

A photograph showing the backs of two people wearing high-visibility yellow-green jackets and hard hats (one white, one yellow) looking out over a calm sea under a cloudy sky. The person on the left is wearing a white hard hat with 'CONCEPT' written on it. The person on the right is wearing a yellow hard hat.

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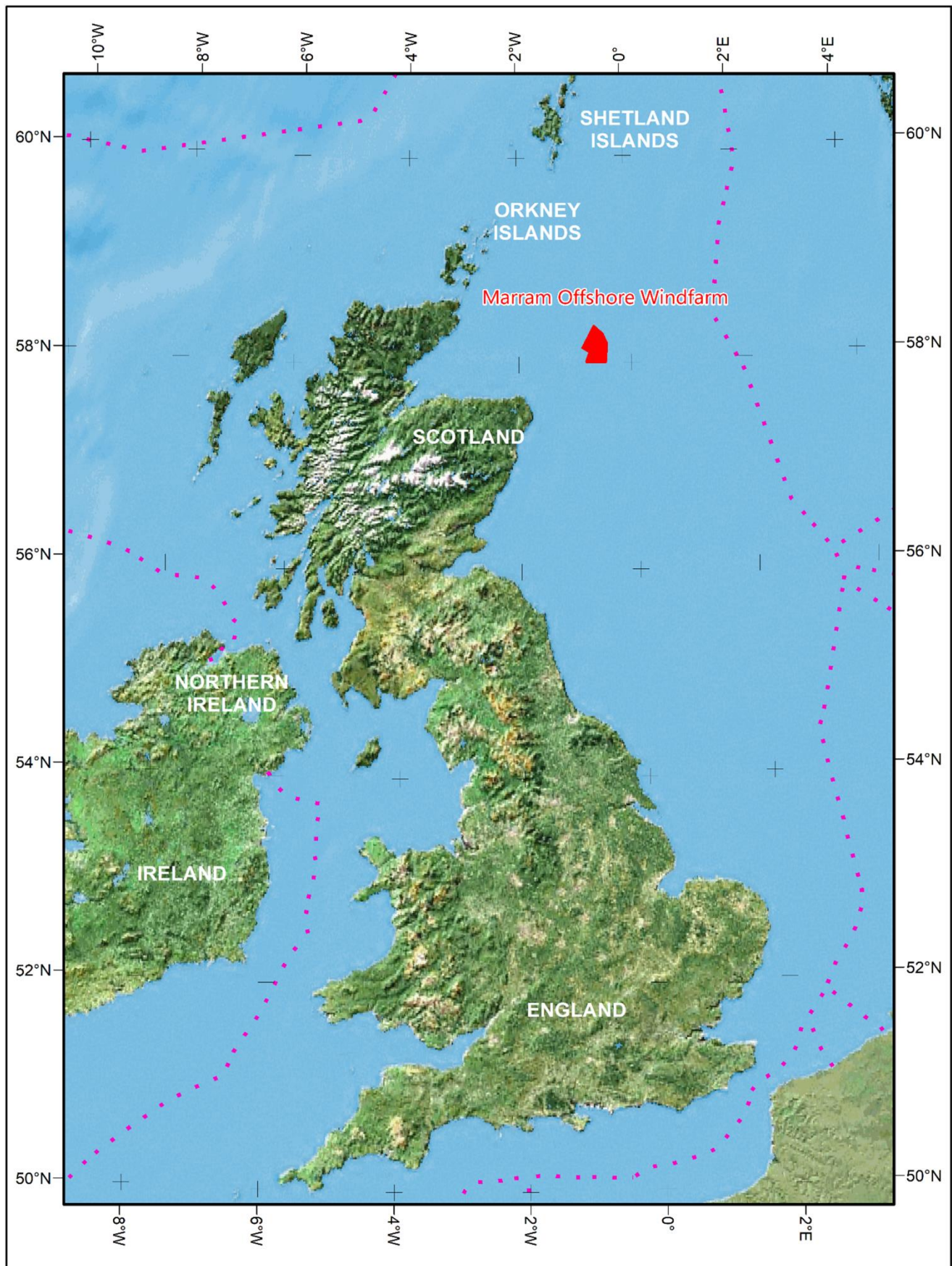
Environmental Impact Assessment Report
Volume 3, Appendix 10.4: Geophysical and
Environmental Offshore Windfarm Survey Volume 2 of 11
Benthic Survey Interpretative Report

MarramWind Offshore Wind Farm

December 2025

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Frontispiece



Executive Summary

Introduction

On the instruction of MarramWind Limited, Fugro performed a geophysical and environmental survey at the proposed MarramWind Floating Offshore Windfarm, NE7. The survey area was located in the central North Sea (CNS). The survey operations were performed onboard the Fugro Venturer and the Fugro Galaxy during the survey period 27 April to 25 August 2022. Table S.1 presents the surface coordinates of the boundaries of the survey area.

Table S.1: Survey area coordinates

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Location	Easting	Northing	Latitude	Longitude
Point 1	637 268.09	6 471 842.95	58° 21' 57.274" N	000° 39' 12.397" W
Point 2	646 794.72	6 463 190.57	58° 17' 06.668" N	000° 29' 46.536" W
Point 3	651 296.15	6 452 867.04	58° 11' 27.711" N	000° 25' 34.654" W
Point 4	650 289.56	6 432 573.66	58° 00' 33.415" N	000° 27' 23.044" W
Point 5	629 968.90	6 432 462.01	58° 00' 52.872" N	000° 48' 00.250" W
Point 6	629 558.69	6 434 023.06	58° 01' 43.743" N	000° 48' 22.137" W
Point 7	632 960.06	6 443 472.89	58° 06' 45.448" N	000° 44' 35.723" W
Point 8	625 421.95	6 447 956.38	58° 09' 18.239" N	000° 52' 07.297" W
Notes Coordinates are client supplied				

Survey Strategy

Eighty grab sampling stations and fifty water sampling stations were proposed. A full suite of grab samples were successfully acquired from seventy-nine stations. Samples were not retrieved at station B15 due to the coarse sediment encountered. Water samples were successfully acquired from all fifty stations.

Video and stills photographs were successfully acquired along all eighty proposed camera stations and fifty-eight transects.

Sediment Characteristics

Using the BGS modified Folk (1954) sediment description, 68 stations were classified as muddy sand, with the 11 remaining stations described as sand.

Macrofauna

The macrofaunal community across the MarramWind survey area were dominated by the polychaetes *Paramphinoe jeffreysii*, *Lanice conchilega* and *Ampharete falcata* and the molluscs *Adontorhina similis* and *Retusa umbilicata* all of which are common for this area of the central North Sea. Five clusters were identified from the macrofauna data, with the main driver identified being the

presence/absence of background taxa and varying abundance of the polychaete *Paramphinome jeffreysii*.

Seabed Habitats and Biotopes

Three benthic biotopes were defined within the survey area; 'Seapens and burrowing megafauna in circalittoral fine mud' (SS.SMu.CFiMu.SpNMeg), 'Circalittoral fine sand' (SS.SSa.CFiSa) and 'Sublittoral mixed sediment' (SS.SMx).

Throughout the survey area, the OSPAR designated 'Sea-pen and burrowing megafauna communities' habitat is likely to be present. One *Arctica islandica* was identified from its siphons on the video data. This species is designated as an OSPAR threatened and/or declining species.

Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and witch flounder (*Glyptocephalus cynoglossus*) are classed as 'Vulnerable' on the IUCN Red List, with the sea urchin *Echinus esculentus* classed as 'Near threatened'. All were observed in the survey area. No other sensitive habitats or species were present in the survey area.

Document Arrangement

Volume No.	Volume Title	Fugro Document No.
Volume 1	Geophysical Final Report	220154-OWF-01
Volume 2	Benthic Survey Interpretive Report	220154-OWF-02
Volume 3	Geophysical Benthic Interpretive Report	220154-OWF-03
Volume 4	Contaminants Report	220154-OWF-04
Volume 5	Seismic Data Processing Report	220154-OWF-05
Volume 6	Geophysical Field Operations Report	220154-OWF-06
Volume 7	Geotechnical Factual Data Report	220154-OWF-07
Volume 8	Vertebrate Metabarcoding Results	220154-OWF-08
Volume 9	Fish Metabarcoding Results	220154-OWF-09
Volume 10	Marine Water Eukaryote Metabarcoding Results	220154-OWF-10
Volume 11	Sediment Invertebrate Metabarcoding Results	220154-OWF-11

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Abbreviations

AFDW	Ash free dry weight
BAP	Biodiversity Action Plan
BGS	British Geological Survey
BSL	Below sea level
CBD	Convention on Biological Diversity
CM	Central meridian
CNS	Central North Sea
DVV	Dual van Veen grab
EC	European Commission
eDNA	environmental Deoxyribonucleic Acid
EMODnet	European Marine Observation and Data Network
EOL	End of line
ETRS 89	European Terrestrial Reference System 1989
EU	European Union
EUNIS	European Nature Information System
FA	Faunal sample A
FWTG	Floating Wind Turbine Generator
GES	Good environmental status
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LED	Light-emitting diode
MDAC	Methane-derived authigenic carbonate
NF	No fix
MPA	Marine Protected Area
MV	Motor vessel
NMBAQC	National Marine Biological Association Quality Control
nMDS	Non-metric multi-dimensional scaling
NERC	Natural Environmental Research Council
NS	No sample
OSPAR	Oslo and Paris Commission
PCA	Principle component analysis
PMF	Priority Marine Feature
PRIMER	Plymouth Routines in Multivariate Ecological Research

PSA	Particle size analysis
PSD	Particle size distribution
SAC	Special Area of Conservation
SACFOR	Superabundant, abundant, common, frequent, occasional and rare (semi-quantitative abundance scale)
SD	Standard deviation
SIMPER	Similarity percentage (analysis)
SIMPROF	Similarity profiling (algorithm)
SOL	Start of line
SPA	Special Protection Area
SSS	Side scan sonar
SSSI	Site of Special Scientific Interest
USBL	Ultra-short baseline
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984
WoRMS	World Register of Marine Species
?	Identification is uncertain

1. Introduction

1.1 General Project Description

On the instruction of MarramWind Limited, Fugro performed a geophysical and environmental survey at the proposed MarramWind Floating Offshore Windfarm, NE7. The survey area was located in the central North Sea (CNS). The survey operations were performed onboard the Fugro Venturer and the Fugro Galaxy during the survey period 27 April to 25 August 2022.

Table 1.1 presents the surface coordinates of the client project area extent.

Table 1.1: Survey area extents

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Location	Easting	Northing	Latitude	Longitude
Point 1	637 268.09	6 471 842.95	58° 21' 57.274" N	000° 39' 12.397" W
Point 2	646 794.72	6 463 190.57	58° 17' 06.668" N	000° 29' 46.536" W
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Point 8	625 421.95	6 447 956.38	58° 09' 18.239" N	000° 52' 07.297" W
Notes Coordinates are client supplied				

The MarramWind Floating Offshore Windfarm site survey was carried out to identify and map geological conditions and foundation feasibility for a Floating Wind Turbine Generator (FWTG).

The environmental survey was conducted to establish whether any sensitive habitats are present in the area, specifically habitats listed under Annex I of the EU Habitats Directive (1992), habitats listed by the Oslo and Paris Commission (OSPAR) as threatened and/or declining habitats (OSPAR, 2008) and habitats and species that qualify as priority marine features (PMF) in Scotland's seas (Joint Nature Conservation Committee [JNCC], 2014a). This comprised a benthic sampling programme to collect drop-down video (DDV) footage and grab samples for the analysis of benthic fauna, particle size distribution (PSD), and sediment chemistry. In addition, eDNA water samples were collected to understand fish breeding and feeding habits.

This report details the results of the benthic characterisation survey. A separate report will be issued detailing the results of the eDNA sediment and water samples.

Appendix A outlines the guidelines for use of this report.

1.2 Environmental Legislation

The relevant environmental legislation applying to the MarramWind Floating Offshore Windfarm site investigation has been summarised in Tables 1.2 and 1.3. Together they guided the identification of habitats and species of conservation importance in the study area.

Table 1.2: Marine environmental legislation

Legislation	Key aims
Conservation of Habitats and Species (Amendment (EU Exit) Regulations 2019), referred to as the 2019 Regulations	Transposes the requirements of the European Union (EU) Habitats Directive and some elements of the Wild Birds Directive (together forming the Nature Directives) into UK law; aims at conserving biodiversity through measures for protection of habitats listed in Annex I and species listed in Annex II of the Directives through the establishment of a national site network of protected sites, referred to as Special Areas of Conservation (SACs) and Special Protection Area (SPA).
UK Marine Strategy	Provides a framework for community action in the field of marine environmental policy through three components: 1. assessment of the state of UK seas and revised objectives for good environmental status (GES) for 2018 to 2024; 2. monitoring progress against set targets and indicators; 3. measuring the achievement of GES.
Natural Environment and Rural Communities Act 2006 (NERC)	Requires the relevant Secretary of State to compile a list of habitats and species of principal importance for the conservation of biodiversity
The Wildlife and Countryside Act 1981 (as amended)	Regulates the designation of Site of Special Scientific Interest (SSSIs), which underpins the designation of Ramsar sites
Oslo and Paris (OSPAR) Convention	Establishes Marine Protected Areas (MPAs)
Convention on Biological Diversity (CBD)	Conservation of biological diversity and sustainable use of its components
Ramsar Convention	Aims at the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development

Table 1.3: Marine Protected Areas biodiversity features

Biodiversity Features	Description
Priority Marine Features (PMF)	Represent habitats and/or species that may be highly sensitive to human activities and therefore need protection
UK Post-2010 Biodiversity Framework priority habitats and/or species	List of important (priority) habitats and species, produced by the UK Biodiversity Action Plan (BAP), superseded by the UK Post-2010 Biodiversity Framework, under the CBD. Under the NERC Act 2006, the UK BAP priority species and habitats in England are referred to as habitats and species of principal importance
Oslo and Paris (OSPAR) list of threatened and/or declining species and habitats	Allows setting priorities for further conservation and protection of marine biodiversity

1.3 Regional Habitats, Species and Protected Areas

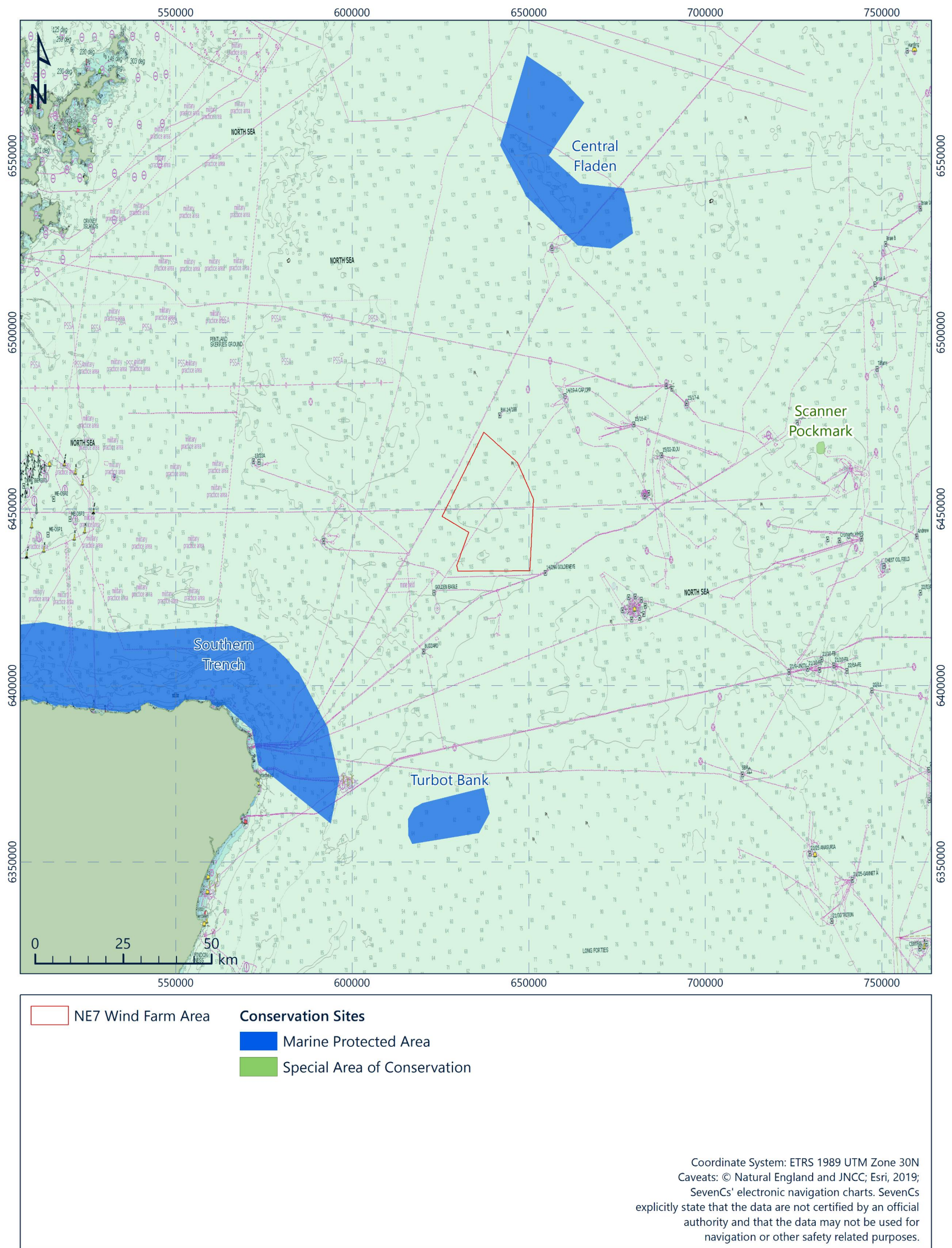
Based on the European Marine Observation and Data Network (EMODnet) seabed habitats map, the MarramWind Floating Offshore Windfarm lies in an area likely to comprise the European Nature Information System (EUNIS) habitat 'Atlantic offshore circalittoral mud' (MD62), with areas of 'Atlantic offshore circalittoral sand' (MD52) (EMODnet, 2022; EUSeaMap, 2021; European Environment Agency [EEA], 2019). These habitats relate to the JNCC classifications SS.SMu.Omu 'Offshore circalittoral mud' and SS.SSa.Osa 'Offshore circalittoral sand', respectively. Therefore, the PMF habitats 'Burrowed mud' and 'Offshore subtidal sands and gravels' could occur within the survey area.

Table 1.4 lists the nearby protected areas within 100 km of the survey area, summarising the sensitive benthic habitats and species for which they were designated to protect. Figure 1.1 spatially displays the protected areas in relation to the Marramwind survey area.

Consideration was also given to the species listed on the International Union for the Conservation of Nature (IUCN) Red List. The IUCN Red List is designed to catalogue and highlight species that are facing higher risks of extinction with the aim that preventative measures can be taken to decrease the risk to the continuation of that species. The classifications are based on a number of factors and each species that has been classified as 'Near Threatened' or worse has a justification provided for that designation. Special note was made of many species that are "Near threatened" or within the three threatened categories ('Vulnerable', 'Endangered' or 'Critically Endangered').

Table 1.4: Summary of nearby protected areas

Protected Area	Status	Distance* [km]	Direction*	Protected Habitats/Species
Central Fladen	Marine Protected Area	61	N	PMF: ▪ Burrowed mud
Southern Trench	Marine Protected Area	54	SW	PMF: • Burrowed mud
Turbot Bank	Marine Protected Area	63	S	UK BAP Species/PMF • Sandeels including: • <i>Ammodytes marinus</i> (UK BAP and PMF) • <i>Ammodytes tobianus</i> (PMF)
Scanner Pockmark	Special Area of Conservation	82	E	EU Habitats directive Annex I 'Submarine structures made by leaking gases'
Notes * = Distance and direction from platform				



Map Document: (S:\430-MGC-IT\Charting\E220004_Shell_Scotwind NE7\3_Plots\2_Draft\Q220004_00_Conservation.mxd)
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Figure 1.1: Protected areas relevant to the survey area

1.4 Coordinate Reference System

All coordinates in this report are based on European Terrestrial Reference System 1989 (ETRS89) and Universal Transverse Mercator Zone 30N, central meridian 3° West. Table 1.5 provides the detailed geodetic and projection parameters.

Table 1.5: Project geodetic and projection parameters

Global Positioning System Geodetic Parameters *						
Datum:		International Terrestrial Reference Frame 2014				
Ellipsoid:		GRS 1980				
Semi-major axis:		A=6 378 137.000 m				
Inverse flattening:		1/f = 298.257222101				
Local Datum Geodetic Parameters †						
Datum:		European Terrestrial Reference System 1989				
Ellipsoid:		GRS 1980				
Semi-major axis:		A = 6 378 137.000 m				
Inverse flattening:		1/f = 298.257222101				
Datum Transformation Parameters from ITRF2014 to ETRS89 – Coordinate Frame Rotation Convention ‡						
Shift dX:	+0.05595	m	Rotation rX:	-0.0027134" arc sec	Scale Factor:	0.00349485 ppm
Shift dY:	+0.05345	m	Rotation rY:	-0.0164143" arc sec		
Shift dZ:	-0.09785	m	Rotation rZ:	+0.0265309" arc sec		
Project Projection Parameters						
Map Projection:		Universal Transverse Mercator (UTM)				
Grid System:		UTM Zone 30 N				
Central Meridian:		003° 00' 00" West				
Latitude of Origin:		00° 00' 00" North				
False Easting:		500 000 m				
False Northing:		0 m				
Scale factor on Central Meridian:		0.9996				
Units:		Metre				
Notes						
* = Fugro Starfix navigation software uses WGS84 geodetic parameters as a primary datum for any geodetic calculations						
† = Source: MarramWind Limited						
‡ = This is the right-hand coordinate frame rotation used by the Fugro Starfix navigation software						

2. Survey Strategy

Environmental sampling stations were predetermined by the client and selected to provide spatial coverage of the survey area. Four different types of station were designated. Table 2.1 lists each type and number of stations.

Table 2.1: Sampling stations

Station ID	Type	Number	Data and Sample Acquisition
A Stations	Camera and grab	40	Video, stills and PSD/FA/CS and eDNA sediment samples
B Stations	Grab	40	PSD/FA/CS and eDNA sediment samples (and clearance camera)
C Stations	Camera	40	Video and stills
D stations	Water	50	eDNA water sample
Notes FA = Faunal sample A PSD = Particle size distribution CS = Contaminants sample eDNA = environmental Deoxyribonucleic Acid			

After geophysical data had been acquired, the side scan sonar and bathymetric data were reviewed by the onboard environmental scientists in conjunction with the onboard geophysicists. Using this data, the pre-selected stations were then micro-sited to ensure that all sediment types and habitats would be surveyed. Camera transects were proposed so that all features of interest would be captured. Particular emphasis was placed on locating areas of potential conservation value (e.g. Annex I listed habitats), on boundaries between areas of differing sonic reflectivity, bathymetric highs and lows and areas characteristic of the general background conditions of the site. Locations for potential infrastructure were also prioritised for sampling. Stations with the suffix '_a' indicate that the station has been relocated.

Fifty-eight transects were proposed to investigate potential seafloor features identified on the geophysical data.

Tables 2.2 and 2.3 provide the coordinates, data to be acquired and rationale for each location. Acceptable sampling accuracy was agreed with the client representative as within 20 m of the target location. Figure 2.1 provides a spatial display of the actual survey locations overlain on the side scan sonar (SSS) mosaic.

Table 2.2: Proposed sampling stations

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
A1	630 165.8	6 433 779.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A2	630 165.3	6 433 778.8	Client pre-defined station	Video, stills

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
				FA, PSD, CS, eDNA
A3	641 967.0	6 433 953.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A4	647 867.9	6 434 040.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A5	636 022.4	6 436 816.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A6	644 873.7	6 436 947.7	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A7	635 978.7	6 439 767.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A8	641 879.6	6 439 854.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A9	647 780.5	6 439 941.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A10	650 557.4	6 439 985.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A11	632 985.0	6 442 674.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A12	638 885.4	6 442 761.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A13	644 786.2	6 442 848.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A14	650 687.2	6 442 936.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A15_a	633 883.8	6 447 037.9	Relocated so on differing sediment type and covered by transect FTR10	Video, stills FA, PSD, CS, eDNA
A16	638 841.6	6 445 711.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A17	644 742.6	6 445 799.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A18	650 643.5	6 445 886.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A19	629 947.1	6 448 531.3	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A20_a	635 226.1	6 447 034.6	Relocated to an area of rippled sand	Video, stills FA, PSD, CS, eDNA
A21	641 748.3	6 448 705.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
A22	647 649.3	6 448 793.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A23	632 853.7	6 451 525.3	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A24_a	638 754.5	6 451 612.9	Relocated to be covered by transect HTR04	Video, stills FA, PSD, CS, eDNA
A25	644 655.0	6 451 699.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A26	650 555.9	6 451 787.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A27	629 859.6	6 454 431.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A28_a	636 762.0	6 456 608.6	Moved to a depression with hard contact and covered by ETR02	Video, stills FA, PSD, CS, eDNA
A29_a	641 559.7	6 454 705.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A30	647 561.7	6 454 694.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A31	650 380.5	6 454 737.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A32	635 716.6	6 457 469.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A33	644 785.8	6 457 415.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A34_a	635 954.8	6 462 075.9	Relocated so covered by transect CTR06	Video, stills FA, PSD, CS, eDNA
A35	641 573.6	6 460 507.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A36	647 474.1	6 460 594.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A37	638 579.4	6 463 414.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A38_a	644 480.3	6 463 502.2	Relocated to be covered by transect HTR03	Video, stills FA, PSD, CS, eDNA
A39	638 535.5	6 466 365.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
A40_a	638 491.7	6 469 315.3	Relocated to be covered by transect BTR01	Video, stills FA, PSD, CS, eDNA
B1	633 115.7	6 433 822.5	Client pre-defined station	Video, stills

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
				FA, PSD, CS, eDNA
B2	639 016.5	6 433 909.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B3	644 917.4	6 433 997.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B4	633 072.4	6 436 773.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B5	638 972.8	6 436 860.2	Client pre-defined station and covered by transect NTR01	Video, stills FA, PSD, CS, eDNA
B6	641 923.3	6 436 904.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B7	647 824.2	6 436 991.3	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B8	633 028.7	6 439 723.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B9	638 929.1	6 439 810.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B10	644 830.0	6 439 898.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B11	635 935.4	6 442 718.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B12	641 835.9	6 442 804.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B13	647 736.8	6 442 892.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B14	629 990.9	6 445 580.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B15	635 587.1	6 445 963.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B16	641 792.1	6 445 755.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B17	647 693.0	6 445 842.7	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B18	626 996.7	6 448 487.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B19	632 897.5	6 448 575.0	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B20	638 899.8	6 448 564.0	Client pre-defined station	Video, stills

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
				FA, PSD, CS, eDNA
B21	644 698.8	6 448 749.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B22	650 599.7	6 448 836.9	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B23	629 903.3	6 451 481.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B24	635 804.2	6 451 569.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B25	641 704.6	6 451 656.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B26	647 605.5	6 451 743.6	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B27	632 809.9	6 454 475.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B28	638 710.8	6 454 563.3	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B29	644 611.2	6 454 650.3	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B30	632 766.2	6 457 426.2	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B31_a	638 826.6	6 457 369.3	Relocated to be covered by transect FTR03	Video, stills FA, PSD, CS, eDNA
B32_a	641 617.4	6 457 557.5	Relocated to an area of mottled reflectivity on the SSS	Video, stills FA, PSD, CS, eDNA
B33	647 517.9	6 457 644.5	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B34_a	633 652.1	6 460 136.6	Relocated to be covered by transect BTR04	Video, stills FA, PSD, CS, eDNA
B35	638 623.2	6 460 464.1	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B36	644 524.1	6 460 551.8	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B37	635 628.9	6 463 370.7	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B38	641 529.8	6 463 458.4	Client pre-defined station	Video, stills FA, PSD, CS, eDNA
B39_a	636 026.1	6 465 716.9	Relocated to be covered by transect BTR03	Video, stills FA, PSD, CS, eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
B40_a	639 909.6	6 463 771.7	Relocated to be covered by transect ETR04	Video, stills FA, PSD, CS, eDNA
C1	634 569.0	6 435 319.5	Relocated to be covered by transect KTR01 and is now C1_a	Video, stills
C2_a	641 147.6	6 435 903.8	Relocated to be covered by transect PTR01	Video, stills
C3_a	649 003.0	6 437 420.3	Relocated to an area of mottled reflectivity on the SSS	Video, stills
C4_a	631 758.1	6 438 108.8	Relocated to be covered by transect HTR02	Video, stills
C5	637 475.8	6 438 313.6	Client pre-defined station	Video, stills
C6	643 376.7	6 438 401.0	Client pre-defined station	Video, stills
C7_a	648 803.1	6 438 238.2	Relocated to an area of hard contacts on the SSS	Video, stills
C8	634 482.1	6 441 220.9	Client pre-defined station	Video, stills
C9	640 382.5	6 441 307.7	Client pre-defined station	Video, stills
C10_a	645 949.9	6 440 887.8	Client pre-defined station	Video, stills
C11_a	637 388.7	6 444 215.1	Relocated to ground truth an irregular raised feature	Video, stills
C12_a	643 708.0	6 443 704.9	Relocated to be covered by transect OTR01	Video, stills
C13_a	649 459.0	6 443 777.0	Relocated to an area of increased seabed reflectivity on the SSS	Video, stills
C14_a	631 172.5	6 447 108.6	Relocated to be covered by transect DTR03	Video, stills
C15	637 705.2	6 446 940.3	Client pre-defined station	Video, stills
C16_a	643 918.6	6 447 787.1	Relocated to be covered by transect NTR05	Video, stills
C17_a	649 355.4	6 447 794.6	Relocated to an area of low reflectivity on the SSS	Video, stills
C18	628 450.0	6 449 984.5	Client pre-defined station	Video, stills
C19_a	632 011.3	6 447 400.3	Relocated to be covered by transect ETR01	Video, stills
C20	640 251.7	6 450 159.6	Client pre-defined station	Video, stills
C21_a	646 751.1	6 450 725.3	Relocated to be covered by transect OTR02	Video, stills
C22_a	651 006.1	6 450 044.0	Client pre-defined station	Video, stills
C23	631 356.7	6 452 978.7	Client pre-defined station	Video, stills
C24_a	635 085.0	6 450 971.0	Relocated to be covered by transect FTR02	Video, stills
C25	643 157.9	6 453 153.2	Client pre-defined station	Video, stills

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
C26	649 058.9	6 453 240.8	Client pre-defined station	Video, stills
C27	634 263.3	6 455 972.8	Client pre-defined station	Video, stills
C28_a	640 064.8	6 456 347.3	Moved to an area of differing reflectivity	Video, stills
C29_a	645 255.9	6 456 391.1	Relocated to be covered by transect KTR03	Video, stills
C30_a	631 360.0	6 459 495.0	Relocated to be covered by transect ATR04	Video, stills
C31_a	636 890.9	6 459 078.0	Relocated to be covered by transect DTR02	Video, stills
C32_a	643 070.7	6 459 054.6	Relocated to be covered by transect ITR03	Video, stills
C33_a	644 785.8	6 457 415.9	Relocated to be covered by transect MTR02	Video, stills
C34_a	633 523.5	6 461 691.2	Relocated to be covered by transect ATR06	Video, stills
C35_a	639 190.7	6 461 982.5	Relocated to be covered by transect ETR03	Video, stills
C36	643 810.3	6 464 119.6	Client pre-defined station	Video, stills
C37	637 082.3	6 464 867.8	Client pre-defined station	Video, stills
C38	642 983.1	6 464 955.5	Client pre-defined station	Video, stills
C39_a	637 411.9	6 467 612.1	Relocated to be covered by transect BTR06	Video, stills
C40_a	641 017.2	6 467 187.8	Relocated to be covered by transect DTR01	Video, stills
D_01	638 885.8	6 442 761.7	Client pre-defined station	eDNA water sample
D_02	644 786.7	6 442 849.1	Client pre-defined station	eDNA water sample
D_03	641 967.4	6 433 954.2	Client pre-defined station	eDNA water sample
D_04	650 380.5	6 454 737.5	Client pre-defined station	eDNA water sample
D_05	647 868.3	6 434 041.5	Client pre-defined station	eDNA water sample
D_06	644 874.2	6 436 948.3	Client pre-defined station	eDNA water sample
D_07	635 979.1	6 439 767.6	Client pre-defined station	eDNA water sample
D_08	641 880.0	6 439 855.0	Client pre-defined station	eDNA water sample
D_09	633 116.1	6 433 823.1	Client pre-defined station	eDNA water sample
D_10	645 679.9	6 453 340.4	Client pre-defined station	eDNA water sample
D_11	647 737.2	6 442 892.9	Client pre-defined station	eDNA water sample
D_12	641 792.5	6 445 755.8	Client pre-defined station	eDNA water sample
D_13	644 699.2	6 448 750.1	Client pre-defined station	eDNA water sample
D_14	650 600.2	6 448 837.5	Client pre-defined station	eDNA water sample

