Salamander Offshore Wind Farm

Offshore EIA Report

Volume ER.A.4, Annex 9.1: Environmental Baseline Report

SALAMANDER

Powered by Ørsted and Simply Blue Group

Environmental Baseline Report

Salamander Offshore Wind Farm

Geophysical & Environmental Survey

North Sea, UK

CLIENT
Salamander Offshore Wind Co. Ltd.

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Abbreviations and Definitions

Σ16PAH...Sum of the 16 EPA PAHs
AL ....Action Level
CAD...Computer-Aided Design
CBRA...Cable Burial Risk Assessment

CCME ....Canadian Council of Ministers of the Environment
Cefas..Centre for Environment, Fisheries and Aquaculture Science
CTD ....Conductivity, Temperature and Depth
dB ....Decibels
DDV ....Drop Down Video
DG ....Day Grab
DPR..Daily Progress Report
EAC ....Environmental Assessment Criteria
EC ....European Commission
ECR ....Export Cable Route
ECC ....Export Cable Corridor
EIA ....Environmental Impact Assessment
ENF ....Emergency Notification Flowchart
EPSG ....European Petroleum Survey Group
EU ....European Union
EUNIS..European Nature Information System
FLOW ....Floating Offshore Wind
FMGT..Fledermaus
GNSS..Global Navigation Satellite System
HAZOP ....Hazard and Operability Study
HG ....Hamon Grab
HSE ....Health Safety Environment
IA ....Intertidal Area
ISQG ....Interim Sediment Quality Guidelines
IUCN ....International Union for Conservation of Nature
JNCC ....Joint Nature Conservation Committee
KPAL ....Kenneth Pye Associates Limited
LAT ....Lowest Astronomical Tide
LED ....Light Emitting Diode
LOI ....Loss of Ignition
MAC..Mobilisation and Calibrations
MBES ....Multibeam Echo Sounder
MDS..Multi-Dimensional Scaling
MHWS ....Mean High Water Springs
MMO ....Marine Management Organisation
MPA..Marine Protected Area
NEA..Norwegian Environmental Agency
NMBAQC ....NE Atlantic Marine Biological Quality Control
OAA ....Offshore Array Area
OI..Ocean Infinity
OSPAR .... Oslo Paris Conventions for the protection of the marine environment of the North East Atlantic

PAH..Polycyclic Aromatic Hydrocarbon
PC ....Principal Component
PCA..Principal Component Analysis
PEL...Probable Effect Level
PMF ....Priority Marine Feature
PPS ....Pulse Per Second
PRIMER..Plymouth Routines in Multivariate Ecological Research
PSA ....Particle Size Analysis
QA ....Quality Assurance
RA...Risk Assessment
RMS..Root Mean Square
RPL ....Route Position List
SAC ....Special Area of Conservation
SBES...Simply Blue Energy Scotland
SBET...Smoothed Best Estimated Trajectory
SBL...Scottish Biodiversity List
SIMPER ....Similarity Percentages
SIMPROF ....Similarity Profile
SBP ....Sub Bottom Profiler
SPA ....Special Protection Area
SSS..Side Scan Sonar
STR ....Subsea Technology & Rentals
THC..Total Hydrocarbons
TOC..Total Organic Content
TOM ....Total Organic Matter
UKAS..The United Kingdom Accreditation Service
UKHO...UK Hydrographic Office
USBL ....Ultra-short Baseline
UTC..Coordinated Universal Time
UTM ....Universal Transverse Mercator
UXO ....Unexploded Ordnance
VORF...Vertical Offshore Reference Frame
WAA ....Windfarm Array Area
WFD...Water Framework Directive
WGS84 ....World Geodetic System 1984
WTG ....Wind Turbine Generator

Executive Summary

This report details the results of the benthic survey performed east of Peterhead in the Northeast of Scotland at the Salamander Offshore Wind Farm for Salamander Offshore Wind Company Ltd.

Geophysical data was acquired to determine water depths, surficial geology, seabed features, shallow geology, and objects present within the survey area. Instruments used during the geophysical survey were multibeam echo sounder, magnetometer, side scan sonar and sub-bottom profiler. The environmental data acquisition included sediment sampling and imagery to establish a baseline for the habitats and faunal communities in the survey area. The survey was performed using drop down video, Day grab and Hamon grab samplers.

The geophysical interpretation combined with the environmental data was used as the basis for the European Nature Information System habitat classifications and assessments of potential areas and species of conservation importance.

All geophysical and benthic equipment was deployed from the survey vessel M/V Northern Franklin.

A total of 52 grab sample sites were selected for sampling, based on geophysical data, and sampled for taxonomic identification, particle size analysis and contaminants. Five additional grab sites were added to the survey due to the presence of Ross worm *Sabellaria spinulosa*, as well as one was a standalone extended video transect to investigate a distinct seabed feature.

The benthic survey started on the 1st of September 2022 and was completed on the 22nd of September 2022.

A total of six broad-scale habitats, including one habitat complex, were identified within the survey area. Additionally, taxonomic assemblages from the acquired grab sample data further indicate the presence of 11 species-specific habitats, including seven habitat complexes. One Priority Marine Feature habitat, offshore subtidal sands and gravels, and one Scottish Biodiversity List habitat, Subtidal sands and gravels, were also noted present. No features qualifying as Annex I (1170) were identified within the survey area although aggregations of Ross worm, *S. spinulosa*, were present both along the Export Cable Route and within the Windfarm Array Area.

Two Priority Marine Feature species, sandeel *Ammodytes* sp. and ocean quahog *Arctica islandica*, were also identified within the survey area together with the Scottish Biodiversity Listed sea pen species *Pennatula phosphorea.*

The results of the particle size analysis showed limited variation in the sediment composition across the survey area, with sand being the dominant sediment fraction.

Metal concentrations were generally low, with threshold values for arsenic being exceeded at six sites and cadmium at one site. Hydrocarbon levels were low, with polycyclic aromatic hydrocarbon concentration exceeding the threshold limits at five sites.

The faunal analyses of the grab samples showed that the phyletic composition was dominated by annelids. The two most abundant taxa were the mollusc *Kurtiella bidentata* and the annelid *Scoloplos armiger*.

Pielou's Evenness index, Shannon-Wiener index, and Simpson's Index of Dominance had a limited variation across the grab sample sites, with the SIMPROF (Similarity Profile) test identifying five faunal groups. Bryozoa followed by Cnidaria, had the highest frequency of occurrence and presented the highest number of different taxa among the sessile colonial epifauna. Mollusca comprised the majority of the biomass. The most abundant non-colonial phyla in still photographs were Arthropoda followed by Cnidaria, and the colonial fauna with the highest coverage was Annelida.

1. Introduction

1.1 Project Information and Survey Area

The Salamander Offshore Wind Farm is being developed by Salamander Offshore Wind Company Ltd., a joint venture partnership between Ørsted, Simply Blue Group and Subsea7.

The project area is located approximately 35 km east of Peterhead in the Northeast of Scotland, in the Windfarm Array Area (WAA) of interest of approximately 84.1 km^2 with water depths up to 115 m. The Export Cable Route (ECR) has an approximate route length of 35 km and an approximate area of 41 km^2.

For the Salamander Reconnaissance Geophysical and Environmental Site Investigation, data is required within the Salamander array area and along the offshore export cable corridor that runs between the array area and the landfall. Given the project schedule and consenting application submission, this survey will also aim to provide the necessary data to feed into the Environmental Impact Assessment (EIA) process.

Project details are stated in Table 1. An overview of the survey area is presented in Figure 1.

Table 1 Project details.

Client	Salamander Offshore Wind Company Ltd.
Project	Salamander Offshore Wind Farm
Ocean Infinity (OI) Project Number	104052
Survey Type	Geophysical and Environmental
Area	North-East Scotland (UK)
Survey Period	August – September 2022
Survey Vessels	Northern Franklin (Offshore)
OI Project Manager	Daniel Jenkins
Client Focal Point	Eric Kiltie

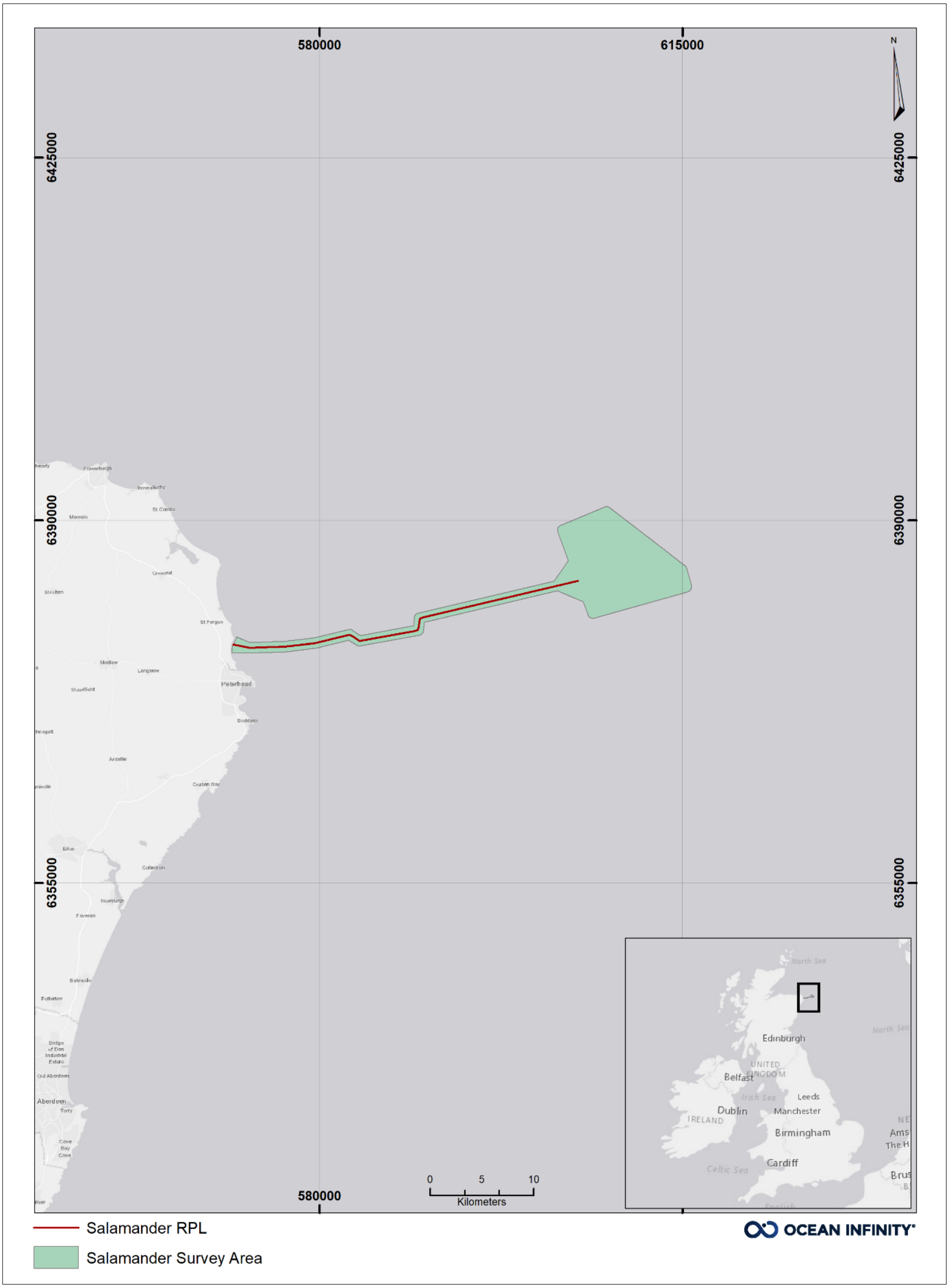


Figure 1 Overview of the Salamander Offshore Wind Farm survey area.

1.2 Project Requirements

A reconnaissance geophysical plus environmental survey was required to support project development. The primary uses for the collected data were:

- To characterise the site for the purposes of the EIA process;
- To map and identify the shallow geology, seabed features, local topography and any geohazards at the reconnaissance level;
- To refine the site boundary and preliminary Wind Turbine Generator foundations (WTG) layout;
- To inform preliminary cable route evaluation and to determine preferred cable route;
- To inform early mooring concept design / screening;
- Refinement of the desk study ground model and planning of the reconnaissance geotechnical campaign.

Secondary uses for the data may include the following (although additional specific survey data may be required for each of these secondary applications):

- Informing physical processes;
- Informing Water and Sediment Quality;
- Supporting Benthic Ecology assessment;
- Supporting Marine Archaeology;
- Early data to assist Unexploded Ordnance (UXO) studies;
- Inform the geotechnical site investigations;
- Informing preliminary cable engineering studies.

1.3 Scope of Work

The reconnaissance geophysical and environmental survey of the proposed Windfarm Array Area (WAA) and the Export Cable Route (ECR) was undertaken to:

- Provide data necessary for the consenting application
- Map and sample the benthic ecology habitat
- Act as a baseline for a reconnaissance-level ground model, which will be developed through the different stages of the project
- Aid the engineering studies, namely, mooring feasibility, concept selection and design, Cable Burial Risk Assessment (CBRA)
- Corroborate constraints and geohazards identified from desktop studies as well as capturing those that were not observed at that stage.

The WAA has an area of approximately 84.1 km² and it includes a 500 m buffer. The offshore and nearshore sections of the ECR have an approximate length of 35 km and an area of 40.9 km². The cut off between the offshore and the nearshore sections of the ECR is at a water depth of 20 m LAT. The intertidal area (IA) of the export cable route is defined between 0 m LAT and the mean high water springs (MHWS) point with a corridor of 500 m (104052-SBE-OI-SUR-REP-TIDALRE).

1.4 Environmental Scope of Work

Environmental Baseline Survey Sediment Sampling Sites

It was required that the benthic physical and faunal characteristics of the survey area, both nearshore and offshore, were established in order to determine the baseline conditions of the area. The key objective was to ensure that all the interpreted surface sediment units identified during the Geophysical Survey were sampled adequately.

Habitat Assessment Survey

The environmental survey of the ECR and WAA was conducted to assess for the presence of potentially important and environmentally sensitive habitats such as:

- Annex I habitats of the European Union (EU) Habitats Directive (1992)
- Any evidence of the threatened and/or declining species and habitats listed by OSPAR (2008), Scottish Priority Marine Features (PMF) and Scottish Biodiversity List (SBL) species.
- Species on the International Union for Conservation of Nature (IUCN) Global Red List of threatened species (IUCN, 2019).

Any potentially sensitive habitats identified during the survey were investigated using high-resolution video and stills photography and the extent of any habitats or features identified were mapped. All sediment types identified by the geophysical data acquisition were ground-truthed during the habitat assessment survey. In addition, any potential features of cultural/heritage importance (e.g. wrecks) were investigated.

Biotope Mapping

All biotope determination was undertaken in line with Joint Nature Conservation Committee (JNCC) guidance on assigning benthic biotopes within the European Nature Information System (EUNIS), marine version 2022, habitat classification system.

1.5 Purpose Of Document

The purpose of this report is to present the environmental methodology and results within the survey area. This report presents the baseline environmental conditions from the Salamander Offshore Wind Farm.

This Report details the data and results of the 2022 survey spanning the majority of the Export Cable Route (ECR), to approximate KP 8.3, as well as the entire Windfarm Array Area (WAA). Future reports will use revised nomenclature for the ECR as Offshore Export Cable Corridor (ECC) and the WAA as Offshore Array Area (OAA), with the OAA comprising <33.33 km^2 of the original 84.1 km^2 of the WAA.

Areas of special interest within the survey area are presented in this report as well as in the GIS habitat charts. All existing OI data from the survey are correlated with each other and compared against the existing background information and the environmental survey data, to strengthen the accuracy of the interpretations.

1.6 Reference Documents

The documents used as references to this Environmental Survey Report are presented in Table 2.

Table 2 Reference documents.

Document Number	Title	Author
QUA_W-QUA-QASSURAN-MAN	OI Quality Assurance Manual	OI
104052-SBE-OI-DCC-MDR-MDR006	Master Document Register	OI

Document Number	Title	Author
104052-SBE-OI-QAC-PRO-CADGIS	CAD and GIS Specification	OI
104052-SBE-OI-QAC-PRO-PROJMANU	Project Manual – Northern Franklin	OI
104052-SBE-OI-SCH-PRO-SCHEDULE	Time Schedule	OI
104052-SBE-OI-MAC-PRO-NFRANKLIN	Mobilisation and Calibration Procedures - Northern Franklin	OI
104052-SBE-OI-MAC-REP-NFRANKLIN	Mobilisation and Calibration Report - Northern Franklin	OI
104052-SBE-OI-QAC-PRO-COMMMATR	Communications Matrix	OI
104052-SBE-OI-MOB-PLA-NFRANKLIN	Mobilisation Plan - Northern Franklin	OI
104052-SBE-OI-QAC-PRO-PROJQPLA	Project Quality Plan	OI
104052-SBE-OI-HSE-PRO-HSEPLAN	HSE Plan	OI
104052-SBE-OI-HSE-PRO-HIRAAP	Hazard Identification & Risk Assessment - APEM	OI
104052-SBE-OI-HSE-PRO-HAZOPNF	Hazard and Operability Study - Northern Franklin	OI
104052-SBE-OI-HSE-PRO-ENFRANKLIN	Emergency Notification Flowchart - Northern Franklin	OI
104052-SBE-OI-HSE-PRO-ERPFRANKLIN	Emergency Response Plan - Northern Franklin	GS
104052-SBE-OI-SUR-REP-ENVFIERE	Environmental Field Report	OI
104052-SBE-OI-SUR-REP-MMO	Marine Mammal Mitigation Report	OI
104052-SBE-OI-SUR-REP-SURVEYRE	Integrated Geophysical and Habitat Assessment Report	OI
104052-SBE-OI-SUR-REP-TIDALRE	Intertidal Report	OI
104052-SBE-OI-SUR-REP-ENVSURRE	Environmental Baseline Survey Report- *this document*	OI
104052-SBE-OI-SUR-REP-GISCAD	GIS and CAD datasets (with Final Survey Report)	OI
104052-SBE-OI-SUR-REP-SURVEYRE	Integrated Geophysical and Habitat Assessment Report	OI

2. Survey Parameters

2.1 Geodetic Datum and Grid Coordinate System

The geodetic and projection parameters used during the project are presented in Table 3 and Table 4.

Table 3 Geodetic parameters.

Horizontal Datum: WGS 84	
Datum	World Geodetic System 1984 (6326)
Ellipsoid	World Geodetic System 1984 (7030)
Prime Meridian	Greenwich (8901)
Semi-major axis	6 378 137.000 m
Semi-minor axis	6 356 752.3142 m
Inverse Flattening (1/f)	298.257223563
Unit	International metre

Table 4 Projection parameters.

Projection Parameters	
Projection	UTM Zone 30 N (EPSG 32630)
Zone	30 N
Central Meridian	03° 00' 00'' W
Latitude Origin	0
False Northing	0 m
False Easting	500 000 m
Central Scale Factor	0.9996
Units	metres

The ITRF2014 realization is treated as equivalent to WGS84. Thus, no transformation is required.

2.1 Vertical Datum

The bathymetric survey data was reduced to the Lowest Astronomical Tide (LAT) through the usage of the UK Hydrographic Office (UKHO) Vertical Offshore Reference Frame (VORF) model.

The Global Navigation Satellite System (GNSS) tides was used to correct the bathymetry data to the project vertical reference level. The GNSS tide was obtained by post-processing GNSS data collected by an Applanix PosMV 320 system. The GNSS data was then post-processed and applied to the data. This tidal reduction methodology encompassed all vertical movement of the vessel, including tidal effect and vessel movement due to waves and currents.

The short variations in height were identified as heave and the long variations as tide. This methodology was very robust since it is not limited by the filter settings defined in the online systems and provided very good results in complicated environmental conditions.

The output from POSPac is a so-called SBET (Smoothed Best Estimated Trajectory) solution with ellipsoidal heights with accuracies of 5 cm Root Mean Square (RMS), which are corrected for motion and referenced to the Multi-beam Echo Sounder (MBES) reference point.

The procedure has proven to be very accurate as it accounts for any changes in height caused by changes in atmospheric pressure, storm surge, squat, loading or any other effect not accounted for in a tidal prediction. By incorporating a height model of the defined vertical datum into the process, all heights used the same vertical reference which was valid at the location of the actual measurement independent of the size of the survey area, instead of choosing a single mean value. Comparisons with the closest water-level station were performed to ensure that the data is levelled correctly.

The vertical reference datum parameters and height model used during the project are presented in Table 5.

Table 5 Vertical reference parameters.

Vertical Reference Parameters	
Vertical Reference	LAT
Height Model	VORF

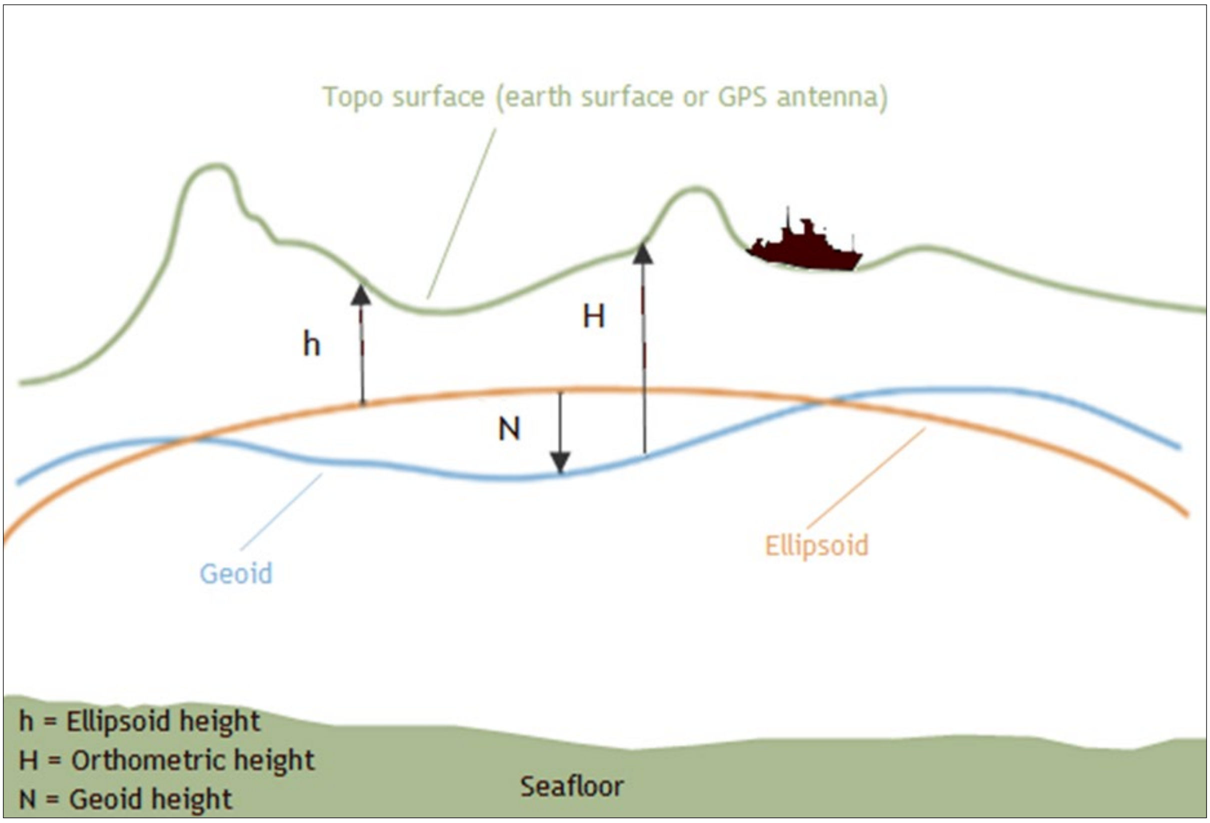


Figure 2 Overview of the relation between different vertical references.

2.2 Time Datum

Coordinated universal time (UTC) was used on all survey systems on board the vessel. The synchronisation of the vessel's onboard system was governed by the pulse per second (PPS) issued by the primary positioning system. All displays, overlays and logbooks were annotated in UTC. The Daily Progress Report (DPR) refers to UTC.

3. Survey Performance

3.1 Survey Tasks

The Environmental Survey tasks are presented in Table 6.

Table 6 Survey tasks.

Task	Date	Description
Mobilisation and Calibration	2022-08-06 – 2022-08-08	Mobilisation and calibration of geophysical survey equipment.
Geophysical survey – WAA	2022-08-08 – 2022-08-30	Geophysical Survey with MBES/Sub-bottom profiler (SBP) (vessel mounted) and Side Scan Sonar (SSS)/Magnotometer (MAG) (ROTV towed), 2D Sparker (vessel towed)
Geophysical survey – ECR	2022-08-30 – 2022-09-01	Geophysical Survey with MBES/SBP (vessel mounted) and SSS/MAG (ROTV towed), 2D Sparker (vessel towed)
Re-mobilisation	2022-09-01 - 2022-09-02	Mobilisation for benthic survey – Drop down camera Sea Spyder STR, Hamon Grab, Day grab
Environmental Survey	2022-09-10 - 2022-09-21	Drop down camera and grab survey
Demobilisation	2022-09-22	Demobilisation in Aberdeen.

3.2 Mobilisation and Calibration Test

Mobilisation and calibrations (MAC) were conducted between 2nd September and 10th September 2022 in Aberdeen, Scotland.

Detailed methodology and acceptance test procedures are presented in the Mobilisation and Calibration Report, 104052-SBE-OI-MAC-REP-NFRANKLIN and the Environmental Field Report 104052-SBE-OI-SUR-REP-ENVFIERE.

3.3 Vessel and Equipment

3.3.1 Vessel Equipment

The Environmental survey operations were conducted by the offshore vessel M/V Northern Franklin (Figure 3).

The vessel is equipped with a DP1 system and can perform geophysical seabed mapping (including UXO surveys) and geotechnical/environmental sampling assignments. Deployment of equipment was performed via a starboard A-frame.

Figure 3 M/V Northern Franklin.

The vessel M/V Northern Franklin is equipped with navigation and positioning systems as stated in Table 7 with environmental sampling equipment stated in Table 8.

Table 7 Vessel Equipment.

Instrument	Name
Primary Positioning System	Applanix POS MV 320 with C-Nav 3050 with C-NavC² corrections on the SF2 service
Secondary Positioning System	C-Nav 3050 using C-NavC² corrections on the SF1 service
Primary Gyro and INS System	Applanix POS MV 320
Secondary Gyro	iXblue GAPS
Underwater Positioning System	iXblue GAPS
Survey Navigation System	QPS QINSy
Surface Pressure Sensor	Vaisala Pressure Sensor
Multibeam Echo Sounder (Deep Water)	Kongsberg EM710 (70-100 kHz)
Multibeam Echo Sounder (Medium to Shallow Water)	Kongsberg EM2040D (200-400 kHz)
Parametric Sub-Bottom Profiler	Hull mounted Innomar 2000 SES – Medium 100
Low frequency Sub-Bottom Profiler	Towed GEOSPARK-1000 (200 tip)
Sound Velocity Sensor	Valeport SVX2, deployed over the side Real-time SVS Valeport miniSVS, hull-mounted at the MBES transducers

Table 8 Benthic survey equipment.

Equipment	Name
Benthic Grab	Day Grab (0.1m^2)
Benthic Grab	Hamon Grab (0.1m^2)
Video System and Photographic Camera	STR SeaSpyder
Sieve Table	1 mm & 5 mm Sieves and Sampling Table

4. Methodology

4.1 Field Methods

4.1.1 Survey Design

The benthic survey was conducted using grab samplers and a video and still camera system. Sample sites were selected using the information provided from the geophysical survey data and in accordance with the requirements of the Client.

A Senior Benthic Ecologist planned the benthic survey based on the geophysical data and preliminary geological interpretations, ensuring that the different habitats as interpreted from the Side Scan Sonar (SSS), Multibeam Echo Sounder (MBES), including normalised backscatter values, were ground-truthed. A detailed account of selected sites, including a geophysical overview, is presented in Appendix A.

The full SSS data coverage available was reviewed and interpreted based on texture and reflectivity. The SSS data were compared and correlated with MBES and backscatter.

Sample sites were documented by video and still photography and by grab sampling. Where grab sampling was not possible due to coarse substrates or sensitive habitats, only video/still photo was used for sampling. The methods used, correlate the geophysical information from MBES, and SSS with information on the substrate through Particle Size Analysis (PSA) and quantitative taxonomic analysis of the infauna. These survey and analytical methods provide a comprehensive overview of present conditions.

The final sample site locations were agreed upon in consultation with the Client prior to the commencement of the sample collection, and the site selection was validated through a rationale submitted to the Client. The locations of the sample sites were based on depth variation, sediment, and habitat changes as delineated during the geophysical survey to provide benthic data of all habitats interpreted within the survey area.

4.1.2 Drop Down Video (DDV)

A SeaSpyder DDV system from Subsea Technology & Rentals Ltd (STR) (Figure 4 and Figure 5) was used to acquire still and video imagery at each sample site.

The DDV system was fitted with four lasers which produced a 17 x 14 cm pattern of dots on the seabed for scaling. Lighting was provided by Light Emitting Diode (LED) lamps with adjustable intensity. A surface control unit and powerful topside processor gave full remote control of the camera. The unit was positioned via an Ultra-short Baseline (USBL) beacon attached to the camera frame for subsea positioning. Acquisition settings are presented in Table 9.

Figure 4 Offshore SeaSpyder DDV System.

Figure 5 Example image from the survey.

Table 9 DDV system settings during acquisition.

Camera	White Balance	ISO	F-stop	Exposure	Resolution
Stills	Auto	800	F/16	1/125 or 160	24 MP
Video	Auto	n/a	n/a	1/25, 1/30	1920 x 1080 and 30 frames/second

Each sample site was planned as a 50 m line transect covering the centre location of the proposed grab sample site. A minimum of seven (7) stills were taken along the 50 m transect at positions +25 m, +15 m, +5 m, 0 m, -5 m, -15 m, and -25 m from the target centre. One standalone video transect (ECR_T53) was performed, with a length of 490 m along which 30 images were obtained. Stills were taken more frequently if the seabed exhibited features of interest i.e., reefs and/or evidence of increased diversity.

The camera was positioned as close as possible to the pre-selected starting point using the vessel's dynamic positioning system during the survey. The camera frame was lowered onto the seabed to adjust the camera focus. When the camera focus was set, an initial photo was taken, before the video recording was initiated.

The camera frame was eased off the seabed and towed slowly at approximately 0.3 - 0.5 knots. It was positioned as close to the seabed as possible with an approximate altitude of 0.5 - 1 m. Altitude was determined by seabed topography and weather conditions.

Prior to grab sampling, an experienced marine biologist reviewed all grab sites onboard to confirm the presence/absence of any potentially sensitive habitats or features of conservation interest.

4.1.3 Faunal Grab Sampling

At each grab sample site, two (2) grab samples were to be acquired: one (1) sample for faunal analyses and one (1) sample that was subsampled for Particle Size Analysis (PSA) and contaminant analyses.

The primary grab sampler utilised for PSA and contaminants sampling was the Day Grab (DG) (Figure 6). The Hamon Grab (HG) was used as a secondary grab to sample PSA and fauna in areas of coarse sediment, however, the Hamon Grab could not be used for contaminants samples (Figure 7). Upon retrieval, samples were checked for adequate sample volume and samples covering less than 0.1 m^2 of bottom surface sediment were deemed unacceptable. No samples of less than 5 cm (7 cm in fine sediments) for the DG or 2.7 litres for HG were considered acceptable samples (Worsfold, Hall, & O'Reilly, 2010; Davies, et al., 2001).

If an acceptable sample volume was not achieved within three (3) attempts at the grab sample site (e.g., in areas of coarse sediment) then this was recorded, and the survey continued with the next grab sample site. Samples that were not accepted were not included in any statistical analyses.

The third attempt was repositioned slightly, to obtain a representative sample. Real-time observations of existing geophysical data were undertaken onboard by the experienced marine biologist in order to determine the closest area of suitable substrate.

A field log of sample positions including time, sediment type, and water depth was kept for later reference. All samples were photo-documented in-situ. Approved faunal samples were carefully sieved with seawater over stacked 5 mm and 1 mm sieves using gentle hose pressure. Sieve fractions were fixated with 95% ethanol in separate jars, that were labelled with a unique label containing the grab sample site ID and replicate number.

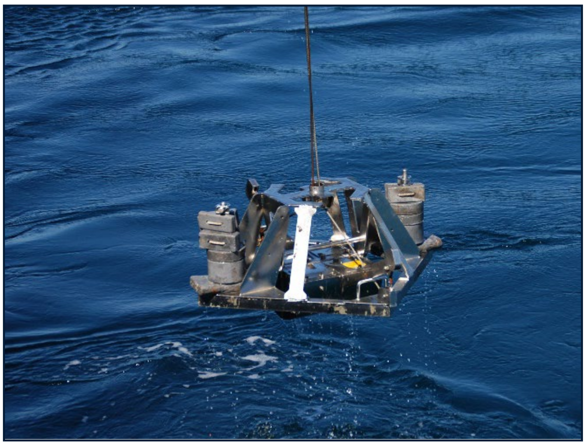


Figure 6 Day grab sampler.

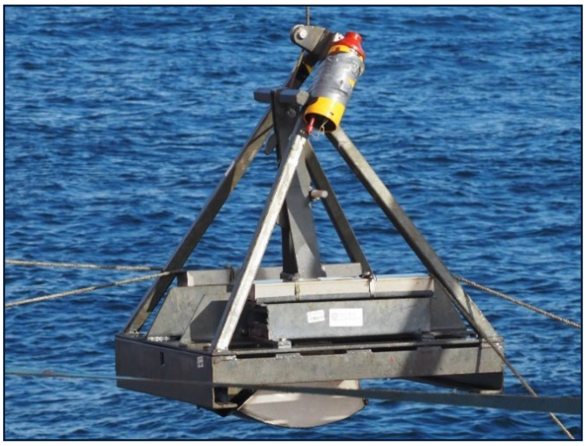


Figure 7 Hamon grab sampler.

4.1.4 Particle Size and Contaminants Grab Sampling

The primary grab sampler utilised for the PSA and chemical sampling was the DG. The HG was used as a secondary grab to sample PSA in areas of coarse sediment, however, the HG could not be used for chemical samples.

Upon retrieval, samples were checked for adequate sample volume and samples covering less than 0.1 m^2 of bottom surface sediment were deemed unacceptable. No samples of less than 5 cm (7 cm in fine sediments) for the DG or 2.7 litres for HG were considered acceptable samples (Worsfold, Hall, & O'Reilly, 2010; Davies, et al., 2001). Sample re-attempts follow the same procedures as outlined in Section 4.1.3.

Samples for metals, hydrocarbons (Total Hydrocarbons, THC, and Polycyclic Aromatic Hydrocarbon, PAH), and organics (Loss of Ignition, LOI, and total organic content, TOC) were sampled from the top 2 cm of an undisturbed surface.

Contaminant samples for organics and hydrocarbons were sampled using a metal spoon and stored in labelled 250 ml metal tins. Samples for metal analyses were sampled using a plastic spoon and stored in labelled one (1) L plastic container. The grab sampler was cleaned between samples and sample sites.

The sample containers were labelled with a unique sample site ID. Metal and contaminant samples were immediately frozen after processing. Any replicate samples for all the analyses were collected and stored as back-up samples (not analysed).

A field log of sample positions including time, sediment type, and water depth was kept for later reference. Samples were photo-documented in situ. For further information regarding sample volume and the number of attempts, see Appendix B.

4.2 Laboratory Methods

4.2.1 Particle Size Analysis

The Particle Size Analysis (PSA) was conducted by UK based company Kenneth Pye Associates Limited. (KPAL). Prior to analysis, a sub-sample was acquired from each container and sent for analysis of TOC and TOM.

Up to one litre of sediment from each sample site was analysed to detail the different particle fraction components with a combination of sieving and sedimentation methods.

PSA samples were analysed in accordance with NMBAQC Guidelines for Particle Size Analysis (PSA) for Supporting Biological Analysis (Mason, 2022) to provide data over the complete particle size range allowing determination of the gravel to sand plus mud ratio. KPAL also hold Marine Management Organisation (MMO) accreditation for particle size analysis.

Samples were wet separated at 2.0 mm. The >2.0 mm fraction, where present, was analysed using nested British Standard sieves at 'half' phi intervals. The sub-2.0 mm fraction was analysed via laser diffraction (size range 0.04 µm to 2.0 mm). The laser and sieve data were mathematically merged and calculations of particle size summary parameters (percentages of mud, sand, and gravel, silt/clay ratio, sand/mud ratio, median, mean, d10, d90, etc.) were calculated using GRADISTAT software (Blott & Pye, 2001).

The particle sizes were grouped into five large textural groups for description purposes (Table 10). The samples were described according to British standard 1377 (British Standard, 2010) and British Geological Society (BGS) modified Folk classification (Long, 2006). Detailed results for each grab sample site are provided in Appendix F.

Table 10 British standard (2010) sieve sizes.

Classification	Particle Size Intervals (Diameter mm)	Grouped Classification
Boulder	>75	Boulders/cobbles
Cobble	75-64	
Coarse Gravel	64-20	Gravel
Medium Gravel	20-6	
Fine Gravel	6-2	
Coarse Sand	2-0.6	Sand
Medium Sand	0.6-0.2	
Fine Sand	0.2-0.063	
Coarse Silt	0.063-0.02	Silt
Medium Silt	0.02-0.006	
Fine Silt	0.006-0.002	
Clay	<0.002	Clay

4.2.2 Contaminants Analyses

The contaminants analyses were conducted by the UK based company SOCOTEC. The different compounds that were analysed along with detection limits are stated in Table 11. The analyses included concentrations/contents of metals, TOM, TOC, THC and PAH.

Detailed results of each grab sample site are provided in Appendix G.

Table 11 Marine sediment contaminants analyses.

Analytes	Method	Accreditation	Method Reporting Limit, PPM Unless Stated Otherwise
Particles Size Analysis and Distribution (PSA, PSD)	NMBAQC	NMBAQC	N/A
Total Organic Carbon	Sulphurous acid/combustion at 1600°`C/NDIR	UKAS 17025	0.02 %
Total Organic Matter by LOI	Combustion at 450°C	Not accredited	0.20 %

Analytes	Method	Accreditation	Method Reporting Limit, PPM Unless Stated Otherwise
Metals suite: As(1), Cd(0.1), Cr(0.5), Cu(2), Ni(0.5), Pb(2), Sn (0.5), V(2), Zn(3)	Microwave assisted HF/Boric extraction & ICPMS	UKAS 17025	Limits of detection within parentheses.
Metals suite: Hg(0.001)	Nitric/peroxide extraction & ICPMS	Not accredited	Limits of detection within parentheses.
Metals suite: Al(10), Ba(1), Fe(10)	Microwave assisted HF/Boric extraction & ICPOES	UKAS 17025	Limits of detection within parentheses.
THC (inc. saturates)	Solvent extraction & GC-FID	Not accredited	100 µg/kg (Total) 1 µg/kg (Individual alkanes)
PAH	Solvent extraction & GC-MS	UKAS 17025	1 µg/kg

4.2.3 Biological Analysis

The faunal analysis was conducted by the UK-based company APEM Ltd. Analysis was conducted in accordance with the NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme (Worsfold, Hall, & O'Reilly, 2010), and all the samples were quality controlled.

