DOGGER BANK D WIND FARM

Preliminary Environmental Information Report

Volume 2
Appendix 10.3 Benthic Ecology Baseline Characterisation Report (Part 1 of 6)

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Dogger Bank D 2024 Benthic Survey

Dogger Bank D 2024
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Benthic Characterisation Report
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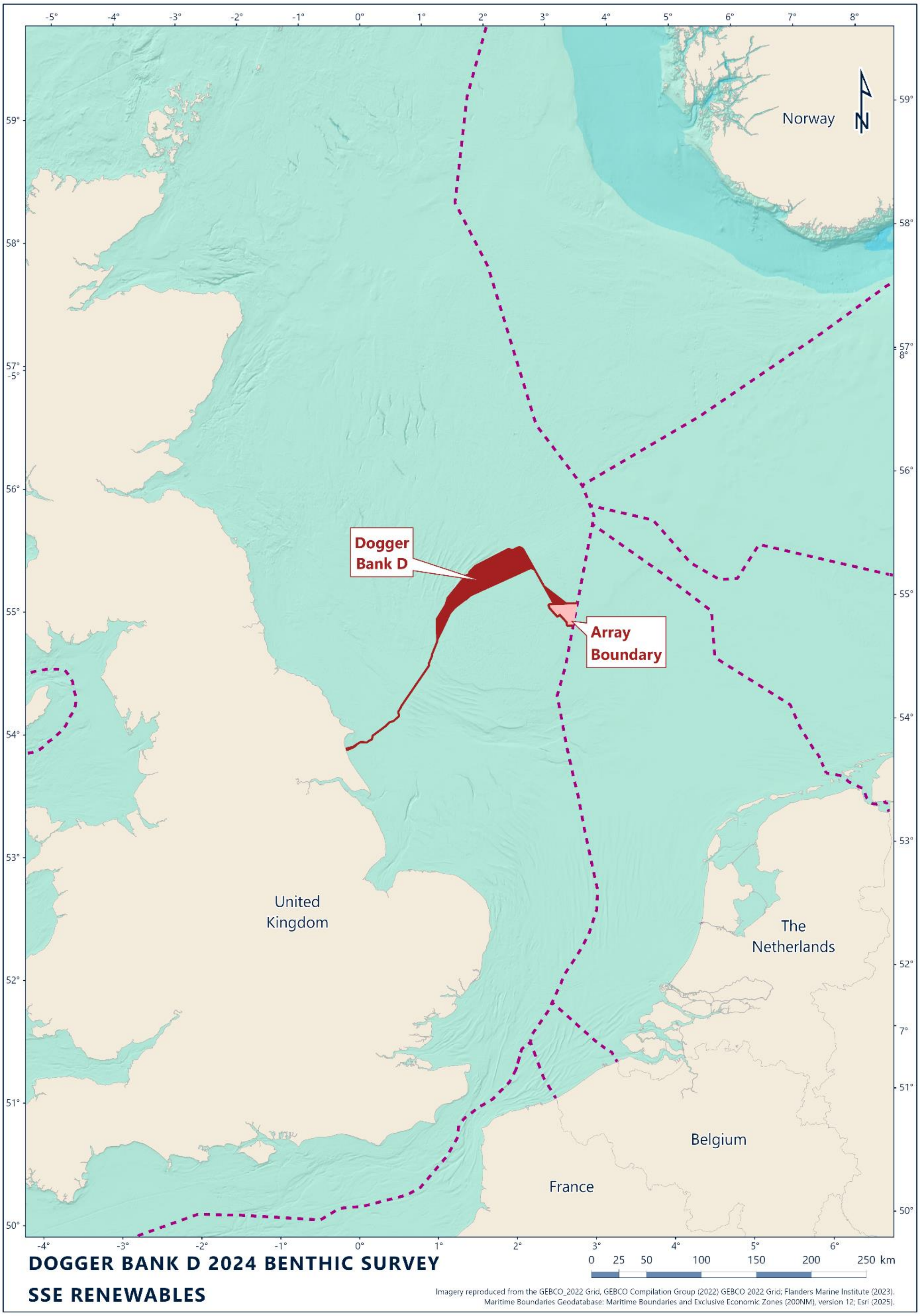
Frontispiece



Executive Summary

Introduction

SSE Renewables contracted Fugro to undertake an environmental survey along the Dogger Bank D (DBD) Export Corridor (hereafter referred to as export cable corridor [ECC]) and an additional area within the DBD Array, in the UK sector of the North Sea. Survey operations were conducted onboard the MV Fugro Helmert from 9 to 25 September 2024 and the MV Fugro Venturer from 20 to 26 September 2024.

The aim of the benthic survey was to provide a characterisation of the benthos along the DBD ECC and an additional area within the DBD array as well as an area outside the proposed ECC and array boundaries, denoted characterisation area (CA). This was fulfilled through the acquisition of sediment samples and seafloor photographic data. Sediment samples were subsequently analysed for physico-chemical characteristics and biological communities, including the identification of potential non-native species (NNS).

Seafloor photographic data analysis provided information on habitat types, with a focus on habitats of conservation importance, such as those listed under Annex I of the Conservation of Habitats and Species Regulations 2019, on the Oslo and Paris (OSPAR) list of threatened and/or declining habitats and species, and on the UK Biodiversity Framework 2024, formerly Biodiversity Action Plan (BAP).

Environmental deoxyribonucleic acid (eDNA) analysis of water samples was undertaken to evaluate the presence of bony fish taxa, which was to be considered with the results from the seafloor photographic data. The results of the seafloor photographic data analysis were integrated with those from the grab sample analysis to define the habitat types (e.g. biotopes or biotope complexes) and associated biological communities in line with the European Nature Information System (EUNIS) habitat classification.

Data from a previous survey of the Dogger Bank D array area have been presented following the Client's request to aid contextualisation of the results. In addition, a descriptive temporal comparison was requested regarding 12 stations within the array that were sampled in both studies.

Survey Strategy

A total of 104 environmental sampling stations was predetermined by the client. At each environmental station, the acquisition of data included drop-down video (DDV) and grab sampling was proposed. Grab sampling was undertaken to acquire a single macrofaunal sample and a single particle size distribution (PSD) sample at each station. Acquisition of single samples for sediment chemistry analysis was proposed at 15 environmental stations to evaluate potential contamination. Acquisition of water samples for environmental deoxyribonucleic acid (eDNA) analysis was proposed at 17 stations. An additional set of 20 sampling stations was predetermined as 'contingency or reserve stations', in case of unsuccessful sampling at the nearby proposed sampling station.

Seafloor video and photography were acquired using a SubC Rayfin camera system (MV Fugro Helmert) and SeaSpyder deep-sea camera system (MV Fugro Venturer). Samples for macrofaunal and sediment PSD analysis were acquired using a 0.1 m^2 Hamon grab. Samples for chemistry analysis were acquired using a 0.1 m^2 Day grab (MV Fugro Helmert) and a 0.1 m^2 dual van Veen (MV Fugro Venturer). Water samples for eDNA analysis were acquired using a 5 L Niskin bottle, with one near-surface and one near-seafloor sample collected at each station.

Camera transects were taken across each environmental sampling station and had a length of approximately 50 m. Four client predefined stations, ST001, ST002, ST003 and ST105 were revised and relocated approximately 1000 m east of their original positions prior to data collection as the shallow water depths were unsuitable for the vessel.

Seafloor photographic data were successfully acquired at 104 proposed stations and the 7 reserve stations. Grab samples were acquired at 97 proposed stations and 7 contingency stations. A complete suite of samples was retained at 92 of these stations. Water samples were successfully acquired at all 17 stations.

Contingency stations ST105, ST106, ST107, ST108, ST118, ST119, and ST121 were sampled due to failed grab attempts at stations ST001, ST011, ST014, ST025, ST048, ST049 and ST084. Station ST105 was relocated due to the presence of fishing gear and renamed ST105A. Station ST015 was relocated 35 m north and station ST016 was relocated 50 m northeast of the proposed sampling location due to the presence of boulders.

Insufficient grab volumes for a full suite of samples were obtained at stations ST004, ST008, ST012, ST033, ST041, ST050, ST069, ST071, ST086, ST087 and ST105A. No samples for macrofaunal analysis (FA) were collected at these stations. No sample for chemistry analysis was acquired at station ST119 due to sediment washout.

Sediment Characteristics

The sediment across the DBD survey area comprised mostly sand and, to a lesser extent, gravel, whereas the fines content was low, with 51 stations being devoid of fines. Shell fragments contributed to the gravel content, as recorded on the survey from the in situ qualitative description of the grab samples. The sediment sorting ranged from ‘well sorted’ to ‘very poorly sorted’, with most stations having ‘moderately well sorted’ sediments.

The varying percentages of gravel, sand and fines, resulted in seven sediment classes being identified through the Folk (British Geological Survey [BGS] modified) classification. Of these, ‘sand’ typified 67 stations, ‘gravelly sand’ typified 12 stations, ’sandy gravel’ typified 11 stations, ‘muddy sandy gravel’ typified 7 stations, ‘gravelly muddy sand’ typified 4 stations with ‘gravel’ and ‘muddy gravel’ each typifying 1 station.

The Wentworth (1922) scale was used to assess the coarseness of the sediment resulting in seven sediment descriptions being identified, including ‘fine sand’, which typified 75 stations, ‘coarse sand’, which typified 10 stations, ‘granule’, which typified 6 stations, ‘very coarse sand’, which typified 5 stations, ‘fine pebble’ which typified 4 stations, ‘medium sand’ which typified 3 stations and ‘medium pebble’ which typified 1 station.

In general, the sediments at stations along the export cable corridor (ECC) were more diverse than the sediments at stations in the array area and characterisation area.

Most stations had unimodal distributions. Twenty-seven stations had bimodal or polymodal distributions, which are indicative of different sources of sediment, likely associated with sediment disturbance in a high energy environment, such as that of the study area.

Sediment Chemistry

Sediment samples were analysed for total hydrocarbon content (THC), polycyclic aromatic hydrocarbons (PAHs), metal content, polychlorinated biphenyls (PCBs), and organotins. Twenty-two PAHs were analysed, including the United States Environmental Protection Agency (US EPA) 16 PAHs, selected alkyl naphthalenes, C1-phenanthrene, benzo[e]pyrene and perylene.

Results were compared against marine sediment quality guidelines (SQGs) namely the OSPAR effects range low (ERL), the National Oceanic and Atmospheric Administration (NOAA) effects range median (ERM), the Centre for Environment, Fisheries and Aquaculture Science (Cefas) Guideline Action Levels (ALs), and the Canadian threshold effect level (TEL) and probable effect level (PEL).

The THC content at the majority of stations along the ECC and all stations in the array area; all stations in the characterisation area were below the limit of detection (LOD). The exception was one station along the ECC (station ST009). However, the THC content was below the Cefas AL1 at all stations.

Concentrations of most individual PAHs were below their respective marine SQGs at all stations except station ST009, where anthracene, benzo[a]anthracene and phenanthrene were above their respective TELs. In general, PAH concentrations were higher along the nearshore section of the ECC and in the characterisation area than further offshore section of the ECC and in the array.

Arsenic concentrations at stations ST070, ST074, ST080, ST085 and ST093 were above the Canadian TEL. All other metal concentrations were below their respective marine SQGs.

The concentrations of all individual PCB congeners analysed and the sum of the 25 congeners were below the LOD at all the stations. The sum of the 25 congeners was below the Cefas Action Level 1 (AL1) and Action Level 2 (AL2) at all stations.

The organotins analysed were dibutyltin (DBT) and tributyltin (TBT), the concentrations of which were below their respective LODs and below the Cefas ALs at all stations.