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
D_15	647 605.9	6 451 744.2	Client pre-defined station	eDNA water sample
D_16_a	649 146.8	6 447 340.4	Relocated to increase spatial coverage	eDNA water sample
D_17	643 158.3	6 453 153.8	Client pre-defined station	eDNA water sample
D_18	649 278.0	6 438 489.1	Client pre-defined station	eDNA water sample
D_19	640 723.0	6 447 536.1	Client pre-defined station	eDNA water sample
D_20	644 984.3	6 456 424.6	Client pre-defined station	eDNA water sample
D_21	645 811.9	6 458 730.9	Client pre-defined station	eDNA water sample
D_22	645 030.9	6 455 519.6	Client pre-defined station	eDNA water sample
D_23	648 609.1	6 45 8676.4	Client pre-defined station	eDNA water sample
D_24	639 112.4	6 436 833.5	Client pre-defined station	eDNA water sample
D_25	641 620.7	6 442 950.8	Client pre-defined station	eDNA water sample
D_26	626 996.7	6 448 488.0	Client pre-defined station	eDNA water sample
D_27	631 360.0	6 459 495.0	Client pre-defined station	eDNA water sample
D_28	633 488.1	6 460 178.0	Client pre-defined station	eDNA water sample
D_29	631 356.7	6 452 979.0	Client pre-defined station	eDNA water sample
D_30	637 411.9	6 467 612.1	Client pre-defined station	eDNA water sample
D_31	639 649.3	6 468 762.0	Client pre-defined station	eDNA water sample
D_32	629 947.1	6 448 531.0	Client pre-defined station	eDNA water sample
D_33	641 017.2	6 467 187.8	Client pre-defined station	eDNA water sample
D_34	635 716.6	6 457 470.0	Client pre-defined station	eDNA water sample
D_35	629 990.9	6 445 581.0	Client pre-defined station	eDNA water sample
D_36	634 350.8	6 450 072.0	Client pre-defined station	eDNA water sample
D_37	638 623.2	6 460 464.0	Client pre-defined station	eDNA water sample
D_38	642 983.1	6 464 956.0	Client pre-defined station	eDNA water sample
D_39	638 826.6	6 457 369.3	Client pre-defined station	eDNA water sample
D_40	633 883.8	6 447 037.9	Client pre-defined station	eDNA water sample
D_41	635 226.1	6 447 034.6	Client pre-defined station	eDNA water sample
D_42	641 573.6	6 460 508.0	Client pre-defined station	eDNA water sample
D_43	644 480.3	6 463 502.0	Client pre-defined station	eDNA water sample
D_44	638 754.5	6 451 613.0	Client pre-defined station	eDNA water sample
D_45	631 758.1	6 438 109.0	Client pre-defined station	eDNA water sample
D_46	641 559.7	6 454 706.0	Client pre-defined station	eDNA water sample
D_47	634 482.1	6 441 221.0	Client pre-defined station	eDNA water sample
D_48	633 072.4	6 436 773.0	Client pre-defined station	eDNA water sample
D_49	637 388.7	6 444 215.0	Client pre-defined station	eDNA water sample
D_50	640 251.7	6 450 160.0	Client pre-defined station	eDNA water sample

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
Notes FA = Faunal sample A CS = Contaminants sample SSS = Side scan sonar PSD = Particle size distribution eDNA = Environmental deoxyribonucleic acid				

Table 2.3: Proposed transects

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]					
Transect		Easting	Northing	Rationale	Data Acquisition
ATR04	SOL	631 377.0	6 459 286.0	One large depression with pockmarks and high reflectivity which could indicate possible MDAC. This transect includes the relocated C30_a station	Video, stills
	EOL	631 348.0	6 459 670.0		
ATR06	SOL	633 506.4	6 461 660.4	A small depression with pockmarks and high reflectivity - possible MDAC. This transect includes the relocated station C34_a	Video, stills
	EOL	633 544.5	6 461 725.7		
BTR01	SOL	638 972.3	6 470 027.3	Two large depressions with high reflectivity which could indicate possible MDAC. This transect includes the relocated station A40_a	Video, stills
	EOL	638 793.5	6 469 846.7		
BTR03	SOL	636 043.0	6 465 695.6	One large depression with high reflectivity. This transect includes the relocated station B39_a	Video, stills
	EOL	635 915.5	6 465 849.6		
BTR04	SOL	633 394.2	6 460 202.4	Two large depressions with high reflectivity. This transect includes the relocated station B34_a	Video, stills
	EOL	633 853.8	6 460 085.8		
BTR06	SOL	637 488.0	6 467 613.0	One large depression with high reflectivity - close to predetermined station C39.	Video, stills
	EOL	637 306.0	6 467 611.0		
CTR01	SOL	639 593.0	6 468 749.4	Area of mixed reflectivity	Video, stills
	EOL	639 696.2	6 468 772.2		
CTR06	SOL	635 949.6	6 462 073.5	Depression with potential MDAC, covering station A34_a	Video, stills
	EOL	636 019.6	6 462 102.2		
DTR01	SOL	641 006.7	6 467 181.9	Depression with potential MDAC, covering station C40_a	Video, stills
	EOL	641 125.5	6 467 252.9		
DTR02	SOL	636 849.8	6 459 068.7	Area of mixed reflectivity and depression, covering station C31	Video, stills
	EOL	637 046.6	6 459 113.3		
DTR03	SOL	631 165.7	6 447 105.2	Area of lower reflectivity, covering station C14_a	Video, stills
	EOL	631 235.4	6 447 139.6		
ETR01	SOL	631 983.8	6 447 396.3	Depression with potential MDAC. This transect includes the relocated station C19_a	Video, stills
	EOL	632 045.7	6 447 404.5		

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]					
Transect		Easting	Northing	Rationale	Data Acquisition
ETR02	SOL	636 758.5	6 456 613.9	Depression with potential MDAC	Video, stills
	EOL	636 801.1	6 456 554.2		
ETR03	SOL	639 149.0	6 461 972.7	Area of higher reflectivity. This transect includes the relocated station C35_a	Video, stills
	EOL	639 230.8	6 461 991.5		

ETR04	SOL	639 907.5	6 463 780.7	Area of mixed reflectivity and depressions. This transect includes the relocated station B40_a	Video, stills
	EOL	639 951.7	6 463 617.2		
FTR02	SOL	635 085.0	6 450 971.0	Depression with potential MDAC. This transect includes the relocated station C24_a	Video, stills
	EOL	635 170.0	6 451 041.0		
FTR03	SOL	638 827.0	6 457 376.0	Area of higher reflectivity. This transect includes the relocated station B31_a	Video, stills
	EOL	638 816.0	6 457 234.0		
FTR04	SOL	639 521.0	6 459 227.0	Potential pockmark with hard contact	Video, stills
	EOL	639 619.0	6 459 028.0		
FTR07	SOL	642 582.0	6 465 571.0	Potential pockmark with hard contact	Video, stills
	EOL	642 838.0	6 465 661.0		
FTR08	SOL	643 253.0	6 465 289.0	Potential pockmark with hard contact	Video, stills
	EOL	643 186.0	6 465 392.0		
FTR10	SOL	633 843.0	6 447 020.0	Rippled sand - differing sediment type. This transect includes the relocated station A15_a	Video, stills
	EOL	633 954.0	6 447 075.0		
GTR01	SOL	644 242.7	6 464 662.6	Depression with hard contact	Video, stills
	EOL	644 128.7	6 464 775.7		
GTR02	SOL	640 754.9	6 459 917.6	Potential pockmark with gas seepage on sub bottom profiler data	Video, stills
	EOL	640 799.2	6 459 787.3		
GTR03	SOL	640 404.5	6 458 505.8	Potential pockmark cluster	Video, stills
	EOL	640 574.9	6 458 541.1		
GTR04	SOL	643 810.3	6 464 119.6	Depression with hard contact	Video, stills
	EOL	643 950.6	6 464 181.6		
HTR02	SOL	631 824.0	6 437 208.0	Geo identified potential pockmark cluster. This transect includes station C4	Video, stills
	EOL	631 941.0	6 437 194.0		
HTR03	SOL	644 710.9	6 463 124.2	Depression with high reflectivity centre. This transect includes the relocated station A38_a	Video, stills
	EOL	644 488.5	6 463 117.4		

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]					
Transect		Easting	Northing	Rationale	Data Acquisition
HTR04	SOL	638 485.5	6 451 848.2	Depressions with hard contacts. Representative of the block. This transect includes the relocated station A24_a	Video, stills
	EOL	638 544.1	6 451 684.6		
ITR01	SOL	646 262.1	6 463 393.5	Investigate a potential pockmark cluster	Video, stills
	EOL	646 102.4	6 463 339.0		

ITR02	SOL	635 694.6	6 444 029.6	Depression with hard contact - representative of the A block	Video, stills
	EOL	635 796.2	6 443 999.3		
ITR03	SOL	643 456.0	6 459 337.9	Move C32 to here to cover depression with hard contact	Video, stills
	EOL	643 564.9	6 459 376.1		
JTR01	SOL	631 551.5	6 433 363.6	Depression with hard contacts	Video, stills
	EOL	631 561.9	6 433 300.8		
JTR02	SOL	645 823.7	6 461 714.3	Depressions with hard contacts. Representative of other high reflectivity areas in the block	Video, stills
	EOL	645 841.2	6 461 631.4		
KTR01	SOL	634 750.3	6 435 746.4	Transect spanning two possible pockmarks. This transect includes the relocated station C1_a	Video, stills
	EOL	634 747.1	6 435 863.8		
KTR02	SOL	640 609.7	6 447 407.3	Transect spanning sediment ridges, areas of lower reflectivity and numerous hard contacts	Video, stills
	EOL	640 884.1	6 447 720.0		
KTR03	SOL	645 255.9	6 456 391.1	Transect over area of bathymetric depressions with series of hard contacts in the middle. Possible pockmarks. This transect includes the relocated station C29_a	Video, stills
	EOL	644 941.1	6 456 426.6		
KTR04	SOL	645 812.2	6 458 699.9	Transect over possible MDAC	Video, stills
	EOL	645 802.2	6 458 763.9		
LTR01	SOL	647 785.8	6 459 868.4	Transect over area of bathymetric depression with series of hard contacts in the middle. Possible MDAC	Video, stills
	EOL	647 811.5	6 459 672.8		
LTR02	SOL	645 004.5	6 455 456.6	Transect over area of bathymetric depression with a hard contact in the middle	Video, stills
	EOL	645 070.9	6 455 614.4		
MTR01	SOL	645 553.8	6 453 234.1	Transect over area of bathymetric depressions with series of hard contacts. Different reflectivity suggesting different sediment type and associated fauna	Video, stills
	EOL	645 797.4	6 453 442.9		
MTR02	SOL	648 503.5	6 458 733.3		Video, stills

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]					
Transect		Easting	Northing	Rationale	Data Acquisition
	EOL	648 646.5	6 458 656.4	Transect spanning station C33 and an area of bathymetric depression with a hard contact in the middle and series of contacts scattered around	
NTR01	SOL	638 964.8	6 436 861.7	Area of mottled reflectivity - possible MDAC; extended to cover station B5	Video, stills
	EOL	639 148.0	6 436 826.9		
NTR02	SOL	647 990.4	6 456 358.8	Area of large depressions and patches of high reflectivity	Video, stills
	EOL	648 052.3	6 456 244.7		
NTR03	SOL	647 126.5	6 4529 42.9	Transect over group of small depressions; possible pockmarks	Video, stills
	EOL	647 278.3	6 453 005.6		
NTR04	SOL	643 918.6	6 447 787.1	Moved station C16 to transect NTR05 - Two patches of varying reflectivity, potential debris	Video, stills
	EOL	643 737.7	6 447 617.0		
NTR05	SOL	641 667.2	6 442 964.3	Transect over two large depressions	Video, stills
	EOL	641 416.8	6 442 892.0		
OTR01	SOL	643 708.0	6 443 704.9	Moved station C12 to transect OTR01 - Transect covering series of depressions and patches of higher reflectivity	Video, stills
	EOL	643 744.5	6 443 400.2		
OTR02	SOL	646 751.1	6 450 725.3	Moved station C21 to transect OTR02 - Patch of higher reflectivity with dark contacts, potential coarse sediment	Video, stills
	EOL	646 807.9	6 450 843.2		
PTR01	SOL	641 147.6	6 435 903.8	Moved station C2 to transect PTR01 - Dense patch of high reflectivity, surrounded by mottled reflectivity. Potential debris	Video, stills
	EOL	641 217.0	6 435 830.7		
PTR02	SOL	645 846.2	6 443 578.2	Large depression, with low reflectivity patch shown on the SSS data	Video, stills
	EOL	645 945.8	6 443 320.1		
PTR03	SOL	645 520.2	6 445 648.1	Group of depressions, with one larger one of higher reflectivity in the centre. Potential pockmarks	Video, stills
	EOL	645 573.7	6 445 502.1		
PTR04	SOL	645 521.0	6 445 273.1	Group of very regular shaped circular depressions, potential pockmarks. Example of feature seen throughout the survey area	Video, stills
	EOL	645 555.7	6 445 177.0		
QTR01	SOL	646 356.0	6 442 585.0	Group of three depressions of variable reflectivity surrounded by potential pockmarks so potential MDAC	Video, stills
	EOL	646 660.0	6 442 568.0		
QTR02	SOL	644 373.3	6 437 954.9	Raised feature in depressions surrounded by extended pockmarks, possible MDAC	Video, stills
	EOL	644 589.5	6 437 941.5		

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]					
Transect		Easting	Northing	Rationale	Data Acquisition
QTR03	SOL	643 500.2	6 437 147.1	Circular depression surrounded by potential pockmarks, possible MDAC	Video, stills
	EOL	643 576.7	6 437 010.6		
QTR04	SOL	644 022.1	6 436 246.7	Much reduced area of seabed reflectivity on SSS data, possibly indicative of stony reef or change in seabed surface type	Video, stills
	EOL	644 126.0	6 436 129.5		
QTR05	SOL	642 634.6	6 433 874.8	Depression feature with low reflectivity and raised, possibly pockmarked edges	Video, stills
	EOL	642 634.1	6 433 834.6		
RTR01	SOL	646 703.3	6 438 405.1	Depression of increased seabed reflectivity surrounded by smaller depressions, representative of others in block	Video, stills
	EOL	646 836.8	6 438 388.7		
Notes SOL = Start of line EOL = End of line MDAC = Methane-derived authigenic carbonates					

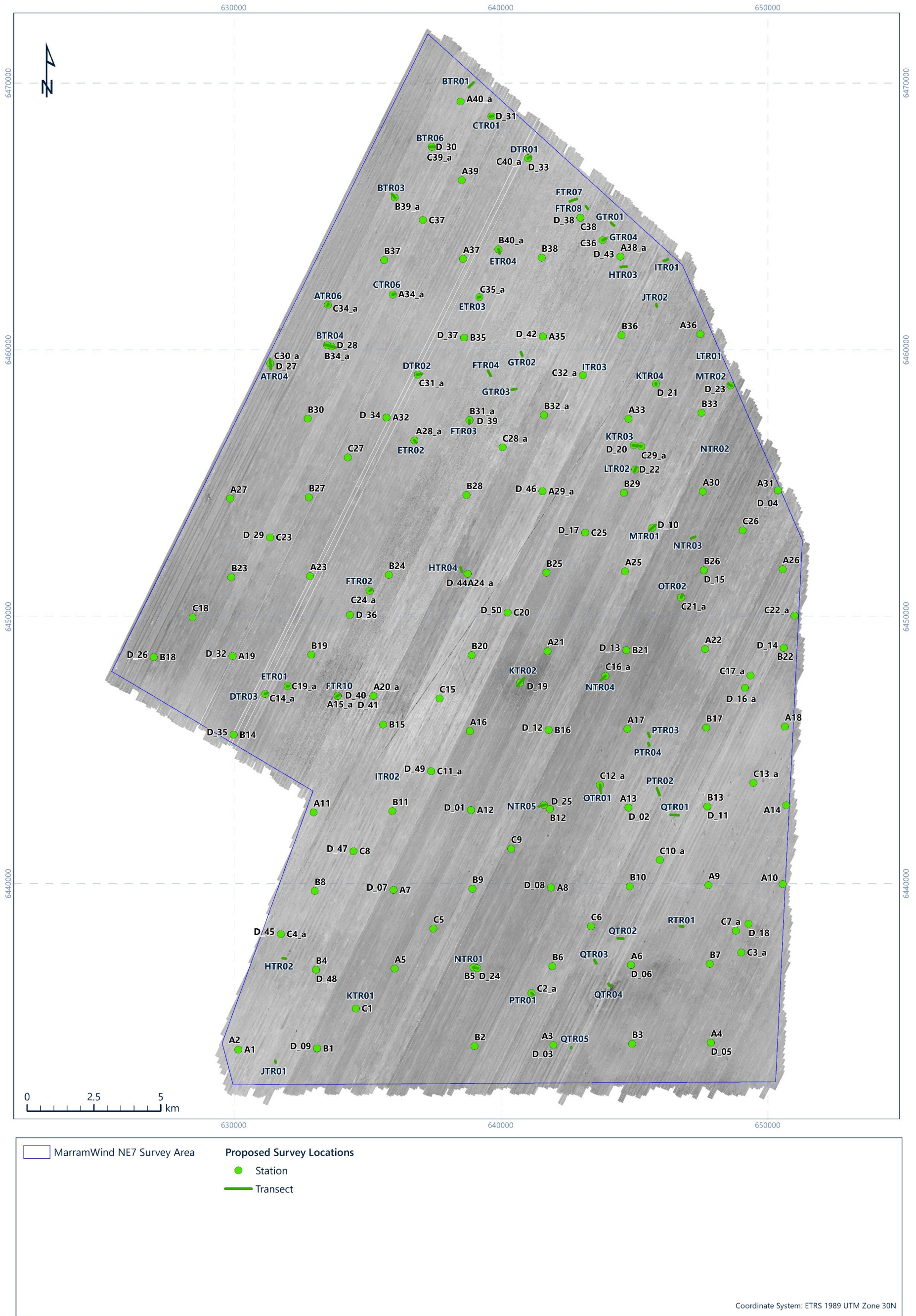


Figure 2.1: Proposed environmental survey locations

3. Methods

3.1 Survey Methods

3.1.1 Seafloor Photography

Seafloor photography was acquired using a Subsea Technology and Rentals Limited deep-sea camera system mounted within a purpose-built camera frame, complete with a standard definition video camera and high-resolution stills camera (14.7 mega pixel), a separate high-power strobe and four LED lamps. Four lasers were set up 17 cm apart to provide a scale. The camera system was equipped with an ultra short baseline (USBL) beacon for subsea positioning.

Seafloor video footage was displayed on a computer monitor and recorded directly onto the server. A navigation string from the attached USBL beacon, including the time, date, depth and location (easting and northing) was overlain on the video. The survey location and station number were also displayed (manually updated). The stills camera imagery was visible on a second window of the computer. Footage was viewed in real time via a sonar cable, assisting in the control of the camera in the water.

Operational procedures for seabed photography were as follows:

- The camera was setup on deck prior to deployment and a test photograph taken;
- The camera was deployed into the water just below the sea surface, at which point the system was switched on;
- The camera was lowered to the seafloor using the side scan sonar winch and recording started when the seafloor was visible;
- The vessel was moved along the line with the winch adjusted to keep the seabed visible on the live feed;
- Still photography were taken when the environmental scientist manually triggered the camera while the camera moved over the seafloor. Whenever a photograph was taken the surveyor captured a positional fix;
- The camera system switched off just beneath the surface and then recovered to the deck;
- On completion, photographs were downloaded and backed up onto the ship's system and an external hard drive.

3.1.2 Sediment Sampling

Seabed samples were acquired using a 0.1 m² dual van Veen grab.

Operational procedures for grab sampling were as follows:

- The 0.1 m² dual van Veen grab was prepared for operations prior to arrival on station. A USBL beacon was attached to the grab frame. The Bridge communicated to the deck via

a VHF radio when the vessel was steady and on location, and the grab was deployed from the starboard A-frame;

- When the engineer operating the winch observed that the grab had reached the seabed (evidenced through a distinct slackening of the wire rope and snatch block), the online surveyor was informed (via VHF radio) and a fix was taken;
- On recovery to the deck, the sample was inspected and judged acceptable or otherwise (see below for rejection criteria);
- Once accepted, a grab sample was retained for faunal analysis and a 40 g sediment eDNA sample and one grab sample was retained and sub-sampled for contaminants samples;
- Deck logs were completed for each sample acquired (including no samples) with: date, time, sample number, fix number, sediment type, depth and colour of strata in the sediment (if any) using Munsell colour codes, odour (i.e. H₂S), bioturbation or debris.

Samples were considered unacceptable in the following instances:

- Evidence of sediment washout caused through improperly closed grab jaws or inspection hatch;
- Sediment sample taken on an angle; where the grab jaws have not been parallel to the seabed when the grab fired;
- Disruption of the sample through striking the side of the vessel;
- Sample represented less than approximately 7 cm bite depth of the grab (unless deemed acceptable by the client representative);
- Sample is more than 20 m from the target location (unless deemed acceptable by the client representative);
- Deemed unacceptable by the client representative for any other reason;

Further details on survey methodology are available within Appendix B.

3.1.3 Water Sampling

- A five litre Niskin bottle was attached to a metal arm trigger and attached to the winch wire with a weight on the bottom. The bottle was armed before deployment. A USBL beacon was attached to the wire below the Niskin bottle. The Bridge communicated to the deck via a VHF radio when the vessel was steady and on location, and the bottle was lowered to within 5 meters of the seabed;
- A messenger weight was sent down the wire to trigger the Niskin. Once the bottle was triggered, (evidenced through vibrations coming back up the wire), the online surveyor was informed (via VHF radio) and a fix was taken;
- On recovery to the deck, the sample was emptied into a bucket;
- The sample was then filtered for eDNA using a vampire sampler and kit filters supplied by NatureMetrics;
- Once the sample was processed and the filter was packaged in the bags supplied by Nature Metrics, the sample was stored in the freezer at approximately –20 °C.

3.2 Laboratory Methods

Brief analytical methodologies are described in the following subsections. Further descriptions of the analytical methodologies are detailed in Appendix B.

3.2.1 Sediment Characteristics

3.2.1.1 Particle Size Distribution

Sediment samples were analysed for their particle size distribution (PSD) using a combination of two techniques; sieve analysis for all material retained by a 1.0 mm sieve followed by laser diffraction analysis of the finer material.

Sieve and laser data are merged and inputted into GRADISTAT to derive statistics including mass and percentage retained within each size fraction, mean and median grain size, bulk sediment classes (percentage gravel, sand and silt/clay), skewness, sorting coefficients and Folk classification.

The PSD parameters include the descriptive statistics derived in GRADISTAT (Blott, 2010), based on the Folk and Ward (1957) method. The sediment descriptions are based on the Wentworth (1922) scale and the British Geological Survey (BGS) modified Folk classification (Long, 2006).

Results were presented in 0.5 phi intervals and microns. The phi scale is a logarithmic scale that allows grain size data to be expressed in units of equal value.

3.2.2 Sediment Macrofauna

The sediment macrofauna is defined as those animals living in or on the seabed. Each of the 0.1 m² van Veen buckets provided a sample; only one sample was collected at each station (FA). Macrofaunal samples were processed on a sieve mesh of 0.5 mm, with retained taxa identified and enumerated.

Biomass was determined for infaunal invertebrates to phyla level from grab samples; epifauna was not biomassed.

3.3 Data Analysis

Summary statistics (minimum, maximum, mean, standard deviation) for all reported datasets were derived in Excel.

3.3.1 Sediment Particle Size Distribution Statistics

Table 3.1 summarises the sediment PSD statistics that were calculated using Gradistat V8 (Blott, 2010).

Table 3.1: Sediment particle size distribution statistics

Statistic	Definition and Descriptive Terminology
Mean	A measure of central tendency: sum of values, divided by number of observations
Median	A measure of central tendency: central value
Mode	A measure of central tendency: most frequently observed value
Modality	A measure of the number of peaks in the frequency distribution
Sorting	A measure of the grain size range and magnitude of their spread around the mean, presented as a coefficient and descriptor (as a range of values)
Skewness	A measure of the degree of symmetry, presented as a coefficient and descriptor (as a range of values)

3.3.2 Sediment Macrofauna Data Rationalisation

Prior to analysis, the macrofaunal dataset was rationalised. Damaged taxa were removed, and indeterminable taxa were merged to avoid spurious enhancement of the species list. Juvenile species were removed, as they represent an ephemeral stage and are, therefore, not considered part of the permanent benthic community. Meiofauna, fish, algae, eggs and foraminifera were also removed for this reason. Sessile colonial epifauna was recorded as present, and assessed separately from the enumerated fauna, which comprised infaunal and solitary epifaunal taxa.

3.3.3 Sediment Macrofaunal Univariate Analysis

Table 3.2 summarises the univariate statistics derived from Plymouth Routines in Multivariate Ecological Research (PRIMER) version 7 (v7).

Table 3.2: Macrofaunal Univariate Statistics

Statistic	Definition
Number of taxa (S)	Count of taxa
Abundance (N)	Count of individuals
Margalef's index of richness (d)	A measure of the number of species present for a given number of individuals (less dependent on sampling size than S and N)
Shannon-Wiener index of diversity ($H' \log_2$)	A measure of the number of taxa in a sample and the distribution of abundance across these taxa; results were assessed in line with the threshold values in Dauvin et al. (2012): ■ High diversity ($H' \log_2 > 4.00$); ■ Good diversity ($3.00 < H' \log_2 < 4.00$); ■ Moderate diversity ($2.00 < H' \log_2 < 3.00$); ■ Poor diversity ($1.00 < H' \log_2 < 2.00$); ■ Bad diversity ($H' \log_2 < 1.00$).
Pielou's index of evenness (J)	A measure of how evenly distributed the individuals are among the different species;
Complement of the Simpsons index of dominance ($1-\lambda$)	A measure of evenness in which its highest value corresponds to assemblages with individuals evenly distributed across taxa, whilst its lowest value corresponds to those in which the total abundance is dominated by one or very few of the taxa present.

Statistic	Definition
Simpsons index of dominance (λ)	A measure of dominance based on the probability that any two individuals from the sample, when chosen at random, are from the same species. High values correspond to assemblages whose total abundance is dominated by one, or a very few, of a species.

3.3.4 Biomass Analysis

The macrofaunal blotted wet weight biomass dataset was converted to ash free dry weight (AFDW) by applying the appropriate standard corrections, as outlined in Eleftheriou and Basford (1989). Table 3.3 summarises the corrections applied.

Table 3.3: Macrofaunal standard biomass corrections by phyla

Phyla	Standard Biomass Correction [%]
Annelida	15.5
Arthropoda	22.5
Mollusca	8.5
Echinodermata	8.0
Other Taxa	15.5
Notes Standard biomass corrections to convert blotted wet weight to ash free dry weight, from Eleftheriou & Basford (1989)	

3.3.5 Multivariate Analysis

Various multivariate statistical techniques were applied to the macrofauna (abundance) and sediment characteristics (percentage of sediment fractions in half phi increments) data to investigate patterns of similarity in PRIMER v7 (Table 3.4). For the sediment data, transformation is used to reduce skewness of data; for the macrofaunal data, transformation is used to reduce the influence of the dominant taxa. For optimal performance of multivariate analysis macrofaunal data were fourth root transformed and PSD data were left untransformed.

Table 3.4: Multivariate Statistics

Statistic	Definition
CLUSTER	Hierarchical clustering analysis 'Cluster' to group samples based on the nearest neighbour sorting of a matrix of sample similarities using Bray Curtis similarity (for biological datasets) or Euclidean distance measure (for environmental datasets)
nMDS	Non-metric multi-dimensional scaling (nMDS) ordination of Bray Curtis and Euclidean Distance similarity/distance matrices
SIMPROF	Similarity profiling ('SIMPROF' algorithm), to identify statistically significant clusters; in ecological terms the statistical relevance of similarity profile testing is assessed in line with the recommendation of Clarke et al. (2008), thus defining coarser grouping can be appropriate if the resulting groups are supersets of the similarity profile clusters
SIMPER	Similarity percentage analysis ('SIMPER' algorithm), to gauge the distinctiveness of each of the multivariate groups
PCA	Principal component analysis (PCA), to identify spatial patterns and relationships between variables

3.3.6 Seabed Habitats and Biotopes

3.3.6.1 Seabed Habitat Classification

To assess the habitats present within the survey area, detailed analysis of video and still photographic data was undertaken, noting the locations of any observed changes in sediment type and/or associated faunal community.

Taxa were recorded to the lowest possible taxonomic level. It should be noted that many species cannot be identified from photographic data alone and, as such, higher taxonomic levels were used.

Descriptions of the substrate composition, corresponding to sediment changes, were undertaken to support the EUNIS habitat identification (Long, 2006). These descriptions were largely based on a reclassification of the Folk (1954) sediment classes, with the Wentworth (1922) classification also considered as the latter differentiates between pebbles, cobbles and boulders. The Folk (1954) sediment classification was reclassified into four categories, namely 'coarse sediment', 'mixed sediment', 'mud and sandy mud' and 'sand and muddy sand' (Long, 2006). Further sub-categories, namely 'mud', 'sandy mud' and 'muddy sand' are utilised to further account for differences in sediment in the 'mud to sandy mud' fraction (Kaskela et al., 2019). These categories are defined by the proportions of mud (the 'fines' fraction), sand and gravel. For example, a description of 'muddy sand' defines sediments that have sand as the principal component (50 % to 90 %) with a secondary component of mud (10 % to 50 %) and < 5 % gravel (Kaskela et al., 2019). The European Marine Observation and Data Network (EMODnet) Geology Consortium further revised these categories to include an additional category 'Rock and Boulders' (Kaskela et al., 2019), which includes the Wentworth (1922) categories 'boulders' and 'cobbles'. The presence of shell fragments and evident anthropogenic features were also noted.

Table 3.5 presents a summary of the sediment particle sizes and corresponding classifications.

Table 3.5: Sediment particle size and classification terms

Particle Size	Wentworth (1922)	Folk (1954)	Folk, 5 classes (Kaskela et al., 2019)			
> 256 mm	Boulder	Gravel	Rock & Boulders			
64 mm to 256 mm	Cobble					
32 mm to < 64 mm	Pebbles		Coarse sediment: (Gravel ≥ 80 %, or Gravel ≥ 5 % and Sand ≥ 90 %)	Mixed sediment: (Mud ≥ 10 % - 95 % Sand < 90 % Gravel ≥ 5%)	Mud to sandy mud*: (Mud 10 % -100 % Sand < 90 % Gravel < 5 %)	Sand: (Mud < 10 % Sand ≥ 90 % Gravel < 5%)
16 mm to < 32 mm						
8 mm to < 16 mm						
4 mm to < 8 mm						
2 mm to < 4 mm	Granules					
1 mm to < 2 mm	Very coarse sand					
0.5 mm to < 1 mm	Coarse sand					
0.25 mm to < 0.5 mm	Medium sand					
0.125 mm to < 0.25 mm	Fine sand					
62.5 μm to 0.125 mm	Very fine sand	Mud				
> 4 μm to 62.5 μm	Silt					
> 1 μm to 4 μm	Clay					
Notes						
* = Mud to sandy mud includes: Mud (Mud ≥ 90 %, Sand <10 %, Gravel < 5%); Sandy mud (Mud 50 % to 90 %, Sand 10 % to 50 %, Gravel < 5%); Muddy sand (Mud 10 % to 50 %, Sand 50 % to 90 %, Gravel < 5%) (Kaskela et al., 2019)						

Habitats within the survey area have been classified in accordance with 'The Marine Habitat Classification for Britain and Ireland – Version 22.04' (JNCC, 2022) which has compiled habitat information from a wide range of marine scientists and conservation bodies into a single database. Table 3.6 summarises the JNCC hierarchy, with an example of the coding system. These classification systems are designed to incorporate small-scale temporal variations (e.g. seasonal) into the biotope/habitat categories. However, biological communities and marine environments can be highly dynamic and temporally variable, therefore the biotopes and habitats identified by the current assessment are representative of the survey area at the time of sampling only.

Table 3.6: JNCC (2022) biotope classification hierarchy example

Level	Example Classification Name	Example Classification Code
1. Environment	Marine habitats	-
2. Broad habitat types	Sublittoral sediments	SS
3. Main habitats	Sublittoral sands and muddy sands	SS.SSa
4. Biotope complexes	Circolittoral fine sand	SS.SSa.CFiSa
5 & 6. Biotopes and sub-biotopes	<i>Echinocyamus pusillus</i> , <i>Ophelia borealis</i> and <i>Abra prismatica</i> in circolittoral fine sand	SS.SSa.CFiSa.EpusOborApri

Classifications were assigned to each habitat type observed within the video and stills photography. Additional information from grab sampling, such as sediment particle size and macrofaunal communities, was used where applicable. Although, theoretically, a biotope can be assigned to any sized area of seafloor, for the purposes of this assessment the commonly accepted minimum habitat size of 25 m² was adopted. For distinct areas of mixed habitats/biotopes (e.g. rock interspersed with coarse sediment) where the overall area was at least 25 m², biotope mosaics were considered (Parry, 2019).

3.3.6.2 Sensitive Habitats and Species Assessments

Habitats and biotopes were subsequently assessed for their ecological and conservation importance using the JNCC correlation spreadsheet which allows users to translate between the EUNIS marine classification, the Marine Habitat Classification for Britain and Ireland, and other marine habitats listed for conservation importance under current conservation legislation (JNCC, 2018b).

Species were assessed for their conservation status using the Annex I habitats list (JNCC, n.d), Annex II species list (JNCC, n.d.), the UK Biodiversity Action Plan (BAP) list of priority species (JNCC, 2019) and the OSPAR list of threatened and/or declining species and habitats (OSPAR, 2008).

Methane-derived authigenic carbonate (MDAC)

To assess whether the submarine structures made by leaking gases were present, bathymetry and SSS data were reviewed together to identify any depressions, any areas of potential hard substratum particularly in association with depressions, and to identify the presence of gas

bubbles in the water column. Environmental ground-truthing by video and stills photography is undertaken where features are observed with significant potential to comprise methane-derived authigenic carbonate (MDAC). Where the SSS data indicates the presence of high reflectivity signatures within seabed depressions, reference is made to the geophysical interpretation to assess whether the features are likely to comprise naturally occurring harder substrate (i.e. coarser sediments or exposed clay) boulders or anthropogenic debris.

Analysis of faunal assemblages is also informative as MDAC provides a hard substratum for colonisation and refuge and supports a faunal assemblage like that of stony reef, which is different from the surrounding soft sediment (Judd, 2001; JNCC, 2014b). Epifaunal communities near MDAC typically show an increased number of anemones. Additionally, if the seep is active, mat-forming sulphur oxidising bacteria may be evident (Judd, 2001). Though pockmark characteristics including size, shape and density have been documented there is currently no published classification for assessing the quality of MDAC itself, which can vary substantially between pockmarks.

Sea pens and burrowing megafauna

To assess the abundance and density of sea pens and burrowing megafauna, the seafloor video was reviewed at half speed to real-time, with visible sea pen taxa, burrows and mounds enumerated. Counts were then converted to the superabundant, abundant, common, frequent, occasional, rare (SACFOR) abundance scale used by the Marine Nature Conservation Review and Joint Nature Conservation Committee (JNCC) to semi-quantitatively record the abundance and density of marine benthic flora and fauna (JNCC, 2015b). When assessing density, the SACFOR scale converts 'numbers per m²' to an abundance category with consideration of the size class of the species. Table 3.7 presents the SACFOR scale conversion used and Table 3.8 outlines the size classes used to assess taxa and cryptic bioturbation signs.