The faunal samples were sorted from sediment residue, and the fauna was identified to the lowest taxonomic level possible, mainly species and enumerated. When the species could not be identified, the specimen was grouped into the nearest identifiable taxon of a higher rank, i.e., genus, family, or order etc.

If the species remained unknown but separated from any other found within the same genus, it was assigned a “Type” denomination, i.e., Type A or Type B. Juveniles were marked with the qualifier “juvenile” and excluded from further statistical analyses. Colonial fauna was not quantified in the laboratory analysis and recorded as Present (P).

Biomass analysis was conducted on the infauna from grab samples following identification and enumeration. Biomass was measured for each taxon for each sample, using the blotted wet-weight method, to the nearest 0.0001 g. All infaunal analyses followed the NMBAQC scheme. For a more detailed description, view Appendix E.

4.3 Data Analyses

4.3.1 Visual Data Analyses

For epifauna identification, seven (7) stills along each transect were selected. Results are presented as an average of individuals or colonies per m^2. For the extended standalone transect (T53), 18 stills were selected.

The stills were analysed to identify species and densities, including seabed substrate. Particular attention was paid to the elevation of habitats above ambient seabed level, together with their spatial extent, percentage biogenic cover and patchiness, as these are key criteria for evaluating areas of conservation importance and reef structures (Gubbay, 2007; Irving, 2009).

Quantitative methods were used for the identification of biota in grab samples and still photographs, with all the data presented as individuals per square metre and percentage cover of colonial species. Stills were analysed in AutoCAD Map 3D 2022 where visual epibenthic fauna was counted and results summarised in a log, containing scientific name, position, date, time, stills ID and quality checked.

For a more detailed description of species, view Appendix D.

4.3.2 Particle Size Distribution

Sediment particle size distribution statistics for each sample were calculated from the raw data by the laboratory. Main sediment fractions and percentages were plotted to examine sediment composition changes across the survey area and used to aid the habitat assessment. Multivariate analyses were undertaken on the PSA data set, to identify patterns in the sediment distribution.

The PSA results were analysed using Plymouth Routines in Multivariate Ecological Research (PRIMER) software and normalised before being included in any statistical analysis.

Data for the percentage composition was analysed in a cluster analysis using the Euclidean distance. A Principal Component Analysis (PCA) was undertaken on the sediment data set to identify spatial patterns and relationships between variables.

Detailed results for each grab sample site are provided in Appendix F.

4.3.3 Contaminant Analysis

Environmental Quality Standards (EQS) for metals and hydrocarbons in sediments are not yet developed for UK waters.

Assessment criteria developed by the Canadian Council of Ministers of the Environment (CCME) together with the Centre for Environment, Fisheries and Aquaculture Science (Cefas) guideline action levels for disposal of dredged material have been considered common practice to use.

The Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic (OSPAR) Environmental Assessment Criteria (EAC) have also been used as guidelines for metal and PAH concentrations, when applicable, within this report. The Canadian sediment quality guidelines include two values as assessment criteria, the Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL).

The ISQG are threshold levels that are set to protect all aquatic life during an indefinite period of exposure, and for values above PEL, adverse effects are expected to occur frequently (CCME, 1995; CCME, 2001). For concentrations between the ISQG and PEL, adverse effects occur occasionally.

Cefas Action Levels are used as a part of assessing the contamination status in dredged material, where material below Action Level 1 (AL1) generally indicates that contaminant levels are of no concern, while contaminant levels above Action Level 2 (AL2) generally are considered unsuitable for disposal in the sea (MMO, 2015).

OSPAR's Environmental Assessment Criteria (EACs) are under development, and OSPAR uses "Effect range-low" (ERL) values for sediment assessment of metals and PAH, where EACs are not available. The ERL value indicates a concentration below which adverse effects on organisms are rarely observed (OSPAR, 2011).

Condition classes established by the Norwegian Environmental Agency (NEA) for contamination in coastal sediments (NEA, 2016, revised 2020) for metals, PAH and other organic compounds were also used. This system uses five classes, class 1 - Background levels, class 2 - Good, with no known toxic effects, class 3 - Moderate, with chronic effects at long-term exposure, class 4 - Poor, with acute toxic effects at short-term exposure and class 5 - Very Poor, with extensive toxic effects.

There are no OSPAR or UK contamination threshold values regarding THC for marine sediments. In the absence of such guidelines, Dutch intervention levels for aquatic sediments can offer a useful comparison.

Concentrations above the Dutch intervention values represent a serious level of contamination, where functional properties of the sediment are seriously impaired or threatened (Hin, Osté, & Schmidt, 2010).

Detailed results are presented in Appendix G.

4.3.4 Univariate Statistical Analyses

Univariate analyses were undertaken using the Plymouth Routines in Multivariate Ecological Research (PRIMER) v7.0 statistical package (Clarke, 2015).

Univariate analyses included the primary variables, the number of taxa (S) and abundance (N) together with the Margalef’s index of Richness (D), Pielou’s index of Evenness (J), Shannon- Wiener index of Diversity (H’) and the Simpson’s index of Dominance (λ) which are summarised in Table 12.

Table 12 Univariate statistical analyses.

Analyses	Parameters	Formula	Description
No. of Taxa (S)	Species richness	S	The number of species (taxa) in each sample.
No. of Individuals (N)	Abundance	N	The number of individuals in each sample.
Margalef's Index of Richness (D)	Richness	d = (S-1) / ln(N)	A measure of the number of species present for a given number of individuals
Shannon-Wiener Index of Diversity (H')	Diversity	H’ = Σi Pi ln(Pi)	The diversity index incorporates both species richness and equitability, where Pi is the proportion of the total count arising from the /th species. A lower value equals a high chance that all abundance is concentrated to one species.
Pielou's Index of Evenness (J)	Evenness	J = H' / ln (s)	Measures how evenly individuals are distributed between species. Gives a value between 0 to 1, where a higher value equals a more even community.
Simpson's Index of Dominance (1-λ)	Dominance	λ = (Σ pi2)	Dominance index between 0 - 1 where 0 corresponds to assemblages whose total abundance is dominated by one or very few of the species present and 1 represents a more evenly species distribution.

4.3.5 Multivariate Statistical Analyses

Multivariate analysis was undertaken using the Plymouth Routines in Multivariate Ecological Research (PRIMER) v7.0 statistical package (Clarke, 2015). The statistical analyses were based on macrofaunal data derived from the taxonomic analyses of one replicate from each sample site. All samples had sufficient sample volume to be included in the analyses. Abundances were expressed as a number of individuals per square metre.

The macrofaunal organisms were separated into non-colonial and sessile colonial fauna. Colonial fauna was not quantified in the laboratory analysis and was treated separately in the statistical analyses. All colonial fauna were considered to be epifauna. Juvenile (JUV) taxa were excluded from the dataset. Foraminiferans were excluded from the datasets. The faunal composition was linked to physical variables such as depth and sediment composition.

Square root transformation was applied to the non-colonial enumerated fauna datasets before calculating the Bray-Curtis similarity measures. This transformation was made to prevent abundant species from influencing the Bray-Curtis similarity index measures, excessively and to take the rarer species into account (Clarke & Warwick, 2001).

The macrofaunal laboratory results were compared for faunal composition within and between sampling sites. Site related differences in community structure were examined in a clustering analysis using Euclidean distance and the Bray-Curtis similarity coefficient. This method is common when measuring ecological distance in biological sample data.

Multi-Dimensional Scaling (MDS) analysis was undertaken in conjunction with the cluster analysis. The MDS analysis is based on the same similarity matrix as that of the cluster analysis and produces a multidimensional ordination of samples.

The number of restarts was set to 999 with a minimum stress of 0.01. The MDS plot visualises the relative (dis)similarities between samples; the closer they are the more similar the species composition between the samples. The degree to which these relations can be satisfactorily represented is expressed as the stress coefficient statistic, low values (<0.1) indicate a good ordination with low probabilities of misleading interpretation. Generally, the higher the stress, the greater the likelihood of non-optimal solutions (Clarke & Warwick, 2001).

A Similarity Profile (SIMPROF) test was run in conjunction with the cluster analysis, which was used to identify significantly different naturally occurring groups among grab samples.

The results are presented in the cluster dendrogram as black lines indicating significant statistical differences. Significance level for the cluster analysis was set to 5 %. Red lines represent samples that are not statistically different. The SIMPROF is based on taxa, and the abundance of each taxon in each sample, thus different SIMPROF groups may host similar fauna which differ in abundance.

A Similarity Percentages analysis (SIMPER) was undertaken following the cluster analysis. SIMPER examines variable relations to each other and presents the species' contributions and similarities within and among groups.

PSA data were analysed in PRIMER and normalised before included in any statistical analysis. Data for the percentage composition was analysed in a cluster analysis using the Euclidean distance. A Principal Component Analysis (PCA) was undertaken on the sediment data set in order to identify spatial patterns and relationships between variables.

The relationship between the physical and biological data was tested using the BIOENV method, with Spearman rank correlations, in the BEST procedure in PRIMER v.7. This analysis identifies variables that exert the greatest influence on the spatial distribution of the input dataset. Prior to the BEST analyses species abundance data were square root transformed and the physical variables were normalised.

4.4 MBES Derivatives

During the post-processing and assessment of benthic data, an additional MBES data derivative backscatter was produced to further strengthen the accuracy of the interpretations.

4.4.1 Backscatter

The use of backscatter data to assist habitat interpretations and mapping is a methodology under development, increasingly used in these types of analyses (Lurton, et al., 2015).

Backscatter Normalised Values are a measurement of the MBES echo that is scattered in the direction of the transducer. This data records the intensity, in decibels (dB), of the echo that returns to the transducer after the emitted pulse interacts with the seabed.

The backscatter amplitude varies with several factors such as frequency, beam pattern, range and losses due to absorption and spreading, angle with the seabed as well as sediment type and other factors.

The raw data were processed with the Fledermaus (FMGT) software, which applied various standard normalisations to the data to compensate for how the intensity varied across the swath producing a grayscale floating-point raster image gridded at 1 m, where each gridded cell contains a measured intensity value.

The intensity decibel value interval, varied between the datasets acquired within the WAA and along the ECR due to their varying directionality. The range is typically 0 (hard seabed) to -47 (soft seabed) for the exported raster data.

Backscatter values varied across a small spatial scale, making interpretations on a larger scale challenging due to the small-scale variation. To mitigate this, the Focal Statistics tool in ArcGIS was used to reduce the variation in the values. The backscatter raster data was imported into ArcGIS and a raster image was created based on the measured intensity values for each cell and plotted.

Within ArcGIS, a secondary raster image was created through the calculation of the cell value with the Focal Statistics tool. The tool calculates a new value for each input cell based on the neighbouring cell values. The new value output was based on the average value of the neighbouring cells in a 5x5 m (5x5 cells) square area with the target cell included (Figure 8). The new cells maintained the original cell size of 1x1 m.

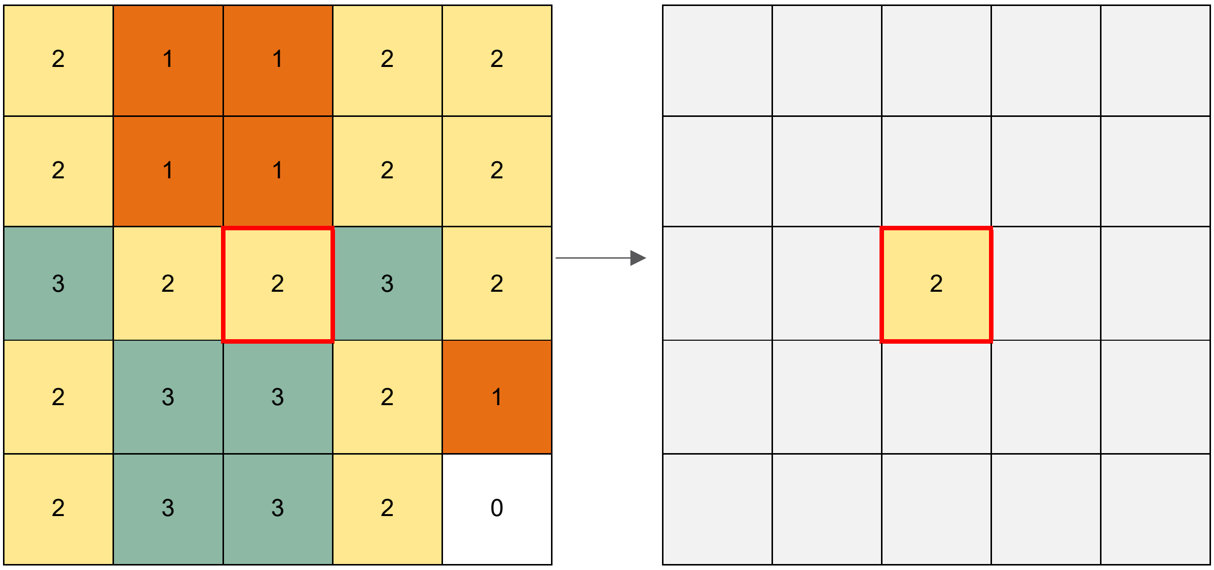


Figure 8 Focal Statistics settings.

Ground-truthing data (imagery) together with geophysical data were used to align the backscatter reflectivity intervals based on the trends interpreted, with regard to substrate and habitats (Lurton, et al., 2015). However, there were limiting factors due to the numerous and morphologically different ripple features in the area as well as the particle density in the water column.

The difficulties, that features such as ripples, impose on backscatter data are due to changes in elevation and angle of the seabed. These affect the amount of reflected sound, resulting in values indicating too hard or too soft a substrate. These potential errors are partially mitigated by using the Focal Statistics tool in ArcGIS, as the interpolation used in the tool averages out the overestimated and underestimated values from the backscatter.

Outlier values from the outermost ranges from the data sets were naturally excluded as the grouping of the intervals were set and these are detailed in Table 13.

Table 13 Backscatter Intensity colour schema for each area (intensity is presented in dB).

Datasets	Colour Bars and Classes (dB)	Outliers (dB)
RAW		-6 - 4; -47 - -26
FOCAL ECR		-35 - -22; -6 - 10

Datasets	Colour Bars and Classes (dB)	Outliers (dB)
FOCAL WAA		-28 - -23; -13 - -10

4.5 Habitat Classification

Habitats were classified to the lowest hierarchic level possible and based on interpretations that combine biotope descriptions of species abundance, diversity, depth and seabed features from grab samples, video and photos acquired at each sample site.

The classification of the communities of the different habitat types was based on physical characteristics such as benthic geology, wave exposure, tidal currents, temperature, and salinity together with key species present in the area. In addition, normalized backscatter data from MBES was used to delineate habitats in areas of homogenous sediments.

The EUNIS classification (EEA, 2022) is divided into six hierarchic levels, (Figure 9). At Level 1, the habitats are divided into marine, coastal and terrestrial habitats. The marine habitats are further divided into three separate categories: benthic, pelagic and ice-associated habitats.

At Level 2, the biological zone and presence/ absence of rock is a classification criterion, and at Level 3, the classifications are separated into marine regions.

Level 4 gives references to specific taxa. For rocky substrates, the major epifauna is used, and for softer substrates, the classification relies on both zonation and physical attributes. Further, at Level 5, the classification is based on both the physical and biological characters of the habitats, and classes are defined with both infauna and epifauna on different substrates. At the highest level, level 6, the different characterising taxa are associated with different environmental characteristics of the habitat.

If two different habitat classifications within what appears to be a similar habitat are identified, without any apparent differences in the interpreted geophysical data, a low number of transects may lead to the assignment of a matrix of two habitats. Extrapolating a large area based on a low number of samples may lead to a lower hierarchic biotope level for that area, than the actual biotope level for a singular sample within the habitat.

These compromises are reviewed individually. A smaller homogenous and distinctive area can be assigned to a higher hierarchic level compared to a larger and more variable area containing several different biotopes. The result of the habitat classification is presented in the results section and GIS charts.

L1	(M) Marine Habitats
L2	(MC4) Circalittoral mixed sediment
L3	(MC42) Atlantic circalittoral mixed sediment
L4	(MC421) Faunal communities of Atlantic circalittoral mixed sediment
L5	(MC4211) *Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment
L6	(MC42111) *Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment

Figure 9 Example of 2022 EUNIS Hierarchy.

4.6 Protected Habitats and Species Assessments

For the assessment and classification of potential areas and/or species of conservation importance, the following legislation and guidelines have been applied when relevant.

The European Commission (EC) Habitat Directive specifies the European nature conservation policy (EUR 28, 2013). Species and habitats of special interest for conservation are specified in the different annexes to the directive. Annex I states the habitats of special conservation interest and Annex II states the species of special conservation interest. Among the habitats specified in Annex I are the “Reefs” (code 1170). Reefs can be of biogenic, e.g. mussel beds or corals, or geogenic origin, e.g. stony areas with epifauna.

The Oslo and Paris Conventions for the protection of the marine environment of the North-East Atlantic (OSPAR), list protected species and habitats, as well as sensitive habitats and species in need of protection in the North-East Atlantic. This serves also as a complement to the EC (European Commission) Habitats Directive.

The species and habitats found in this survey were compared to the list of Scottish Priority Marine Features (PMF) (Tyler-Walters, et al., 2016) that further defines the habitats and species which are considered to be marine nature conservation priorities in Scottish waters.

In addition to the above-mentioned policies and guidelines the Scottish Biodiversity List (SBL) identifying the species and habitats which are the highest priority for biodiversity conservation in Scotland was also consulted (SBL, 2009).

In the Habitat Directive’s interpretation manual (EUR 28, 2013) reefs are explained as follows:

“Reefs can be either biogenic concretions or of geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions.”

The distinction between what *is* and what *is not* a “reef” is not so precise and is generally referred to as “reefiness”. This is particularly relevant in the case of the tube-building polychaete, *Sabellaria spinulosa* and areas of cobbles and boulders (stony reef).

If for example *S. spinulosa* or the horse mussel, *Modiolus modiolus,* is found in an area it does not automatically qualify as a “reef”, Annex I habitat or a potential Annex I habitat. Therefore, a scoring/assessment system based on a series of physical, biological and spatial characteristics is used to assess the degree of “reefiness”.

A method to assess ‘reefiness’ was presented by Gubbay (2007) and involves the quantification of three separate criteria: Elevation (average tube height in cm), Area (m^2) and Patchiness (percentage cover) as presented in Table 14. A similar assessment matrix for stony reefs by Irving (2009) is presented in Table 16.

Table 14 Proposed matrix for Sabellaria spinulosa reef identification (Gubbay, 2007).

Characteristic	Not A Reef	“Reefiness”		
		Low	Medium	High
Elevation (cm) (Average tube height)	<2	2 – 5	5 – 10	>10
Extent (m^2)	<25	25 – 10 000	10 000 – 1 000 000	>1 000 000
Patchiness (% cover)	<10	10 – 20	20 – 30	>30

The general definition of biogenic reefs is made by (Holt, Rees, Hawkings, & Seed, 1998) as;

"Solid, massive structures which are created by accumulations of organisms, usually arising from the seabed or at least clearly forming a substantial, discrete community or habitat which is very different from the surrounding seabed. The structure of the reef may be composed almost entirely of the reef-building organism and its tubes or shells or it may to some degree be composed of sediments, stones and shells bound together by the organism."

To assess the overall 'reefiness' the Collins (2010) method of combining the three separate criteria (elevation, extent and patchiness) as established by Gubbay (2007) was implemented. Reef structure was assessed in Step 1 followed by Step 2 aimed to categorise the final 'reefiness' (Table 15).

The patchiness of *S. spinulosa* was derived from the visual data analysis and the percentage coverage was calculated from each still image taken along the transect. Elevation of the *S. spinulosa* tubes was estimated from each still image taken along the transect. The area was calculated from boundaries (polygons) drawn in GIS based on the interpreted geophysical and bathymetrical data.

For the purpose of this report, areas comprising aggregations of *S. spinulosa* are designated as *"S. spinulosa* aggregations" to illustrate the presence and spatial distribution of aggregations.

Table 15 Sabellaria spinulosa *Reef Structure Matrix (Step 1) and S. spinulosa Reef Structure Matrix vs Area Matrix (Step 2) to determine final "Reefiness" (Collins, 2010).*

Step 1						
Reef Structure Matrix			**Elevation (cm)**			
			<2	**2 - 5**	**5 - 10**	**>10**
			Not a reef	**Low**	**Medium**	**High**
Patchiness (%)	<10	**Not a reef**	Not a reef	Not a reef	Not a reef	Not a reef
	10 – 20	**Low**	Not a reef	Low	Low	Low
	20 – 30	**Medium**	Not a reef	Low	Medium	Medium
	>30	**High**	Not a reef	Low	Medium	High

Step 2					
Reef Structure vs Area		**Area (m²)**			
		<25	**25 – 10 000**	**10 000 – 1 000 000**	**>1 000 000**
		Not a reef	**Low**	**Medium**	**High**
Reef Structure	**Not a reef**	Not a reef	Not a reef	Not a reef	Not a reef
	Low	Not a reef	Low	Low	Low
	Medium	Not a reef	Low	Medium	Medium
	High	Not a reef	Medium	High	High

Table 16 Guidelines used to categorise 'reefiness' for stony reefs (Irving, 2009).

Measure of 'reefiness'	Not a stony reef	Low	Medium	High
Composition	<10 %	10-40 % Matrix supported	40-95 %	>95 % Clast supported
Notes: Diameter of cobbles / boulders being greater than 64 mm. Percentage cover relates to a minimum area of 25 m^2. This 'composition' characteristic also includes 'patchiness'.				
Elevation	Flat Seabed	<0.064 m	0.064 m-5 m	>5 m
Notes: Minimum height (64 mm) relates to minimum size of constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seabed.				
Extent	<25 m^2	>25 m^2		
Biota	Dominated by infaunal species			>80 % of species present composed of epifaunal species.

This scoring system indicates that stony reefs should be elevated by at least 0.064 m and with a composition of at least 10 % stones, covering an area of at least 25 m^2 and having an associated community of largely epifaunal species.

For Stony Reefs with a Low resemblance, the methodologies proposed by Brazier and Golding *et al* (2020) were consulted to assess whether or not an area would meet the criteria for inclusion in Annex I (1170) – Reefs, Stony Reefs. The methodology is still under review and development and is therefore not fully implemented but contains guidance on classifying and enumerating reef habitat "Key Species" as well as "Reef-Species" often present in Stony Reef habitats (Table 17).

Table 17 Guidelines used to categorise low resemblance stony reefs (Brazier, 2020).

	Key Species Count	Reef-Species Count
Reef	≥3	>20
Possible Reef	>1 and <3	<5 and <20
Not Reef	0	<5

For "Bedrock Reefs" no similar scoring system exists. In areas where the geophysical data cannot provide information on the degree of bedrock exposure, these areas will be delineated as "Potential Bedrock Reefs." The qualifying criteria for the classification "Bedrock Reefs" is the presence of bedrock that could support an epifaunal community.

5. Results

A total of 57 grab sample sites were sampled. Faunal samples were successfully obtained at 52 grab sample sites and ground-truthing imagery was obtained at 57 sample sites. PSA and contaminants were successfully obtained at 51 sites.

No PSA or contaminants samples were obtained at site S06 due to the presence of *Sabellaria spinulosa* aggregations acquired in the first (faunal) grab sample, as agreed with the Client during the survey. DDV was performed prior to grab sampling and aggregations of *S. spinulosa* were identified in the DDV but these sparsely distributed in low densities with large patches of rippled shelly sand in between. The aggregations obtained in the faunal grab sample were mainly buried as they were only visible once the sample had been sieved. Subsequent faunal analyses of the sample showed no living specimens of *S. spinulosa* in these aggregations.

Grab sampling was not undertaken at sites S45, S47, S49, S50 and S52 due to the presence of *Sabellaria spinulosa* aggregations identified from DDV. These sites were replaced respectively by sites S54, S55, S56, S57 and S58 where faunal, PSA and contaminant samples were successfully acquired. Both the original and replacement site DDV transects were analysed to identify epifauna.

An additional standalone DDV transect (site T53) was performed in the ECR to investigate a seabed feature identified from the geophysical data. Transect T53 was 490 m in length and confirmed the presence of two raised seabed features identified as a possible sea channel (104052-SBE-OI-SUR-REP-SURVEYRE).

See Table 18 and Appendix A for details regarding planned sites with geophysical data. Further information regarding sample site coordinates is provided in Appendix B.

Table 18 Number of sampled sites and transects.

Number of Sample Sites	Standalone Transect Sites	Grab Sample Sites
	1	57
Still Images	18	434
Faunal Samples	N/A	52
Contaminant Samples	N/A	51
PSA Samples	N/A	51

5.1 Summary of Identified Habitats

A total of six (6) habitats, including one (1) habitat complex, are interpreted to be present within the survey area. An overview of the distribution of habitats and grab sample sites is presented in Table 19 and illustrated in Figure 10.

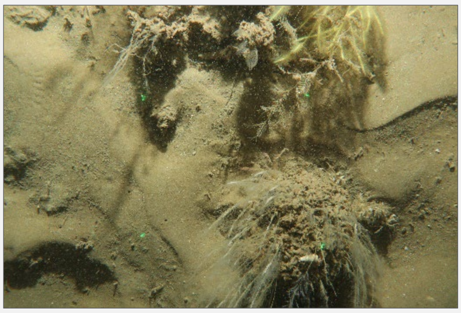
One PMF habitat, Offshore subtidal sands and gravels, and one SBL habitat, Subtidal sands and gravels, are both interpreted to be present along the ECR and within the WAA. Both habitats are very common subtidal habitats around the British Isles and throughout the North Sea, and overlap with one another.

Large areas of the tube building polychaete *S. spinulosa* was found, the composition consisted of scattered aggregations surrounded in high mobile sediments. This habitat will be delineated as “S. spinulosa aggregations presence”, it is interpreted to be present along the ECR and within the WAA based on the assessment seen in 4.6 results seen in 5.8.2 along with overview images Figure 40, Figure 41 and Figure 42 and Figure 40.

The taxonomic assemblages from the acquired grab sample data further indicate the presence of 11 species-specific habitats, including 7 habitat complexes, that are presented in Table 20 and illustrated in Figure 11.

The ID column in Table 19 and Table 20 defines the colour in the GIS charts for the specific habitat type.

Table 19 Identified habitats within the surveyed area.

Habitat Image	ID	Habitat Classification	Habitat Code	Site ID
		Atlantic circalittoral coarse sediment	MC32	ECR_S48, ECR_S51, ECR_T53, ECR_S54, ECR_S55, ECR_S56, ECR_S57, ECR_S58
		Atlantic circalittoral mixed sediment	MC42	ECR_S49, ECR_S50, ECR_S52
		Atlantic circalittoral sand	MC52	WAA_S09, WAA_S13, WAA_S18, WAA_S19, WAA_S22, WAA_S27, WAA_S28, WAA_S31, WAA_S32, ECR_S42, ECR_S44, ECR_S46
		Atlantic circalittoral sand/ *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment	MC52/ MC2211	WAA_S01, WAA_S02, WAA_S03, WAA_S04, WAA_S05, WAA_S06, WAA_S07, WAA_S08, WAA_S10, WAA_S11, WAA_S12, WAA_S14, WAA_S15, WAA_S17, WAA_S20, WAA_S21, ECR_S39, ECR_S40,
		*Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment	MC2211	WAA_S25, WAA_S26, WAA_S24, ECR_S41, ECR_S43, ECR_S45, ECR_S47

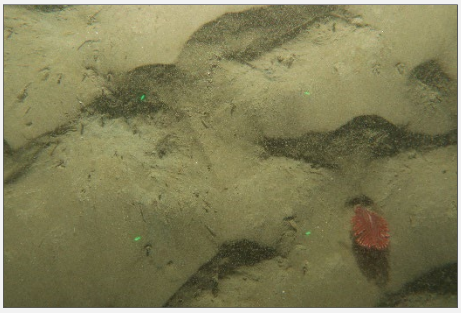
Habitat Image	ID	Habitat Classification	Habitat Code	Site ID
		Atlantic circalittoral mud	MC62	WAA_S16, WAA_S23, WAA_S29, WAA_S30, WAA_S33, WAA_S34, WAA_S35, WAA_S36, WAA_S37, WAA_S38

Table 20 Species-specific habitats within the surveyed area.

Habitat Classification	Habitat Code	ID	Site ID
Sabellaria spinulosa on stable Atlantic circalittoral mixed sediment	MC2211		ECR_S40, ECR_S41
Mysella bidentata and *Thyasira* spp. in circalittoral muddy mixed sediment/ *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand	MC4213/ MC5212		WAA_S21, WAA_S22, WAA_S24, WAA_S25
Mysella bidentata and *Thyasira* spp. in circalittoral muddy mixed sediment/ *Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in Atlantic circalittoral sandy mud	MC4213/ MC6211		WAA_S18
Mysella bidentata and *Thyasira* spp. in circalittoral muddy mixed sediment/ *Amphiura filiformis* and *Nuculoma tenuis* in Atlantic circalittoral and offshore muddy sand	MC4213/ MC6213		WAA_S09, WAA_S15
Faunal communities of Atlantic circalittoral sand	MC521		WAA_S13
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	MC5211		ECR_S44, ECR_S46, ECR_S48, ECR_S51, ECR_S54, ECR_S55, ECR_S56, ECR_S57, ECR_S58, WAA_S17, WAA_S19, WAA_S20, WAA_S26
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand/ *Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in Atlantic circalittoral sandy mud	MC5211/ MC6211		ECR_S39, ECR_S42, ECR_S43, WAA_S01, WAA_S04, WAA_S05, WAA_S11, WAA_S12
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand/ *Amphiura filiformis* and *Nuculoma tenuis* in Atlantic circalittoral and offshore muddy sand	MC5211/ MC6213		WAA_S07, WAA_S08, WAA_S10, WAA_S14
Abra prismatica, *Bathyporeia elegans* and polychaetes in circalittoral fine sand/	MC5212/ MC6211		WAA_S02, WAA_S03, WAA_S06

Habitat Classification	Habitat Code	ID	Site ID
Amphiura filiformis, *Mysella bidentata* and *Abra nitida* in Atlantic circalittoral sandy mud			
Medium to very fine sand, 100-120 m, with polychaetes *Spiophanes kroyeri*, *Amphipectene auricoma*, *Myriochele* sp., *Aricidea wassi* and amphipods *Harpinia antennaria/* *Thyasira* spp. and *Nuculoma tenuis* in Atlantic circalittoral sandy mud	MC5213/ MC6212		WAA_S16, WAA_S23, WAA_S30, WAA_S33, WAA_S35, WAA_S36, WAA_S37, WAA_S38
Amphiura filiformis, *Mysella bidentata* and *Abra nitida* in Atlantic circalittoral sandy mud	MC6211		WAA_S27, WAA_S28, WAA_S29, WAA_S31, WAA_S32, WAA_S34

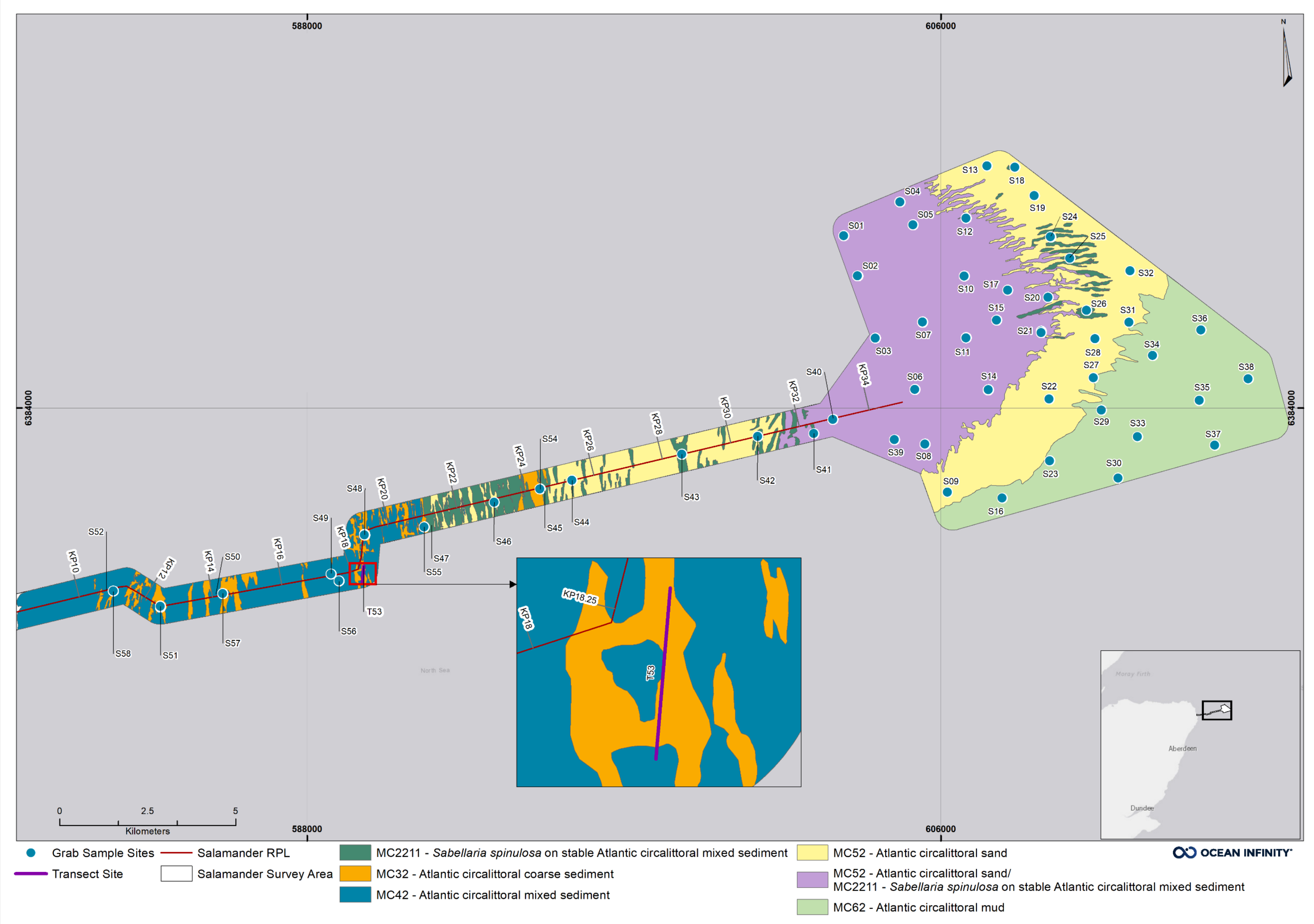


Figure 10 Overview of sampled sites and classified habitats.

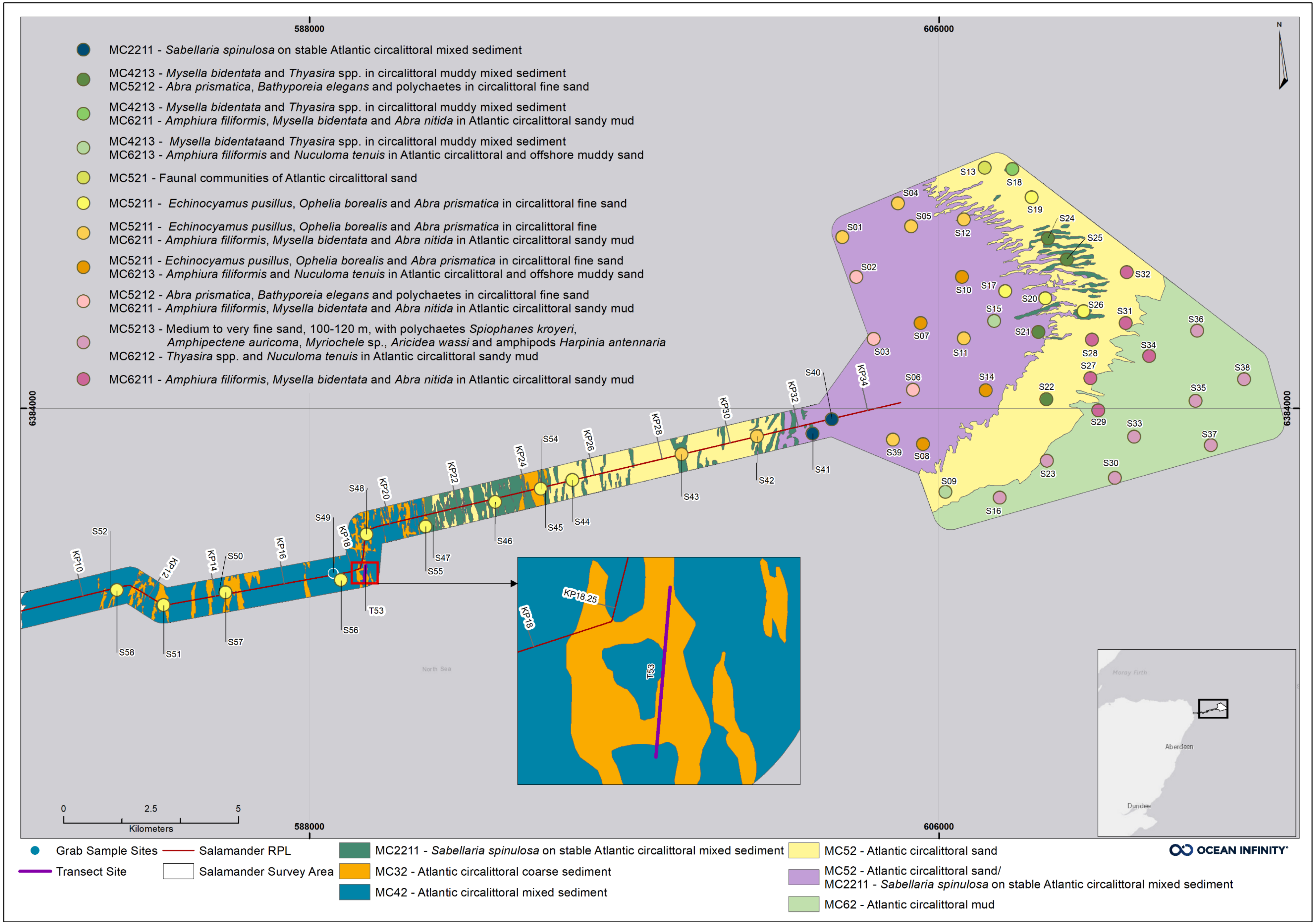


Figure 11 Overview of sampled sites and species-specific habitats.