Macrofauna

The macrofaunal community comprised infaunal and epifaunal taxa, the latter being represented by solitary and colonial organisms. Annelida were dominant in terms of taxa composition and abundance of the enumerated macrofauna, which comprised infauna and solitary epifauna. Annelida mainly comprised polychaetes such as *Spiophanes bombyx, Protodorvillea kefersteini, Lumbrineris cf. cingulata and Mediomastus fragilis*. The polychaete *Sabellaria spinulosa* was recorded in grab samples from 12 stations, with abundances of between 1 and 22 individuals.

Arthropoda were represented mainly by crustaceans such as the *Balanus crenatus, Galathea intermedia, Phtisica marina* and *Upogebia deltaura*. Mollusca were represented mainly by bivalves such as *Kurtiella bidentata*, *Fabulina fabula*, *Abra prismatica* and *Phaxas pellucidus*. Echinodermata were represented mainly by brittlestars such as *Amphiura filiformis*, *Acrocnida brachiata* and *Amphipholis squamata* and urchins such as *Echinocyamus pusillus* and *Echinocardium cordatum*. Other phyla were represented mainly by species of *Phoronis*, Nemertea and Ceriantharia, the lancelet *Branchiostoma lanceolatum*, anemones from the family Edwardsiidae and the ascidian *Dendrodoa grossularia*.

Some fish were recorded in the grab samples, namely *Merluccius merluccius*, *Callionymus reticulatus* and *Ammodytes marinus* as well as species of the genera *Ammodytes* and *Callionymus reticulatus* and taxa of the family Gobiidae.

The macrobenthic communities recorded in this study are in line with those reported to be typical of this region of the North Sea and the Dogger Bank. The faunal diversity, calculated through the Shannon-Wiener index ($H'Log_2$) and assessed in line with the criteria of Dauvin et al. (2012), was good across the DBD survey area, with faunal abundances fairly evenly distributed across the taxa recorded, as indicated by the Pielou's index of evenness.

Five macrofaunal assemblages were identified through the multivariate analysis, each group having an average similarity of 29.8 % to 47.0 % and reflecting the diversity of the sediment.

Biomass

The infaunal biomass was represented mainly by echinoderms and molluscs, the former owing to the abundance as well as the size of invertebrates, notably urchins. The biomass of molluscs was associated with their numerical abundance as well as the size of selected bivalves.

Colonial epifauna from the grab samples was recorded across most of the survey area and was represented mainly by low-lying bryozoans and hydroids. Erect forms of bryozoans, such as *Flustra foliacea*, were also recorded, particularly on coarse substrata along the nearshore section of the ECC.

Environmental deoxyribonucleic acid (eDNA) Analysis

Environmental DNA samples were collected from approximately 1 m below sea surface (TOP) and approximately 1 m from the seafloor (BOT). The results indicated comparable eDNA taxa composition, with BOT samples containing a higher number of operational taxonomic units (OTUs) associated with bottom-dwelling bony fish taxa. The highest OTUs count for bony fish taxa included Atlantic mackerel (*Scomber scombrus*), followed by European sprat (*Sprattus sprattus*), and Atlantic herring (*Clupea harengus*). These bony fish are commercially important and are known to have spawning grounds within Dogger Bank. There was no direct comparison eDNA data between the 2023 and 2024 stations, as samples collected in 2023, from stations that were re-sampled in 2024, did not provide significant data due to inadequate target DNA present in the samples. However, the overall eDNA results from the 2024 survey were largely comparable to those from 2023.

eDNA analysis complemented the other methods used to identify bony fish taxa in the survey area. The total number of fish taxa OTUs (family level or higher) identified by the eDNA analysis was 25, whilst 12 were identified by photographic and macrofaunal analyses. The overall number of bony fish taxa identified for the survey area was 27, with 10 taxa (37 %) identified by all methods, a further 15 (56 %) identified by eDNA analysis, and an additional 2 taxa (7 %) identified by photographic and macrofaunal analyses. The eDNA analysis was able to provide a more comprehensive dataset, with lower taxonomic identification, whilst avoiding the need to undertake more destructive sampling to obtain data.

Seafloor Habitat Types

The following habitat types were identified:

- '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236), assigned to 21 stations;
- '*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand' (MC5215), assigned to 16 stations in combination with '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236);
- '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211), assigned to 20 stations;
- '*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (MC3212) assigned to 15 stations;
- '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (MC5214) assigned to four stations;
- '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' (MC5212), assigned to three stations;
- '*Nephtys cirrosa* and *Bathyporeia* sp. in Atlantic infralittoral sand' (MB5233), assigned to three stations;
- '*Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand' (MC3213), assigned to four stations;
- 'Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)' (MB3231), assigned to two stations;
- 'Faunal communities of Atlantic offshore circalittoral sand' (MD521), assigned to 16 stations;
- 'Faunal communities of Atlantic circalittoral sand' (MC521) assigned to four stations;
- 'Atlantic circalittoral sand' (MC52) assigned to eight stations;
- 'Atlantic offshore circalittoral sand' (MD52) assigned to three stations;
- 'Atlantic infralittoral coarse sediment' (MB32) assigned to four stations;
- 'Atlantic infralittoral mixed sediment' (MB42) assigned to five stations;
- 'Atlantic circalittoral mixed sediment' (MC42) assigned to one station.

Sensitive Habitats and Species

The UK Biodiversity Action Plan (BAP) broad scale habitat (BSH) 'Subtidal sands and gravel', which encompasses sandy and coarse sediment habitat types was recorded throughout the survey area. The BSH 'Subtidal sands and gravel' encompasses most of the habitat types recorded throughout the survey area and is a Habitat of Conservation Importance (HOCI) in Marine Conservation Zones (MCZs).

Aggregations of cobbles at 19 stations were evaluated for the potential of Annex I habitat 'Reef' (stony reef). Aggregation of cobbles and boulders were classified as 'low resemblance to a stony reef' at four stations and 'medium resemblance to a stony reef' at five stations.

Aggregations of *S. spinulosa* at station ST025 were evaluated for the potential of Annex I habitat '*S. spinulosa* Reef'. The overall assessment for the aggregations of *S. spinulosa* was of 'not a reef', and therefore the Annex I habitat is not present in the survey area.

Due to the occurrence of faunal burrows and sea pens, 52 stations were assessed for the presence of the OSPAR listed threatened and/or declining habitat 'Sea pen and burrowing megafauna'. Faunal burrows were present along 52 stations, ranging from 'rare' to 'superabundant'. The sea pen *Pennatula phosphorea* was recorded as 'occasional' to 'common' along seven stations. Of all the transects observed, 25 stations were recorded to have faunal burrows with a frequent abundance, two as common and one as superabundant. Due to the occurrence of sea pens and burrows occurring as 'frequent' or above, the OSPAR listed threatened and/or declining habitat 'Sea pen and burrowing megafauna' may be present across the survey area.

Species of conservation importance recorded in this study included the fish *Clupea harengus, Gadus morhua*, *Merlangius merlangius*, *Merluccius merluccius*, *Pleuronectes platessa*, *Scomber scombrus*, *Solea solea*, and *Trachurus trachurus*, which are UK BAP priority species. *Gadus morhua* is also on the OSPAR list of threatened and/or declining habitats and species along with the fish *Salmo salar*, and on the IUCN red list of threatened species as 'vulnerable' along with the fish *Trachurus trachurus* and *Melanogrammus aeglefinus*. Sand eel of the species *A. marinus* and anemones of the family Edwardsiidae were recorded, and therefore there is the potential for the UK BAP species *A. marinus* and *E. timida* to occur in the DBD survey area.

The OSPAR threatened and/or declining species *A. islandica* was present in the grab samples as juveniles and two individuals were identified from visual observations of the grab samples prior to being released back into the sea.

Non-Native and Cryptogenic Species

One non-native species (NNS) was recorded in the grab samples, namely the polychaete *Goniadella gracilis*.

eDNA analysis tentatively detected *Leucaspius delineatus*, a freshwater NNS in the UK.

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Abbreviations

AFDW	Ash free dry weight
agg.	Aggregate
AL1/AL2	Action Level 1 or 2
BAC	Background assessment concentration
BAP	Biodiversity Action Plan
BGS	British Geological Survey
BOT	Near seafloor
BRIG	Biodiversity Reporting and Information Group
BS	British Standards
BSH	Broad scale habitat
BSL	Below sea level
CABI	Centre for Agriculture and Bioscience International
CBD	Convention of Biological Diversity
CCME	Canadian Council of Ministers of the Environment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Coordinated Environmental Monitoring Programme
CM	Central meridian
CSEMP	Clean Seas Environmental Monitoring Programme
DAISIE	Delivering Alien Invasive Species Inventories for Europe
DBD	Dogger Bank D
DBT	Dibutyltin
DCM	Dichloromethane
DDV	Drop-down video
eDNA	Environmental deoxyribonucleic acid sample
ECC	Export cable corridor
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EMODnet	European Marine Observation Data Network
EOL	End of line
ERL	Effects range low
ERM	Effects range medium
EU	European Union
EUNIS	European Nature Information System
FA	Faunal sample A
FGBL	Fugro GB Limited
FOCI	Feature of Conservation Interest
GBIF	Global Biodiversity Information Facility
GC-MS	Gas chromatography – mass spectrometry
GDS	Government Digital Service
GES	Good environmental status
GRIIS	Global Register of Introduced and Invasive Species
HML	Hull Marine Laboratory
HOCI	Habitat of conservation importance
HRA	Habitat Regulation Assessment
ICP-MS	Inductively coupled plasma-mass spectrometry
ICP-OES	Inductively coupled plasma-optical emission spectrometry
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature
LOD	Limit of detection
JNCC	Joint Nature Conservation Committee
LED	Light-emitting diode
MCZ	Marine Conservation Zone

MMO	Marine Management Organisation
MPA	Marine Protected Area
MV	Motor vessel
N	Abundance of individuals
NCBI	National Centre for Biotechnology Information
NBN	National Biodiversity Network
NEMESIS	National Exotic Marine and Estuarine Species Information System
NERC	Natural Environment and Rural Communities Act 2006
NMBAQC	North-East Marine Biological Association Quality Control
nMDS	Non-metric multi-dimensional scaling
NNS	Non-native species
NNSS	Non-native Species Secretariat
NOAA	National Oceanic and Atmospheric Administration
OSPAR	Oslo and Paris Commission
OTU	Operational Taxonomic Unit
P	Present
PAH	Polycyclic aromatic hydrocarbon
PC	Physico-chemical sample
PCA	Principal component analysis
PCB	Polychlorinated biphenyls
PCR	Polymerase chain reaction
PEL	Probable effects level
PRIMER	Plymouth Routines in Multivariate Ecological Research
PSA	Particle size analysis
PSD	Particle size distribution
PVC	Polyvinyl chloride
RNA	Ribonucleic acid
RSD	Relative standard deviation
S	Species richness
SAC	Special Area of Conservation
SC	Sediment chemistry
SD	Standard deviation
SQGs	Sediment quality guidelines
SIMPER	Similarity percentage (analysis)
SIMPROF	Similarity Profile
SOL	Start of line
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TBT	Tributyltin
TEL	Threshold effects level
THC	Total hydrocarbon content
TOP	Near surface
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
US	United States
USBL	Ultra short baseline
US EPA	United States Environmental Protection Agency
US EPA 16	United States Environmental Protection Agency's 16 priority PAH pollutants
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984
WoRMS	World Register of Marine Species
WW	Wet weight

1. Introduction

1.1 General Project Description

SSE Renewables contracted Fugro to undertake a benthic characterisation survey along the Dogger Bank D (DBD) Export Corridor hereafter referred to as export cable corridor (ECC), and an additional area within the DBD Array. An area outside the proposed array and ECC boundaries, denoted characterisation area (CA), was also surveyed, to support the export cable route site selection. Operations were conducted onboard MV Fugro Helmert from 9 to 25 September 2024 and the MV Fugro Venturer from 20 to 26 September 2024.

