraea	1.28	0.47	0.72	0.98	71.56
Ampelisca spinipes	1.38	0.45	0.63	0.95	72.51
Nothria britannica	0.85	0.45	1.04	0.95	73.45
Serpulidae	0.97	0.44	1.03	0.92	74.38
Nephasoma (Nephasoma) minutum	1.2	0.43	0.71	0.91	75.29
Sipuncula	0.9	0.37	0.69	0.78	76.07

Gattyana cirrhosa	1.01	0.36	0.72	0.75	76.83
Caulleriella alata	0.95	0.36	0.69	0.75	77.58
Tharyx killariensis	0.87	0.34	0.72	0.72	78.3
Leptochiton	0.98	0.33	0.72	0.7	79
Gnathiid indet.	0.96	0.33	0.7	0.69	79.69
Schistomeringos rudolphi	0.98	0.32	0.72	0.69	80.37
Podarkeopsis	0.77	0.32	0.73	0.68	81.06
Hemilepton nitidum	0.98	0.32	0.71	0.68	81.73
Scoloplos armiger	0.86	0.32	0.71	0.67	82.4
Glycera	0.68	0.31	0.73	0.66	83.06
Praxillella affinis	1.05	0.3	0.51	0.64	83.69
Owenia	0.81	0.3	0.72	0.63	84.32
Nudibranchia	0.68	0.28	0.73	0.59	84.92
Hydroides norvegica	0.8	0.22	0.48	0.46	85.38
Scalibregma inflatum	0.68	0.21	0.51	0.44	85.82
Nereididae	0.66	0.2	0.5	0.43	86.24
Anthura gracilis	0.76	0.2	0.51	0.42	86.66
Syllides	0.5	0.19	0.51	0.41	87.07
Hyala vitrea	0.9	0.19	0.34	0.4	87.47
Spio armata	0.5	0.19	0.51	0.4	87.87
Psammechinus miliaris	0.55	0.18	0.51	0.39	88.26
Leptosynapta inhaerens	0.5	0.18	0.51	0.39	88.65
Goniadella gracilis	0.71	0.18	0.51	0.38	89.03
Dendrochirotida	0.5	0.18	0.51	0.38	89.41
Pseudopolydora pulchra	0.55	0.18	0.51	0.37	89.79
Poecilochaetus serpens	0.55	0.18	0.51	0.37	90.16
Group c					
Less than 2 samples in group					
Group d					
Average similarity: 49.26					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Echinocyamus pusillus	3.3	3.13	13.25	6.35	6.35
Paradoneis lyra	2.81	2.71	4.9	5.5	11.85
Nemertea	2.54	2.51	12.63	5.09	16.94
Kurtiella bidentata	2.91	2.47	11.68	5.02	21.96
Scalibregma inflatum	2.37	1.97	3.45	3.99	25.95
Phoronis	2.2	1.83	11.26	3.71	29.67
Ampelisca	1.97	1.76	5.03	3.57	33.23
Owenia	1.96	1.7	5.69	3.45	36.68
Pholoe baltica	1.96	1.7	6.27	3.44	40.13
Grania	2.17	1.7	6.27	3.44	43.57
Praxillella affinis	1.85	1.66	6.51	3.38	46.95
Lysidice unicornis	1.68	1.47	2.75	2.98	49.93
Aonides paucibranchiata	1.6	1.36	2.82	2.76	52.68
Tharyx killariensis	1.52	1.24	5.88	2.51	55.2

Parexogone hebes	1.43	1.16	3.48	2.35	57.55
Pseudopolydora pulchra	1.51	1.1	6.8	2.23	59.77
Polycirrus	1.21	1.1	6.8	2.23	62
Hydroides norvegica	1.1	1.03	20.42	2.09	64.09
Syllis armillaris	1.41	0.86	0.88	1.76	65.85
Ampelisca spinipes	1.22	0.78	0.91	1.59	67.44
Lumbrineris aniara	1.29	0.76	0.9	1.55	68.99
Sphaerosyllis hystrix	1.14	0.73	0.91	1.48	70.47
Cirrophorus branchiatus	1.41	0.68	0.8	1.38	71.85
Nototropis vedlomensis	0.96	0.61	0.88	1.24	73.09
Caulleriella alata	0.96	0.61	0.89	1.23	74.33
Urothoe elegans	1.54	0.57	0.89	1.16	75.49
Euclymene oerstedii	1.1	0.57	0.9	1.16	76.65
Glycinde nordmanni	0.93	0.54	0.91	1.09	77.73
Scoloplos armiger	0.93	0.54	0.91	1.09	78.82
Aglaophamus agilis	1.25	0.52	0.91	1.05	79.87
Leiochone	1	0.52	0.91	1.05	80.92
Tanaopsis graciloides	0.85	0.52	0.91	1.05	81.97
Cerianthus lloydii	0.75	0.52	0.91	1.05	83.01
Atherospio guillei	0.85	0.5	0.91	1.02	84.04
Cylichna cylindracea	0.85	0.5	0.91	1.02	85.06
Spirobranchus triqueter	0.85	0.5	0.91	1.02	86.08
Dendrochirotida	0.93	0.5	0.91	1.02	87.1
Aricidea (Acmira) cerrutii	0.93	0.29	0.41	0.59	87.68
Gattyana cirrhosa	1.06	0.24	0.41	0.48	88.16
Ophiuridae	0.79	0.23	0.41	0.46	88.62
Nothria britannica	0.6	0.18	0.41	0.37	88.99
Pista lornensis	0.6	0.18	0.41	0.37	89.37
Ascidiacea	0.6	0.18	0.41	0.37	89.74
Dialychone dunerificta	0.6	0.18	0.41	0.36	90.1
Group b					
Average similarity: 40.21					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Scalibregma inflatum	7.69	5.39	#######[1]	13.41	13.41
Kurtiella bidentata	5.83	4.32	#######	10.73	24.14
Echinocyamus pusillus	4.41	2.41	#######	6	30.14
Sthenelais limicola	2.12	1.53	#######	3.79	33.94
Abra	2.32	1.53	#######	3.79	37.73
Phoronis	2.94	1.53	#######	3.79	41.52
Scoloplos armiger	1.98	1.32	#######	3.29	44.81
Atherospio guillei	1.98	1.32	#######	3.29	48.09
Owenia	1.98	1.32	#######	3.29	51.38
Nemertea	3.05	1.32	#######	3.29	54.67
Pholoe baltica	1.71	1.08	#######	2.68	57.35
Lumbrineris aniara	1.71	1.08	#######	2.68	60.03
Leiochone	1.41	1.08	#######	2.68	62.71

Ophelina acuminata	1.83	1.08	#######	2.68	65.4
Ampelisca spinipes	1.57	1.08	#######	2.68	68.08
Upogebia deltaura	1.93	1.08	#######	2.68	70.76
Ocnus planci	1.57	1.08	#######	2.68	73.44
Harmothoe glabra	1.62	0.76	#######	1.9	75.34
Glycinde nordmanni	1	0.76	#######	1.9	77.24
Nephtys	1.37	0.76	#######	1.9	79.13
Notomastus	1	0.76	#######	1.9	81.03
Praxillella affinis	1.91	0.76	#######	1.9	82.93
Caulleriella alata	1.21	0.76	#######	1.9	84.82
Lagis koreni	2.79	0.76	#######	1.9	86.72
Terebellides	1	0.76	#######	1.9	88.62
Urothoe elegans	1.91	0.76	#######	1.9	90.52
Group a					
Average similarity: 34.48					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Asbjornsenia pygmaea	3.15	8.74	#######	25.35	25.35
Echinocyamus pusillus	2.45	7.57	#######	21.96	47.31
Nephtys cirrosa	1.87	5.35	#######	15.53	62.83
Asteroidea	1.87	5.35	#######	15.53	78.36
Glycera oxycephala	1.41	4.37	#######	12.68	91.04
Group i					
Average similarity: 63.20					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Lagis koreni	18.21	15.83	9.26	25.05	25.05
Scalibregma inflatum	6.49	5.56	11.81	8.8	33.86
Sthenelais limicola	5.02	4.21	5.63	6.66	40.52
Spatangoida	4.36	3.57	18.67	5.64	46.16
Kurtiella bidentata	3.16	1.92	1.14	3.04	49.19
Scoloplos armiger	2.45	1.85	6.05	2.92	52.12
Argissa hamatipes	2.19	1.72	10.59	2.71	54.83
Amphiura filiformis	2.74	1.71	1.29	2.71	57.54
Thracia	2.06	1.71	20.39	2.71	60.25
Phaxas pellucidus	2.39	1.64	3.42	2.6	62.85
Ophelina acuminata	1.88	1.51	6.05	2.39	65.23
Owenia	1.72	1.44	5.83	2.28	67.51
Nemertea	2.46	1.43	1.77	2.27	69.78
Phoronis	1.63	1.43	7.94	2.27	72.04
Abra alba	1.82	1.35	1.79	2.14	74.18
Poecilochaetus serpens	1.52	1.33	19.25	2.11	76.29
Pseudocuma (Pseudocuma) longicorne	1.52	1.33	19.25	2.11	78.4
Nucula nitidosa	2.23	1.33	1.99	2.1	80.5

Eumida	1.66	1.16	3.42	1.84	82.34
Chaetozone christiei	1.38	1.08	3.82	1.71	84.04
Podarkeopsis	1.24	0.94	19.25	1.49	85.53
Callianassa subterranea	1.33	0.94	19.25	1.49	87.03
Cardiidae	1.48	0.66	0.58	1.05	88.07
Bivalvia	2.37	0.6	0.58	0.94	89.02
Phyllodoce	1.32	0.54	0.58	0.86	89.88
Pariambus typicus	1.24	0.52	0.58	0.82	90.69
Group m					
Average similarity: 49.04					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Sthenelais limicola	3.82	7.26	7.07	14.81	14.81
Spatangoida	4.08	6.55	4.69	13.35	28.16
Lagis koreni	2.23	3.62	2.19	7.39	35.55
Scoloplos armiger	1.82	3.49	7.07	7.11	42.66
Poecilochaetus serpens	1.67	2.58	3.64	5.26	47.92
Bathyporeia	1.91	2.43	5.4	4.95	52.88
Goniada maculata	1.28	2.3	3.63	4.7	57.57
Nucula nitidosa	1.38	2.3	3.63	4.7	62.27
Spiophanes bombyx	1.62	2.25	14.78	4.59	66.86
Thracia	1.55	2.25	14.78	4.59	71.44
Nemertea	1.38	2.25	14.78	4.59	76.03
Phaxas pellucidus	1.24	2.01	7.07	4.11	80.13
Scalibregma inflatum	1.7	1.39	0.58	2.83	82.96
Naididae	1.05	0.8	0.58	1.63	84.59
Ophelina acuminata	0.8	0.75	0.58	1.53	86.12
Perioculodes longimanus	0.67	0.75	0.58	1.53	87.65
Synchelidium maculatum	0.8	0.7	0.58	1.42	89.07
Bathyporeia tenuipes	1.08	0.7	0.58	1.42	90.5
Group k					
Average similarity: 58.98					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Kurtiella bidentata	9.15	9.74	#######	16.51	16.51
Sthenelais limicola	4.47	5.17	#######	8.76	25.27
Lagis koreni	4.8	5.02	#######	8.51	33.78
Amphiura filiformis	5.14	4.72	#######	7.99	41.78
Scalibregma inflatum	3.1	2.98	#######	5.06	46.83
Spatangoida	4.39	2.98	#######	5.06	51.89
Phoronis	2.34	2.72	#######	4.62	56.51
Callianassa subterranea	2.12	2.44	#######	4.13	60.63
Podarkeopsis	1.57	1.72	#######	2.92	63.55
Ophelina acuminata	1.41	1.72	#######	2.92	66.47
Harpinia antennaria	1.57	1.72	#######	2.92	69.39
Pharidae	1.71	1.72	#######	2.92	72.31