5.2 Area Description

The habitat classifications within the survey area were derived based on the interpreted geophysical data in combination with environmental sample sites (Figure 10 and Figure 11). The habitat interpretations at the benthic sample sites were extrapolated to similar areas, where similarity was based on geophysical interpretations of substrate, texture, topography, and depth.

For further details regarding results from the photo analyses and grab samples sites, see Appendix D and Appendix E, Habitats and Species of interest are further detailed in Section 5.8.

The backscatter intensity values, across the WAA, exhibited limited variation and were low, indicating finer sediments (Figure 12). The ECR was more variable with had higher intensity compared to the WAA. The backscatter values transitioned from lower values in the eastern end of the ECR to higher values in the west, indicating a change in sediment composition from finer to coarser sediments.

The southern and southeasternmost sections of the WAA present a rather featureless flat seabed and are classified as **MC62** - Atlantic circalittoral mud. Bordering the eastern section, a belt of **MC52** - Atlantic circalittoral sand stretches from the southern to the northern ends of the WAA. In the throughs of the sand waves and ripples, present in the central and northern parts of the sand belt, habitat **MC2211** - *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment is interpreted to be present. Due to the complexity and dense presence of sand waves and ripple features within the central and western sections of the WAA, as well as the patchy growth forms of *S. spinulosa*, these areas have been classified as a habitat complex comprising **MC52** and **MC2211**.

The easternmost section of the ECR is classified as predominantly alternating between **MC52/ MC2211** and **MC2211**, where habitat **MC2211** is interpreted to be associated with the crest of the sand wave features.

The central section of the ECR alternates between areas of **MC2211,** together with **MC32** – Atlantic circalittoral coarse sediment, and areas of **MC52**. Habitats **MC32** and **MC52** are predominantly associated with ripple features. The westernmost section of the ECR, closest to shore, comprises heterogeneous areas of mixed sediments classified as **MC42** - Atlantic circalittoral mixed sediment, with areas of rippled accumulated shell gravel, classified as **MC32**.

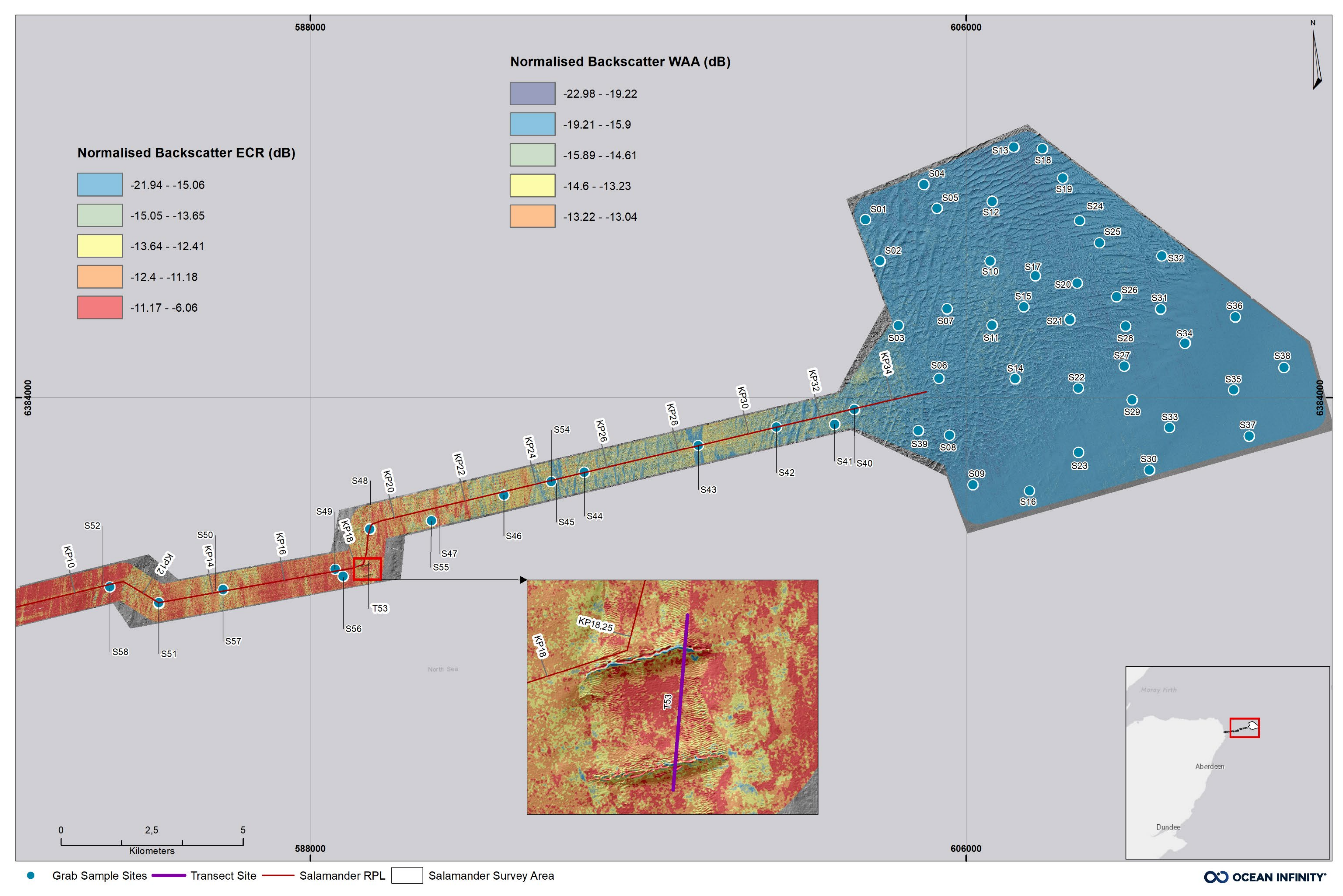


Figure 12 Overview of sampled sites with normalised backscatter data.

5.3 Particle Size Distribution

A total of 52 sample sites were selected for PSA sampling. Samples were successfully acquired at 51 sites, with the sample at site S06 not being acquired due to the presence of *S. spinulosa* aggregations in the faunal sample. Detailed results from the PSA are stated in Appendix F.

The results from the PSA analyses showed a limited variation in the sediment composition. The WAA primarily comprised muddy Sand, which, when moving westwards along the ECR, transitioned to gravelly Sand (Figure 13).

Sand was the dominating sediment fraction, with a mean content of 86.2 % (SD=5.0), followed by Mud which had a mean content of 10.8 % (SD=5.2), comprising 9.4 % (SD=4.6) Silt and 1.4 % (SD=0.7) Clay. The Gravel content was low and variable with a mean content of 3.0 % (SD=5.29) (Table 22).

Sediment fractions were tested for correlations with depth and easting, with Gravel having the strongest correlation to both variables (Table 22), with R^2-values of 0.65 and 0.54, respectively. However, note that depth, easting, and the different sediment fractions correlate with each other to a variable degree (Table 23).

Table 21 Summary of PSA results.

Sample ID	Depth (m)	Sediment Fraction (%)				Mud (%) (Silt-Clay)	BGS (1982) Classification (modified from folk, 1954)
		Gravel	Sand	Silt	Clay		
WAA_S01	97	0.7	87.6	10.2	1.5	11.7	Muddy Sand
WAA_S02	94	1.9	86.1	10.4	1.6	12.0	Slightly Gravelly Muddy Sand
WAA_S03	92	14.5	74.7	9.6	1.2	10.8	Gravelly Muddy Sand
WAA_S04	98	0.0	88.9	9.7	1.4	11.0	Muddy Sand
WAA_S05	97	0.9	76.0	20.2	2.9	23.1	Muddy Sand
WAA_S07	96	0.2	89.9	8.6	1.2	9.9	Sand
WAA_S08	98	0.4	91.1	7.3	1.1	8.4	Sand
WAA_S09	108	0.0	85.9	12.3	1.8	14.1	Muddy Sand
WAA_S10	93	1.1	83.7	13.3	1.9	15.2	Slightly Gravelly Muddy Sand
WAA_S11	92	2.4	87.1	9.1	1.3	10.5	Slightly Gravelly Muddy Sand
WAA_S12	93	1.0	76.8	19.1	3.1	22.2	Muddy Sand
WAA_S13	92	0.1	88.9	9.5	1.4	10.9	Muddy Sand
WAA_S14	98	0.2	89.7	8.8	1.3	10.1	Muddy Sand
WAA_S15	92	0.8	80.2	16.4	2.5	18.9	Muddy Sand
WAA_S16	106	0.0	87.4	10.9	1.7	12.6	Muddy Sand
WAA_S17	92	0.2	95.0	4.1	0.7	4.7	Sand
WAA_S18	93	1.0	82.6	14.3	2.1	16.5	Muddy Sand
WAA_S19	91	0.1	89.6	9.1	1.2	10.3	Muddy Sand
WAA_S20	90	0.0	92.7	6.3	1.0	7.3	Sand
WAA_S21	91	0.0	91.6	7.3	1.1	8.4	Sand
WAA_S22	98	0.1	87.5	10.9	1.5	12.4	Muddy Sand
WAA_S23	102	0.2	85.0	12.9	1.9	14.8	Muddy Sand
WAA_S24	90	2.6	88.0	8.1	1.3	9.4	Slightly Gravelly Sand
WAA_S25	89	0.2	90.2	8.4	1.2	9.7	Sand

Sample ID	Depth (m)	Sediment Fraction (%)				Mud (%) (Silt-Clay)	BGS (1982) Classification (modified from folk, 1954)
		Gravel	Sand	Silt	Clay		
WAA_S26	90	0.0	89.8	8.8	1.3	10.1	Muddy Sand
WAA_S27	96	0.0	88.3	10.1	1.6	11.7	Muddy Sand
WAA_S28	94	0.2	87.7	10.7	1.4	12.1	Muddy Sand
WAA_S29	97	0.1	87.3	11.0	1.6	12.6	Muddy Sand
WAA_S30	103	0.0	85.6	12.4	2.0	14.4	Muddy Sand
WAA_S31	92	0.0	89.6	9.1	1.3	10.4	Muddy Sand
WAA_S32	88	3.2	86.0	9.4	1.4	10.8	Slightly Gravelly Muddy Sand
WAA_S33	99	0.0	86.6	11.7	1.8	13.4	Muddy Sand
WAA_S34	94	0.0	88.0	10.4	1.6	12.0	Muddy Sand
WAA_S35	101	0.0	85.1	13.0	1.9	14.9	Muddy Sand
WAA_S36	97	0.0	84.7	13.1	2.1	15.3	Muddy Sand
WAA_S37	102	0.0	85.1	12.8	2.1	14.9	Muddy Sand
WAA_S38	103	0.0	83.1	14.8	2.2	16.9	Muddy Sand
ECR_S39	97	0.7	88.2	9.6	1.4	11.1	Muddy Sand
ECR_S40	94	9.5	73.6	14.6	2.3	16.9	Gravelly Muddy Sand
ECR_S41	94	3.1	77.7	16.3	2.9	19.2	Slightly Gravelly Muddy Sand
ECR_S42	97	3.2	89.6	6.3	0.9	7.2	Slightly Gravelly Sand
ECR_S43	87	3.6	89.3	6.2	0.9	7.1	Slightly Gravelly Sand
ECR_S44	87	8.2	84.4	6.5	0.9	7.4	Gravelly Sand
ECR_S46	79	8.7	85.5	5.0	0.8	5.8	Gravelly Sand
ECR_S48	80	10.3	88.3	1.1	0.3	1.4	Gravelly Sand
ECR_S51	82	11.4	87.7	0.6	0.2	0.8	Gravelly Sand
ECR_S54	85	2.6	95.4	1.5	0.4	2.0	Slightly Gravelly Sand
ECR_S55	72	16.5	81.1	2.0	0.5	2.5	Gravelly Sand
ECR_S56	81	10.4	86.4	2.6	0.6	3.2	Gravelly Sand
ECR_S57	85	7.6	91.4	0.8	0.2	1.1	Gravelly Sand
ECR_S58	75	26.1	73.0	0.8	0.2	1.0	Gravelly Sand
Mean		**3.0**	**86.2**	**9.4**	**1.4**	**10.8**	
SD		**5.3**	**5.0**	**4.6**	**0.7**	**5.2**	
Min		**0.0**	**73.0**	**0.6**	**0.2**	**0.8**	
Max		**26.1**	**95.4**	**20.2**	**3.1**	**23.1**	
Median		**0.4**	**87.4**	**9.6**	**1.4**	**10.9**	

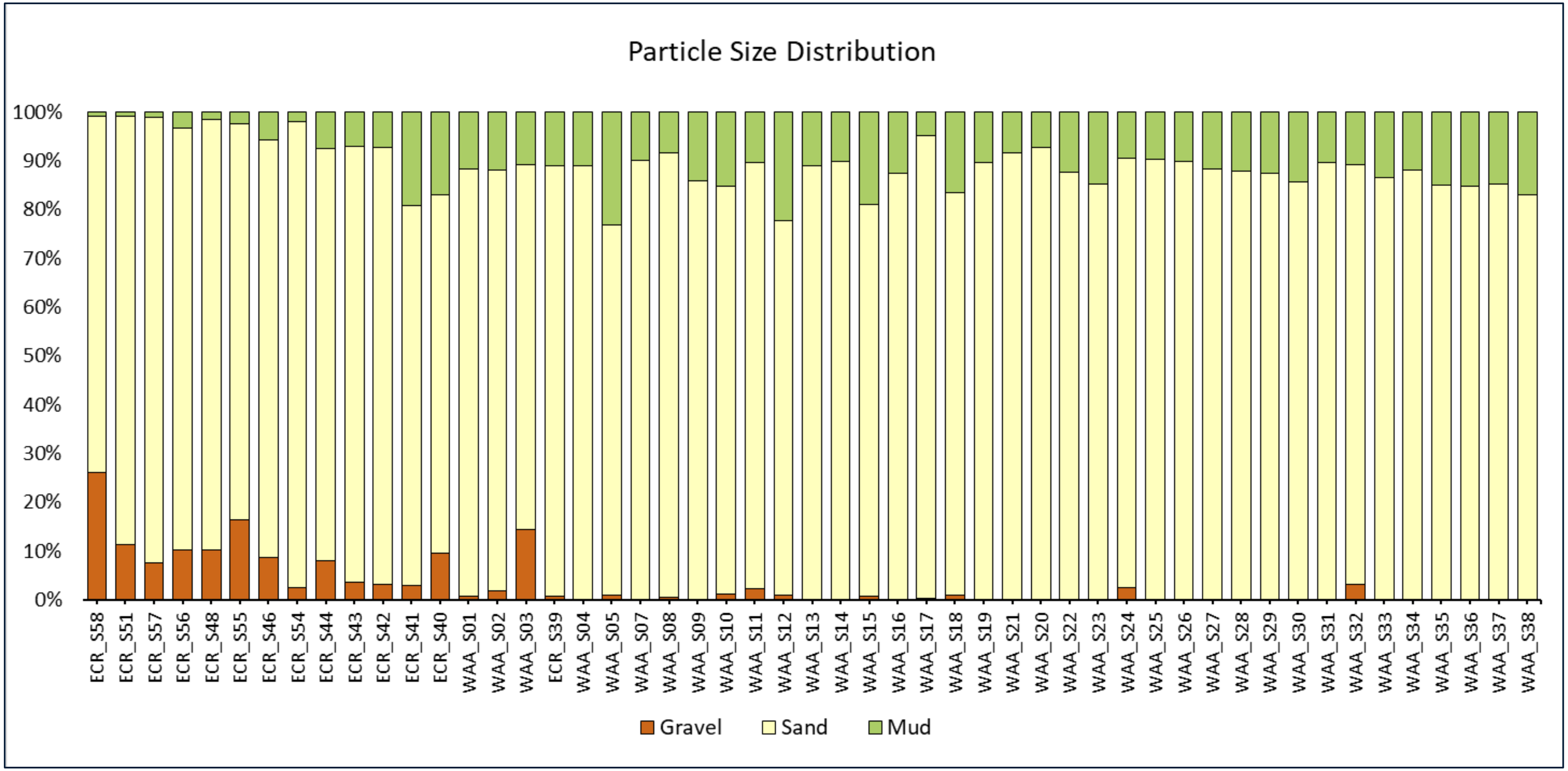


Figure 13 Particle size distribution from grab samples, sorted by increasing easting.

Table 22 Summary of correlation results for sediments.

Variable #1	Variable #2	R^2 value	Relationship
Gravel	Easting	0.65	Negative
Gravel	Depth	0.54	Negative
Silt	Easting	0.49	Positive
Silt	Depth	0.48	Positive
Mud	Depth	0.48	Positive
Mud	Easting	0.48	Positive
Clay	Depth	0.42	Positive
Clay	Easting	0.41	Positive
Sand	Easting	0.02	Positive
Sand	Depth	0.00	Positive

Table 23 Summary of correlation results for sediment fractions, easting and depth against one another.

Variable #1	Variable #2	R^2 value	Relationship
Silt	Mud	1.00	Positive
Clay	Mud	0.98	Positive
Silt	Clay	0.97	Positive
Easting	Depth	0.56	Positive
Gravel	Silt	0.30	Negative
Gravel	Mud	0.30	Negative
Gravel	Clay	0.26	Negative
Sand	Clay	0.24	Negative
Gravel	Sand	0.23	Negative
Sand	Mud	0.22	Negative
Sand	Silt	0.22	Negative

5.3.1 Multivariate Analyses for Sediment

Multivariate analyses were undertaken on the PSA data set, to identify patterns in the sediment distribution. Analyses included hierarchical clustering employing the Euclidean distance resemblance matrix, SIMPROF analysis and principal component analysis (PCA). The datasets were normalised prior to the analyses being performed.

The SIMPROF analysis of the sediment composition produced 18 distinct groups separating the 51 grab samples (Figure 14).

Principal component 1 (PC1), explaining 51.5% of the variation, separated the sites based on the gravel-to-mud ratio. Principal component 2 (PC2), explaining 48.5 % of the variation, separated the sites based on the sand content (Figure 15).

SIMPROF group c comprises mixed sediment composition, corresponding to the Folk class Gravelly Muddy Sand; Groups b, f, g, h, I, j, k, l, m, n, and p comprise sand with a noticeable mud content, corresponding to the Folk classes Muddy Sand, and Slightly Gravelly Muddy Sand; Groups a and d comprise sand with gravel and low mud content, corresponding to the Folk classes Gravelly Sand; Groups e, o, q, r and one (1) of the four (4) sites in group j comprises clean sands, corresponding to Folk classes Sand, and Slightly Gravelly Sand.

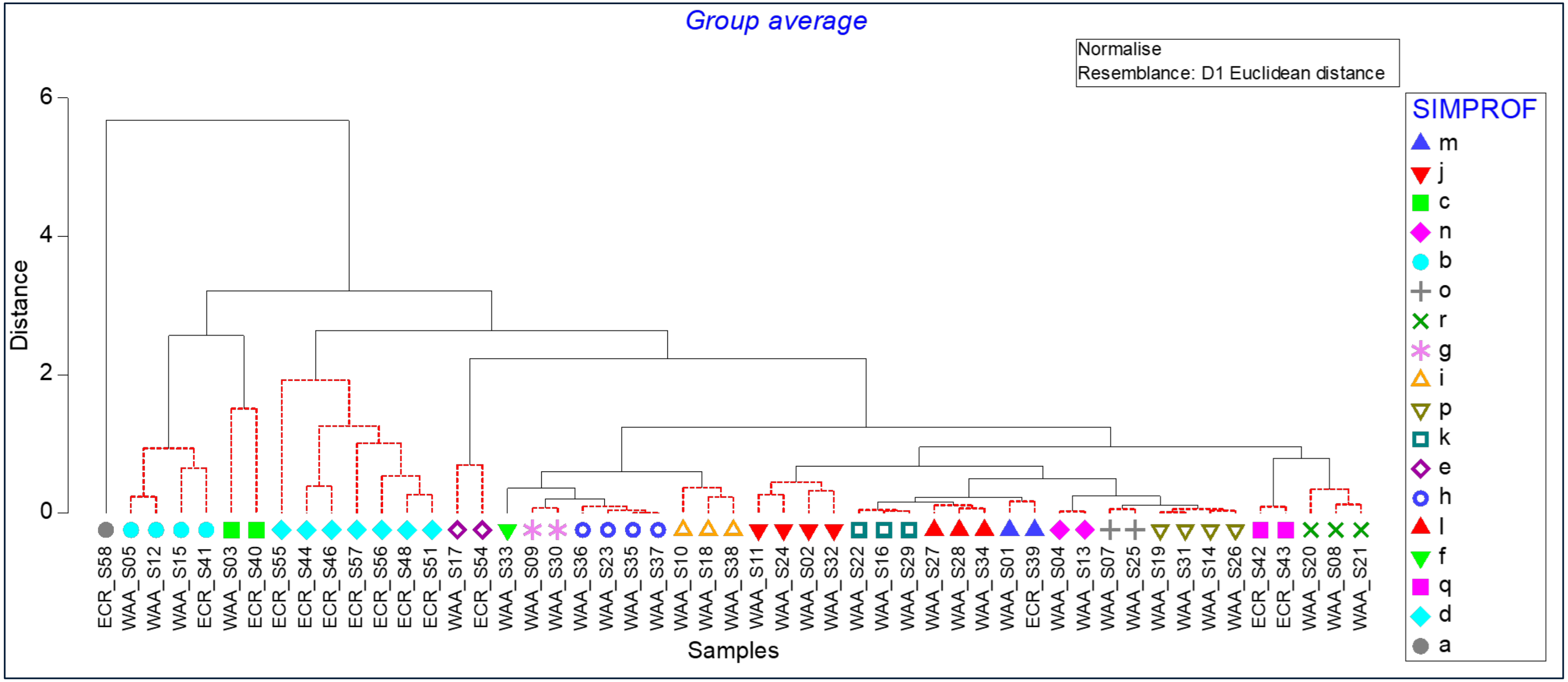


Figure 14 Dendrogram based on Euclidian distance for the sediment composition, showing SIMPROF groups with a 5 % significance level.

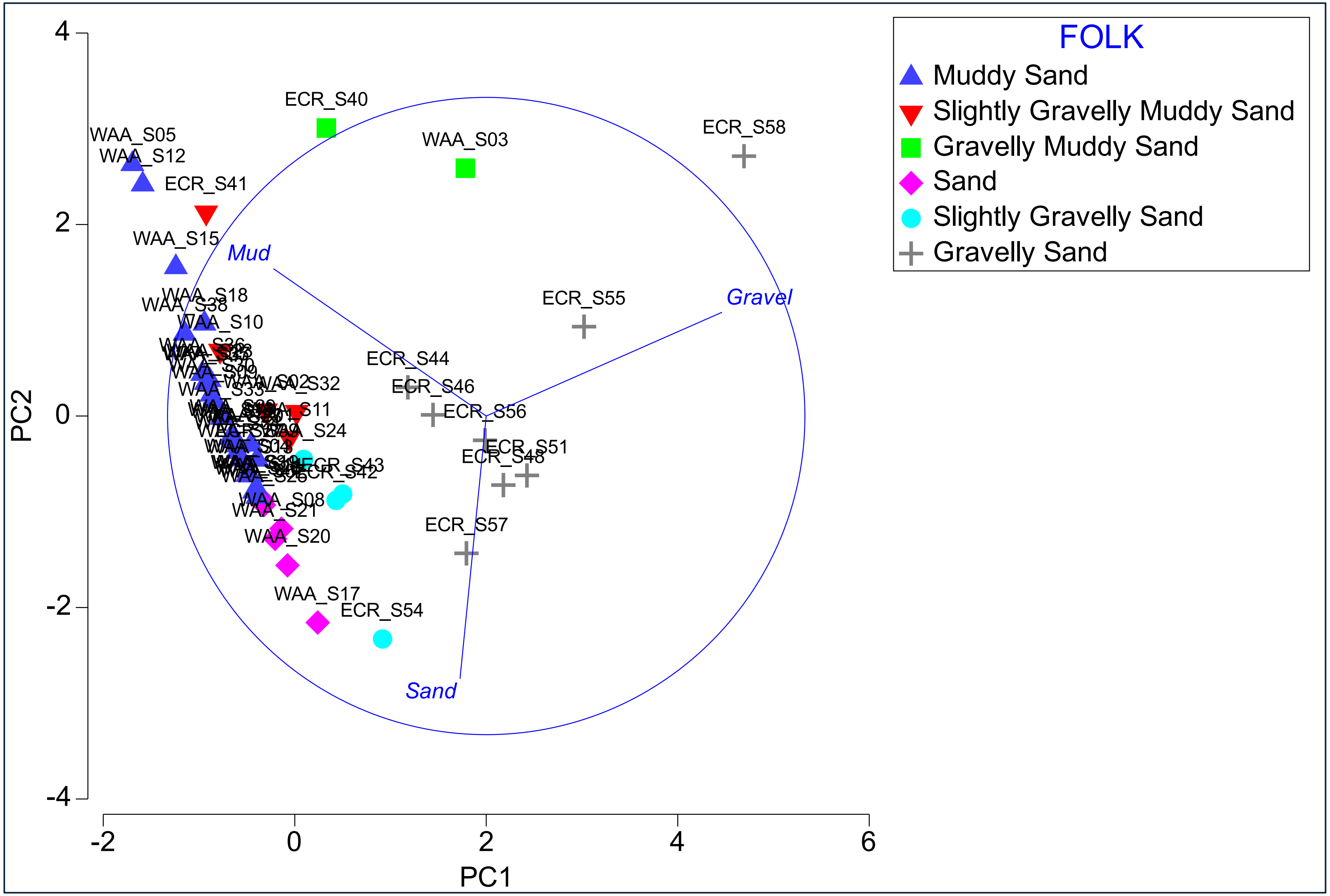


Figure 15 PCA plot of sediment composition for each grab sample site, showing groups based on the FOLK classifications.

5.4 Contaminant Analyses

A total of 52 sample sites were selected for contaminant sampling. Samples were successfully acquired at 51 sites, with the sample at site S06 not being acquired due to the presence of *S. spinulosa* aggregations in the faunal sample.

Detailed results from the chemical analyses are stated in Appendix G.

5.4.1 Metals

Metal concentrations were overall low across the survey area. Threshold values were exceeded at seven (7) grab sample sites (Table 25).

The threshold value for arsenic (As) according to the Canadian Council of Ministers of the Environment's (CCME) ISQG (7.24 mg/kg) was exceeded at six (6) sites; ECR_S48, ECR_S51, ECR_55, ECR_56, ECR_S57 and ECR_S58 (Figure 16). Exceeding the ISQG threshold indicates "the possible effect range within which adverse effects occasionally occur" (CCME, 2001). Furthermore, at one of these sites (ECR_S58) the lower threshold of the Norwegian Environment Agency's (NEA) class 3 Moderate (18 mg/kg) was exceeded. These sites are all situated towards the western section of the offshore ECR.

The lower threshold value for cadmium (Cd) according to NEA's class 2 - Good (0.2 mg/kg) was exceeded at site WAA_S18 (Table 25), thereby exceeding the expected natural background levels (class 1 - Background), according to NEA (2016, revised 2020). Concentrations of Cd were below the detection limit at all other sites.

Arsenic concentrations were tested for correlations with depth, easting, and sediment fractions (Table 24). Easting, followed by Gravel, had the strongest correlation with As, both having an R^2-value of 0.67. However, note that depth, easting, and sediment fractions correlate with each other to a variable degree (Table 22 and Table 23).

Table 24 Summary of correlation results for arsenic (As).

Variable #1	Variable #2	R^2 value	Relationship
Arsenic	Easting	0.67	Negative
Arsenic	Gravel	0.67	Positive
Arsenic	Depth	0.47	Negative
Arsenic	Silt	0.42	Negative
Arsenic	Mud	0.42	Negative
Arsenic	Clay	0.37	Negative
Arsenic	Sand	0.04	Negative

Table 25 Metal concentrations (mg/kg dry weight) with threshold values. Highlighted cells and their colour indicates where and which threshold values have been exceeded.

Analyte	As	Cd	Cr	Cu	Pb	Ni	Sn	V	Zn	Al	Ba	Fe	Hg
Method	SEDMS	SEDMS	SEDMS	SEDMS	SEDMS	SEDMS	SEDMS	SEDMS	SEDMS	SEDOES	SEDOES	SEDOES	TMMS1
Limit of Detection	0.5	0.2	2	2	1.2	2	1	1	3	10	1	45	0.01
NEA 1 Background	0	0	0	0	0	0	-	-	0	-	-	-	0
NEA 2 Good	15	0.2	60	20	25	30	-	-	90	-	-	-	0.05
NEA 3 Moderate	18	2.5	620	-	150	42	-	-	139	-	-	-	0.52
NEA 4 Poor	71	16	6000	48	1480	271	-	-	750	-	-	-	0.75
NEA 5 Very Poor	580	147	15500	147	2000	533	-	-	6690	-	-	-	1.45
OSPAR ERL		1.2	81	34	47	-	-	-	150	-	-	-	0.15
Cefas AL1	20	0.4	40	40	50	20	-	-	130	-	-	-	0.3
Cefas AL2	100	5	400	400	500	200	-	-	800	-	-	-	3
CCME PEL	41.6	4.2	160	108	112	-	-	-	271	-	-	-	0.7
CCME ISQG	7.24	0.7	52.3	18.7	30.2	-	-	-	124	-	-	-	0.13
Dutch RIVM	85	14	380	190	580	210	-	-	2000	-	-	-	10
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
WAA_S01	5.1	<0.2*	17.3	2.2	10.4	4.7	<1.0*	19.1	24.0	22300	353	7670	0.01
WAA_S02	4.4	<0.2*	20.4	2.4	10.2	4.6	<1.0*	18.8	13.5	21300	349	7250	<0.01*
WAA_S03	5.6	<0.2*	20.1	3.3	10.1	5.2	<1.0*	19.1	14.5	20100	327	7960	<0.01*
WAA_S04	4.4	<0.2*	16.5	2.3	9.9	4.7	<1.0*	17.9	20.4	22300	365	7220	0.01
WAA_S05	4.5	<0.2*	20.5	3.3	11.5	6.5	<1.0*	20.2	18.7	23600	397	7380	<0.01*
WAA_S07	4.9	<0.2*	14.5	2.2	9.3	4.2	<1.0*	18.5	12.4	20900	340	7130	<0.01*
WAA_S08	5.4	<0.2*	16.3	2.4	10.6	4.5	<1.0*	18.9	15.4	21300	360	7290	<0.01*
WAA_S09	1.5	<0.2*	6.0	<2.0*	3.4	2.1	<1.0*	5.6	10.8	21000	355	7260	<0.01*
WAA_S10	4.4	<0.2*	17.7	2.7	10.7	5.1	<1.0*	19.7	15.0	22900	389	7440	<0.01*
WAA_S11	4.9	<0.2*	16.8	2.9	10.5	5.6	<1.0*	21.1	14.4	21200	341	7630	<0.01*
WAA_S12	4.0	<0.2*	18.8	3.6	10.8	6.8	<1.0*	21.0	24.0	23400	359	7460	<0.01*
WAA_S13	3.7	<0.2*	15.8	2.3	9.7	4.6	<1.0*	16.9	15.0	22400	357	6860	<0.01*
WAA_S14	4.3	<0.2*	15.2	<2.0*	9.8	4.1	<1.0*	17.4	13.5	21500	348	6610	<0.01*
WAA_S15	5.1	<0.2*	15.6	2.2	10.0	4.3	<1.0*	19.0	13.4	22400	363	6950	<0.01*
WAA_S16	1.2	<0.2*	5.6	<2.0*	<1.2*	<2.0*	<1.0*	5.1	4.0	23800	416	7240	0.01
WAA_S17	5.6	<0.2*	14.1	<2.0*	9.2	3.6	<1.0*	18.8	13.7	19500	324	6760	0.02
WAA_S18	3.6	0.2	16.3	2.3	10.1	5.1	<1.0*	17.6	13.4	22600	376	6440	<0.01*
WAA_S19	4.1	<0.2*	14.3	<2.0*	10.0	4.2	<1.0*	15.6	13.5	23100	360	5840	<0.01*
WAA_S20	5.7	<0.2*	13.7	<2.0*	9.5	3.6	<1.0*	17.7	11.1	21700	342	6710	<0.01*
WAA_S21	4.4	<0.2*	16.5	2.1	10.6	4.0	<1.0*	20.0	14.0	23300	350	7570	0.01
WAA_S22	4.0	<0.2*	19.3	2.5	11.3	6.0	1.4	19.5	15.6	25700	423	7770	<0.01*
WAA_S23	4.6	<0.2*	18.5	2.1	11.2	5.4	<1.0*	19.8	24.2	24100	420	7770	0.01
WAA_S24	3.6	<0.2*	17.6	2.1	9.5	4.9	<1.0*	17.9	15.2	22100	358	6900	0.01
WAA_S25	4.3	<0.2*	16.8	2.7	9.7	5.0	<1.0*	18.2	13.6	22000	370	7320	0.01
WAA_S26	4.4	<0.2*	15.5	2.3	9.9	5.5	<1.0*	18.1	15.1	22300	358	6760	<0.01*
WAA_S27	3.9	<0.2*	16.5	2.0	9.6	5.4	<1.0*	14.8	12.8	22300	378	5890	<0.01*
WAA_S28	4.0	<0.2*	16.2	2.4	10.5	4.9	<1.0*	17.4	13.5	24600	413	7260	0.02
WAA_S29	4.2	<0.2*	24.3	2.1	10.4	5.4	<1.0*	17.2	13.3	23900	397	6770	0.01
WAA_S30	3.9	<0.2*	17.1	2.4	10.2	4.9	<1.0*	16.6	13.7	23400	386	6540	0.01
WAA_S31	4.0	<0.2*	16.2	3.1	10.1	5.1	<1.0*	15.7	12.3	23700	387	7090	0.01
WAA_S32	3.6	<0.2*	15.9	2.7	9.3	3.9	<1.0*	16.2	11.0	21400	344	6340	0.01
WAA_S33	3.6	<0.2*	16.0	2.0	10.1	4.8	<1.0*	16.7	19.5	23600	376	6250	0.01
WAA_S34	3.8	<0.2*	17.2	2.9	10.1	5.7	<1.0*	16.2	12.9	23700	387	6820	<0.01*
WAA_S35	4.3	<0.2*	17.5	2.4	10.9	5.6	<1.0*	17.8	14.4	25600	436	6760	<0.01*
WAA_S36	3.4	<0.2*	17.4	2.4	10.7	5.1	<1.0*	16.6	13.8	24400	423	6110	0.01
WAA_S37	3.7	<0.2*	18.8	3.0	10.9	6.3	<1.0*	18.6	15.5	25300	425	6770	0.01
WAA_S38	3.4	<0.2*	17.5	2.7	10.5	5.9	<1.0*	17.7	13.9	24700	411	6480	0.01
ECR_S39	5.8	<0.2*	17.3	2.5	<1.2*	4.7	<1.0*	20.9	15.5	22000	376	8110	0.02

Analyte	As	Cd	Cr	Cu	Pb	Ni	Sn	V	Zn	Al	Ba	Fe	Hg
ECR_S40	6.4	<0.2*	16.9	2.7	<1.2*	4.9	<1.0*	18.8	16.8	22800	368	7380	<0.01*
ECR_S41	3.9	<0.2*	18.4	3.5	10.7	6.2	<1.0*	20.7	18.0	23300	380	7700	0.01
ECR_S42	6.8	<0.2*	18.6	2.9	10.5	4.6	<1.0*	21.3	15.6	20000	327	7890	<0.01*
ECR_S43	7.0	<0.2*	17.6	2.6	10.3	4.5	<1.0*	21.0	15.3	19800	324	7370	<0.01*
ECR_S44	6.3	<0.2*	12.2	2.0	9.4	3.5	<1.0*	19.0	11.0	18400	320	6570	<0.01*
ECR_S46	5.1	<0.2*	12.3	2.6	9.1	4.2	<1.0*	19.8	13.1	20200	331	8230	<0.01*
ECR_S48	11.9	<0.2*	10.9	2.3	9.9	5.9	<1.0*	28.1	14.6	19900	291	8290	<0.01*
ECR_S51	11.1	<0.2*	14.9	<2.0*	9.4	6.4	<1.0*	28.7	11.9	17300	248	7680	<0.01*
ECR_S54	5.4	<0.2*	10.9	<2.0*	8.2	3.6	<1.0*	16.0	12.3	17700	395	6120	<0.01*
ECR_S55	7.8	<0.2*	13.7	<2.0*	9.3	5.1	<1.0*	25.5	13.4	21700	361	7960	<0.01*
ECR_S56	7.6	<0.2*	13.1	2.4	10.7	4.6	<1.0*	24.6	14.1	22300	330	8360	<0.01*
ECR_S57	12.0	<0.2*	10.1	2.8	10.1	8.4	<1.0*	28.1	10.7	16900	229	6130	<0.01*
ECR_S58	19.3	<0.2*	15.6	2.3	13.4	8.8	<1.0*	42.3	16.1	15100	238	10600	<0.01*
Mean	**5.3**	**0.2**	**15.9**	**2.5**	**10.0**	**5.1**	**1.4**	**19.2**	**14.6**	**21976**	**360**	**7189**	**0.01**
SD	**2.9**	**-**	**3.3**	**0.4**	**1.3**	**1.1**	**-**	**5.3**	**3.4**	**2230**	**44**	**802**	**0.00**
Min	**1.2**	**0.2**	**5.6**	**2.0**	**3.4**	**2.1**	**1.4**	**5.1**	**4.0**	**15100**	**229**	**5840**	**0.01**
Max	**19.3**	**0.2**	**24.3**	**3.6**	**13.4**	**8.8**	**1.4**	**42.3**	**24.2**	**25700**	**436**	**10600**	**0.02**
Median	**4.4**	**0.2**	**16.5**	**2.4**	**10.1**	**4.9**	**1.4**	**18.8**	**13.9**	**22300**	**360**	**7240**	**0.01**

**Not included in statistical analyses of Mean, SD, Min, Max and Median.*

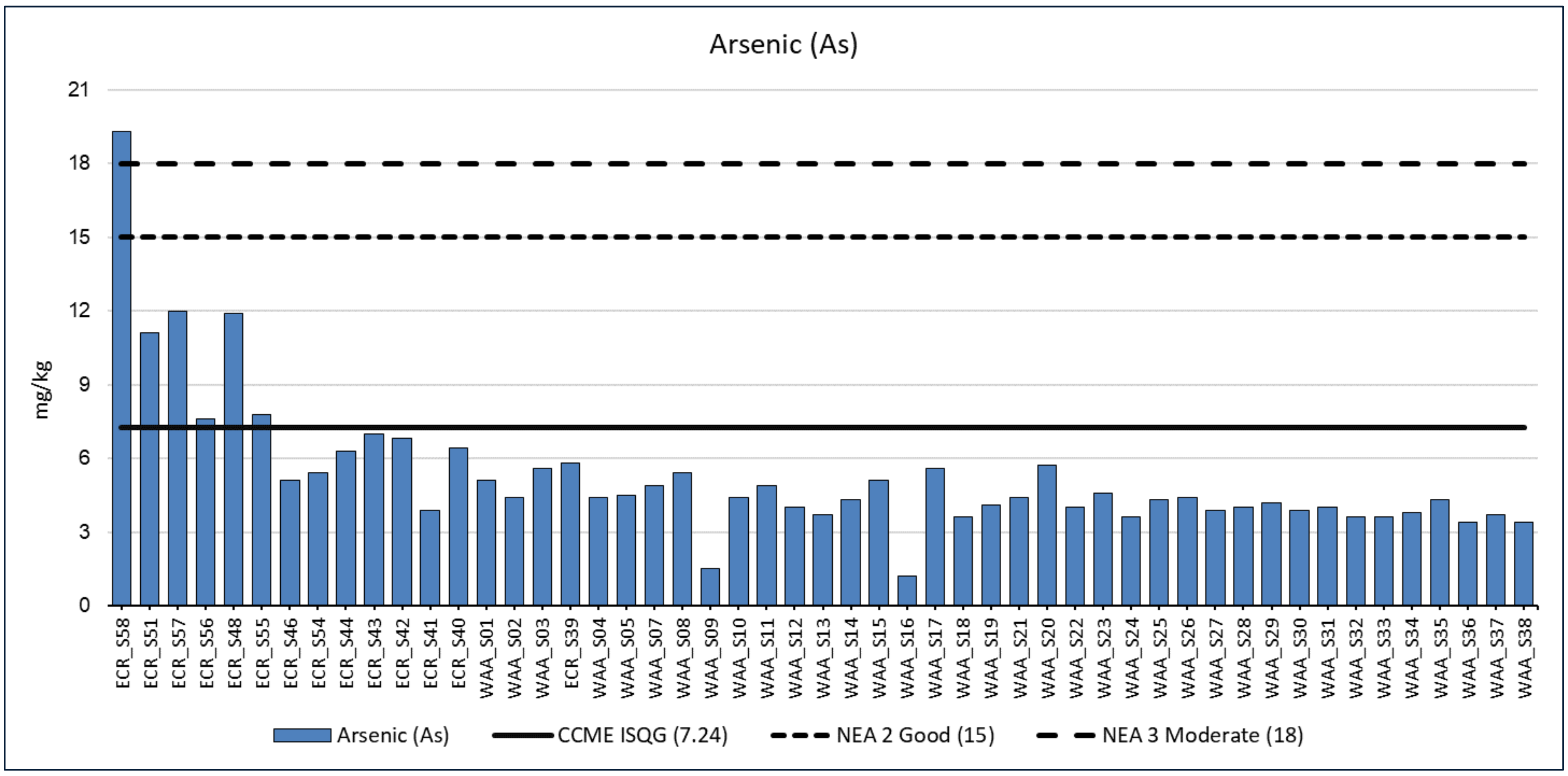


Figure 16 Arsenic (As) levels (mg/kg dry weight) from grab samples with threshold values, sorted by increasing easting.