The environmental survey was required to investigate the physico-chemical and biological properties of the sediment to provide a benthic characterisation and supplement the knowledge of the environment across the DBD export cable corridor and array survey area in support of the Environmental Impact Assessment (EIA) and the Habitat Regulation Assessment (HRA).

Appendix A outlines the guidelines for use of this report.

1.2 Scope of Work

The aims of the environmental survey were:

- Determine the distribution and abundance of marine habitats and communities within the potential export cable corridors/array area;
- Identify the location and extent of habitats and/or species of conservation importance;
- Determine the physical characteristics of the seafloor at all sampling locations;
- Identify and quantify any areas of potential chemical contamination.

The aims of the study were fulfilled through the acquisition of seafloor photographic data, water and sediment samples. Sediment samples were subsequently analysed for physico-chemical characteristics and biological communities. Water samples were analysed for environmental deoxyribonucleic acid (eDNA) analysis.

The seafloor photographic data allowed evaluation of the habitat types across the DBD survey area, with a particular focus on habitats of conservation importance, such as those listed under Annex I of the of the Conservation of Habitats and Species Regulations 2019, on the Oslo and Paris Commission (OSPAR) list of threatened and/or declining habitats and species (OSPAR, 2024) and on the UK Biodiversity Framework 2024, formerly Biodiversity Action Plan [BAP] (Biodiversity Reporting and Information Group [BRIG], 2011). Sediment samples allowed evaluation of the physico-chemical and biological properties of the seafloor and the characterisation of the biotic communities including the identification of potential non-native species (NNS). Water samples allowed eDNA taxonomic classification of fish taxa that would occur in trawl samples. A comparison between the taxa detected by the eDNA water sampling and the taxa detected by photographic data analysis for habitat assessment is also presented to evaluate how the two sampling methods may complement each other in sampling fish across the survey area.

Data from a previous survey of the Dogger Bank D array in 2023 (Fugro, 2024a) have been presented in Section 4.1 following the Client's request to aid contextualisation of the results. In addition, a descriptive temporal comparison regarding 12 stations within the array that were sampled in 2023 and the current survey has been presented in Section 4.3.

1.3 Environmental Legislation

Table 1.1 presents a summary of the UK's marine nature conservation legislation and Table 1.2 presents a summary of the Marine Protected Areas (MPA) biodiversity features. Together they guide the identification of habitats and species of conservation importance in the study area.

Table 1.1: Environmental Legislation

Legislation	Key Aims
Conservation of Habitats and Species (Amendment (EU Exit) Regulations 2019), referred to as the 2019 Regulations	Transposes the requirements of the European Union (EU) Habitats Directive and some elements of the Wild Birds Directive (together forming the Nature Directives) into UK law; aims at conserving biodiversity through measures for protection of habitats listed in Annex I and species listed in Annex II of the Directives through the establishment of a national site network of protected sites, referred to as Special Areas of Conservation (SACs) and Special Protection Area (SPA)
UK Marine Strategy	Provides a framework for community action in the field of marine environmental policy through three components: 1. assessment of the state of UK seas and revised objectives for good environmental status (GES) for 2018 to 2024; 2. monitoring progress against set targets and indicators; 3. measuring the achievement of GES
Marine and Coastal and Access Act 2009	Enables the designation of Marine Conservation Zones (MCZs) in England, Wales and UK offshore waters
Natural Environment and Rural Communities Act 2006 (NERC)	Requires the relevant Secretary of State to compile a list of habitats and species of principal importance for the conservation of biodiversity
The Wildlife and Countryside Act 1981 (as amended)	Regulates the designation of Site of Special Scientific Interest (SSSIs), which underpins the designation of Ramsar sites
Oslo and Paris (OSPAR) Convention	Establishes Marine Protected Areas (MPAs)
Convention on Biological Diversity (CBD)	Conservation of biological diversity and sustainable use of its components
Ramsar Convention	Aims at the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development
The UK Marine Policy Statement (MPS)	Provides a framework for achieving sustainable development in the marine environment.
National Policy Statement for Renewable Energy Infrastructure (EN-3)	Guidance for developing renewable energy infrastructure

Legislation	Key Aims
North East Inshore and North East Offshore Marine Plan	Introduces a strategic approach to planning within the English inshore and offshore waters between the Scottish border and Flamborough Head, in Yorkshire. It provides a clear, evidence-based approach to inform decision-making by marine users and regulators on where, when or how activities might take place within the north east inshore and north east offshore marine plan areas.

Table 1.2: Marine Protected Areas Biodiversity Features

Biodiversity Feature	Description
Broad-scale habitats (BSH)	Represent the main types of seafloors and associated biota in UK; their conservation ensures preservation of the full range of marine biodiversity
Features of conservation importance (FOCI)	Represent habitats and/or species that are particularly threatened, rare or declining and therefore need protection
UK Post-2010 Biodiversity Framework priority habitats and/or species	List of important (priority) habitats and species, produced by the UK Biodiversity Action Plan (BAP), superseded by the UK Biodiversity Framework 2024, under the CBD. Under the NERC Act 2006, the UKBAP priority species and habitats in England are referred to as habitats and species of principal importance
OSPAR list of threatened and/or declining species and habitats	Allows setting priorities for further conservation and protection of marine biodiversity

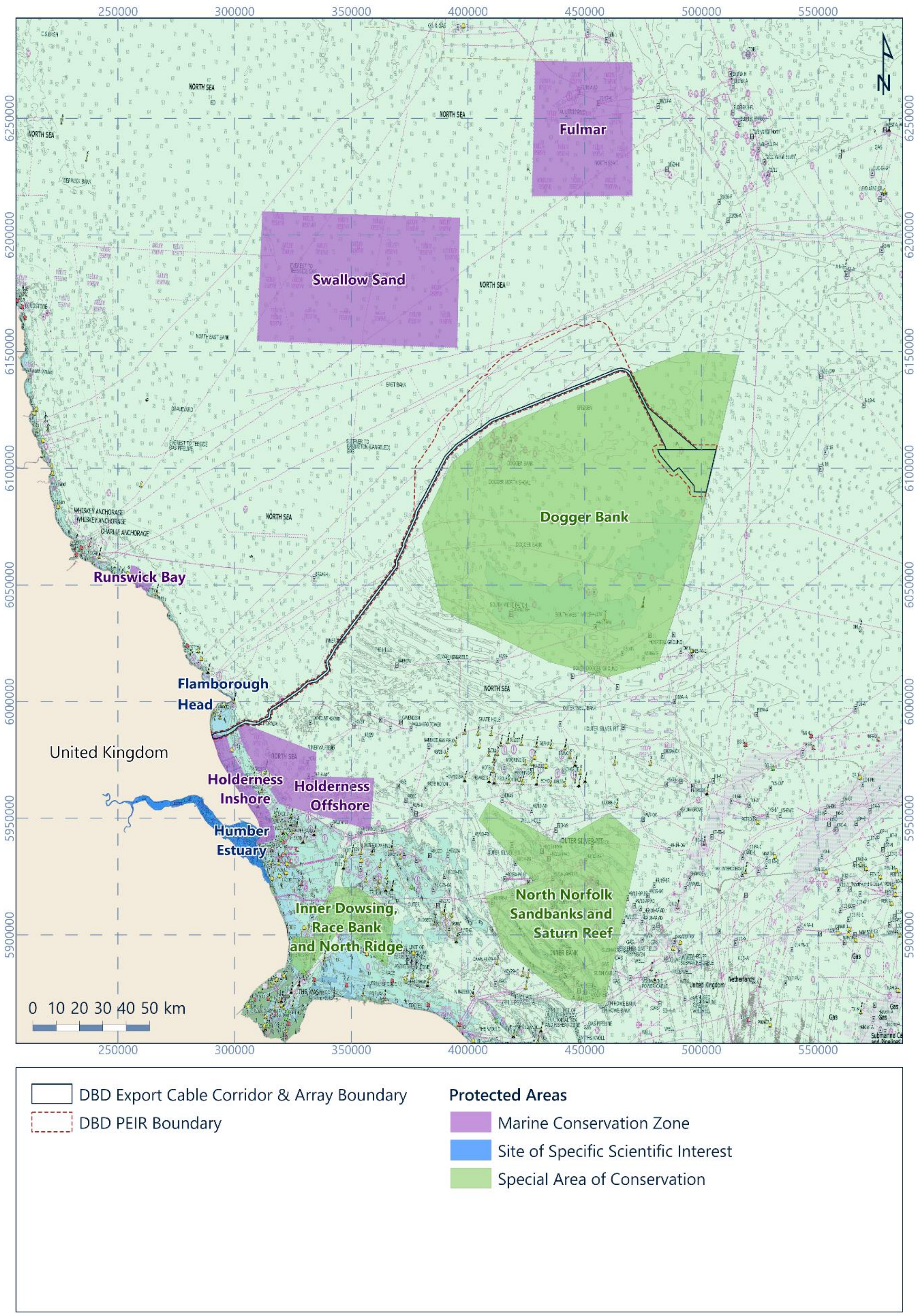
1.4 Regional Habitats, Species and Protected Areas

Table 1.3 lists the protected areas in UK waters within 100 km of the survey area, summarising the sensitive habitats and species for which they were designated. Figure 1.1 illustrates the protected areas in relation to the DBD survey area.

Table 1.3: Summary of nearby marine protected areas relating to benthic habitats and species

Protected Area	Status	Distance* [km]	Direction*	Protected Habitats/Species
Dogger Bank	SAC	Overlapped by survey area		Annex I habitat ■ Sandbanks which are slightly covered by sea water all the time
North Norfolk Sandbanks and Saturn Reef	SAC	90	S	Annex I habitats ■ Reefs ■ Sandbanks which are slightly covered by sea water all the time
Inner Dowsing, Race Bank and North Ridge	SAC	75	S	Annex I habitats ■ Reefs ■ Sandbanks which are slightly covered by sea water all the time
Flamborough Head	SAC	11	N	Annex I habitats ■ Reefs ■ Submerged or partially submerged sea caves
Humber Estuary	SAC†	44	S	Annex I habitats ■ Estuaries ■ Mudflats and sandflats not covered by seawater at low tide
Fulmar	MCZ	56	N	FOCI and OSPAR list of Threatened and/or Declining habitats /species ■ Ocean quahog (*Arctica islandica*) Broad-scale habitats: ■ Subtidal mixed sediments ■ Subtidal mud ■ Subtidal sand
Swallow Sand	MCZ	22	N	Broad-scale habitats ■ Subtidal coarse sediment ■ Subtidal sand
Holderness Offshore	MCZ	0.3	SE	FOCI and OSPAR list of Threatened and/or Declining habitats /species ■ Ocean quahog (*Arctica islandica*) Broad-scale habitats ■ Subtidal coarse sediment ■ Subtidal mixed sediments ■ Subtidal sand
Holderness Inshore	MCZ	Overlapped by survey area		Broad-scale habitats ■ High energy circalittoral rock ■ Intertidal sand and muddy sand ■ Moderate energy circalittoral rock ■ Subtidal coarse sediment ■ Subtidal mixed sediments ■ Subtidal mud ■ Subtidal sand
Runswick Bay	MCZ	64	NW	FOCI and OSPAR list of Threatened and/or Declining habitats /species ■ Ocean quahog (*Arctica islandica*) Broad-scale habitats ■ Low energy intertidal rock ■ Moderate energy intertidal rock ■ High energy intertidal rock ■ Intertidal sand and muddy sand ■ Moderate energy infralittoral rock ■ Moderate energy circalittoral rock ■ Subtidal coarse sediment ■ Subtidal mixed sediments ■ Subtidal sand ■ Subtidal mud

Notes
FOCI = Feature of conservation importance
MCZ = Marine Conservation Zone
OSPAR = Oslo and Paris
SAC = Special Area of Conservation
* = Distance (to nearest kilometre) and direction from the closest sampling station
† = Also designated as Special Protection Area, Site of Special Scientific Interest and Ramsar Site



Coordinate System: WGS 1984 UTM Zone 31N; **Caveats:** Esri, 2025; © Natural England. Contains Ordnance Survey data © Crown copyright and database right 2025; SevenCs' electronic navigation charts. SevenCs explicitly state that the data are not certified by an official authority and that the data may not be used for navigation or other safety related purposes.