Table 3.7: The SACFOR scale used for sea pen, mound and burrow density assessment

SACFOR Scale	3 cm to 15 cm*		> 15 cm†	
	Individuals per m ²	Density	Individuals per m ²	Density
Superabundant	100 – 1000	1 – 9/0.01 m ² (10 × 10 cm)	10 – 99	1 – 9/0.1 m ²
Abundant	10 – 99	1 – 9/0.1 m ²	1 – 9	1 – 9/m ²
Common	1 – 9	1 – 9/ m ²	0.1 – 0.99	1 – 9/10 m ² (3.16 × 3.16 m)
Frequent	0.1 – 1.0	1 – 9/10 m ² (3.16 × 3.16 m)	0.01 – 0.09	1 – 9/100 m ² (10 × 10 m)
Occasional	0.01 – 0.09	1 – 9/100 m ² (10 × 10 m)	0.001 – 0.009	1 – 9/1000 m ² (31.6 × 31.6 m)
Rare	0.001 – 0.009	1 – 9/1000 m ² (31.6 × 31.6 m)	0.0001 – 0.0009	< 1/1000 m ²
Notes * = 3 cm to 15 cm: <i>Pennatula phosphorea</i> , <i>Virgularia</i> sp., mounds and megafaunal burrows, with the exception of those created by taxa that reach more than 15 cm in length (e.g. <i>Nephrops norvegicus</i>) † = > 15 cm: <i>Funiculina quadrangularis</i> , <i>Nephrops norvegicus</i> burrows				

Table 3.8: Summary of sea pen, mound and burrows enumeration methodology

Feature	SACFOR size class	Additional information
<i>Pennatula phosphorea</i>	3 cm to 15 cm	-
<i>Virgularia</i> sp.	3 cm to 15 cm	Includes <i>Virgularia tuberculata</i> and <i>Virgularia mirabilis</i>
<i>Funiculina quadrangularis</i>	> 15 cm	Only live specimens were counted; structures covered by soft coral (Alcyonacea) were not considered
Mounds	3 cm to 15 cm	Include distinctive mounds, particularly those created by the mud volcano worm, <i>Maxmuelleria lankesteri</i>
<i>Nephrops norvegicus</i> burrows	> 15 cm	<i>N. norvegicus</i> burrows identification features: shape and angle of opening, evidence of scrapes
Other visible burrows	3 cm to 15 cm	Burrows other than <i>N. norvegicus</i> burrows (e.g. mud shrimps <i>Callinassa subterranea</i> and <i>Calocaris macandreae</i>)

Annex I Stony Reef Assessment

When considering the potential of an area as the Annex I habitat 'Stony reef', there are four criteria (composition, elevation, extent and biota) that the seabed is measured against. Refined guidance on the four criteria is also provided in Golding et al (2020) with stability and biodiversity also considered in the assessment of any areas classified as 'low' resemblance to stony reef.

Table 3.9 presents the Irving (2009) criteria of 'reefiness for stony reef habitat assessments.

Table 3.9: Measures of 'Reefiness' for stony reef habitat (Irving, 2009)

Characteristic	Resemblance to a 'Stony reef'			
	Not a Reef	Low	Medium	High
Composition Diameter of cobbles/boulders being greater than 64 mm. Percentage cover relates to a minimum area of 25 m ² . The 'composition' characteristic also includes 'patchiness'.	< 10 %	10 % – 40 %	40 % – 95 %	> 95 %
Elevation Minimum height (64 mm) relates to minimum size constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seafloor. Note that two units (mm and m) are used.	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 epifaunal species

4. Results

4.1 Field Operations

4.1.1 Bathymetry and Seabed Features

The minimum water depth (87.8 m LAT) was located in the central region of the survey area on a broad bathymetric high. This area was characterised by seabed sediments comprising sand.

The maximum water depth (133.7 m LAT) was located in the south-east of the survey area within a large depression. Within this area the seabed sediments comprise sandy mud and many large depressions were present.

Relict ploughmarks were present across the survey area. These were associated with shallow bathymetric gradients. Figure 4.1 shows the bathymetry across the survey area.

4.1.2 Seabed Photography

Photographic stills and video data were successfully acquired at all 80 proposed stations (including those that were re-located to transects) and fifty-eight transects (Table 4.1 and Figure 4.1).

Table 4.1: Completed transects

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
A1	SOL	630 145.6	6 433 794.7	100	55	5 min 57 sec 9 stills
	EOL	630 188.4	6 433 760.3			
A2	SOL	636 090.7	6 433 885.9	105	31	10 min, 54 sec 17 stills
	EOL	636 068.6	6 433 865.0			
A3	SOL	641 976.5	6 433 982.7	104	58	11 min, 41 sec 5 stills
	EOL	641 962.1	6 433 926.7			
A4	SOL	647 870.6	6 434 070.0	116	57	10 min 9 sec 20 stills
	EOL	647 864.0	6 434 013.0			
A5	SOL	636 029.1	6 436 792.0	100	52	8 min, 34 sec 8 stills
	EOL	636 018.1	6 436 843.0			
A6	SOL	644 895.9	6 436 930.0	113	58	8 min 35 sec 16 stills
	EOL	644 852.8	6 436 968.0			
A7	SOL	635 985.7	6 439 742.8	106	51	8 min, 25 sec 7 stills
	EOL	635 975.6	6 439 792.9			
A8	SOL	641 856.9	6 439 821.9	107	68	11 min, 32 sec 24 stills
	EOL	641 900.3	6 43 9874.5			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
A9	SOL	647 768.8	6 43 9971.2	120	58	11 min, 3 sec 20 stills
	EOL	647 792.3	6 439 918.5			
A10	SOL	650 540.8	6 440 016.3	120	57	10 min, 49 sec 17 stills
	EOL	650 568.8	6 439 966.6			
A11	SOL	632 995.7	6 442 708.8	107	66	6 min 54 sec 10 stills
	EOL	632 974.6	6 442 645.8			
A12	SOL	638 886.3	6 442 786.2	106	52	7 min, 51 sec 10 stills
	EOL	638 884.2	6 442 734.8			
A13	SOL	644 815.9	6 442 843.4	119	57	11 min, 50 sec 22 stills
	EOL	644 759.9	6 442 856.0			
A14	SOL	650 694.6	6 442 900.4	122	64	10 min, 26 sec 32 stills
	EOL	650 683.0	6 442 963.0			
A16	SOL	638 842.1	6 445 736.9	95	52	8 min, 2 sec 9 stills
	EOL	638 843.7	6 445 685.4			
A17	SOL	644 777.4	6 445 788.2	113	70	12 min, 10 sec 19 stills
	EOL	644 709.2	6 445 801.6			
A18	SOL	650 633.6	6 445 908.0	122	52	9 min, 19 sec 19 stills
	EOL	650 655.8	6 445 861.0			
A19	SOL	629 980.4	6 448 528.5	100	64	10 min 38 sec 17 stills
	EOL	629 916.3	6 448 533.6			
A20_a	SOL	635 213.8	6 447 003.8	87	67	6 min 5 sec 15 stills
	EOL	635 238.2	6 447 065.8			
A21	SOL	641 742.8	6 448 730.5	99	51	7 min, 54 sec 8 stills
	EOL	641 752.5	6 448 680.3			
A22	SOL	647 661.1	6 448 825.0	110	59	10 min, 16 sec 17 stills
	EOL	647 642.7	6 448 769.0			
A23	SOL	632 885.3	6 451 525.9	106	63	10 min 29 sec 18 stills
	EOL	632 822.3	6 451 521.5			
A25	SOL	644 682.6	6 451 668.0	113	70	12 min, 26 sec 27 stills
	EOL	644 637.7	6 451 721.2			
A26	SOL	650 549.3	6 451 757.0	112	60	10 min, 46 sec 20 stills
	EOL	650 562.5	6 451 815.0			
A27	SOL	630 146.9	6 454 674.2	107	59	10 min 58 sec 28 stills
	EOL	630 147.0	6 454 615.0			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
A29	SOL	641 209.0	6 455 030.7	101	65	7 min 2 sec
	EOL	641 226.9	6 454 968.3			14 stills
A30	SOL	647 596.6	6 45 4672.2	115	71	12 min, 6 sec
	EOL	647 536.8	6 454 710.0			22 stills
A31	SOL	650 388.9	6 454 765.0	117	58	9 min, 52 sec
	EOL	650 372.0	6 454 710.0			21 stills
A32	SOL	635 733.6	6 457 496.4	105	62	11 min 10 sec
	EOL	635 699.6	6 457 444.2			29 stills
A33	SOL	644 783.7	6 457 440.8	112	52	8 min, 7 sec
	EOL	644 786.8	6 457 388.6			7 stills
A35	SOL	641 567.7	6 460 545.1	108	75	10 min 0 sec
	EOL	641 585.2	6 460 471.7			19 stills
A36	SOL	647 472.5	6 460 620.5	115	53	8 min, 14 sec
	EOL	647 475.4	6 460 567.9			8 stills
A37	SOL	638 564.7	6 463 445.6	105	65	10 min 29 sec
	EOL	638 593.4	6 463 387.6			17 stills
A39	SOL	638 560.5	6 466 342.6	110	63	10 min 25 sec
	EOL	638 514.8	6 466 386.7			18 stills
B1	SOL	633 122.4	6 433 815.0	109	21	2 min, 29 sec
	EOL	633 105.6	6 433 828.0			6 stills
B2	SOL	639 023.5	6 433 926.8	103	31	2 min, 46 sec
	EOL	639 012.9	6 433 898.0			15 stills
B3	SOL	644 920.1	6 434 011.0	118	26	5 min, 29 sec
	EOL	644 915.8	6 433 985.0			10 stills
B4	SOL	633 070.7	6 436 764.7	100	18	02 min 48 sec
	EOL	633 075.2	6 436 781.7			5 stills
B6	SOL	641 926.1	6 436 917.7	107	41	8 min, 5 sec
	EOL	641 918.0	6 436 878.0			10 stills
B7	SOL	647 814.3	6 436 999.6	118	26	5 min, 1 sec
	EOL	647 833.8	6 436 983.0			11 stills
B8	SOL	633 027.6	6 439 735.4	105	21	3 min 6 sec
	EOL	633 028.2	6 439 714.6			7 stills
B9	SOL	638 936.7	6 439 817.7	105	26	5 min, 38 sec
	EOL	638 917.5	6 439 799.9			12 stills

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
B10_a	SOL	644 831.5	6 439 908.5	117	24	4 min, 25 sec 11 stills
	EOL	644 826.1	6 439 885.2			
B11	SOL	635 939.5	6 442 729.5	100	20	2 min 55 sec 5 stills
	EOL	635 936.9	6 442 710.1			
B12	SOL	641 846.9	6 442 819.0	112	31	4 min, 4 sec 12 stills
	EOL	641 829.0	6 442 793.5			
B13	SOL	647 745.1	6 442 885.9	122	22	4 min, 18 sec 8 stills
	EOL	647 730.3	6 442 902.3			
B14	SOL	630 004.3	6 445 581.5	106	25	4 min 16 sec 8 stills
	EOL	629 979.8	6 445 580.4			
B15	SOL	635 578.6	6 445 953.4	87	25	4 min 58 sec 9 stills
	EOL	635 594.0	6 445 972.5			
B16	SOL	641 799.0	6 445 751.0	101	23	3 min, 49 sec 10 stills
	EOL	641 779.3	6 445 763.1			
B17_a	SOL	647 703.7	6 445 843.7	113	24	4 min, 52 sec 12 stills
	EOL	647 680.2	6 445 842.0			
B18	SOL	626 995.4	6 448 500.4	105	24	5 min 24 sec 15 stills
	EOL	626 998.7	6 448 477.0			
B19	SOL	632 896.6	6 448 581.1	92	11	2 min 40 sec 6 stills
	EOL	632 898.4	6 448 569.8			
B20	SOL	638 891.2	6 448 570.4	91	16	4 min 12 sec 7 stills
	EOL	638 898.0	6 448 555.6			
B21	SOL	644 711.3	6 448 740.7	111	28	4 min, 51 sec 21 stills
	EOL	644 689.5	6 448 757.4			
B22	SOL	650 595.5	6 448 819.0	118	34	6 min, 24 sec 17 stills
	EOL	650 602.0	6 448 852.0			
B23	SOL	629 903.3	6 451 492.8	107	22	4 min 27 sec 13 stills
	EOL	629 904.5	6 451 471.0			
B24	SOL	635 818.2	6 451 567.0	92	21	3 min 52 sec 6 stills
	EOL	635 797.1	6 451 568.8			
B25	SOL	641 705.8	6 451 646.5	105	21	3 min, 6 sec 5 stills
	EOL	641 704.9	6 451 667.1			
B26	SOL	647 623.8	6 451 736.0	114	38	7 min, 1 sec 15 stills
	EOL	647 589.5	6 451 751.6			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
B27	SOL	632 821.4	6 454 471.1	104	25	3 min 50 sec 16 stills
	EOL	632 799.2	6 454 482.4			
B28	SOL	638 720.0	6 454 557.5	98	20	4 min 5 sec 7 stills
	EOL	638 703.0	6 454 568.0			
B29	SOL	644 610.6	6 454 639.6	112	22	3 min, 47 sec 6 stills
	EOL	644 606.7	6 454 661.3			
B30	SOL	632 760.0	6 457 441.8	107	27	5 min 12 sec 11 stills
	EOL	632 771.2	6 457 416.7			
B32_a	SOL	640 854.4	6 456 482.0	102	21	4 min 17 sec 7 stills
	EOL	640 855.1	6 456 461.1			
B33	SOL	647 530.1	6 457 633.1	116	30	2 min, 29 sec 12 stills
	EOL	647 506.5	6 457 650.8			
B35	SOL	638 624.7	6 460 465.3	105	6	3 min 17 sec 4 stills
	EOL	638 621.3	6 460 460.1			
B36	SOL	644 525.9	6 460 547.3	109	15	3 min 3 sec 7 stills
	EOL	644 522.4	6 460 561.6			
B37	SOL	635 624.8	6 463 379.6	111	20	3 min 41 sec 9 stills
	EOL	635 634.4	6 463 361.6			
B38	SOL	641 538.6	6 463 448.1	109	25	7 min 36 sec 17 stills
	EOL	641 527.4	6 463 471.0			
C3_a	SOL	648 959.4	6 437 420.1	117	86	14 min, 43 sec 31 stills
	EOL	649 045.1	6 437 418.0			
C5	SOL	637 482.6	6 438 289.3	102	51	8 min, 24 sec 10 stills
	EOL	637 471.2	6 438 339.2			
C6	SOL	643 381.0	6 438 427.6	108	58	9 min, 56 sec 18 stills
	EOL	643 371.6	6 438 369.9			
C7_a	SOL	648 757.1	6 438 244.7	118	94	15 min, 59 sec 25 stills
	EOL	648 850.2	6 438 232.3			
C8	SOL	634 483.0	6 441 232.6	105	51	6 min 15 sec 9 stills
	EOL	634 486.8	6 441 181.9			
C9	SOL	640 391.8	6 441 337.8	112	59	13 min, 5 sec 27 stills
	EOL	640 373.8	6 441 281.5			
C10_a	SOL	645 940.9	6 440 859.7	119	63	12 min, 54 sec 33 stills
	EOL	645 959.0	6 440 914.6			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
C11_a	SOL	633 482.5	6 436 291.1	101	71	7 min 7 sec 9 stills
	EOL	633 474.6	6 436 361.7			
C13_a	SOL	649 485.6	6 443 752.8	122	63	14 min 43 sec 27 stills
	EOL	649 437.2	6 44 3792.4			
C15	SOL	637 687.5	6 446 900.9	89	75	7 min 48 sec 16 stills
	EOL	637 718.2	6 446 969.7			
C17_a	SOL	649 365.2	6 447 822.0	117	57	10 min, 19 sec 21 stills
	EOL	649 346.6	6 447 768.0			
C18	SOL	628 451.2	6 450 016.3	101	58	10 min 54 sec 26 stills
	EOL	628 450.1	6 449 958.3			
C20	SOL	640 236.3	6 450 191.1	95	63	6 min 10 sec 11 stills
	EOL	640 259.6	6 450 132.7			
C22_a	SOL	651 004.1	6 450 008.0	113	65	11 min, 29 sec 27 stills
	EOL	651 007.6	6 450 073.0			
C23	SOL	631 365.2	6 452 943.6	107	66	12 min 15 sec 28 stills
	EOL	631 349.0	6 453 007.8			
C25	SOL	643 161.8	6 453 127.8	112	52	8 min, 13 sec 10 stills
	EOL	643 155.4	6 453 179.2			
C26	SOL	649 086.1	6 453 213.9	116	70	12 min, 05 sec 22 stills
	EOL	641 394.4	6 442 889.4			
C27	SOL	634 295.8	6 455 975.8	106	65	10 min 25 sec 29 stills
	EOL	634 231.6	6 455 969.0			
C28_a	SOL	640 039.1	6 456 364.8	100	58	6 min 0 sec 10 stills
	EOL	640 086.4	6 456 332.0			
C36	SOL	642 372.4	6 462 487.8	109	70	10 min 29 sec 21 stills
	EOL	642 376.8	6 462 417.9			
C37	SOL	637 117.8	6 464 873.4	107	68	11 min 15 sec 18 stills
	EOL	637 050.3	6 464 867.3			
C38	SOL	642 982.0	6 464 991.0	113	60	8 min 47 sec 12 stills
	EOL	642 983.7	6 464 931.1			
ATR04A	SOL	631 349.1	6 459 674.3	112	390	62 min 35 sec 80 stills
	EOL	631 375.6	6 459 285.2			
ATR06	SOL	633 548.4	6 461 726.5	110	79	12 min 26 sec 23 stills
	EOL	633 505.9	6 461 660.0			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
BTR01	SOL	638 973.2	6 470 027.1	111	263	46 min 46 sec 56 stills
	EOL	638 787.0	6 469 841.1			
BTR03	SOL	635 914.6	6 465 849.9	117	201	32 min 39 sec 42 stills
	EOL	636 042.3	6 465 694.8			
BTR04	SOL	633 389.8	6 460 199.5	110	481	77 min 20 sec 80 stills
	EOL	633 857.3	6 460 086.0			
BTR06	SOL	637 302.9	6 467 609.1	112	187	30 min 5 sec 42 stills
	EOL	637 490.0	6 467 610.6			
CTR01	SOL	639 701.4	6 468 769.7	117	111	17 min 58 sec 29 stills
	EOL	639 592.8	6 468 748.1			
CTR06	SOL	636 023.2	6 462 106.4	109	82	13 min 4 sec 26 stills
	EOL	635 949.3	6 462 071.4			
DTR01	SOL	641 128.9	6 467 253.0	115	142	22 min 34 sec 34 stills
	EOL	641 009.7	6 467 184.4			
DTR02	SOL	637 053.4	6 459 115.6	108	214	34 min 30 sec 57 stills
	EOL	636 844.6	6 459 071.3			
DTR03	SOL	631 240.2	6 447 140.4	95	83.2	13 min 14 sec 24 stills
	EOL	631 165.0	6 447 104.5			
ETR01	SOL	632 047.6	6 447 403.7	90	68	7 min 18 sec 13 stills
	EOL	631 980.5	6 447 394.0			
ETR02	SOL	636 802.1	6 456 548.5	100	80	8 min 8 sec 15 stills
	EOL	636 756.9	6 456 614.6			
ETR03	SOL	639 234.4	6 461 994.2	104	92	12 min 59 sec 23 stills
	EOL	639 145.3	6 461 970.1			
ETR04	SOL	639 953.9	6 463 606.7	105	200	29 min 44 sec 43 stills
	EOL	639 904.7	6 463 800.6			
FTR02	SOL	635 060.3	6 450 952.6	94	145	15 min 46 sec 26 stills
	EOL	635 171.4	6 451 045.3			
FTR03	SOL	638 815.8	6 457 233.3	101	146	14 min 15 sec 20 stills
	EOL	638 828.0	6 457 378.9			
FTR04	SOL	639 618.8	6 459 021.1	104	224	22 min 18 sec 26 stills
	EOL	639 521.1	6 459 223.2			
FTR07	SOL	642 839.9	6 465 661.7	114	276	38 min 22 sec 46 stills
	EOL	642 578.9	6 465 570.4			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
FTR08	SOL	643 187.1	6 465 391.9	115	122	17 min 43 sec 18 stills
	EOL	643 252.9	6 465 289.1			
FTR10	SOL	633 841.3	6 447 020.2	87	130	12 min 56 sec 18 stills
	EOL	633 956.3	6 447 081.6			
GTR01	SOL	644 124.2	6 464 779.2	113	164	22 min 55 sec 23 stills
	EOL	644 239.8	6 464 662.7			
GTR02	SOL	640 751.4	6 459 922.0	106	146	20 min 26 sec 29 stills
	EOL	640 798.2	6 459 783.7			
GTR03	SOL	640 574.9	6 458 541.1	104	172	24 min 18 sec 31 stills
	EOL	640 406.3	6 458 505.8			
GTR04	SOL	643 956.6	6 464 180.1	112	160	22 min 59 sec 21 stills
	EOL	643 809.4	6 464 116.6			
HTR02	SOL	631 814.1	6 437 210.5	105	127	12 min 49 sec 20 stills
	EOL	631 940.4	6 437 194.1			
HTR03	SOL	644 482.5	6 463 107.9	110	229	26 min 16 sec 28 stills
	EOL	644 710.3	6 463 127.3			
HTR04	SOL	638 485.3	6 451 852.3	95	183	17 min 47 sec 32 stills
	EOL	638 544.6	6 451 679.3			
ITR01	SOL	646 098.9	6 463 335.8	112	179	25 min 7 sec 33 stills
	EOL	646 266.9	6 463 397.6			
ITR02	SOL	635 801.1	6 443 995.9	102	115	11 min 21 sec 19 stills
	EOL	635 691.3	6 444 029.0			
ITR03	SOL	643 564.6	6 459 373.6	109	142	20 min 2 sec 27 stills
	EOL	643 429.3	6 459 331.3			
JTR01	SOL	631 549.3	6 433 365.4	108	67	7 min 45 sec 15 stills
	EOL	631 559.9	6 433 298.9			
JTR02	SOL	645 841.8	6 461 627.0	109	95	13 min 49 sec 17 stills
	EOL	645 821.8	6 461 719.4			
KTR01	SOL	634 752.2	6 435 746.0	106	118	19 min, 4 sec 24 stills
	EOL	634 749.3	6 435 864.0			
KTR02	SOL	640 884.3	6 447 721.0	96	418	45 min, 53 sec 31 stills
	EOL	640 609.2	6 447 406.0			
KTR03	SOL	645 256.3	6 456 390.6	112	319	54 min, 20 sec 37 stills
	EOL	644 939.8	6 456 428.5			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
KTR04	SOL	645 805.2	6 458 763.6	112	67	10 min, 30 sec 13 stills
	EOL	645 814.2	6 458 697.7			
LTR01	SOL	647 785.5	6 459 868.6	116	199	21 min, 50 sec 28 stills
	EOL	647 812.0	6 459 671.2			
LTR02	SOL	645 004.2	6 455 456.6	110	172	24 min, 49 sec 23 stills
	EOL	645 070.5	6 455 615.6			
MTR01	SOL	645 821.4	6 453 447.5	112	346	35 min, 42 sec 117 stills
	EOL	645 551.1	6 453 232.4			
MTR02	SOL	648 502.1	6 458 732.3	116	165	24 min, 46 sec 28 stills
	EOL	648 648.0	6 458 655.3			
NTR01	SOL	639 174.5	6 436 819.6	102	218	25 min 6 sec 53 stills
	EOL	638 961.1	6 436 864.2			
NTR02	SOL	647 977.4	6 456 383.6	115	161	14 min, 36 sec 37 stills
	EOL	648 053.0	6 456 241.1			
NTR03	SOL	647 302.7	6 453 009.4	113	194	30 min, 13 sec 56 stills
	EOL	647 123.9	6 452 935.4			
NTR04	SOL	643 918.6	6 447 786.8	108	255	25 min, 53 sec 50 stills
	EOL	643 732.6	6 447 612.3			
NTR05	SOL	641 716.0	6 442 982.2	112	335	62 min, 12 sec 38 stills
	EOL	641 394.4	6 442 889.4			
OTR01	SOL	643 704.6	6 443 725.6	116	356	58 min, 30 sec 62 stills
	EOL	643 748.8	6 443 372.1			
OTR02	SOL	646 821.3	6 450 862.5	113	172	58 min, 34 sec 62 stills
	EOL	646 744.8	6 450 708.3			
PTR01	SOL	641 140.8	6 435 915.0	106	116	20 min, 15 sec 46 stills
	EOL	641 220.3	6 435 830.9			
PTR02	SOL	645 948.2	6 443 318.3	122	161	47 min, 1 sec 71 stills
	EOL	645 880.8	6 443 466.6			
PTR03	SOL	645 520.2	6 445 469.4	113	212	37 min 3 sec 32 stills
	EOL	645 514.4	6 445 669.0			
PTR04	SOL	645 568.0	6 445 141.6	115	170	28 min, 32 sec 18 stills
	EOL	645 509.4	6 445 301.2			
QTR01	SOL	646 352.2	6 442 587.1	130	331	51 min, 16 sec 99 stills
	EOL	646 663.3	6 442 572.0			

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]						
Station		Easting	Northing	Depth [m LAT]	Length [m]	Data Acquisition
QTR02	SOL	644 603.1	6 437 941.5	118	243	16 min, 4 sec 52 stills
	EOL	644 360.9	6 437 951.9			
QTR03	SOL	643 586.9	6 436 997.0	115	179	21 min, 8 sec 30 stills
	EOL	643 494.8	6 437 151.0			
QTR04	SOL	644 127.3	6 436 129.0	100	262	16 min, 41 sec 35 stills
	EOL	644 020.6	6 436 251.0			
QTR05	SOL	642 634.1	6 433 881.0	106	52	8 min 47 sec 24 stills
	EOL	642 635.6	6 433 829.0			
RTR01	SOL	646 861.5	6 438 386.3	119	171	28 min, 18 sec 37 stills
	EOL	646 691.2	6 438 402.8			
Notes LAT = Lowest Astronomical Tide SOL = Start of line EOL = End of line						

4.1.3 Grab and Water Sampling

Grab samples were successfully acquired at 79 proposed stations. Three unsuccessful attempts were made to retrieve a sample at station B15 with the dual van Veen grab. One further unsuccessful attempt was made with the Hamon grab. The station was then abandoned. A complete suite of samples (one faunal sample, one PSD sample, one contaminants sample and one sediment eDNA sample) were retained at all other stations (Table 4.2).

Water eDNA samples were successfully obtained at all 50 proposed stations (Table 4.2 and Figure 4.1).

Table 4.2: Completed sampling stations

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting*	Northing*	Depth [m LAT]	Sample Acquisition
A1	630 166.5	6 433 771.8	114	FA, PSD, CS, eDNA
A2	636 067.6	6 433 865.9	105	FA, PSD, CS, eDNA
A3	641 967.8	6 433 956.1	105	FA, PSD, CS, eDNA
A4	647 868.0	6 434 042.4	116	FA, PSD, CS, eDNA
A5	636 022.4	6 436 819.7	100	FA, PSD, CS, eDNA
A6	644 874.1	6 436 950.0	113	FA, PSD, CS, eDNA
A7	635 979.6	6 439 771.1	106	FA, PSD, CS, eDNA
A8	641 881.8	6 439 848.7	107	FA, PSD, CS, eDNA
A9	647 780.4	6 439 945.3	120	FA, PSD, CS, eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting*	Northing*	Depth [m LAT]	Sample Acquisition
A10	650 557.4	6 439 988.6	120	FA, PSD, CS, eDNA
A11	632 983.9	6 442 679.8	110	FA, PSD, CS, eDNA
A12	638 884.3	6 442 762.2	106	FA, PSD, CS, eDNA
A13	644 786.0	6 442 850.7	119	FA, PSD, CS, eDNA
A14	650 686.0	6 442 932.2	122	FA, PSD, CS, eDNA
A15_a	633 883.4	6 447 036.3	92	FA, PSD, CS, eDNA
A16	638 841.2	6 445 712.6	95	FA, PSD, CS, eDNA
A17	644 743.0	6 445 798.7	113	FA, PSD, CS, eDNA
A18	650 645.2	6 445 881.7	122	FA, PSD, CS, eDNA
A19	629 946.5	6 448 530.1	100	FA, PSD, CS, eDNA
A20_a	635 226.7	6 447 025.1	92	FA, PSD, CS, eDNA
A21	641 748.8	6 448 704.6	99	FA, PSD, CS, eDNA
A22	647 649.3	6 448 794.6	110	FA, PSD, CS, eDNA
A23	632 853.5	6 451 524.7	106	FA, PSD, CS, eDNA
A24_a	638 534.2	6 451 714.9	100	FA, PSD, CS, eDNA
A25	644 655.7	6 451 698.1	113	FA, PSD, CS, eDNA
A26	650 557.3	6 451 780.8	112	FA, PSD, CS, eDNA
A27	630 146.8	6 454 643.3	107	FA, PSD, CS, eDNA
A28_a	636 759.3	6 456 607.5	102	FA, PSD, CS, eDNA
A29_a	641 218.8	6 454 999.7	104	FA, PSD, CS, eDNA
A30	647 562.8	6 454 691.6	115	FA, PSD, CS, eDNA
A31	650 381.3	6 454 734.9	117	FA, PSD, CS, eDNA
A32	635 715.6	6 457 471.2	104	FA, PSD, CS, eDNA
A33	644 784.4	6 457 418.1	112	FA, PSD, CS, eDNA
A34_a	635 955.2	6 462 078.9	109	FA, PSD, CS, eDNA
A35	641 575.0	6 460 511.5	110	FA, PSD, CS, eDNA
A36	647 475.2	6 460 587.5	115	FA, PSD, CS, eDNA
A37	638 578.5	6 463 418.5	110	FA, PSD, CS, eDNA
A38_a	644 532.7	6 463 117.4	102	FA, PSD, CS, eDNA
A39	638 535.1	6 466 368.7	109	FA, PSD, CS, eDNA
A40_a	638 888.1	6 469 940.5	117	FA, PSD, CS, eDNA
B1	633 114.0	6 433 823.0	109	FA, PSD, CS, eDNA
B2	639 018.2	6 433 911.3	103	FA, PSD, CS, eDNA
B3	644 919.4	6 433 996.8	118	FA, PSD, CS, eDNA
B4	633 069.7	6 436 769.1	105	FA, PSD, CS, eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting*	Northing*	Depth [m LAT]	Sample Acquisition
B5	638 974.3	6 436 861.0	102	FA, PSD, CS, eDNA
B6	641 922.4	6 436 904.8	108	FA, PSD, CS, eDNA
B7	647 823.7	6 436 990.6	118	FA, PSD, CS, eDNA
B8	633 030.8	6 439 730.0	108	FA, PSD, CS, eDNA
B9	638 930.7	6 439 804.6	105	FA, PSD, CS, eDNA
B10	645 940.9	6 440 859.7	117	FA, PSD, CS, eDNA
B11	635 935.9	6 442 717.4	107	FA, PSD, CS, eDNA
B12	641 835.2	6 442 801.0	101	FA, PSD, CS, eDNA
B13	647 736.8	6 442 893.4	122	FA, PSD, CS, eDNA
B14	629 991.3	6 445 578.9	105	FA, PSD, CS, eDNA
B16	641 793.3	6 445 751.9	113	FA, PSD, CS, eDNA
B17	647 693.0	6 445 843.5	111	FA, PSD, CS, eDNA
B18	626 997.2	6 448 487.4	105	FA, PSD, CS, eDNA
B19	632 898.3	6 448 575.7	94	FA, PSD, CS, eDNA
B20	638 901.0	6 448 566.0	94	FA, PSD, CS, eDNA
B21	644 670.0	6 448 749.7	111	FA, PSD, CS, eDNA
B22	650 600.8	6 448 833.6	118	FA, PSD, CS, eDNA
B23	629 902.7	6 451 482.3	107	FA, PSD, CS, eDNA
B24	635 792.7	6 451 557.3	96	FA, PSD, CS, eDNA
B25	641 705.5	6 451 654.1	105	FA, PSD, CS, eDNA
B26	647 605.9	6 451 742.7	114	FA, PSD, CS, eDNA
B27	632 810.2	6 454 475.8	104	FA, PSD, CS, eDNA
B28	638 708.7	6 454 561.7	102	FA, PSD, CS, eDNA
B29	644 611.8	6 454 648.7	112	FA, PSD, CS, eDNA
B30	632 766.5	6 457 428.4	106	FA, PSD, CS, eDNA
B31_a	638 824.2	6 457 368.8	105	FA, PSD, CS, eDNA
B32_a	640 856.2	6 456 475.5	105	FA, PSD, CS, eDNA
B33	647 518.9	6 457 648.4	116	FA, PSD, CS, eDNA
B34_a	633 651.5	6 460 139.9	109	FA, PSD, CS, eDNA
B35	638 624.5	6 460 462.4	107	FA, PSD, CS, eDNA
B36	644 523.1	6 460 555.2	112	FA, PSD, CS, eDNA
B37	635 628.9	6 463 372.1	110	FA, PSD, CS, eDNA
B38	641 528.9	6 463 454.0	113	FA, PSD, CS, eDNA
B39_a	636 027.1	6 465 717.7	112	FA, PSD, CS, eDNA
B40	639 911.1	6 463 765.3	104	FA, PSD, CS, eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting*	Northing*	Depth [m LAT]	Sample Acquisition
D_01	638 885.8	6 442 761.7	107	eDNA
D_02	644 786.7	6 442 849.1	117	eDNA
D_03	641 969.3	6 433 952.6	105	eDNA
D_04	650 381.2	6 454 733.9	117	eDNA
D_05	647 867.6	6 434 041.4	116	eDNA
D_06	644 873.6	6 436 944.3	114	eDNA
D_07	635 977.9	6 439 775.1	106	eDNA
D_08	641 879.6	6 439 851.7	106	eDNA
D_09	633 116.7	6 433 826.1	109	eDNA
D_10	645 682.5	6 453 339.7	110	eDNA
D_11	647 735.4	6 442 891.8	122	eDNA
D_12	641 795.4	6 445 747.7	103	eDNA
D_13	644 699.4	6 448 751.4	110	eDNA
D_14	650 601.1	6 448 834.1	118	eDNA
D_15	647 604.1	6 451 741.9	113	eDNA
D_16_a	649 355.4	6 447 795.0	117	eDNA
D_17	643 156.3	6 453 153.2	110	eDNA
D_18	649 281.5	6 438 486.4	117	eDNA
D_19	640 718.4	6 447 535.6	91	eDNA
D_20	644 983.9	6 456 430.2	110	eDNA
D_21	645 808.7	6 458 734.2	112	eDNA
D_22	645 030.2	6 455 524.9	111	eDNA
D_23	648 609.3	6 458 676.8	105	eDNA
D_24	639 110.1	6 436 829.3	103	eDNA
D_25	641 622.1	6 442 948.4	112	eDNA
D_26	626 999.4	6 448 483.8	104	eDNA
D_27	631 357.8	6 459 494.3	105	eDNA
D_28	633 490.5	6 460 179.2	110	eDNA
D_29	631 359.3	6 452 974.5	107	eDNA
D_30	637 408.6	6 467 613.8	110	eDNA
D_31	639 648.9	6 468 763.2	110	eDNA
D_32	629 947.6	6 448 530.4	100	eDNA
D_33	641 019.2	6 467 189.1	112	eDNA
D_34	635 718.3	6 457 468.8	105	eDNA
D_35	629 993.5	6 445 576.4	106	eDNA