5.4.2 Organics and Moisture

Total organic matter (TOM) and total organic carbon (TOC) both varied slightly across the survey area, with a mean content of 1.3 % (SD=0.3) and 0.18 % (SD=0.07), respectively (Table 26). Both TOM and TOC had notably higher values at site ECR_S44, which is situated centrally within the offshore ECR.

Table 26 Total organic matter, total organic carbon, and moisture content in samples.

Analyte	Total Organic Matter	Total Organic Carbon	Total Moisture @ 120 °C
Method	Loss On Ignition (LOI)	WSLM59	ASC/SOP/303
Limit of Detection	0.2	0.02	0.2
Units	%	%	%
WAA_S01	1.4	0.13	26.1
WAA_S02	1.2	0.15	29.7
WAA_S03	1.5	0.16	31.1
WAA_S04	1.7	0.13	28.3
WAA_S05	1.5	0.28	26.5
WAA_S07	1.1	0.14	24.2
WAA_S08	1.4	0.11	28.3
WAA_S09	1.6	0.18	30.0
WAA_S10	1.5	0.16	28.1
WAA_S11	1.3	0.19	24.4
WAA_S12	1.9	0.35	29.5
WAA_S13	1.4	0.16	27.0
WAA_S14	1.1	0.09	33.2
WAA_S15	1.2	0.16	26.8
WAA_S16	1.6	0.17	28.9
WAA_S17	1.0	0.10	28.9
WAA_S18	1.2	0.18	26.6
WAA_S19	1.3	0.16	28.6
WAA_S20	0.9	0.12	25.2
WAA_S21	0.9	0.13	26.5
WAA_S22	1.1	0.16	31.2
WAA_S23	1.4	0.16	31.3
WAA_S24	1.3	0.13	29.6
WAA_S25	1.6	0.14	30.1
WAA_S26	0.9	0.14	25.0
WAA_S27	1.3	0.17	16.0
WAA_S28	1.2	0.16	23.8
WAA_S29	2.0	0.18	30.1
WAA_S30	1.7	0.21	31.3
WAA_S31	1.1	0.18	28.3
WAA_S32	1.6	0.12	28.1

Analyte	Total Organic Matter	Total Organic Carbon	Total Moisture @ 120 ºC
WAA_S33	1.5	0.21	25.5
WAA_S34	0.9	0.17	27.4
WAA_S35	1.4	0.25	30.2
WAA_S36	1.3	0.21	31.2
WAA_S37	1.9	0.21	31.9
WAA_S38	1.5	0.22	31.3
ECR_S39	1.1	0.15	28.2
ECR_S40	1.2	0.20	26.5
ECR_S41	1.4	0.29	34.9
ECR_S42	1.2	0.19	30.7
ECR_S43	1.2	0.19	31.2
ECR_S44	2.4	0.46	30.0
ECR_S46	0.7	0.11	29.5
ECR_S48	0.9	0.13	17.2
ECR_S51	1.1	0.21	21.5
ECR_S54	1.0	0.11	23.4
ECR_S55	0.7	0.10	28.1
ECR_S56	0.9	0.12	23.8
ECR_S57	1.4	0.24	14.9
ECR_S58	1.8	0.19	16.4
Mean	**1.3**	**0.18**	**27.4**
SD	**0.3**	**0.07**	**4.3**
Min	**0.7**	**0.09**	**14.9**
Max	**2.4**	**0.46**	**34.9**
Median	**1.3**	**0.16**	**28.3**

5.4.3 Total Hydrocarbons

Total Hydrocarbon (THC) concentrations were low but variable across the survey area and did not exceed the Dutch RIVM intervention values at any grab sample site (Table 27).

The concentration of THCs was generally higher in the WAA compared to the ECR, with the lowest concentrations recorded at the sites towards the western end of the survey area.

Total oil concentrations were tested for correlations with depth, easting, and sediment fractions (Table 27). Silt, followed by Mud and Easting, had the strongest correlation with Total oil, with R^2-values of 0.35, 0.35 and 0.34, respectively. However, note that depth, easting, and sediment fractions correlate with each other to a variable degree (Table 22 and Table 23).

Table 27 Summary of correlation results for Total Oil.

Variable #1	Variable #2	R^2 value	Relationship
Total Oil	Silt	0.35	Positive
Total Oil	Mud	0.35	Positive
Total Oil	Easting	0.34	Positive
Total Oil	Clay	0.31	Positive
Total Oil	Gravel	0.25	Negative
Total Oil	Depth	0.25	Positive
Total Oil	Sand	0.01	Negative

Table 28 THC concentrations (µg/kg dry weight) in samples.

Analyte	Total Oil	Total n alkanes	Carbon Preference Index	Pristane	Phytane	Pristane / phytane ratio
Limit of Detection	100	28	1	1	1	1
Dutch RIVM	5000000	-	-	-	-	-
Units	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
WAA_S01	1930	52.1	2.56	6.97	<1*	-*
WAA_S02	1720	63.5	2.25	5.80	<1*	-*
WAA_S03	2200	82.6	2.86	8.60	<1*	-*
WAA_S04	3100	77.3	2.40	8.67	<1*	-*
WAA_S05	6490	260	1.81	40.1	1.49	26.9
WAA_S07	4850	171	2.12	12.5	<1*	-*
WAA_S08	1830	53.8	2.69	6.61	<1*	-*
WAA_S09	4800	178	2.66	12.4	6.57	1.88
WAA_S10	5310	157	1.88	15.4	<1*	-*
WAA_S11	3520	127	1.73	7.82	<1*	-*
WAA_S12	5790	176	2.52	13.2	<1*	-*
WAA_S13	4660	155	1.78	13.4	<1*	-*
WAA_S14	6990	220	2.02	14.0	<1*	-*
WAA_S15	3750	117	2.50	8.56	<1*	-*
WAA_S16	1180	49.6	1.78	4.21	<1*	-*
WAA_S17	2360	83.6	1.94	2.94	<1*	-*
WAA_S18	5650	178	1.51	65.4	<1*	-*
WAA_S19	4990	148	2.29	11.3	<1*	-*

Analyte	Total Oil	Total n alkanes	Carbon Preference Index	Pristane	Phytane	Pristane / phytane ratio
WAA_S20	2100	59.0	2.15	1.97	<1*	-*
WAA_S21	2790	88.8	2.31	5.32	<1*	-*
WAA_S22	4830	153	2.05	11.1	1.30	8.57
WAA_S23	7440	314	1.73	14.4	3.28	4.40
WAA_S24	3620	96.6	1.72	12.4	<1*	-*
WAA_S25	5060	134	2.43	9.64	1.02	9.43
WAA_S26	2480	88.1	1.79	4.90	<1*	-*
WAA_S27	4670	152	1.96	14.1	<1*	-*
WAA_S28	3970	133	2.07	9.39	<1*	-*
WAA_S29	4700	127	2.17	10.9	1.30	8.39
WAA_S30	5700	147	2.72	14.0	1.04	13.5
WAA_S31	3710	128	2.80	8.56	<1*	-*
WAA_S32	6460	217	1.67	15.4	4.47	3.44
WAA_S33	3190	73.8	2.55	8.25	<1*	-*
WAA_S34	4820	147	2.23	14.0	<1*	*
WAA_S35	5340	182	2.02	20.0	2.42	8.27
WAA_S36	5030	146	2.78	14.9	1.64	9.09
WAA_S37	6490	175	2.14	18.9	2.01	9.41
WAA_S38	6020	125	3.06	25.5	1.01	25.2
ECR_S39	2250	76.7	2.53	5.89	<1*	-*
ECR_S40	2810	73.4	2.13	4.55	<1*	-*
ECR_S41	4150	121	2.16	7.47	<1*	-*
ECR_S42	5260	207	3.01	9.76	2.38	4.11
ECR_S43	4250	139	2.90	11.6	<1*	-*
ECR_S44	4880	177	2.65	12.3	<1*	-*
ECR_S46	1220	39.5	4.29	3.33	<1*	-*
ECR_S48	1130	48.4	2.61	5.02	<1*	-*
ECR_S51	1120	<28	2.23	2.24	<1*	-*
ECR_S54	5110	187	2.07	17.3	4.39	3.95
ECR_S55	1400	45.0	1.91	3.14	<1*	-*
ECR_S56	771	28.9	2.92	1.19	<1*	-*
ECR_S57	658	<28*	2.83	1.42	<1*	-*
ECR_S58	1620	62.7	2.08	3.79	<1*	-*
Mean	**3846**	**127.4**	**2.31**	**11.38**	**2.45**	**9.75**
SD	**1820**	**61.3**	**0.49**	**10.23**	**1.66**	**7.59**
Min	**658**	**28.9**	**1.51**	**1.19**	**1.01**	**1.88**
Max	**7440**	**314.0**	**4.29**	**65.40**	**6.57**	**26.90**
Median	**4150**	**128.0**	**2.23**	**9.64**	**1.83**	**8.48**

**Not included in statistical analyses of Mean, SD, Min, Max and Median.*

5.4.4 Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAH) concentrations were overall low but variable across the survey area. The concentration of PAHs was generally higher in the WAA compared to the ECR.

Threshold values were exceeded at five (5) sites (Table 30). These sites are summarised below:

- WAA_S09: seven (7) individual congeners and the sum of the 16 EPA PAHs (Σ16PAH) exceeded the lower threshold of NEA's class 2 – Good, and one individual congener exceeded the lower threshold of NEA's class 3 – Moderate.
- WAA_S16: twelve (12) individual congeners and the Σ16PAH exceeded the lower threshold of NEA's class 2 – Good, and one individual congener exceeded the lower CCME ISQG threshold at site
- WAA_S23: one (1) individual congener exceeded the lower threshold of NEA's class 2 – Good.
- WAA_S32: two (2) individual congeners and the Σ16PAH exceeded the lower threshold of NEA's class 2 – Good.
- WAA_S37: the Σ16PAH exceeded the lower threshold of the NEA's class 2 – Good.

Σ16PAH concentrations were tested for correlations with depth, easting, and sediment fractions (Table 29). Whilst weak, depth had the strongest correlation with Σ16PAH, with an R^2-value of 0.19, with the other variables exhibiting no correlations. However, note that depth, easting, and sediment fractions correlate with each other to a variable degree (Table 22 and Table 23).

Table 29 Summary of correlation results for Σ16PAH.

Variable #1	Variable #2	R^2 value	Relationship
Σ16PAH	Depth	0.19	Positive
Σ16PAH	Silt	0.03	Positive
Σ16PAH	Silt	0.03	Positive
Σ16PAH	Clay	0.03	Positive
Σ16PAH	Gravel	0.03	Negative
Σ16PAH	Easting	0.02	Positive
Σ16PAH	Sand	0.00	Negative

Table 30 PAH concentrations (μg/kg dry weight) in samples. Highlighted cells and their colour indicates where and which threshold values have been exceeded.

Analyte	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Dibenzothiophene**	Anthracene	Fluoranthene	Pyrene	Benzo[a]anthracene	Chrysene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[e]pyrene**	Benzo[a]pyrene	Perylene**	Indeno[123,cd]pyrene	Dibenzo[a,h]anthracene	Benzo[ghi]perylene	SUM (EPA 16)
Limit of Detection	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
NEA 1 Background	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	-	0	0	0	0
NEA 2 Good	2	1.6	2.4	6.8	6.8	-	1.2	8	5.2	3.6	4.4	90	90	-	6	-	20	12	18	30
NEA 3 Moderate	27	33	96	150	780	-	4.8	-	84	60	-	-	-	-	183	-	-	27	-	2000
NEA 4 Poor	1754	85	195	694	2500	-	30	400	840	501	280	140	135	-	230	-	63	273	84	6000
NEA 5 Very Poor	8769	8500	19500	34700	25000	-	295	2000	8400	50100	2800	10600	7400	-	13100	-	2300	2730	1400	20000
OSPAR ERL	160	-	-	-	240	190	85	600	665	-	384	-	-	-	430	-	240	-	85	-
Cefas AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-
CCME PEL	391	128	88.9	144	544	-	245	1494	1398	693	846	-	-	-	763	-	-	135	-	-
CCME ISQG	34.6	5.87	6.71	21.2	86.7	-	46.9	113	153	74.8	108	-	-	-	88.8	-	-	6.22	-	-
Units	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg	μg/kg
WAA_S01	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.36	1.37	<1	1.45	1.37
WAA_S02	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.74	1.69	<1	<1	1.50	1.23	<1	1.19	4.66
WAA_S03	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.15	1.03	<1	<1	<1	1.63	<1	1.55	3.81
WAA_S04	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.32	1.24	<1	<1	1.16	2.11	<1	1.97	4.67
WAA_S05	<1	<1	<1	<1	1.50	<1	<1	1.78	1.57	<1	1.32	2.83	2.47	2.11	1.34	2.87	4.43	<1	4.11	17.24
WAA_S07	<1	<1	<1	<1	1.04	<1	<1	1.12	<1	<1	<1	1.94	1.94	1.30	<1	1.68	2.91	<1	2.66	8.95
WAA_S08	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.33	<1	1.38	1.33
WAA_S09	1.98	3.99	<1	2.15	25.5	<1	8.00	34.9	36.7	13.6	13.4	11.8	11.3	10.1	16.6	5.72	13.0	1.99	13.5	194.91
WAA_S10	<1	<1	<1	<1	1.31	<1	<1	1.57	1.24	<1	1.01	2.50	1.74	1.60	<1	2.19	2.93	<1	2.94	12.30
WAA_S11	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.34	1.20	<1	<1	1.42	2.14	<1	1.91	4.68
WAA_S12	<1	<1	<1	<1	1.21	<1	<1	1.30	1.07	<1	1.05	2.79	1.99	1.73	<1	2.54	3.89	<1	3.52	13.30
WAA_S13	<1	<1	<1	<1	1.18	<1	<1	1.15	<1	<1	<1	1.98	1.87	1.35	<1	1.18	2.53	<1	2.52	8.71
WAA_S14	<1	<1	<1	<1	1.26	<1	<1	1.43	1.16	<1	<1	2.47	2.23	1.90	1.04	2.75	4.24	<1	3.83	13.83
WAA_S15	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.61	1.53	1.07	<1	1.20	2.50	<1	2.09	5.64
WAA_S16	22.4	3.05	4.61	4.85	73.5	6.99	3.97	22.9	20.6	11.9	20.3	45.9	24.6	30.9	14.7	46.4	61.4	8.93	54.2	343.61
WAA_S17	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.24	<1	1.29	1.24
WAA_S18	<1	<1	<1	<1	1.50	<1	<1	1.32	1.06	<1	<1	2.33	1.91	1.46	<1	1.40	3.08	<1	2.90	11.20
WAA_S19	<1	<1	<1	<1	1.03	<1	<1	2.17	1.77	1.16	1.46	2.56	2.45	1.74	1.38	1.53	3.06	<1	3.19	17.04
WAA_S20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.11	<1	1.23	1.11
WAA_S21	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.34	1.33	<1	<1	<1	1.59	<1	1.76	4.26
WAA_S22	1.27	<1	<1	<1	1.82	<1	<1	<1	<1	<1	<1	1.85	1.53	1.34	<1	1.34	2.59	<1	2.62	9.06
WAA_S23	2.45	<1	<1	<1	3.36	<1	<1	2.10	1.61	<1	1.40	3.05	2.65	2.11	1.43	2.25	3.38	<1	3.72	21.43
WAA_S24	<1	<1	<1	<1	1.19	<1	<1	<1	<1	<1	<1	1.33	<1	<1	<1	1.07	1.54	<1	1.47	4.06
WAA_S25	<1	<1	<1	<1	1.57	<1	<1	1.29	1.10	<1	<1	1.57	1.04	1.29	<1	1.94	2.40	<1	2.36	8.97
WAA_S26	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.23	<1	<1	<1	1.11	1.74	<1	1.61	2.97
WAA_S27	<1	<1	<1	<1	1.33	<1	<1	1.20	<1	<1	<1	1.98	2.20	1.55	<1	1.44	2.76	<1	2.84	9.47
WAA_S28	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.85	1.44	1.28	<1	1.02	2.51	<1	2.45	5.80
WAA_S29	<1	<1	<1	<1	2.03	<1	<1	1.07	<1	<1	<1	2.07	1.58	1.32	<1	<1	2.66	<1	2.54	9.41
WAA_S30	<1	<1	<1	<1	1.21	<1	<1	1.23	1.04	<1	<1	2.29	1.88	1.79	1.06	1.39	3.48	<1	3.43	12.19
WAA_S31	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.50	1.45	1.12	<1	<1	2.25	<1	2.39	5.20
WAA_S32	1.32	<1	<1	<1	6.16	<1	1.67	7.37	7.66	3.44	3.54	3.80	3.99	3.15	4.01	1.98	4.85	<1	4.63	47.81
WAA_S33	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.64	1.52	1.05	<1	<1	2.30	<1	2.19	5.46
WAA_S34	1.13	<1	<1	<1	2.24	<1	<1	1.20	1.03	<1	<1	2.40	1.61	1.56	<1	1.36	3.03	<1	2.94	12.64
WAA_S35	1.49	<1	<1	<1	3.01	<1	<1	1.93	1.66	<1	1.58	2.97	2.47	2.28	1.33	1.81	4.36	<1	4.12	20.80
WAA_S36	<1	<1	<1	<1	1.91	<1	<1	1.35	1.17	<1	1.00	2.69	2.04	1.73	<1	1.49	3.49	<1	3.42	13.65
WAA_S37	<1	<1	<1	<1	3.05	<1	<1	5.28	4.37	2.66	3.06	4.82	4.21	3.14	2.79	2.27	5.82	<1	5.33	36.06
WAA_S38	<1	<1	<1	<1	1.59	<1	<1	1.62	1.31	<1	1.15	2.98	2.75	2.12	1.12	1.82	4.48	<1	4.20	17.00

Analyte	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Dibenzothiophene**	Anthracene	Fluoranthene	Pyrene	Benzo[a]anthracene	Chrysene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[e]pyrene**	Benzo[a]pyrene	Perylene**	Indeno[123,cd]pyrene	Dibenzo[a,h]anthracene	Benzo[ghi]perylene	SUM (EPA 16)
ECR_S39	<1	<1	<1	<1	1.28	<1	<1	1.33	1.11	<1	<1	2.63	2.32	1.70	1.13	1.83	3.87	<1	3.24	13.67
ECR_S40	<1	<1	<1	<1	<1	<1	<1	1.15	<1	<1	<1	2.37	1.64	1.48	<1	1.83	3.39	<1	2.95	8.55
ECR_S41	<1	<1	<1	<1	3.75	<1	<1	4.10	3.66	1.92	2.55	3.92	2.08	2.88	2.24	3.00	5.25	<1	4.70	29.47
ECR_S42	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.41	1.07	<1	<1	<1	1.97	<1	1.66	4.45
ECR_S43	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.18	<1	<1	<1	1.12	1.72	<1	1.41	2.90
ECR_S44	<1	<1	<1	<1	<1	<1	<1	1.20	1.27	<1	<1	1.55	1.00	<1	<1	<1	1.61	<1	1.41	6.63
ECR_S46	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00
ECR_S48	1.16	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.16
ECR_S51	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00
ECR_S54	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00
ECR_S55	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00
ECR_S56	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00
ECR_S57	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00
ECR_S58	1.17	<1	<1	<1	1.16	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.33

**Not included in statistical analyses of Mean, SD, Min, Max and Median.*

***Not included in the EPA 16 PAHs.*

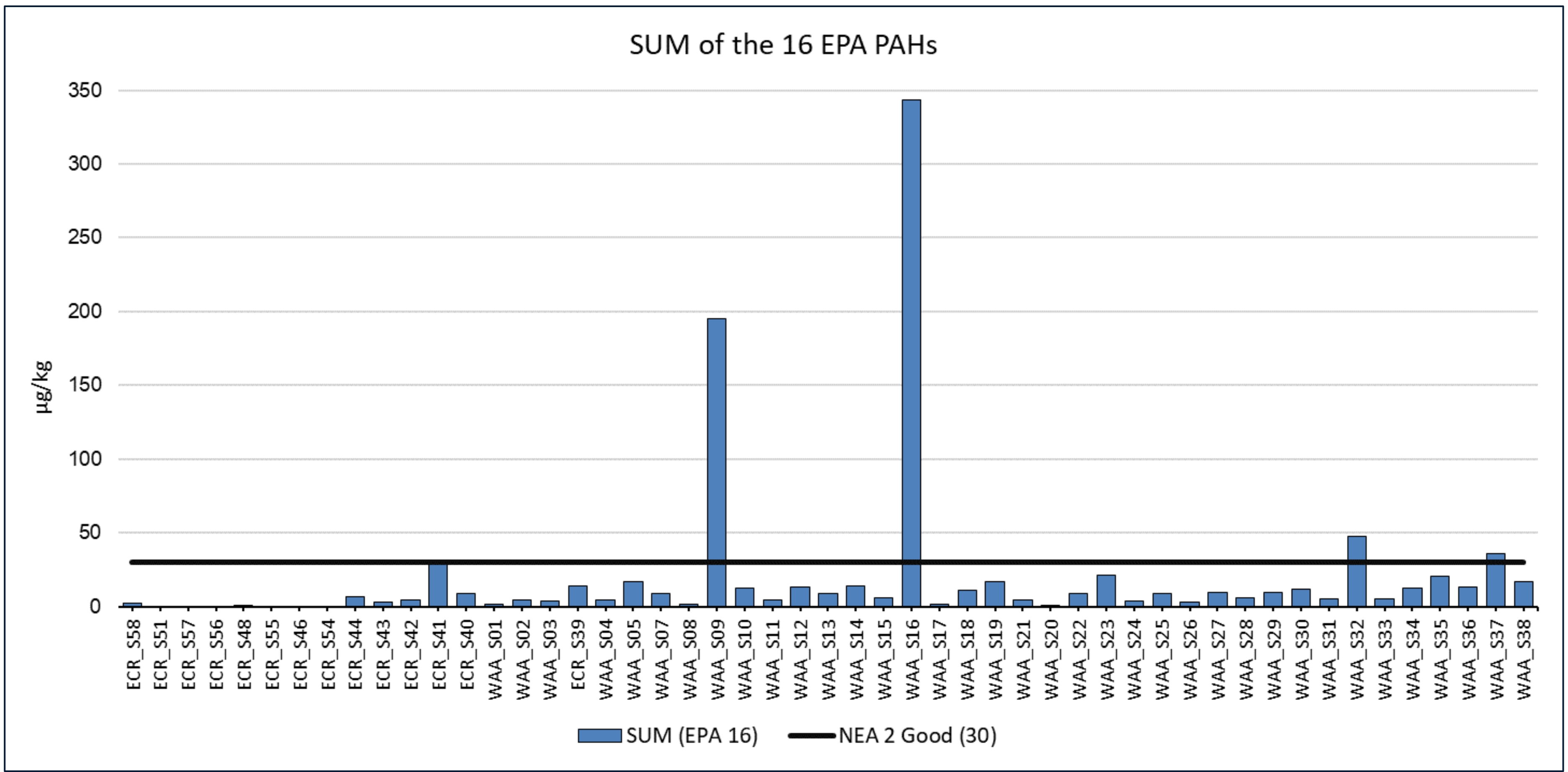


Figure 17 Levels of EPA 16 PAHs summarized (µg/kg) samples with threshold values, sorted by increasing easting.

5.5 Statistical Analyses

5.5.1 Non-Colonial Fauna from Grab Samples

The non-colonial epifauna was identified to the lowest taxonomic level possible and the individuals were enumerated. The infauna and non-colonial epifauna were combined and analysed together. When analysing phyletic composition, the following phyla: Chordata, Cnidaria, Hemichordata, Nematoda, Phoronida and Platyhelminthes were combined into the group “Others”.

Samples were obtained at 52 grab sample sites. The colonial epifauna was identified to the lowest taxonomic level possible. The sessile colonial epifauna was recorded as Presence (P) of taxa per square meter (ind./ m^2) and analysed separately. The results are presented in Section 5.5.6.

A full list of species from the grab samples is presented in Appendix E.

5.5.2 Phyletic Composition

The phyletic composition of the non-colonial fauna identified from the grab samples is illustrated in Figure 18 and Figure 19, and summarised in Table 31. Annelida had the highest relative percentage abundance, followed by Mollusca and Echinodermata. These three phyla contributed to 83 % of the recorded individuals. Annelida had the highest number of taxa, followed by Arthropoda and Mollusca. These three phyla contributed to 90 % of the recorded taxa.

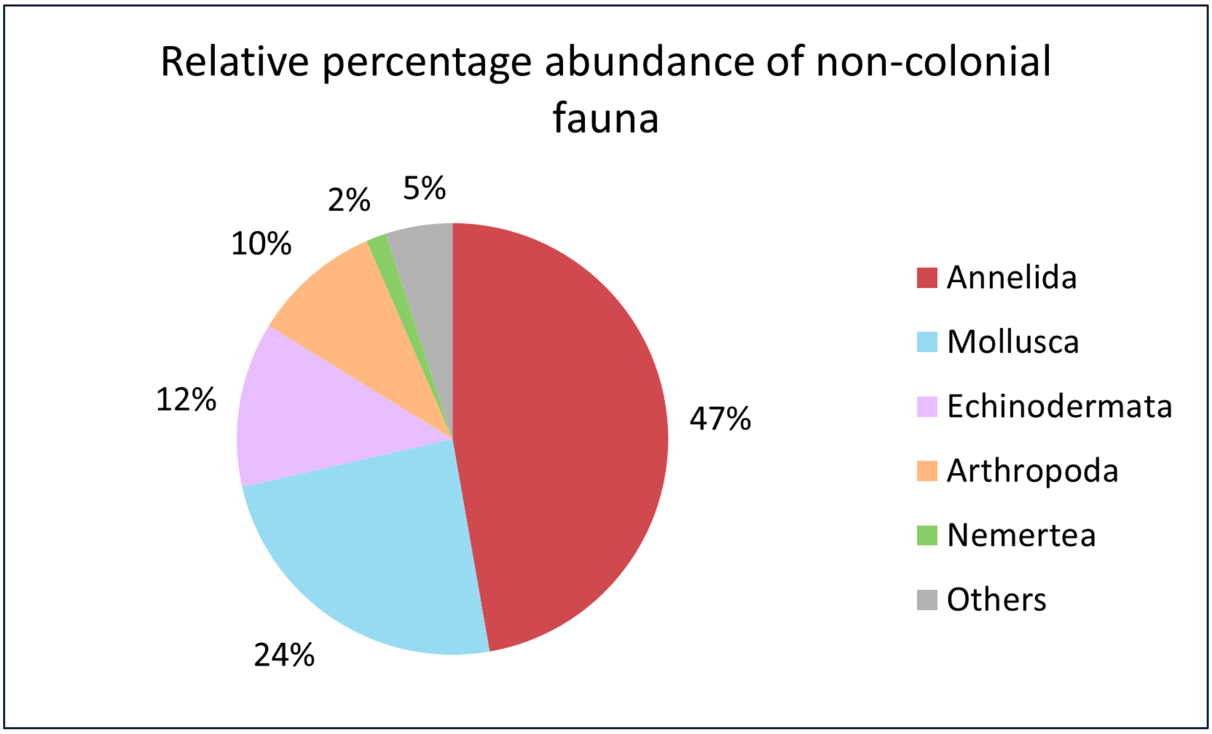


Figure 18 Relative percentage abundance of non-colonial fauna from grab samples.

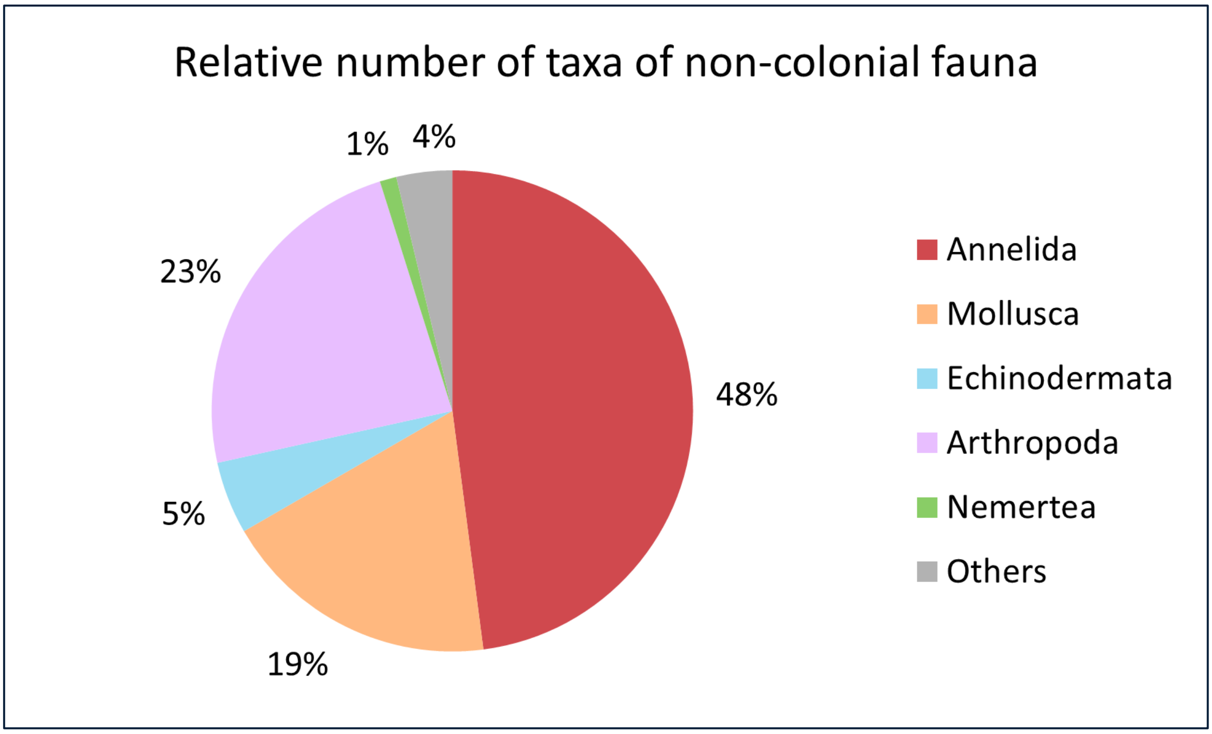


Figure 19 Relative percentage number of non-colonial fauna from grab samples.

Table 31 Phyletic composition of non-colonial fauna from grab samples.

Phylum	Number of Taxa	Abundance (Total Number of Individuals)
Annelida	128	1696
Mollusca	50	868
Echinodermata	13	444
Arthropoda	63	348
Nemertea	3	54
Others	10	180
Total	**267**	**3590**

A list of the ten (10) most abundant taxa, with total abundance and frequency of occurrence, is presented in Table 32. The most abundant taxon is the mollusc *Kurtiella bidentata*, with a total of 203 individuals recorded, and the species occurred in 52 % of the grab samples.

Table 32 The ten most abundant taxa from grab samples, together with frequency of occurrence.

Phylum	Taxa	Total Abundance	Mean Abundance	SD	Frequency of Occurrence (%)
Mollusca	*Kurtiella bidentata*	203	3.90	8.19	52
Annelida	*Scoloplos armiger*	154	2.96	2.71	73
Echinodermata	*Ophiactis balli*	145	2.79	14.15	8
Echinodermata	*Echinocyamus pusillus*	138	2.65	3.30	81
Echinodermata	*Amphiura filiformis*	123	2.37	2.92	73
Annelida	*Paradoneis lyra*	114	2.19	8.98	27

Phylum	Taxa	Total Abundance	Mean Abundance	SD	Frequency of Occurrence (%)
Mollusca	*Antalis entalis*	111	2.13	2.21	69
Annelida	*Spiophanes kroyeri*	108	2.08	2.04	73
Mollusca	*Abra prismatica*	101	1.94	1.53	81
Annelida	*Lumbrineris cingulata* (aggregate)	90	1.73	3.94	46

A list of the ten (10) most frequently occurring taxa, with total abundance, is presented in Table 33. The most frequently occurring taxon was the sea urchin *Echinocyamus pusillus*, which occurred in 81 % of the grab samples, with a total abundance of 138 individuals.

Table 33 The ten most frequently occurring taxa from grab samples, together with total abundance.

Phylum	Taxa	Frequency of Occurrence (%)	Total Abundance
Echinodermata	*Echinocyamus pusillus*	81	138
Mollusca	*Abra prismatica*	81	101
Annelida	*Scoloplos armiger*	73	154
Echinodermata	*Amphiura filiformis*	73	123
Annelida	*Spiophanes kroyeri*	73	108
Mollusca	*Antalis entalis*	69	111
Mollusca	*Ennucula tenuis*	60	87
Phoronida	*Phoronis*	58	61
Annelida	*Owenia*	56	65
Annelida	*Phascolion strombus*	56	53

5.5.3 Univariate Statistical Analyses

Univariate analyses were performed to assess the non-colonial faunal richness, diversity, evenness and dominance. The results of the univariate analyses are presented in Table 34.

The number of Taxa (S) per site varied with a mean of 28.48 (SD= 9.67) where site ECR_S41 contained the highest number of Taxa (68 different taxa) and ECR_S54 the lowest (14 different taxa). An overview of the number of Taxa (S) identified per grab sample site in the survey area is presented in Figure 20.

The number of individuals (N) per site (expressed per 0.1 m^2) varied with a mean of 69.04 (SD= 70.24) where ECR_S41 contained the highest number of individuals (506 individuals) and WAA_S19 the lowest with 24 individuals. An overview of the number of Individuals (N) identified per grab sample site in the survey area is presented in Figure 21.

The species richness measured with Margalef's diversity index (D) varied between 3.79 and 10.76, with grab sample ECR_S41 having the highest value of 10.76. Pielou's evenness index (J') ranged from 0.7 to 0.98, with grab sample WAA_S36 having the highest value of 0.98.

Simpson's index of dominance (1-λ) ranged from 0.83 to 0.99, with site WAA_S36 having the highest value of 0.99.

The Shannon-Wiener index (H') varied from 2.28 to 3.53, with grab sampling site ECR_43 having the highest value of 3.53. An overview of the Shannon-Wiener index (H') identified per grab sample site in the survey area is presented in Figure 22.

Table 34 Univariate indices of species richness, diversity, and evenness for fauna in grab samples.