Figure 1.1: Protected areas relating to benthic habitat and species relevant to the survey area, Dogger Bank D 2024

1.5 Environmental Quality Standards for Sediment Chemical Concentrations

Sediment quality guidelines (SQGs) to evaluate the chemical concentrations included:

- The effects range low (ERL) and effects range median (ERM) concentrations (OSPAR, 2014);
- The Centre for Environment, Fisheries and Aquaculture Science (Cefas) Guideline Action Levels (ALs) for the disposal of dredged material (Marine Monitoring Organisation [MMO], 2015);
- The Canadian SQGs for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment [CCME], 2024).

The ERL value is defined as the lower tenth percentile of the dataset of concentrations in sediments associated with biological effects; the ERM is defined as the median (or 50th percentile) of the concentrations associated with biological effects (OSPAR, 2009). Adverse effects on organisms are rarely observed when concentrations fall below the ERL, while they are often or always observed at concentrations above the ERM (OSPAR, 2009). The numerical values of ERL and ERM were derived from biological toxicity assays and synoptic sampling and are incorporated in SQGs developed for the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends program, as informal tools to evaluate whether a contaminant concentration in sediment might have toxicological effects (Long et al., 1995).

The UK adopts the ERLs as a signatory of the OSPAR Convention for the assessment of monitoring data of hazardous substances in the environment (OSPAR, 2014), delivering its commitment through the Clean Seas Environmental Monitoring Programme (CSEMP). Some ERLs, however, have not been used in the OSPAR assessment, because their values are less than the OSPAR Background Assessment Concentration (BAC) used to evaluate the contamination status of marine sediment across the OSPAR maritime area. This is the case for the metals arsenic and nickel (OSPAR, 2009). Background Assessment Concentrations are normalised to 5 % aluminium, while no normalisation is made when deriving the ERL values (OSPAR, 2009).

The Cefas ALs are non-statutory guidelines to determine whether dredged material is suitable for disposal at sea by providing a proxy risk assessment for potential impacts on biological features such as fish and benthos (Mason et al., 2022). In general, concentrations below Cefas AL1 are of no concern, while concentrations above Cefas AL2 indicate that dredged material is unsuitable for disposal at sea. Values between Cefas AL1 and AL2 may require further investigatory work prior to a disposal decision (MMO, 2015).

The Canadian SQGs for the Protection of Aquatic Life are numerical concentrations or narrative statements intended to protect all forms of freshwater and marine (including estuarine) aquatic life for an indefinite period of exposure to substances associated with seafloor sediments (CCME, 2024). The guidelines consist of threshold effects levels (TELs) and probable effects levels (PELs). Together, they are used to identify three ranges of chemical concentrations for biological effects:

- Values below TEL indicate the minimal effect range within which adverse effects rarely occur;
- Values between TEL and PEL indicate the possible effect range where adverse effects occasionally occur;
- Values above the PEL indicate the probable effect range within which adverse effects frequently occur.

1.6 Coordinate Reference System

All coordinates detailed in this report are referenced World Geodetic System 1984 (WGS 84) Universal Transverse Mercator (UTM) projection Zone 31N central meridian (CM) 3° East (CM 3° E). Table 1.4 presents the detailed geodetic and projection parameters.

Table 1.4: Project geodetic and projection parameters

Global Navigation Satellite System (GNSS) Geodetic Parameters	
Datum:	World Geodetic System 1984 (WGS 84)
Spheroid:	WGS 84
Semi major axis:	a = 6 378 137.000 m
Reciprocal flattening:	1/f = 298.257 223 563
Project Projection Parameters	
Grid Projection:	Universal Transverse Mercator (UTM)
UTM Zone:	31N
Central Meridian:	003° 00′ 00″ East
Latitude of Origin:	00° 00′ 00″ North
False Easting:	500 000 m
False Northing:	0 m
Scale factor on Central Meridian:	0.9996
Units:	metre

Notes
* = Fugro Starfix® navigation software always uses WGS 84 geodetic parameters as a primary datum for any geodetic calculations
† = This is the right-hand coordinate frame rotation used by the Fugro Starfix® navigation software

2. Survey Strategy

In total, 104 environmental sampling stations were predetermined by the client to ensure spatial coverage along the DBD ECC and an additional area within the DBD array, as well as an area outside the proposed ECC and array boundaries (CA). At each environmental sampling station, acquisition of photographic data was proposed prior to obtaining single samples for sediment particle size distribution (PSD) and macrofaunal (FA) analysis. At 15 sampling stations, acquisition of single samples for sediment chemistry analysis was proposed to assess for potential contamination. At 17 sampling stations, two water samples were to be collected for environmental DNA (eDNA) analysis, one near-seafloor and one near-surface. An additional set of 20 sampling stations (ST105 to ST124) were selected as contingency or reserve sampling locations in the event of unsuccessful sampling at nearby environmental sampling locations.

Photographic data were collected along an approximately 50 m long transect across each proposed sampling station.

Table 2.1 presents the coordinates data to be acquired and rationale for each proposed environmental sampling location. Acceptable sampling accuracy was agreed with the client representative as within 20 m of the target location.

Figure 2.1 illustrates the proposed survey locations.

Table 2.1: Proposed sampling stations

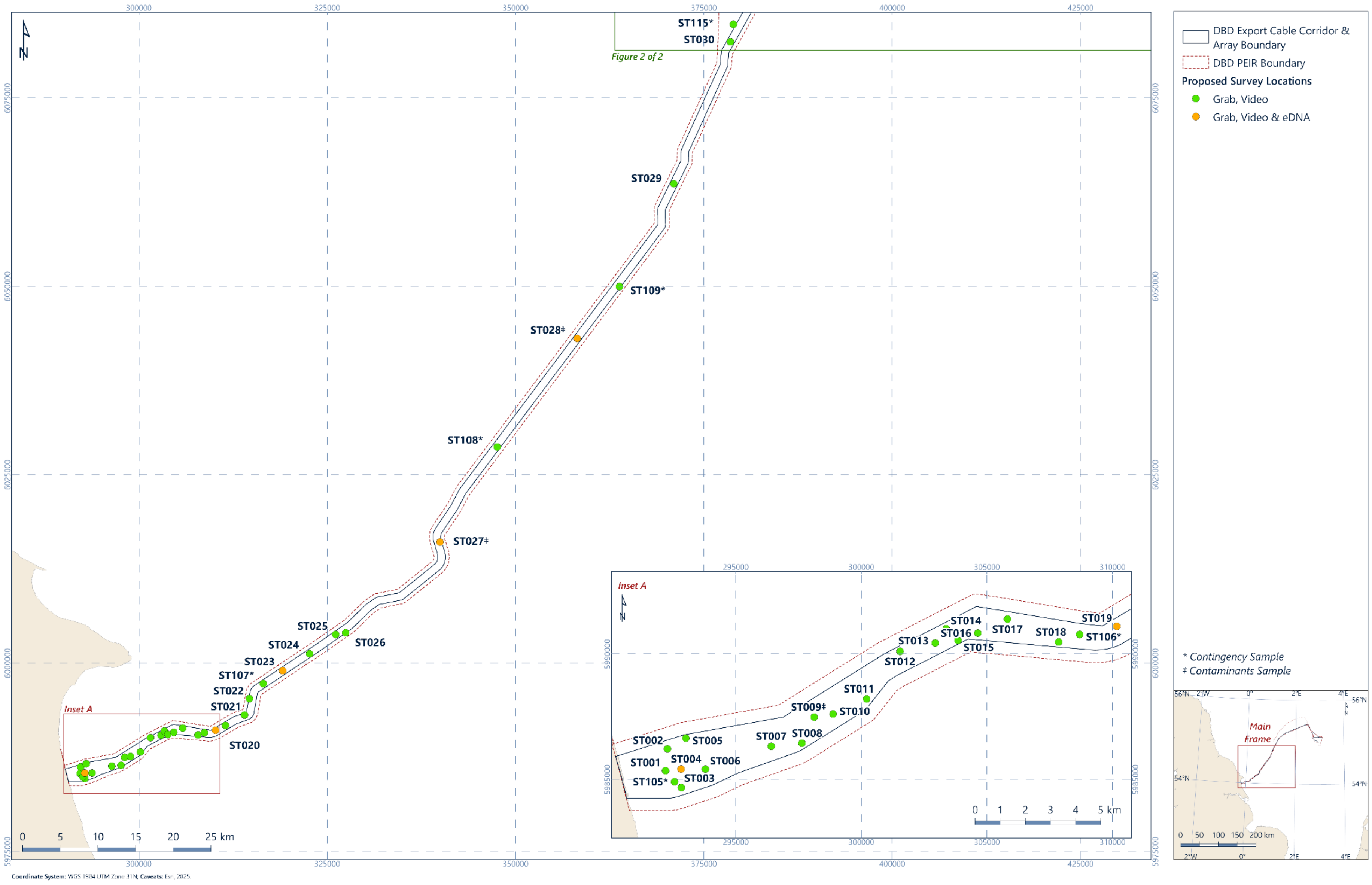
Geodetic Parameters: WGS 84, UTM 31N [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
Export Cable Corridor				
ST001	292 200	5 985 350	Client predefined	Video, stills, FA, PSDA
ST002	292 281	5 986 218	Client predefined	Video, stills, FA, PSDA
ST003	292 835	5 984 675	Client predefined	Video, stills, FA, PSDA
ST004	292 822	5 985 413	Client predefined	Video, stills, FA, PSDA & eDNA
ST005	293 012	5 986 642	Client predefined	Video, stills, FA, PSDA
ST006	293 788	5 985 411	Client predefined	Video, stills, FA, PSDA
ST007	296 411	5 986 319	Client predefined	Video, stills, FA, PSDA
ST008	297 634	5 986 444	Client predefined	Video, stills, FA, PSDA
ST009	298 120	5 987 483	Client predefined	Video, stills, FA, PSDA & Contaminants
ST010	298 873	5 987 606	Client predefined	Video, stills, FA, PSDA
ST011	300 212	5 988 206	Client predefined	Video, stills, FA, PSDA
ST012	301 543	5 990 100	Client predefined	Video, stills, FA, PSDA
ST013	302 938	5 990 433	Client predefined	Video, stills, FA, PSDA
ST014	303 376	5 991 001	Client predefined	Video, stills, FA, PSDA
ST015	303 847	5 990 540	Client predefined	Video, stills, FA, PSDA
ST016	304 636	5 990 827	Client predefined	Video, stills, FA, PSDA
ST017	305 817	5 991 384	Client predefined	Video, stills, FA, PSDA
ST018	307 856	5 990 471	Client predefined	Video, stills, FA, PSDA
ST019	310 171	5 991 098	Client predefined	Video, stills, FA, PSDA & eDNA
ST020	311 492	5 991 730	Client predefined	Video, stills, FA, PSDA
ST021	314 025	5 993 119	Client predefined	Video, stills, FA, PSDA
ST022	314 669	5 995 292	Client predefined	Video, stills, FA, PSDA
ST023	319 081	5 998 991	Client predefined	Video, stills, FA, PSDA & eDNA
ST024	322 668	6 001 242	Client predefined	Video, stills, FA, PSDA
ST025	326 120	6 003 814	Client predefined	Video, stills, FA, PSDA
ST026	327 444	6 004 027	Client predefined	Video, stills, FA, PSDA
ST027	339 972	6 016 066	Client predefined	Video, stills, FA, PSDA, eDNA & Contaminants
ST028	358 197	6 043 103	Client predefined	Video, stills, FA, PSDA, eDNA & Contaminants
ST029	371 006	6 063 628	Client predefined	Video, stills, FA, PSDA
ST030	378 533	6 082 479	Client predefined	Video, stills, FA, PSDA
ST031	384 153	6 093 056	Client predefined	Video, stills, FA, PSDA, eDNA & Contaminants
ST032	388 408	6 100 778	Client predefined	Video, stills, FA, PSDA