Acrocnida brachiata	1.57	1.72	#######	2.92	75.23
Malmgrenia andreapolis	1.21	1.22	#######	2.06	77.29
Goniada maculata	1	1.22	#######	2.06	79.36
Oxydromus flexuosus	1.21	1.22	#######	2.06	81.42
Lumbrineris aniara	1.37	1.22	#######	2.06	83.49
Poecilochaetus serpens	1.21	1.22	#######	2.06	85.55
Pseudocuma (Pseudocuma) longicorne	1	1.22	#######	2.06	87.61
Bathyporeia	1.21	1.22	#######	2.06	89.68
Cylichna cylindracea	1	1.22	#######	2.06	91.74
Group t					
Average similarity: 55.44					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphiura filiformis	9.48	8.47	8.08	15.29	15.29
Kurtiella bidentata	11.06	8.46	4.84	15.26	30.55
Pholoe baltica	4.97	3.86	4.7	6.96	37.51
Phoronis	4.03	2.95	2.98	5.33	42.84
Callianassa subterranea	2.61	2.47	9.51	4.46	47.3
Hyala vitrea	4.35	2.21	1.09	3.98	51.28
Sthenelais limicola	2.34	1.91	7.44	3.45	54.73
Prionospio multibranchiata	2.87	1.74	2.37	3.13	57.86
Diplocirrus glaucus	2.16	1.73	3.18	3.12	60.98
Lumbrineris aniara	2.38	1.71	3.41	3.08	64.07
Cylichna cylindracea	2.04	1.68	3.55	3.03	67.1
Lagis koreni	2.16	1.54	3.07	2.77	69.87
Nephtys	1.64	1.13	1.38	2.04	71.91
Pariambus typicus	1.63	0.99	1.44	1.79	73.7
Pseudocuma (Pseudocuma) longicorne	1.45	0.95	1.55	1.71	75.42
Kirkegaardia	1.35	0.88	1.47	1.6	77.01
Podarkeopsis	1.34	0.8	0.99	1.44	78.46
Nucula	1.66	0.73	0.72	1.32	79.78
Eudorella truncatula	1.16	0.68	1.01	1.23	81.01
Diastylis laevis	1.2	0.67	1.01	1.21	82.22
Harpinia antennaria	1.29	0.6	0.73	1.08	83.3
Nephtys hombergii	0.93	0.57	1.01	1.02	84.32
Nemertea	1.26	0.55	0.67	0.99	85.31
Platyhelminthes	0.75	0.54	1.05	0.98	86.29
Scalibregma inflatum	1.46	0.54	0.65	0.97	87.26
Spatangoida	1.93	0.53	0.68	0.96	88.22
Thyasira gouldii	1.08	0.52	0.67	0.93	89.15
Thysanocardia procera	1.07	0.41	0.69	0.74	89.89
Bivalvia	0.85	0.41	0.72	0.74	90.63

Group s					
Average similarity: 61.18					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphiura filiformis	12.24	16.17	11.29	26.43	26.43
Kurtiella bidentata	10.45	13.27	5.58	21.69	48.12
Pholoe baltica	7.84	9.32	4.94	15.24	63.36
Lumbrineris aniara	3.51	3.83	4.4	6.26	69.62
Kirkegaardia	2.03	2.58	5.33	4.22	73.84
Phoronis	1.46	1.54	1.45	2.51	76.35
Thysanocardia procera	1.61	1.42	0.97	2.33	78.68
Cylichna cylindracea	1.2	1.13	0.96	1.85	80.53
Lagis koreni	1.28	1.09	1.01	1.78	82.31
Diplocirrus glaucus	1	1.08	1.67	1.77	84.09
Sthenelais limicola	1.16	1.03	1	1.69	85.77
Hyala vitrea	1.42	1.01	0.99	1.66	87.43
Nemertea	1.04	0.9	1.03	1.47	88.9
Callianassa subterranea	1.01	0.71	0.69	1.17	90.06
Group p					
Less than 2 samples in group					
Group o					
Less than 2 samples in group					
Group x					
Average similarity: 47.01					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Lagis koreni	6.17	7.68	5.47	16.33	16.33
Scalibregma inflatum	4.32	4.57	5.37	9.72	26.06
Abra	3.03	4.06	6.26	8.63	34.69
Kurtiella bidentata	3.27	3.92	7.44	8.34	43.03
Varicorbula gibba	3.33	3.37	2.99	7.16	50.19
Amphiura filiformis	2.28	3	5.72	6.39	56.57
Pholoe baltica	2.08	2.38	6.23	5.07	61.64
Sthenelais limicola	1.79	2.27	6.46	4.83	66.47
Lumbrineris aniara	2.37	2.05	2.49	4.36	70.82
Phaxas pellucidus	1.55	1.75	2.53	3.72	74.55
Glycera alba	1	1.5	5.72	3.19	77.74
Spiophanes bombyx	1.14	1.5	5.72	3.19	80.93
Nucula nitidosa	1.97	1.12	0.58	2.39	83.32
Pharidae	2.72	1.02	0.58	2.18	85.5
Pseudocuma (Pseudocuma) longicorne	1.05	0.85	0.58	1.81	87.31
Nemertea	1.24	0.77	0.58	1.63	88.94

Diastylis laevis	0.94	0.65	0.58	1.38	90.32
Group j					
Average similarity: 50.70					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Lagis koreni	18.29	17.76	4.98	35.04	35.04
Scalibregma inflatum	4.17	4.16	4.95	8.21	43.25
Sthenelais limicola	4.1	3.68	7.12	7.25	50.5
Abra	3.26	3.52	4.9	6.95	57.45
Echinocyamus pusillus	3.05	2.31	4.93	4.57	62.01
Cardiidae	2.74	1.95	2.75	3.86	65.87
Scolelepis bonnieri	2.21	1.93	4.9	3.81	69.68
Chaetozone christiei	2.08	1.75	9.61	3.45	73.13
Aphroditidae	1.63	1.67	8.1	3.3	76.42
Gnathiid indet.	2.03	1.55	2.69	3.05	79.48
Podarkeopsis	1.96	1.44	1.85	2.85	82.32
Scoloplos armiger	2.72	1.03	0.58	2.04	84.37
Nemertea	2.56	0.9	0.58	1.77	86.13
Spiophanes bombyx	1.33	0.6	0.58	1.18	87.31
Glycera oxycephala	1.24	0.52	0.58	1.02	88.33
Poecilochaetus serpens	1.87	0.52	0.58	1.02	89.35
Bivalvia	0.94	0.52	0.58	1.02	90.37
Group h					
Less than 2 samples in group					
Group n					
Average similarity: 48.06					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bathyporeia	3.91	5.92	9.96	12.32	12.32
Sthenelais limicola	3.02	4.91	2.83	10.22	22.54
Lagis koreni	2.62	4.06	2.15	8.45	31
Echinocyamus pusillus	2.42	3.44	5.41	7.16	38.15
Spatangoida	2.06	3.01	8.59	6.26	44.41
Pharidae	1.5	2.67	3.93	5.56	49.97
Magelona filiformis	1.5	2.33	3.73	4.85	54.81
Scoloplos armiger	1.89	2.12	1.24	4.41	59.23
Spiophanes bombyx	1.24	2.07	6.12	4.3	63.53
Bathyporeia tenuipes	1.4	1.72	1.25	3.58	67.11
Goniada maculata	1.04	1.57	1.26	3.26	70.36
Thracia	1.29	1.36	1.3	2.84	73.2
Bathyporeia elegans	1.48	1.15	0.72	2.38	75.58
Nucula	1.03	1.06	0.72	2.2	77.79
Cardiidae	0.93	1.01	0.75	2.11	79.89
Poecilochaetus serpens	0.67	0.84	0.78	1.75	81.64

Pseudocuma (Pseudocuma) longicorne	0.74	0.79	0.79	1.64	83.28
Kurtiella bidentata	0.97	0.72	0.79	1.49	84.77
Nephtys cirrosa	1.07	0.7	0.48	1.47	86.23
Abra	0.84	0.56	0.48	1.16	87.39
Aglaophamus agilis	0.74	0.45	0.47	0.94	88.34
Lumbrineris aniara	0.5	0.43	0.48	0.9	89.23
Scalibregma inflatum	0.67	0.43	0.48	0.9	90.13
Group l					
Average similarity: 56.55					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Spatangoida	5.54	7.68	5.39	13.58	13.58
Sthenelais limicola	3.88	5.46	4.45	9.66	23.24
Lagis koreni	5.12	5.42	3.03	9.58	32.83
Phoronis	2.46	3.45	3.21	6.11	38.93
Tellimya ferruginosa	2.1	2.7	6.75	4.77	43.7
Nucula nitidosa	2.43	2.68	4.74	4.74	48.44
Cardiidae	1.9	2.64	4.74	4.67	53.11
Thracia	1.77	2.39	9.66	4.23	57.35
Scalibregma inflatum	2	2.35	2.52	4.16	61.5
Harpinia antennaria	2.01	2.19	2.96	3.87	65.37
Chaetozone christiei	1.82	2.09	3.96	3.7	69.07
Amphiura filiformis	1.62	1.94	3.88	3.44	72.51
Abra	1.51	1.71	4.82	3.03	75.54
Poecilochaetus serpens	1.25	1.6	8.45	2.83	78.37
Pseudocuma (Pseudocuma) longicorne	1.49	1.57	0.91	2.78	81.14
Scoloplos armiger	1.06	1.06	0.91	1.87	83.01
Pharidae	1.32	1.06	0.91	1.87	84.88
Nemertea	1.39	0.95	0.84	1.67	86.55
Bathyporeia tenuipes	1.51	0.91	0.88	1.61	88.16
Nephtys assimilis	0.75	0.86	0.91	1.53	89.69
Kurtiella bidentata	1.66	0.84	0.9	1.48	91.17
Group r					
Average similarity: 63.39					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphiura filiformis	13.07	10.64	6.51	16.78	16.78
Kurtiella bidentata	12.97	9.97	5.26	15.73	32.51
Pholoe baltica	8.85	7.09	9.29	11.19	43.7
Phoronis	4.79	3.45	5.09	5.44	49.14
Lumbrineris aniara	4.31	3.08	6.4	4.86	54.01
Kirkegaardia	3.58	2.78	4.46	4.38	58.39

Lagis koreni	3.13	2.11	8.25	3.33	61.72
Diplocirrus glaucus	2.38	1.8	3.78	2.84	64.56
Nucula	2.61	1.48	1.3	2.34	66.9
Mediomastus fragilis	1.83	1.4	4.25	2.21	69.11
Phaxas pellucidus	2.99	1.39	1.2	2.2	71.31
Callianassa subterranea	1.62	1.33	5.71	2.1	73.41
Cylichna cylindracea	1.64	1.29	3	2.03	75.44
Hyala vitrea	2.39	1.14	1.07	1.8	77.24
Magelona alleni	1.63	1.11	3.94	1.74	78.98
Nemertea	1.68	1.09	3.51	1.73	80.71
Diastylis laevis	1.62	1.09	4.93	1.71	82.42
Goniada maculata	1.21	0.97	6.47	1.52	83.95
Edwardsia claparedii	2.14	0.87	1.19	1.38	85.32
Eudorella truncatula	1.21	0.65	1.22	1.02	86.34
Prionospio multibranchiata	1.12	0.62	1.28	0.97	87.31
Cardiidae	1.63	0.59	0.71	0.93	88.24
Sthenelais limicola	1.09	0.51	0.78	0.81	89.05
Spiophanes bombyx	1	0.5	0.78	0.79	89.84
Podarkeopsis	1.02	0.48	0.77	0.76	90.6
Group q					
Less than 2 samples in group					
Group g					
Average similarity: 59.31					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nemertea	3.23	3.91	#######	6.59	6.59
Magelona filiformis	3.56	3.45	#######	5.81	12.4
Glycera tridactyla	2.64	3.19	#######	5.38	17.78
Magelona johnstoni	3.96	3.19	#######	5.38	23.16
Pseudocuma (Pseudocuma) longicorne	3.05	2.91	#######	4.91	28.07
Mactra stultorum	2.24	2.91	#######	4.91	32.98
Perioculodes longimanus	2.22	2.61	#######	4.39	37.38
Kurtiella bidentata	3	2.61	#######	4.39	41.77
Spio decorata	1.73	2.26	#######	3.8	45.58
Chaetozone christiei	2.87	2.26	#######	3.8	49.38
Nucula nitidosa	2.09	2.26	#######	3.8	53.18
Pholoe baltica	1.71	1.84	#######	3.11	56.29
Sthenelais limicola	1.71	1.84	#######	3.11	59.4
Eumida	1.57	1.84	#######	3.11	62.5
Spiophanes bombyx	1.83	1.84	#######	3.11	65.61
Fabulina fabula	2.37	1.84	#######	3.11	68.72
Edwardsia claparedii	2.03	1.84	#######	3.11	71.82
Naididae	2.12	1.84	#######	3.11	74.93

Phoronis	1.83	1.84	#######	3.11	78.03
Scalibregma inflatum	1.37	1.3	#######	2.2	80.23
Pseudopolydora pulchra	1.5	1.3	#######	2.2	82.43
Lagis koreni	1.37	1.3	#######	2.2	84.62
Lanice conchilega	1.37	1.3	#######	2.2	86.82
Diastylis bradyi	1.72	1.3	#######	2.2	89.02
Argissa hamatipes	1.21	1.3	#######	2.2	91.21
Group v					
Less than 2 samples in group					
Group w					
Average similarity: 71.67					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Kurtiella bidentata	8.14	8.57	#######	11.96	11.96
Lagis koreni	6.56	6.51	#######	9.08	21.05
Amphiuridae	6.11	5.91	#######	8.24	29.29
Varicorbula gibba	5.57	5.47	#######	7.63	36.92
Edwardsia claparedii	3.8	4.03	#######	5.62	42.53
Nucula nitidosa	4.02	3.87	#######	5.4	47.93
Abra alba	3.46	3.7	#######	5.17	53.1
Nemertea	3.59	3.7	#######	5.17	58.26
Phaxas pellucidus	3.87	3.53	#######	4.93	63.19
Phoronis	3.86	3.16	#######	4.41	67.59
Magelona johnstoni	2.81	2.73	#######	3.82	71.41
Pholoe baltica	2.44	2.5	#######	3.48	74.89
Bivalvia	2.32	2.23	#######	3.12	78.01
Lumbrineris aniara	2.52	1.93	#######	2.7	80.7
Spisula	2.28	1.93	#######	2.7	83.4
Pseudopolydora pulchra	2.21	1.58	#######	2.2	85.6
Lanice conchilega	1.41	1.58	#######	2.2	87.81
Pseudocuma (Pseudocuma) longicorne	1.57	1.58	#######	2.2	90.01
Group u					
Average similarity: 58.75					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Kurtiella bidentata	11.97	6.81	2.07	11.58	11.58
Varicorbula gibba	6.61	5.08	7.4	8.64	20.22
Nucula nitidosa	5.61	4.12	7.25	7.01	27.23
Amphiura filiformis	6.75	3.36	1.71	5.73	32.96
Lumbrineris aniara	3.87	2.78	8.04	4.74	37.69
Pholoe baltica	4.1	2.62	7.83	4.46	42.15
Phoronis	5.29	2.37	3.52	4.04	46.2
Phaxas pellucidus	4.77	2.15	1.83	3.66	49.85