Sample ID	Number of Taxa (S)	Number of Individuals (N)	Margalef's Richness Index (D)	Pielou's Evenness Index (J')	Shannon-Wiener Index (H')	Simpson's Index of Dominance (1-Λ)
ECR_S39	28	62	6.54	0.92	3.07	0.96
ECR_S40	54	235	9.71	0.70	2.78	0.83
ECR_S41	68	506	10.76	0.79	3.35	0.94
ECR_S42	25	37	6.65	0.98	3.15	0.98
ECR_S43	45	90	9.78	0.93	3.53	0.97
ECR_S44	31	56	7.45	0.92	3.17	0.96
ECR_S46	23	59	5.40	0.80	2.52	0.88
ECR_S48	34	100	7.17	0.90	3.17	0.95
ECR_S51	23	79	5.03	0.86	2.69	0.91
ECR_S54	14	31	3.79	0.87	2.31	0.90
ECR_S55	18	44	4.49	0.85	2.46	0.90
ECR_S56	23	62	5.33	0.86	2.69	0.92
ECR_S57	21	79	4.58	0.75	2.28	0.83
ECR_S58	49	135	9.79	0.88	3.42	0.95
WAA_S01	32	61	7.54	0.95	3.29	0.97
WAA_S02	38	102	8.00	0.92	3.33	0.96
WAA_S03	37	76	8.31	0.91	3.28	0.96
WAA_S04	33	57	7.91	0.94	3.29	0.97
WAA_S05	28	59	6.62	0.91	3.05	0.95
WAA_S06	33	63	7.72	0.92	3.21	0.96
WAA_S07	22	42	5.62	0.93	2.87	0.95
WAA_S08	20	30	5.59	0.97	2.90	0.97
WAA_S09	28	60	6.59	0.90	3.01	0.95
WAA_S10	26	41	6.73	0.94	3.07	0.97
WAA_S11	18	32	4.91	0.97	2.79	0.96
WAA_S12	26	43	6.65	0.96	3.11	0.97
WAA_S13	33	49	8.22	0.96	3.35	0.98
WAA_S14	21	36	5.58	0.96	2.91	0.97
WAA_S15	34	97	7.21	0.75	2.65	0.84
WAA_S16	27	52	6.58	0.90	2.97	0.94
WAA_S17	24	49	5.91	0.92	2.92	0.95

Sample ID	Number of Taxa (S)	Number of Individuals (N)	Margalef's Richness Index (D)	Pielou's Evenness Index (J')	Shannon-Wiener Index (H')	Simpson's Index of Dominance (1-Λ)
WAA_S18	40	71	9.15	0.95	3.49	0.98
WAA_S19	20	24	5.98	0.97	2.90	0.98
WAA_S20	26	56	6.21	0.92	3.01	0.96
WAA_S21	20	35	5.34	0.93	2.78	0.95
WAA_S22	29	68	6.64	0.83	2.80	0.89
WAA_S23	24	39	6.28	0.96	3.05	0.97
WAA_S24	27	86	5.84	0.78	2.57	0.85
WAA_S25	35	64	8.18	0.92	3.28	0.96
WAA_S26	23	41	5.92	0.96	3.01	0.97
WAA_S27	20	39	5.19	0.91	2.73	0.94
WAA_S28	28	101	5.85	0.82	2.74	0.89
WAA_S29	24	42	6.15	0.94	2.99	0.96
WAA_S30	26	49	6.42	0.90	2.92	0.94
WAA_S31	20	38	5.22	0.93	2.77	0.95
WAA_S32	26	53	6.30	0.89	2.90	0.93
WAA_S33	21	39	5.46	0.94	2.86	0.96
WAA_S34	28	49	6.94	0.93	3.09	0.96
WAA_S35	35	61	8.27	0.93	3.32	0.97
WAA_S36	29	35	7.88	0.98	3.30	0.99
WAA_S37	18	39	4.64	0.96	2.77	0.96
WAA_S38	26	37	6.92	0.96	3.14	0.98
Mean	**28.48**	**69.04**	**6.67**	**0.90**	**2.98**	**0.94**
SD	**9.67**	**70.24**	**1.50**	**0.06**	**0.29**	**0.04**
Min	**14.00**	**24.00**	**3.79**	**0.70**	**2.28**	**0.83**
Max	**68.00**	**506.00**	**10.76**	**0.98**	**3.53**	**0.99**
Median	**26.00**	**54.50**	**6.56**	**0.92**	**3.00**	**0.96**

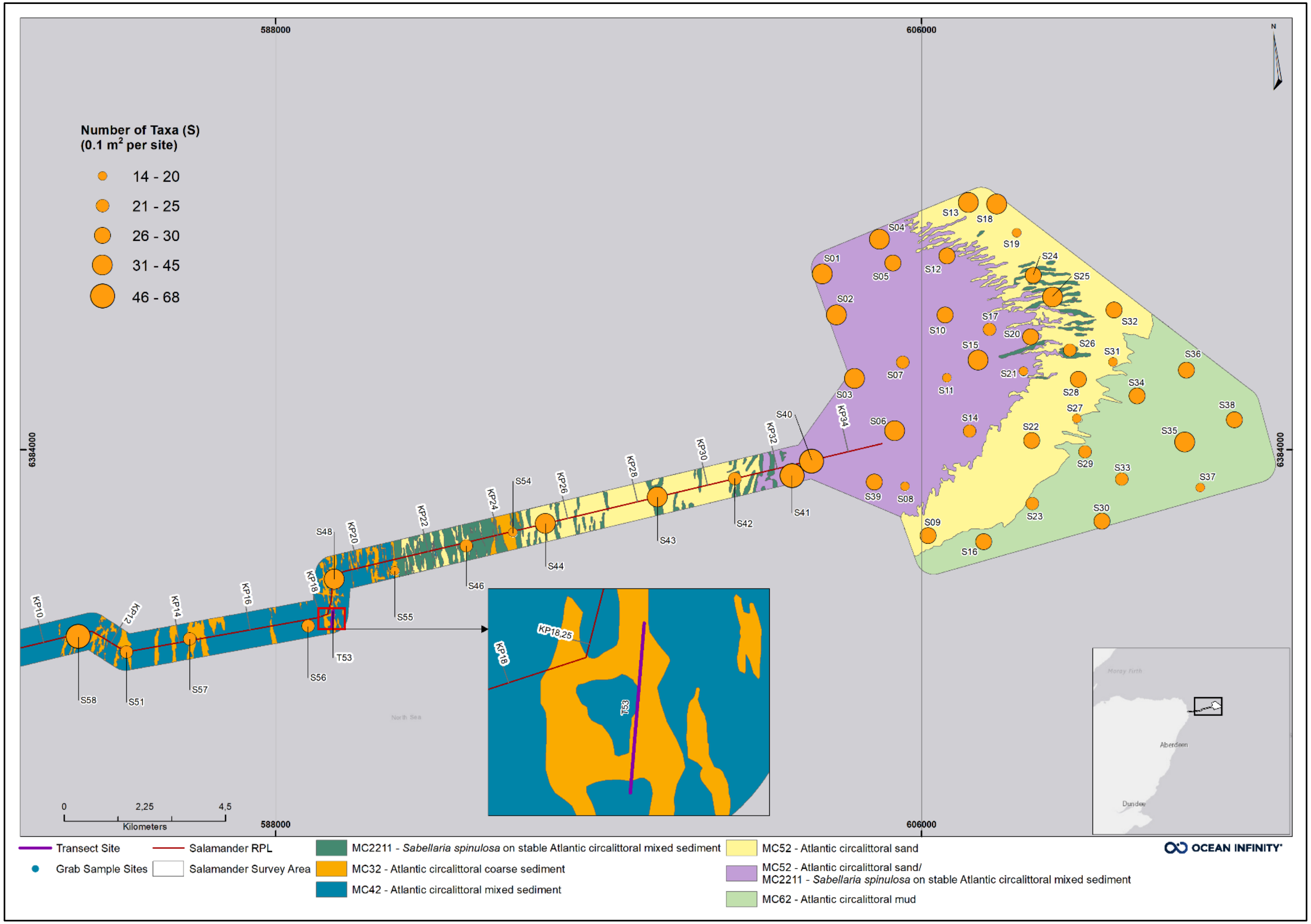


Figure 20 Overview of the Number of Taxa (S) per grab sample site.

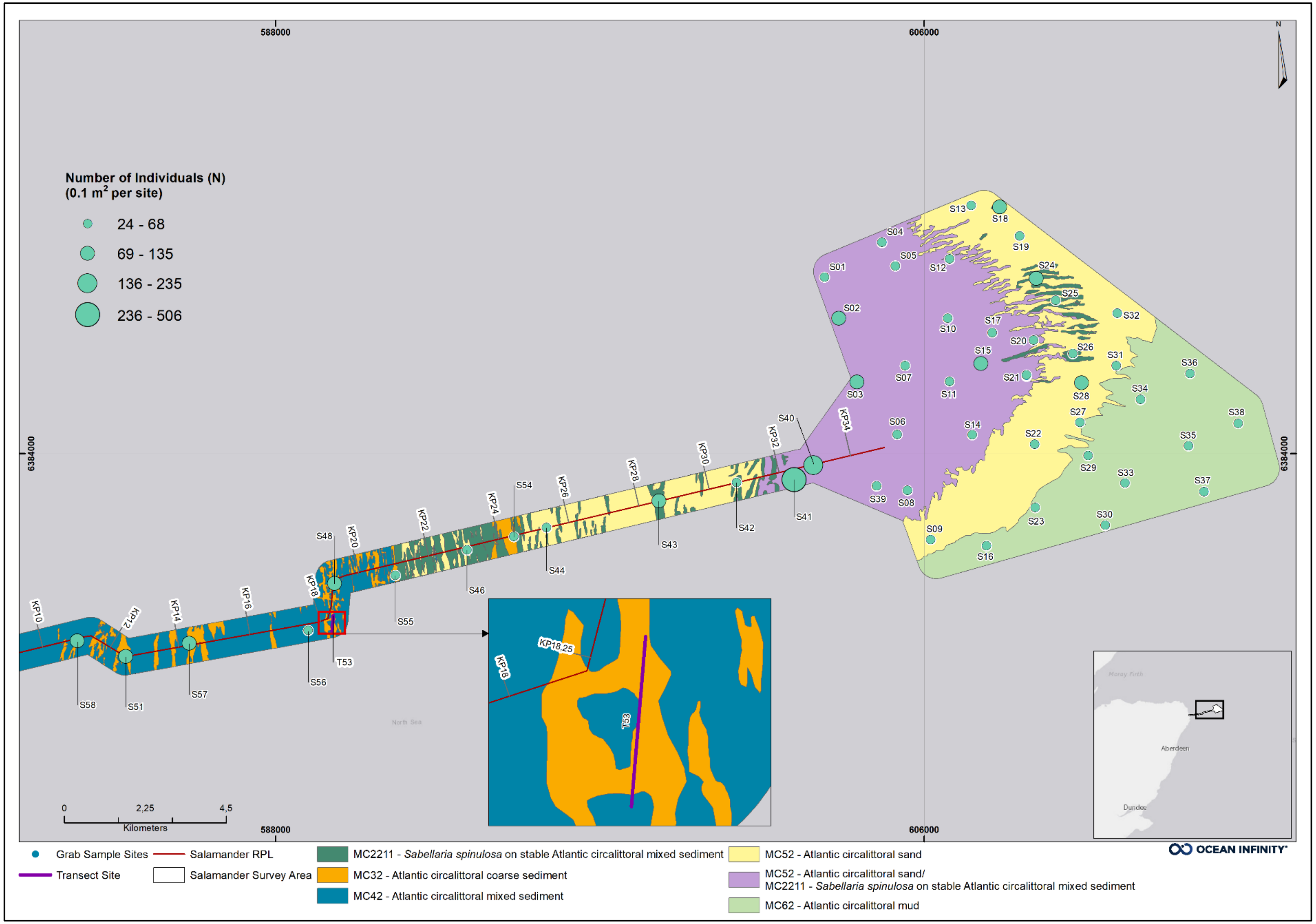


Figure 21 Overview of the Number of Individuals (N) per grab sample site.

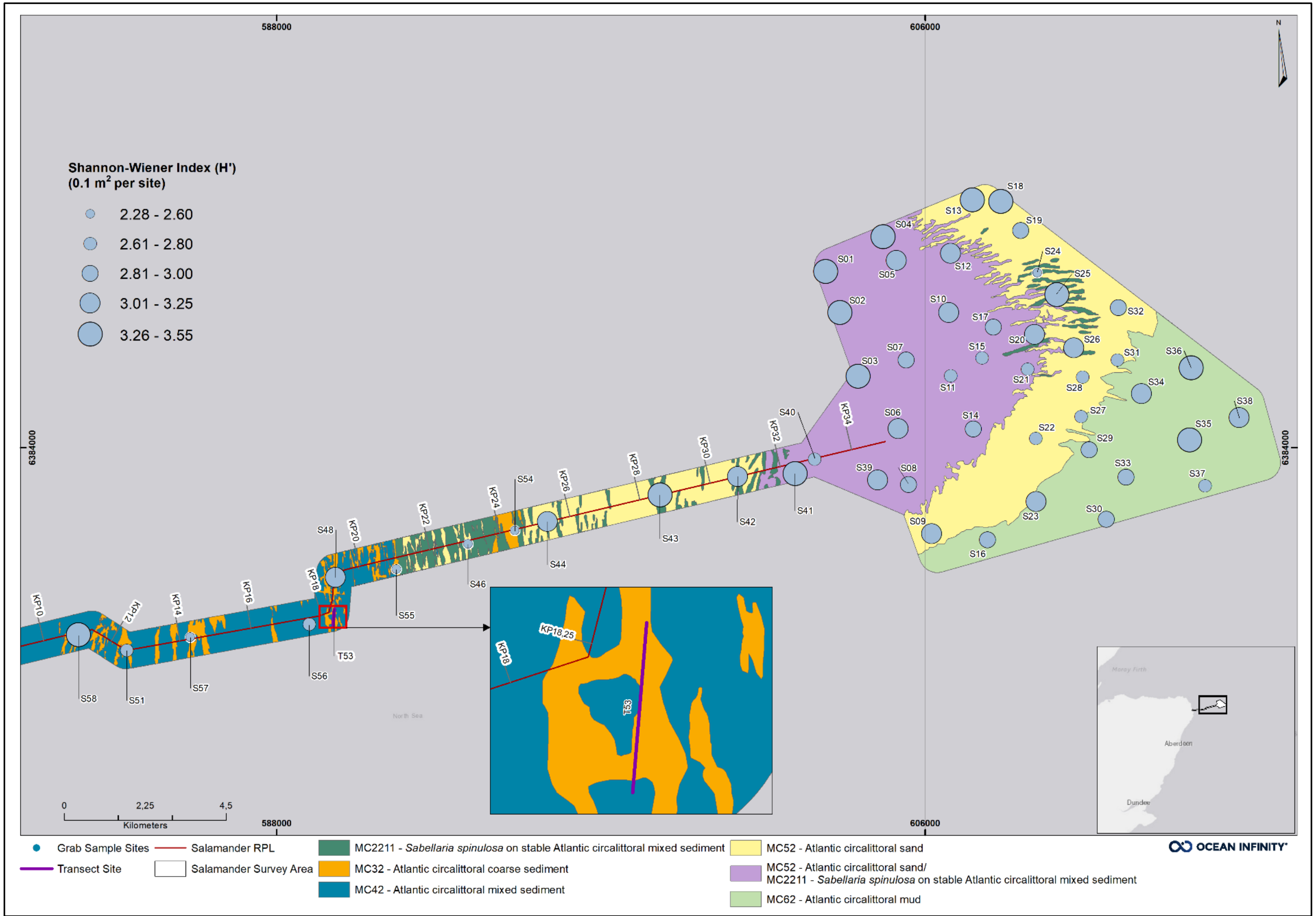


Figure 22 Overview of the Shannon-Wiener Index (H') per grab sample site.

5.5.4 Multivariate Analyses

Square root transformation was applied to the dataset before calculating the Bray-Curtis similarity measures in the SIMPROF and SIMPER analyses. The transformation was applied to prevent abundant species from influencing the Bray-Curtis similarity index measures excessively and to take the rarer species into account species (Clarke, 2015). The statistical analyses were based on macrofaunal data derived from the taxonomic analyses of the grab samples. Significance level for the cluster analysis was set to 5 %.

5.5.4.1 Simprof Cluster Analysis

The SIMPROF analysis of the non-colonial faunal composition produced five (5) statistically distinct groups (black lines) and presented in a hierarchical dendrogram in Figure 23.

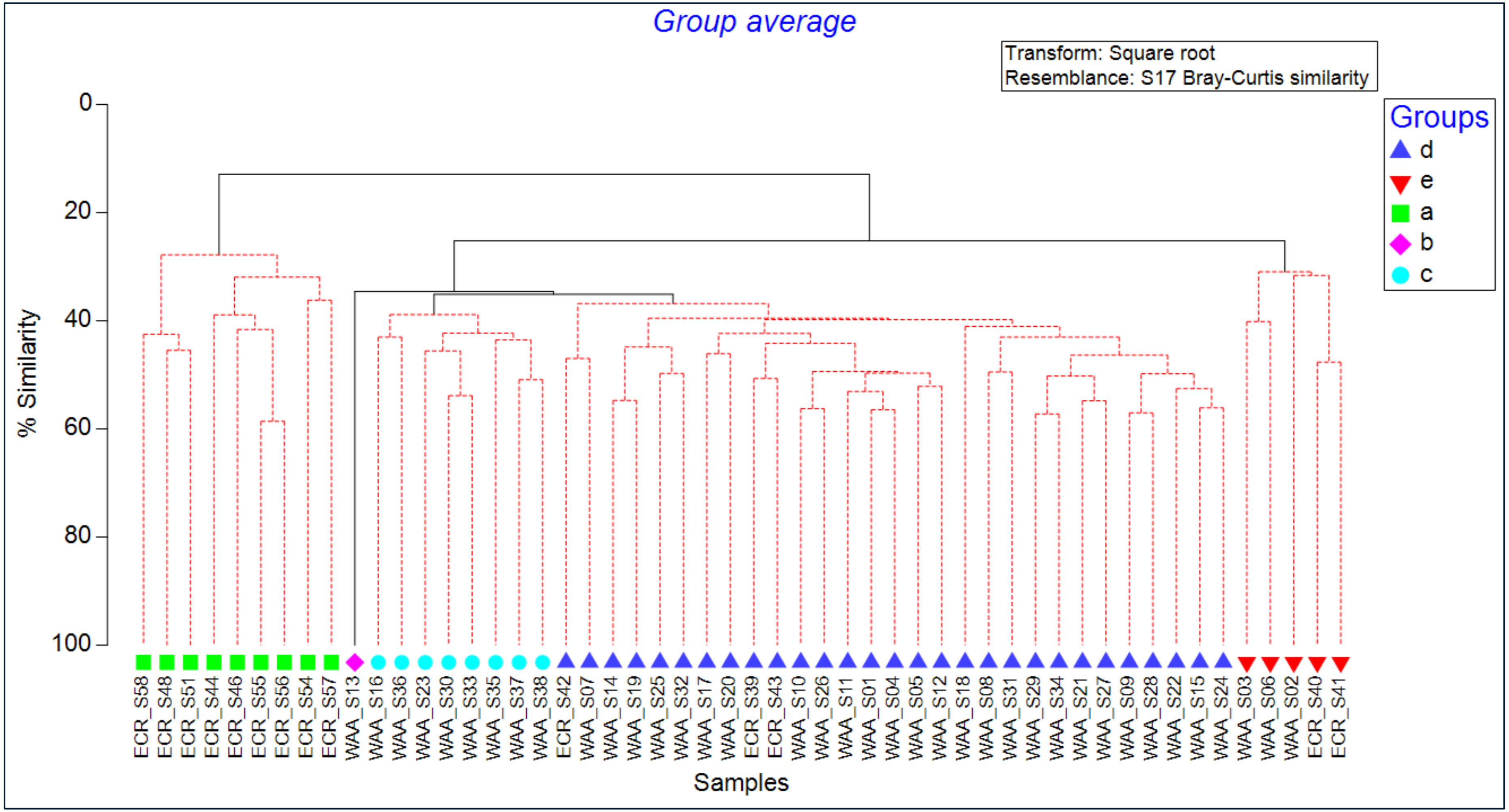


Figure 23 SIMPROF dendrogram of non-colonial faunal composition from grab samples.

5.5.4.2 Non-Metric Multi-Dimensional Scaling

Sample similarity is further explored in the Non-Metric Multi-Dimensional Scaling plot (nMDS), presented in Figure 24. The nMDS-plot reflects the dendrogram and displays the similarity between grab sample sites at 20 % to highlight homogenous species composition.

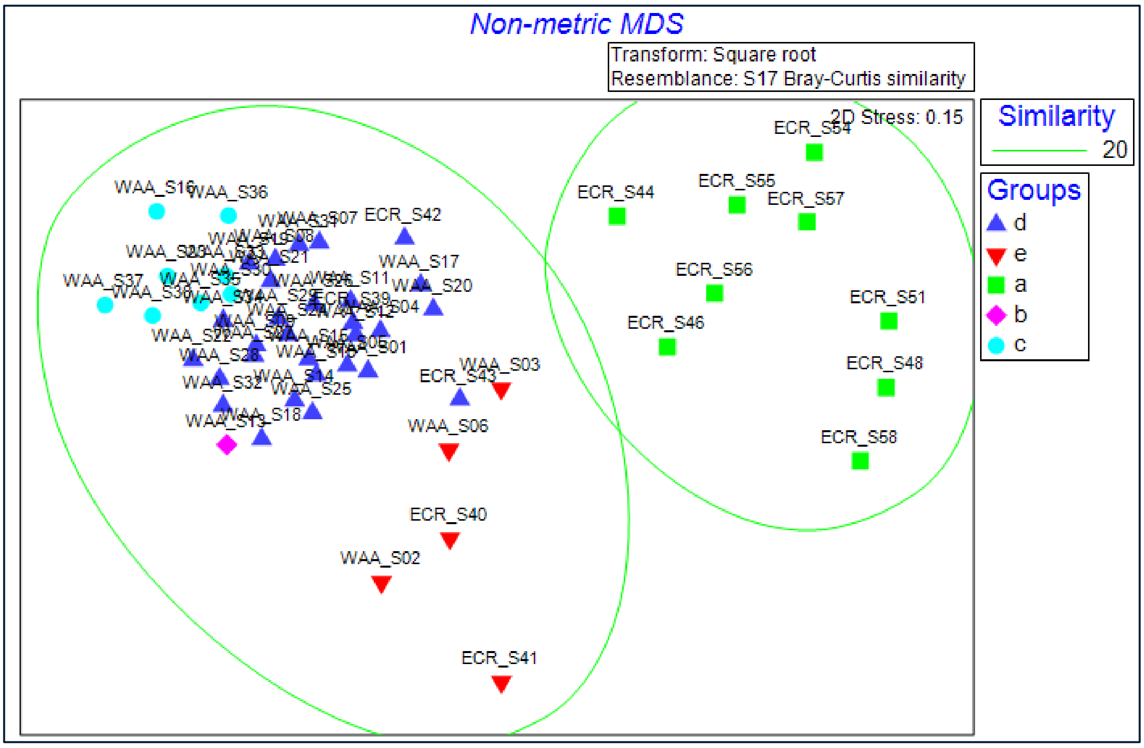


Figure 24 nMDS-plot of non-colonial faunal composition from grab samples with group based on the SIMPROF analysis.

5.5.4.3 SIMPER Results

A SIMPER test, displaying the percentage contribution of the most important species seen in the Bray-Curtis similarities test is presented in Table 35 with species abundance for each SIMPROF group. Average abundance refers to the square root transformed data and is expressed per 0.1 m^2 within the multivariate groups.

An overview of the five (5) distinct groups produced in the SIMPROF dendrogram is presented in the survey area in Figure 25.

Table 35 Summary of characteristics of the non-colonial faunal groups from grab samples derived from the SIMPER test.

Group	Sample ID	Depth (m)	Species	Average Abundance	Contribution (%)
a Average similarity: 32.82	ECR_S44	87	*Echinocyamus pusillus*	2.63	17.86
	ECR_S46	79	Nematoda	2.24	8.69
	ECR_S48	80	*Ophelia borealis*	1.58	7.24
	ECR_S51	82	*Polycirrus*	1.58	6.89
	ECR_S54	85	*Asbjornsenia pygmaea*	1.70	6.55
	ECR_S55	72	*Goodallia triangularis*	1.30	6.28
	ECR_S56	81	*Notomastus*	1.17	5.86
	ECR_S57	85	*Glycera lapidum* (aggregate)	1.39	4.97
	ECR_S58	75	*Chaetozone christiei*	1.24	3.80
			Eulalia mustela	0.88	2.42

Group	Sample ID	Depth (m)	Species	Average Abundance	Contribution (%)
b Single Sample	WAA_S13	92	Less than 2 samples in group	-	-
c Average similarity: 41.88	WAA_S16 WAA_S23 WAA_S30 WAA_S33 WAA_S35 WAA_S36 WAA_S37 WAA_S38	106 102 103 99 101 97 102 103	*Scoloplos armiger* *Harpinia antennaria* *Spiophanes kroyeri* *Thyasira flexuosa* *Abra prismatica* *Diplocirrus glaucus* *Nephtys hombergii* *Phascolion strombus* *Sthenelais limicola* *Phoronis*	1.90 1.44 1.59 1.34 1.27 1.14 0.98 1.12 1.04 0.97	9.84 8.01 7.80 7.59 7.53 5.96 5.77 5.52 4.57 3.26
d Average similarity: 41.34	ECR_S39, ECR_S42, ECR_S43, WAA_S01, WAA_S04, WAA_S05, WAA_S07, WAA_S08, WAA_S09, WAA_S10, WAA_S11, WAA_S12, WAA_S14, WAA_S15, WAA_S17, WAA_S18, WAA_S19, WAA_S20, WAA_S21, WAA_S22, WAA_S24, WAA_S25, WAA_S26, WAA_S27, WAA_S28, WAA_S29, WAA_S31, WAA_S32, WAA_S34	97, 97, 87, 97, 98, 97, 96, 98, 108, 93 92, 93, 98, 92, 92, 93, 91, 90, 91, 98, 90, 89, 90, 96, 94, 97, 92, 88, 94	*Scoloplos armiger* *Amphiura filiformis* *Antalis entalis* *Ennucula tenuis* *Abra prismatica* *Spiophanes kroyeri* *Kurtiella bidentata* *Echinocyamus pusillus* *Phoronis* *Owenia*	1.71 1.59 1.63 1.43 1.38 1.29 1.88 1.11 1.02 1.03	9.06 9.04 8.64 7.39 6.83 6.43 5.93 5.44 4.41 3.94
e Average similarity: 33.69	ECR_S40 ECR_S41 WAA_S02 WAA_S03 WAA_S06	94 94 94 92 97 94	*Lumbrineris cingulata* (aggregate) *Paradoneis lyra* *Echinocyamus pusillus* *Antalis entalis* *Amphiura filiformis* *Spiophanes kroyeri* *Nereis zonata* *Ophiactis balli* *Sabellaria spinulosa* *Verruca stroemia*	3.13 3.55 1.84 1.70 2.06 1.62 1.74 3.74 2.71 2.15	10.48 6.88 6.47 6.01 4.36 4.25 3.49 3.40 3.38 1.37

SIMPROF group **a** comprised of nine (9) sites (ECR_S44, ECR_S46, ECR_S48, ECR_S51, ECR_S54 - ECR_S58) all distributed along the ECR within a depth range of 72 - 87 m (Figure 25). These sites were located in **MC32** - Atlantic circalittoral coarse sediment and **MC52** - Atlantic circalittoral sand. The pea urchin *Echinocyamus pusillus* was the most abundant species and had the highest contribution (17.86 %) within group **a**.

SIMPROF group **b** comprised one (1) site WAA_S13, located in the north WAA at a depth of 92 m, in **MC52** - Atlantic circalittoral sand. The amphipod *Harpinia antennaria* was the most abundant species and had the highest contribution (10.20 %) within group **b**. Additionally, *Scoloplos armiger*, *Paradoneis lyra, Owenia* and *Amphiura filiformis* were some of the more abundant taxa within the group.

Group **c** comprised eight (8) sites (WAA_S16, WAA_S23, WAA_S30, WAA_S33, WAA_S35 - WAA_S38) all distributed in the southeast WAA within a depth range of 97 - 106 m. These sites were all located in the same habitat **MC62** - Atlantic circalittoral mud. The polychaete *Scoloplos armiger* was the most abundant species and had the highest contribution (9.84 %) within group **c.**

SIMPROF group **d** comprised 29 sites (ECR_S39, ECR_S42, ECR_S43, WAA_S01, WAA_S04, WAA_S05, WAA_S07, WAA_S08 - WAA_S12, WAA_S14, WAA_S15, WAA_S17 - WAA_S22, WAA_S24 - WAA_S29, WAA_S31, WAA_S32, WAA_S34) located at the eastern end of ECR and within WAA, within a depth range of 87 - 108 m. These sites were located in four (4) habitats **MC52/ MC2211** - Atlantic circalittoral sand/ *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment, **MC52** - Atlantic circalittoral sand, **MC2211** - *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment and **MC62** - Atlantic circalittoral mud. A majority of the samples within group **d** were located in the habitat **MC52/ MC2211** - Atlantic circalittoral sand/ *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment. *S. armiger* had the highest contribution (9.06 %) and the mollusc *Kurtiella bidentata* was the most abundant species within group **d**.

Group **e** consisted of a total of five (5) sites (ECR_S40, ECR_S41, WAA_S02, WAA_S03, WAA_S06), which were situated at the eastern end of ECR and in the western WAA within a depth range of 92 - 97 m. These sites were all located in the habitat **MC52/ MC2211** - Atlantic circalittoral sand/ *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment. The polychaetes *Lumbrineris cingulata* had the highest contribution (10.48 %) and *Paradoneis lyra* was the most abundant species within group **e**.

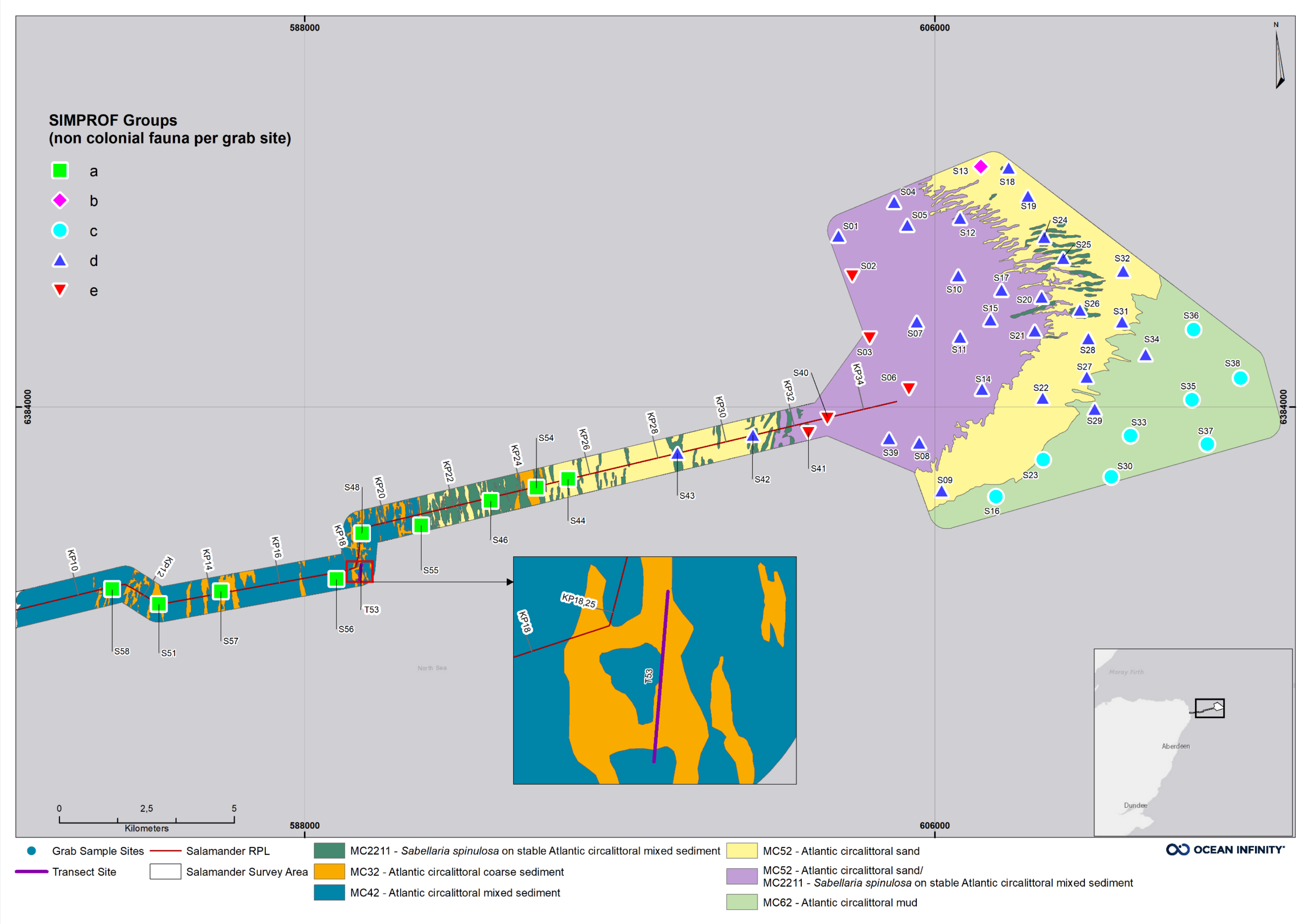


Figure 25 Spatial overview of groups produced in SIMPROF dendrogram of non-colonial faunal composition.

5.5.5 Relationship Between Physical and Biological Data

The relationship between physical and biological data was assessed by applying the BEST analysis from PRIMER suite. The BEST test identifies which of the variables best explains macrofaunal distribution in the survey area. Square root transformation was applied to the faunal abundance data (expressed per 0.1 m^2) before calculating the Bray-Curtis similarity measures. Normalisation was applied to the physical variables before calculating the Euclidean distance. A total of 51 sample sites were selected for the BEST analysis, including physical and biological data. Selected variables in the BEST test included depth, PSA, Arsenic (As) and Σ16PAH. Among the contaminants the metal Arsenic was the most distinguishing variable and thus selected for the BEST analysis.

Results of the BEST analysis for single and Multiple variables are presented in Table 36.

Results presented for single variables gave a global correlation (σ) of 0.649 for gravel. The significance level was 1 % which means that the null hypothesis of 'no agreement in multivariate pattern between physical and biological data' can be rejected at p<1 %. The variables Arsenic (As) and mud followed with a correlation (σ) of 0.571 and 0.532 respectively.

Results presented for the multiple variables gave a global correlation (σ) of 0.689 for the combined variables depth, Arsenic (As), gravel and mud. The significance level was 1 % which means that the null hypothesis of 'no agreement in multivariate pattern between physical and biological data' can be rejected at p<1 %.

Table 36 Results of BEST test between physical data and biological data for single and multiple variables.

Max nr of trail variables	Number of variables	Spearman correlation (σ)	Physical Variables
Single variables Global Test (σ): 0.649 Significance: 1%	1	0.649	Gravel
	1	0.571	As
	1	0.532	Mud
	1	0.523	Depth
	1	0.186	Sand
	1	0.175	Σ16PAH
Multiple variables Global Test (σ): 0.689 Significance: 1%	4	0.689	Depth, As, Gravel, Mud
	3	0.687	As, Gravel, Mud
	2	0.683	As, Gravel
	3	0.678	Depth, As, Gravel
	3	0.664	Depth, Gravel, Mud
	4	0.664	Depth, As, Gravel, Sand

5.5.6 Sessile Colonial Epifauna from Grab Samples

The phyletic composition of sessile colonial epifauna identified from grab samples is summarised in Table 37 and illustrated in Figure 26.

The Frequency of Occurrence was dominated by Bryozoa, being present at a total of 29 sites represented by 20 different taxa. Penetrantiidae, *Omalosecosa ramulosawas* and *Tubulipora* were among the most dominant taxa within the bryozoans. Cnidaria was present at 28 sites and represented by 13 taxa. The hydroid Filifera was the most dominant taxon within the cnidarians. Ciliophora was present at 25 sites and represented by one single taxon, Folliculinidae.

Entoprocta occurred at 10 sites with a total of three taxa, *Loxosomella murmanica*, *Loxosomella atkinsae* and *Pedicellina*. Porifera was present at 9 sites with two taxa identified, one colony of *Leucosolenia* present and the other colonies identified as Porifera.

The sessile colonial epifauna dataset was recorded as Presence (P) of taxa per square meter (ind./ m^2).

Table 37 Phyletic composition of colonial epifauna from grab samples.

Phylum	Number of Taxa	Number of Sites	Frequency of Occurrence (%)
Bryozoa	20	29	56
Cnidaria	13	28	54
Ciliophora	1	25	48
Entoprocta	3	10	19
Porifera	2	9	17
Total	**39**		

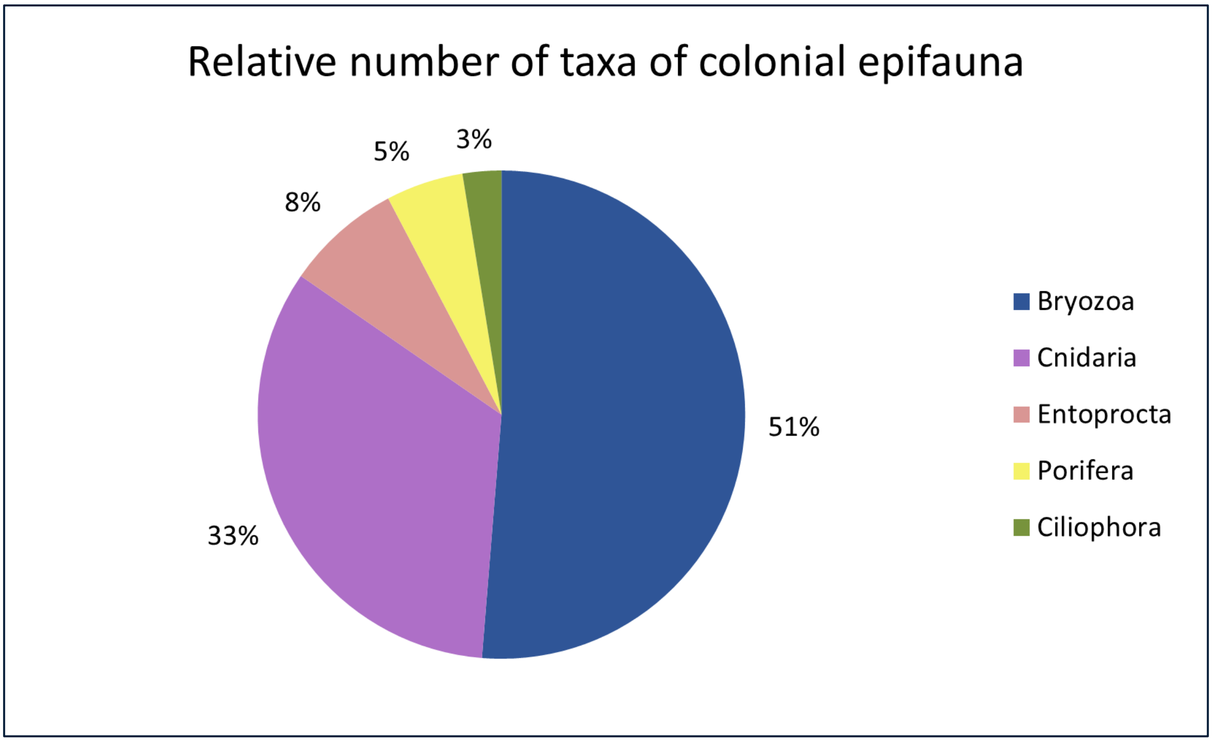


Figure 26 Relative number of taxa of colonial epifauna from grab samples.