Geodetic Parameters: WGS 84, UTM 31N [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
ST033	391 841	6 106 527	Client predefined	Video, stills, FA, PSDA & eDNA
ST034	394 828	6 109 915	Client predefined	Video, stills, FA, PSDA & Contaminants
ST035	397 691	6 111 757	Client predefined	Video, stills, FA, PSDA
ST036	400 455	6 113 961	Client predefined	Video, stills, FA, PSDA & eDNA
ST037	403 713	6 116 165	Client predefined	Video, stills, FA, PSDA
ST038	404 440	6 116 599	Client predefined	Video, stills, FA, PSDA
ST039	406 204	6 116 828	Client predefined	Video, stills, FA, PSDA
ST040	406 339	6 117 872	Client predefined	Video, stills, FA, PSDA
ST041	407 585	6 118 262	Client predefined	Video, stills, FA, PSDA & Contaminants
ST042	412 218	6 121 036	Client predefined	Video, stills, FA, PSDA
ST043	418 468	6 123 926	Client predefined	Video, stills, FA, PSDA & Contaminants
ST044	420 080	6 124 388	Client predefined	Video, stills, FA, PSDA
ST045	432 262	6 129 442	Client predefined	Video, stills, FA, PSDA
ST046	433 993	6 130 064	Client predefined	Video, stills, FA, PSDA
ST047	438 022	6 131 989	Client predefined	Video, stills, FA, PSDA
ST048	442 252	6 132 882	Client predefined	Video, stills, FA, PSDA
ST049	448 437	6 135 653	Client predefined	Video, stills, FA, PSDA, eDNA & Contaminants
ST050	451 996	6 137 670	Client predefined	Video, stills, FA, PSDA
ST051	462 382	6 141 491	Client predefined	Video, stills, FA, PSDA & Contaminants
ST052	471 300	6 136 292	Client predefined	Video, stills, FA, PSDA
ST053	472 035	6 134 862	Client predefined	Video, stills, FA, PSDA & Contaminants
ST054	474 686	6 129 791	Client predefined	Video, stills, FA, PSDA & eDNA
ST055	483 017	6 120 069	Client predefined	Video, stills, FA, PSDA
ST056	481 914	6 115 200	Client predefined	Video, stills, FA, PSDA
ST057	488 225	6 114 561	Client predefined	Video, stills, FA, PSDA
ST058	489 975	6 113 811	Client predefined	Video, stills, FA, PSDA
ST059	492 258	6 111 262	Client predefined	Video, stills, FA, PSDA
ST060	488 941	6 108 636	Client predefined	Video, stills, FA, PSDA & eDNA
ST061	494 638	6 108 767	Client predefined	Video, stills, FA, PSDA
ST062	496 076	6 108 684	Client predefined	Video, stills, FA, PSDA
ST105*	292 562	5 984 908	Client predefined	Video, stills, FA, PSDA
ST106*	308 694	5 990 776	Client predefined	Video, stills, FA, PSDA
ST107*	316 515	5 997 276	Client predefined	Video, stills, FA, PSDA
ST108*	347 564	6 028 686	Client predefined	Video, stills, FA, PSDA
ST109*	363 792	6 049 982	Client predefined	Video, stills, FA, PSDA
ST110*	402 581	6 115 563	Client predefined	Video, stills, FA, PSDA

Geodetic Parameters: WGS 84, UTM 31N [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
ST111*	408 644	6 119 709	Client predefined	Video, stills, FA, PSDA
ST112*	426 719	6 127 303	Client predefined	Video, stills, FA, PSDA
ST113*	469 066	6 140 231	Client predefined	Video, stills, FA, PSDA
ST114*	484 745	6 113 831	Client predefined	Video, stills, FA, PSDA
Array Area				
ST090	481 639	6 107 664	Client predefined	Video, stills, FA, PSDA
ST091	494 808	6 107 463	Client predefined	Video, stills, FA, PSDA
ST092	484 848	6 104 285	Client predefined	Video, stills, FA, PSDA
ST093	490 289	6 104 947	Client predefined	Video, stills, FA, PSDA, eDNA & Contaminants
ST094	494 910	6 105 950	Client predefined	Video, stills, FA, PSDA
ST095	504 831	6 105 782	Client predefined	Video, stills, FA, PSDA & eDNA
ST096	487 281	6 101 384	Client predefined	Video, stills, FA, PSDA
ST097	487 102	6 103 208	Client predefined	Video, stills, FA, PSDA
ST098	492 369	6 100 228	Client predefined	Video, stills, FA, PSDA
ST099	498 764	6 102 640	Client predefined	Video, stills, FA, PSDA
ST100	498 236	6 099 637	Client predefined	Video, stills, FA, PSDA
ST101	497 453	6 095 520	Client predefined	Video, stills, FA, PSDA & eDNA
ST102	499 995	6 096 666	Client predefined	Video, stills, FA, PSDA
ST103	497 172	6 092 500	Client predefined	Video, stills, FA, PSDA
ST104	502 043	6 092 393	Client predefined	Video, stills, FA, PSDA
ST123*	489 310	6 105 763	Client predefined	Video, stills, FA, PSDA
ST124*	499 853	6 095 527	Client predefined	Video, stills, FA, PSDA
Characterisation Area				
ST063	379 110	6 097 210	Client predefined	Video, stills, FA, PSDA
ST064	380 643	6 094 208	Client predefined	Video, stills, FA, PSDA
ST065	381 910	6 095 303	Client predefined	Video, stills, FA, PSDA
ST066	388 758	6 113 596	Client predefined	Video, stills, FA, PSDA
ST067	394 255	6 111 621	Client predefined	Video, stills, FA, PSDA
ST068	396 219	6 116 107	Client predefined	Video, stills, FA, PSDA & Contaminants
ST069	396 928	6 124 060	Client predefined	Video, stills, FA, PSDA
ST070	397 502	6 112 265	Client predefined	Video, stills, FA, PSDA
ST071	404 420	6 118 118	Client predefined	Video, stills, FA, PSDA
ST072	403 600	6 125 503	Client predefined	Video, stills, FA, PSDA
ST073	407 353	6 121 166	Client predefined	Video, stills, FA, PSDA
ST074	410 012	6 124 803	Client predefined	Video, stills, FA, PSDA & Contaminants
ST075	411 327	6 131 033	Client predefined	Video, stills, FA, PSDA

Geodetic Parameters: WGS 84, UTM 31N [m]				
Station	Easting	Northing	Rationale	Data and Sample Acquisition
ST076	420 173	6 141 755	Client predefined	Video, stills, FA, PSDA
ST077	420 305	6 132 827	Client predefined	Video, stills, FA, PSDA & eDNA
ST078	422 332	6 135 893	Client predefined	Video, stills, FA, PSDA
ST079	425 322	6 130 932	Client predefined	Video, stills, FA, PSDA
ST080	429 110	6 150 814	Client predefined	Video, stills, FA, PSDA & Contaminants
ST081	430 994	6 131 857	Client predefined	Video, stills, FA, PSDA
ST082	433 791	6 130 998	Client predefined	Video, stills, FA, PSDA
ST083	434 121	6 144 351	Client predefined	Video, stills, FA, PSDA & eDNA
ST084	441 361	6 151 410	Client predefined	Video, stills, FA, PSDA
ST085	446 945	6 158 043	Client predefined	Video, stills, FA, PSDA, eDNA & Contaminants
ST086	448 981	6 145 202	Client predefined	Video, stills, FA, PSDA
ST087	446 948	6 140 418	Client predefined	Video, stills, FA, PSDA
ST088	457 289	6 146 553	Client predefined	Video, stills, FA, PSDA
ST089	457 974	6 153 966	Client predefined	Video, stills, FA, PSDA
ST115*	378 918	6 084 789	Client predefined	Video, stills, FA, PSDA
ST116*	395 178	6 115 557	Client predefined	Video, stills, FA, PSDA
ST117*	408 413	6 131 290	Client predefined	Video, stills, FA, PSDA
ST118*	434 968	6 131 347	Client predefined	Video, stills, FA, PSDA
ST119*	438 380	6 139 627	Client predefined	Video, stills, FA, PSDA
ST120*	427 809	6 151 620	Client predefined	Video, stills, FA, PSDA
ST121*	442 102	6 158 783	Client predefined	Video, stills, FA, PSDA
ST122*	462 278	6 154 401	Client predefined	Video, stills, FA, PSDA

Notes
Client predefined locations were shared and approved by Natural England, Marine Management Organisation & Cefas as outlined in the Dogger Bank D Export Cable Corridor Sample Planning Document ID: 2024-112-002
* = Client predefined contingency sampling location
eDNA = Environmental deoxyribonucleic acid
FA = Faunal sample
PSD = Particle size distribution