Edwardsia claparedii	3.26	1.83	1.69	3.11	52.96
Diastylis laevis	2.22	1.63	7.05	2.78	55.74
Lagis koreni	2.73	1.59	2.35	2.7	58.45
Abra	2.27	1.54	6.97	2.62	61.07
Nemertea	2.45	1.5	4.31	2.55	63.62
Ampharete lindstroemi	2.77	1.48	8.82	2.52	66.15
Abra alba	2.04	1.41	7.05	2.41	68.55
Ophiuridae	2.49	1.35	1.55	2.3	70.86
Chamelea striatula	1.88	1.34	2.76	2.28	73.14
Amphiuridae	3.87	1.29	0.58	2.19	75.33
Ophiuroidea	2.9	1.05	0.58	1.79	77.12
Cylichna cylindracea	1.28	0.95	2.76	1.61	78.74
Mediomastus fragilis	2.1	0.92	5.58	1.57	80.3
Eudorella truncatula	1.38	0.92	6.13	1.57	81.87
Spisula	1.76	0.84	0.58	1.43	83.3
Diplocirrus glaucus	1.14	0.82	7.05	1.39	84.69
Pariambus typicus	2.11	0.74	0.58	1.27	85.95
Scalibregma inflatum	2	0.5	0.58	0.84	86.8
Hyala vitrea	1.14	0.36	0.58	0.61	87.4
Sthenelais limicola	1.29	0.35	0.58	0.6	88
Podarkeopsis	0.94	0.35	0.58	0.6	88.6
Ampelisca tenuicornis	0.94	0.35	0.58	0.6	89.19
Tellimya ferruginosa	1.41	0.35	0.58	0.6	89.79
Thracia	1.29	0.35	0.58	0.6	90.39
Group f					
Average similarity: 61.15					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Magelona johnstoni	13.66	16.38	#######	26.79	26.79
Glycera tridactyla	4.12	5.23	#######	8.55	35.34
Magelona filiformis	3.82	4.01	#######	6.56	41.89
Donax vittatus	3.16	4.01	#######	6.56	48.45
Mytilidae	3.52	4.01	#######	6.56	55
Pseudocuma (Pseudocuma) longicorne	2.87	2.54	#######	4.15	59.15
Perioculodes longimanus	2.41	2.54	#######	4.15	63.29
Fabulina fabula	2.8	2.54	#######	4.15	67.44
Kurtiella bidentata	2.22	2.54	#######	4.15	71.59
Pholoe baltica	1.73	2.2	#######	3.59	75.18
Lanice conchilega	1.87	2.2	#######	3.59	78.77
Eumida	2.58	1.79	#######	2.93	81.7
Pariambus typicus	1.71	1.79	#######	2.93	84.63
Nucula nitidosa	1.41	1.79	#######	2.93	87.56
Eteone longa	1	1.27	#######	2.07	89.64
Spio decorata	1	1.27	#######	2.07	91.71

[1] ####### indicates faunal groups with 2 stations, which is insufficient for the Similarity/standard deviation calculation, therefore giving a blank result

C.5 Benthic infaunal data univariate analysis results

Appendix Table 11: Data results of benthic infaunal univariate analysis

Station	Biotope	S	N	d	J'	H'	λ
ENV066	SS.SMx.OMx.PoVen	31	63	7.248	0.9515	3.267	0.9695
ENV067	SS.SMx.OMx.PoVen	28	48	6.972	0.9546	3.181	0.9704
ENV068	SS.SMx.OMx.PoVen	29	53	7.064	0.9469	3.188	0.9679
ENV069	SS.SMx.OMx.PoVen	26	49	6.418	0.9477	3.088	0.965
ENV070	SS.SMx.OMx.PoVen	20	40	5.158	0.9378	2.809	0.9506
ENV071	SS.SMx.OMx.PoVen	27	55	6.495	0.9349	3.081	0.9595
ENV072	SS.SMx.OMx.PoVen	15	35	3.934	0.9344	2.53	0.93
ENV074	SS.SMx.OMx.PoVen	18	44	4.496	0.9355	2.704	0.9414
ENV075	SS.SMx.CMx.KurThyMx	22	35	5.89	0.9463	2.925	0.9616
ENV076	SS.SMx.CMx.KurThyMx	21	41	5.378	0.9422	2.868	0.9549
ENV077	SS.SMx.CMx.KurThyMx	21	40	5.439	0.9658	2.94	0.9662
ENV078	SS.SMx.CMx.KurThyMx	19	31	5.226	0.9559	2.815	0.9625
ENV079	SS.SMx.CMx.KurThyMx	20	36	5.316	0.9549	2.861	0.9625
ENV080	SS.SSa.CFiSa.EpusOborApri	17	30	4.69	0.9804	2.778	0.9666
ENV081	SS.SSa.CFiSa.EpusOborApri	18	24	5.316	0.9745	2.817	0.9747
ENV082	SS.SMu.CSaMu.AfilKurAnit	12	16	3.983	0.9675	2.404	0.9609
ENV083	SS.SMu.CSaMu.LkorPpel	6	9	2.258	0.905	1.622	0.8548
ENV084	SS.SMu.CSaMu.LkorPpel	7	11	2.508	0.973	1.893	0.9258
ENV085	SS.SMu.CSaMu.LkorPpel	3	5	1.197	0.8401	0.9229	0.6652
ENV094	SS.SMu.CSaMu.LkorPpel	4	9	1.387	0.8429	1.169	0.7111
ENV098	SS.SMx.CMx.KurThyMx	17	40	4.349	0.9368	2.654	0.9396
ENV099	SS.SMu.CSaMu.LkorPpel	10	12	3.614	0.9814	2.26	0.9705
ENV100	SS.SSa.CFiSa.EpusOborApri	28	46	7.041	0.9689	3.229	0.9772
ENV101	SS.SMu.CSaMu.LkorPpel	12	17	3.848	0.973	2.418	0.9597
ENV102	SS.SMu.CSaMu.LkorPpel	14	17	4.626	0.9885	2.609	0.9831
ENV103	SS.SMu.CSaMu.LkorPpel	8	11	2.966	0.9701	2.017	0.9468
ENV104	SS.SMu.CSaMu.LkorPpel	21	32	5.764	0.965	2.938	0.9701
ENV105	SS.SMu.CSaMu.LkorPpel	13	20	4.01	0.9751	2.501	0.9601
ENV106	SS.SMu.CSaMu.LkorPpel	7	11	2.496	0.9531	1.855	0.9108

Station	Biotope	S	N	d	J'	H'	λ
ENV107	SS.SMu.CSaMu.LkorPpel	8	11	2.903	0.9551	1.986	0.9306
ENV108	SS.SMu.CSaMu.LkorPpel	12	17	3.903	0.9552	2.374	0.9498
ENV109	SS.SMu.CSaMu.LkorPpel	10	13	3.553	0.9749	2.245	0.963
ENV110	SS.SMu.CSaMu.LkorPpel	11	15	3.688	0.9557	2.292	0.9482
ENV111	SS.SMu.CSaMu.LkorPpel	11	16	3.611	0.9404	2.255	0.9327
ENV112	SS.SMu.CSaMu.LkorPpel	10	17	3.17	0.9624	2.216	0.9349
ENV113	SS.SMu.CSaMu.LkorPpel	10	15	3.347	0.9617	2.214	0.9441
ENV114	SS.SMu.CSaMu.LkorPpel	4	9	1.39	0.9944	1.379	0.8438
ENV115	SS.SMu.CSaMu.LkorPpel	7	11	2.468	0.9315	1.813	0.8931
ENV116	SS.SMu.CSaMu.LkorPpel	7	14	2.25	0.9214	1.793	0.8673
ENV124	SS.SMu.CSaMu.LkorPpel	3	7	1.039	0.8503	0.9342	0.6476
ENV125	SS.SSa.CMuSa.AalbNuc	4	9	1.397	0.7446	1.032	0.6078
ENV127	SS.SMu.CSaMu.AfilKurAnit	7	14	2.296	0.8565	1.667	0.8066
ENV128	SS.SMu.CSaMu.AfilKurAnit	7	14	2.281	0.8609	1.675	0.8149
ENV129	SS.SMu.CSaMu.LkorPpel	4	9	1.373	0.7808	1.082	0.6422
ENV130	SS.SMu.CSaMu.AfilKurAnit	4	10	1.329	0.7815	1.083	0.6405
ENV131	SS.SMu.CSaMu.AfilKurAnit	8	14	2.654	0.842	1.751	0.8124
ENV132	SS.SMu.CSaMu.AfilKurAnit	3	9	0.9036	0.8013	0.8803	0.5725
ENV154	SS.SSa.IFiSa	5	9	1.823	0.8731	1.405	0.7901
ENV156	SS.SSa.IFiSa	6	10	2.128	0.8149	1.46	0.753
ENV157	SS.SSa.CMuSa.AalbNuc	6	13	1.934	0.8246	1.478	0.7498
ENV158	SS.SSa.CMuSa.AalbNuc	1	7	0	0	0	0
ENV160	SS.SSa.CMuSa.AalbNuc	3	8	0.9667	0.6739	0.7404	0.4688
ENV162	SS.SSa.CMuSa.AalbNuc	3	9	0.9102	0.6224	0.6837	0.4167
ENV164	SS.SSa.CMuSa.AalbNuc	3	9	0.9151	0.6998	0.7688	0.4859
ENV166	SS.SMu.CSaMu.AfilKurAnit	3	10	0.8827	0.7698	0.8457	0.5514
ENV167	SS.SSa.IFiSa	3	8	0.9437	0.6535	0.7179	0.4477
ENV168	SS.SSa.IFiSa	3	5	1.178	0.8288	0.9105	0.6501

C.6 Benthic epifaunal data multivariate analysis results

Appendix Table 12: Benthic epifaunal data multivariate analysis results

SIMPER					
Similarity Percentages - species contributions					
One-Way Analysis					
Data worksheet					
Name: Data1					
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	Group				
BP22MOR-ENV-DC-066	e				
BP22MOR-ENV-DC-067	e				
BP22MOR-ENV-DC-068	e				
BP22MOR-ENV-DC-069	e				
BP22MOR-ENV-DC-070	e				
BP22MOR-ENV-DC-071	e				
BP22MOR-ENV-DC-072	e				
BP22MOR-ENV-DC-073	e				
BP22MOR-ENV-DC-074	e				
BP22MOR-ENV-DC-075	e				
BP22MOR-ENV-DC-076	e				
BP22MOR-ENV-DC-077	e				
BP22MOR-ENV-DC-078	d				
BP22MOR-ENV-DC-079	c				
BP22MOR-ENV-DC-080	c				
BP22MOR-ENV-DC-081	h				
BP22MOR-ENV-DC-099	h				
BP22MOR-ENV-DC-101	h				
BP22MOR-ENV-DC-102	h				
BP22MOR-ENV-DC-104	h				
BP22MOR-ENV-DC-105	h				
BP22MOR-ENV-DC-082	g				
BP22MOR-ENV-DC-083	g				
BP22MOR-ENV-DC-084	g				
BP22MOR-ENV-DC-087	g				
BP22MOR-ENV-DC-103	g				
BP22MOR-ENV-DC-106	g				
BP22MOR-ENV-DC-107	g				
BP22MOR-ENV-DC-108	g				