5.6 Biomass

The non-colonial species biomass expressed as blotted wet weight (g per 0.1 m^2) is illustrated in Figure 27 and Figure 28 and summarised in Table 38. Biomass was grouped into the major phyla Mollusca, Echinodermata, Annelida, Chordata and "Others".

The group "Others" included the phyla Cnidaria, Nemertea, Phoronida, Platyhelminthes, Nematoda and Hemichordata. Following the NMBAQC Taxonomic Discrimination Protocol, Ascidiacea were not weighted and included in the biomass analysis (Worsfold, Hall, & O'Reilly, 2010).

The biomass was dominated by Mollusca, which accounted for 48 % of the total biomass. This was primarily due to the presence of bivalves *Acanthocardia echinata* in sample WAA_S18_F2, *Dosinia lupinus* in sample ECR_S43 and *Arctica islandica* in WAA_S34. Together these three individuals constituted 37 % of the total mollusc weight. The *A. islandica* specimen in sample WAA_S34 had a weight of 7.8453 g. The second largest group was

Echinodermata, accounting for 29 % of the total biomass. Two large urchins *Echinocardium penntifidum* in sample WAA_S06 and *Echinocardium cordatum* in WAA_S34 accounted for 75 % of the total echinoderm biomass. Annelida accounted for 16 % of the total biomass, followed by Chordata with 6 %, Arthropoda with 1 % and "Others" with 1 %, respectively.

Within the group "Others", Cnidaria comprised 0.261 %, Nemertea 0.248 %, Phoronida 0.192 %, Platyhelminthes 0.025 %, Nematoda 0.007 % and Hemichordata 0.004 %, respectively of the total biomass. The non-colonial fauna biomass varied between 0.2143 g/0.1 m² in sample WAA_S30 to 21.3083 g/0.1 m² in sample WAA_S34. The mean biomass across all sites was 2.9884 g/0.1 m² (SD=4.5452). The spatial distribution of biomass across the survey area is illustrated in Figure 29.

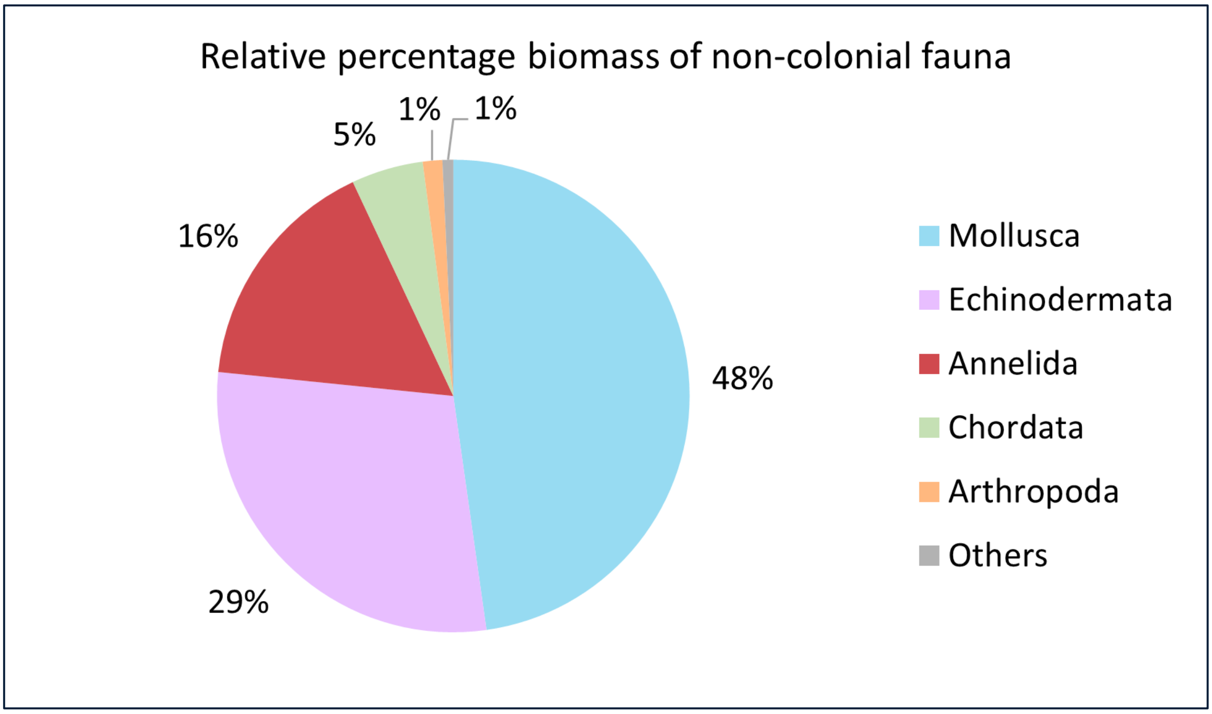


Figure 27 Relative percentage of total biomass (g/0.1 m²) of major phyla.

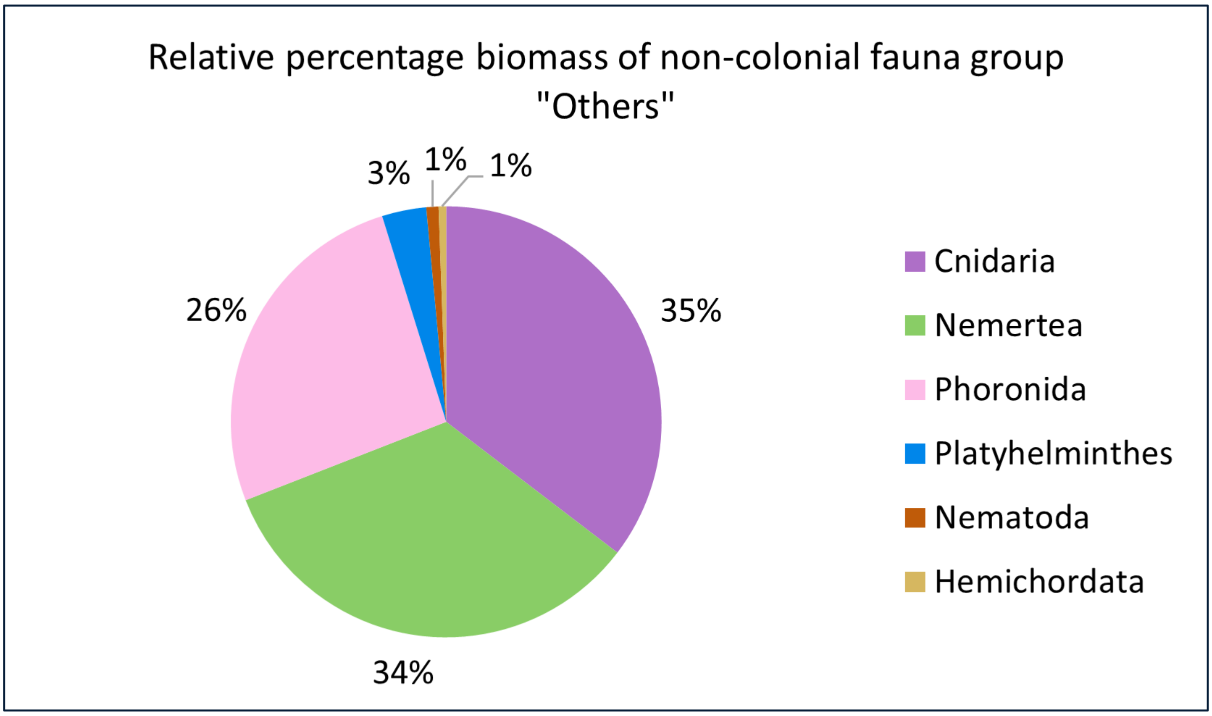


Figure 28 Relative percentage of total biomass (g/0.1 m²) of "Others".

Table 38 Biomass (blotted wet weight in g/0.1 m²).

Sample ID	Annelida	Arthropoda	Mollusca	Echinodermata	Chordata	Others	Total
ECR_S39	1.2101	0.0046	0.9010	0.2304	0.0000	0.0200	2.3658
ECR_S40	0.6938	0.8389	1.8313	1.4002	0.0000	0.0100	4.7743
ECR_S41	1.2785	0.0468	4.8957	1.8995	0.0000	0.0720	8.1927
ECR_S42	0.2705	0.0298	0.2677	0.1011	0.0000	0.0000	0.6691
ECR_S43	1.0327	0.0183	11.0615	0.2932	0.0000	0.0650	12.4708
ECR_S44	0.1968	0.0317	0.0087	0.0168	0.0000	0.0180	0.2722
ECR_S46	0.1972	0.0025	0.3308	0.0181	0.0000	0.0000	0.5490
ECR_S48	1.4609	0.0108	0.0157	0.0659	0.0978	0.0000	1.6512
ECR_S51	0.1005	0.0027	0.0437	0.1313	0.0000	0.0030	0.2807
ECR_S54	0.1011	0.0033	0.0118	0.0381	0.6779	0.0120	0.8438
ECR_S55	0.1115	0.0028	1.2351	0.0139	0.0000	0.0000	1.3635
ECR_S56	0.1738	0.0075	0.0126	0.0583	0.0000	0.0060	0.2578
ECR_S57	0.1069	0.0000	0.1451	0.0162	3.5664	0.0580	3.8924
ECR_S58	0.6730	0.0634	4.9371	0.0892	3.2893	0.0130	9.0654
WAA_S01	0.1279	0.0070	1.2819	0.2107	0.0000	0.0080	1.6350
WAA_S02	2.9188	0.5665	2.5190	0.0704	0.0000	0.0000	6.0747
WAA_S03	1.1599	0.0805	0.4665	0.3286	0.0000	0.0060	2.0414
WAA_S04	0.7286	0.0034	2.2718	0.1506	0.0000	0.0240	3.1780

Sample ID	Annelida	Arthropoda	Mollusca	Echinodermata	Chordata	Others	Total
WAA_S05	0.1759	0.0035	0.5378	0.4868	0.0000	0.0710	1.2750
WAA_S06	0.2355	0.0210	0.0802	20.6722	0.0000	0.0120	21.0208
WAA_S07	0.5426	0.0079	0.4896	0.0748	0.0000	0.0000	1.1149
WAA_S08	0.1663	0.0206	0.0340	0.0411	0.0000	0.0020	0.2636
WAA_S09	0.5651	0.0070	0.6918	1.1973	0.0000	0.0150	2.4765
WAA_S10	0.2183	0.0124	0.5017	0.1433	0.0000	0.0430	0.9188
WAA_S11	0.1056	0.0017	0.3979	0.1286	0.0000	0.0000	0.6339
WAA_S12	1.8905	0.0018	0.0573	0.0463	0.0000	0.0140	2.0094
WAA_S13	0.3306	0.0397	0.8532	0.1263	0.0000	0.0190	1.3685
WAA_S14	0.3577	0.0096	0.7437	0.1719	0.0000	0.0320	1.3148
WAA_S15	0.5281	0.0012	2.2764	0.1795	0.0000	0.0090	2.9939
WAA_S16	0.6057	0.0327	2.0705	0.0157	0.0000	0.0300	2.7547
WAA_S17	0.2397	0.0024	1.6546	0.0527	0.0000	0.0050	1.9540
WAA_S18	0.2538	0.0118	10.7458	0.3040	0.0000	0.0010	11.3160
WAA_S19	0.1361	0.0038	0.1346	0.0736	0.0000	0.0180	0.3657
WAA_S20	0.1238	0.0027	0.9150	0.1476	0.0000	0.0120	1.2014
WAA_S21	0.1505	0.0051	0.1816	0.0121	0.0000	0.0180	0.3676
WAA_S22	0.2224	0.0098	1.2253	0.1606	0.0000	0.0560	1.6737
WAA_S23	0.3346	0.0045	0.1493	0.0103	0.0000	0.0030	0.5020
WAA_S24	0.4194	0.0115	0.8180	0.1607	0.0000	0.0040	1.4133
WAA_S25	0.1595	0.0073	0.9125	0.0119	0.0000	0.0160	1.1067
WAA_S26	0.1349	0.0012	0.9243	0.0428	0.0000	0.0120	1.1148
WAA_S27	0.0936	0.0072	0.7107	0.0107	0.0000	0.0030	0.8250
WAA_S28	1.2540	0.0086	3.1307	0.1562	0.0000	0.0470	4.5960
WAA_S29	0.1197	0.0030	0.1487	0.0225	0.0000	0.0170	0.3108
WAA_S30	0.1387	0.0081	0.0191	0.0210	0.0000	0.0270	0.2143
WAA_S31	0.1726	0.0020	0.5066	0.1202	0.0000	0.0000	0.8015
WAA_S32	0.2377	0.0100	0.2648	1.8078	0.0000	0.0050	2.3248
WAA_S33	0.1650	0.0017	0.6446	0.0953	0.0000	0.0090	0.9159
WAA_S34	0.3188	0.0158	7.9903	12.9704	0.0000	0.0130	21.3083
WAA_S35	0.6266	0.0149	0.1329	0.0025	0.0000	0.0070	0.7841
WAA_S36	0.3887	0.0432	0.0460	0.1101	0.0000	0.0060	0.5942
WAA_S37	1.3078	0.0104	1.0198	0.0160	0.0000	0.0000	2.3540

Sample ID	Annelida	Arthropoda	Mollusca	Echinodermata	Chordata	Others	Total
WAA_S38	0.2184	0.0139	0.9644	0.1254	0.0000	0.3090	1.6306
Total	**25.4807**	**2.0785**	**74.2108**	**44.8507**	**7.6314**	**1.1453**	**155.3974**
Mean	**0.4900**	**0.0400**	**1.4271**	**0.8625**	**0.1468**	**0.0220**	**2.9884**
SD	**0.5481**	**0.1375**	**2.4096**	**3.3377**	**0.6699**	**0.0448**	**4.5452**
Min	**0.0936**	**0.0000**	**0.0087**	**0.0025**	**0.0000**	**0.0000**	**0.2143**
Max	**2.9188**	**0.8389**	**11.0615**	**20.6722**	**3.5664**	**0.3085**	**21.3083**
Median	**0.2387**	**0.0080**	**0.6682**	**0.1056**	**0.0000**	**0.0116**	**1.3660**

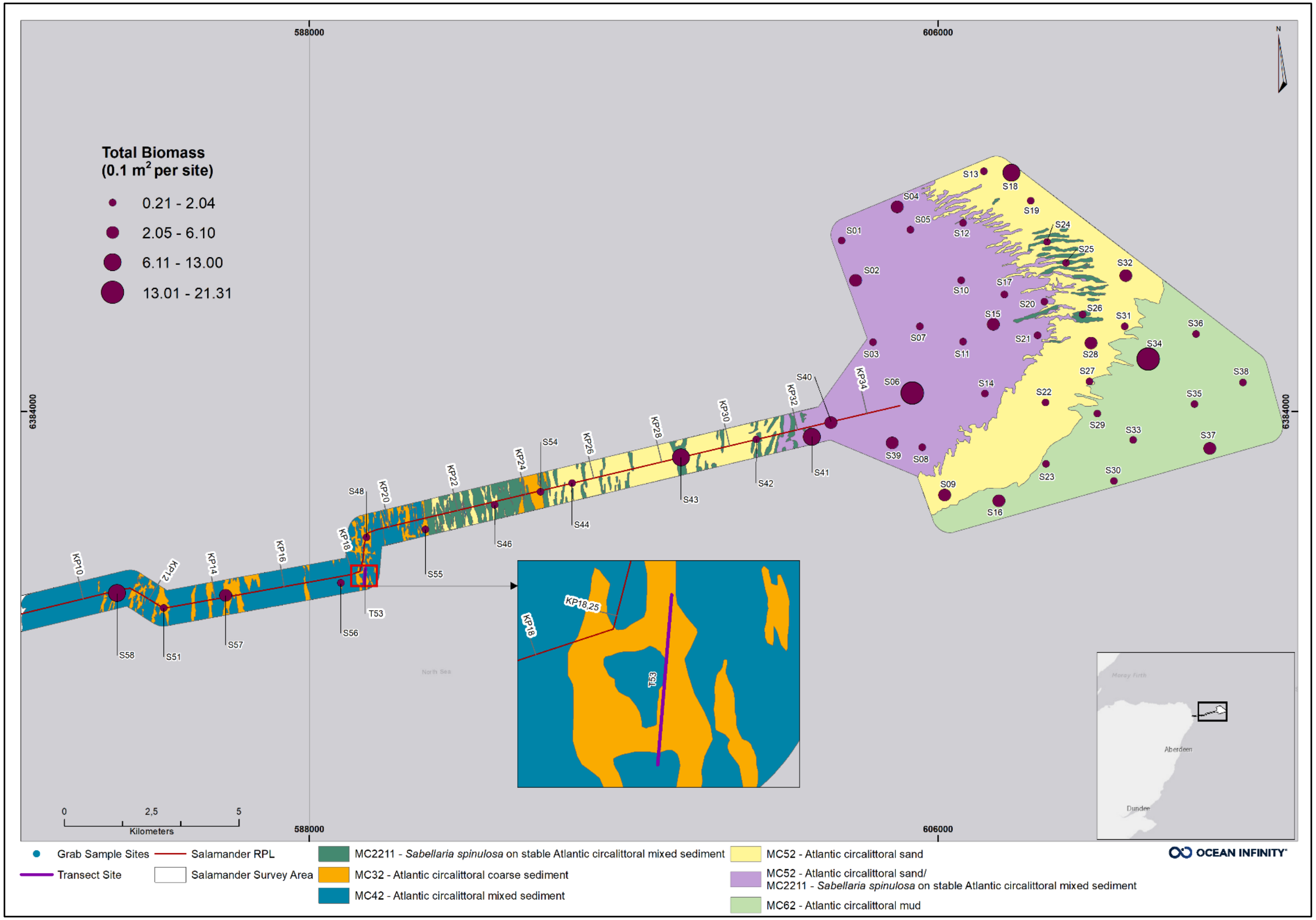


Figure 29 Overview of total biomass (g/0.1 m²) per grab sample site.

5.7 Epibenthic Fauna from Visual Survey

The results from the analyses of the stills from grab sample sites presented habitats generally dominated by sandy and mixed sediments with a presence of *Sabellaria spinulosa aggregations*. Further information regarding *S. spinulosa* and Biogenic Reefs is presented in Section 5.8.2. Noticeable fauna included Cnidaria and Arthropoda, mostly associated with sandy and mixed substrates. Three (3) out of the total 57 grab sample sites had no fauna recorded in the stills acquired (WAA_S23, WAA_S27 and WAA_S31), habitats comprising of circalittoral mud (WAA_S23) and circalittoral sand (WAA_S27 and WAA_S31).

The top ten (10) sites comprising the highest number of taxa, with assigned habitats, are presented in Table 39. The most frequent habitat identified at the top ten (10) sites was habitat complex **MC52** - Atlantic circalittoral sand/ **MC2211** - *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment. The average number of taxa was eight (8) per site.

Figure 30 presents a still photo from ECR_S52, which had the highest number of taxa of all sites. Transect ECR_T53 was not included in the statistical analyses in Section 5.7.

Table 39 Top 10 sites with the highest number of taxa and assigned habitats.

Site ID/Phylum	ECR_S52	ECR_S47	ECR_S50	WAA_S12	ECR_S45	ECR_S49	WAA_S06	ECR_S40	WAA_S24	WAA_S25
Habitat Code	MC42	MC2211	MC42	MC52/ MC2211	MC2211	MC42	MC52/ MC2211	MC52/ MC2211	MC2211	MC2211
Annelida	4	2	1	2	2	2	2	3	2	2
Arthropoda	7	6	4	3	5	3	4	3	4	4
Bryozoa	5	3	5	1	1	5	1	1		
Chordata	3	1	1		1					
Cnidaria	5	5	6	9	4	2	7	5	5	4
Echinodermata	2	1	2	1	2	3		1	2	
Mollusca	4	4	3	1	2	1		1		2
Porifera		1		1						
Grand Total	**30**	**23**	**22**	**18**	**17**	**16**	**14**	**14**	**13**	**12**

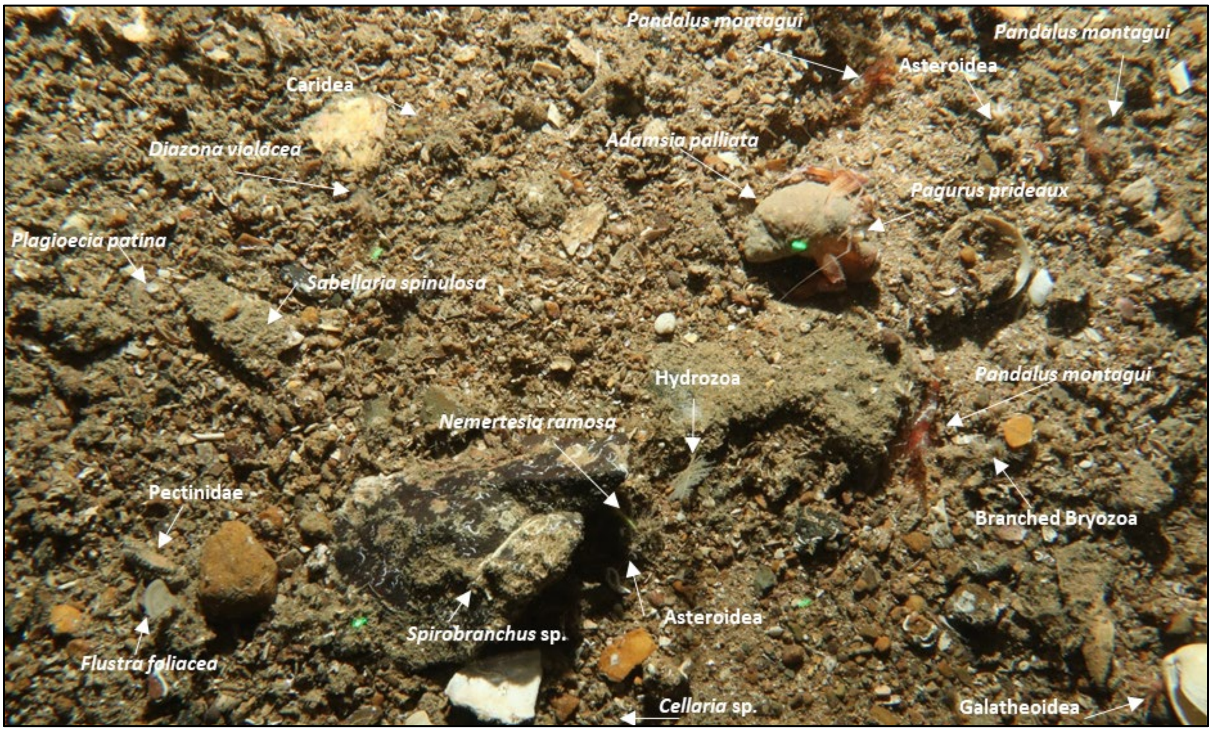


Figure 30 Site photo still from ECR_S52 showing Adamsia palliata, Asteroidea, Caridea, Diazona violacea, Galatheoidea, Gobiidae, Pagurus prideaux, Pandalus montagui, Pectinidae, Plagioecia patina, Spirobranchus sp.

5.7.1 Non-Colonial Epibenthic Fauna in Site Stills

The relative percentage abundance of the number of individuals recorded from the different phyla from the stills acquired is presented in Figure 31.

The most abundant phylum in the epibenthic fauna was Arthropoda, which contributed 33 % of all individuals recorded in the stills. Most of the abundance within the arthropods was represented by Paguridae, which constituted 34 %, followed by Caridea with 17 % of the abundance within the phylum. Caridea followed with 17 % of the abundance within the arthropods.

The second most abundant phylum was Cnidaria, with 22 % of all individuals recorded in the stills. The hydroid *Tubularia indivisa* constituted 66 % of the total abundance within the cnidarians.

The Annelida phylum contributed 19 % of all individuals recorded in the stills. The most abundant taxa within the annelids were *Lanice conchilega* which constituted 94 % of the total abundance.

The Echinodermata phylum contributed with 12 % of all individuals recorded in the stills. The phylum constituted manly of the different species of Asteroidea and Ophiurida.

The Mollusca phylum contributed with 7 % of all individuals recorded in the stills. Gastropoda was the most abundant taxa with 41 % total abundance within the phylum.

The phyla Chordata and Bryozoa contributed with 5 % and 2 % of all individuals recorded in the stills respectively.

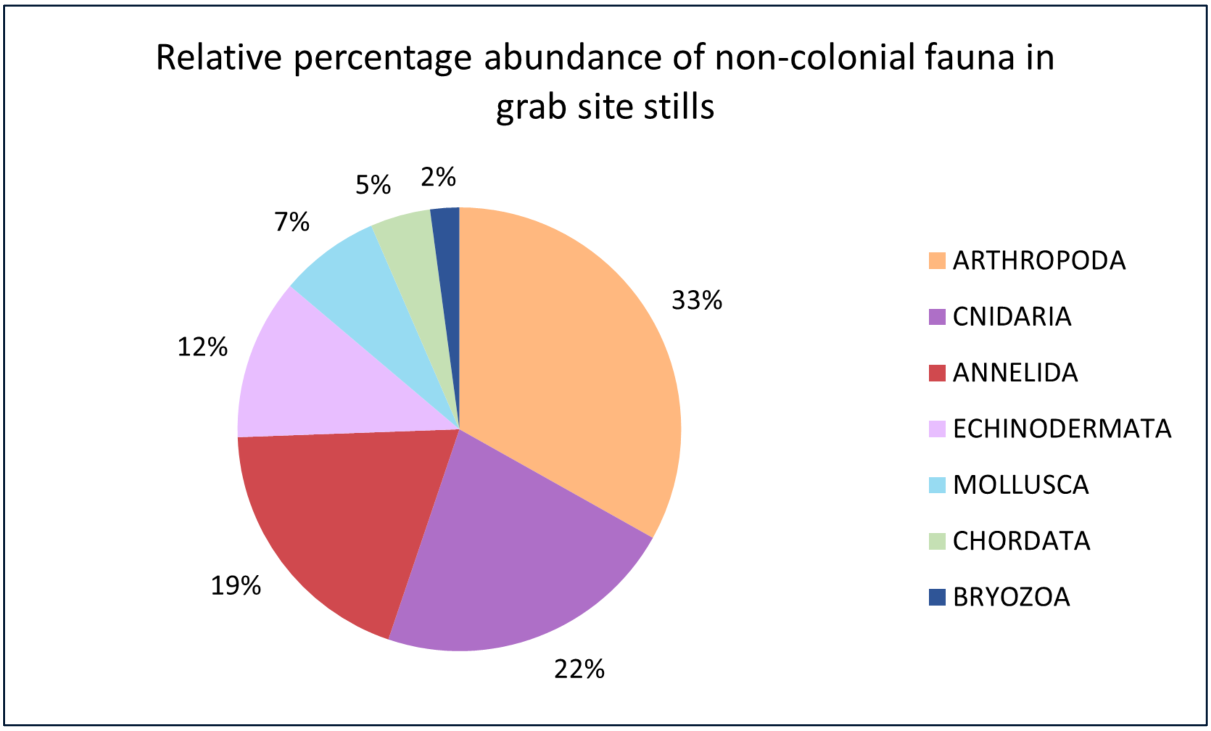


Figure 31 Relative percentage abundance of non-colonial fauna in grab site stills.

The top 10 most frequently occurring non-colonial taxa across all sites is presented in Table 40. Transect ECR_T53 was included when calculating the frequency of occurrences presented below.

The sand mason worm, *L. conchilega* was the overall most frequently occurring taxa, with the frequency of 59 % per site and 16 % per still. In total *L. conchilega* occurred 34 sites and 65 stills.

Table 40 Top 10 most frequently occurring non-colonial taxa across all sites.

Phylum	Taxa	Number of Sites of Occurrence	Frequency of Occurrence (%)	Number of Stills of Occurrence	Frequency of Occurrence (%)
Annelida	*Lanice conchilega*	34	59	65	16
Arthropoda	Paguridae	26	45	55	13
Cnidaria	*Tubularia indivisa*	20	34	29	7
Arthropoda	Caridea	14	24	25	6
Arthropoda	Galatheoidea	12	21	12	3
Echinodermata	Ophiurida	12	21	13	3
Arthropoda	Gastropoda	10	17	11	3
Echinodermata	Asteroidea	8	14	21	5
Echinodermata	*Ophiura* sp.	8	14	9	2
Arthropoda	*Pandalus montagui*	8	14	15	4

The average non-colonial fauna density (ind./m^2) for each grab sample site are presented per phylum in Figure 32.The average density, expressed as individuals per square meter (ind./m^2), varied from zero (0) (ind./m^2) at grab sample sites WAA_S23, WAA_S27 and WAA_S31 to 50 (ind./m^2) at grab sample site ECR_S52. The average non-colonial fauna density per grab sample site was ten (10) (SD=10) (ind./m^2).

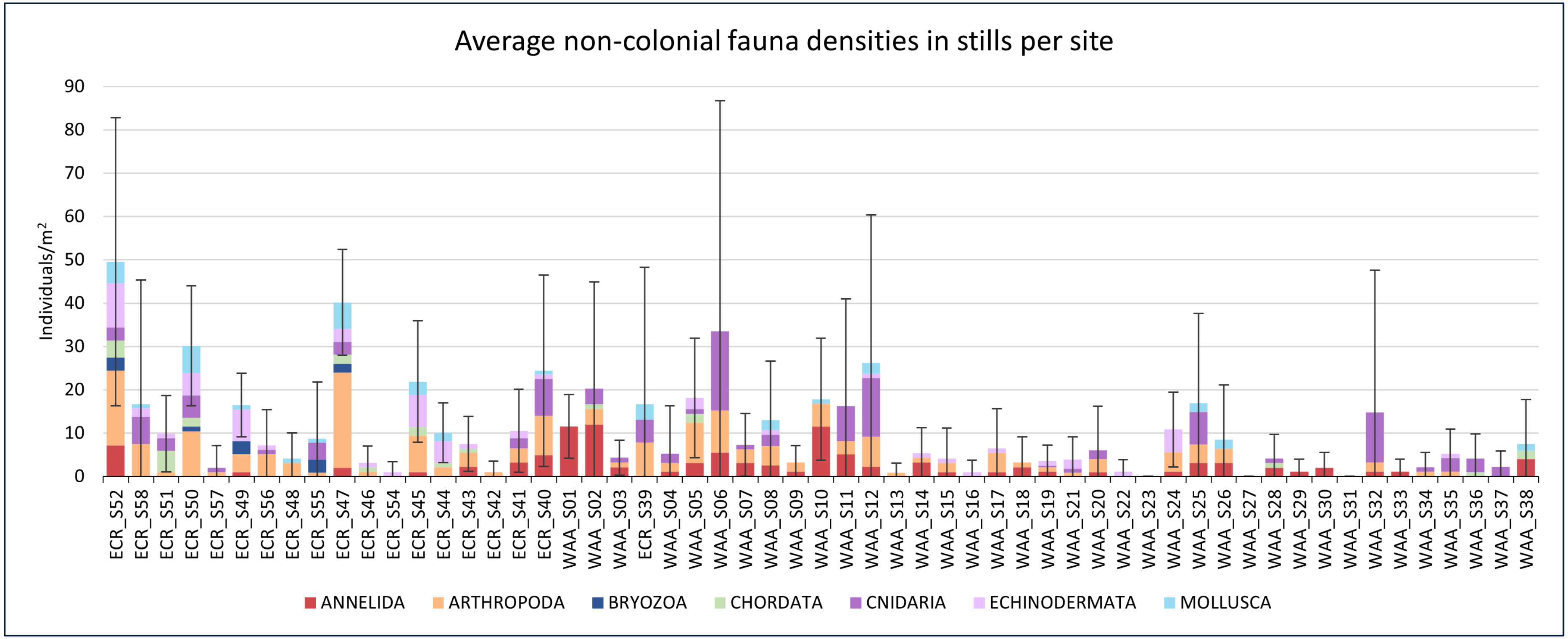


Figure 32 Average non-colonial faunal densities (ind./m²) in stills per grab sample site. Error bars represent ± SD for the total faunal density per still (ind./m²) per site.

5.7.2 Colonial Epifauna in Site Stills

The relative percentage proportions total coverage of colonial species, recorded in the grab site stills is presented in Figure 33. The phylum Annelida represented the phylum with the taxa covering the largest surface area, with a total contribution of 87 %. Cnidaria and Bryozoa contributed 10 % and 3 % of the recorded taxa respectively, followed by Porifera with <1 %.

The Ross worm *Sabellaria spinulosa* represented the entire constitution of colonial annelids in site stills. S. spinulosa was recorded at 28 out of the total 57 sites (49 %) with site ECR_S47 having the highest coverage of all sites. The phylum Cnidaria was recorded at 35 out of the total 57 sites (61 %). Different species of Hydrozoans were the most common taxa within the cnidarians. The phylum Bryozoa was recorded at 20 out of the total 57 sites (35 %). The most common taxa in the bryozoans were *Flustra foliacea* recorded in the western ECR, with site ECR_S56 having the highest coverage of all sites.

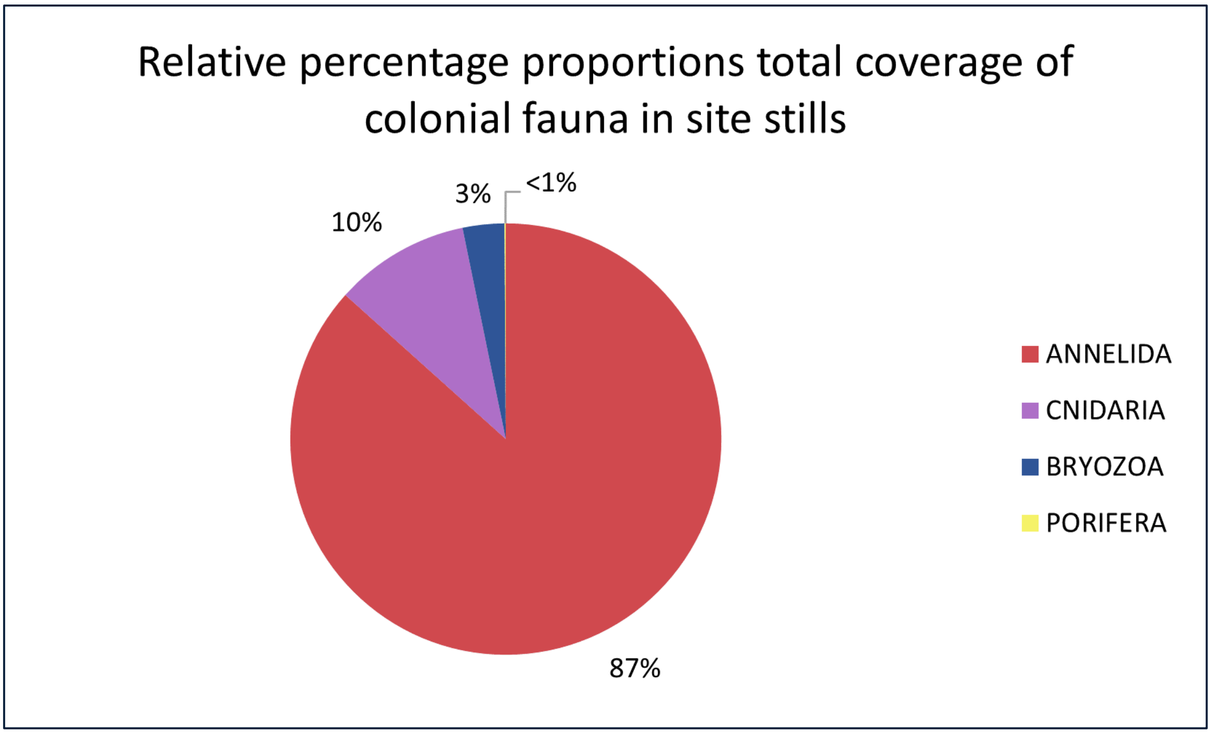


Figure 33 Relative percentage of total coverage of colonial fauna in grab site stills.

The top 10 most frequently occurring colonial taxa across all sites is presented in Table 41. Transect ECR_T53 was included when calculating the frequency of occurrences presented below.

Hydrozoa was the most frequently occurring colonial taxa identified per site, with the frequency of 60 % and occurred in 35 sites. *S. spinulosa* was the most frequently occurring taxa per still, with the frequency of 22 % and occurred in a total of 93 stills.

Table 41 Top 10 most frequently occurring colonial taxa across all sites.

Phylum	Taxa	Number of Sites of Occurrence	Frequency of Occurrence (%)	Number of Stills of Occurrence	Frequency of Occurrence (%)
Cnidaria	Hydrozoa	35	60	76	18
Annelida	*Sabellaria spinulosa*	28	48	93	22
Cnidaria	*Nemertesia ramosa*	14	24	22	5
Cnidaria	Plumulariidae	11	19	19	5

Phylum	Taxa	Number of Sites of Occurrence	Frequency of Occurrence (%)	Number of Stills of Occurrence	Frequency of Occurrence (%)
Bryozoa	Branched Bryozoa	10	17	27	6
Bryozoa	*Flustra foliacea*	8	14	16	4
Cnidaria	*Hydrallmania falcata*	7	12	8	2
Bryozoa	Encrusting Bryozoa	6	10	13	3
Cnidaria	*Alcyonium digitatum*	5	9	5	1
Cnidaria	*Lafoea dumosa*	4	7	4	1

The average coverage of colonial fauna varied from 0 % to 78 % (ECR_S47), presented in Figure 34. The average colonial faunal coverage expressed per site was 8.08 % (SD= 19.09). The average percentage coverage was overall highest along the ECR sites compared to the WAA sites and Annelida was the dominating phylum at most of the sites.