Geodetic Parameters: ETRS89, UTM Zone 30N, CM 3°W [m]				
Station	Easting*	Northing*	Depth [m LAT]	Sample Acquisition
D_36	634 350.8	6 450 070.3	116	eDNA
D_37	638 623.2	6 460 464.1	107	eDNA
D_38	642 983.8	6 464 955.9	96	eDNA
D_39	638 825.3	6 457 368.9	105	eDNA
D_40	633 885.1	6 447 031.5	92	eDNA
D_41	635 232.1	6 447 023.4	92	eDNA
D_42	641 572.3	6 460 506.6	111	eDNA
D_43	644 530.0	6 463 112.5	114	eDNA
D_44	638 532.6	6 451 718.5	97	eDNA
D_45	631 828.7	6 437 202.4	106	eDNA
D_46	641 218.3	6 455 000.4	104	eDNA
D_47	634 483.0	6 441 228.1	108	eDNA
D_48	633 077.4	6 436 769.9	105	eDNA
D_49	633 477.8	6 436 327.8	106	eDNA
D_50	640 253.0	6 450 158.5	98	eDNA
Notes LAT = Lowest Astronomical Tide PSD = Particle size distribution FA = Faunal sample A CS = Contaminants sample eDNA = Environmental deoxyribonucleic acid				

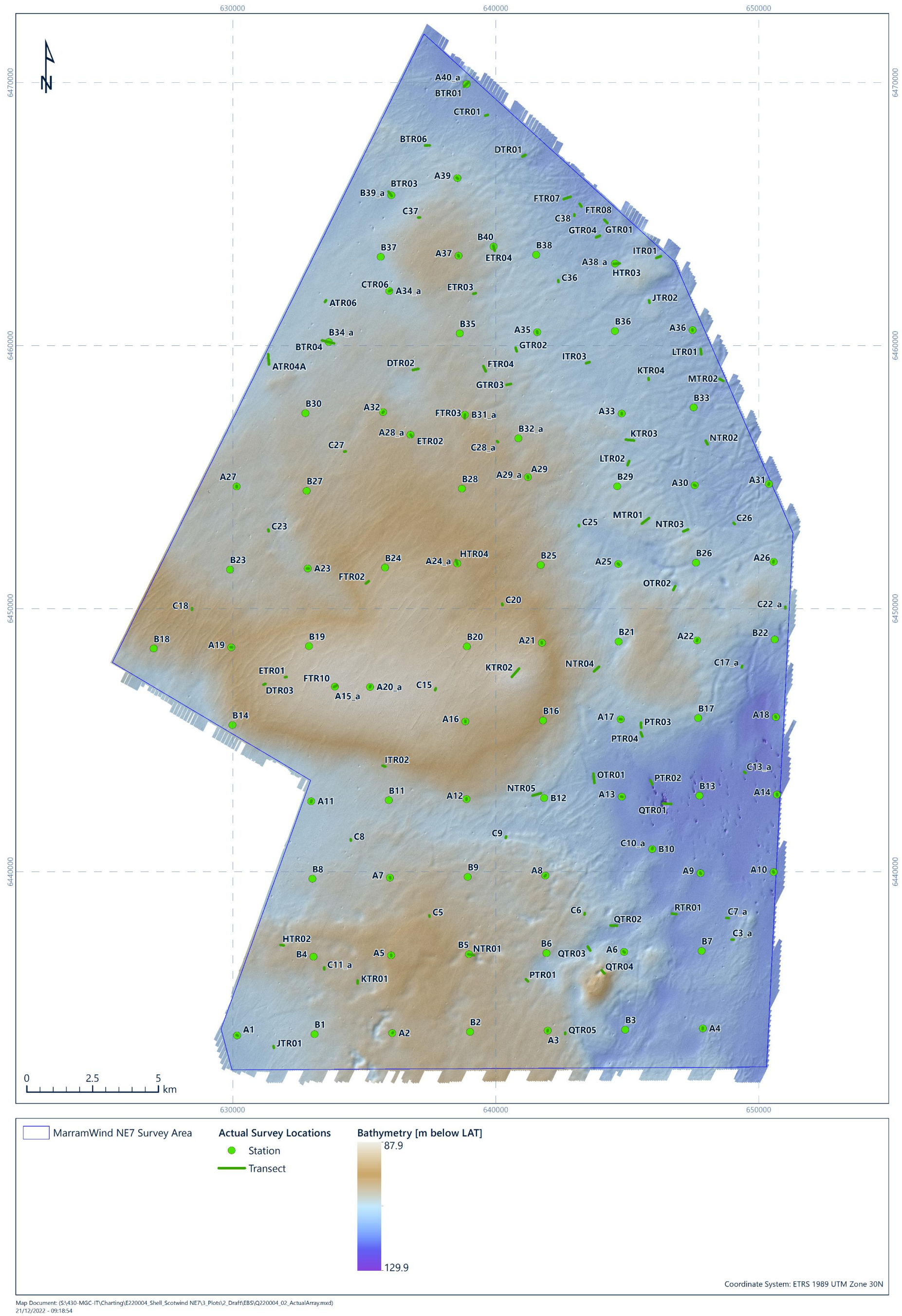


Figure 4.1: Actual environmental survey locations overlain on bathymetry data

4.2 Sediment Characterisation

4.2.1 Univariate Analysis

Table 4.3 presents the sediment characteristics. Figure 4.2 and Figure 4.3 present an overview of the variations of the fractional composition of the sediments, Figure 4.4 presents the fractional composition of the sediments spatially across the survey area and Figure 4.5 presents the mean particle size (μm) spatially across the survey area. Appendix B provides full details of the analytical techniques employed and Appendix D displays the histograms of particle size class summary for each station.

When fractional composition was considered, sand was the dominant fraction of the sediment at all stations with percentages ranging from 57.50 % (station A14) to 94.96 % (station A20_a), with a mean of 79.95 %. Fines (or mud) were recorded at all stations and had a content ranging from 4.72 % (station A15_a) to 42.48 % (station A14), with a mean of 19.97 %. Of the fines, silt content was consistently higher than the clay content (Table 4.3 and Figure 4.2 and Figure 4.3). Gravel was absent from 31 stations and at the remaining stations gravel content ranged from 0.01 % at 11 stations to 2.17 % (station A9), with a mean of 0.08 % (Table 4.3 and Figure 4.4).

The Folk descriptions classify sediment by the relative proportion of sediment fractions (gravel, sand and fines). The Folk description (BGS modified) classified 68 stations as muddy sand and 11 stations as sand.

Table 4.4 presents the physical composition of the sediments (Folk; BGS modified (Long, 2006)) at each station. The mode (or modal distribution) represents the peak of the particle size frequency distribution. Within the current survey, distributions were unimodal at 76 stations and bimodal at the remaining 3.

Figure 4.5 presents the mean particle size (μm) spatially across the survey area. The mean particle size (μm) ranged from 52 μm at station A14 to 336 μm at station A15_a, with a mean of 138 μm .

The Wentworth description, assigned from mean particle size, categorised 34 stations as very fine sand, 34 stations as fine sand, 6 stations as medium sand and 5 stations as coarse silt.

The sorting coefficient of particle size indicates the degree of spread of individual size classes about the mean and provides the basis of a sorting index, in which low values indicate sediments to be fairly homogeneous (well sorted) while high values suggest a relatively large scatter of particle sizes about the mean (poorly sorted). The majority (76) of stations were classed as poorly sorted, with the remaining 3 described as moderately sorted.

Skewness indicates the tendency of particle size classes to be skewed about the mean, either towards finer sediment (negative skewed) or coarser sediment (positive skewedness). Fifty-four stations were very fine skewed, 24 were fine skewed and 1 station (A15_a) was symmetrical.

Table 4.3: Summary of sediment characteristics

Station	Fractional Composition			Fines		Folk Description (BGS modified)
	Gravel [%]	Sand [%]	Fines [%]	Silt [%]	Clay [%]	
A1	0.00	70.15	29.85	25.23	4.62	Muddy sand
A2	0.00	83.09	16.91	14.10	2.80	Muddy sand
A3	0.00	89.19	10.81	8.99	1.82	Muddy sand
A4	0.00	70.28	29.72	25.68	4.04	Muddy sand
A5	0.02	89.18	10.80	9.16	1.65	Muddy sand
A6	0.05	78.82	21.13	17.97	3.16	Muddy sand
A7	0.00	82.24	17.76	14.95	2.81	Muddy sand
A8	0.00	84.97	15.03	12.42	2.61	Muddy sand
A9	2.17	60.32	37.51	32.09	5.42	Muddy sand
A10	0.11	58.42	41.47	35.67	5.80	Muddy sand
A11	0.00	71.94	28.06	23.47	4.59	Muddy sand
A12	0.01	88.14	11.85	9.90	1.95	Muddy sand
A13	0.02	67.62	32.36	27.37	4.99	Muddy sand
A14	0.02	57.50	42.48	37.60	4.88	Muddy sand
A15_a	0.52	94.76	4.72	4.16	0.55	Sand
A16	0.01	93.48	6.51	5.76	0.75	Sand
A17	0.04	80.20	19.76	16.35	3.41	Muddy sand
A18	0.04	63.07	36.89	31.69	5.20	Muddy sand
A19	0.00	89.61	10.39	8.75	1.65	Muddy sand
A20_a	0.09	94.96	4.95	4.47	0.48	Sand
A21	0.00	94.29	5.71	5.10	0.61	Sand
A22	0.02	82.13	17.85	14.97	2.88	Muddy sand
A23	0.00	84.00	16.00	13.27	2.73	Muddy sand
A24_a	0.00	92.56	7.44	6.48	0.96	Sand
A25	0.01	82.01	17.98	14.95	3.02	Muddy sand
A26	0.32	79.56	20.12	16.66	3.46	Muddy sand
A27	0.00	75.50	24.50	20.19	4.31	Muddy sand
A28_a	0.00	84.18	15.82	12.98	2.84	Muddy sand

Station	Fractional Composition			Fines		Folk Description (BGS modified)
	Gravel [%]	Sand [%]	Fines [%]	Silt [%]	Clay [%]	
A29_a	0.00	86.76	13.24	10.92	2.32	Muddy sand
A30	0.03	73.49	26.47	22.69	3.78	Muddy sand
A31	0.07	70.65	29.28	25.15	4.13	Muddy sand
A32	0.00	82.86	17.13	14.16	2.98	Muddy sand
A33	0.14	76.00	23.86	20.05	3.81	Muddy sand
A34_a	0.00	74.78	25.21	21.29	3.92	Muddy sand
A35	0.18	75.94	23.89	19.57	4.31	Muddy sand
A36	0.05	74.59	25.36	21.00	4.36	Muddy sand
A37	0.00	82.82	17.18	14.21	2.97	Muddy sand
A38_a	0.06	77.61	22.33	18.62	3.71	Muddy sand
A39	0.23	76.06	23.71	19.99	3.72	Muddy sand
A40_a	0.24	66.76	33.00	27.99	5.01	Muddy sand
B1	0.02	79.83	20.14	17.06	3.08	Muddy sand
B2	0.32	85.21	14.47	11.87	2.60	Muddy sand
B3	0.00	74.72	25.28	21.24	4.03	Muddy sand
B4	0.00	81.07	18.93	15.67	3.27	Muddy sand
B5	0.01	91.22	8.77	7.46	1.31	Sand
B6	0.01	83.63	16.37	13.27	3.09	Muddy sand
B7	0.01	66.28	33.71	28.61	5.10	Muddy sand
B8	0.05	77.43	22.52	19.04	3.48	Muddy sand
B9	0.01	86.76	13.22	11.03	2.20	Muddy sand
B10	0.24	71.55	28.21	24.03	4.18	Muddy sand
B11	0.00	81.37	18.62	15.27	3.35	Muddy sand
B12	0.00	83.57	16.43	13.65	2.78	Muddy sand
B13	0.00	63.46	36.54	31.46	5.09	Muddy sand
B14	0.02	83.48	16.50	13.56	2.94	Muddy sand
B16	0.00	93.31	6.69	5.97	0.72	Sand
B17	0.11	76.45	23.44	19.52	3.92	Muddy sand
B18	0.00	85.23	14.77	12.00	2.77	Muddy sand

Station	Fractional Composition			Fines		Folk Description (BGS modified)
	Gravel [%]	Sand [%]	Fines [%]	Silt [%]	Clay [%]	
B19	0.07	93.45	6.48	5.69	0.80	Sand
B20	0.03	93.16	6.81	5.91	0.90	Sand
B21	0.00	86.41	13.59	11.17	2.42	Muddy sand
B22	0.05	70.92	29.03	24.41	4.62	Muddy sand
B23	0.08	78.62	21.30	17.75	3.56	Muddy sand
B24	0.00	90.53	9.47	7.83	1.64	Sand
B25	0.00	91.60	8.40	7.01	1.39	Sand
B26	0.06	78.85	21.10	17.54	3.56	Muddy sand
B27	0.01	84.91	15.08	12.39	2.70	Muddy sand
B28	0.01	88.28	11.72	9.37	2.35	Muddy sand
B29	0.03	82.42	17.55	14.61	2.93	Muddy sand
B30	0.00	76.24	23.76	19.81	3.95	Muddy sand
B31_a	0.00	86.52	13.48	11.20	2.28	Muddy sand
B32_a	0.00	88.03	11.97	9.59	2.39	Muddy sand
B33	0.08	72.94	26.98	22.36	4.62	Muddy sand
B34_a	0.08	73.37	26.55	22.58	3.97	Muddy sand
B35	0.03	82.28	17.69	14.42	3.27	Muddy sand
B36	0.01	75.86	24.13	19.44	4.69	Muddy sand
B37	0.05	73.35	26.60	22.57	4.03	Muddy sand
B38	0.00	75.79	24.21	19.59	4.63	Muddy sand
B39_a	0.01	70.28	29.71	25.19	4.52	Muddy sand
B40	0.80	77.20	22.00	17.73	4.27	Muddy sand
Minimum	0.00	57.50	4.72	4.16	0.48	-
Maximum	2.17	94.96	42.48	37.60	5.80	
Median	0.01	81.07	18.93	15.67	3.27	
Mean	0.08	79.95	19.97	16.77	3.20	
Standard Deviation	0.14	8.91	8.85	7.61	1.31	
RSD [%]	172	11	44	45	41	

Table 4.4: Summary of particle size distribution

Station	Modality	Median [μm]*	Mean Particle Size		Sorting Coefficient		Skewness	
			[μm]*	Wentworth (1922) Description	[μm]*	Description†	[μm]*	Description†
A1	Unimodal	93	81	Very fine sand	2.95	Poorly sorted	-0.34	Very fine skewed
A2	Unimodal	160	144	Fine sand	2.97	Poorly sorted	-0.33	Very fine skewed
A3	Unimodal	202	193	Fine sand	2.62	Poorly sorted	-0.27	Fine skewed
A4	Unimodal	98	79	Very fine sand	3.17	Poorly sorted	-0.38	Very fine skewed
A5	Unimodal	234	216	Fine sand	2.59	Poorly sorted	-0.34	Very fine skewed
A6	Unimodal	133	120	Very fine sand	3.08	Poorly sorted	-0.30	Very fine skewed
A7	Unimodal	139	128	Fine sand	2.80	Poorly sorted	-0.31	Very fine skewed
A8	Unimodal	164	151	Fine sand	2.80	Poorly sorted	-0.32	Very fine skewed
A9	Unimodal	79	60	Coarse silt	3.34	Poorly sorted	-0.40	Very fine skewed
A10	Bimodal	73	53	Coarse silt	3.42	Poorly sorted	-0.43	Very fine skewed
A11	Unimodal	97	83	Very fine sand	2.88	Poorly sorted	-0.40	Very fine skewed
A12	Unimodal	153	147	Fine sand	2.40	Poorly sorted	-0.28	Fine skewed
A13	Unimodal	87	67	Very fine sand	3.02	Poorly sorted	-0.47	Very fine skewed
A14	Bimodal	72	52	Coarse silt	3.29	Poorly sorted	-0.43	Very fine skewed
A15_a	Unimodal	338	336	Medium sand	1.68	Moderately sorted	-0.07	Symmetrical
A16	Unimodal	272	267	Medium sand	2.04	Poorly sorted	-0.26	Fine skewed
A17	Unimodal	134	116	Very fine sand	2.93	Poorly sorted	-0.38	Very fine skewed
A18	Unimodal	80	62	Coarse silt	3.19	Poorly sorted	-0.42	Very fine skewed
A19	Unimodal	217	205	Fine sand	2.53	Poorly sorted	-0.31	Very fine skewed
A20_a	Unimodal	314	310	Medium sand	1.64	Moderately sorted	-0.14	Fine skewed
A21	Unimodal	270	265	Medium sand	2.06	Poorly sorted	-0.21	Fine skewed
A22	Unimodal	153	133	Fine sand	2.95	Poorly sorted	-0.37	Very fine skewed
A23	Unimodal	145	135	Fine sand	2.67	Poorly sorted	-0.32	Very fine skewed
A24_a	Unimodal	233	231	Fine sand	2.19	Poorly sorted	-0.24	Fine skewed
A25	Unimodal	139	127	Fine sand	2.85	Poorly sorted	-0.32	Very fine skewed
A26	Unimodal	152	130	Fine sand	3.22	Poorly sorted	-0.36	Very fine skewed
A27	Unimodal	110	102	Very fine sand	3.05	Poorly sorted	-0.28	Fine skewed

Station	Modality	Median [μm]*	Mean Particle Size		Sorting Coefficient		Skewness	
			[μm]*	Wentworth (1922) Description	[μm]*	Description†	[μm]*	Description†
A28_a	Unimodal	153	144	Fine sand	2.84	Poorly sorted	-0.28	Fine skewed
A29_a	Unimodal	182	166	Fine sand	2.65	Poorly sorted	-0.36	Very fine skewed
A30	Unimodal	111	93	Very fine sand	3.18	Poorly sorted	-0.35	Very fine skewed
A31	Bimodal	108	86	Very fine sand	3.60	Poorly sorted	-0.34	Very fine skewed
A32	Unimodal	152	144	Fine sand	3.09	Poorly sorted	-0.25	Fine skewed
A33	Unimodal	125	101	Very fine sand	3.23	Poorly sorted	-0.39	Very fine skewed
A34_a	Unimodal	107	95	Very fine sand	2.90	Poorly sorted	-0.34	Very fine skewed
A35	Unimodal	118	102	Very fine sand	3.15	Poorly sorted	-0.35	Very fine skewed
A36	Unimodal	123	102	Very fine sand	3.45	Poorly sorted	-0.35	Very fine skewed
A37	Unimodal	166	146	Fine sand	3.03	Poorly sorted	-0.36	Very fine skewed
A38_a	Unimodal	128	111	Very fine sand	2.98	Poorly sorted	-0.37	Very fine skewed
A39	Unimodal	120	109	Very fine sand	3.10	Poorly sorted	-0.29	Fine skewed
A40_a	Unimodal	91	79	Very fine sand	3.52	Poorly sorted	-0.27	Fine skewed
B1	Unimodal	130	123	Very fine sand	2.96	Poorly sorted	-0.26	Fine skewed
B2	Unimodal	184	165	Fine sand	2.90	Poorly sorted	-0.34	Very fine skewed
B3	Unimodal	107	93	Very fine sand	2.94	Poorly sorted	-0.37	Very fine skewed
B4	Unimodal	167	144	Fine sand	3.22	Poorly sorted	-0.36	Very fine skewed
B5	Unimodal	239	227	Fine sand	2.37	Poorly sorted	-0.28	Fine skewed
B6	Unimodal	160	145	Fine sand	2.91	Poorly sorted	-0.34	Very fine skewed
B7	Unimodal	86	68	Very fine sand	3.17	Poorly sorted	-0.41	Very fine skewed
B8	Unimodal	115	109	Very fine sand	2.89	Poorly sorted	-0.25	Fine skewed
B9	Unimodal	172	161	Fine sand	2.69	Poorly sorted	-0.30	Fine skewed
B10	Unimodal	98	82	Very fine sand	2.89	Poorly sorted	-0.40	Very fine skewed
B11	Unimodal	129	117	Very fine sand	2.76	Poorly sorted	-0.35	Very fine skewed
B12	Unimodal	135	126	Fine sand	2.61	Poorly sorted	-0.31	Very fine skewed
B13	Unimodal	79	62	Coarse silt	2.99	Poorly sorted	-0.43	Very fine skewed
B14	Unimodal	169	153	Fine sand	3.04	Poorly sorted	-0.32	Very fine skewed
B16	Unimodal	239	234	Fine sand	1.99	Moderately sorted	-0.28	Fine skewed

Station	Modality	Median [μm]*	Mean Particle Size		Sorting Coefficient		Skewness	
			[μm]*	Wentworth (1922) Description	[μm]*	Description†	[μm]*	Description†
B17	Unimodal	126	104	Very fine sand	3.24	Poorly sorted	-0.37	Very fine skewed
B18	Unimodal	168	155	Fine sand	2.86	Poorly sorted	-0.31	Very fine skewed
B19	Unimodal	305	300	Medium sand	2.04	Poorly sorted	-0.25	Fine skewed
B20	Unimodal	277	271	Medium sand	2.09	Poorly sorted	-0.27	Fine skewed
B21	Unimodal	161	151	Fine sand	2.63	Poorly sorted	-0.31	Very fine skewed
B22	Unimodal	107	82	Very fine sand	3.51	Poorly sorted	-0.39	Very fine skewed
B23	Unimodal	125	114	Very fine sand	2.98	Poorly sorted	-0.30	Fine skewed
B24	Unimodal	235	230	Fine sand	2.42	Poorly sorted	-0.29	Fine skewed
B25	Unimodal	216	211	Fine sand	2.36	Poorly sorted	-0.25	Fine skewed
B26	Unimodal	130	114	Very fine sand	2.98	Poorly sorted	-0.35	Very fine skewed
B27	Unimodal	159	150	Fine sand	2.82	Poorly sorted	-0.28	Fine skewed
B28	Unimodal	191	181	Fine sand	2.62	Poorly sorted	-0.32	Very fine skewed
B29	Unimodal	154	138	Fine sand	2.99	Poorly sorted	-0.33	Very fine skewed
B30	Unimodal	115	104	Very fine sand	3.04	Poorly sorted	-0.30	Fine skewed
B31_a	Unimodal	181	167	Fine sand	2.79	Poorly sorted	-0.31	Very fine skewed
B32_a	Unimodal	183	172	Fine sand	2.66	Poorly sorted	-0.31	Very fine skewed
B33	Unimodal	112	89	Very fine sand	3.35	Poorly sorted	-0.40	Very fine skewed
B34_a	Unimodal	101	92	Very fine sand	2.86	Poorly sorted	-0.31	Very fine skewed
B35	Unimodal	143	135	Fine sand	3.00	Poorly sorted	-0.27	Fine skewed
B36	Unimodal	123	100	Very fine sand	3.24	Poorly sorted	-0.41	Very fine skewed
B37	Unimodal	102	93	Very fine sand	2.91	Poorly sorted	-0.31	Very fine skewed
B38	Unimodal	118	103	Very fine sand	3.17	Poorly sorted	-0.34	Very fine skewed
B39_a	Unimodal	94	83	Very fine sand	2.97	Poorly sorted	-0.33	Very fine skewed
B40	Unimodal	134	117	Very fine sand	3.37	Poorly sorted	-0.32	Very fine skewed
Minimum	-	72	52	-	1.64	-	-0.47	-
Maximum		338	336		3.60		-0.07	
Median		135	126		2.94		-0.32	
Mean		152	138		2.86		-0.32	

Station	Modality	Median [µm]*	Mean Particle Size		Sorting Coefficient		Skewness	
			[µm]*	Wentworth (1922) Description	[µm]*	Description†	[µm]*	Description†
SD		59	62		0.41		0.06	
Notes SD = Standard deviation * = Folk & Ward method (Gradistat statistics) † = Sorting and skewness based on geometric Folk & Ward (1957) graphical measures (Gradistat statistics)								