BP22MOR-ENV-DC-109	g				
BP22MOR-ENV-DC-110	g				
BP22MOR-ENV-DC-111	g				
BP22MOR-ENV-DC-112	g				
BP22MOR-ENV-DC-113	g				
BP22MOR-ENV-DC-114	g				
BP22MOR-ENV-DC-115	g				
BP22MOR-ENV-DC-116	g				
BP22MOR-ENV-DC-119	g				
BP22MOR-ENV-DC-154	g				
BP22MOR-ENV-DC-085	f				
BP22MOR-ENV-DC-086	f				
BP22MOR-ENV-DC-088	f				
BP22MOR-ENV-DC-089	f				
BP22MOR-ENV-DC-090	f				
BP22MOR-ENV-DC-091	f				
BP22MOR-ENV-DC-092	f				
BP22MOR-ENV-DC-093	f				
BP22MOR-ENV-DC-094	f				
BP22MOR-ENV-DC-095	f				
BP22MOR-ENV-DC-096	f				
BP22MOR-ENV-DC-097	f				
BP22MOR-ENV-DC-117	f				
BP22MOR-ENV-DC-118	f				
BP22MOR-ENV-DC-120	f				
BP22MOR-ENV-DC-121	f				
BP22MOR-ENV-DC-122	f				
BP22MOR-ENV-DC-123	f				
BP22MOR-ENV-DC-124	f				
BP22MOC-ENV-DC-125	f				
BP22MOC-ENV-DC-126	f				
BP22MOC-ENV-DC-127	f				
BP22MOC-ENV-DC-128	f				
BP22MOC-ENV-DC-129	f				
BP22MOC-ENV-DC-130	f				
BP22MOC-ENV-DC-131	f				
BP22MOC-ENV-DC-132	f				
BP22MOR-ENV-DC-155	f				
BP22MOR-ENV-DC-156	f				
BP22MOR-ENV-DC-157	f				
BP22MOR-ENV-DC-158	f				
BP22MOR-ENV-DC-159	f				
BP22MOR-ENV-DC-160	f				
BP22MOR-ENV-DC-161	f				
BP22MOR-ENV-DC-162	f				
BP22MOR-ENV-DC-163	f				
BP22MOR-ENV-DC-164	f				
BP22MOR-ENV-DC-165	f				

BP22MOR-ENV-DC-166	f				
BP22MOR-ENV-DC-167	f				
BP22MOR-ENV-DC-168	f				
BP22MOR-ENV-DC-098	a				
BP22MOR-ENV-DC-100	b				
Group e					
Average similarity: 63.13					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Serpulidae stet.	6.08	11.86	5.95	18.78	18.78
Alcyonium digitatum	4.7	8.64	3.29	13.68	32.47
Pectinidae stet.	3.12	4.68	1.91	7.42	39.89
Tubularia indivisa inc.	2.54	4.01	2.48	6.35	46.24
Ophiura albida inc.	2.45	3.49	1.7	5.53	51.76
Myxicola stet.	1.77	3.06	3.72	4.85	56.61
Adamsia palliata	1.68	2.77	2.93	4.39	61
Spatangus purpureus	1.54	2.57	1.78	4.07	65.07
Pagurus prideaux inc.	1.58	2.42	1.75	3.83	68.89
Echinoidea indet. GL0002	1.54	2.33	1.3	3.7	72.59
Ceriantharia stet.	1.84	2.3	1.26	3.64	76.23
Actiniaria indet. 01	1.34	1.82	1.32	2.89	79.11
Scaphopoda stet.	1.24	1.59	0.96	2.51	81.63
Paguroidea stet.	1.33	1.54	0.96	2.44	84.07
Suberites indet. 03	1.24	1.5	1.01	2.38	86.45
Ophiura ophiura inc.	0.95	1.1	0.82	1.74	88.19
Asterias rubens	1.05	1.09	0.81	1.73	89.92
Psolus phantapus inc.	0.93	1.04	0.82	1.65	91.57
Group d					
Less than 2 samples in group					
Group c					
Average similarity: 53.69					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Tubularia indivisa inc.	3.15	8.58	########[1]	15.97	15.97
Actiniaria indet. 01	2	6.06	########	11.3	27.27
Ceriantharia stet.	2.73	6.06	########	11.3	38.56
Ophiura ophiura inc.	2.73	6.06	########	11.3	49.86
Pectinidae stet.	2.22	6.06	########	11.3	61.15
Alcyonium digitatum	2.28	5.25	########	9.78	70.94
Psolus phantapus inc.	1.87	5.25	########	9.78	80.72
Ophiura albida inc.	1.57	4.29	########	7.99	88.7
Serpulidae stet.	2.08	3.03	########	5.65	94.35
Group h					
Average similarity: 47.97					

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ophiura ophiura inc.	2.71	10.78	5.14	22.48	22.48
Paguroidea stet.	1.67	6.98	3.32	14.54	37.02
Astropecten irregularis	1.77	5.04	1.14	10.51	47.53
Ceriantharia stet.	1.23	3.83	1.3	7.98	55.51
Adamsia palliata	1.08	3.74	1.29	7.8	63.31
Psolus phantapus inc.	0.83	3.55	1.29	7.39	70.71
Actiniaria indet. 01	0.97	3.24	1.27	6.75	77.46
Naticidae indet. 01	0.8	2.03	0.74	4.22	81.68
Actiniaria indet. 03	0.74	1.75	0.77	3.66	85.34
Hydractinia echinata	0.57	1.31	0.48	2.73	88.07
Actiniaria stet.	0.93	1.22	0.47	2.53	90.6
Group g					
Average similarity: 48.75					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ophiura ophiura inc.	3.5	23.47	4.38	48.14	48.14
Astropecten irregularis	1.67	10	2.13	20.52	68.66
Actiniaria indet. 07	0.8	2.18	0.52	4.47	73.13
Actiniaria indet. 06	0.75	1.91	0.54	3.92	77.05
Ceriantharia stet.	0.57	1.77	0.45	3.64	80.69
Actiniaria stet.	0.5	1.75	0.54	3.59	84.28
Actiniaria indet. 01	0.61	1.61	0.46	3.31	87.59
Paguroidea stet.	0.56	1.48	0.46	3.03	90.62
Group f					
Average similarity: 63.18					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ophiura ophiura inc.	5.55	56.19	4.19	88.93	88.93
Astropecten irregularis	0.88	3.66	0.6	5.79	94.72
Group a					
Less than 2 samples in group					
Group b					
Less than 2 samples in group					

1 ######## indicates faunal groups with 2 stations, which is insufficient for the Similarity/standard deviation calculation, therefore giving a blank result

C.7 Benthic epifaunal data univariate analysis results

Appendix Table 13: Data results of benthic epifaunal univariate analysis

Station	Biotope	S	N	d	J'	H'	λ
ENV066	SS.SMx.CMx	31	63	7.248	0.9515	3.267	0.9695

Station	Biotope	S	N	d	J'	H'	λ
ENV067	SS.SMx.CMx	28	48	6.972	0.9546	3.181	0.9704
ENV068	SS.SMx.CMx	29	53	7.064	0.9469	3.188	0.9679
ENV069	SS.SMx.CMx	26	49	6.418	0.9477	3.088	0.965
ENV070	SS.SMx.CMx	20	40	5.158	0.9378	2.809	0.9506
ENV071	SS.SMx.CMx	27	55	6.495	0.9349	3.081	0.9595
ENV072	SS.SMx.CMx	15	35	3.934	0.9344	2.53	0.93
ENV073	SS.SMx.CMx	32	68	7.352	0.9385	3.252	0.966
ENV074	SS.SMx.CMx	18	44	4.496	0.9355	2.704	0.9414
ENV075	SS.SMx.CMx	22	35	5.89	0.9463	2.925	0.9616
ENV076	SS.SMx.CMx	21	41	5.378	0.9422	2.868	0.9549
ENV077	SS.SMx.CMx	21	40	5.439	0.9658	2.94	0.9662
ENV078	SS.SMx.CMx	19	31	5.226	0.9559	2.815	0.9625
ENV079	SS.SSa.CMuSa	20	36	5.316	0.9549	2.861	0.9625
ENV080	SS.SSa.CMuSa	17	30	4.69	0.9804	2.778	0.9666
ENV081	SS.SSa.CFiSa	18	24	5.316	0.9745	2.817	0.9747
ENV082	SS.SSa.CFiSa	12	16	3.983	0.9675	2.404	0.9609
ENV083	SS.SSa.CFiSa	6	9	2.258	0.905	1.622	0.8548
ENV084	SS.SSa.CFiSa	7	11	2.508	0.973	1.893	0.9258
ENV085	SS.SSa.CMuSa	3	5	1.197	0.8401	0.9229	0.6652
ENV086	SS.SSa.CMuSa	7	13	2.335	0.8501	1.654	0.8036
ENV087	SS.SSa.CFiSa	9	18	2.744	0.9145	2.009	0.8834
ENV088	SS.SSa.CMuSa	4	9	1.349	0.8438	1.17	0.7015
ENV089	SS.SSa.CMuSa	7	12	2.388	0.8843	1.721	0.8381
ENV090	SS.SSa.CMuSa	4	8	1.41	0.8831	1.224	0.7481
ENV091	SS.SSa.CMuSa	7	16	2.179	0.9003	1.752	0.8382
ENV092	SS.SSa.CMuSa	3	8	0.9358	0.7649	0.8403	0.5499
ENV093	SS.SSa.CMuSa	2	7	0.5112	0.7219	0.5004	0.3727
ENV094	SS.SSa.CMuSa	4	9	1.387	0.8429	1.169	0.7111
ENV095	SS.SSa.CMuSa	1	5	0	0	0	0
ENV096	SS.SSa.CMuSa	2	7	0.5295	0.7489	0.5191	0.3963
ENV097	SS.SSa.CMuSa	1	6	0	0	0	0
ENV098	SS.SMx.CMx.OphMx	17	40	4.349	0.9368	2.654	0.9396
ENV099	SS.SSa.CFiSa	10	12	3.614	0.9814	2.26	0.9705

Station	Biotope	S	N	d	J'	H'	λ
ENV100	SS.SSa.CMuSa	28	46	7.041	0.9689	3.229	0.9772
ENV101	SS.SSa.CFiSa	12	17	3.848	0.973	2.418	0.9597
ENV102	SS.SSa.CFiSa	14	17	4.626	0.9885	2.609	0.9831
ENV103	SS.SSa.CFiSa	8	11	2.966	0.9701	2.017	0.9468
ENV104	SS.SSa.CFiSa	21	32	5.764	0.965	2.938	0.9701
ENV105	SS.SSa.CFiSa	13	20	4.01	0.9751	2.501	0.9601
ENV106	SS.SSa.CFiSa	7	11	2.496	0.9531	1.855	0.9108
ENV107	SS.SSa.CFiSa	8	11	2.903	0.9551	1.986	0.9306
ENV108	SS.SSa.CFiSa	12	17	3.903	0.9552	2.374	0.9498
ENV109	SS.SSa.CFiSa	10	13	3.553	0.9749	2.245	0.963
ENV110	SS.SSa.CFiSa	11	15	3.688	0.9557	2.292	0.9482
ENV111	SS.SSa.CFiSa	11	16	3.611	0.9404	2.255	0.9327
ENV112	SS.SSa.CFiSa	10	17	3.17	0.9624	2.216	0.9349
ENV113	SS.SSa.CFiSa	10	15	3.347	0.9617	2.214	0.9441
ENV114	SS.SSa.CFiSa	4	9	1.39	0.9944	1.379	0.8438
ENV115	SS.SSa.CFiSa	7	11	2.468	0.9315	1.813	0.8931
ENV116	SS.SSa.CFiSa	7	14	2.25	0.9214	1.793	0.8673
ENV117	SS.SSa.CMuSa	6	11	2.077	0.8559	1.534	0.7957
ENV118	SS.SSa.CMuSa	11	17	3.499	0.8991	2.156	0.8968
ENV119	SS.SSa.CFiSa	5	9	1.82	0.8097	1.303	0.7222
ENV120	SS.SSa.CMuSa	6	9	2.248	0.8709	1.56	0.8194
ENV121	SS.SSa.CMuSa	3	10	0.8751	0.8233	0.9045	0.6064
ENV122	SS.SSa.CMuSa	7	17	2.098	0.8858	1.724	0.8275
ENV123	SS.SSa.CMuSa	3	7	1.028	0.7995	0.8784	0.5948
ENV124	SS.SSa.CMuSa	3	7	1.039	0.8503	0.9342	0.6476
ENV125	SS.SSa.CMuSa	4	9	1.397	0.7446	1.032	0.6078
ENV126	SS.SSa.CMuSa	7	13	2.329	0.8473	1.649	0.8005
ENV127	SS.SSa.CMuSa	7	14	2.296	0.8565	1.667	0.8066
ENV128	SS.SSa.CMuSa	7	14	2.281	0.8609	1.675	0.8149
ENV129	SS.SSa.CMuSa	4	9	1.373	0.7808	1.082	0.6422
ENV130	SS.SSa.CMuSa	4	10	1.329	0.7815	1.083	0.6405
ENV131	SS.SSa.CMuSa	8	14	2.654	0.842	1.751	0.8124
ENV132	SS.SSa.CMuSa	3	9	0.9036	0.8013	0.8803	0.5725

Station	Biotope	S	N	d	J'	H'	λ
ENV154	SS.SSa.CFiSa	5	9	1.823	0.8731	1.405	0.7901
ENV155	SS.SSa.CMuSa	1	6	0	0	0	0
ENV156	SS.SSa.CMuSa	6	10	2.128	0.8149	1.46	0.753
ENV157	SS.SSa.CMuSa	6	13	1.934	0.8246	1.478	0.7498
ENV158	SS.SSa.CMuSa	1	7	0	0	0	0
ENV159	SS.SSa.CMuSa	1	5	0	0	0	0
ENV160	SS.SSa.CMuSa	3	8	0.9667	0.6739	0.7404	0.4688
ENV161	SS.SSa.CMuSa	2	7	0.5022	0.5751	0.3986	0.2731
ENV162	SS.SSa.CMuSa	3	9	0.9102	0.6224	0.6837	0.4167
ENV163	SS.SSa.CMuSa	1	6	0	0	0	0
ENV164	SS.SSa.CMuSa	3	9	0.9151	0.6998	0.7688	0.4859
ENV165	SS.SSa.CMuSa	1	4	0	0	0	0
ENV166	SS.SSa.CMuSa	3	10	0.8827	0.7698	0.8457	0.5514
ENV167	SS.SSa.CMuSa	3	8	0.9437	0.6535	0.7179	0.4477
ENV168	SS.SSa.CMuSa	3	5	1.178	0.8288	0.9105	0.6501

C.8 Species scientific, common names and biotopes

The below table contains all known common names for the scientific species names which have been referred to in the main text of this benthic subtidal and intertidal ecology technical report.