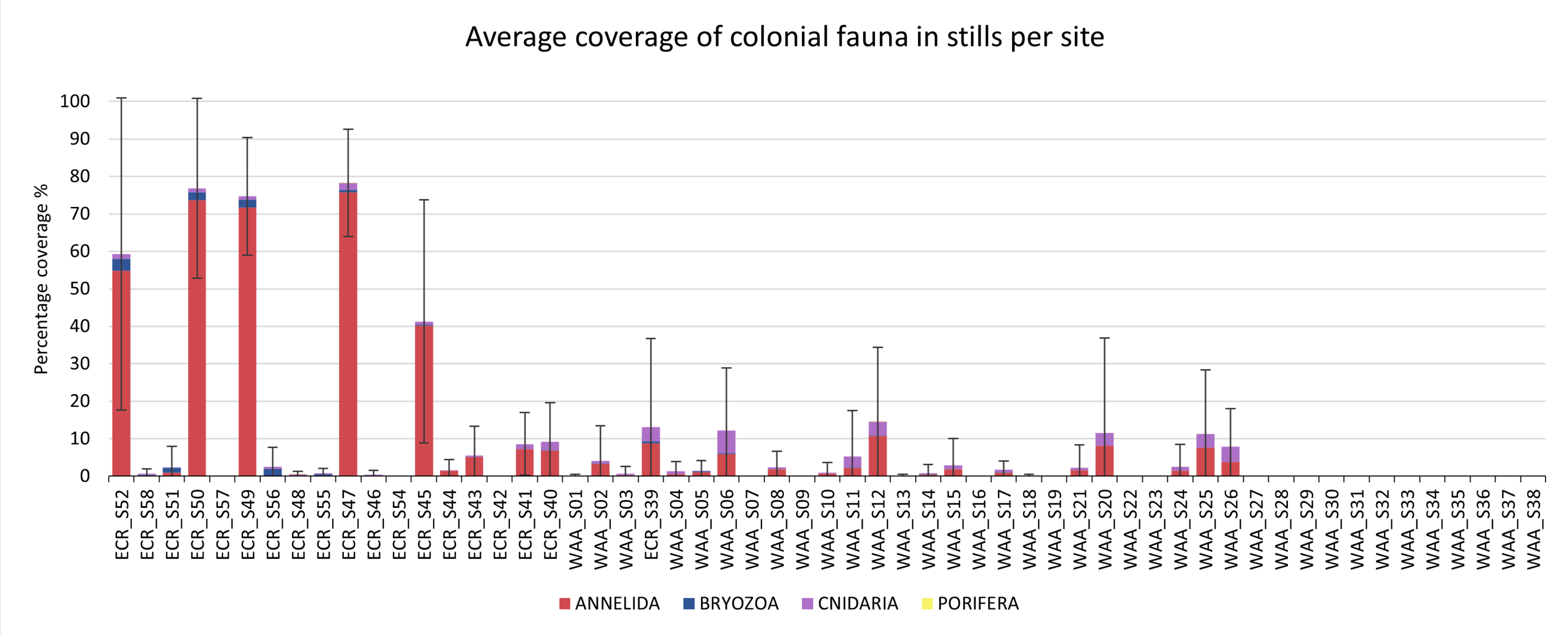


Figure 34 Average percentage coverage per m² for colonial fauna in stills per grab site. Error bars represent ± SD for the total faunal coverage per still (m2) per site.

5.8 Potential Areas and Species of Conservation Importance

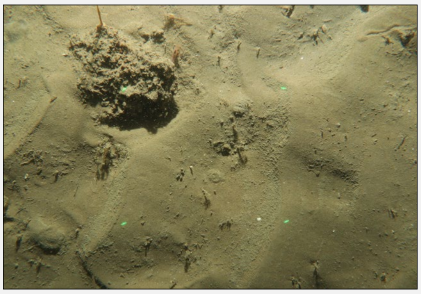
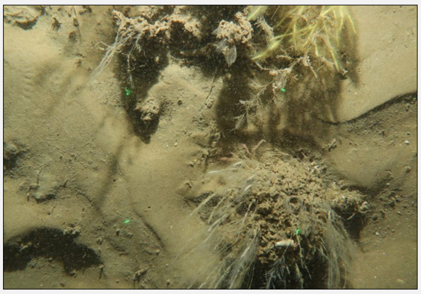
The habitats and species corresponding to those defined in the EC's Habitats Directive, the OSPAR List of threatened and/or Declining Species and Habitats, Scottish PMF, and SBL are listed in Table 42 and Table 43

Areas and species of conservation importance identified within the ECR, and WAA are presented in (Table 42). The delineations are based on the findings with regard to descriptive qualifiers outlined by designators.

The assessments are considered in conjunction with reported information on the presence of habitats and the conservation status of habitat types and species by the UK, to the Habitats Directive as required by Article 17 (JNCC, 2019).

Areas comprising aggregations of *S. spinulosa* assessed as "Not a reef" are delineated as "*S. spinulosa* aggregations presence" in maps to further provide contextual information on potential distribution patterns.

Table 42 Habitats of conservation interest within the ECR and WAA.

<table>
<tr><th>Habitat Image</th><th>Note</th><th>PMF/SBL/ OSPAR/Annex I</th><th>Designated Sites</th><th>Site ID</th></tr>
<tr><td></td><td rowspan="3">Exemplified Potential to Low and Medium Aggregations</td><td rowspan="3">-</td><td rowspan="3">-</td><td>Potential Aggregations: WAA_S03 - WAA_S05, WAA_S08, WAA_S10, WAA_S14, WAA_S17, WAA_S21, WAA_S25, ECR_S44, ECR_S47, ECR_S49 - ECR_S52</td></tr>
<tr><td></td><td>Low Aggregations: WAA_S02, WAA_S06, WAA_S11, WAA_S12, WAA_S15, WAA_S25, ECR_S39, ECR_S40, ECR_S43, ECR_S45</td></tr>
<tr><td></td><td>Medium Aggregations: WAA_S06, WAA_S12, WAA_S20, WAA_S26, ECR_S39</td></tr>
<tr><td></td><td>-</td><td>PMF
Offshore Subtidal sands and gravels
SBL
Subtidal Sands and Gravels</td><td>-</td><td>WAA_S01 - WAA_S15, WAA_S17 - WAA_S18, WAA_S19 - WAA_S22, ECR_S39 - ECR_S42, ECR_S44 - ECR_S46, ECR_S48 - ECR_S58</td></tr>
</table>

Habitat Image	Note	PMF/SBL/ OSPAR/Annex I	Designated Sites	Site ID
	Stony Reefs Low	-	-	ECR_S47

Table 43 Species of conservation interest within the ECR and WAA.

Species	Annex I	PMF/SBL/OSPAR	Site ID
Ammodytes sp.	-	PMF and SBL	ECR_S48, ECR_S54, ECR_S57, ECR_S58
Arctica islandica	-	OSPAR and PMF	WAA_S04, WAA_S30, WAA_S37, WAA_S38
Pennatula phosphorea	-	SBL	WAA_S19, WAA_S28, WAA_S34, WAA_S35, WAA_S36, WAA_S37

5.8.1 Rocky Reefs

Bedrock and Stony Reefs are listed as subtypes within the EC Habitats Directive Annex I (1170) – Reefs comprising reefs of geogenic and biogenic origin. Geogenic reefs are further sub-divided into Bedrock and Stony Reefs (EUR 28, 2013).

The stony reef areas were assessed in accordance with the criteria as outlined in JNCC Report No.432 (2009) and JNCC Report No.656 by Golding *et al* (2020) and Brazier (2020). Guidance for standardising an approach to the assessment criteria is introduced by the JNCC in Report No 656 (2020) to align the interpretation of Composition, Elevation, Extent and Biota, with regards to the application of Annex I to Stony Reefs. Stony reefs are generally divided into Clast supported (cobbles neighbouring cobbles) and Matrix supported (intermediate fine sediments are present) reefs.

An area comprising boulders and cobbles was identified in the ground truthing data at grab sample site S47. Site S47, located within the ECR, was classified as **MC2211** and due to the presence of *Sabellaria spinulosa* crusts no grab sampling was attempted.

The composition matches the qualifying descriptors of low 'reefiness' based on the cobble and boulder size composition being larger than 64 mm. The elevation is interpreted to be higher or equal to 64 mm. However, these were most often matrix supported individual cobbles and boulders. The cobbles and boulders were partly buried by the intermediated sediments and the composition is assessed as low. Biota showed mainly epifaunal species and encrusting *Sabellaria spinulosa*.

In line with the guidance outlined in JNCC Report No.432 (2009), a strong justification is required for an area to be considered as Annex I - Stony Reefs should the area score a "low" resemblance in any of the four categories. Site S47 scored predominantly Low and would thus not qualify as an Annex I habitat.

A detailed assessment of each acquired still against the four qualifying criteria, Composition, Elevation and Extent is presented in Table 44.

Table 44 Stony Reef assessment at site S47.

Photo ID	Elevation	Composition	Area >25m^2	Final Assessment
ECR_S47_01	Low	Potential	Y	Potential
ECR_S47_02	Low	Low	Y	Low
ECR_S47_03	Low	Low	Y	Low
ECR_S47_04	Low	Low	Y	Low
ECR_S47_05	Low	Low	Y	Low
ECR_S47_06	Low	Low	Y	Low
ECR_S47_07	Low	Potential	Y	Potential

No features qualifying as Annex I (1170) – Reefs, subtypes Bedrock Reefs and Stony Reefs, were identified within the ECR and WAA.

5.8.2 Biogenic Reefs

Biogenic Reefs are listed as a subtype within the EC Habitats Directive Annex I (1170) – Reefs comprising reefs of geogenic and biogenic origin (EUR 28, 2013). The Ross-worm *Sabellaria spinulosa* qualifies for conservation interest when it forms reef features, and the species occurs commonly on sand with shell gravel.

The assessment procedure (Collins, 2010) used within this report presented in Section 4.6. *S. spinulosa* reefs are described as defined areas with a distinct elevation variance, from the surrounding seabed. The spatial extent can be large and complex and growth form can be either patchy or cohesive creating a hard stable surface with an internal maze of cavities promoting diversity.

Aggregations of *S. spinulosa* were observed at 31 out of the 58 surveyed sites, where 17 were located within the WAA and 14 sites were distributed along the ECR. The 'reefiness' assessment combined with the interpretation of geophysical data resulted in the delineation of several areas of *S. spinulosa*. Individual stills acquired were classified as of Low and Medium reefiness, and it cannot be excluded that potential reef features could be present within these delineated areas.

Findings of *S. spinulosa*, as identified in the grab samples (expressed per/ 0.1 m^2), are summarised in Table 45. *S. spinulosa* was identified in the samples acquired at ten (10) grab sample sites where ECR_S40 and ECR_S41 comprised the highest abundance with 12 and 54 individual specimens, respectively. Images of the grab samples taken at sites ECR_S40 and ECR_S41 (Figure 35 and Figure 36) show *S. spinulosa* tube clusters within the samples. Images from the remaining eight (8) sites had a minor number of individual tubes after sieving.

The spatial distribution of *S. spinulosa* quantities per grab sample site is further illustrated in Figure 37.

Table 45 Summary of S. spinulosa quantities per grab sample site.

Site ID	Abundance of *Sabellaria spinulosa* / 0.1 m^2
ECR_S40	12
ECR_S41	54
ECR_S43	1
ECR_S46	1
ECR_S48	1
ECR_S51	1
ECR_S58	1
WAA_S02	3

Site ID	Abundance of *Sabellaria spinulosa* / 0.1 m^2
WAA_S03	1
WAA_S05	1

Figure 35 ECR_S40 sample before sieving.

Figure 36 ECR_S41 sample before sieving.

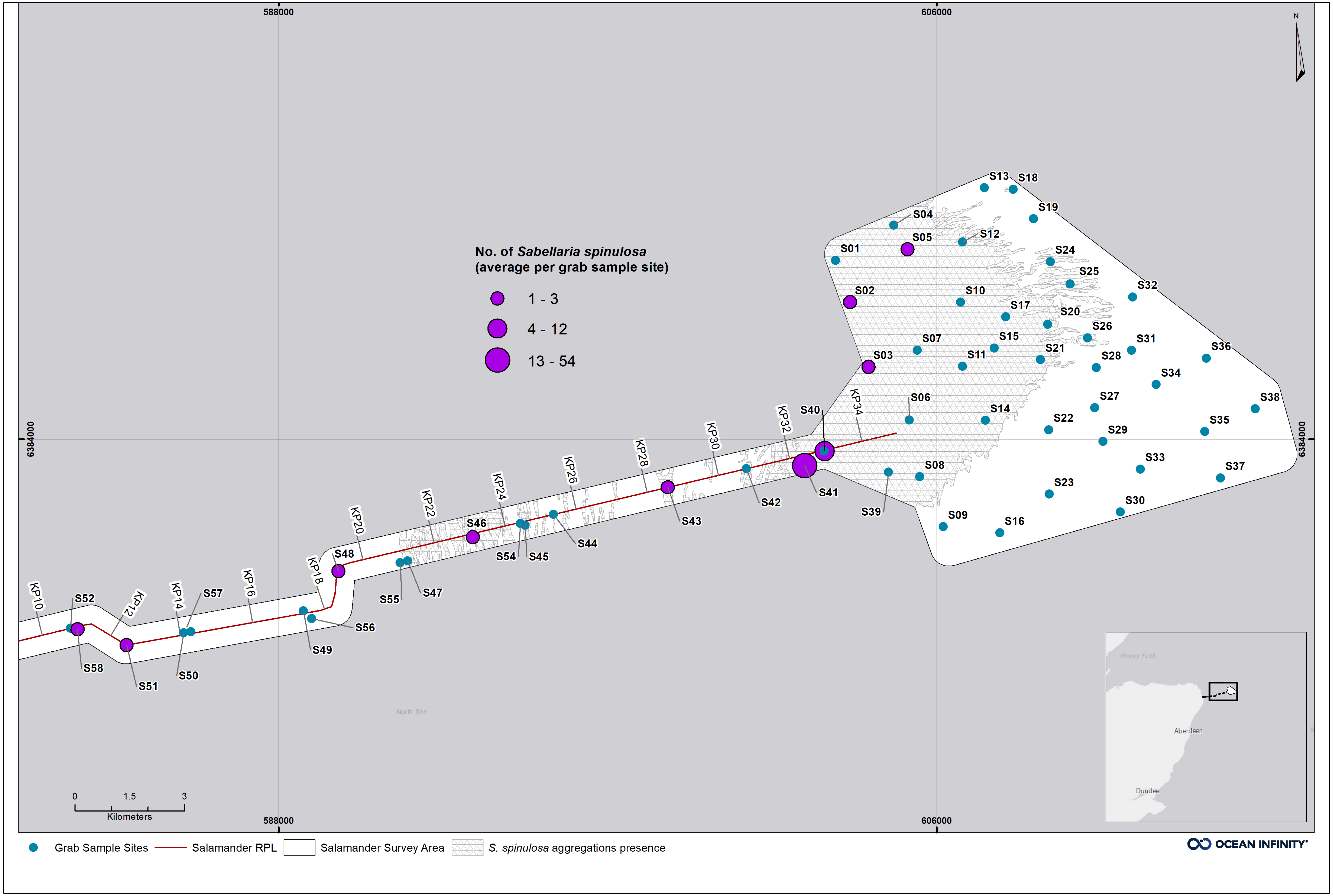


Figure 37 Distribution of S. spinulosa *quantities per grab sample site.*

Sabellaria spinulosa aggregation findings as identified from the stills acquired (expressed per still/per grab site) are summarised in Table 46 and presented in Figure 38. *Sabellaria spinulosa* aggregations were identified at 28 grab sites and ECR_S47, ECR_S49 and ECR_S50 presented the highest average coverage with 76 %, 72 % and 74 % respectively. The spatial distribution of *S. spinulosa* percentage coverage per square meter is further illustrated in Figure 39.

Table 46 Percentage coverage per square meter of S. spinulosa from grab site stills, with avg coverage and SD.

Site ID	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6	Image 7	AVG	SD
WAA_S02	0	0	0	3	19	1	0	3	7
WAA_S03	2	0	0	0	0	0	0	0	1
WAA_S04	0	0	3	0	1	0	0	1	1
WAA_S05	0	2	0	6	0	0	0	1	2
WAA_S06	11	0	0	0	1	0	29	6	11
WAA_S08	0	5	8	0	0	0	0	2	3
WAA_S10	5	0	0	0	0	0	0	1	2
WAA_S11	0	0	15	0	0	0	1	2	6
WAA_S12	14	0	39	0	0	22	0	11	15
WAA_S14	0	0	0	0	0	0	3	0	1
WAA_S15	0	0	0	0	0	0	13	2	5
WAA_S17	2	0	4	0	1	0	0	1	2
WAA_S20	0	0	48	0	9	0	0	8	18
WAA_S21	0	0	0	11	0	0	0	2	4
WAA_S24	0	0	0	0	0	10	0	1	4
WAA_S25	0	0	29	0	2	19	3	8	12
WAA_S26	0	20	0	4	0	0	3	4	7
ECR_S39	1	15	0	0	0	45	1	9	17
ECR_S40	0	21	3	1	13	10	0	7	8
ECR_S41	21	13	5	0	12	0	0	7	8
ECR_S43	7	1	2	0	3	2	21	5	7
ECR_S44	0	6	0	0	0	0	4	1	3
ECR_S45	94	64	47	38	19	3	16	40	31
ECR_S47	58	88	72	76	56	84	96	76	15
ECR_S49	51	57	77	79	79	96	63	72	16
ECR_S50	91	91	42	38	83	84	87	74	23
ECR_S51	0	0	0	6	0	0	1	1	2
ECR_S52	18	3	88	89	91	12	83	55	41

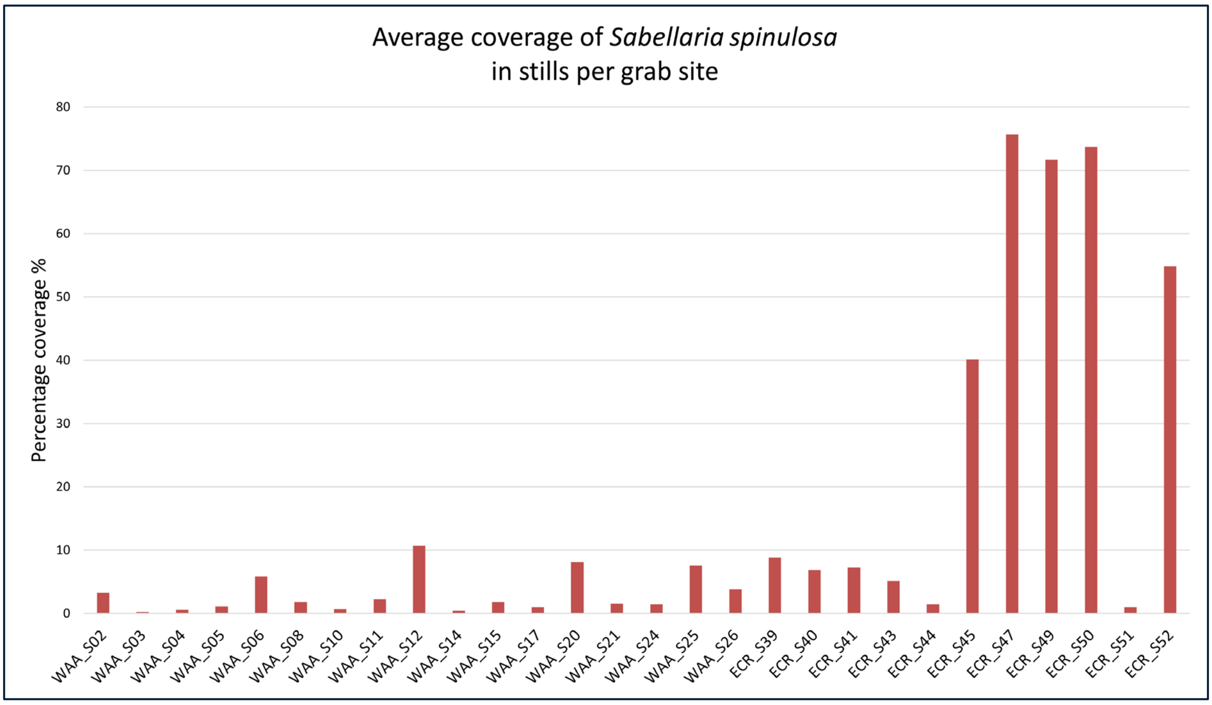


Figure 38 Average percentage coverage per m² of S. spinulosa from stills.

The presence of *S. spinulosa* aggregations was identified in stills acquired at 28 sites: WAA_S02, WAA_S03 to WAA_S06, WAA_S08, WAA_S10 to WAA_S12, WAA_S14, WAA_S15, WAA_S17, WAA_S20, WAA_S21, WAA_S24, WAA_S25, WAA_S26, ECR_S39, ECR_S40, ECR_S41, ECR_S43, ECR_S44, ECR_S45, ECR_S47, ECR_S49, ECR_S50, ECR_S51, ECR_S52.

Visibility in the video and stills was generally good. Example stills of identified *S. spinulosa* are presented in Table 47 to Table 52.

Table 47 Example stills from WAA_S06.

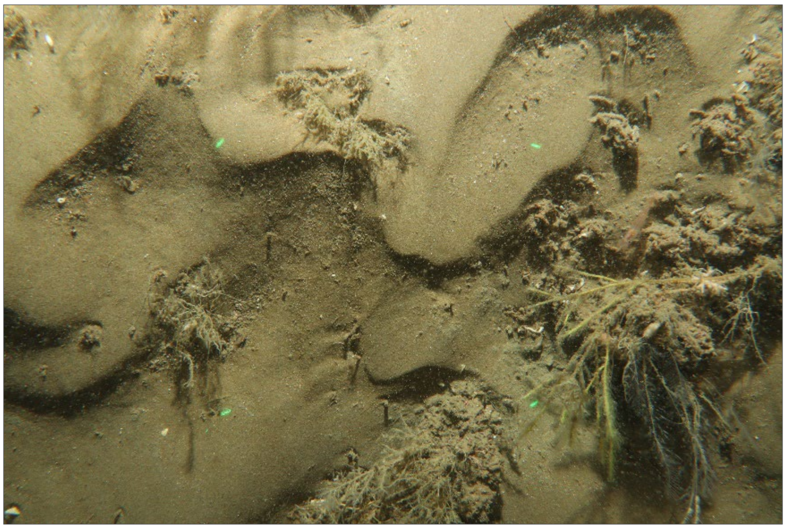
 *WAA_S06_001.*	 *WAA_S06_005.*  *WAA_S06_007.*

Table 48 Example stills from WAA_S12.

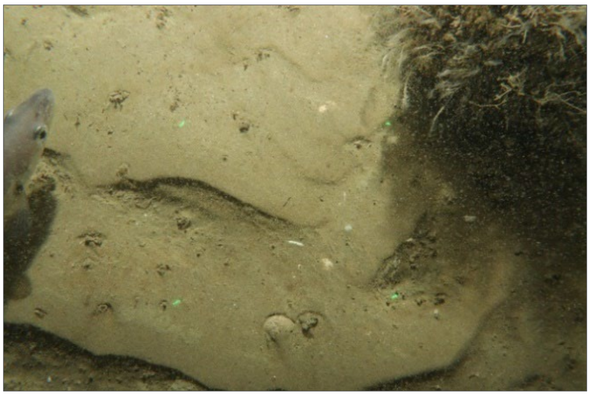
WAA_S12_001.

WAA_S12_003.

WAA_S12_006.

Table 49 Example stills from WAA_S20.

WAA_S20_003.



WAA_S20_005.

Table 50 Example stills from WAA_S25.

WAA_S25_003.

WAA_S25_006.

WAA_S25_007.

Table 51 Example stills from WAA_S26.

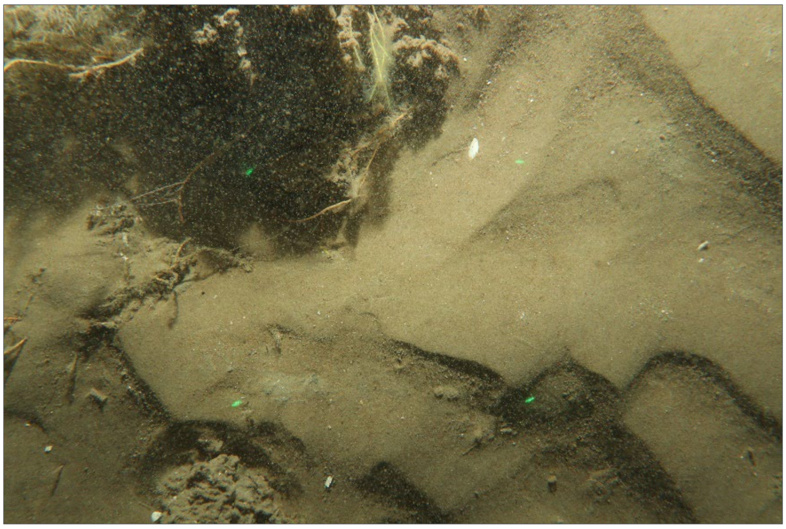
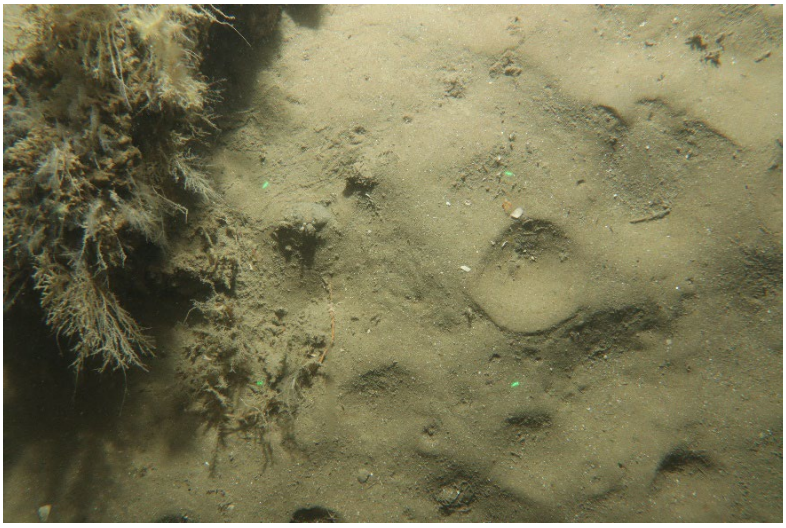
 *WAA_S26_002.*	 *WAA_S26_004.*  *WAA_S26_007.*

Table 52 Example stills from ECR_S39.

 *ECR_S39_002.*	 *ECR_S39_004.*  *ECR_S39_007.*

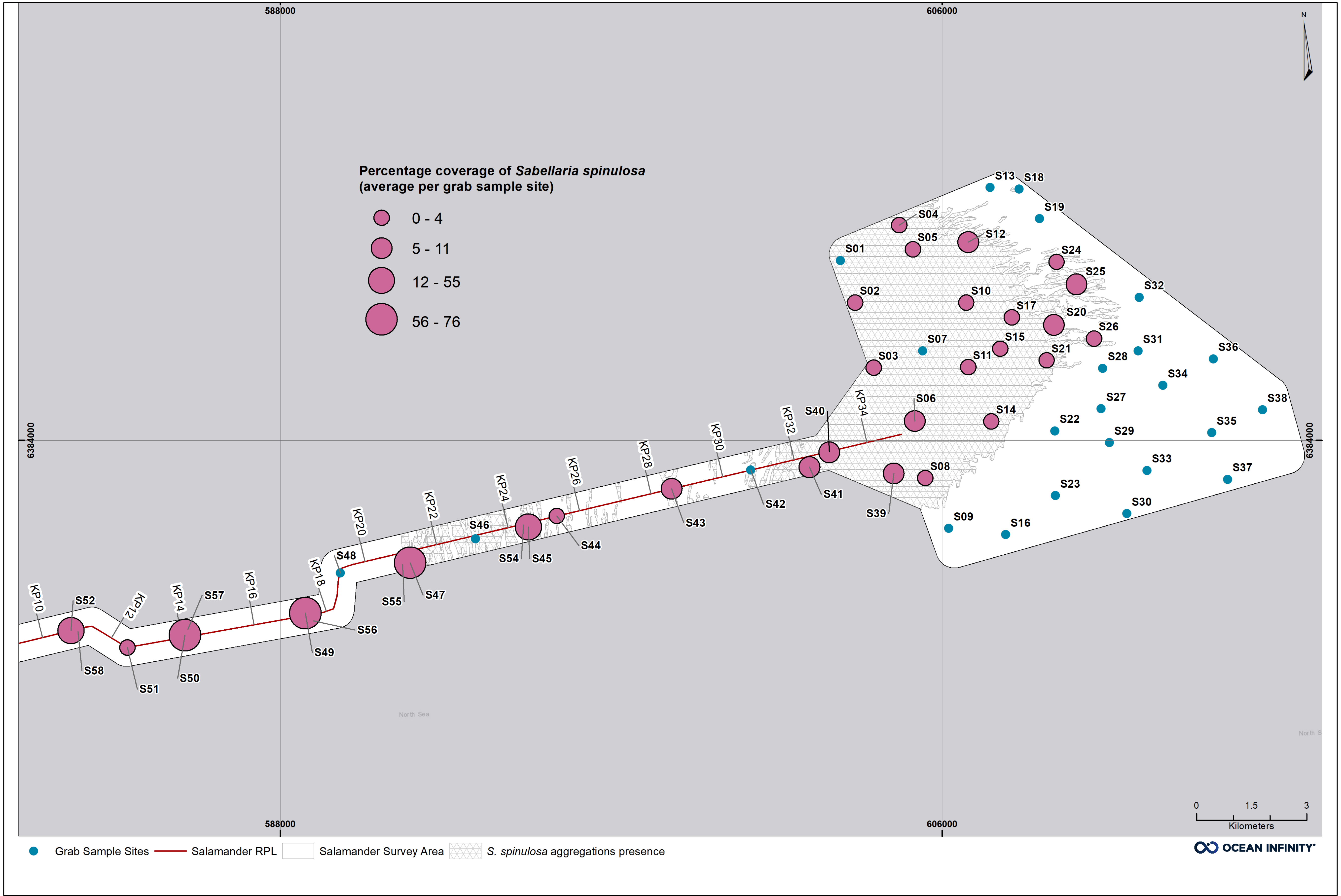


Figure 39 Distribution of S. spinulosa *percentage coverage per square meter.*

Each acquired still image, where *S. spinulosa* aggregations were noted present, were assessed on an individual level against the qualifying criteria in addition to a collective assessment for each site. The assessment is further exemplified in Table 54 and the detailed results are listed in Table 55. The table includes Image ID, Elevation, Patchiness, Area and Final 'reefiness' for all images where S. spinulosa aggregations are present.

A short summary is presented below:

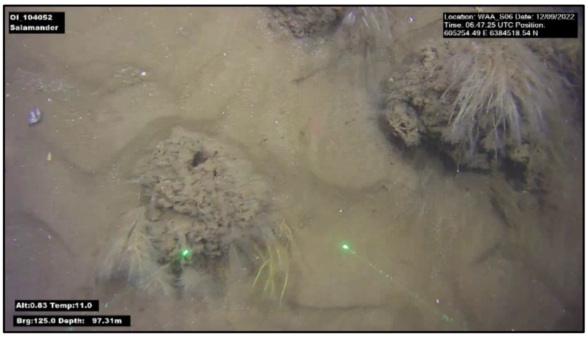
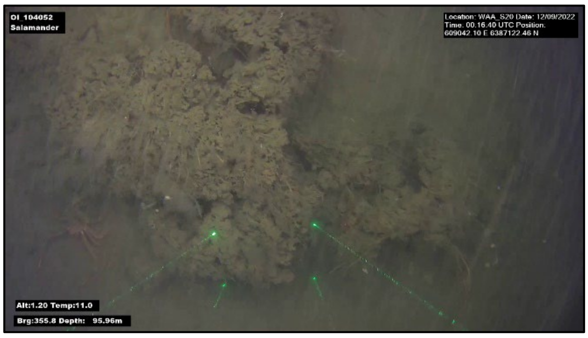
Sites: WAA_S02, WAA_S11, WAA_S15, WAA_S24, ECR_S40, ECR_S41, ECR_S43, and ECR_S45 comprise individual stills which were assessed to meet the criteria of Annex I (1170) – Biogenic Reef of Low 'reefiness'.

Sites: WAA_S06, WAA_S12, WAA_S20, WAA_S25, WAA_S26, and ECR_S39 comprise individual stills which were assessed to meet the criteria of Annex I (1170) – Biogenic Reef of Medium 'reefiness'.

Sites: WAA_S03, WAA_S04, WAA_S05, WAA_S08, WAA_S10, WAA_S14, WAA_S17, WAA_S21, ECR_S44, ECR_S47, ECR_S49, ECR_S50, ECR_S51, ECR_S52 comprise individual stills which were assessed to meet the criteria of Potential Annex I (1170) – Biogenic Reef.

Review of the video and high-resolution acoustic data shows high patchiness of 'Bommies', a new sub-type *S. spinulosa* reefs. This sub type forms in fine mobile sediments (Pearce, 2020) with a distance between each patch often exceeding 1 metre. Example images of 'Bommies' noted at sites WAA_S06 and WAA_S20 are presented in Table 53.

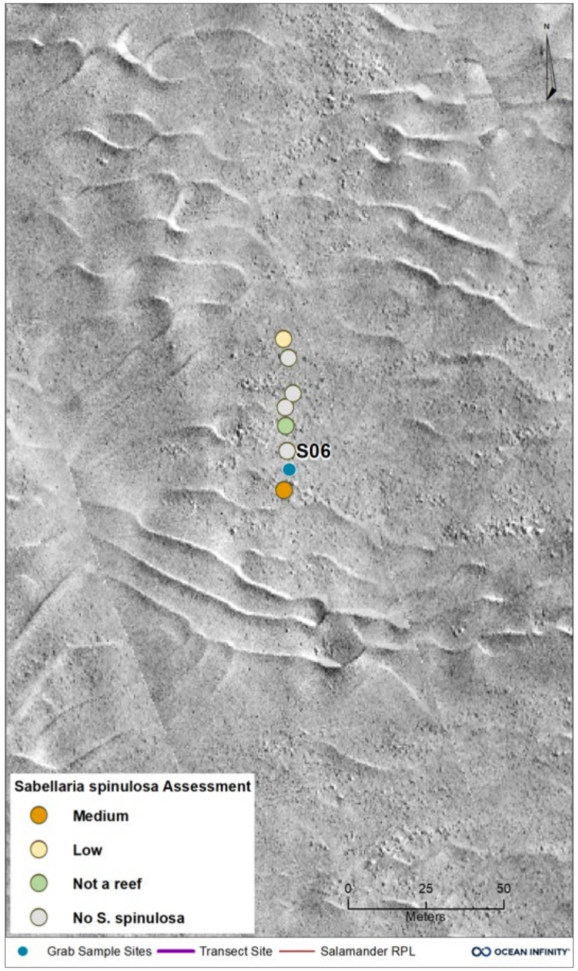
Table 53 Example screen shots from video of 'Bommies'.

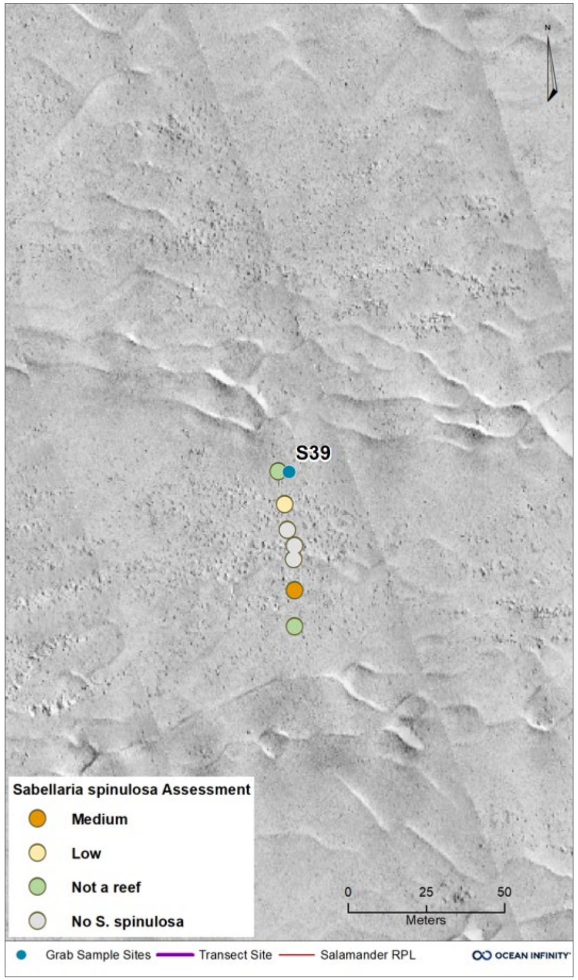
 WAA_S06	 WAA_S20

The collective assessment of data from each site concluded that none of the ground-truthed sites qualify as Annex I (1170) – Biogenic Reefs mainly due to a lack of sufficient extent. Areas comprising *S. spinulosa* aggregations have been delineated based on presence and the spatial distribution is presented in Figure 40 - Figure 42.

Note: The stills were acquired along a linear transect centred on the grab sample site. However, due to the scale of the overview maps in Figure 40 - Figure 42 and due to the dense interval at which images were acquired, the symbols are plotted in a ring as an alternative. This was done to illustrate and present the outcome and distribution of each individual assessment more easily.

Table 54 Example of S. spinulosa assessment per grab sample site/ per still acquired.





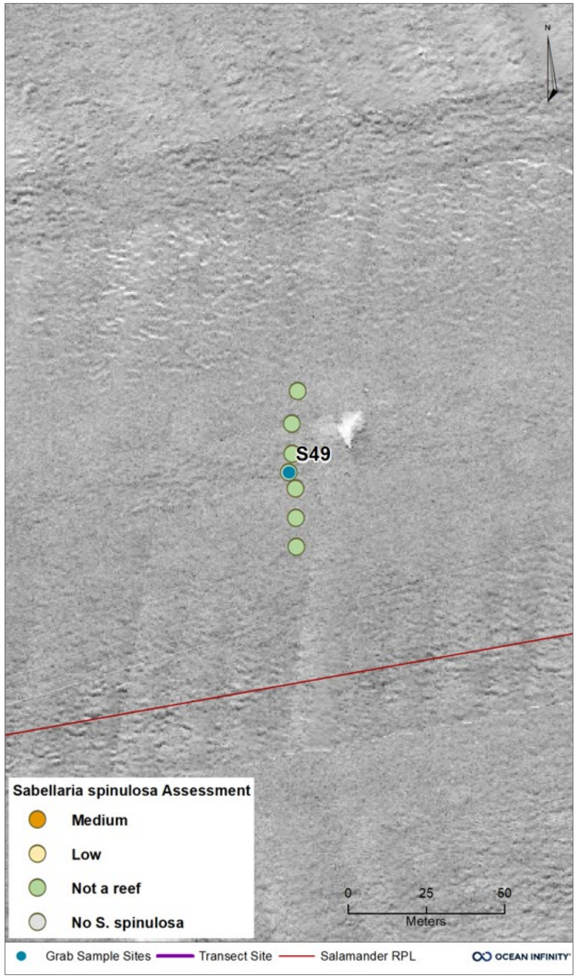


Table 55 Sabellaria spinulosa 'reefiness' assessment.