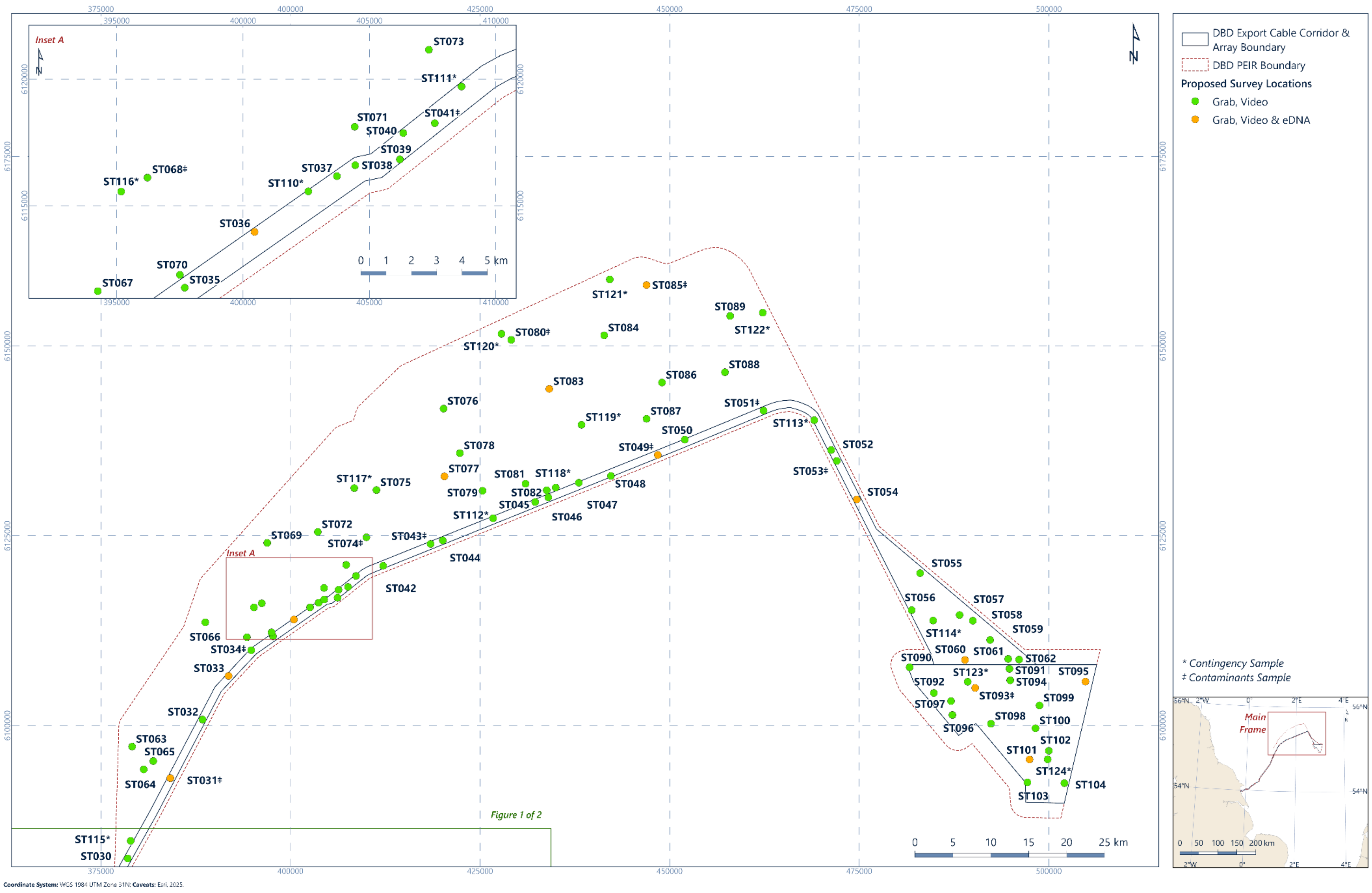


Figure 2.1: Proposed survey locations Dogger Bank D 2024

3. Methods

3.1 Survey Methods

The following sections provide a summary of the survey operational procedures, with further details provided in the field report (Fugro, 2024b) and Appendix B.

3.1.1 Seafloor Photography

Seafloor photographic data were acquired using camera systems mounted within purpose-built frames. On the MV Fugro Helmert a SubC Rayfin Coastal video/stills camera (high-definition video, 12.3 megapixel stills) was used, equipped with two Aquorea LED lights and MantaRay Lasers to provide scale (10 cm parallel, accurate to 5 m). On the MV Fugro Venturer, a Subsea Technology and Rentals Limited SeaSpyder deep-sea camera system was used, complete with a high-definition video camera and high-resolution stills camera (24 megapixel). A separate high-power strobe and four high-intensity LED lamps provided illumination and quad scaling lasers were set up 17 cm wide by 17 cm high to provide a scale. The camera systems were equipped with ultra short baseline (USBL) beacons for subsea positioning.

On the MV Fugro Helmert, seafloor video was displayed on a computer monitor and recorded directly onto the acquisition computer using SubC Single Channel Inspection software. Still images were saved directly on the acquisition computer via the same software. On the MV Fugro Venturer, seafloor video was displayed on a computer monitor and recorded directly onto the server. The stills camera imagery was visible on a second window of the computer. The stills camera imagery was visible on a second window of the computer. Photographic data were viewed in real time, assisting in the control of the camera in the water.

3.1.2 Sediment Sampling

Samples for macrofaunal and sediment PSD analysis were acquired using a 0.1 m^2 Hamon grab. Samples for chemistry analysis were acquired using a 0.1 m^2 Day grab (MV Fugro Helmert) and a 0.1 m^2 dual van Veen (MV Fugro Venturer). Grab samples were positioned using a USBL beacon attached to the grab frame, with a positional fix taken when the grab reached the seafloor (evidenced through a distinct slackening of the wire rope and snatch block).

3.1.3 Water Sampling for eDNA Analysis

Water samples were acquired using a 5 L Niskin bottle sampler. At each station two samples were acquired, one near-surface, denoted ‘TOP’ and one near-seafloor, denoted ‘BOT’.

3.2 Laboratory Methods

A sample delivery log accompanied the samples to Fugro laboratories as part of the chain of custody. Upon receipt of samples at Fugro laboratories, sample handling and labelling of each sample was inspected to ascertain correct storage, in line with the sampling methods. Any potential deviations from sampling methods would be addressed and resolved at this stage in line with Fugro's Quality Assurance Management System.

3.2.1 Sediment Characteristics

3.2.1.1 Particle Size Distribution

Sediment samples were analysed by Fugro using dry sieve analysis and laser diffraction.

Dry sieve PSD analysis was undertaken in accordance with Fugro GB Limited (FGBL) in-house methods based on the North-East Atlantic Marine Biological Association Quality Control (NMBAQC) scheme's best practice guidance document – Particle Size Analysis (PSA) for Supporting Biological Analysis (Mason, 2022), and British Standards ([BS] 1377: Parts 1: 2016 and 2: 1990). Representative material > 1 mm was split from the bulk sub-sample and oven dried before being sieved through a series of sieves with apertures corresponding to 0.5 phi intervals between 63 mm and 1 mm as described by the Wentworth scale (Wentworth, 1922). The weight of the sediment fraction retained on each mesh was subsequently measured and recorded.

Laser diffraction PSD analysis was undertaken in accordance with FGBL in-house methods based on Mason (2022), and BS International Organisation for Standardisation ([ISO] 13320: 2020). Representative material < 1 mm was removed from the bulk subsample for laser analysis, with a minimum of three triplicate analyses performed using the laser sizer at 0.5 phi intervals between < 1 mm to < 0.98 µm.

3.2.2 Sediment Hydrocarbons

The sediment samples were analysed for total hydrocarbon content (THC) and polycyclic aromatic hydrocarbons (PAHs) by SOCOTEC.

3.2.2.1 Total Hydrocarbon Content

Total hydrocarbons were analysed using ultra-violet fluorescence spectroscopy. Anhydrous sodium sulphate, sodium chloride and dichloromethane (DCM) were added to a portion of the sample and vigorously agitated. The sample was placed in an ultrasonic bath and then centrifuged. The extract was then analysed by ultraviolet fluorescence screening and quantified by comparing the results against a forties oil calibration curve.

3.2.2.2 Polycyclic Aromatic Hydrocarbons (PAH)

Polycyclic aromatic hydrocarbons were analysed using solvent extraction and clean up followed by gas chromatography – mass spectrometry (GC-MS) analysis. Methanol and DCM were added to a portion of the sample and mixed on a magnetic stirring plate. The solvent extract was then water partitioned and concentrated to a low volume. A double clean-up stage was employed to remove contaminants that may interfere with the analysis. The extract was then analysed by GC-MS and quantified by comparing the results against a calibration curve for each of the target analytes.

3.2.3 Sediment Metals

The sediment samples were analysed for trace and heavy metal content by SOCOTEC using an aqua regia digest followed by inductively coupled plasma (ICP) analysis. The nine metals analysed were arsenic, cadmium, chromium, copper, lead, mercury, nickel, tin and zinc.

A portion of air dried and ground sample was digested with aqua regia. Once cooled, the extract was filtered and pre-diluted before being analysed by inductively coupled plasma-mass spectrometry (ICP-MS) or by inductively coupled plasma-optical emission spectrometry (ICP-OES) and quantified by comparing the results against a calibration curve for each of the target analytes.

The analytical technique provides a strong partial digest, releasing into solution metals associated with the fines fraction within the sediments (but does not extract all trace elements associated with the coarse fraction). The concentrations of metals released by an aqua regia digest are considered indicative of those influencing biological interactions, as the released metals are not incorporated into the mineral matrix and are therefore potentially available for biological uptake.

3.2.4 Sediment Polychlorinated Biphenyls

Sediment samples were analysed by SOCOTEC using solvent extraction and clean-up followed by analysis by gas chromatography coupled to a triple quadruple mass spectrometer (GC-MS-MS) analysis.

A portion of air-dried and sieved sample was spiked with ^{13}C labelled internal standards, ultrasonically solvent extracted and concentrated under nitrogen. A clean-up stage was employed to remove contaminants that may interfere with the analysis. The sample extract was analysed by GC-MS-MS and quantified by comparison with a solution containing each of the targeted compounds, normalised to the ^{13}C labelled internal standards.

3.2.5 Sediment Organotins

Sediment samples were analysed by SOCOTEC using solvent extraction and derivatisation followed by GC-MS analysis.

A portion of the sample was digested with hydrochloric acid and methanol before being extracted into toluene. The extract was then derivatised using sodium tetraethylborate before concentration and a copper/silica clean-up was performed. The extract was analysed by GC-MS and quantified by comparing the results against a calibration curve for each of the target analytes.

3.2.6 Sediment Macrofauna

Samples were analysed for macrofaunal content at Fugro GB and Hull Marine Laboratory (HML) University of Hull in accordance with the requirements of the NMBAQC scheme (Worsfold et al., 2010) and the relevant ISO standards for macrobenthic analysis.

Macrofaunal samples were sieved over a 1.0 mm mesh sieve and taxa were identified to the lowest possible taxonomic level and enumerated. Sessile colonial epifauna was recorded as present (P). Nomenclature follows the World Register of Marine Species [WoRMS] (WoRMS Editorial Board, 2024), or more recent literature where applicable. Species nomenclature is consistent with that of WoRMS. The taxonomic order is based on Species Directory codes (Howson & Picton, 1997). Taxa of doubtful identification due to damage of specimen or unresolved taxonomic status are indicated by a question mark preceding the genus (e.g. ?*Capitella*) or species (e.g. *Capitella* ?*capitata*) name.

Biomass was undertaken following identification and enumeration. The infauna from each sample was sorted into: Annelida, Cnidaria (only burrowing taxa), Crustacea, Mollusca, Echinodermata, and other phyla. Biomass was undertaken using the wet blot method.

3.2.7 Environmental DNA Analysis

Water samples were analysed for eDNA by NatureMetrics.

Environmental DNA comprises DNA fragments shed from any living form into the environment, including the water environment. TOP and BOT water samples were collected by filtration (Fugro, 2024a) and were analysed for eDNA taxonomic classification of bony fish taxa at the time of sampling. Environmental DNA is currently considered to persist in the environment in temperate marine environments for approximately 48 h before degradation greatly affects eDNA quality (Holman et al., 2022) therefore results of this study cover this temporal window. Consequently, the eDNA detected at the sampling stations may include eDNA of organisms outside the survey area due to hydrodynamic effects. Cartilaginous fish (e.g. sharks and rays) were not included in this analysis. The eDNA was extracted following a protocol modified to increase DNA yields and an extraction blank was also processed for the extraction batch.