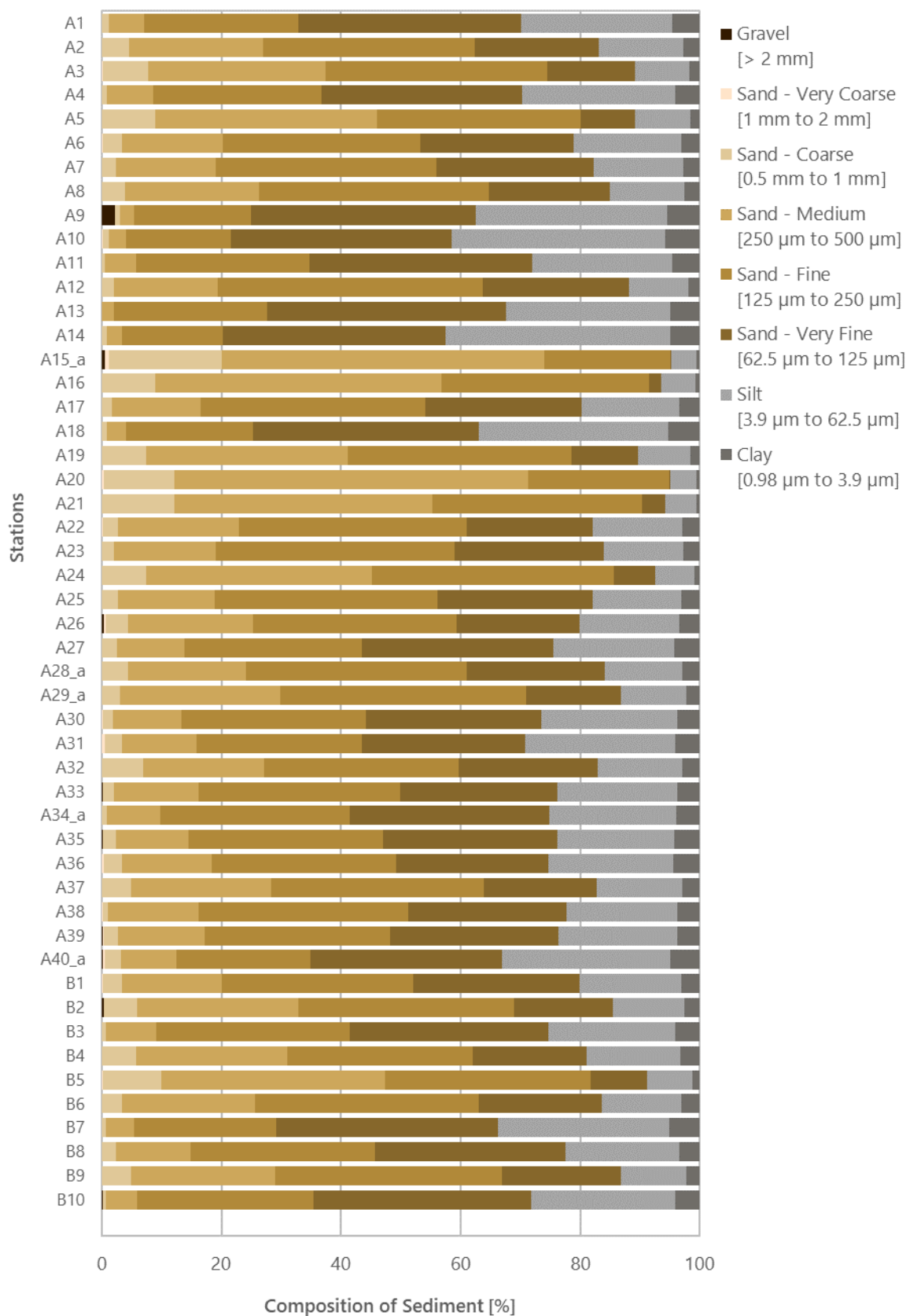


Figure 4.2: Sediment fractional composition, stations A1 to B10

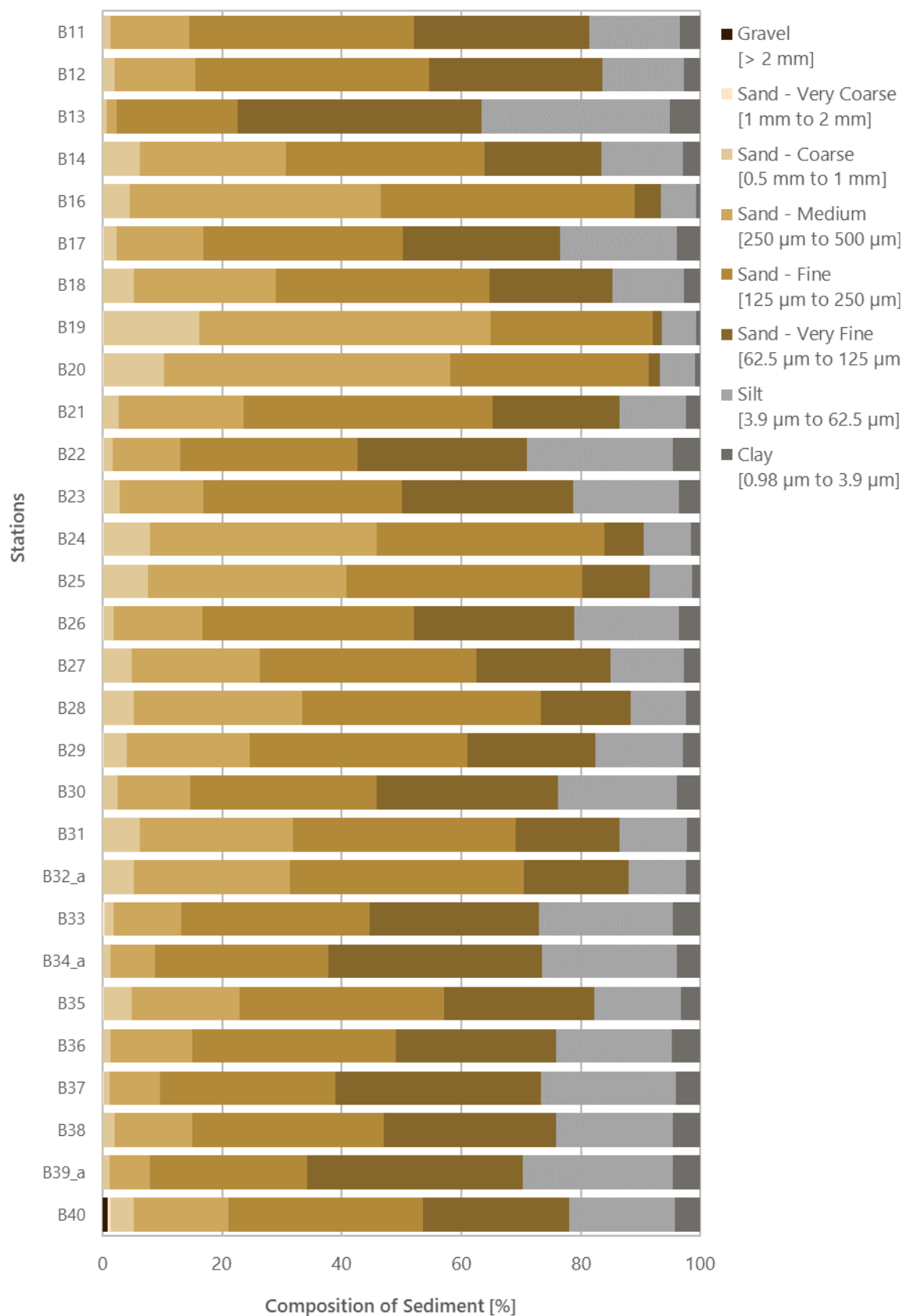


Figure 4.3: Sediment fractional composition, stations B11 to B40

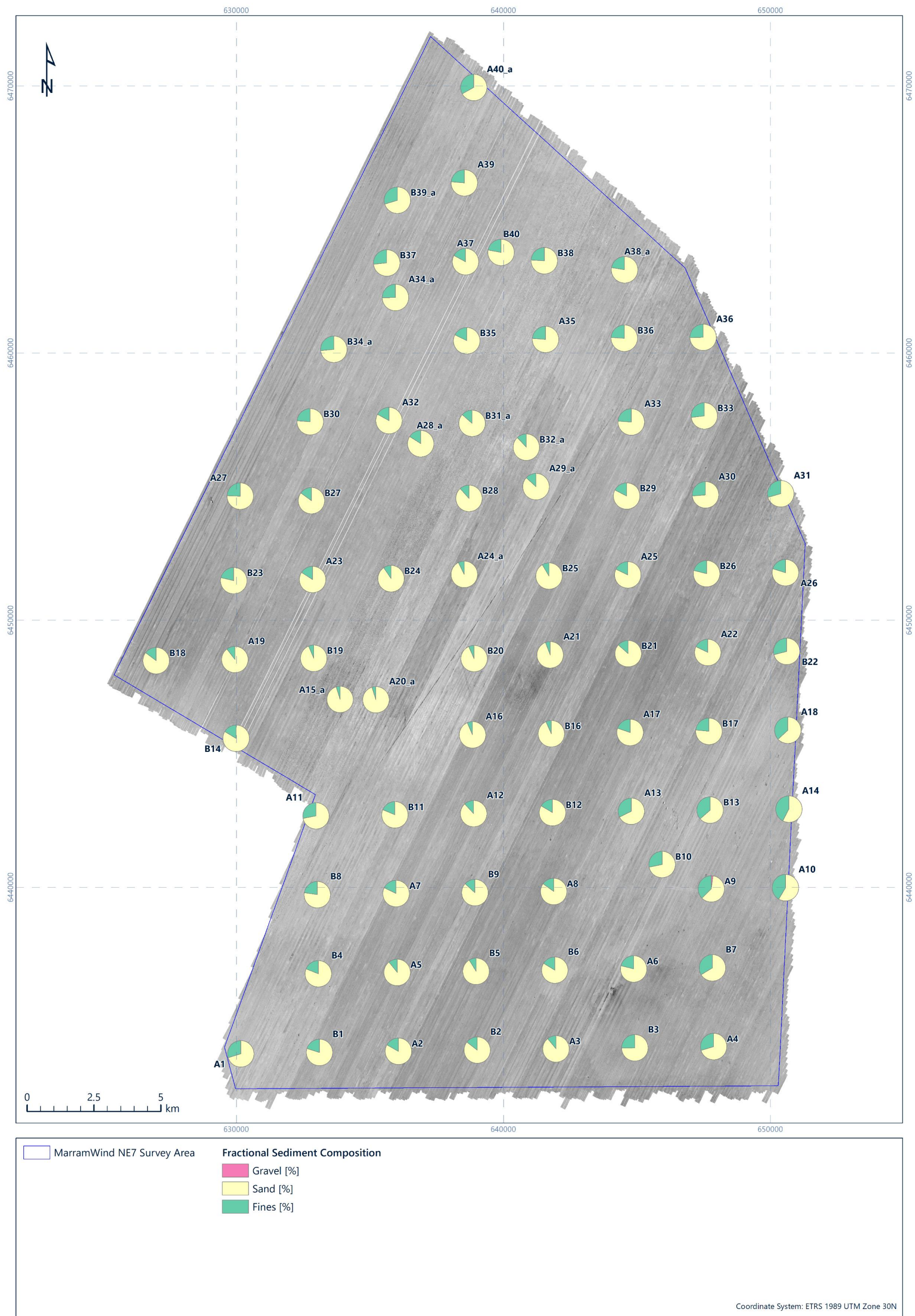


Figure 4.4: Sediment fractional composition on side scan sonar mosaic

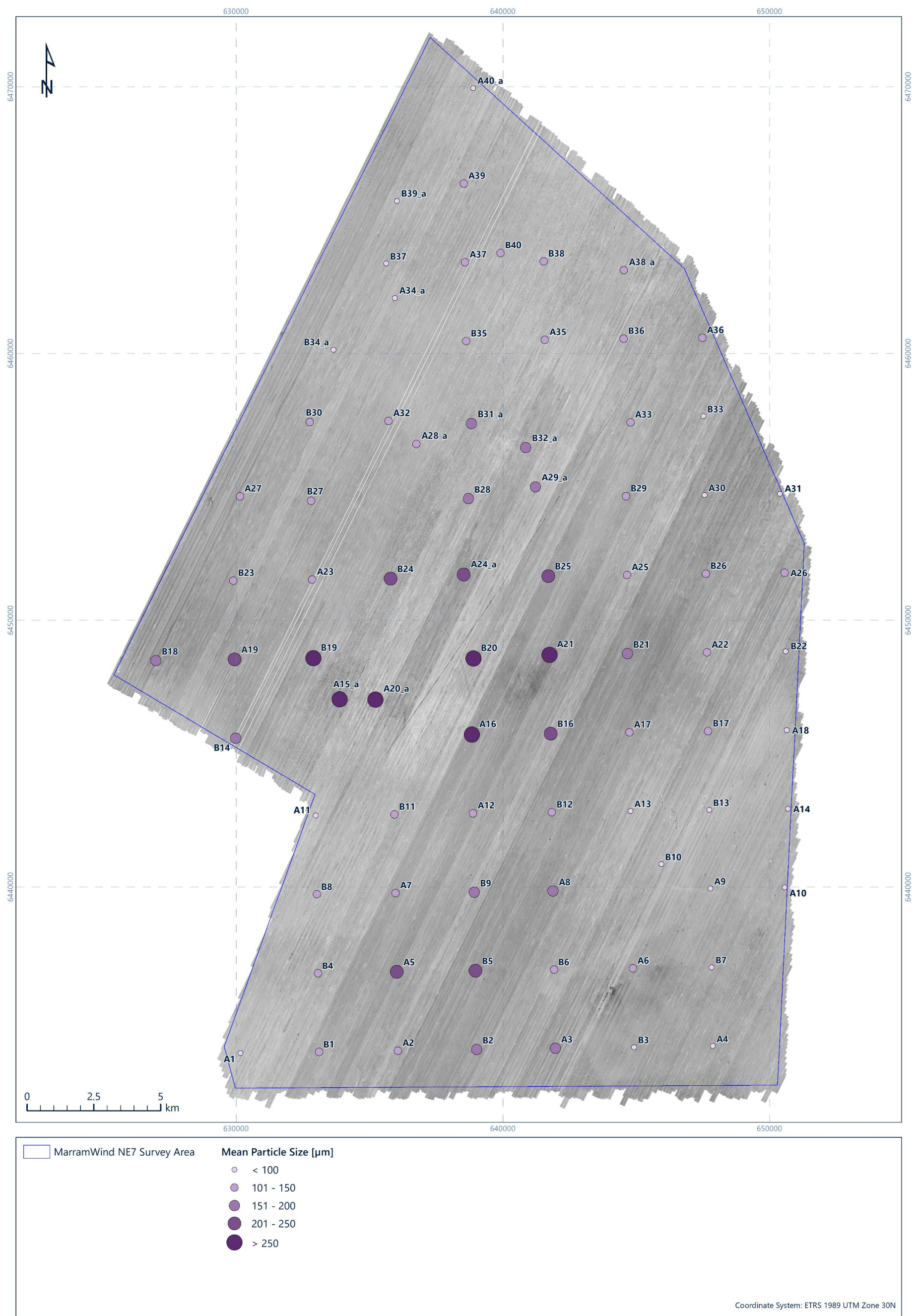


Figure 4.5: Sediment mean particle size (μm) overlaid on a side scan sonar mosaic

4.2.2 Investigation of Granular Similarities

4.2.2.1 Cluster Analysis

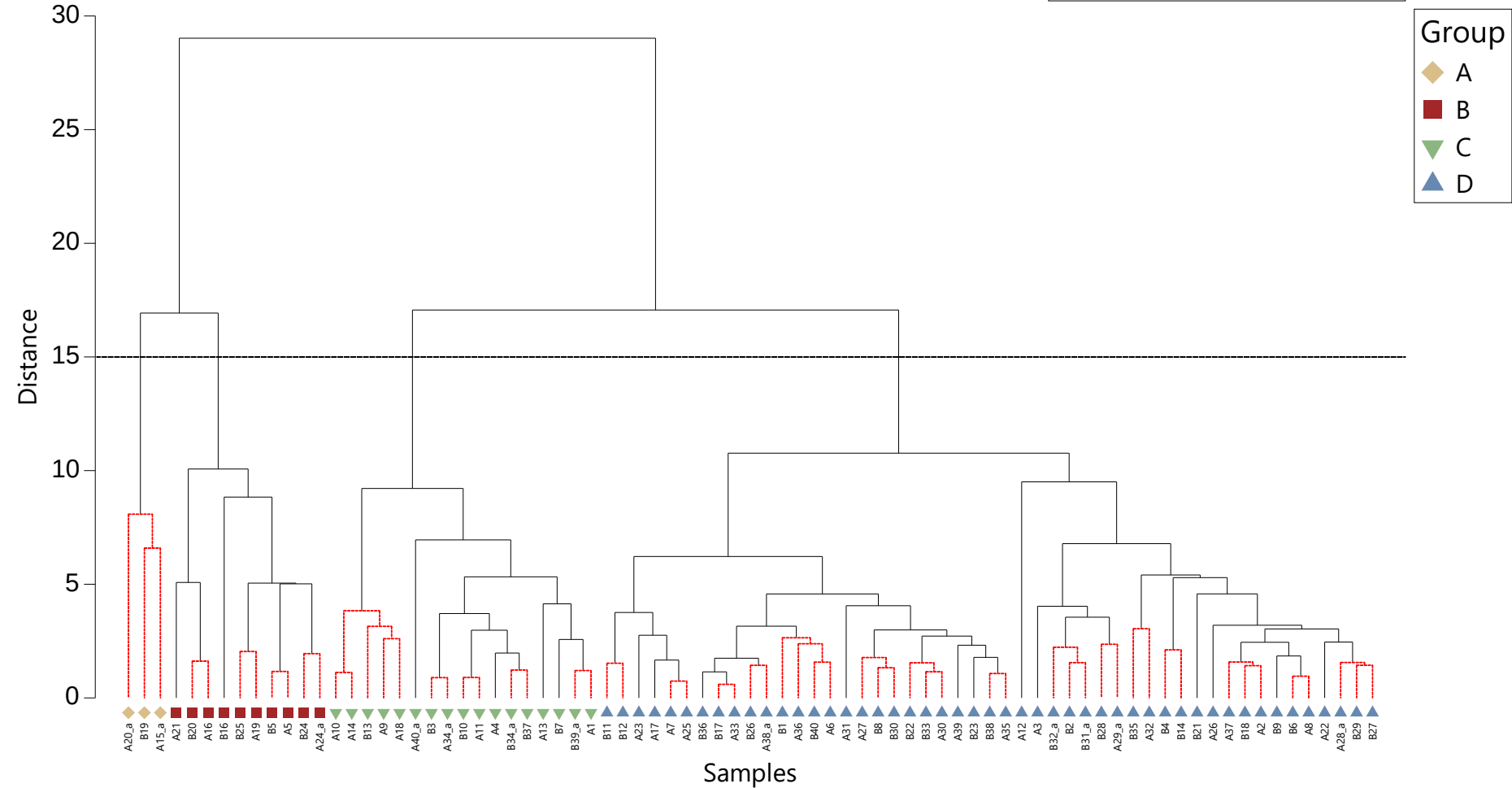
In PRIMER, the 'Cluster' algorithm was used to group samples according to their similarity. Figure 4.6 presents the dendrogram for untransformed sample data. The 'SIMPROF' algorithm was used to identify statistically significant ($P = 0.05$) differences between samples, with significant splits depicted as black lines and non-significant splits as red lines. Statistically significant splits may not be ecologically significant (Clarke et al., 2008), with ecological significance considered in subsequent sections of this report.

Four multivariate groups (A, B, C and D) were identified through the cluster analysis.

- Group A comprised three stations grouped together with an average squared distance of 29.07;
- Group B comprised ten stations grouped together with an average squared distance of 34.48;
- Group C comprised seventeen stations grouped together with an average squared distance of 26.79;
- Group D comprised forty-nine stations grouped together with an average squared distance of 40.35;

Table 4.5 summarises the mean physical characteristics of the sediment groups identified in multivariate analysis. Figure 4.7 spatially presents the sediment groups identified in multivariate analysis overlaid on a side scan sonar mosaic. Sand is the common fraction between all groups. The stations in group A contain less fines and a slightly higher percentage of gravel than stations in groups B, C and D. Group B has the second highest sand content (compared to group A) out of the four groups, with slightly higher fines content to group A. Group C has the lowest sand content and highest fines content of all the groups and group D is transitional between group B and C in terms of sand and fines content. The sediments with the largest sand fractions are located towards the centre of the survey area (Figure 4.4).

Resemblance: D1 Euclidean distance



Note

Slice at 15 resemblance based on Euclidean distance

Figure 4.6: Dendrogram of hierarchical clustering of sediment characteristics data

Table 4.5: Summary of physical characteristics of sediment groups identified in multivariate analysis

Sediment Group	Stations	Depth* [m]	Mean Particle Size* [μm]	Fractional Composition [%]			Folk Description (BGS modified)†
				Gravel*	Sand*	Fines*	
A 	A15_a, A20_a, B19	93 ± 1.15	315 ± 18.6	0.23 ± 0.256	94.39 ± 0.81 9	5.38 ± 0.958	Sand
B 	A5, A16, A19, A24_a, B5, B16, B20, B24, B25	101 ± 5.07	232 ± 23.1	0.01 ± 0.011	91.63 ± 1.62	8.36 ± 1.62	Muddy sand to sand
C 	A1, A9, A10, A11A13, A14, A18, A34_a, A40_a, B3, B7, B10, B11, B13, B34_a, B37, B39_a	116 ± 5.26	78 ± 17.5	0.18 ± 0.519	68.53 ± 6.48	31.30 ± 6.32	Muddy sand
D 	A2, A3, A6, A7, A8, A12, A17, A22, A23, A25, A26, A27, A28_a, A29_a, A30, A31, A32, A33, A35, A36, A37, A38_a, A39, B1, B2, B4, B6, B8, B9, B11, B12, B14, B17, B18, B21, B22, B23, B26 to B33, B35, B36, B38, B40	109 ± 411	130 ± 26.2	0.06 ± 0.131	80.82 ± 4.79	19.12 ± 4.76	Muddy sand
Notes * = Mean ± standard deviation within each sediment group † = Range of Folk descriptions (BGS modified) within each group							

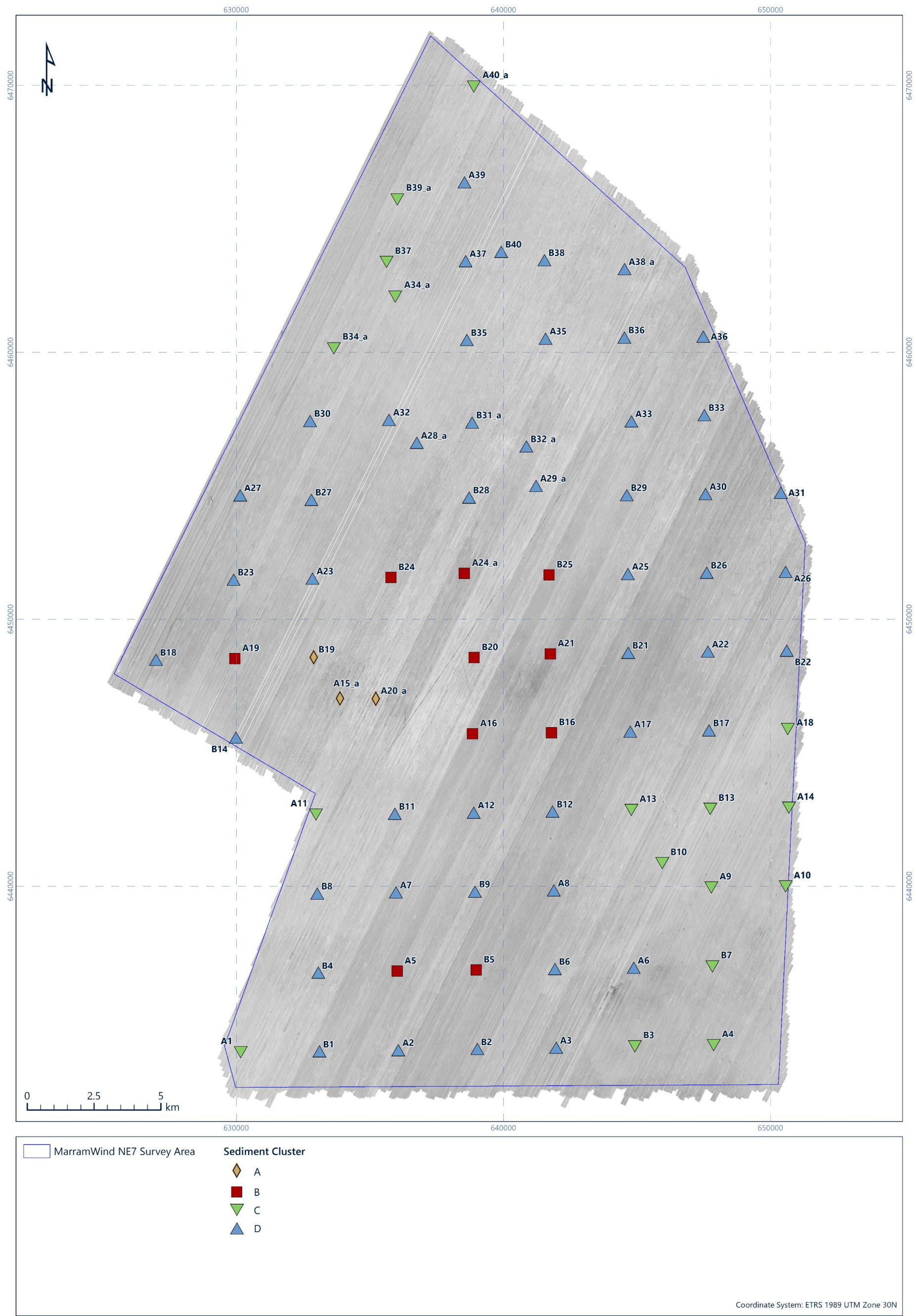


Figure 4.7: Sediment groups overlaid on side scan sonar mosaic

4.2.2.2 Principal Components Analysis

Figure 4.8 presents a principal components analysis (PCA) ordination plot. It displays the percentage of the sediment that comprised each sediment fraction used to identify the sediment groups driving the variability of the sediment composition across the survey area. The first two components accounted for 98.8 % of the variation, with the percentage of fine sand (62 μm ; 0.399 %) having the largest (absolute) value along PC1 and the percentage of coarse sand (125 μm ; 0.634 %) having the largest value along PC2. The PCA analysis compounds the results of the cluster analysis and demonstrates that the driving differences between the clusters are small differences in the percentages of the finer/coarser sediment fractions.

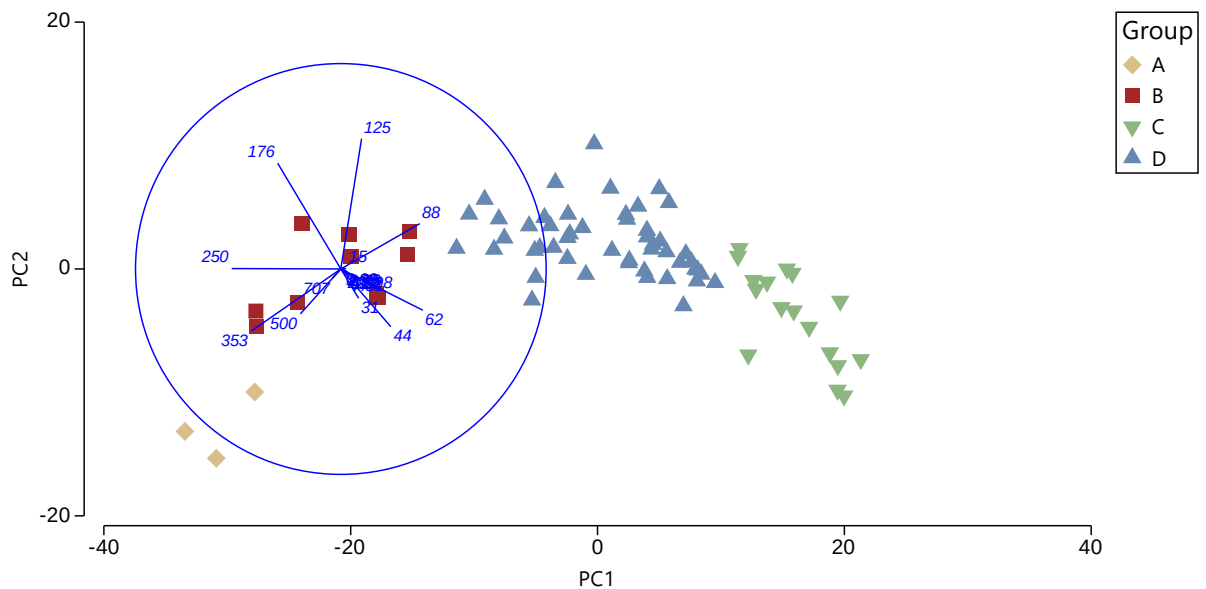


Figure 4.8: Principal components analysis (PCA) ordination of particle sizes (μm)/fractional composition (%)

4.3 Sediment Macrofauna

4.3.1 Infauna

4.3.1.1 Phyletic Composition

A full list of taxa identified and enumerated (individuals per 0.1 m²) from the survey area are presented in Appendix E.

A total of 444 taxa and 55 883 individuals were identified within grab samples from the survey area. Of these taxa, 108 were recorded as juveniles, damaged, meiofauna, pelagic or solitary epifauna. Several other indeterminable specimens were merged. To represent the permanent macrofaunal community and to avoid spurious enhancement of the species list, the dataset was rationalised and these taxa were removed prior to statistical analysis (Appendix E).

Table 4.6 summarises the abundance of taxonomic groups identified within the rationalised dataset across the survey area and Figure 4.9 and Figure 4.10 display the data graphically.

The rationalised data comprised 336 benthic taxa, of which 148 (44.0%) were annelids, 92 (27.4 %) were arthropods, 71 (21.1 %) were molluscs, 14 (4.2 %) were echinoderms and 11 (3.3 %) were other phyla. A total of 43 743 individuals was identified in the rationalised data, of which 32 642 (74.6 %) were annelids, 3072 (7.0 %) were arthropods, 6164 (14.1 %) were molluscs, 550 (1.3 %) were echinoderms and 2606 (6.0 %) were other phyla (Table 4.6).

Table 4.6: Taxonomic groups of macrofauna

Taxonomic Group	Number of Taxa	Composition of Taxa [%]*	Abundance	Composition of Individuals [%]*
Annelida	148	44.0	33105	74.8
Arthropoda	92	27.4	3116	7.0
Mollusca	71	21.1	6240	14.1
Echinodermata	14	4.2	555	1.3
Other phyla	11	3.3	1265	2.9
Total	336	100	44281	100
Notes Macrofaunal samples were processed through a 0.5 mm sieve Other phyla include: Hemichordata, Chordata, Cnidaria, Platyhelminthes, Nemertea and Phoronida * = Percentages expressed to 1 decimal place and, due to numerical rounding, values presented may not equate to 100 %				

Figure 4.9 and Figure 4.10 illustrate the phyletic composition of taxa and individuals for each station (per 0.1 m²), respectively, facilitating spatial comparison and highlighting the broad similarities between stations across the survey area.

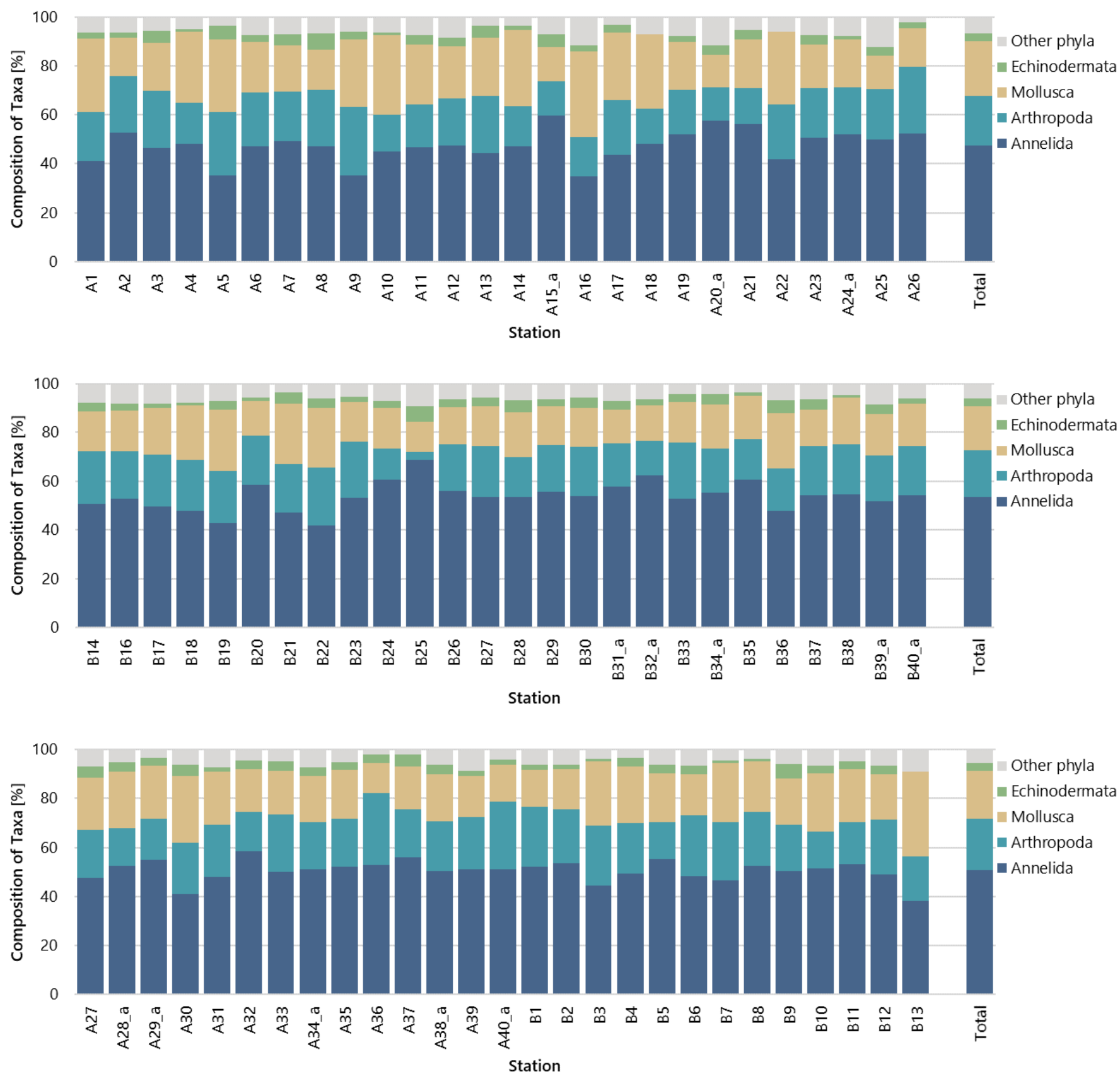


Figure 4.9: Phyletic composition of macrofaunal taxa

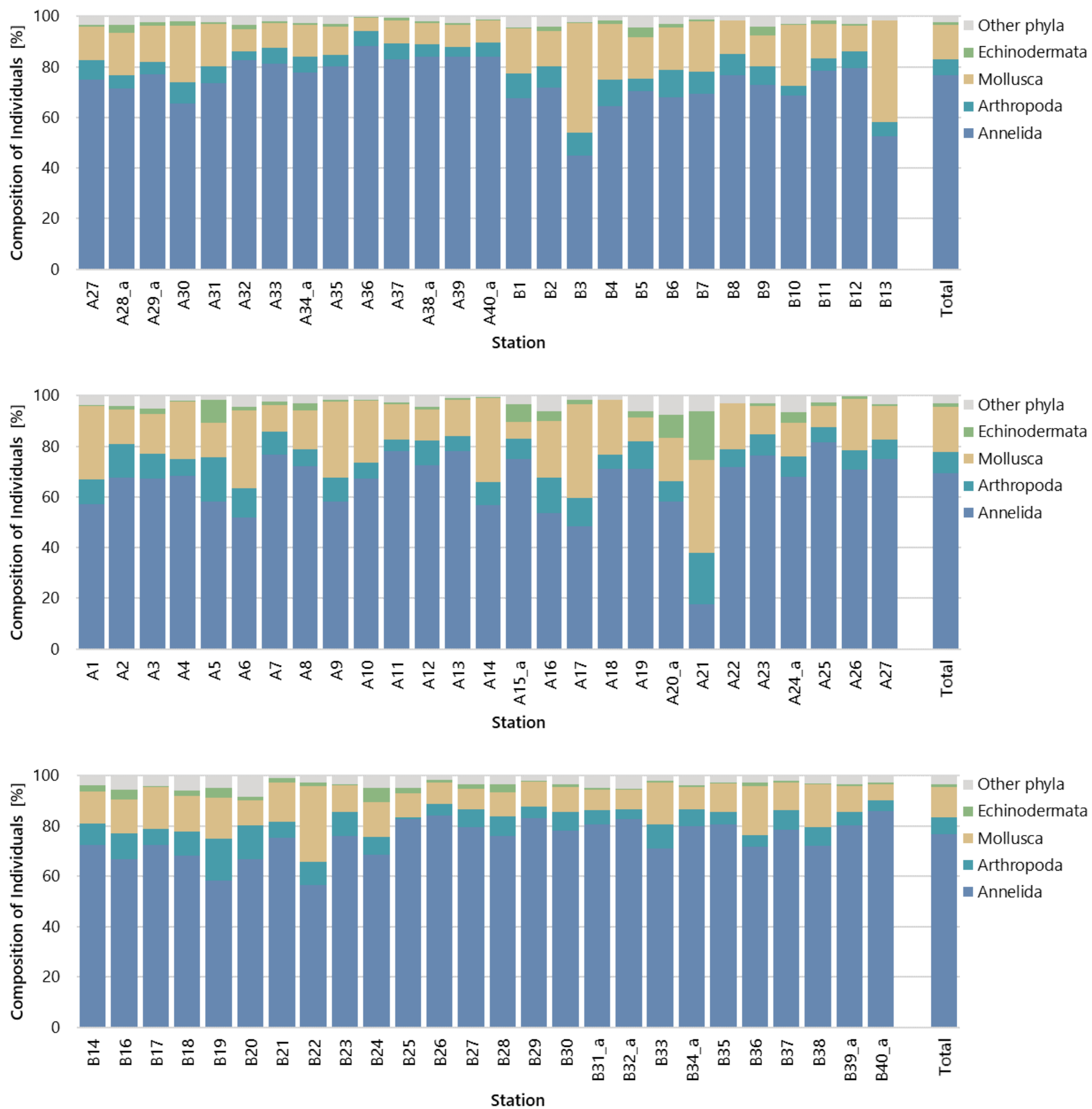


Figure 4.10: Phyletic composition of macrofaunal individuals

4.3.1.2 Community Statistics

Table 4.7 presents the number of taxa and individuals identified within the rationalised dataset from each station, along with commonly used diversity and evenness indices. Figure 4.11 and Figure 4.12 spatially presents the number of taxa and individuals across the survey area.

The number of taxa per station (0.1 m²) ranged from 32 at stations B25 to 119 at station B30, with a mean of 82 and low variability (RSD 20 %).

The number of individuals per station (0.1 m²) ranged from 51 at station B25 to 241 at station B30 with a mean of 157 and low variability (RSD 25 %).

Diversity was high across the survey area, when the Shannon-Wiener diversity index ($H'Log_2$) was considered (when referenced to the classifications within Table 3.2). The Shannon-Wiener diversity index ranged from 4.68 at station B25 to 6.55 at station B30, with a mean of 6.00 and low variability (RSD 5 %).

The Pielou's evenness index (J) is a measure of the distribution of individuals between taxa. The Simpson's index of dominance considers the number and relative abundance of taxa, measuring community diversity by assigning higher weight to dominant taxa. Consequently, the complement of the Simpson's index of dominance (expressed as $1 - \lambda$) also gives an indication of evenness. Pielou's evenness index (J) showed a high level of evenness with low variability across the taxa recorded (mean 0.949; RSD 1 %) indicating a community dominated by one or few taxa. The complement of the Simpson's index of dominance ($1 - \lambda$) largely mirrored the Pielou's evenness index.