Appendix Table 14: Scientific and common names of species

Scientific name	Common name
Abra alba	White furrow shell
Abra nitida	Glossy furrow shell
Acanthocardia aculeata	Spiny cockle
Acanthocardia echinata	European prickly cockle
Acteon tornatilis	lathe acteon
Actinia equina	Beadlet anemone
Adamsia palliata	Cloak anemone
Alcyonidium diaphanum	Deadman’s fingers anemone
Ammophila arenaria	Marram grass
Amphiura chiajei	Heart urchin
Amphiura filiformis	Bristle worm
Arctica islandica	Ocean quahog

Scientific name	Common name
Arenicola defodiens	Black lug worm
Arenicola marina	Lug worm
Ascophyllum nodosum	Knotted wrack
Asterias rubens	Common starfish
Bathyporeia pilosa	Sand digger shrimp
Branchiostoma lanceolatum	Common lancet
Brissopsis lyrifera	Heart urchin
Carcinus maenas	Green shore crab
Cerastoderma edule	Common cockle
Cerianthus lloydii	North Sea tube anemone
Chamelea striatula	No known common name
Chamelea gallina	Striped venus clam
Corallina officinalis	Coral weed
Corophium arenarium	No known common name
Dendrodoa grossularia	Baked bean ascidian
Donax vittatus	Banded wedge shell
Dumontia contorta	No known common name
Echinocardium cordatum	Sea potato
Echinocyamus pusillus	Pea urchin
Edwardsia timida	Worm anemone
Ennucula tenuis	Smooth nutclam
Ensis siliqua	Pod razor
Euspira catena	Large necklace shell
Euspira nitida	Common necklace shell
Eurydice pulchra	Speckled sea louse
Fabulina fabula	Bean-like tellin
Fucus serratus	Toothed wrack
Fucus spiralis	Spiral wrack
Glauco-Puccinellietalia maritimae	Atlantic salt meadow
Glycera lapidum	No known common name
Glycera tridactyla	No known common name
Glycymeris	Bittersweet clam
Golfingia (Golfingia) elongata	No known common name

Scientific name	Common name
Halidrys siliquosa	Sea-oak
Hediste diversicolor	Rag worm
Kurtiella bidentata	Two-toothed Mantagu shell
Lagis koreni	Trumpet worm
Laminaria digitata	Oar weed
Laminaria hyperborea	Cuvie
Lanice conchilega	Sand mason worm
Limaria hians	Flame shell
Littorina littorea	Common periwinkle
Loripes lucinalis	No known common name
Leymus arenarius	Lyme grass
Macoma balthica	Baltic tellin
Macomangulus tenuis	Thin tellin
Mactra stultorum	Edible salt water clam
Magelona mirabilis	Bristle worm
Mastocarpus stellatus	False Irish moss
Modiolus modiolus	Northern horse mussel
Mytilus edulis	Common blue mussel
Nephtys cirrosa	White catworm
Nucella lapillus	Dog whelk
Nucula nitidosa	Shiny nut clam
Ophiocomina nigra	Black brittlestar
Ophiothrix fragilis	Common brittlestar
Ostrea edulis	European flat oyster
Owenia fusiformis	Tube worm
Pennatula phosphorea	Phosphorescent seapen
Pharus legumen	Razor shell
Phascolion (Phascolion) strombus strombus	Peanut worm
Phaxas pellucidus	Transparent razor shell
Pomacea canaliculata	Golden apple snail
Pomatoceros triqueter	Keel worm
Porcellana platycheles	Broad clawed porcelain crab
Pygospio elegans	No known common name

Scientific name	Common name
Sabellaria alveolata	Honeycomb worm
Sabellaria spinulosa	Ross worm
Salicornia	Glasswort
Scalibregma inflatum	T-headed worm
Scoloplos armiger	Armoured bristle worm
Scrobicularia plana	Peppery furrow shell
Spatangus purpureus	Purple heart urchin
Spirobranchus triqueter	Tube worm
Stauromedusae	Stalked jellyfish
Thia scutellata	Thumbnail crab
Urticina felina	Dahlia anemone
Zostera marina	Eel grass

The below table contains all the biotope codes referred to in the main text of this benthic subtidal and intertidal ecology technical report as well as their full biotope names.

Appendix Table 15: List of subtidal infaunal and epifaunal biotopes within the survey area

Biotope code	Biotope name
CR.HCR.XFa.ByErSp	Bryozoan turf and erect sponges on tide-swept circalittoral rock
CR.HCR.XFa.FluCoAs.X	*Flustra foliacea* and colonial ascidians on tide-swept exposed circalittoral mixed substrata
CR.HCR.XFa.FluHocu	*Flustra foliacea* and *Haliclona oculata* with a rich faunal turf on tide-swept circalittoral mixed substrata
CR.HCR.XFa.SpNemAdia	Sparse sponges, *Nemertesia* spp. And *Alcyonidium diaphanum* on circalittoral mixed substrata
CR.MCR	Moderate energy circalittoral rock
CR.MCR.CSab.Sspi	*Sabellaria spinulosa* encrusted circalittoral rock
CR.MCR.EcCr.FaAlCr	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
LGS.S.Aeur	Burrowing amphipods and *Eurydice pulchra* in well-drained clean sand shores
LS.LGS.S.Lan	*Lanice conchilega* in tide-swept lower shore sand
LR.FLR.Eph.BlitX	Barnacles and *Littorina* spp. on unstable eulittoral mixed substrata
LR.FLR.Eph.EphX	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata
LS.LBR.LMus.Myt.Mx	*Mytilus edulis* beds on littoral mixed substrata

Biotope code	Biotope name
LS.LCS.Sh.BarSh	Barren shingle or gravel shores
LS.LSa.FiSa	Polychaete/amphipod-dominated fine sand shores
LS.LSa.FiSa.Po	Polychaetes in littoral fine sand
LS.LSa.FiSa.Po.Ncir	*Nephtys cirrosa* dominated littoral fine sand
LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores
LS.LSa.MuSa	Polychaete/bivalve-dominated muddy sand shores
LS.LSa.MuSa.BatCare	*Bathyporeia pilosa* and *Corophium arenarium* in littoral muddy sand
LS.LSa.MuSa.Lan	Lanice conchilega in littoral sand
LS.LSa.MuSa.MacAre	Macoma balthica and Arenicola marina in littoral muddy sand
LS.LSa.St.Tal	Talitrids on the upper shore and strand-line
SLR.FX.BIlit	*Littorina littorea* on unstable eulittoral mixed substrata
SLR.MX.MytX	*Mytilus edulis* beds on eulittoral mixed substrate
SS.SCS.CCS	Circalittoral coarse sediment
SS.SCS.CCS.Blan	*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel
SS.SCS.CCS.PKef	*Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand
SS.SCS.CCS.PomB	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
SS.SCS.ICS.Glap	*Glycera lapidum* in impoverished infralittoral mobile gravel and sand
SS.SCS.ICS.MoeVen	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand
SS.SCS.OCS	Offshore circalittoral coarse sediment
SS.SMu.CFiMu.BlyrAchi	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud
SS.SMu.CFiMu.MegMax	Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud
SS.SMu.CFiMu.SpnMeg	Seapen and burrowing megafauna community
SS.SMu.CSaMu	Circalittoral sandy mud
SS.SMu.CSaMu.AfilKurAnit	*Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud
SS.SMu.CSaMu.LkorPpel	*Lagis koreni* and *Phaxas pellucidus* in circalittoral sandy mud
SS.SMu.CSaMu.ThyEten	*Thyasira* spp. and *Ennucula tenuis* in circalittoral sandy mud
SS.SMu.ISaMu.AmpPlon	*Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral sandy mud
SS.SMu.ISaMu.KurAbr	*Kurtiella bidentata* and *Abra* spp. in infralittoral sandy mud
SS.SMu.OMu	Offshore circalittoral mud
SS.SMx	Sublittoral mixed sediment
SS.SMx.CMx	Circalittoral mixed sediment

Biotope code	Biotope name
SS.SMx.CMx.ClloMx.Nem	*Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment
SS.SMx.CMx.FluHyd	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment
SS.SMx.CMx.KurThyMx	Kurtiella bidentata and Thyasira spp. in circalittoral muddy mixed sediment
SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment
SS.SMx.OMx	Offshore circalittoral mixed sediment
SS.SMx.OMx.PoVen	Polychaete-rich deep *Venus* community in offshore mixed sediments
SS.SSa.CFiSa	Circalittoral fine sand
SS.SSa.CFiSa.EpusOborApri	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand
SS.SSa.CMuSa	Circalittoral muddy sand
SS.SSa.CMuSa.AalbNuc	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment
SS.SSa.IFiSa	Infralittoral fine sand
SS.SSa.IFiSa.NcirBat	*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
SS.SSa.IMuSa.EcorEns	*Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand
SS.SSa.IMuSa.FfabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods
SS.SSa.OSa	Offshore circalittoral sand

C.9 Sediment metabarcoding

C.9.1 Overview

Two samples were collected from 103 stations within the survey area; of which a subset of 52 stations throughout the Morgan Offshore Wind Project: Generation Assets and Transmission Assets, but excluding the Morecambe Offshore Windfarm: Generation Assets, were sent to the laboratory for bacterial and infaunal DNA analysis. The remaining samples were retained as spares. It should be noted that this analysis included additional samples collected within the zone of influence of the Morgan Offshore Wind Project: Generation Assets which have not been reported within this benthic subtidal and intertidal ecology technical report for the Transmission Assets but could not be separated out of this analysis. All relevant data collected for the Morecambe Offshore Windfarm: Generation Assets assessment have been included in **Appendix A**.

C.9.2 Summary statistics

A total of 1,906 OTUs were detected across the survey area, as detailed in **Appendix Table 16**. Of the 1,906 detected OTUs (bacterial and infaunal), a greater percentage of infaunal OTUs were identified to species level (10%) compared to the bacterial OTUs (1%), which may be due to a larger pool of reference material for infaunal OTUs.

Appendix Table 16: OTU detections per target and percentage successfully classified

Target	Number of OTUs	Percentage of OTUs classified to					
		Phylum	Class	Order	Family	Genus	Species
Bacteria	1409	69%	51%	30%	23%	6%	1%
Infauna	497	100%	81%	88%	75%	35%	10%

A total of 14 bacterial OTUs (1%) were present in all the sediment samples, while 31% (n=443) occurred in a single sediment sample. The relatively high numbers of widespread taxa and lone taxa across the survey area suggested that the community has been exposed to relatively little disturbance.

A total of 443 (31%) bacterial OTUs and 225 (45%) infaunal OTUs were present in a single sample across the survey area, with no OTUs either bacterial or infaunal present across all stations. The absence of a consistent community across the survey area, as well as the high proportion (>30%) of rare OTUs suggest the community heterogeneity across the survey area may have been under sampled for the bacterial and infaunal size class.

The bacterial data set identified 34 taxonomic groups based on class, with the proportional contributions of these groups to the overall community structure of the survey area detailed in **Appendix Table 17** and graphically presented in **Appendix Figure 1**. Bacterial OTUs which could not be successfully identified to class were grouped into the ‘Other’ category.

The ‘Other’ taxonomic group was recorded as the richest within the bacterial data set, accounting for 48.7% (n=686) of OTUs. The second most abundant taxonomic group was the *Gammaproteobacteria*, 16.4% of OTUs across the survey area. The relative *Gammaproteobacteria* dominance is likely given it is one of the richest classes within the bacterial phyla (Williams *et al*., 2010). The dominance of ‘Other’ within the proportional contributions was partly due to the inability to determine these OTUs further than phylum.