Transect ID	Image ID	Elevation	Patchiness	Area	Final 'Reefiness'
WAA_S02	WAA S02 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S02	WAA S02 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S02	WAA S02 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S02	WAA S02 004	Not a reef	Not a reef	High	Not a reef
WAA_S02	WAA S02 005	Low	Low	High	Low
WAA_S02	WAA S02 006	Not a reef	Not a reef	High	Not a reef
WAA_S02	WAA S02 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S03	WAA S03 001	Not a reef	Not a reef	High	Not a reef
WAA_S03	WAA S03 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S03	WAA S03 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S03	WAA S03 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S03	WAA S03 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S03	WAA S03 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S03	WAA S03 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S04	WAA S04 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S04	WAA S04 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S04	WAA S04 003	Low	Not a reef	High	Not a reef
WAA_S04	WAA S04 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S04	WAA S04 005	Not a reef	Not a reef	High	Not a reef
WAA_S04	WAA S04 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S04	WAA S04 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S05	WAA S05 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S05	WAA S05 002	Low	Not a reef	High	Not a reef
WAA_S05	WAA S05 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S05	WAA S05 004	Low	Not a reef	High	Not a reef
WAA_S05	WAA S05 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S05	WAA S05 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S05	WAA S05 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S06	WAA S06 001	Low	Low	High	Low
WAA_S06	WAA S06 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S06	WAA S06 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S06	WAA S06 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S06	WAA S06 005	Low	Not a reef	High	Not a reef
WAA_S06	WAA S06 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*

Transect ID	Image ID	Elevation	Patchiness	Area	Final 'Reefiness'
WAA_S06	WAA S06 007	Medium	Medium	High	Medium
WAA_S08	WAA S08 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S08	WAA S08 002	Medium	Not a reef	High	Not a reef
WAA_S08	WAA S08 003	Low	Not a reef	High	Not a reef
WAA_S08	WAA S08 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S08	WAA S08 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S08	WAA S08 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S08	WAA S08 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S10	WAA S10 001	Low	Not a reef	High	Not a reef
WAA_S10	WAA S10 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S10	WAA S10 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S10	WAA S10 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S10	WAA S10 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S10	WAA S10 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S10	WAA S10 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S11	WAA S11 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S11	WAA S11 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S11	WAA S11 003	Medium	Low	High	Low
WAA_S11	WAA S11 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S11	WAA S11 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S11	WAA S11 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S11	WAA S11 007	Low	Not a reef	High	Not a reef
WAA_S12	WAA S12 001	Medium	Low	High	Low
WAA_S12	WAA S12 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S12	WAA S12 003	Medium	High	High	Medium
WAA_S12	WAA S12 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S12	WAA S12 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S12	WAA S12 006	Medium	Medium	High	Medium
WAA_S12	WAA S12 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S14	WAA S14 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S14	WAA S14 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S14	WAA S14 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S14	WAA S14 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S14	WAA S14 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*

Transect ID	Image ID	Elevation	Patchiness	Area	Final 'Reefiness'
WAA_S14	WAA S14 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S14	WAA S14 007	Medium	Not a reef	High	Not a reef
WAA_S15	WAA S15 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S15	WAA S15 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S15	WAA S15 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S15	WAA S15 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S15	WAA S15 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S15	WAA S15 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S15	WAA S15 007	Medium	Low	High	Low
WAA_S17	WAA S17 001	Low	Not a reef	High	Not a reef
WAA_S17	WAA S17 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S17	WAA S17 003	Low	Not a reef	High	Not a reef
WAA_S17	WAA S17 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S17	WAA S17 005	Not a reef	Not a reef	High	Not a reef
WAA_S17	WAA S17 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S17	WAA S17 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S20	WAA S20 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S20	WAA S20 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S20	WAA S20 003	Medium	High	High	Medium
WAA_S20	WAA S20 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S20	WAA S20 005	Medium	Not a reef	High	Not a reef
WAA_S20	WAA S20 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S20	WAA S20 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S21	WAA S21 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S21	WAA S21 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S21	WAA S21 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S21	WAA S21 004	Not a reef	Low	High	Not a reef
WAA_S21	WAA S21 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S21	WAA S21 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S21	WAA S21 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S24	WAA S24 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S24	WAA S24 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S24	WAA S24 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S24	WAA S24 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*

Transect ID	Image ID	Elevation	Patchiness	Area	Final 'Reefiness'
WAA_S24	WAA S24 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S24	WAA S24 006	Low	Low	Medium	Low
WAA_S24	WAA S24 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S25	WAA S25 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S25	WAA S25 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S25	WAA S25 003	Medium	Medium	Medium	Medium
WAA_S25	WAA S25 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S25	WAA S25 005	Low	Not a reef	Medium	Not a reef
WAA_S25	WAA S25 006	Low	Low	Medium	Low
WAA_S25	WAA S25 007	Low	Not a reef	Medium	Not a reef
WAA_S26	WAA S26 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S26	WAA S26 002	Medium	Medium	Medium	Medium
WAA_S26	WAA S26 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S26	WAA S26 004	Low	Not a reef	Medium	Not a reef
WAA_S26	WAA S26 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S26	WAA S26 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
WAA_S26	WAA S26 007	Low	Not a reef	Medium	Not a reef
ECR_S39	ECR S39 001	Not a reef	Not a reef	High	Not a reef
ECR_S39	ECR S39 002	Medium	Low	High	Low
ECR_S39	ECR S39 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S39	ECR S39 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S39	ECR S39 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S39	ECR S39 006	Medium	High	High	Medium
ECR_S39	ECR S39 007	Not a reef	Not a reef	High	Not a reef
ECR_S40	ECR S40 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S40	ECR S40 002	Low	Medium	High	Low
ECR_S40	ECR S40 003	Not a reef	Not a reef	High	Not a reef
ECR_S40	ECR S40 004	Not a reef	Not a reef	High	Not a reef
ECR_S40	ECR S40 005	Low	Low	High	Low
ECR_S40	ECR S40 006	Low	Low	High	Low
ECR_S40	ECR S40 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S41	ECR S41 001	Low	Medium	Medium	Low
ECR_S41	ECR S41 002	Low	Low	Medium	Low
ECR_S41	ECR S41 003	Low	Not a reef	Medium	Not a reef

Transect ID	Image ID	Elevation	Patchiness	Area	Final 'Reefiness'
ECR_S41	ECR S41 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S41	ECR S41 005	Not a reef	Low	Medium	Not a reef
ECR_S41	ECR S41 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S41	ECR S41 007	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S43	ECR S43 001	Not a reef	Not a reef	Medium	Not a reef
ECR_S43	ECR S43 002	Not a reef	Not a reef	Medium	Not a reef
ECR_S43	ECR S43 003	Not a reef	Not a reef	Medium	Not a reef
ECR_S43	ECR S43 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S43	ECR S43 005	Not a reef	Not a reef	Medium	Not a reef
ECR_S43	ECR S43 006	Not a reef	Not a reef	Medium	Not a reef
ECR_S43	ECR S43 007	Low	Medium	Medium	Low
ECR_S44	ECR S44 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S44	ECR S44 002	Low	Not a reef	Low	Not a reef
ECR_S44	ECR S44 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S44	ECR S44 004	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S44	ECR S44 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S44	ECR S44 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S44	ECR S44 007	Low	Not a reef	Low	Not a reef
ECR_S45	ECR S45 001	Not a reef	High	Medium	Not a reef
ECR_S45	ECR S45 002	Not a reef	High	Medium	Not a reef
ECR_S45	ECR S45 003	Low	High	Medium	Low
ECR_S45	ECR S45 004	Low	High	Medium	Low
ECR_S45	ECR S45 005	Not a reef	Low	Medium	Not a reef
ECR_S45	ECR S45 006	Not a reef	Not a reef	Medium	Not a reef
ECR_S45	ECR S45 007	Not a reef	Low	Medium	Not a reef
ECR_S47	ECR S47 001	Not a reef	High	Medium	Not a reef
ECR_S47	ECR S47 002	Not a reef	High	Medium	Not a reef
ECR_S47	ECR S47 003	Not a reef	High	Medium	Not a reef
ECR_S47	ECR S47 004	Not a reef	High	Medium	Not a reef
ECR_S47	ECR S47 005	Not a reef	High	Medium	Not a reef
ECR_S47	ECR S47 006	Not a reef	High	Medium	Not a reef
ECR_S47	ECR S47 007	Not a reef	High	Medium	Not a reef
ECR_S49	ECR S49 001	Not a reef	High	High	Not a reef
ECR_S49	ECR S49 002	Not a reef	High	High	Not a reef

Transect ID	Image ID	Elevation	Patchiness	Area	Final 'Reefiness'
ECR_S49	ECR S49 003	Not a reef	High	High	Not a reef
ECR_S49	ECR S49 004	Not a reef	High	High	Not a reef
ECR_S49	ECR S49 005	Not a reef	High	High	Not a reef
ECR_S49	ECR S49 006	Not a reef	High	High	Not a reef
ECR_S49	ECR S49 007	Not a reef	High	High	Not a reef
ECR_S50	ECR S50 001	Not a reef	High	Medium	Not a reef
ECR_S50	ECR S50 002	Not a reef	High	Medium	Not a reef
ECR_S50	ECR S50 003	Not a reef	High	Medium	Not a reef
ECR_S50	ECR S50 004	Not a reef	High	Medium	Not a reef
ECR_S50	ECR S50 005	Not a reef	High	Medium	Not a reef
ECR_S50	ECR S50 006	Not a reef	High	Medium	Not a reef
ECR_S50	ECR S50 007	Not a reef	High	Medium	Not a reef
ECR_S51	ECR S51 001	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S51	ECR S51 002	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S51	ECR S51 003	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S51	ECR S51 004	Not a reef	Not a reef	Medium	Not a reef
ECR_S51	ECR S51 005	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S51	ECR S51 006	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*	No *S. spinulosa*
ECR_S51	ECR S51 007	Not a reef	Not a reef	Medium	Not a reef
ECR_S52	ECR S52 001	Not a reef	Low	High	Not a reef
ECR_S52	ECR S52 002	Not a reef	Not a reef	High	Not a reef
ECR_S52	ECR S52 003	Not a reef	High	High	Not a reef
ECR_S52	ECR S52 004	Not a reef	High	High	Not a reef
ECR_S52	ECR S52 005	Not a reef	High	High	Not a reef
ECR_S52	ECR S52 006	Not a reef	Low	High	Not a reef
ECR_S52	ECR S52 007	Not a reef	High	High	Not a reef

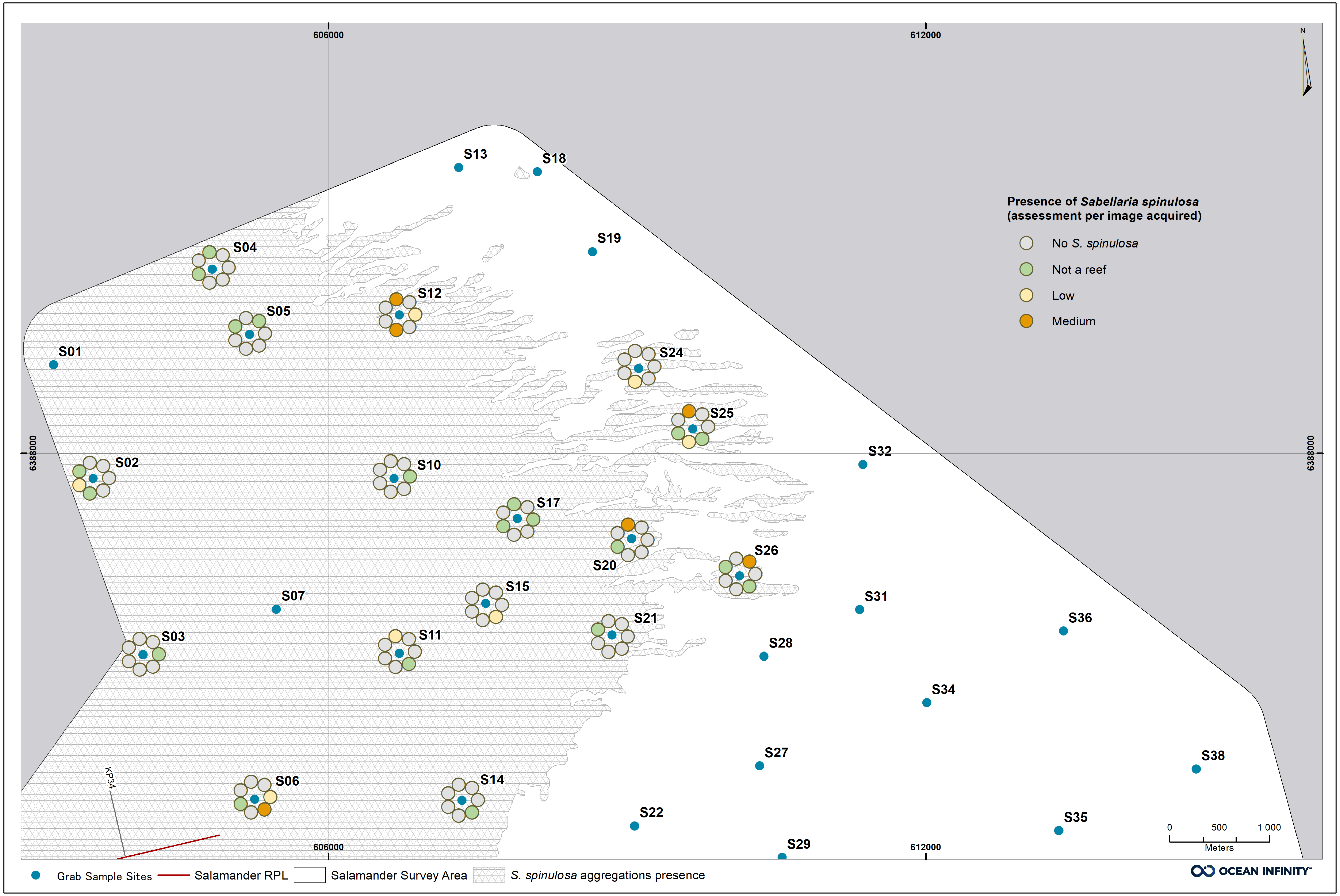


Figure 40 Distribution of individual stills with S. spinulosa reefiness assessment within the WAA.

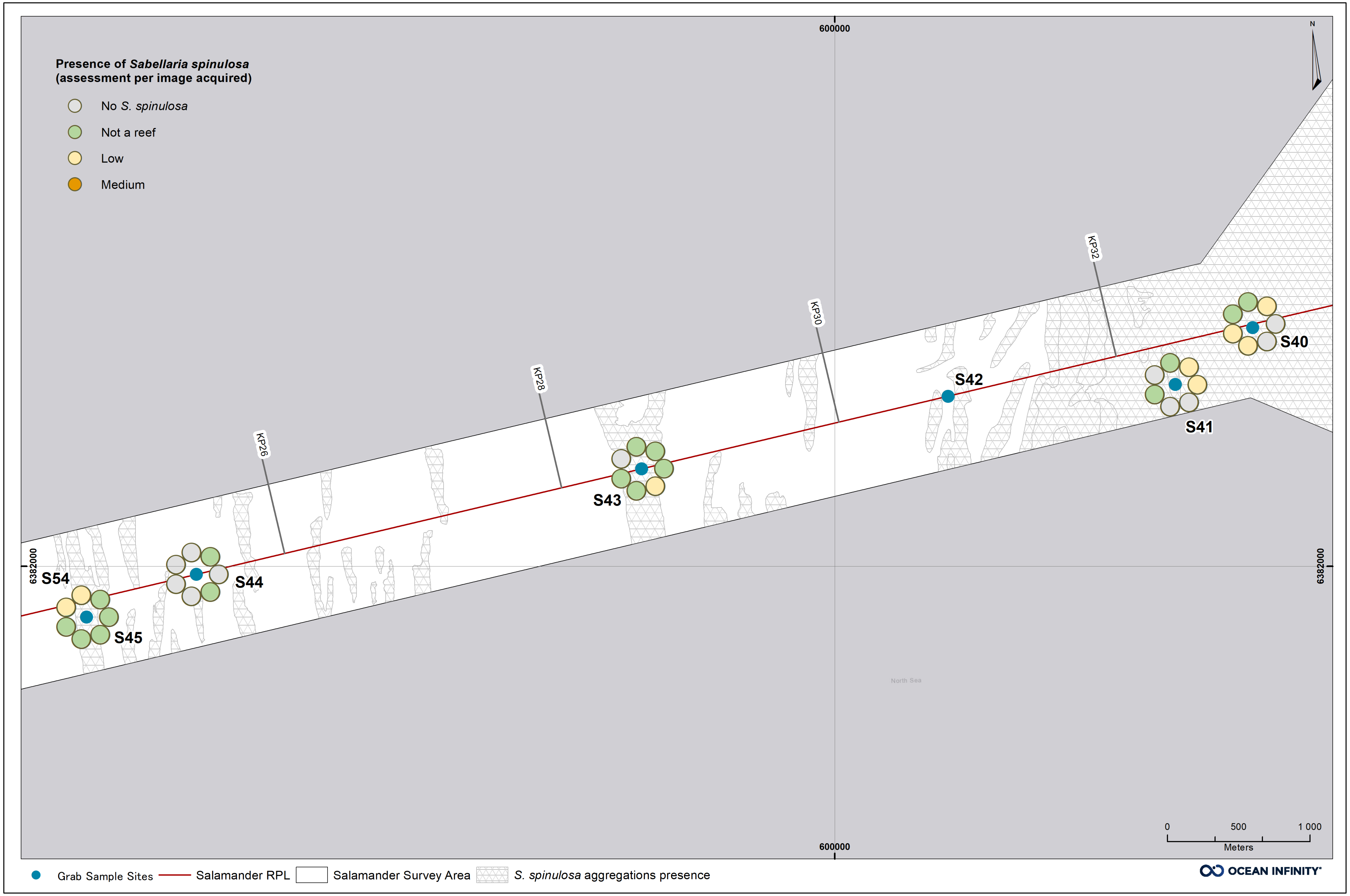


Figure 41 Distribution of individual stills with S. spinulosa reefiness assessment within the ECR, east.

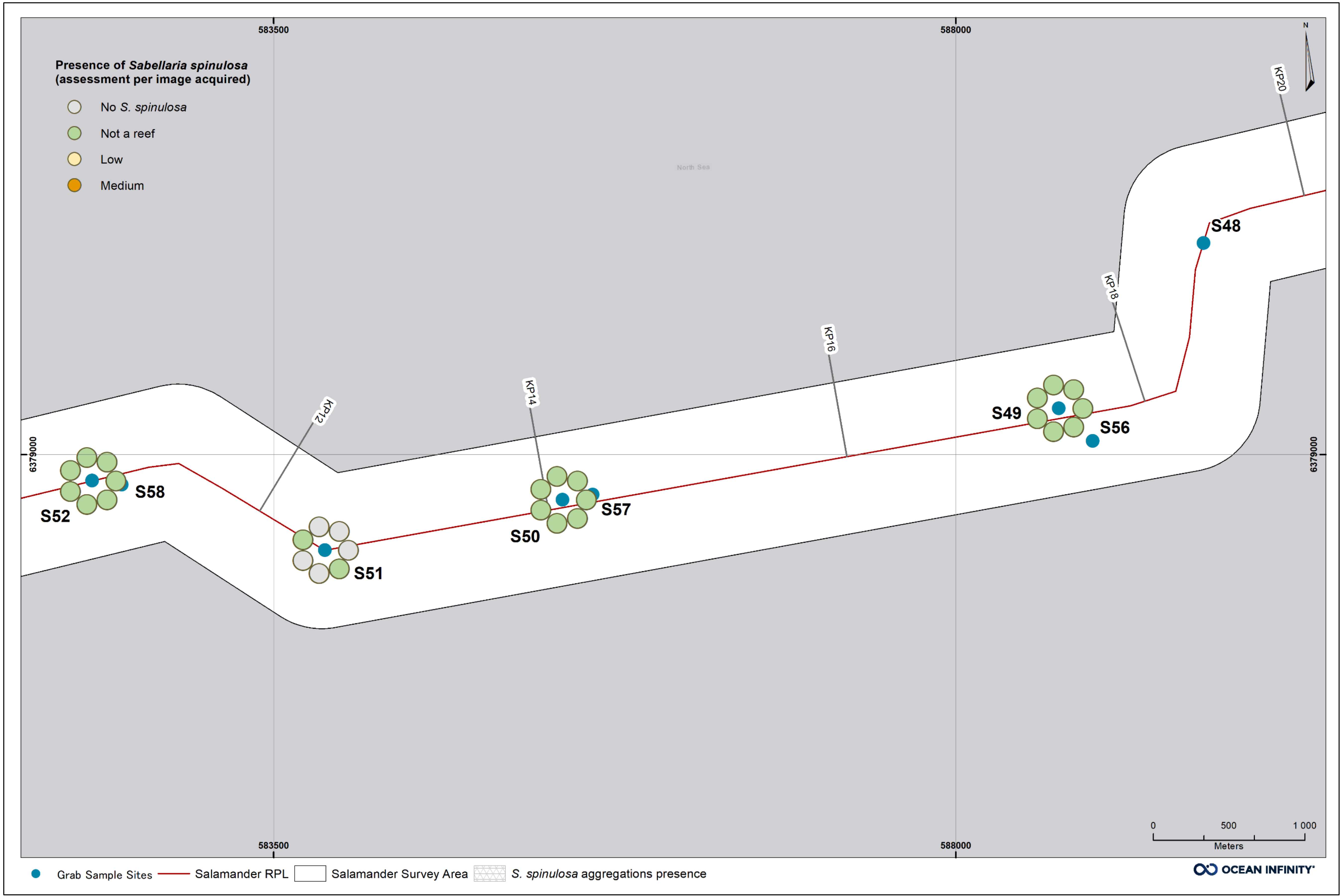


Figure 42 Distribution of individual stills with S. spinulosa reefiness assessment within the ECR, west.

5.8.3 Offshore Subtidal Sands and Gravels

The habitats PMF habitat Offshore Subtidal Sands and Gravels as well as the SBL habitat Subtidal sands and gravels were identified across parts of the survey area (Tyler-Walters, et al., 2016; SBL, 2009). It is the most common subtidal habitat around the British Isles and includes a wide variety of sediments across a wide depth range. All subtype habitats of **MC32** - Atlantic circalittoral coarse sediment and **MC52** - Atlantic circalittoral sand including habitat complexes where such habitats are included have been interpreted to qualify as Subtidal Sands and Gravels.

5.8.4 Notable Taxa

Invasive and Non-Native Taxa

No invasive or non-native species were identified with the ECR and WAA samples.

Rarely Recorded Taxa

Three (3) rarely recorded species were identified in the grab samples (Table 56). The three species identified were all molluscs: *Ceratia proxima, Euspira fusca* and *Jordaniella trunculata*.

Table 56 Species rarely recorded in the UK identified during the survey.

Rarely Recorded	Sample Site	Abundance / 0.1m^2
Ceratia proxima	WAA_S13	1
Euspira fusca	WAA_S37	1
Jordaniella truncatula	ECR_S41	1

Sandeels (PMF & SBL)

Sandeel *Ammodytes* sp. is a taxon of commercial importance as well as a PMF and SBL (Tyler-Walters, et al., 2016; SBL, 2009) listed species. A total of nine (9) individual specimens were identified at four (4) grab sample sites; ECR_S48, ECR_S54, ECR_S57 and ECR_S58.

Ocean quahog (PMF & OSPAR)

Ocean quahog *Arctica islandica*, which is generally found in fine sand and muddy substrates throughout the North Sea, is a PMF (Tyler-Walters, et al., 2016), and is considered under threat and/or decline in region II, i.e., the Greater North Sea under OSPAR (OSPAR, 2008).

A total of four (4) individual specimens were identified at four (4) different grab sample sites; WAA_S04, WAA_S30, WAA_S37 and WAA_S38.

Sea-Pen and Burrowing Megafauna (OSPAR) & Burrowed Mud (PMF)

The sea pen *Pennatula phosphorea* was identified in the video and still photos from sample sites WAA_S19, WAA_S28, WAA_S34, WAA_S35, WAA_S36, and WAA_S37. The species is characteristic of the OSPAR habitat Sea-Pen and Burrowing Megafauna, and PMF habitat Burrowed Mud. The absence of frequent burrows or mounds and the absence of other key components such as Norway lobster *Nephrops norvegicus* in addition to the more overall sandy composition of the seabed within the survey area indicates neither of the habitats is present.

Octocorallia (SBL)

Two species of Octocorallia were identified. The first species was *Alcyonium digitatum* identified in the video and stills from sample sites ECR_S40, ECR_S45, ECR_S49, ECR_S50, ECR_T53. The second species was the sea pen

P. phosphorea identified in the video and still photos from sample sites WAA_S19, WAA_S28, WAA_S34, WAA_S35, WAA_S36, and WAA_S37.

6. Discussion

Despite the limited variation in sediment composition, there was a trend with the WAA samples containing more Mud compared to the ECR samples which contained more Gravel. This trend was supported by Mud having a positive correlation (R^2=0.48) with the eastings of the samples, whilst Gravel had a negative correlation (R^2=0.65). It is worth noting that the depth of the samples did correlate with easting (R^2=0.56) but yielded lower R^2-values compared to easting. Sand did not correlate with either easting (R^2=0.02) or depth (R^2=0.00). Silt and Clay, the two sediment fractions comprising Mud, had similar trends and correlations as those found with Mud.

Threshold values were exceeded for arsenic at six (6) sites which all were located along the ECR, with the highest concentrations (19.3 mg/kg) recorded in the sample for the site closest to the coast. When plotting arsenic concentration against the eastings of the samples, a negative correlation (R^2=0.67) was observed, indicating that the sediment closer to the coast has higher concentrations of arsenic compared to the sites located further offshore. Whilst overall higher in the WAA compared to the ECR, neither THC nor Σ16PAH had any strong correlation to sample site eastings, with R^2-values of 0.34 and 0.02, respectively.

The Total Organic Matter (TOM) and Total Organic Carbon (TOC) analyses results indicate a low fraction of TOM and TOC in the sediment at all grab sample sites. TOC levels were within the expected range of surface sediments of 0 – 2 % (Smeaton, Hunt, Turrell, & Austin, 2021). The highest levels of TOM, >= 2 %, was identified at sites WAA_S29 and, highest, at ECR_S44.

Pielou's Evenness index, Shannon-Wiener index, and Simpson's Index of Dominance presented a limited variation, which can be seen in the indices listed in Table 34. Simpson's Index of Dominance presented a mean value close to 1 (0.94) indicating a more evenly species distribution. The standard deviation for Simpson's Index of Dominance presented a significant value (SD=0.04) indicating that data values are reliable and closely clustered around the mean. The low variation seen in the univariate indices listed above could partly be explained by the limited variation in the sediment composition.

The number of taxa and the number of individuals presented notably higher values in ECR_S40 and ECR_S41. These were also the sites that contained the highest abundance (per/ 0.1 m^2) of *S. spinulosa* identified per grab sample site (Table 45).

The SIMPROF analysis produced five (5) statistical groups. These groups were based on grab samples that were spatially relatively close to each other within the survey area (Figure 25), and classified in similar habitats, indicating the possibility of some between-site homogeneity.

The similarity between SIMPROF groups is further reflected in the nMDS-plot where two larger clusters can be identified with 20 % similarity. First cluster (Figure 24) constitutes four (4) groups **b**, **c**, **d** and **e** with a majority of the sites located in the WAA area. This cluster is likely driven by similarities in species composition, substrate and depth range. The second cluster (Figure 24) constituted group **a**, all sites located along the ECR located at a shallower depth range when compared to the WAA sites. A majority of these sites were located in **MC32** - Atlantic circalittoral coarse sediment except for the two sites ECR_S44 and ECR_S46. These two sites were located in the habitat **MC52** - Atlantic circalittoral sand and positioned closer to the second cluster in the nMDS-plot.

SIMPROF group **b** was the only group that contained one site (WAA_S13). Group **b** was separated from the other groups not solely by its habitat, but also by the species composition, which included a greater number of *Harpinia antennaria*. This confirms the results of the SIMPROF analysis and the classification of site WAA_S13 as a separate group. By analysing the nMDS-plot, it is evident that group **b** is closely positioned to cluster group **d** and lies within the 20 % similarity level. Looking at the spatial overview (Figure 25) it is evident that group **b** is located in close proximity to the group **d** sites. This indicates that there are some similarities between group **b** and cluster group **d**.

The main driving variables for the faunal assemblage appears to be Gravel, Arsenic, Mud and Depth, as these variables together constituted the best correlation (0.689) with the macrofaunal distribution in the survey area, which is presented in the multiple variables BEST analysis in Section 5.5.5.

In theory, strongly correlated variables tend to increase or decrease together (Taylor, 1990). The relationship between sediment composition and the faunal communities has long been known (Sanders, 1958). Gravel presented the best correlation both in the single and multiple variables test, emphasising how sediment composition plays a major role in forming faunal communities. Both the single and multiple variables test presented the same four main variables.

The presence of *Sabellaria spinulosa* tube aggregates is widespread throughout both the ECR and the WAA based on the grab sample site data acquired. It is present in sand and coarser sediments with pebbles and cobbles, as well as in areas where the sediment units are more mixed. In areas of coarser sediments *S. spinulosa* tube aggregates are noted only in video and stills. In areas of finer sediments, large tube aggregates were seen in video and stills and on some locations in the side scan sonar data.

Minor clusters of tube aggregations were found after sieving the grab samples, indicating that the mobile sediments in the area had covered them, and the taxonomic analyses results showed the presence of live *S. spinulosa* in ten (10) samples in total. ECR_S40 with 12 individuals and ECR_S41 with 54 individuals. The sites comprising *S. spinulosa* aggregations, showed a high number of taxa and individuals as detailed in Section 5.5. It is not uncommon to find *S. spinulosa* when sampling in areas where *S. spinulosa* is known to be distributed and may be buried beneath sediments (Gubbay, 2007).

The overall health of the aggregations is hard to estimate but the data indicates a highly stressed environment due to the presence of sand waves indicates a highly mobile sediment. The long-clawed porcelain crab *Pisidia longicornis* is commonly found in high abundance at *S. spinulosa* reefs (Fariñas-Franco, et al., 2014) yet no specimens of *P. longicornis* were identified in the samples.

The majority of the sampled sites share components, to a varying degree, of subtypes to **MC521** - Faunal communities of Atlantic circalittoral sand, in different complexes with **MC2211** - *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment, as well as **MC621** - Faunal communities of Atlantic circalittoral mud and **MC421** - Faunal communities of Atlantic circalittoral mixed sediment.

There is minor variation in the sediment composition at the respective sites between areas, as detailed by the PSA results and the species composition is overlapping, with some variation in composition and abundance between the sites.

Each of the grab sample sites was further classified individually and to a higher level where possible. It was deemed most appropriate to present these high-level classifications overlaid on the extrapolated lower-level classifications.

7. Conclusions

A total of 57 grab sample sites and one (1) standalone video transect were surveyed as part of the Benthic Survey for the Salamander Offshore Wind Farm, located approximately 35 km east of Peterhead, Scotland.

The eastern WAA comprised muddy featureless sediment, which transitioned to sandy and mixed sediments in the central and western WAA, with the ECR comprising more complex heterogenic mixed and coarse sediments.

The sediment composition had limited variation across the survey area, with sand being the dominant sediment fraction. The PCA grouped the samples, nearly equally weighted, based on the gravel-to-mud ratio and sand content.

Metal concentrations were generally low, with threshold values exceeded at seven (7) sites, out of which six (6) were due to elevated arsenic levels and one (1) due to elevated cadmium levels. Arsenic levels correlated with distance to shore as sample concentrations decreased with increased eastings of the sample sites. Carbon and organic content generally had limited variation whereas hydrocarbon concentrations were variable, with concentrations of PAHs exceeding threshold values at five (5) sites. Hydrocarbons were generally higher at the WAA sites, but no evident correlation was identified.

The phyletic composition from grab samples, both regarding the total number of taxa and abundance, was dominated by Annelida. The two most abundant taxa were the mollusc *Kurtiella bidentata* and the annelid *Scoloplos armiger*. *K. bidentata* had a total abundance of 203 individuals and occurred in 52 % of the grab samples. *S. armiger* had a total abundance of 154 individuals and occurred in 73 % of the grab samples.

The univariate indices Pielou's Evenness index, Shannon-Wiener index, and Simpson's Index of Dominance had a limited variation, were as Margalef's Richness Index presented a slightly higher variation across the grab samples. The number of taxa and the number of individuals varied between 14 - 68 taxa and 24 - 506 (ind./m^2), respectively per grab sample site. Four key sites were identified when analysing the univariate indices. Grab sample site ECR_S54, identified in habitat **MC32** - Atlantic circalittoral coarse sediment, presented the lowest number of taxa as well as the lowest value of Margalef's Richness Index. Grab sample site ECR_S57, identified in habitat **MC32** - Atlantic circalittoral coarse sediment, presented the lowest value of Shannon-Wiener index as well as Simpson's Index of Dominance. Grab sample site ECR_S41, identified in habitat **MC2211** - *Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment, presented the highest number of taxa, number of individuals and the largest value of Margalef's Richness Index. Grab sample site WAA_S36, identified in habitat **MC62** - Atlantic circalittoral mud, presented the largest values of Pielou's Evenness index and Simpson's Index of Dominance.

The SIMPROF analysis of the non-colonial faunal composition produced five (5) statistically distinct groups. The sample similarity explored in the nMDS-plot presented a stress value of 0.15.

In the results of the BEST analysis limited to a single variable, Gravel was the most distinguished variable with a global correlation (σ) of 0.649 and was the statistically significant variable for the distribution of the biological data. The strength of this correlation is considered moderate (Taylor, 1990).

In the results of the BEST analysis using multiple variables, Depth, Arsenic, Gravel and Mud together were the most distinguished variables with a global correlation (σ) of 0.689 and were statistically significant variables for the distribution of the biological data. The strength of this correlation is considered high (Taylor, 1990).

Bryozoa followed by Cnidaria, had the highest frequency of occurrence and presented the highest number of different taxa in the sessile colonial epifauna. The biomass was dominated by Mollusca with 48 % of the total biomass, followed by Echinodermata with 29 %. The total non-colonial fauna biomass varied between 0.2143 (g/0.1 m^2) in sample WAA_S30, to 21.3083 (g/0.1 m^2) in sample WAA_S34. The mean biomass across all sites was 2.9884 (g/0.1 m^2) (SD=4.5452).

Grab sampling site ECR_S52 presented the highest number of taxa from the analysis of the stills, with a total of 30 different taxa.

The most abundant phyla of non-colonial fauna were Arthropoda with 33 %, followed by Cnidaria and Annelida with 22 % and 19 %, respectively. The sand mason worm, *L. conchilega* was the overall most frequently occurring taxa, with the frequency of 59 % per site and 16 % per still.

The average density of non-colonial fauna varied from zero (0) (ind./m^2) at grab sample sites WAA_S23, WAA_S27 and WAA_S31 to 50 (ind./m^2) at grab sample site ECR_S52. The average non-colonial fauna abundance per grab sample site still was ten (10) (SD=10) (ind./m^2).

Annelida represented the phylum with taxa covering the largest surface area, with 87 %. Cnidaria and Bryozoa contributed 10 % and 3 % of the recorded taxa in stills, respectively, followed by Porifera with <1 %.

Hydrozoa was the most frequently occurring colonial taxa identified per site, with the frequency of 60 % and occurred in 35 sites. *S. spinulosa* was the most frequently occurring taxa per still, with the frequency of 22 % and occurred in a total of 93 stills. The average coverage of colonial fauna from stills varied from 0 % to 78 % (ECR_S47). The average cover of fauna was 8.08 % (SD= 19.9). The average percentage coverage was overall highest along the ECR sites compared to the WAA sites and Annelida was the dominating phylum in a majority of the sites.

A total of six (6) broad scale habitats, including one (1) habitat complex were identified within the survey area. Additionally, taxonomic assemblages from the acquired grab sample data further indicates the presence of 11 species-specific habitats, including seven (7) habitat complexes. One PMF habitat, Offshore subtidal sands and gravels, and one SBL habitat, Subtidal sands and gravels, were also noted present. Although *S. spinulosa* aggregations are frequently present along the ECR and throughout the WAA, the low elevation combined with the high patchiness, none of the ground-truthed sites qualify as Annex I (1170) – Biogenic Reefs.

Three taxa of conservation value were identified within the survey area. These were sandeel *Ammodytes* sp., identified at four (4) sites in the ECR, ocean quahog *A. islandica*, identified at four (4) sites in the WAA and sea pen *Pennatula phosphorea* identified at six (6) sites in the ECR.

8. Reservations

The results in this report are based on the data derived from the faunal grab sampling and still imagery data together with sediment and contaminant analyses from each sample site investigated within this survey, together with interpretations of geophysical data obtained during the geophysical survey conducted in conjunction with the benthic survey. It should be considered that there is a natural limitation in the accuracy of interpretation. Where considered applicable, the sampling results have been extrapolated to constitute a base for verifications also in the surroundings.

The definition of a "Reef" is not defined within the EC Habitats Directive. Areas interpreted as stony reefs in this report are based on methods defined in the JNCC Reports No. 432 "The identification of the main characteristics of stony reef habitats under the Habitats Directive" (Irving, 2009) and JNCC Report No. 656 "Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef" (Golding, Albrecht, & McBreen, 2020).

The JNCC Report No. 405 "Defining and managing *Sabellaria spinulosa* reefs: Report of an inter-agency workshop1-2 May" (Gubbay, 2007), presents methods for defining *S. spinulosa* reef structures and setting different criteria to assess the quality of the reef. The report stated the following as the baseline for the definition of *S. spinulosa* reefs:

"The simplest definition of Sabellaria spinulosa reef in the context of the Habitats Directive was considered to be an area of Sabellaria spinulosa which is elevated from the seabed and has a large spatial extent. Colonies may be patchy within an area defined as reef and show a range of elevations."

A number of evaluation criteria were agreed upon in this report to be considered as "a starting point for wider discussion rather than accepted and fully agreed thresholds for *Sabellaria spinulosa* reef identification" (Gubbay, 2007).

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Appendix A Geophysical Overview of Sample Locations

Appendix B Sample Position List

Appendix C Environmental Field Report

Appendix D Photo Identification Results

Appendix E Grab Identification Results

Appendix F Particle Size Analysis Results

Appendix G Chemical Analyses Results

Appendix H GIS Database