Table 4.7: Macrofaunal community statistics (0.1 m²)

Station	Numbers		Diversity Indices	Evenness	
	Taxa	Individuals	Shannon-Wiener ($H'Log_2$)	Pielou (J)	Simpson ($1 - \lambda$)
A1	80	151	6.09	0.963	0.988
A2	95	170	6.34	0.965	0.991
A3	86	173	6.21	0.966	0.990
A4	83	159	5.98	0.939	0.981
A5	64	108	5.78	0.964	0.988
A6	68	112	5.89	0.967	0.989
A7	85	166	6.10	0.952	0.987
A8	74	135	5.89	0.948	0.984
A9	65	119	5.65	0.939	0.980
A10	80	147	5.95	0.941	0.982
A11	81	147	5.96	0.940	0.982

Station	Numbers		Diversity Indices	Evenness	
	Taxa	Individuals	Shannon-Wiener (H'Log ₂)	Pielou (J)	Simpson (1 – λ)
A12	84	159	6.05	0.946	0.985
A13	81	144	5.82	0.918	0.972
A14	55	101	5.41	0.937	0.977
A15_a	57	95	5.66	0.971	0.988
A16	43	67	5.24	0.965	0.983
A17	62	100	5.72	0.961	0.987
A18	83	158	5.96	0.934	0.980
A19	77	151	6.00	0.958	0.988
A20_a	52	85	5.55	0.973	0.988
A21	38	53	5.09	0.969	0.985
A22	81	152	6.00	0.946	0.983
A23	79	154	6.00	0.952	0.986
A24_a	77	131	6.00	0.957	0.987
A25	82	165	5.96	0.938	0.981
A26	92	176	6.16	0.945	0.985
A27	88	175	6.17	0.954	0.987
A28_a	78	142	6.07	0.965	0.989
A29_a	60	109	5.55	0.939	0.977
A30	66	120	5.74	0.950	0.983
A31	98	187	6.21	0.939	0.985
A32	87	191	6.13	0.951	0.986
A33	102	222	6.24	0.936	0.983
A34_a	94	177	6.26	0.954	0.987
A35	96	189	6.21	0.943	0.984
A36	110	259	6.25	0.922	0.980
A37	106	208	6.37	0.947	0.988
A38_a	99	202	6.16	0.929	0.979
A39	94	202	6.12	0.933	0.982
A40_a	94	199	6.03	0.920	0.976
B1	98	202	6.28	0.949	0.988
B3	81	141	6.06	0.956	0.987
B4	87	154	6.21	0.964	0.990
B5	94	186	6.30	0.960	0.990
B6	89	170	6.18	0.955	0.987

Station	Numbers		Diversity Indices	Evenness	
	Taxa	Individuals	Shannon-Wiener (H'Log ₂)	Pielou (J)	Simpson (1 – λ)
B7	88	164	6.07	0.939	0.982
B8	82	144	6.05	0.951	0.985
B9	101	185	6.33	0.951	0.989
B10	93	177	6.19	0.946	0.986
B11	64	114	5.69	0.949	0.981
B12	108	213	6.35	0.941	0.986
B13	55	93	5.40	0.935	0.977
B14	87	163	6.19	0.960	0.989
B16	72	124	5.91	0.958	0.987
B17	99	186	6.31	0.951	0.987
B18	90	174	6.26	0.965	0.990
B19	56	88	5.63	0.970	0.988
B2	99	186	6.34	0.956	0.990
B20	70	122	5.86	0.956	0.987
B21	85	163	6.06	0.945	0.985
B22	81	137	6.00	0.947	0.985
B23	92	193	6.21	0.952	0.988
B24	71	140	5.91	0.961	0.987
B25	32	51	4.68	0.937	0.965
B26	93	188	6.10	0.934	0.980
B27	86	170	6.16	0.959	0.989
B28	86	153	6.15	0.957	0.988
B29	95	190	6.15	0.935	0.982
B30	119	241	6.55	0.951	0.989
B31_a	85	186	6.05	0.944	0.983
B32_a	77	170	5.89	0.939	0.981
B33	95	182	6.21	0.945	0.986
B34_a	94	192	6.20	0.946	0.986
B35	79	158	5.94	0.943	0.983
B36	75	134	5.87	0.942	0.982
B37	94	184	6.18	0.943	0.985
B38_a	88	166	6.11	0.946	0.985
B39_a	81	169	5.93	0.936	0.981
B40_a	98	203	6.20	0.938	0.983

Station	Numbers		Diversity Indices	Evenness	
	Taxa	Individuals	Shannon-Wiener (H'Log ₂)	Pielou (J)	Simpson (1 – λ)
Minimum	32	51	4.68	0.918	0.965
Maximum	119	259	6.55	0.973	0.991
Median	85	163	6.06	0.948	0.985
Mean	82	157	6.00	0.949	0.985
Standard Deviation	16.3	40.1	0.304	0.0121	0.0045
RSD	20	25	5	1	0
Notes RSD – Relative standard deviation					

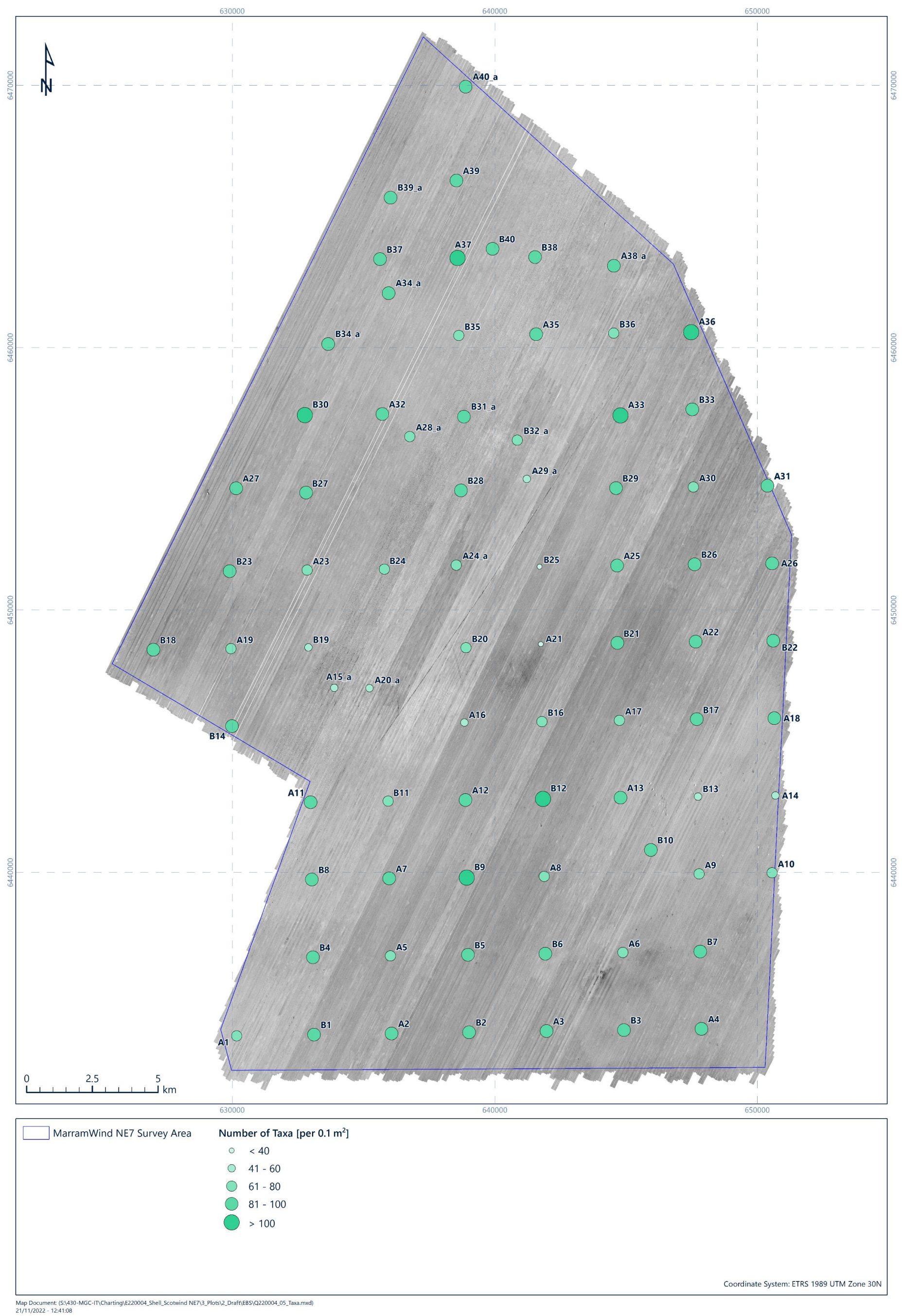


Figure 4.11: Number of macrofaunal taxa per station/sample (0.1 m²) overlaid on a side scan sonar mosaic

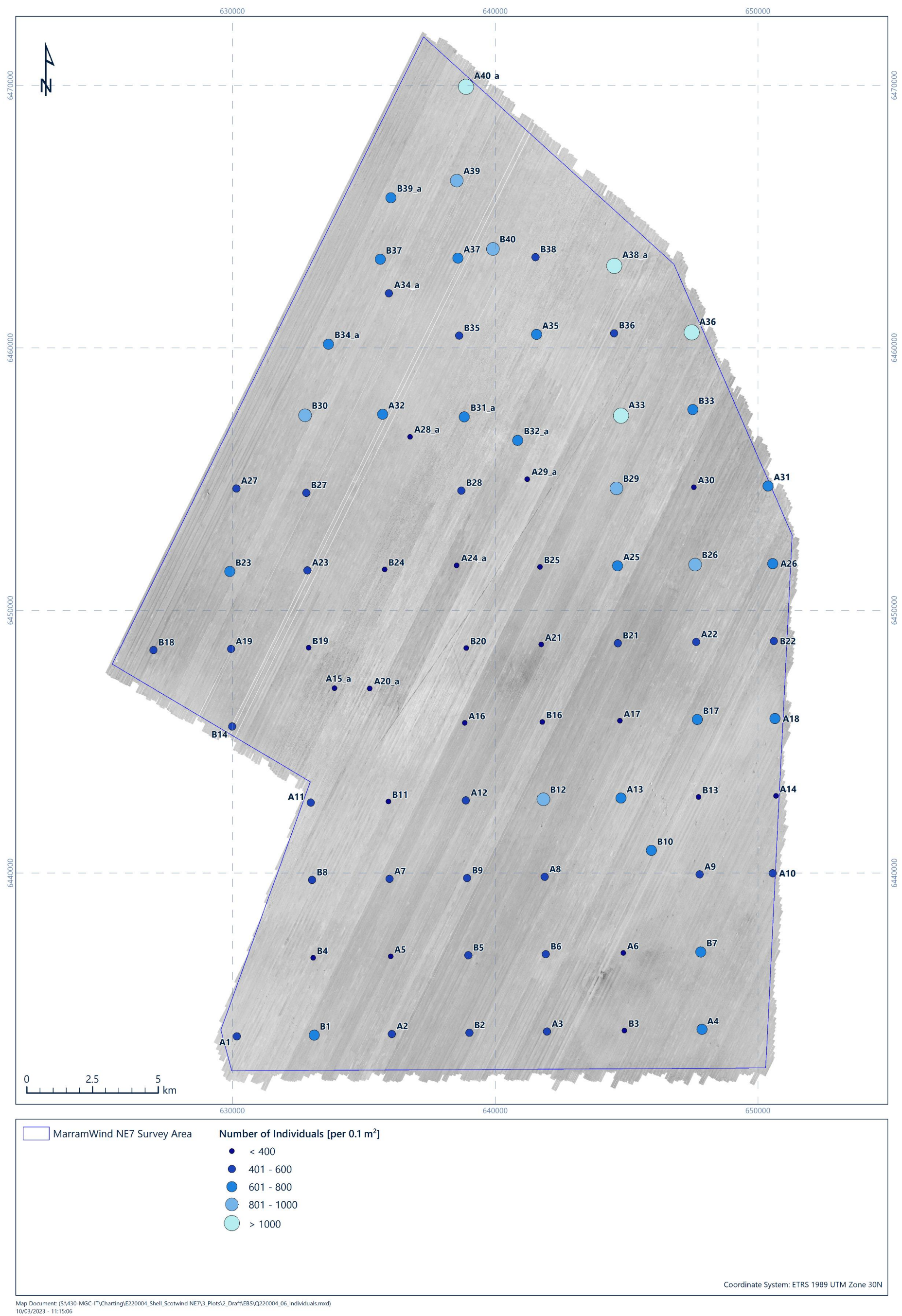


Figure 4.12: Number of macrofaunal individuals per station/sample (0.1 m²) overlaid on a side scan sonar mosaic

4.3.1.3 Investigation of Faunal Similarities

Univariate statistics can summarise large and complex datasets (see Appendix B) to a certain extent, condensing a large data matrix to a much more manageable form and allowing direct comparison of variables. Multivariate analysis examines relationships among multiple variables at the same time, which allows assessment of structure and provides synthesised conclusions with less error and more robustness. In doing so, subtle trends in the data may be elucidated.

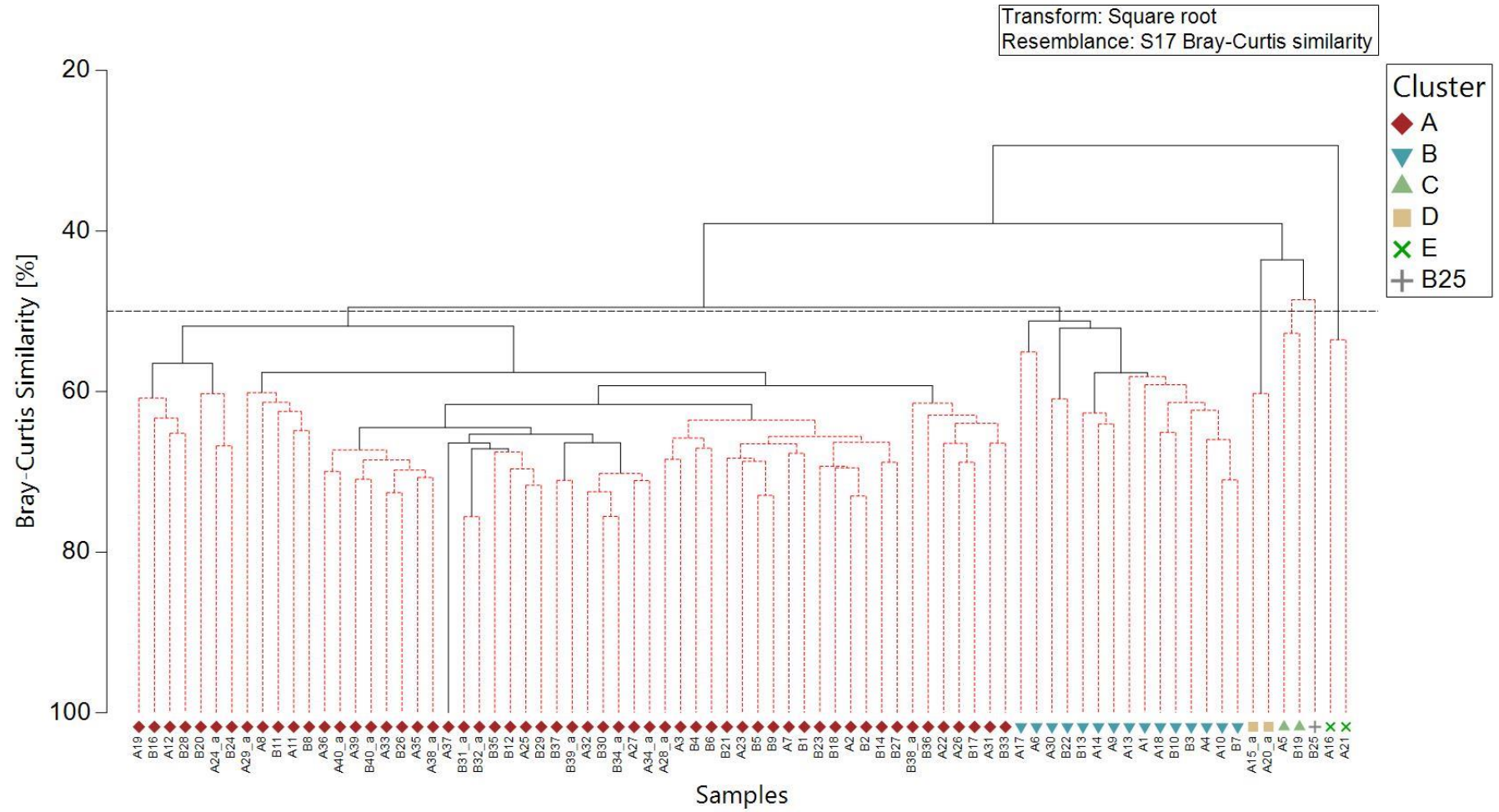
Various multivariate statistical techniques were applied to the macrofauna data to investigate patterns of similarity within the macrobenthic community; for example, hierarchical agglomerative clustering (subsequently referred to as 'Cluster') analysis and non-metric multi-dimensional scaling (nMDS). Figure 4.13 presents the multivariate statistical analyses of the macrobenthic community from PRIMER v7: the 'Cluster' dendrogram. Figure 4.14 displays the clusters spatially across the survey area.

4.3.1.3.1 Cluster Analysis

In PRIMER, the 'Cluster' algorithm was used to group stations according to their faunal similarity. Figure 4.13 presents the hierarchical agglomerative cluster dendrogram for square root transformed station data. The 'SIMPROF' algorithm was used to identify statistically significant ($P = 0.05$) differences between stations, with significant splits depicted as black lines and non-significant splits as red lines. Statistically significant splits may not be ecologically significant (Clarke et al., 2008), with ecological significance considered in subsequent sections of this report.

The whole dataset showed a low to high degree of similarity across the survey area, with similarity between stations ranging from 29.4 to 75.6 %. From the dendrogram, five clusters and an ungrouped station were identified. All the clusters identified were grouped together with a similarity > 50%:

- Cluster A stations were 51.9 % similar and comprised the largest cluster of 57 stations;
- Cluster B was grouped together by a similarity of 51.2 % and comprised 15 stations;
- Cluster C was grouped together by a similarity of 52.8 % and comprised 2 stations (A5 and B19);
- Cluster D was grouped together by a similarity of 60.3 % and comprised 2 stations (A15_a and A20_a);
- Cluster E was grouped together by a similarity of 53.6 % and comprised 2 stations (A16 and A21);
- The ungrouped station (B25) was located towards the centre of the survey area and had 48.6 % similarity with the clusters.



Note
Slice at 50 % resemblance

Figure 4.13: Dendrogram of hierarchical clustering of macrofaunal station (0.1 m²) abundance data

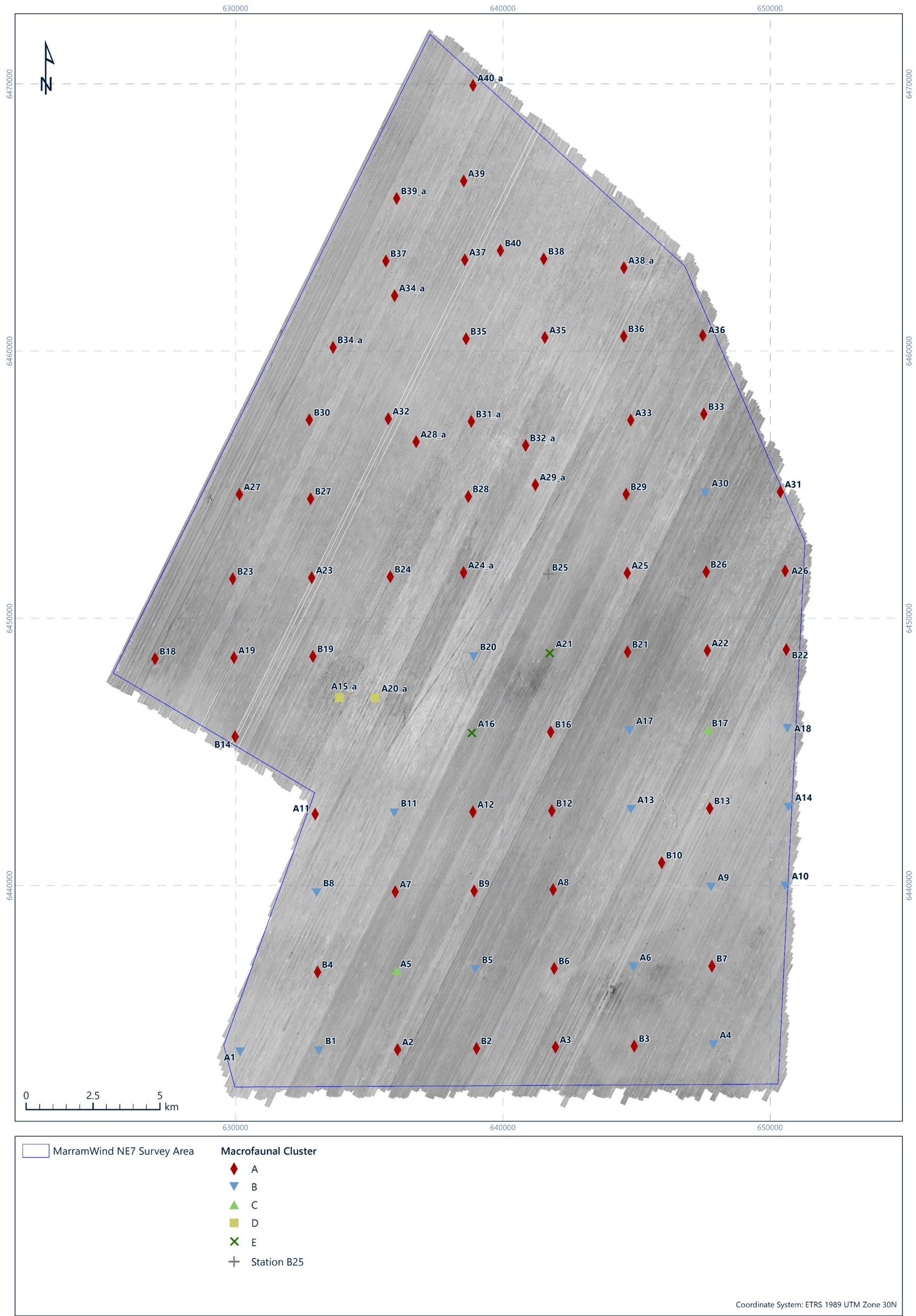


Figure 4.14: Macrofaunal clusters overlaid on side scan sonar mosaic

4.3.1.3.2 Characteristic Taxa from Similarity Percentage Analysis

Table 4.8 summarises the top 10 most abundant taxa within each cluster and ungrouped station.

The top 10 most abundant taxa comprised 61.5 % of cluster A, 67.5 % of cluster B, 56.7 % cluster C, 51.5 % of cluster D and 67.6 % of cluster E (Table 4.8). Therefore, the top 10 taxa are largely representative of the macrofaunal community within each cluster. The clusters were largely similar with differences in number of species within each clusters. The polychaete *Paramphinoe jeffreysii* was the most abundant taxa within cluster A, cluster B, the ungrouped station B25 and was present in the top 10 of the remaining clusters.

Table 4.9 summarises the attributes of multivariate clusters of enumerated macrofauna, including their contribution to the similarity of each cluster from SIMPER.

SIMPER analysis highlighted that the key differences between the statistically significant clusters and ungrouped station were largely due to small scale variability in the abundances and presence/absence of background taxa and species identified as the top ten most abundant taxa. For example, SIMPER analysis highlighted that the increased abundance of the polychaete *P. jeffreysii* appears to influence the observed differences between the clusters and ungrouped station. The abundance of *P. jeffreysii* was responsible for the highest percentage contribution of any taxa to the differences between all groupings (dissimilarity ranged from 3.59 % to 9.42 %), with the exception of differences between clusters C, D and E only (*P. jeffreysii* dissimilarity ranged from 10.2% to 2.65 % between these clusters, where it was not the most abundant taxa; Table 4.8). Figure 4.15 displays the abundances of *P. jeffreysii* across the survey area.

Table 4.8: Top 10 most abundant macrofaunal taxa within each macrofaunal clusters

Cluster A	Ind# [0.1 m ²]	Cum [%]	Cluster B	Ind# [0.1 m ²]	Cum [%]
<i>Paramphinoe jeffreysii</i>	12952	36.3	<i>Paramphinoe jeffreysii</i>	2721	39.4
<i>Sosane wahrbergi</i>	1423	4.0	<i>Adontorhina similis</i>	486	7.0
<i>Lanice conchilega</i>	1379	3.9	<i>Retusa umbilicata</i>	437	6.3
<i>Eclysippe vanelli</i>	1159	3.3	<i>Mendicula ferruginosa</i>	283	4.1
<i>Adontorhina similis</i>	1107	3.1	<i>Diplocirrus glaucus</i>	270	3.9
<i>Exogone verugera</i>	982	2.8	<i>Ampharete falcata</i>	110	1.6
<i>Retusa umbilicata</i>	913	2.6	<i>Eclysippe vanelli</i>	96	1.4
<i>Ampharete falcata</i>	837	2.3	<i>Galathowenia oculata</i>	95	1.4
<i>Galathowenia oculata</i>	571	1.6	<i>Lanice conchilega</i>	82	1.2
<i>Spiophanes kroyeri</i>	566	1.6	Terebellides	82	1.2
Cluster C	Ind# [0.1 m ²]	Cum [%]	Cluster D	Ind# [0.1 m ²]	Cum [%]
<i>Lanice conchilega</i>	60	13.9	<i>Exogone verugera</i>	32	8.6

<i>Paramphinome jeffreysii</i>	45	10.4	<i>Echinocyamus pusillus</i>	27	7.2
<i>Echinocyamus pusillus</i>	24	5.6	<i>Galathowenia oculata</i>	22	5.9
<i>Ampharete falcata</i>	19	4.4	<i>Lanice conchilega</i>	21	5.6
<i>Spiophanes kroyeri</i>	17	3.9	<i>Paramphinome jeffreysii</i>	20	5.3
<i>Exogone verugera</i>	16	3.7	<i>Spiophanes kroyeri</i>	19	5.1
<i>Urothoe elegans</i>	16	3.7	<i>Paradoneis lyra</i>	17	4.5
<i>Tryphosites longipes</i>	16	3.7	<i>Urothoe elegans</i>	12	3.2
<i>Sosane wahrbergi</i>	12	2.8	<i>Parexogone hebes</i>	12	3.2
<i>Paradoneis lyra</i>	10	2.3	<i>Aonides paucibranchiata</i>	11	2.9
<i>Antalis entalis</i>	10	2.3			
Cluster E	Ind[‡] [0.1 m²]	Cum [%]	Station B25	Ind[‡] [0.1 m²]	Cum [%]
<i>Lanice conchilega</i>	48	20.2	<i>Paramphinome jeffreysii</i>	72	51.4
<i>Retusa umbilicata</i>	26	10.9	<i>Lanice conchilega</i>	11	7.9
<i>Echinocyamus pusillus</i>	19	8.0	<i>Retusa umbilicata</i>	8	5.7
<i>Eudorellopsis deformis</i>	17	7.1	<i>Galathowenia oculata</i>	5	3.6
<i>Paramphinome jeffreysii</i>	10	4.2	<i>Phoronis</i>	5	3.6
<i>Scoloplos armiger</i>	8	3.4	<i>Sosane wahrbergi</i>	3	2.1
<i>Antalis entalis</i>	7	2.9	<i>Adontorhina similis</i>	3	2.1
<i>Phoronis</i>	6	2.5	<i>Ampharete falcata</i>	3	2.1
<i>Galathowenia oculata</i>	5	2.1	<i>Spiophanes kroyeri</i>	3	2.1
<i>Owenia</i>	5	2.1	<i>Eclysippe vanelli</i>	2	1.4
<i>Urothoe elegans</i>	5	2.1	<i>Exogone verugera</i>	2	1.4
<i>Myriochele danielsseni</i>	5	2.1	<i>Scoloplos armiger</i>	2	1.4
Notes Ind = Number of individuals of each taxon within the station (0.1 m ²) Cum = Cumulative percentage of the individuals of each taxon relative to the total number of individuals recorded within the station (0.1 m ²) [‡] = Mean ± standard deviation within each macrofaunal community group					

Table 4.9: Summary of attributes of multivariate clusters of enumerated macrofauna

Cluster	Stations	Characterising Features	Characterising Taxa	Mean Abundance [N]	Frequency [%]	Contribution to Similarity [%]
Cluster A	A2, A3, A7, A8, A11, A12, A19, A22, A23, A24_a, A25, A26, A27, A28_a, A29_a, A31, A32, A33, A34_a, A35, A36, A37, A38_a, A39, A40_a, B1, B4, B5, B6, B8, B9, B11, B12, B14, B16, B17, B18, B2, B20, B21, B23, B24, B26, B27, B28, B29, B30, B31_a, B32_a, B33, B34_a, B35, B36, B37, B38_a, B39_a, B40_a	Taxa: 318 Individuals: 35 650 Depth [m BSL]: 107 Gravel [%]: 0.06 Sand [%]: 81.4 Fines [%]: 18.6 Median [µm]: 151 Sorting [µm]: 2.89	<i>Paramphinome jeffreysii</i>	14.13	100.0	10.88
			<i>Eclysippe vanelli</i>	4.35	100.0	3.58
			<i>Lanice conchilega</i>	4.59	100.0	3.56
			<i>Retusa umbilicata</i>	3.94	100.0	3.47
			<i>Adontorhina similis</i>	4.18	98.2	3.29
			<i>Ampharete falcata</i>	3.74	100.0	3.21
			<i>Exogone verugera</i>	3.91	98.2	3.02
			<i>Sosane wahrbergi</i>	4.41	96.5	2.88
			<i>Spiophanes kroyeri</i>	3.05	100.0	2.53
			<i>Galathowenia oculata</i>	3.02	100.0	2.41
Cluster B	A1, A4, A6, A9, A10, A13, A14, A17, A18, A30, B3, B7, B10, B13, B22	Taxa: 220 Individuals: 6909 Depth [m BSL]: 118 Gravel [%]: 0.19 Sand [%]: 68.5 Fines [%]: 31.4 Median [µm]: 95.8 Sorting [µm]: 3.14	<i>Paramphinome jeffreysii</i>	12.71	100.0	13.17
			<i>Adontorhina similis</i>	5.65	100.0	7.01
			<i>Retusa umbilicata</i>	5.28	100.0	6.23
			<i>Mendicula ferruginosa</i>	4.25	100.0	4.96
			<i>Diplocirrus glaucus</i>	3.92	93.3	3.9
			<i>Ampharete falcata</i>	2.62	100.0	2.99
			<i>Lanice conchilega</i>	2.26	100.0	2.54

Cluster	Stations	Characterising Features	Characterising Taxa	Mean Abundance [N]	Frequency [%]	Contribution to Similarity [%]
			<i>Eclysippe vanelli</i>	2.33	93.3	2.29
			<i>Axinulus croulinensis</i>	2.00	93.3	2.28
			<i>Galathowenia oculata</i>	2.26	93.3	2.21
Cluster C	A5, B19	Taxa: 88 Individuals: 432 Depth [m BSL]: 97 Gravel [%]: 0.04 Sand [%]: 91.3 Fines [%]: 8.6 Median [µm]: 269 Sorting [µm]: 2.32	<i>Lanice conchilega</i>	5.48	100.0	10.61
			<i>Paramphinome jeffreysii</i>	4.69	100.0	7.75
			<i>Spiophanes kroyeri</i>	2.91	100.0	5.48
			<i>Exogone verugera</i>	2.78	100.0	4.33
			<i>Paradoneis lyra</i>	2.24	100.0	4.33
			<i>Echinocyamus pusillus</i>	3.30	100.0	4.33
			<i>Scoloplos armiger</i>	2.12	100.0	3.87
			<i>Urothoe elegans</i>	2.73	100.0	3.87
			<i>Retusa umbilicata</i>	2.12	100.0	3.87
			<i>Eclysippe vanelli</i>	1.87	100.0	3.35
Cluster D	A15_a, A20_a	Taxa: 77 Individuals: 374 Depth [m BSL]: 92 Gravel [%]: 0.30 Sand [%]: 94.9 Fines [%]: 4.8 Median [µm]: 326 Sorting [µm]: 1.66	<i>Exogone verugera</i>	3.98	100.0	6.64
			<i>Echinocyamus pusillus</i>	3.67	100.0	6.38
			<i>Paramphinome jeffreysii</i>	3.16	100.0	5.53
			<i>Spiophanes kroyeri</i>	3.08	100.0	5.53
			<i>Lanice conchilega</i>	3.23	100.0	5.53
			<i>Galathowenia oculata</i>	3.26	100.0	4.87
			<i>Urothoe elegans</i>	2.44	100.0	4.12
			<i>Timoclea ovata</i>	2.24	100.0	4.12
			<i>Paradoneis lyra</i>	2.80	100.0	3.68

Cluster	Stations	Characterising Features	Characterising Taxa	Mean Abundance [N]	Frequency [%]	Contribution to Similarity [%]
			<i>Aonides paucibranchiata</i>	2.32	100.0	3.68
Cluster E	A16, A21	Taxa: 59 Individuals: 238 Depth [m BSL]: 97 Gravel [%]: 0.01 Sand [%]: 93.9 Fines [%]: 6.1 Median [µm]: 271 Sorting [µm]: 2.05	<i>Retusa umbilicata</i>	3.58	100.0	9.82
			<i>Lanice conchilega</i>	4.62	100.0	9.32
			<i>Eudorellopsis deformis</i>	2.91	100.0	8.78
			<i>Echinocyamus pusillus</i>	2.99	100.0	6.94
			<i>Scoloplos armiger</i>	2.00	100.0	6.21
			<i>Paramphinome jeffreysii</i>	2.19	100.0	5.38
			Owenia	1.57	100.0	4.39
			<i>Kurtiella bidentata</i>	1.41	100.0	4.39
			Phoronis	1.71	100.0	4.39
			Edwardsiidae	1.21	100.0	3.11

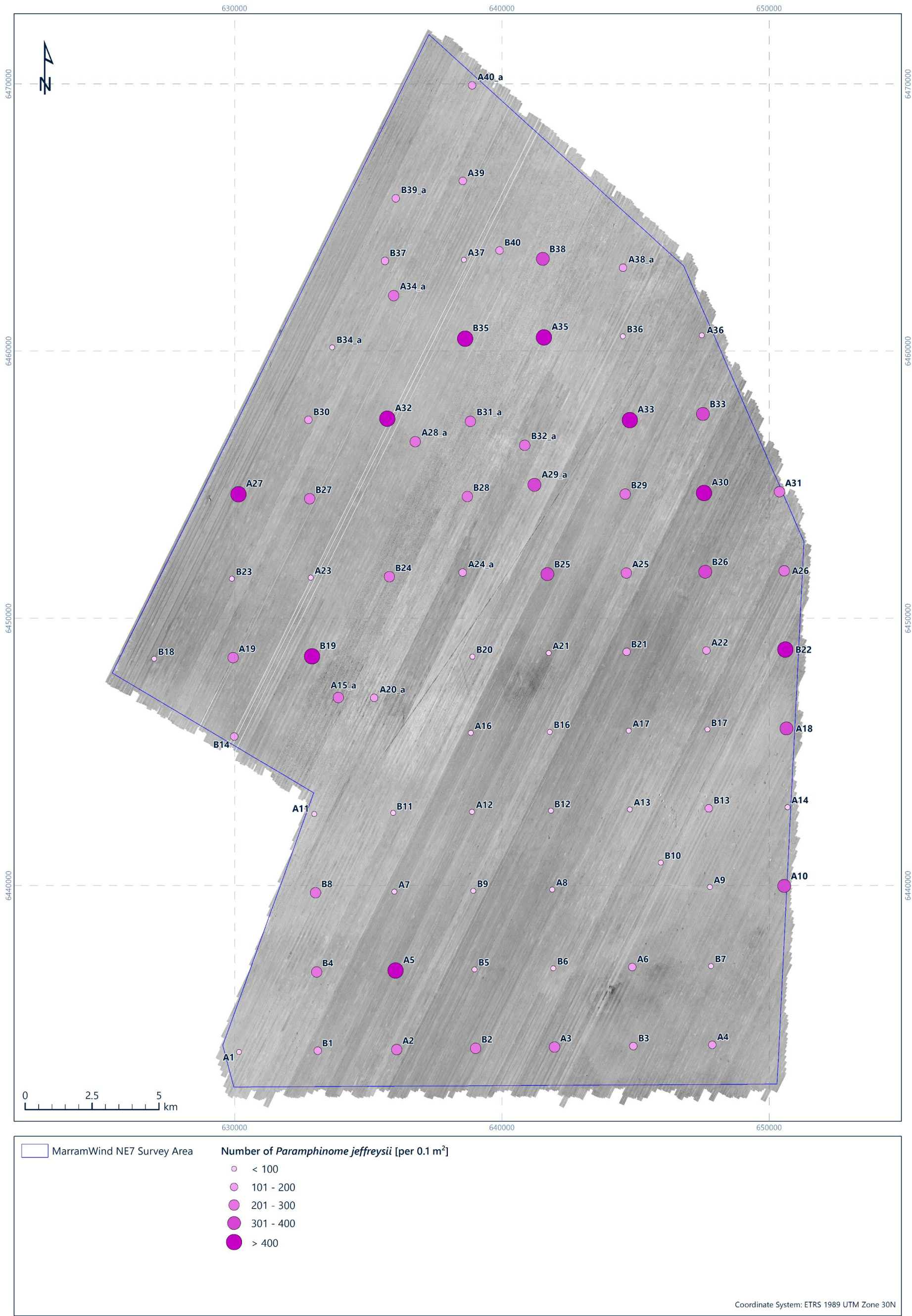


Figure 4.15: Number of *Paramphinome jeffreysii* per station/sample (0.1 m²) overlaid on a side scan sonar mosaic

4.3.1.4 Biomass

Table 4.10 summarises the total macrofaunal biomass and phyletic composition of the biomass by station across the survey area. Figure 4.16 to Figure 4.18 present the phyletic composition of the biomass graphically, whilst Figure 4.19 spatially presents the total macrofaunal biomass across the survey area. Appendix E presents the full list of macrofaunal biomass by taxa.