The DNA collected was purified to remove polymerase chain reaction (PCR) inhibitors and amplified with PCR for a hypervariable region of the 12S r-ribonucleic acid (RNA) gene to target fish (excluding sharks and rays). Consensus taxonomic assignments were made for each operational taxonomic unit (OTU) using sequence similarity searches against the National Centre for Biotechnology Information (NCBI) nucleotide (GenBank) reference database. Searches against databases were made using BLAST (Altschul et al., 1990; Camacho et al., 2009) and required hits to have a minimum e-score of 1e-20 and cover at least 90 % of the query sequence. The taxonomic identification with all hits was converted to match the GBIF taxonomic backbone. Assignments were made to the lowest possible taxonomic level. Minimum similarity thresholds of 99 %, 97 %, and 95 % were used for species, genus, and higher-level taxonomic classification, respectively. In instances where equally good matches to multiple species occurred, public records from the Global Biodiversity Information Facility [GBIF] (GBIF, 2023) were used to assess which were most likely to be present. Higher-level taxonomic identifications or multiple potential identifications were reported in case of uncertainties.

The OTU table was filtered to remove low abundance OTUs from each sample (< 0.02 % or < 10 reads, whichever is the greater threshold for the sample). Unassigned OTUs, and OTUs identified to human and domesticated mammals, were removed from the dataset prior to subsequent analysis.

A summary of the results is presented in the sections below. Full laboratory reports are presented in Appendix H.

3.3 Data Analysis

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

3.3.1 Sediment Particle Size Distribution Statistics

Data from the sieve and laser analysis were merged and entered in Gradistat version 8 (v8) (Blott, 2010) to derive statistics including cumulative percentage of each particle size passing through each sieve, percentage retained on each sieve stack, mean and median grain size, bulk sediment classes (percentage fines, sand and gravel), skewness and sorting coefficients, and Folk (1954) classification. Table 3.1 summarises the sediment PSD statistics that were calculated using Gradistat v8. Statistics are based on the Folk and Ward (1957) method.

The Wentworth (1922) sediment classification is based on mean sediment particle size. The Folk (British Geological Survey (BGS) modified) classification (Long, 2006) is based on percentages of main sediment fractions (fines, sand and gravel). Results are reported in micron (µm) and phi (ϕ) measurement units. Phi is a logarithmic scale which allows particle size data to be expressed in unit of equal value for graphical plotting and statistical calculations; the scale is based on the relationship:

Phi $(\phi) = -\log_2 d$, where d is the particle size diameter in mm.

Table 3.1: Sediment particle size distribution statistics

Statistic	Definition and Descriptive Terminology
Mean	The arithmetic mean of all the sediment particles in a sample, expressed in metric and phi units
Median	A measure of central tendency, that is the midpoint of the grain size distribution where half of the sediment grains resides above this point and half below
Mode	The peak of the frequency distribution, that is the particle size (or size range), most commonly found in the distribution
Modality	A measure of the number of peaks in the frequency distribution
Sorting	A measure of the grain size range and magnitude of their spread around the mean, presented as a coefficient and descriptor (as a range of values)
Skewness	A measure of the degree of symmetry, presented as a coefficient and descriptor (as a range of values)

3.3.2 Sediment Macrofauna Data Rationalisation

Prior to analysis, the macrofaunal dataset was rationalised. To avoid spurious enhancement of the species list, damaged taxa were removed whereas some taxa were merged with a higher corresponding taxon identified. Juveniles were also removed as they represent an ephemeral stage of the macrofaunal community and are, therefore, not representative of prevailing benthic conditions. Sessile colonial epifauna recorded as P was also removed prior to analysis and assessed separately from the enumerated dataset.

3.3.3 Sediment Macrofaunal Univariate Analysis

Table 3.2 summarises the univariate statistics derived from PRIMER v7.

Table 3.2: Macrofaunal Univariate Statistics

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

3.3.4 Biomass Analysis

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

Table 3.3: Macrofaunal standard biomass corrections by phyla

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

3.3.5 Multivariate Analysis

Table 3.4 summarises the multivariate analysis undertaken for macrofaunal and sediment datasets in PRIMER v7 (Clarke & Gorley, 2015). Data transformation was undertaken prior to multivariate analysis, where deemed necessary. Fourth root transformation was applied to sediment particle size data to reduce the degree of skewness and allow optimal performance of the multivariate analysis (detailed in Section 4.2.2). Fourth root transformation was applied to macrofaunal data matrix to reduce the influence of the numerically dominant taxa which may mask the underlying community composition (detailed in Section 4.5.1.3) (Clarke et al., 2014).

Table 3.4: Multivariate Statistics

Statistic	Definition
Cluster	Hierarchical clustering, 'Cluster' analysis, groups samples based on the nearest neighbour sorting of a matrix of sample similarities using Bray Curtis similarity (for biological datasets) or Euclidean distance measure (for environmental datasets)
Dendrogram and nMDS	Dendrogram and non-metric multidimensional scaling (nMDS) ordination are outputs of Bray Curtis and Euclidean Distance similarity/distance matrices. The dendrogram is a tree-like diagram illustrating the relationships between samples based on their level of similarity. The nMDS ordinates the samples in a two-dimensional plane where the more similar samples are, the nearer they are. The extent to which these relations can be adequately represented in a two-dimensional map is expressed as the stress coefficient statistic, low values (< 0.1) indicating a good ordination with no real prospect of misleading interpretation (Clarke et al., 2014). Used together, dendrogram and nMDS allow checking adequacy and mutual consistency of both representations to ensure correct interpretation
SIMPROF	Similarity profiling ('SIMPROF' algorithm), to identify statistically significant clusters; in ecological terms the statistical relevance of similarity profile testing is assessed in line with the recommendation of Clarke et al. (2008), thus defining coarser grouping can be appropriate if the resulting groups are supersets of the similarity profile clusters

Statistic	Definition
SIMPER	Similarity Percentage analysis gauges the distinctiveness of each of the multivariate groups of samples, by listing the species that most contribute to the multivariate group in terms of abundance and frequency of occurrence
PCA	Principal component analysis (PCA), to identify multidimensional patterns and relationships between variables, subsequently compressed by reducing the number of dimensions without loss of information. The degree to which a 2D PCA succeeds in representing the full multidimensional information is in the percentage of the total variance expressed by the first two principal component axes. A picture which accounts for as much as 70 % to 75 % of the original variation describes the overall structure well (Clarke et al., 2014)
BIOENV	Identifies relationships between biological and environmental variables; available in PRIMER v7 as BEST, which amalgamates the Bio-Env and Stepwise procedures, and allows to evaluate the strength of association between the variables tested and the significance level

3.3.6 Environmental DNA Analysis

The original data analysis, as provided in the report presented in Appendix H, was carried out by NatureMetrics. Additional data analysis and the interpretation was carried out by Fugro GB Limited.

The eDNA analysis aims at displaying species level or lowest taxonomic level confidently detected. Identifications were sense-checked against GBIF occurrence records for presence in the sampling country and elevated to higher taxonomic levels where required (rgbif; Chamberlain et al., 2023). Unassigned OTUs, and OTUs identified to human and domesticated mammals, were removed from the dataset for subsequent analyses.

Due to the compositional nature of the eDNA data, results were transformed into relative proportions of OTUs (McKnight et al., 2019), prior to analysis. Bar plots were used to visualise bony fish OTUs, to order level, detected in the TOP and BOT samples. The eDNA signal, which indicates the proportion of DNA sequences within a sample, was represented using a bubble plot. Larger bubble size potentially indicates a stronger eDNA signal. As the seafloor photographic and macrofaunal data analyses also identified fish taxa (Actinopterygii), data were analysed by means of in-house data analysis (within R v. 4.4.2, 2024) to generate a Venn Diagram. The datasets were raised to family or higher taxonomic level to ensure comparability between datasets. Overlap of circles represents the proportion of fish taxa at families, or higher taxonomic levels, which have been identified by more than one method.

All OTUs with species-level identifications were queried against the International Union for Conservation of Nature (IUCN) red list of threatened species (IUCN, 2023), a comprehensive inventory of the global conservation status of species. Species were also assessed for their conservation status using the UK Biodiversity Action Plan (BAP) list of priority species (JNCC, 2024), and the OSPAR threatened and/or declining species and habitats (OSPAR, 2024).

3.3.7 Seafloor Photographic Data Analysis

To assess the habitats present within the survey area, detailed analysis of photographic data was undertaken, noting the locations of any observed changes in sediment type and/or associated faunal community. Results of the sediment PSD analysis were used to provide further information on sediment composition.

Taxa were recorded to the lowest possible taxonomic level. It should be noted that many taxa cannot be identified to low taxonomic level (e.g. genus or species level) from photographic data alone and, as such, where appropriate, higher taxonomic levels were used.

Descriptions of the substrate composition, corresponding to sediment changes, were undertaken for each video segment. As detailed in Kaskela et al. (2019), these descriptions follow the European Marine Observation Data Network (EMODnet) sediment classification which is based on a reclassification of the Folk (1954) sediment classes and was developed to support the European Nature Information System (EUNIS) habitat identification (Long, 2006; European Environment Agency [EEA], 2022) in conjunction with the Wentworth (1922) classification. Table 3.5 presents a summary of the sediment particle sizes and corresponding classifications.

Table 3.5: Sediment particle size and classification terms

<table>
<tr><th>Particle Size</th><th>Wentworth (1922)</th><th>Folk (1954)</th><th colspan="4">Folk, 5 classes (Kaskela et al., 2019)</th></tr>
<tr><td>> 256 mm</td><td>Boulder</td><td rowspan="7">Gravel</td><td colspan="4" rowspan="2">Rock and boulders</td></tr>
<tr><td>64 mm to 256 mm</td><td>Cobble</td></tr>
<tr><td>32 mm to < 64 mm</td><td rowspan="4">Pebbles</td><td rowspan="10">Coarse sediment:
(Gravel ≥ 80 %,
or
Gravel ≥ 5 %
and Sand ≥ 90 %)</td><td rowspan="12">Mixed sediment:
(Mud ≥ 10 % - 95 %
Sand < 90 %
Gravel ≥ 5%)</td><td rowspan="12">Mud to muddy sand*:
(Mud 10 % - 95 %
Sand < 90 %
Gravel < 5 %)</td><td rowspan="12">Sand:
(Mud < 10 %
Sand ≥ 90 %
Gravel < 5%)</td></tr>
<tr><td>16 mm to < 32 mm</td></tr>
<tr><td>8 mm to < 16 mm</td></tr>
<tr><td>4 mm to < 8 mm</td></tr>
<tr><td>2 mm to < 4 mm</td><td>Granules</td></tr>
<tr><td>1 mm to < 2 mm</td><td>Very coarse sand</td><td rowspan="5">Sand</td></tr>
<tr><td>0.5 mm to < 1 mm</td><td>Coarse sand</td></tr>
<tr><td>0.25 mm to < 0.5 mm</td><td>Medium sand</td></tr>
<tr><td>0.125 mm to < 0.25 mm</td><td>Fine sand</td></tr>
<tr><td>62.5 µm to 0.125 mm</td><td>Very fine sand</td></tr>
<tr><td>> 4 µm to 62.5 µm</td><td>Silt</td><td rowspan="2">Mud</td><td rowspan="2">–</td></tr>
<tr><td>> 1 µm to 4 µm</td><td>Clay</td></tr>
<tr><td colspan="7">Notes
* = Mud to muddy sand includes:
Mud (Mud ≥ 90 %, Sand < 10 %, Gravel < 5 %)
Sandy mud (Mud 50 % to 90 %, Sand 10 % to 50 %, Gravel < 5 %)
Muddy sand (Mud 10 % to 50 %, Sand 50 % to 90 %, Gravel < 5 %) (Kaskela et al., 2019)</td></tr>
</table>

3.3.8 Seafloor Habitats Classification

Habitat types were classified in line with the hierarchical EUNIS habitat classification (EEA, 2022), which has compiled criteria for habitat identification across Europe into a single database. Table 3.6 presents the EUNIS hierarchy, with an example of the coding system. The equivalent of 'The Marine Habitat Classification for Britain and Ireland – Version 22.04' (Joint Nature Conservation Committee [JNCC], 2022) was also noted. The JNCC classification formed the basis of the marine section of the EUNIS habitat classification scheme (Davies & Moss, 2004).