Appendix Table 17: Contribution of sediment bacterial taxonomic groups

Groups	Abundance	Proportional Contribution %
Acidobacteriae	46	3.3%
Aminicenantia	4	0.3%
Acidimicrobiia	2	0.1%
Actinomycetia	27	1.9%
Bacteroidia	81	5.7%

Groups	Abundance	Proportional Contribution %
Ignavibacteria	2	0.1%
Rhodothermia	1	0.1%
Calditrichia	3	0.2%
Campylobacteria	4	0.3%
Anaerolineae	35	2.5%
Chloroflexia	3	0.2%
Dehalococcoidia	7	0.5%
Cyanobacteriia	1	0.1%
Deinococci	1	0.1%
Babeliae	2	0.1%
Desulfobacteria	5	0.4%
Desulfobulbia	1	0.1%
Fibrobacteria	1	0.1%
Bacilli	2	0.1%
Clostridia	9	0.6%
Fusobacteriia	1	0.1%
Gemmatimonadetes	4	0.3%
Latescibacteria	1	0.1%
Moduliflexia	3	0.2%
Nitrospiria	12	0.9%
Thermodesulfovibrionia	1	0.1%
Gracilibacteria	1	0.1%
Phycisphaerae	11	0.8%
Planctomycetes	77	5.5%
Alphaproteobacteria	97	6.9%
Gammaproteobacteria	231	16.4%
Spirochaetia	12	0.9%
Kiritimatiellae	8	0.6%
Verrucomicrobiae	27	1.9%
Other	686	48.7%
Total	**1409**	**100%**

A total of 27 taxonomic groups based on class were identified from the sediment infaunal data sets with the proportional contribution of these taxonomic groups to the overall structure of the survey area detailed in **Appendix Table 18** and graphically presented in **Appendix Figure 2**. OTUs which could not be identified to class were grouped into an 'Other' category.

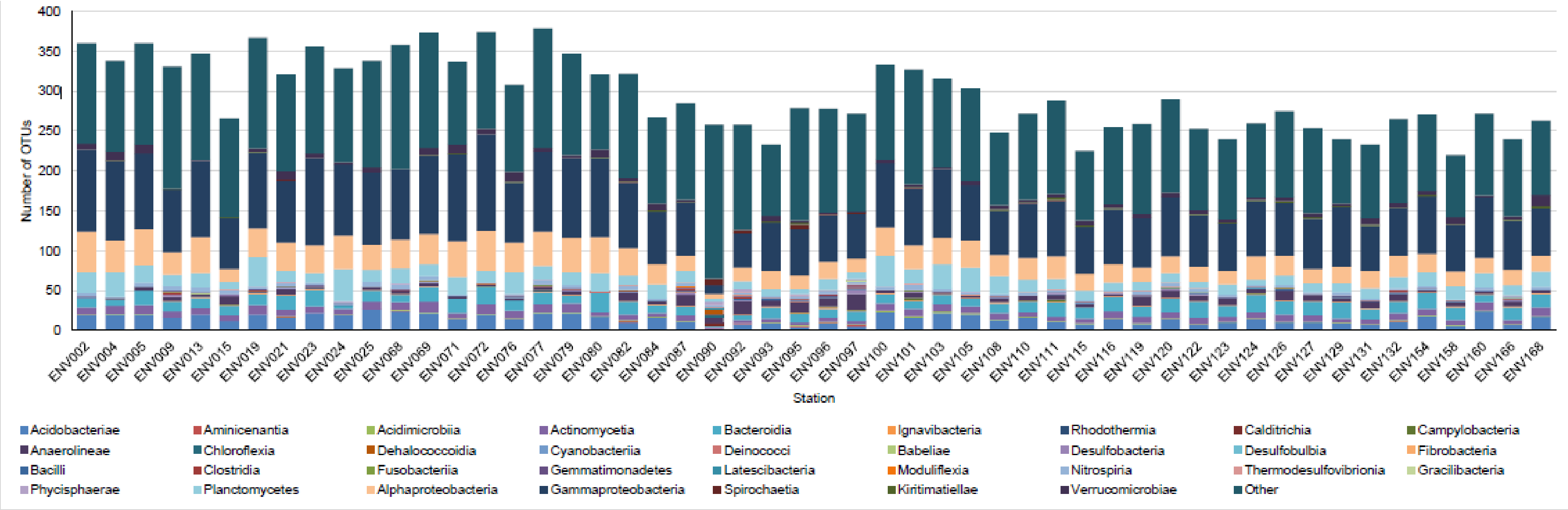
Adenophorea (n=188) was the most abundant taxonomic group across the survey area, accounting for 37.8% of OTUs. The next most abundant groups were 'Other' (n=94, 18.9%) and *Hexanaulia* (n=71, 14.3%). Seven taxonomic groups (*Appendicularia*, *Asteroidea*, *Branchiopoda*, *Enteropneusta*, *Maxilopoda*, *Scyphozoa* and *Trematoda*) were represented by a single OTU. When comparing with the previous Gardline (2022b) survey, *Adenophorea* and *Hexanauplia* were the two most abundant groups. *Branchiopoda* and *Trematoda* were also represented by a single OTU within the comparison survey.

A greater number of bacterial and infaunal taxonomic groups and individual OTUs were recorded within the current survey than the previous (Gardline, 2022b); however, this cannot be used to conclude that the bacterial or infaunal community within the current survey was more diverse, due to continuing advancements in metabarcoding and additions to the pool of reference material.

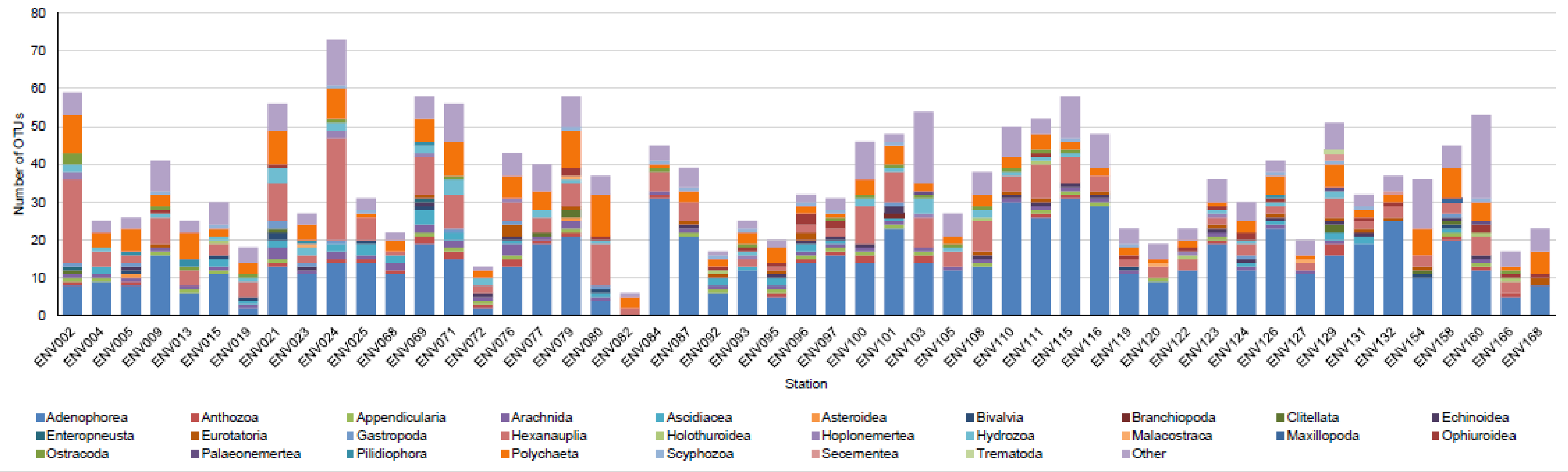
Appendix Table 18: Contributions of sediment faunal OUT taxonomic groups

Group	Abundance	Proportional contribution %
Adenophorea	188	37.8%
Anthozoa	4	0.8%
Appendicularia	1	0.2%
Arachnida	5	1.0%
Ascidiacea	9	1.8%
Asteroidea	1	0.2%
Bivalvia	5	1.0%
Branchiopoda	1	0.2%
Clitellata	5	1.0%
Echinoidea	2	0.4%
Enteropneusta	1	0.2%
Eurotatoria	7	1.4%
Gastropoda	7	1.4%
Hexanauplia	71	14.3%
Holothuroidea	2	0.4%
Hoplonemertea	4	0.8%
Hydrozoa	9	1.8%
Malacostraca	2	0.4%

Group	Abundance	Proportional contribution %
Maxillopoda	1	0.2%
Ophiuroidea	3	0.6%
Ostracoda	4	0.8%
Palaeonemertea	2	0.4%
Pilidiophora	4	0.8%
Polychaeta	60	12.1%
Scyphozoa	1	0.2%
Secernentea	3	0.6%
Trematoda	1	0.2%
Other	94	18.9%
Total	**497**	**100%**

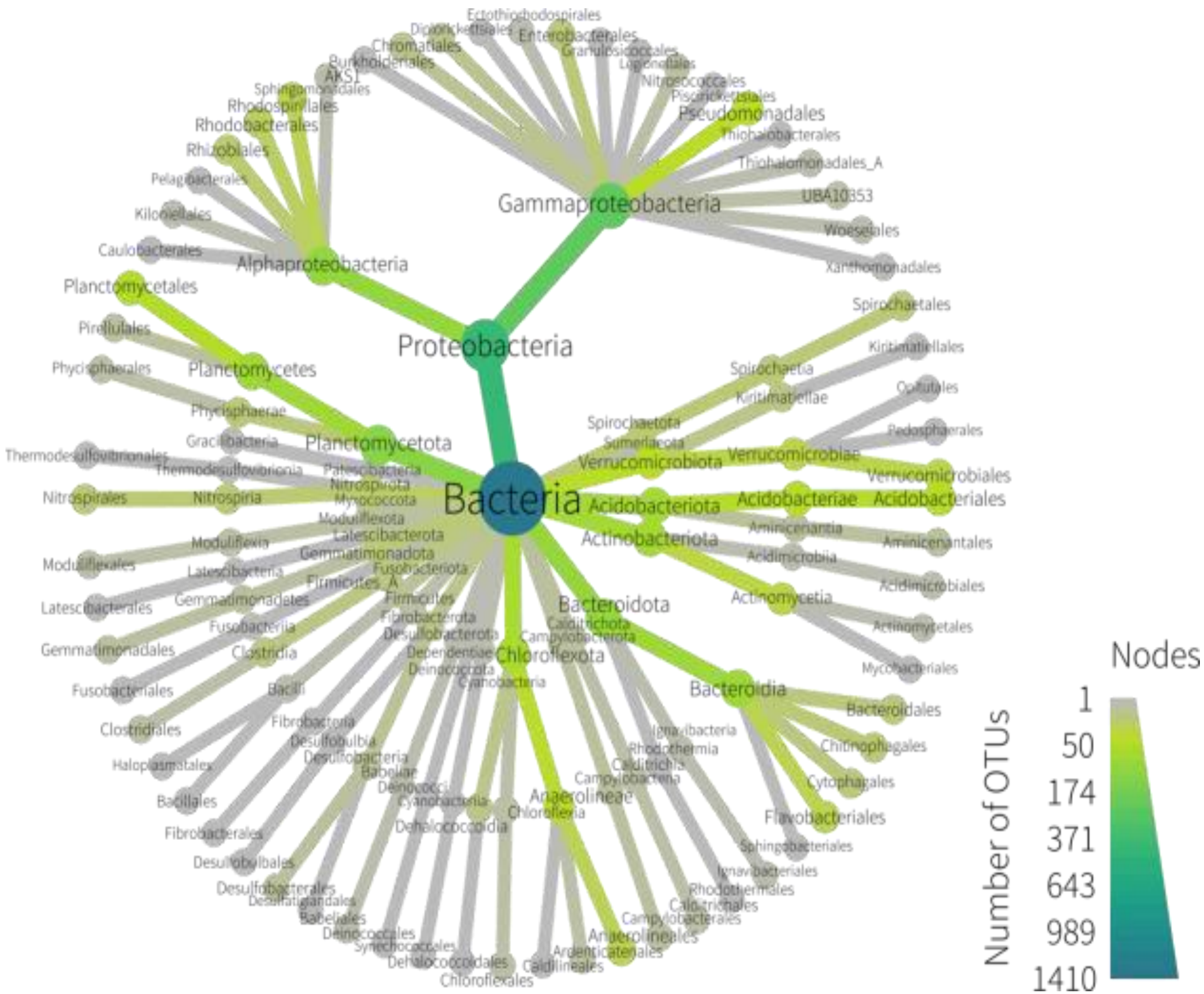


Appendix Figure 1: Contributions of gross sediment bacterial OTU taxonomic groups by samples