Overall, annelids comprised most of the macrofaunal biomass across the survey area, particularly related to the high abundance of the polychaete *Paramphinoe jeffreysii*.

At stations A1, A4, A30, A33, A36, A38, B9, B10, B21, B25, B34_a, B37 and B39_a, the highest biomass values were recorded for echinoderms, generally associated with brittlestars *Amphiura chiajei* and *Amphiura filiformis*, which comprised a total of 36 individuals, the urchin *Echinocyamus pusillus*, which comprised 19 individuals, and the holothurian *Labidoplax buskii*, which comprised 15 individuals.

At stations A18 and A21, the highest biomass values were recorded for molluscs, associated with the high abundance of the gastropod *Retusa umbilicata*, which comprised 64 individuals, the bivalves *Adontorhina similis*, which comprised 41 individuals and, to a lesser extent, *Mendicula ferruginosa*, which comprised 10 individuals.

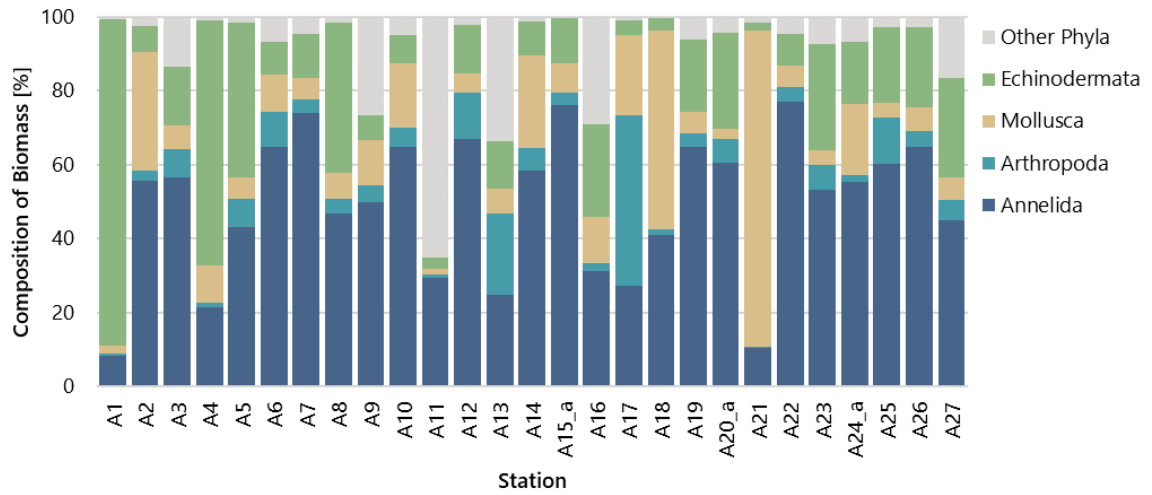
At stations A11, B13, B26 and B38, the highest biomass values were recorded for miscellaneous phyla, associated with high abundance of the nemerteans *Tubulanus polymorphus* and species of the genus *Cerebratulus*, which comprised 17 and 10 individuals respectively, and *Phoronis*, which comprised 14 individuals.

Table 4.10: Phyletic composition of macrofaunal biomass

Station	Biomass					Total
	Annelida	Arthropoda	Mollusca	Echinodermata	Other Phyla	
A1	0.0945	0.0085	0.0249	1.0201	0.0064	1.1544
A2	0.1545	0.0080	0.0888	0.0195	0.0071	0.2779
A3	0.0534	0.0070	0.0062	0.0149	0.0127	0.0942
A4	0.1120	0.0060	0.0530	0.3441	0.0058	0.5208
A5	0.0336	0.0059	0.0046	0.0328	0.0011	0.0781
A6	0.0616	0.0090	0.0095	0.0083	0.0064	0.0949
A7	0.0717	0.0036	0.0058	0.0114	0.0046	0.0970
A8	0.0686	0.0059	0.0102	0.0596	0.0024	0.1466
A9	0.0790	0.0076	0.0190	0.0107	0.0425	0.1587
A10	0.0875	0.0071	0.0234	0.0106	0.0065	0.1351
A11	0.1783	0.0060	0.0096	0.0185	0.3939	0.6062
A12	0.0933	0.0174	0.0073	0.0183	0.0028	0.1390
A13	0.1138	0.1017	0.0318	0.0589	0.1548	0.4610
A14	0.1103	0.0117	0.0469	0.0177	0.0022	0.1889

Station	Biomass					Total
	Annelida	Arthropoda	Mollusca	Echinodermata	Other Phyla	
A15_a	0.1013	0.0046	0.0107	0.0162	0.0005	0.1332
A16	0.0235	0.0018	0.0094	0.0188	0.0220	0.0755
A17	0.0177	0.0303	0.0141	0.0027	0.0006	0.0654
A18	0.1932	0.0073	0.2531	0.0165	0.0014	0.4714
A19	0.0635	0.0035	0.0059	0.0190	0.0062	0.0981
A20_a	0.1157	0.0125	0.0048	0.0498	0.0083	0.1912
A21	0.0775	0.0025	0.6271	0.0146	0.0126	0.7343
A22	0.1681	0.0086	0.0127	0.0184	0.0100	0.2179
A23	0.1379	0.0173	0.0105	0.0743	0.0193	0.2594
A24_a	0.0565	0.0016	0.0197	0.0171	0.0069	0.1017
A25	0.1423	0.0294	0.0094	0.0481	0.0065	0.2357
A26	0.0870	0.0061	0.0084	0.0292	0.0038	0.1344
A27	0.0893	0.0111	0.0120	0.0535	0.0326	0.1985
A28_a	0.0622	0.0076	0.0135	0.0536	0.0009	0.1377
A29_a	0.0311	0.0040	0.0039	0.0079	0.0029	0.0497
A30	0.1377	0.0086	0.0115	0.2164	0.0005	0.3746
A31	0.1673	0.0465	0.0210	0.0221	0.0126	0.2695
A32	0.1980	0.0071	0.0332	0.0544	0.0065	0.2993
A33	0.1623	0.0217	0.0112	0.4649	0.0117	0.6718
A34_a	0.1195	0.0089	0.0096	0.0262	0.0133	0.1775
A35	0.1123	0.0246	0.0143	0.0264	0.0023	0.1798
A36	0.2507	0.1101	0.0072	1.3311	0.1472	1.8463
A37	0.2949	0.0654	0.0500	0.2023	0.0049	0.6174
A38_a	0.1438	0.0264	0.0168	0.2461	0.0062	0.4394
A39	0.1881	0.0048	0.0092	0.0163	0.1221	0.3405
A40_a	0.1796	0.0115	0.0209	0.0315	0.0921	0.3355
B1	0.0973	0.0121	0.0144	0.0047	0.0068	0.1352
B2	0.0773	0.0050	0.0140	0.0251	0.0034	0.1249
B3	4.0592	0.0072	0.2744	0.0041	0.0026	4.3474
B4	0.0516	0.0092	0.0142	0.0068	0.0024	0.0842
B5	0.1244	0.0090	0.0261	0.0460	0.0218	0.2272
B6	0.1092	0.0159	0.0123	0.0270	0.0378	0.2021
B7	0.3034	0.0095	0.0284	0.0011	0.0027	0.3451
B8	0.0743	0.0080	0.0089	0.0050	0.0014	0.0976
B9	0.0718	0.0062	0.0110	0.2652	0.0015	0.3559
B10	0.3152	0.0074	0.0264	0.4801	0.0072	0.8362
B11	0.0393	0.0002	0.0064	0.0106	0.0022	0.0588
B12	0.0870	0.0087	0.0134	0.0171	0.0336	0.1598
B13	0.0755	0.0279	0.0142	0.0220	0.4679	0.6075

Station	Biomass					
	Annelida	Arthropoda	Mollusca	Echinodermata	Other Phyla	Total
B14	0.0864	0.0186	0.0284	0.0401	0.0400	0.2134
B16	0.0941	0.0026	0.0053	0.0150	0.0044	0.1215
B17	0.1861	0.0122	0.0225	0.0258	0.0136	0.2602
B18	0.0790	0.0065	0.0129	0.0134	0.0049	0.1168
B19	0.1488	0.0301	0.0075	0.0037	0.0135	0.2035
B20	0.1164	0.0102	0.0118	0.0248	0.0032	0.1663
B21	0.0812	0.0023	0.0134	0.0497	0.0003	0.1468
B22	0.1607	0.0306	0.0177	0.2630	0.0148	0.4867
B23	0.1256	0.0205	0.1721	0.0328	0.0123	0.3633
B24	0.0360	0.0011	0.0226	0.0293	0.0021	0.0911
B25	0.0670	0.0039	0.0004	0.0092	0.0030	0.0835
B26	0.1943	0.0073	0.0113	0.8445	0.0066	1.0641
B27	0.1115	0.0106	0.0201	0.0225	0.3605	0.5251
B28	0.1358	0.0061	0.0062	0.0161	0.0089	0.1732
B29	0.1174	0.0169	0.0088	0.0162	0.0029	0.1622
B30	0.1943	0.0104	0.0097	1.4091	0.0408	1.6643
B31_a	0.0396	0.0026	0.0062	0.0172	0.0053	0.0710
B32_a	0.0764	0.0031	0.0066	0.0069	0.0039	0.0969
B33	0.2171	0.0866	0.0171	0.0415	0.0690	0.4315
B34_a	0.1662	0.0060	0.0058	1.4489	0.0148	1.6417
B35	0.0902	0.0034	0.0187	0.0336	0.0014	0.1473
B36	0.1307	0.0075	0.0706	0.0418	0.0094	0.2601
B37	0.1064	0.0169	0.0228	0.8395	0.0330	1.0185
B38	0.1133	0.1591	0.0080	0.0039	0.4714	0.7557
B39_a	0.1913	0.0097	0.0058	0.6038	0.2927	1.1034
B40_a	0.1472	0.0071	0.0069	0.0729	0.0111	0.2452
Minimum	0.0177	0.0002	0.0004	0.0011	0.0003	0.0497
Maximum	4.0592	0.1591	0.6271	1.4489	0.4714	4.3474
Median	0.1115	0.0085	0.0127	0.0251	0.0066	0.2035
Mean	0.1687	0.0166	0.0325	0.1464	0.0410	0.4051
SD	0.4476	0.0257	0.0813	0.3182	0.0992	0.5849
Notes Biomass expressed as ash free dry weight in g/0.1 m ² grab sample Other Phyla includes Cnidaria, Platyhelminthes, Nemertea, Phoronida, Hemichordata and Chordata						

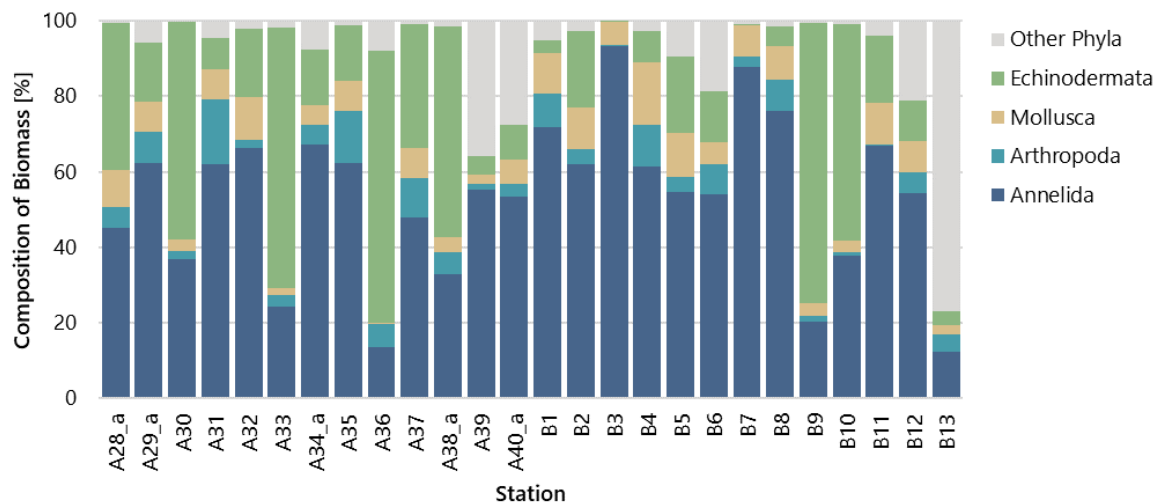


Notes

Biomass expressed as ash free dry weight in g/0.1 m² grab sample

Other Phyla includes Cnidaria, Platyhelminthes, Nemertea, Phoronida, Hemichordata and Chordata

Figure 4.16: Phyletic composition of biomass

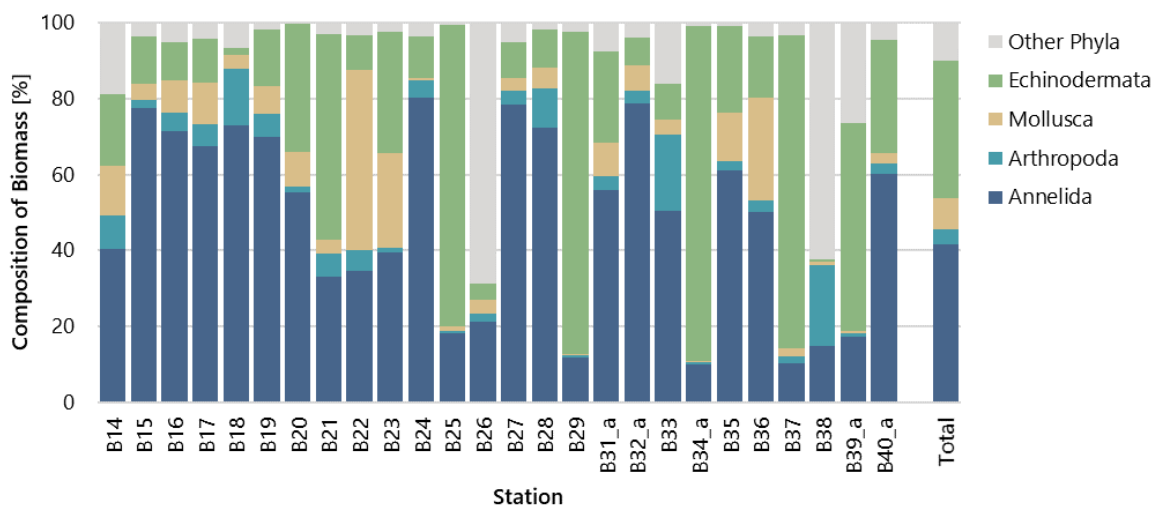


Notes

Biomass expressed as ash free dry weight in g/0.1 m² grab sample

Other Phyla includes Cnidaria, Platyhelminthes, Nemertea, Phoronida, Hemichordata and Chordata

Figure 4.17: Phyletic composition of biomass



Notes

Biomass expressed as ash free dry weight in g/0.1 m² grab sample

Other Phyla includes Cnidaria, Platyhelminthes, Nemertea, Phoronida, Hemichordata and Chordata

Figure 4.18: Phyletic composition of biomass

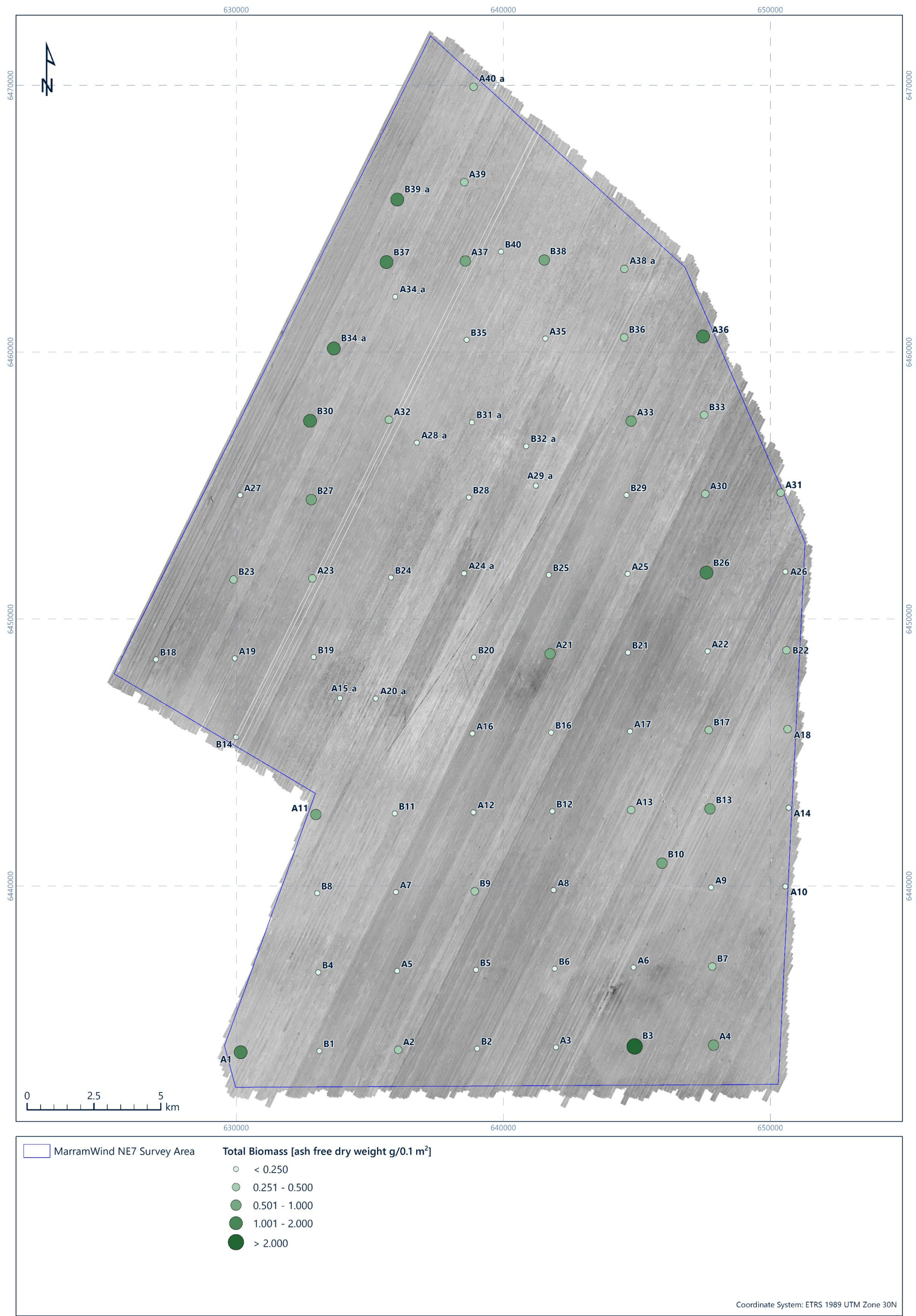


Figure 4.19: Total biomass overlaid on a side scan sonar mosaic

4.4 Seabed Habitats and Biotopes

4.4.1 Biotope Classifications

From photographic data the seafloor observed across the survey area was largely homogeneous. The main sediment type observed was muddy sand, with varying proportions of shell fragments. Small areas of mixed sediment were interspersed throughout the survey area, generally in conjunction with the numerous depressions. These sediment descriptions are consistent with the geophysical seafloor features interpretation that the dominant sediments varying proportions of silt/sand with shell fragments and areas of shell fragments, gravels, cobbles and boulders, largely associated with the depressions (Report No: 220154-OWF-03).

The physical and biological characteristics of the multivariate groups apparent within the macrofaunal community (Section 4.3.1) were considered in conjunction with the geophysical and photographic data for habitat classification. Soft sediment habitats are often defined on the sediment type and infaunal community composition. Therefore, soft sediments within the survey area have been classified using data from grab samples (specifically the PSD and macrofaunal data) alongside the photographic data analysis. Stations with a 'B' prefix have been classified on grab data alone as camera at these stations was for clearance purposes only. Stations with a 'C' prefix and transects have been classified on video and photographic data only.

Table 4.11 summarises the hierarchy of the assigned JNCC (2022) classifications. Figure 4.20 spatially presents the distribution of high-level biotopes across the survey area extrapolated from geophysical seabed features, PSD results, macrofaunal data and camera data. When all data was considered, three habitat types (one habitat, one biotope complex and one biotope) were assigned to the transects and stations surveyed. Biotopes assigned are relevant to the time of sampling, with this survey completed in summer.

Table 4.12 summarises the physical and biological parameters characteristic of the biotopes assigned, along with example photographs. Appendix C provides further example photographs. Sections 4.4.1.1 to 4.4.1.3 provide detailed descriptions of each biotope.

Table 4.11: Habitat classifications

JNCC (2022) Habitat Classification					Equivalent EUNIS (2022) Classification
Environment Level 1	Broad Habitat Level 2	Habitat Level 3	Biotope Complex Level 4	Biotopes and sub biotopes Level 5 & 6	
Marine	SS Sublittoral sediment	SS.SMu	SS.SMu.CFiMu Circalittoral fine mud	SS.SMu.CFiMu.Sp nMeg Seapens and burrowing megafauna in circalittoral fine mud	MC6216: Seapens and burrowing megafauna in Atlantic circalittoral fine mud

JNCC (2022) Habitat Classification					Equivalent EUNIS (2022) Classification
Environment Level 1	Broad Habitat Level 2	Habitat Level 3	Biotope Complex Level 4	Biotores and sub biotores Level 5 & 6	
		SS.SSa Sublittoral sand and muddy sands	SS.SSa.CFiSa Circalittoral fine sand	-	MC5: Circalittoral sand
		SS.SMx Sublittoral mixed sediment	-	-	MC4: Circalittoral mixed sediment
Notes EUNIS = European Nature Information System JNCC = Joint Nature Conservation Committee					

4.4.1.1 Seapens and burrowing megafauna in circalittoral fine mud (SS.SMu.CFiMu.SpnMeg)

This biotope comprises soft mud habitats that can feature burrows and mounds constructed by burrowing megafauna and conspicuous populations of the sea pens *P. phosphorea* and *V. mirabilis*. Burrowing crustacea can typically include *Nephrops norvegicus* (JNCC, 2022).

This biotope categorises the epifaunal community observed across the majority of the MarramWind survey area (Figure 4.20).

The proportion of fines/sand do not match the physical descriptor of 'fine mud' for this JNCC biotope, but it was considered the best match for the epifaunal community and the diverse polychaete infaunal community.

Sediment characteristics from grab samples described the seabed as muddy sand (Table 4.3), which corresponds with sediment descriptions from video analysis completed for the transects and C stations throughout the survey area (Table 4.12 and Appendix C). This also corresponds with the low reflectivity observed on the SSS record and agrees with the geophysical sediment description of varying proportions of silt/sand (Report No: 220154-OWF-03).

Infaunal analysis from stations across the survey area recorded a dominant polychaete community. The characteristic taxa included the polychaetes *Paramphinome jeffreysii* and *Lanice conchilega*. (Table 4.12).

The epifauna recorded across the survey area was characteristic of this biotope. The sea pens *P. phosphorea* and *V. mirabilis* were observed throughout, along with *N. norvegicus*, *Asterias rubens*, hermit crabs (Paguridae) and brittlestars (Ophiuroidea). Burrows formed a common feature of the soft sediments across the survey area.

4.4.1.2 Circalittoral fine sand (SS.SSa.CFiSa)

This biotope complex comprises clean, fine sand with less than 5 % silt/clay content that can extend offshore. This biotope complex is characterised by a wide range of echinoderms (including the sea urchin *Echinocyamus pusillus*), polychaetes and bivalves (JNCC, 2022).

This biotope complex categorised the infaunal community for clusters D and E which were located towards the centre of the survey area (Figure 4.14). Sediment characteristics from grab samples described the seabed at these stations as 'sand' (Table 4.3) which corresponded with the ground-truthed video transect descriptions (Table 4.12 and Appendix C). These sediments represented areas of low sonar reflectivity on the side scan mosaic. This aligns with the geophysical interpretation of the sediments, described as 'slightly silty sand' (Report No: 220154-OWF-03). Although these stations had an average fines content of 5.47 % (Table 4.12), the infaunal and epifaunal communities provide a good representation of this biotope complex.

Infaunal analysis from cluster D and E recorded a diverse community of polychaetes, and echinoderms and bivalves representative of 'Circalittoral fine sand'. The characteristic taxa included the polychaetes *Lanice conchilega* and *Exogone verugera*, the echinoderm *Echinocyamus pusillus* and the mollusc *Retusa umbilicata* (Table 4.12).

The epifauna at these stations was as expected for central North Sea sandy sediments. The most regularly observed taxa included sea urchins (*Gracilechinus acutus*), starfish (Asteroidea), hermit crabs (Paguridae) and sea pens (*P. phosphorea*).

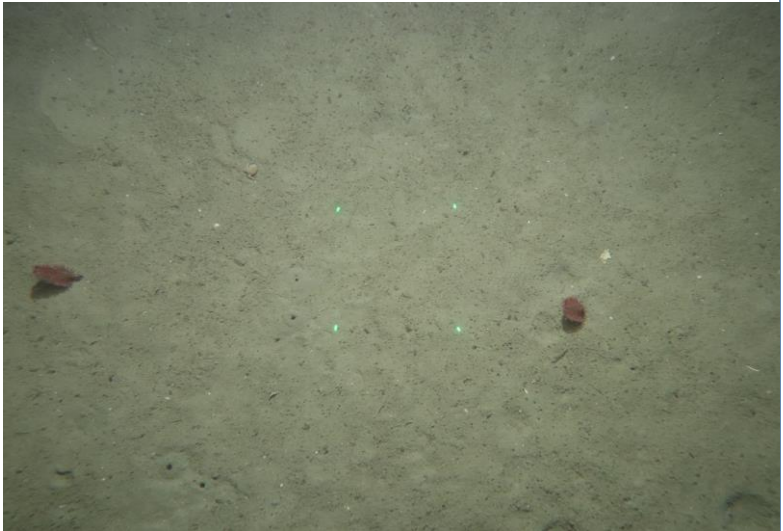
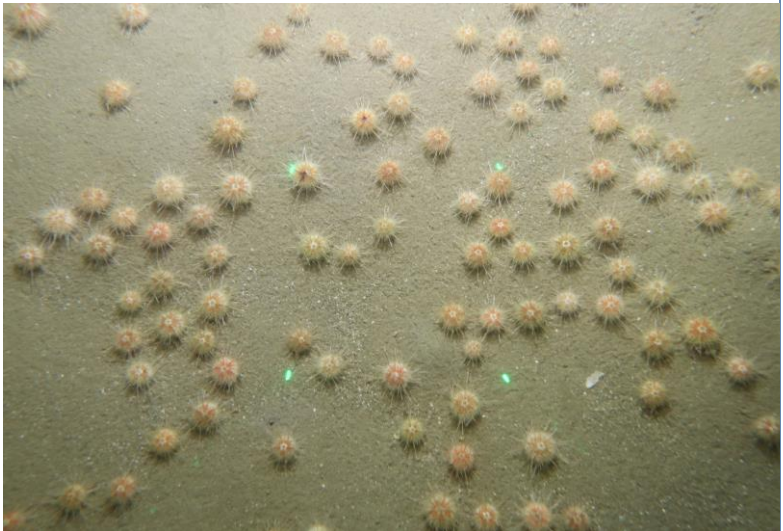
4.4.1.3 Sublittoral mixed sediment (SS.SMx.)

This habitat extends from the nearshore to deep offshore circalittoral areas. It encompasses a range of sediments from muddy gravelly sands to mosaics of cobbles or pebbles embedded in or lying upon sand, gravel or mud. These habitats can support a rich infaunal and epifaunal community of polychaetes, bivalves, echinoderms, anemones, hydroids and Bryozoans (JNCC, 2022).

This habitat was found throughout the survey area, particularly on the western side, in small patches generally associated with the numerous depressions interspersed across the area. Sediment characteristics ranged from muddy gravelly sands to cobbles, pebbles and boulders embedded in muddy sands and was assigned based on video data only. It coincided with areas of high reflectivity on the SSS data. Due to the small areas associated with this habitat, patches are difficult to discern on Figure 4.20; however, labels have been assigned to associated polygons.

The epifauna was diverse and included anemones (Actiniaria including Hormathiidae, *Urticina* sp. and *Metridium* sp.), crabs (*Cancer pagurus*), squat lobster (*Munida* sp.), possible sponge (Porifera), tube worms (Serpulidae), cup corals (*Caryophyllia smithii*) and faunal turf (Hydrozoa/Bryozoa).

Table 4.12: Summary of JNCC habitat classifications

JNCC Habitat Classification (JNCC 2022)	Distribution	Physical Characteristics	Biological Characteristics	Example Photograph
SS.SMu.CFiMu.SpNMeg Seapens and burrowing megafauna in circalittoral fine mud	Group ABC* †	Mean gravel†: 0.08 %	Mean number of taxa†: 84 per 0.1 m²	
		Mean sand†: 78.91 %	Mean number of individualst†: 580 per 0.1 m²	
		Mean mud†: 20.91 %	Characteristic taxa†: <i>Paramphinome jeffreysii</i> , <i>Retusa umbilicate</i> , <i>Lanice conchilega</i> , <i>Adontorhina similis</i> , <i>Ampharete falcata</i>	
	Transects and C stations‡: All transects, C3_a, C5 -C11_a, C13_a, C17_a, C18, C20, C22_a, C23, C25 – C27, C36-C38	‘Muddy sand’‡	Characteristic taxa‡: <i>Pennatula phosphorea</i> , <i>Virgularia mirabilis</i> , <i>Nephrops norvegicus</i> , Paguroidea, Asteroidea	
		Bathymetry: 80-120 m LAT	Mean Biomass†: 0.3744	
SS.SSa.CFiSa Circalittoral fine sand	Group DE* Stations: C15, C28_a, transect FTR10	Mean gravel†: 0.16	Mean number of taxa†: 52	
		Mean sand†: 94.34	Mean number of individualst†: 149	
		Mean mud†: 5.47	Characteristic taxa†: <i>Exogone verugera</i> , <i>Echinocyamus pusillus</i> , <i>Spiophanes kroyeri</i> , <i>Lanice conchilega</i>	
		‘Sand’‡	Characteristic taxa‡: <i>Gracilechinus acutus</i> , Asteroidea,	
		Bathymetry: ca. 100 m LAT	Mean Biomass†: 0.4051	
SS.SMx Sublittoral mixed sediment	Transects and C stations‡: ATR04A, BTR04, CTR01, DTR01, ETR01, ETR02, FTR04, GTR02, GTR03, HTR04, JTR01, JTR02, KTR01, LTR02, MTR02, MTR01, NTR03, OTR01, PTR03, C3_a, RTR01, QTR03, QTR04, QTR05	Mean gravel†: -	Mean number of taxa†: -	
		Mean sand†: -	Mean number of individualst†: -	
		Mean mud†: -	Characteristic taxa†: -	
		‘Muddy sand with shell, pebbles, cobbles and boulders’‡	Characteristic taxa‡: Anemones (Actiniaria, inc. Hormathiidae, <i>Urticina</i> sp., ? <i>Metridium</i> sp.), cup corals (? <i>Caryophyllia smithii</i>), ?encrusting sponges (Porifera), starfish (<i>Asterias rubens</i>), crabs (<i>Cancer pagurus</i>)	
		Bathymetry: 80-120 m LAT	Mean Biomass†: -	
Notes Biomass expressed as ash free dry weight in g/0.1 m² grab sample JNCC = Joint Nature Conservation Committee LAT = Lowest Astronomical Tide * Group ABC comprises clusters A, B and C and Group DE comprises clusters D and E † = Data from grab analysis. Mean values generated for sample data within multivariate grouping of macrofaunal community ‡ = Data from photographic analysis ? = Identification is uncertain				

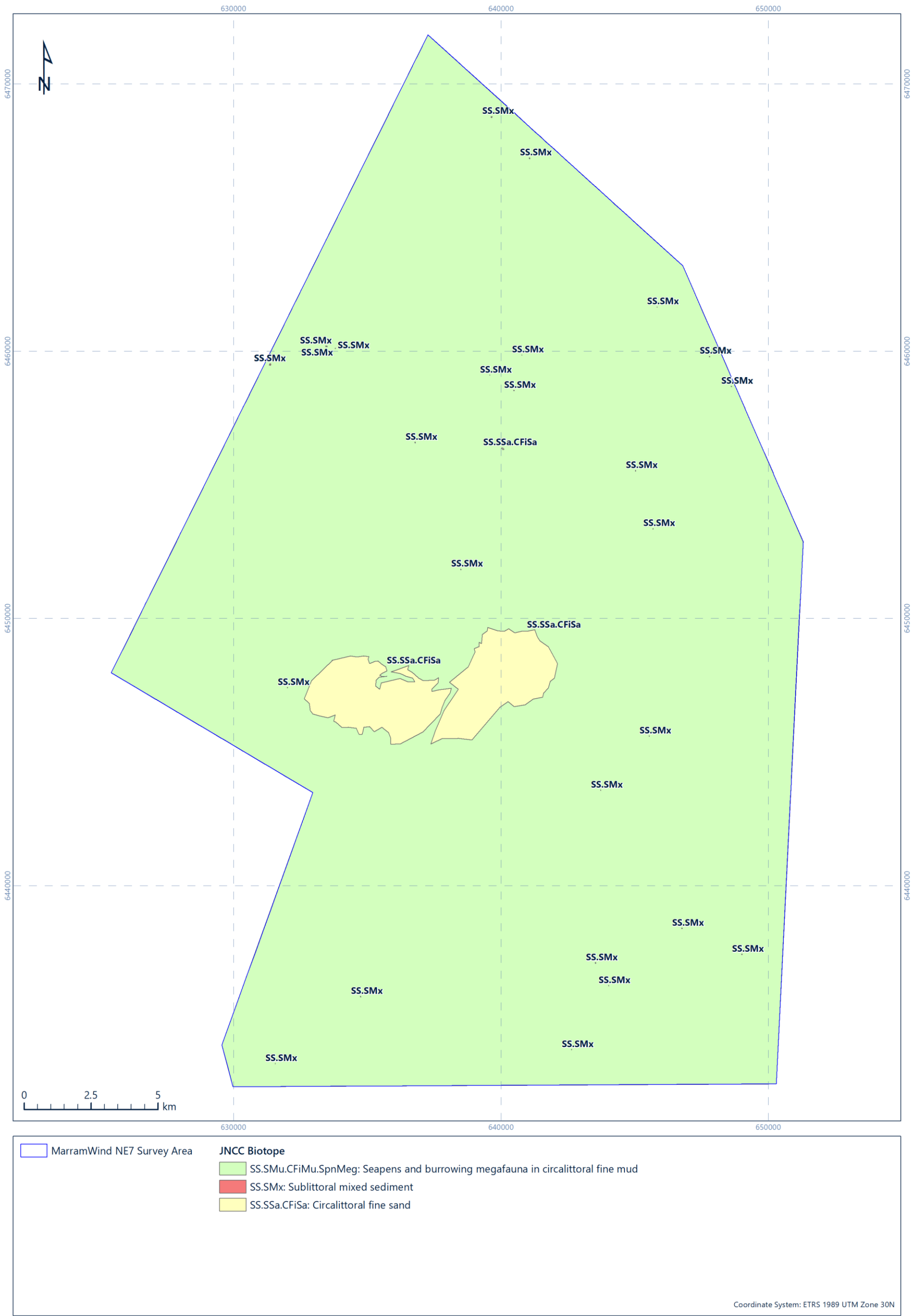


Figure 4.20: The spatial distribution of JNCC habitat classifications (JNCC, 2022)

4.4.2 Potential Sensitive Habitats and Species

4.4.2.1 Methane Derived Authigenic Carbonates (MDAC)

Review of the SSS and MBES data showed numerous depressions across the MarramWind survey area. Many of these contained hard contacts. However, the depressions that were ground-truthed displayed no evidence of MDAC, with hard contacts and areas of differing reflectivity being attributed to coarse shell material, pebbles, cobbles and boulders, or anthropogenic debris.