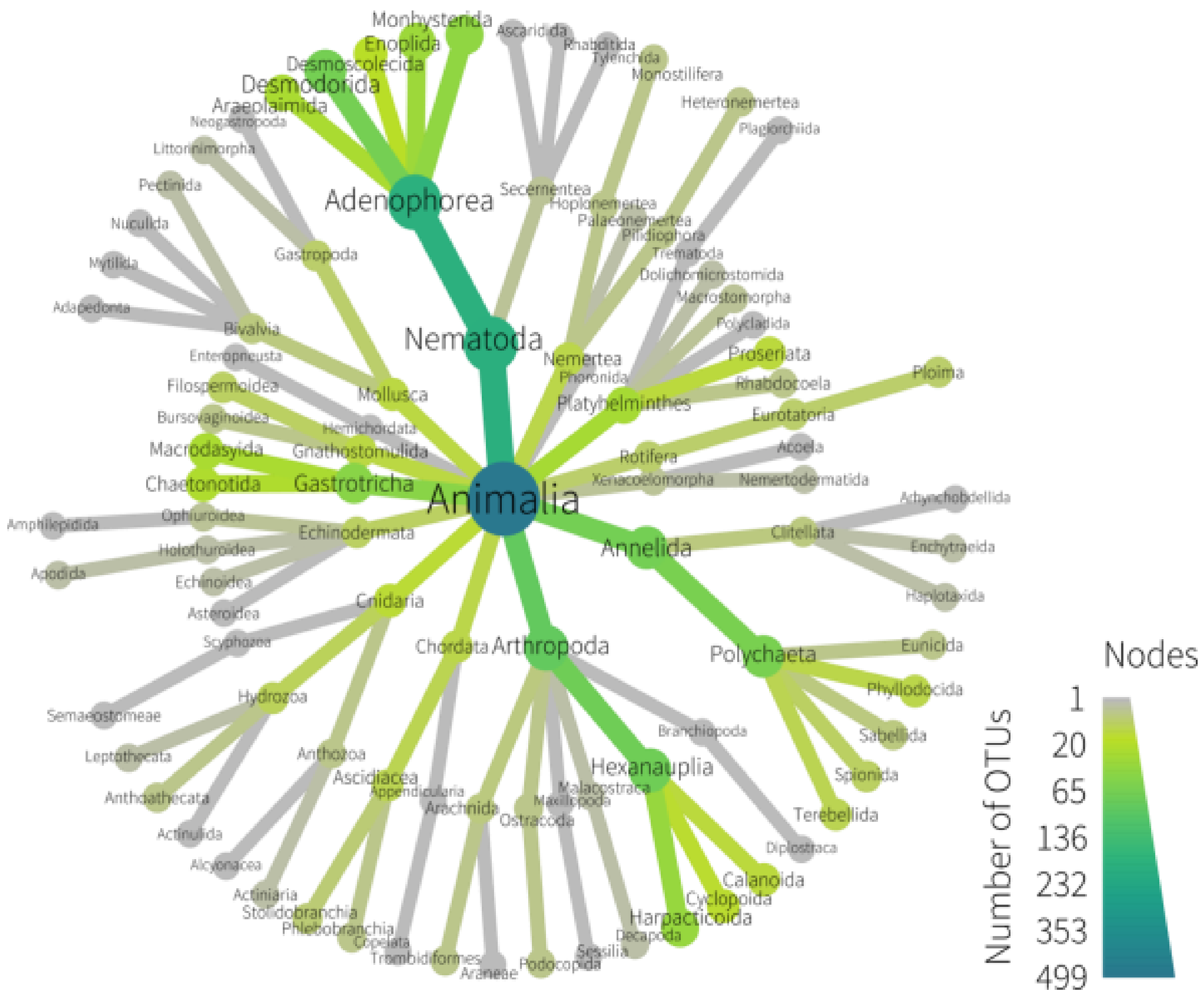


Appendix Figure 2: Contributions of gross sediment infaunal OTU taxonomic groups by samples

Comparative taxonomic heat trees detailing the number of OTUs across the survey from bacterial taxa, down to the order rank are presented in **Appendix Figure 3** while the taxonomic heat trees detailing the discrete infaunal taxa OTUs down to the order rank are presented in **Appendix Figure 4**. The nodes (circles) represent a 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 **Appendix Table 19**.



Appendix Figure 3: Sediment bacterial taxonomic heat trees of the number of OTUs



Appendix Figure 4: Sediment infaunal taxonomic heat trees of the number of OTUs

Page 242

Appendix Table 19: Summary of sediment OTU richness

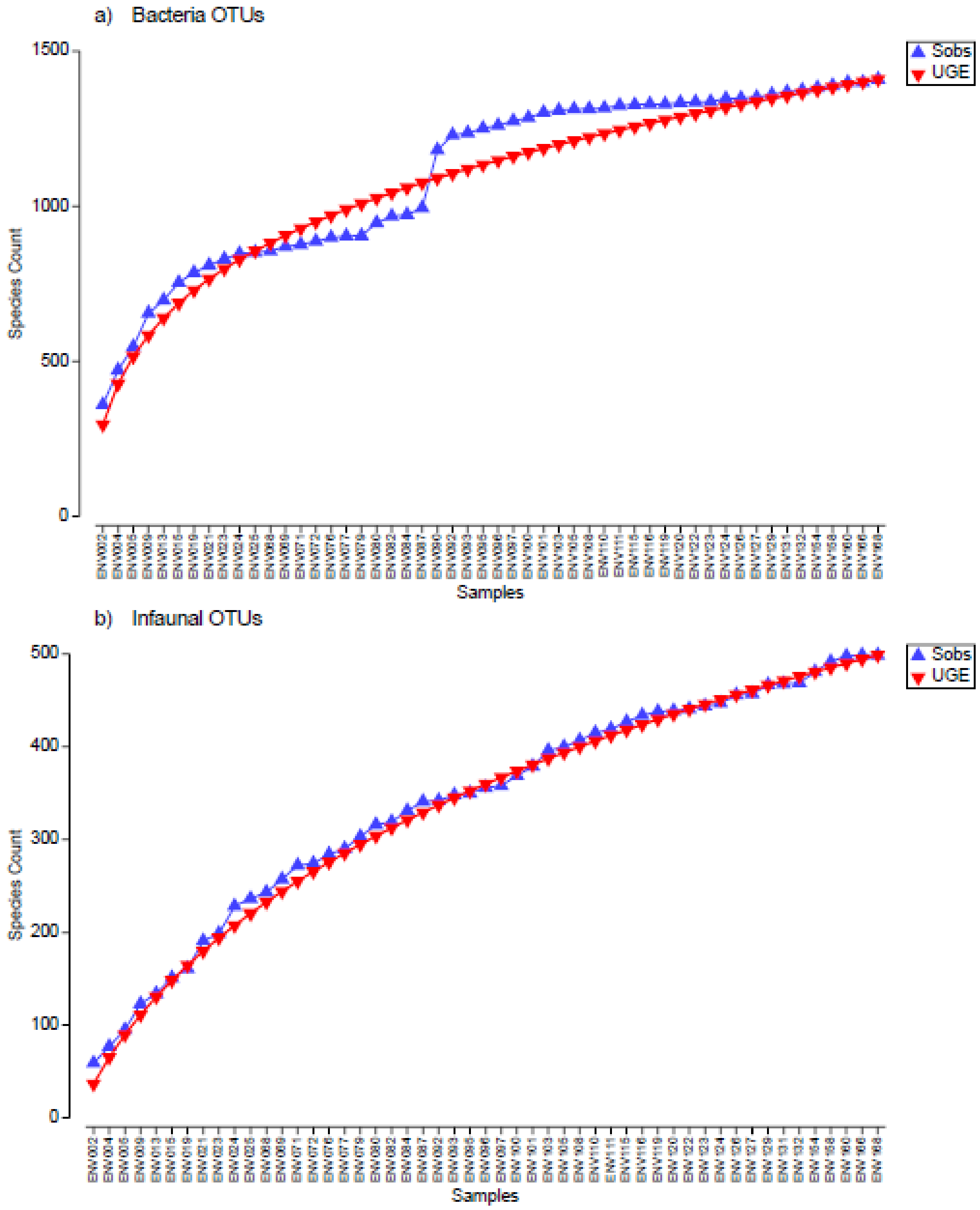
	Bacterial OTUs	Faunal OTUs
Minimum	220	6
Maximum	379	73
Mean	295.5	36.5
±SD	45.6	14.7

Accumulation plots of OTUs for the sediment bacterial and infaunal data sets for the survey are presented in **Appendix Figure 1**. Two lines are plotted; the first (plotted in blue and often referred to as a 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 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). Sharp changes in the slope of the species in order of observation (Sobs) curve reflect notable changes in community between stations. Further, the relation of the Sobs curve to that of the permutated average of samples (such as the UGE curve generated average after 999 random sample combinations) can reflect the number of OTUs versus expectations.

The Sobs curve for the sediment bacterial data set (**Appendix Figure 1a**) initially began above the UGE curve indicating that a greater number of OTUs were present than was to be expected, the Sobs curve then continued to follow the curve of the UGE curve until the addition of Station ENV025 where the Sobs curve plateaued. Upon the addition of Station ENV090 the Sobs curve steeply increased where the Sobs curve increased above the UGE curve. Station additions after this followed the curve of the UGE curve.

The Sobs curve for the infaunal data set (**Appendix Figure 1b**) began above the UGE curve with the addition of Sample ENV002 subsequent sample additions lead the Sobs curve to follow the curve of the UGE curve.

The Sobs and UGE curves of both the sediment bacterial and infaunal data OTU accumulation plots continued to rise with the addition of the last samples. This reflected that further samples across the survey area may elicit additional OTUs to those reported during the current sampling efforts.



Appendix Figure 1: OTU accumulation curves

C.9.2.1 OTU community structure using multivariate statistics

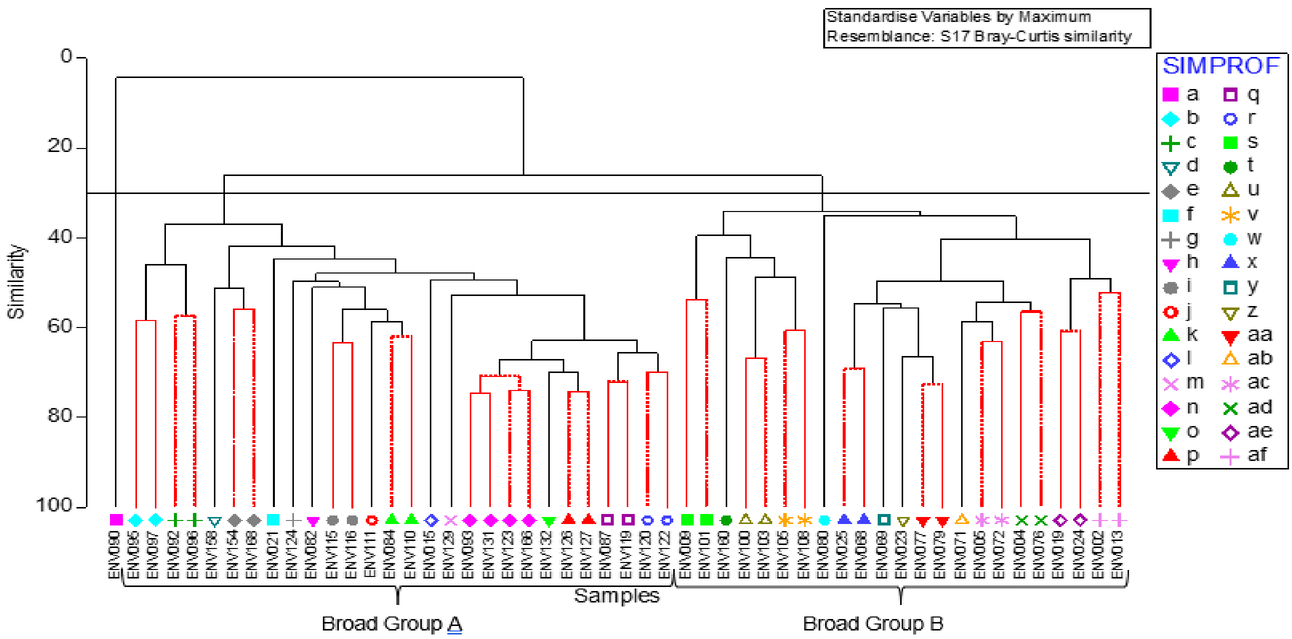
The results of the CLUSTER analysis including SIMPROF analysis in the form of a Bray-Curtis similarity dendrogram and nMDS plot based upon standardised data for the sediment bacteria samples are displayed **Appendix Figure 2** for the survey area. Similarly results of the same analysis on the standardised infaunal data are presented in **Appendix Figure 3**.

The CLUSTER analysis and resulting dendrogram for the sediment bacterial OTU data set (**Appendix Figure 2a**) identified 32 groups which comprised 14 outliers (SIMPROF *a, d, f, g, h, j, l, m, o, t, w, y, z* and *ab*), 17 closely associated pairs (SIMPROF *b, c, e, i, k, p, q, r, s, u, v, x, aa, ac, ad, ae* and *af*)and a single cluster (SIMPROF *n*). All samples were considered more dissimilar than similar to one another and grouped at *c.*4% similarity. The generally low similarities are potentially due to the bacterial communities being far richer than equivalent metazoan communities and are less discriminately bound to the sediment given their established variation with both overlying water quality along with direct sediment physico-chemistry (Allison and Martiny, 2008; Frühe *et al.*, 2021). However, they still provide a suitable sensitive receptor to environmental pressures for monitoring impacts (Horton *et al.*, 2019).