4.4.2.2 Seapen and Burrowing Megafauna Communities

The presence of the OSPAR listed threatened and/or declining habitat 'Seapens and burrowing megafauna communities' was considered, due to observations of the sea pens *P. phosphorea* and *Virgularia* sp., along with faunal burrows, including the characteristic burrows of the Norway lobster (*N. norvegicus*). The photographic data collected were analysed using the SACFOR methodology (3.3.6.2). Appendix F summarises the results of the SACFOR assessment.

Faunal burrows were present along the majority of transects and stations with the exception of transects ETR01 and FTR10 and stations C15 and A20_a. Where present, faunal burrows were assessed as 'occasional' on transect FTR02 and 'frequent' to 'common' at all other stations/transects.

The abundance of sea pens *P. phosphorea* across the survey area was 'occasional' to 'common' along all transects and stations. *Virgularia* sp. individuals were present across 54 stations and transects distributed across the survey area in abundances ranging from 'rare' to 'frequent'. Figures 4.21 and 4.22 display the SACFOR abundances of *P. phosphorea* and *Virgularia* sp. across the survey area, whilst Figure 4.23 displays the SACFOR abundances of burrows (3 cm to 15 cm).

4.4.2.3 Annex 1 Stony Reef

To qualify as a 'stony reef' there should be a minimum elevation of 64 mm above the seabed, a coverage of at least 10 % cobbles and boulders and a minimum area extent of 25 m². However, if 'low' is scored in any of the categories a strong justification would be required to consider the reef as contributing to the Marine Natura site network of qualifying reefs in terms of the EU Habitats Directive (Irving, 2009).

Areas of pebbles, cobbles and boulders were observed along 16 stations and transects across the survey area. The majority of these areas were classified as 'not a reef', with a patch on transect BTR04 classified as 'low reef' covering an area of 14 m². The cobbles and boulders within this patch were mostly low-lying and surrounded by soft sediment, which covered the hard substrate in places. The dominant taxa associated with the hard substrate were anemones (Actiniaria and *Metridium* sp.) and low-lying faunal turf (Hydrozoa/Bryozoa). Along 2 transects (BTR04 and QTR03), areas of cobbles and/or boulders were classified as 'medium

reef'. However, the largest of these was estimated to cover 20 m² and therefore did not meet the qualifying 25m² minimum area extent. The full assessment can be found in Appendix F.

4.4.2.4 Other Potentially Sensitive Habitats and Species

The OSPAR listed low or limited mobility bivalve species ocean quahog (*Arctica Islandica*) was identified through its siphons on the video data for station A32. Although *A. islandica* is infaunal, its filter feeding habit sometimes allows siphons to be identified from seabed photographic data. Although only one specimen was observed, the absence of siphons does not necessarily mean more *A. islandica* are not present in the survey area as this species can withdraw their siphons below the sediment surface.

An area towards the centre of the survey area was classified as the JNCC biotope complex 'Circalittoral fine sand' (SS.SSa.CFiSa), which falls within the broad PMF habitat 'Offshore subtidal sands and gravels'.

This sediment type is widely distributed in the central North Sea (EMODnet, 2022) and is likely to have been represented elsewhere within the Scottish MPA network.

No other Annex I habitats or Annex II species, OSPAR threatened and/or declining species and habitats or UK Biodiversity Action Plan priority habitats and species were observed within the survey area.

Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and witch flounder (*Glyptocephalus cynoglossus*) are classed as 'Vulnerable' on the IUCN Red List, with the sea urchin *Echinus esculentus* classed as 'Near threatened'. Numerous skates and rays are classified as 'Near threatened' to 'Critically endangered'. Rays (Rajidae) were observed within the survey area, but identification to species level was not possible from the video data. The American plaice (*Hippoglossoides platessoides*) is classified as 'Endangered' with Pleuronectiformes observed within the survey area.

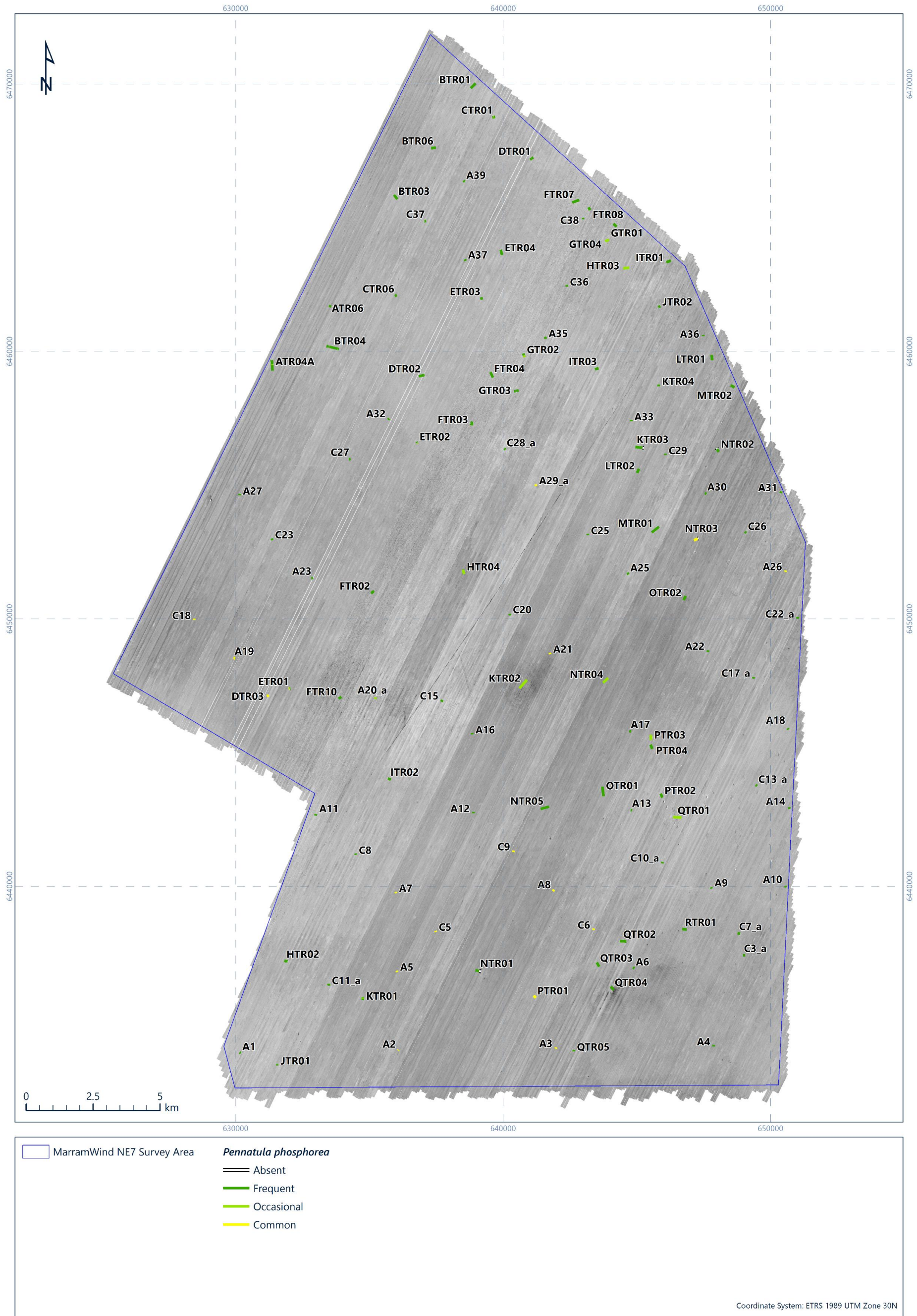


Figure 4.21: *Pennatula phosphorea* SACFOR classification

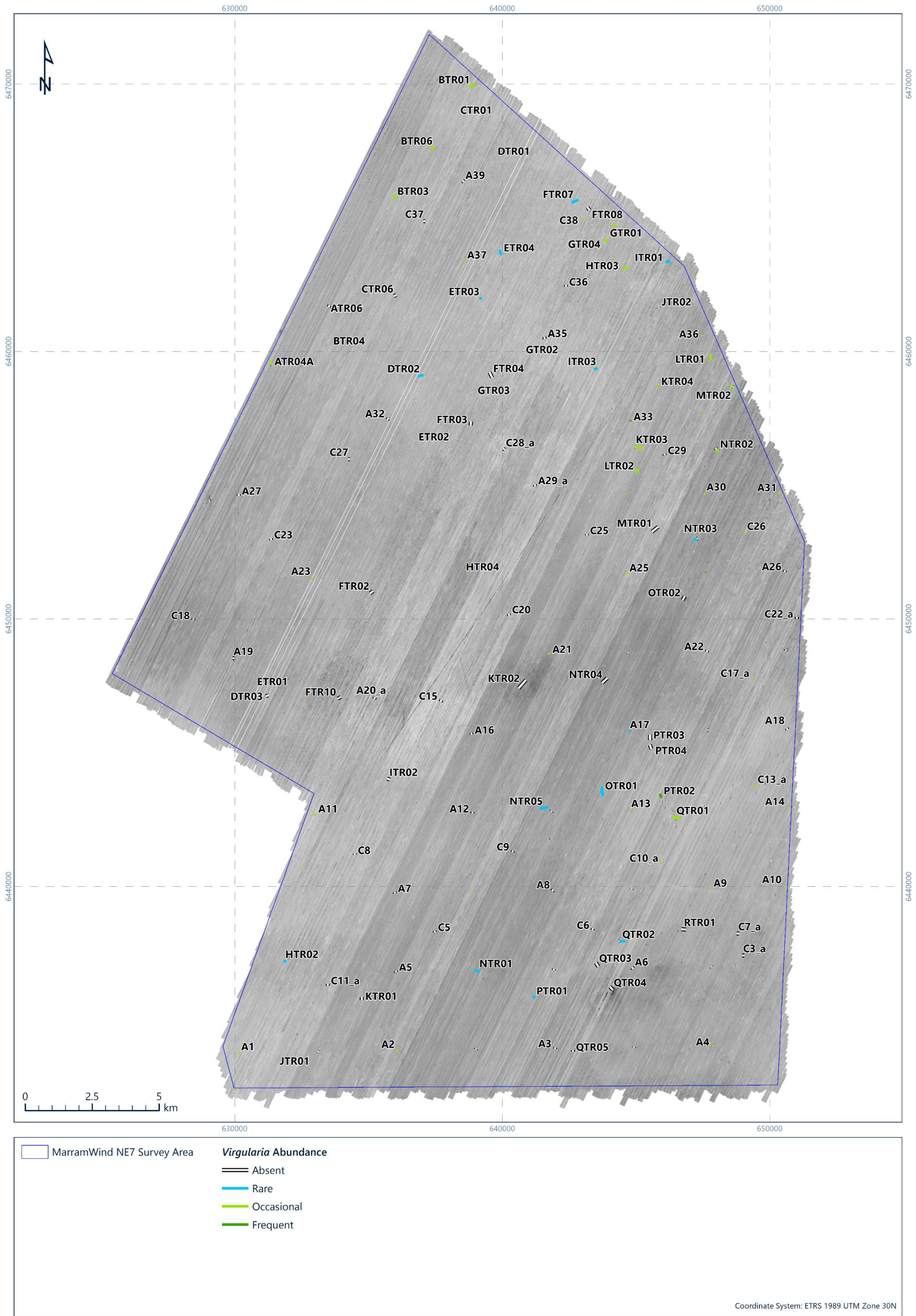


Figure 4.22: *Virgularia* sp. SACFOR classification

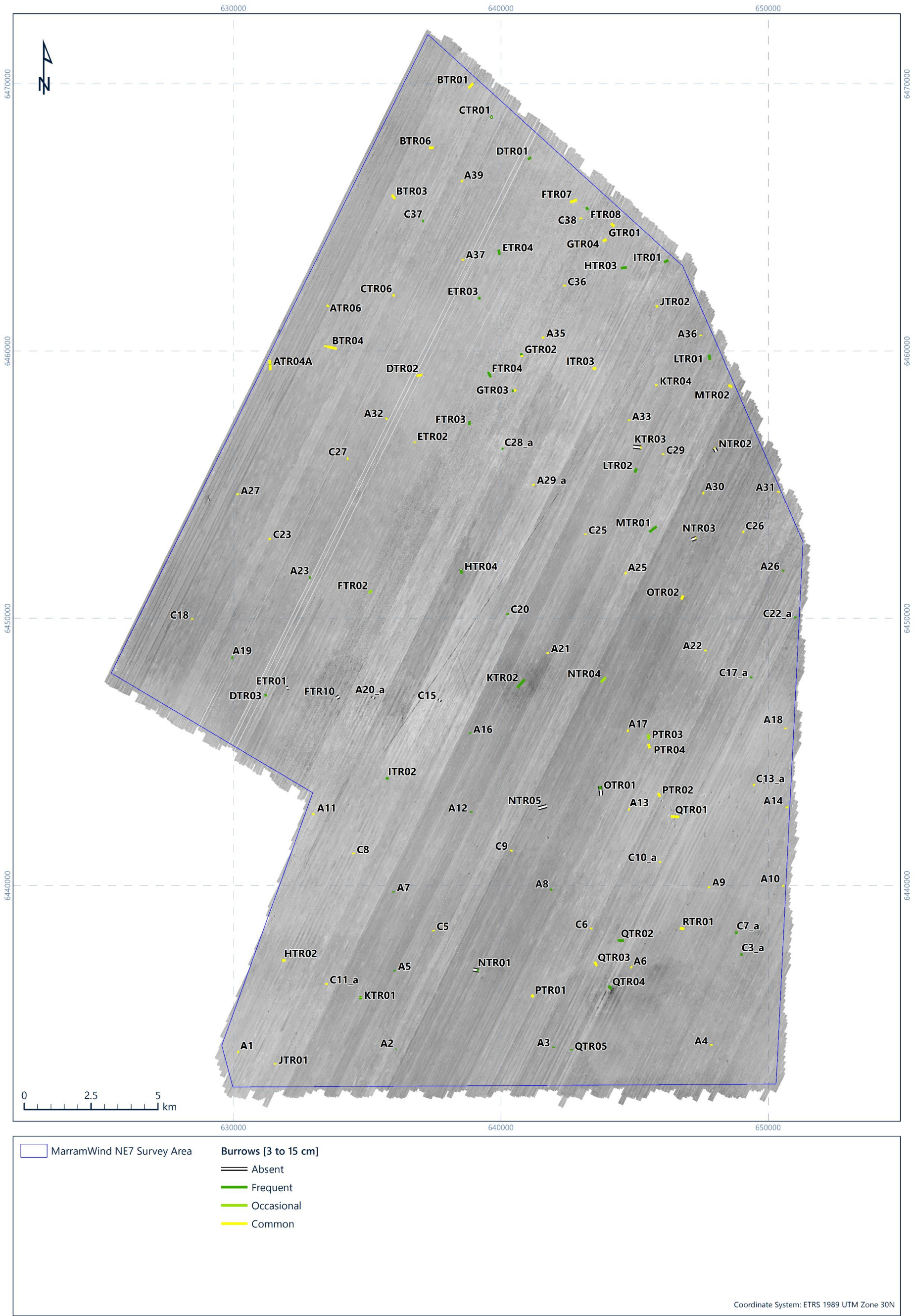


Figure 4.23: Burrows (3 cm to 15 cm) SACFOR classification

5. Discussion

5.1 Sediment Characterisation

The general physical and chemical characteristics of sediment particles have a significant effect on how other chemical components and biological species interact with seabed sediments. For example, the silt/clay fraction is known to adsorb petroleum hydrocarbons/heavy metals from seawater and through this pathway, these chemicals become incorporated into the sediment system (Meyers & Quinn, 1973). Granulometry data can therefore be critical when interpreting chemical and biological data obtained in this type of benthic study.

With regard to macrofaunal communities, the species distributions and community structure can be greatly influenced by the nature of the sediment, which represents the effects of a complex set of hydrological factors, such as water movement, turbulence and suspended load, at one particular point in time. Some animals have a behavioural preference for sediment of a particular grain size (Meadows, 1964; Gray, 1981), while this factor and organic matter content are closely associated with other properties of the sediment such as density, porosity, permeability, oxygenation and bacterial count (Buchanan, 1984), all of which affect animal functions such as locomotion, attachment, tube construction and feeding. Specifically, the proportion of fine (silt/clay) material often influences the distribution of macrofaunal communities.

The sediments within the survey area demonstrated low interstation variability in mean diameter (μm) and gravel and sand content (Table 4.3 and Table 4.4). Sediment descriptions using the Folk description (1954) categorised the seabed across the survey area as predominantly muddy sand (68 stations), with remaining 11 stations described as sand. This was supported by the geophysical interpretation of the sediments. This was classified further within the laboratory to Wentworth (1922) sediment descriptions of 'coarse silt' to 'medium sand', with sand as the dominant fraction (mean 79.95 %). The stations classified as sand were generally found towards the centre of the survey area. Multivariate cluster analysis reinforced these results, with four significant clusters. Principle component analysis refined these results and demonstrated that the driving differences between the clusters were small differences in the percentages of the finer/coarser sediment fractions.

Previously reported sediments across the survey area include fine sand to mud, (EMODnet, 2022). These sediments are typical of what was observed across the MarramWind area and in the wider geographical context of the central North Sea.

5.2 Macrofaunal Communities

Seafloor sediments provide support, protection and the food source for many macrofaunal species. The sediment macrofauna, most of which are infaunal (living within the sediment), are therefore particularly vulnerable to external influences that alter the sediments' physical,

chemical or biological nature. Such infaunal animals are largely sedentary and are thus unable to avoid unfavourable conditions. Each species has its own response and degree of sensitivity to changes in the physical and/or chemical environment and consequently the species composition and their relative abundance in a particular location provides a reflection of the health and condition of the immediate environment, both current and historical. The recognition that aquatic contaminant inputs may alter sediment characteristics, together with the relative ease of obtaining quantitative samples from specific locations, has led to the widespread use of infaunal communities in monitoring the impact of disturbances to the marine environment over a long period of time.

The phyletic composition, for both taxa and abundance had low variation throughout the survey area. Annelids were the most diverse and numerous phyla, followed by arthropods. The most abundant and dominant taxa across the survey area were the polychaete *P. jeffreysii* followed by the mollusc *Retusa umbilicata* and the polychaete *Lanice conchilega*. All species are typical of the North Sea and inhabit sand to sandy mud (MarLIN, 2022).

Univariate analysis highlighted that diversity was high across the survey area, with low interstation variability (Table 4.7). This was supported by the multivariate analysis. Five statistically significant clusters were apparent from multivariate analysis with a moderate degree of inter-cluster similarity. SIMPER analysis showed that the differences between clusters were largely due to small scale variability in the abundances and presence/absence of background taxa and species identified as the top ten most abundant taxa, predominantly the abundances of *P. jeffreysii* between stations.

In addition to the comparison of the analytical data against available references, statistical correlations of the sediment parameters recorded with biological determinants in the survey are summarised (for the main environmental parameters) in Appendix E.4. The statistical analysis selected was the Spearman's rank correlation coefficient (Spearman, 1904), sometimes referred to as Spearman's rho. This coefficient is used to test the association between two reported values for statistical dependence. It is a measure of rank correlation, or the similarity of the orderings of the data when ranked by each of the values. Correlations can only suggest a relationship and do not prove a causal link between status of the chemical or physical nature of the seabed and the infaunal community composition. Correlations occur as both positive and negative: they are positive when both reported values increase or decrease in unison, whilst negative correlations indicate that as one value increases the other decreases and vice versa.

The key correlations in the grab samples collected within the survey area were as follows:

- Both Pielou's evenness index (J) and the complement of the Simpsons index of dominance ($1 - \lambda$) were strongly positively correlated ($P > 0.01$) with median and mean particles size (μm) and with the percentage of the sand fraction. Conversely to

this, they were strongly negatively correlated ($P > 0.01$) with the percentage of the fines (including both silt and clay) fraction;

- Both the number of taxa and the number of individuals were negatively correlated ($P > 0.05$) with median and mean particles size (μm) and with the percentage of the sand fraction. Conversely to this, they were positively correlated ($P > 0.01$) with the percentage of the fines (including both silt and clay) fraction.

Correlations analysis highlights that the benthic communities are associated with sediment type in line with the literature, which reports granulometry as the major physical variable affecting macrofaunal occurrence and distribution in the North Sea (Künitzer et al., 1992; Reiss et al., 2010; Callaway et al., 2002). Figure 5.1 demonstrates the relationship between the sediment fractions and the impact on the macrofaunal clusters. Clusters A and B were dominated by the polychaete *P. jeffreysii* which is typically found in muddy sand sediments (MarLIN, 2022). Clusters C and E were dominated by the polychaete *L. conchilega* which inhabit sediments with a higher sand fraction (Künitzer et al., 1992). Cluster D also contained a higher sand fraction with the associated species *Exogone verugera* and *Echinocyamus pusillus* (MarLIN, 2022).

When considered ecologically, it is apparent that the macrofaunal community within the survey area can be considered typical of the muddy sand sediments in the central North Sea (Künitzer et al., 1992).

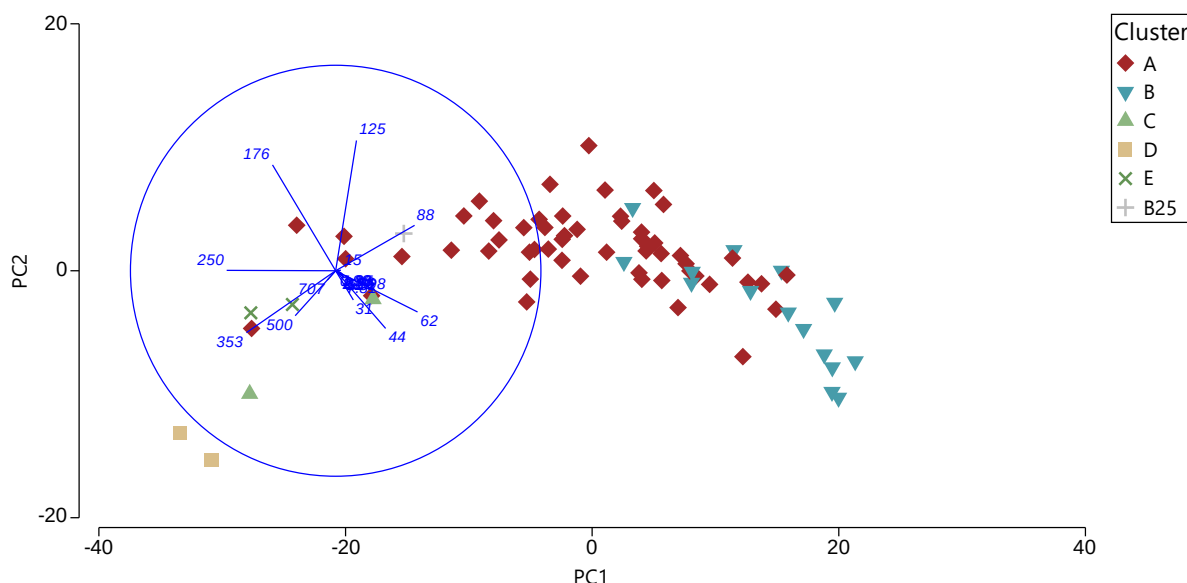


Figure 5.1: PCA of sediment composition with superimposed macrofaunal clusters

5.3 Seabed Habitats and Biotores

When seafloor photographic data, particle size data and macrofaunal data were considered, three JNCC biotopes were assigned to the survey area.

The majority of the survey area was classified as 'Seapens and burrowing megafauna in circalittoral fine mud' (SS.SMu.CFiMu.SpMg.). Although the fines fraction from the PSD results were lower than expected, the abundances of the sea pen *P. phosphorea*, along with associated community species such as hermit crabs (Paguridae), starfish (*Asterias rubens*) and *Nephrops norvegicus* documented by the epifaunal analysis matched the criteria for this biotope. The infaunal analysis also recorded a diverse polychaete community typical of soft sediments.

Consideration was given to classifying the area as the OSPAR threatened and /or declining habitat 'Sea pen and Burrowing Megafauna Communities' due to the above biotope assignment. As such, a full assessment across the survey areas was undertaken.

Pennatula phosphorea was classified as 'frequent' to 'common' at most stations/transects, with *Virgularia* sp. showing less prevalence.

The JNCC (2014c) habitat guidelines state that the seabed must be 'heavily bioturbated by burrowing megafauna with burrows and mounds forming a prominent feature of the sediment surface'. Guidelines also state that burrows should be at least 'frequent' on the SACFOR scale to be classified as a 'Sea-pen and burrowing megafauna community'.

Nephrops norvegicus burrows were present at all but 18 stations and transects whereby the abundance ranged from 'occasional' to 'common' using the SACFOR scale (JNCC, 2015).

Other burrows (3 cm to 15 cm) were recorded as 'frequent to common' at all stations except for A20_a, C15 and transects ETR01 and FTR10. The presence of burrowing megafauna is the

essential defining characteristic of the feature, whereas sea pens do not have to be present (JNCC, 2014c). Throughout the survey area, the OSPAR designated 'Sea-pen and burrowing megafauna communities' habitat is likely to be present.

Macrofaunal clusters D and E, along with stations C15, C28_a and transect FTR10 had a higher sand content, with different dominating taxa than those stations assigned the 'Seapens and burrowing megafauna in circalittoral fine mud' biotope and were therefore assigned the 'Circalittoral fine sand' (SS.SSa.CFiSa) biotope complex. This was supported by both the infaunal and epifaunal communities.

The majority of transects executed throughout the survey area were originally selected to ground truth areas of higher sonar reflectivity that could be indicative of a change in sediment boundary or a topographically distinct feature such as a depression that may contain MDAC. As no PSD or macrofaunal data was available for these locations, the biotope classification was assigned using the video data.

Patches along transects ATR04A, BTR04, CTR01, DTR01, ETR01, ETR02, FTR04, GTR02, GTR03, HTR04, JTR01, JTR02, KTR01, LTR02, MTR02, MTR01, NTR03, OTR01, PTR03, RTR01, QTR03, QTR04, QTR05 and station C3_a were classified as 'mixed sediment (SS.SMx.) as the composition of the seabed ranged from gravelly sand with shells to pebbles and cobbles embedded in and on muddy sand. Epifauna increased in areas of hard substrate for attachment, with characterising taxa typical for the mixed sediment biotope complex.

A stony reef assessment was carried out for those transects within this biotope. None of the patches of potential low or medium reef met the qualifying 25 m² area criterion. The patches were located throughout the survey area and coincided with areas of high reflectivity on the side scan record.

One ocean quahog (*Arctica islandica*), an OSPAR threatened and/or declining species, was identified during seabed video and photography analysis at station A32.

The broad PMF habitat 'Offshore subtidal sands and gravels' were present within the survey area but is common in the central North Sea and represented elsewhere in the MPA network.

No other Annex I habitats or Annex II species, OSPAR threatened and/or declining species and habitats, or Scottish biodiversity list species and habitats (OSPAR, 2008; JNCC, 2019a; 2019b, NatureScot, 2020) were observed within the survey areas.

Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and witch flounder (*Glyptocephalus cynoglossus*) are all classed as 'Vulnerable' on the IUCN Red List, with the sea urchin *Echinus esculentus* classed as 'Near threatened'. Various rays and flatfish are listed as 'Near threatened' to 'Critically endangered'. Rays and flatfish were observed throughout the survey area, but it was not possible to identify these to species level from the video data.

6. Conclusions

The aim of this report has been to evaluate the existing physical and biological components in the marine environment and determine any features of ecological significance within the survey area. Based on the overall assessment of the survey area, the following key conclusions can be stated:

Using the BGS modified Folk (1954) sediment description, most stations were classified as muddy sand (68 stations), with the 11 remaining stations described as sand. Multivariate cluster analysis demonstrated this variability in sediment fractions by grouping the stations into four significant clusters. There was no distributional pattern of sediments in relation to depth; stations were grouped based on sediment characteristics with higher sand fractions generally located towards the centre of the survey area.

The most abundant macrofaunal taxa within the survey area displayed a moderate similarity between stations but predominantly comprised annelids, with *Paramphinome jeffreysii* the dominating species. Multivariate analysis highlighted a diverse macrofaunal community across the survey area, with the differences between clusters influenced by differences in abundance of *P. jeffreysii* and those that formed part of the background community. However, the macrofaunal community was considered typical of muddy sand sediments within the region.

Three benthic biotopes were defined within the survey area; Seapens and burrowing megafauna in circalittoral fine mud' (SS.SMu.CFiMu.SpNMeg), 'Circalittoral fine sand' (SS.SSa.CFiSa) and 'Sublittoral mixed sediment' (SS.SMx). The infaunal community decreased across the sand biotope, although both the SS.SMu.CFiMu.SpNMeg and SS.SSa.CFiSa biotopes were polychaete dominated. Due to the assignment of the 'Seapens and burrowing megafauna in circalittoral fine mud' and the burrow counts observed, it is considered that the OSPAR 'Sea-pen and burrowing megafauna communities' habitat is present within the MarramWind survey area. None of the assessed patches of stony reef met the 25 m² area criterion. One *Arctica Islandica* was observed on the video data. Of the taxa observed in the survey area, Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and witch flounder (*Glyptocephalus cynoglossus*) are classed as 'Vulnerable' on the IUCN Red List, with the sea urchin *Echinus esculentus* classed as 'Near threatened'. No other potentially sensitive species or habitats were identified. The habitats and epifauna of the survey area are considered typical for areas of comparable water depth across the wider central North Sea region.

The main limitations of this survey include that the data only provides a 'snapshot' of the environment at the time of year the survey was undertaken, and presence or absence of sensitive habitats can only be confirmed from the areas that were ground-truthed.

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Appendices

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Appendix B Methodologies

- B.1 Laboratory Analysis
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-

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Appendix F Sensitive Habitat Assessments

- F.1 Sea Pen and Burrows Assessment
- F.2 Stony Reef Assessment

Appendix A

Guidelines on Use of Report

Click icon to open the guidelines.



Appendix A
Guidelines

Appendix B

Methodologies

B.1 Laboratory Analysis

Click icon to open the laboratory analysis methodologies.



Appendix B.1 Labs
Methods

B.2 Statistical Analysis

Click icon to open the statistical analysis methodologies.



Appendix B.2
Statistical Analysis

Appendix C

Logs

C.1 Survey Log

Click icon to open the completed log.



Appendix C1.1
Survey Log Galaxy



Appendix C1.2
Survey Log Venturer

C.2 Grab Log

Click icon to open the completed log.



Appendix C2.1 Grab
Log Galaxy



Appendix C2.2 Grab
Log Venturer

C.3 Epifaunal Assessment log

Click icon to open the completed log.



Appendix C.3
Epifaunal Log

Appendix D

Sediment Particle Size Data

D.1 Certificates of Analysis

Click icon to open the certificate of analysis.



Appendix D.1
Certificate of Analys

D.2 Particle Size Distribution and Sample Photographs

Click icon to open the sediment particle size data and sample photographs.



Appendix D.2 PSD
and Sample Photos

Appendix E

Macrofaunal Analysis

E.1 Macrofaunal Abundance

Click icon to open the macrofauna data.



Appendix E.1
Abundance

E.2 Top Ten Taxa Per Station

Click icon to open the top 10 species results.



Appendix E.2 Top
Ten Taxa

E.3 Biomass

Click icon to open the biomass results.



Appendix E.3
Biomass

E.4 Correlations

Click icon to open the biomass results.



Appendix E.4
Correlations Matrix.:

Appendix F

Sensitive Habitat Assessments

F.1 Sea Pen and Burrows Assessment

Click icon to open the macrofauna data.



Appendix F.1 Sea
pen and Burrows

F.2 Stony Reef Assessment

Click icon to open the top 10 species results.



Appendix F.2 Stony
Reef

MarramWind