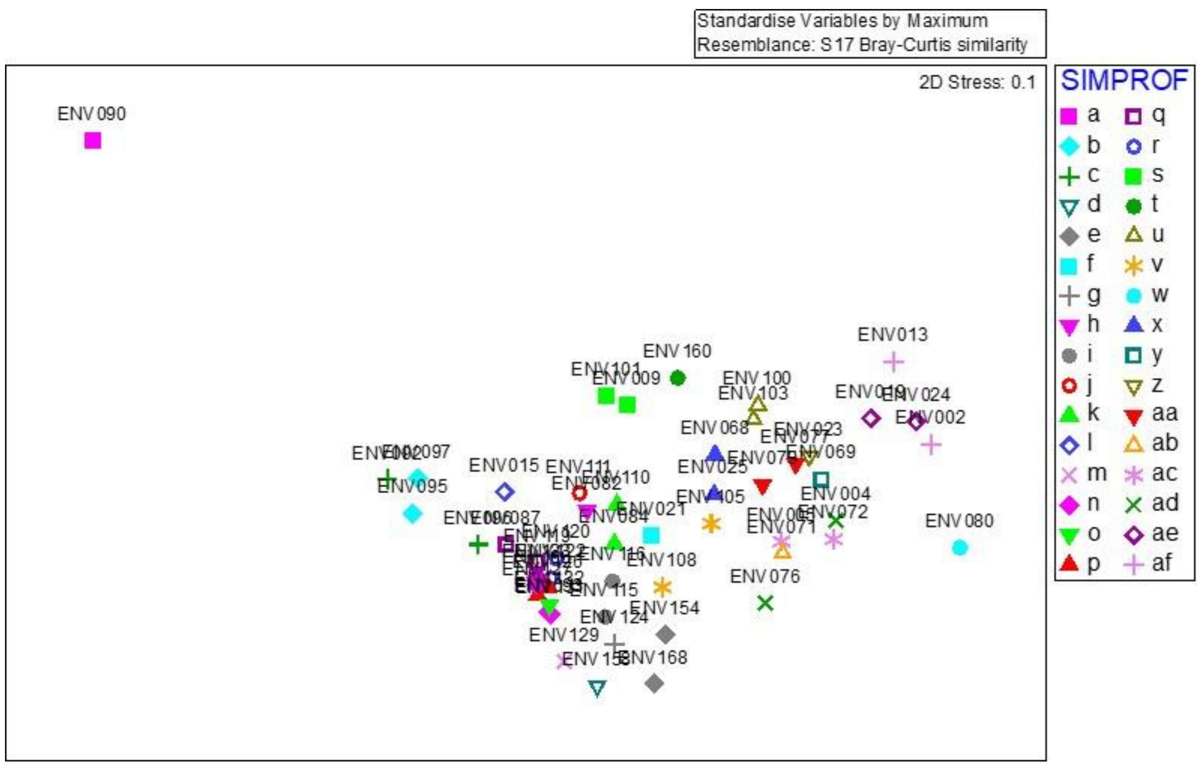
The nMDS ordination of the sediment bacterial data set (**Appendix Figure 2b**) revealed a similar pattern to the cluster analysis with a stress level of 0.1, which can be considered a good two-dimensional representation of rank dis(similarities) and overall pattern observed in the data set.

Examination of the sediment bacterial data set together with results of SIMPER analyses at a group level is presented in **Appendix Table 17**. This was restricted to explaining separations where similarity was less than 30% for conciseness. The broad groups identified showed differences due to subtle variations in taxa community structure within a particular SIMPROF groups.

a. Bray-Curtis Similarity Dendrogram



b. MDS Ordination



Appendix Figure 2: Multivariate analysis of sediment bacterial OTU data by Sample

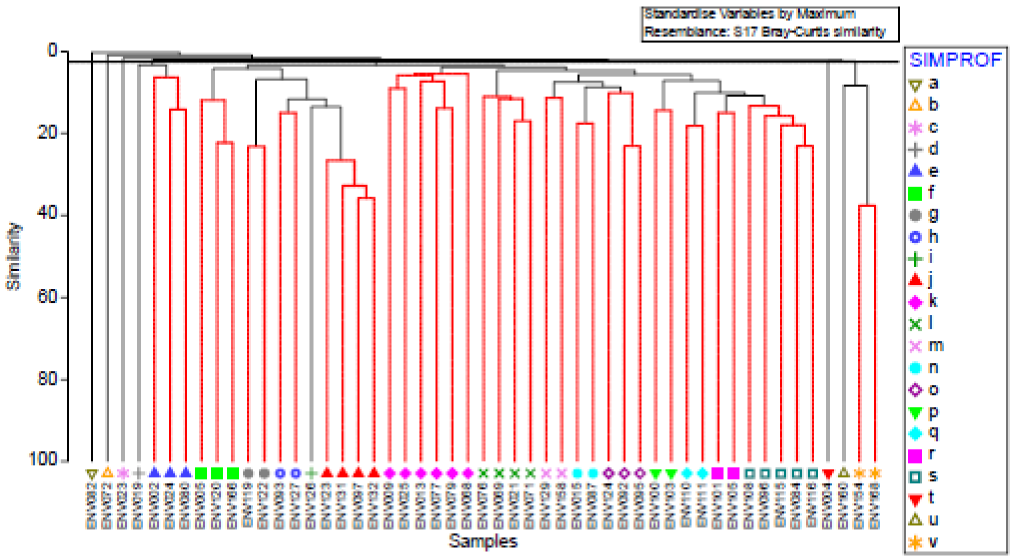
Appendix Table 20: Taxa influencing sediment bacteria OTU SIMPROF variation

Groupings	Dissimilarity (%)	Groups Influencing Separation
SIMPROF *a* vs remaining	96	• 42 Indeterminate Bacteria OTUs were more abundant in SIMPROF *a.* • (*c.* 11.4% of the dissimilarity). • 19 Gammaproteobacteria OTUs were absent from SIMPROF *a* (*c.* 2.2% of the dissimilarity).
Broad Group A vs Broad Group B	74	• 44 Indeterminate Bacteria OTUs were more abundant in Broad Group B (*c*. 6.8% of the dissimilarity). • 34 Gammaproteobacteria OTUs were more abundant in Broad Group B (*c.* 5% of the dissimilarity). • 12 Alphaproteobacteria OTUs were more abundant in Broad Group B (*c*. 1.8% of the dissimilarity). • 12 Bacteroidia OTUs were more abundant in Broad Group B (*c*. 1.7% of the dissimilarity).

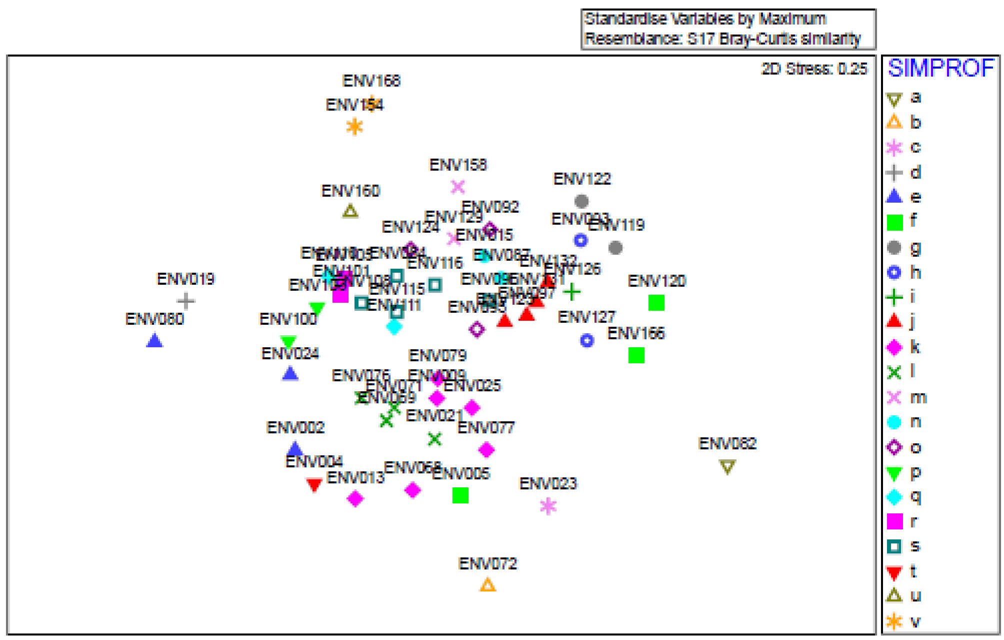
CLUSTER analysis and the resulting dendrograms for the sediment infaunal OTU data set (**Appendix Figure 3a**) identified 22 groups; 7 outliers (SIMPROF *a, b, c, d, i, j* and *u*), 8 closely associated pairs (SIMPROF *g, h, m, n, p, q, r* and *v*) and 7 clusters (SIMPROF *e, f, j, k, l, o* and *s*). All samples were more dissimilar than similar to one another, joining together at c.0.3% similarity.

Examinations of the sediment infaunal data together with results of SIMPER analyses; presented in **Appendix Table 21**, highlighted the principal contributors to the grouping and separation of stations. This was restricted to explaining separations where similarity was less than 2.5% for conciseness.

a. Bray-Curtis Similarity Dendrogram



b. MDS Ordination



Appendix Figure 3: Multivariate analysis of sediment infaunal OTU data

Appendix Table 21: Taxa influencing sediment infaunal OTU SIMPROF variation

SIMPROF	Dissimilarity (%)	Taxa influencing separation
SIMPROF *a* vs remaining	99.7	• *Phyllodoce* IM-19H88I was more abundant in SIMPROF *a* (*c*. 9.0% of the dissimilarity). • The absence of 188 infaunal OTUs from SIMPROF *a* contributed *c*. 57.6% of the dissimilarity.
SIMPROF *b* vs SIMPROF *c*, Broad Groups A-C	99.2	• *Onuphidae* IM-I2992I was unique to SIMPROF b (*c* 7.5% of the dissimilarity). • *Acanthogorgiidae* IM-6HNE0Q was more abundant in SIMPROF *b* (*c*. 7.5% of the dissimilarity). • The absence of 174 infaunal OTUs from SIMPROF *b* contributed *c*. 49.6% of the dissimilarity.
SIMPROF c vs Broad Groups A-C	98.3	• *Callianassidae* IM-32VZ5A, *Oncholaimidae* IM-ELM9Z5 and *Oncholaimidae* IM-W4UI46 were unique to SIMPROF *c* (*c*. 16.1% of the dissimilarity). • The absence of 129 infaunal OTUs from SIMPROF *c* contributed c. 30.8% of the dissimilarity. • Eight infaunal OTUs were more abundant in SIMPROF *c* (*c*. 17.5% of the dissimilarity). • A total of 16 infaunal OTUs were more abundant in Broad Groups A-C which contributed. • *c*. 5.7% of the dissimilarity.
Broad Group A vs Broad Groups B, C	98	• A total of 40 infaunal OTUs were more abundance in Broad Group A which contributed. • *c*. 22.7% of the dissimilarity. • The absence of 56 infaunal OTUs from Broad Groups B and C contributed *c*. 38.4% of the dissimilarity. • The absence of 22 infaunal OTUs from Broad Group A contributed *c*. 5.4% of the dissimilarity.
Broad Group C vs Broad Group B	97.9	• A total of 43 infaunal OTUs were more abundance in Broad Group C which contributed. • *c*. 29.9% of the dissimilarity. • The absence of 22 infaunal OTUs from Broad Group B contributed *c*. 22.5% of the dissimilarity.

C.9.2.2 Multivariate comparison of metabarcoding and physico-chemical data sets

The bacterial and infaunal OTUs detected throughout the survey area were compared to the physico-chemical data to determine if any patterns in the metabarcoding correlated with the environmental factors assessed.

A RELATE analysis identified no correlation between the sediment bacterial OTUs and physico-chemical variables (r=0.042, p>0.05). BIOENV analyses identified a 26% correlation between the bacterial multivariate pattern and arsenic concentrations, with the inclusion of additional variables having little impact on correlations.

A RELATE analysis identified no correlation between the sediment infaunal OTUs and physico-chemical variables (r=-0.013, p>0.05). BIOENV analyses identified a 22% correlation between the infaunal multivariate pattern and mean particle diameter, with the inclusion of additional variables having little impact on correlations.

C.9.2.3 Multivariate comparison of macrofaunal and metabarcoding data sets

The sediment bacterial and infaunal OTU data sets were compared to the adult macrofaunal abundance and biomass data to determine if there was any correlation. As expected, a RELATE analysis identified a significant correlation of 61% for bacterial OTUs and 45% for infaunal OTUs when compared to the adult abundance data. Similar results were found when comparing to the adult biomass data, with a RELATE analysis identifying a significant correlation of 54% for bacterial OTUs and 42% for infaunal OTUs.

It is important to note that despite the significant correlations found, only one replicate sample was analysed for macrofauna abundance and biomass and only one replicate sample was used for metabarcoding of bacteria and infauna.