Habitat types were classified by integrating the results of the grab sampling with the results of the photographic data analysis. Habitat types were subsequently assessed for their ecological and conservation importance drawing upon the current marine nature conservation legislation.

Table 3.6: EUNIS (EEA, 2022) biotope classification hierarchy example

Level	Example Classification Name	Example Classification Code
1. Sea	Atlantic	ATL
2. Biological Zone and Substrate	Offshore circalittoral coarse sediment	MD3
3. Biogeographical Marine Region	Atlantic circalittoral mixed sediment	MC42
4. Biotope complex	Faunal communities of Atlantic circalittoral mixed sediment	MC421
5. Biotopes	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	MC4214
Notes EUNIS = European Nature Information System EEA = European Environment Agency		

3.3.9 Sensitive Habitats and Species Assessments

Species were assessed for their conservation status using the Annex II species list (JNCC, n.d.; EU, 2013), the UK Biodiversity Action Plan (BAP) list of priority species (JNCC, 2024) and the OSPAR list of threatened and/or declining species and habitats (OSPAR, 2024).

The International Union for Conservation of Nature (IUCN) red list of threatened species (IUCN, 2024) was also consulted, although the latter is not a list of conservation priorities, rather a comprehensive inventory of the global conservation status of species. The list is used to assist with decision making about conserving biodiversity at local and global levels.

Habitats were assessed for their conservation status using the Annex I habitat list (JNCC, n.d.; EU, 2013) using the methods outlined below.

3.3.9.1 Stony Reef

When considering the potential of an area as the Annex I habitat 'Stony reef', the composition of the substrate is an important characteristic. Stony reef is defined as comprising coarse sediments with a diameter more than 64 mm (cobbles and boulders) that provide a hard substratum. The relationship between the coarse material and sediment in which it lies is integral in determining 'reefiness'. Matrix (soft sediment) supported material is likely to have a patchier distribution than clast (coarse sediment) supported and so have lower 'reefiness'; additionally, matrix supported material is likely to have a larger infaunal component which again reduces its 'reefiness' (Irving, 2009). Reefs are also defined as having relief from the seafloor, and as such relief is used as another criterion for assessment. The epifaunal community of potential reef habitat is also a key determinant of its 'reefiness' and proportion of epifauna species to infaunal species is therefore included as an assessment criterion. Within the Irving (2009) scheme, areas of potential stony reef habitat must have an area of more than 25 m^2 to be classified as reef; this report also adopts this minimum area, with area of features of interest considered during initial selection of the transect locations. Table 3.7 presents the Irving (2009) criteria of 'reefiness' for stony reef habitat assessments. Table 3.8 presents the stony reef matrix used to assess the overall 'reefiness' of an area.

Table 3.7: Measures of 'reefiness' for stony reef habitat

Characteristic	Resemblance to a 'Stony Reef'			
	Not a reef	Low	Medium	High
Composition Diameter of cobbles/boulders being greater than 64 mm. Percentage cover relates to a minimum area of 25 m^2. The 'composition' characteristic also includes 'patchiness'.	< 10 %	10 % – 40 %	40 % – 95 %	> 95 %
Elevation Minimum height (64 mm) relates to minimum size constituent cobbles. This characteristic could also include 'distinctness' from the surrounding seafloor. Note that two units (mm and m) are used.	Flat seafloor	< 64 mm	64 mm – 5 m	> 5 m
Extent	< 25 m^2	> 25 m^2		
Biota	Dominated by infaunal species	–	–	> 80 % of species present composed of epifaunal species

Notes
When determining whether an area of the seafloor should be considered as Annex I stony reef, if a 'low' is scored in any of the four characteristics (composition, elevation, extent or biota), then a strong justification would be required for this area to be considered as contributing to the Marine Natura site network of qualifying reefs in according to the 2019 Regulations

Table 3.8: Stony reef matrix

Reef Structure	Composition (% of Seafloor Comprised of Cobbles/Boulders)				Biota
Elevation	< 10	10 – 40	40 – 95	> 95	
Flat seafloor	Not a reef	Not a reef	Not a reef	Not a reef	Infauna dominated
< 64 mm	Not a reef	Low	Low	Low	–
64 mm – 5 m	Not a reef	Low	Medium	Medium	–
> 5 m	Not a reef	Low	Medium	High	> 80 %
Notes Full reef assessment not applicable to areas of cobble and/or boulders with an extent of < 25 m^2, which would be classified as 'Not a Reef'					

3.3.9.2 *Sabellaria spinulosa* Reefs

Transects in which potential *S. spinulosa* reef was observed were evaluated in detail using the methodology outlined in Jenkins et al. (2018). This methodology provides detailed analysis, demonstrating spatial variability of *S. spinulosa* reef, thus allowing increased accuracy in classifying potential biogenic reef. The Jenkins et al. (2018) guidelines combine the criteria outlined in Gubbay (2007) to provide an overall reefiness assessment for potential reefs as presented in Table 3.10.

Each video transect was split into 5 second sections. The quality of the photographic data for each segment was recorded using the following categories:

- 0 = completely unusable segment (low visibility or where camera did not move for 5 seconds);
- 1 = low quality image (i.e. low confidence in one or more criteria recorded);
- 2 = good quality (high confidence in criteria recorded).

The percentage cover of *S. spinulosa* was estimated within each segment with the aid of a grid overlay on the video data. Figure 3.1 presents an example of the grid overlain on the video data.

Areas where *S. spinulosa* was observed were analysed in detail for potential classification as a biogenic reef. Video and geophysical data were reviewed according to JNCC guidelines that propose criteria for assessment of 'reefiness' of *S. spinulosa* aggregations (Gubbay, 2007). Within this report, it was decided that the simplest definition of a *S. spinulosa* reef was an area of *S. spinulosa* that is elevated from the seafloor and has a spatial extent of > 25 m^2. Colonies may be patchy within an area defined as reef and represent a range of elevations. These criteria are in the process of being discussed within the scientific communities and may evolve overtime.

Table 3.9: Measures of 'Reefiness' of *Sabellaria spinulosa* aggregations

Measure of 'Reefiness' (Gubbay, 2007)	Not a Reef	Low	Medium	High
Elevation [cm] (mean tube height)	< 2	2 - 5	5 - 10	> 10
Area [m^2]	< 25	25 - 10000	10000 - 1000000	> 1000000
Patchiness [% cover]	< 10%	10 - 20%	20 - 30%	> 30%
Reefiness Key				
Not a Reef	Low	Medium	High	

Table 3.10: *Sabellaria spinulosa* reef structure matrix

Reef Structure (Jenkins et al., 2015)		Elevation [cm]			
		< 2	2 - 5	5 - 10	> 10
		Not a Reef	Low	Medium	High
< 10%	Not a Reef				
10 - 20%	Low				
20 - 30%	Medium				
> 30 %	High				
Reefiness Key					
Not a Reef	Low 'Reefiness'	Medium 'Reefiness'	High 'Reefiness'		

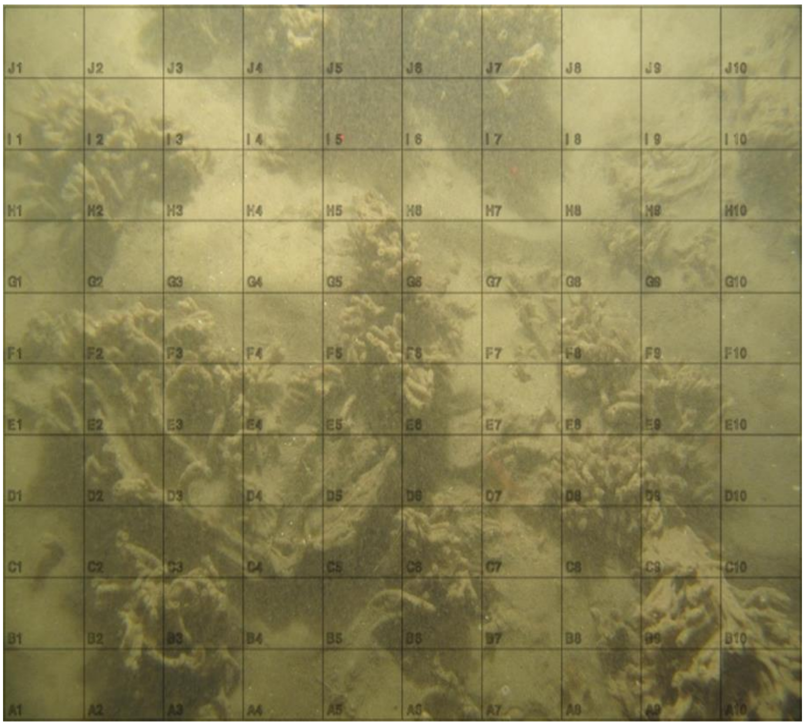


Figure 3.1: Non-project related example picture of a video frame with overlaid grid

3.3.10 Sea Pen and Burrowing Megafauna Communities

To assess the abundance and density of sea pens and burrowing megafauna, the seafloor video was reviewed at half speed to real-time, with visible sea pen taxa, burrows and mounds enumerated. Counts were then converted to the superabundant, abundant, common, frequent, occasional, rare (SACFOR) abundance scale used by the Marine Nature Conservation Review and Joint Nature Conservation Committee (JNCC) to semi-quantitatively record the abundance and density of marine benthic flora and fauna (JNCC, 2015). When assessing density, the SACFOR scale converts 'numbers per m^2' to an abundance category with consideration of the size class of the species. Table 3.11 presents the SACFOR scale conversion used and Table 3.12 outlines the size classes used to assess taxa and cryptic bioturbation signs.

Table 3.11: The SACFOR scale used for sea pen, mound and burrow density assessment

SACFOR Scale	3 cm to 15 cm*		> 15 cm†	
	Individuals per m^2	Density	Individuals per m^2	Density
Superabundant	100 – 1000	1 – 9/0.01 m^2 (10 × 10 cm)	10 – 99	1 – 9/0.1 m^2
Abundant	10 – 99	1 – 9/0.1 m^2	1 – 9	1 – 9/m^2
Common	1 – 9	1 – 9/ m^2	0.1 – 0.99	1 – 9/10 m^2 (3.16 × 3.16 m)
Frequent	0.1 – 1.0	1 – 9/10 m^2 (3.16 × 3.16 m)	0.01 – 0.09	1 – 9/100 m^2 (10 × 10 m)
Occasional	0.01 – 0.09	1 – 9/100 m^2 (10 × 10 m)	0.001 – 0.009	1 – 9/1000 m^2 (31.6 × 31.6 m)
Rare	0.001 – 0.009	1 – 9/1000 m^2 (31.6 × 31.6 m)	0.0001 – 0.0009	< 1/1000 m^2

Notes
* = 3 cm to 15 cm: *Pennatula phosphorea*, *Virgularia* sp., mounds and megafaunal burrows, with the exception of those created by taxa that reach more than 15 cm in length (e.g., *Nephrops norvegicus*)
† = > 15 cm: *Funiculina quadrangularis*, *Nephrops norvegicus* burrows

Table 3.12: Summary of sea pen, mound and burrows enumeration methodology

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

3.3.11 Non-native Species (NNS)

Species of unknown origin (cryptogenic) and NNS were assessed using pertinent literature and databases including:

- Cottier-Cook et al. (2017);
- Harrower et al. (2023);
- Hill et al. (2009);
- Roy et al. (2012);
- Compendium Invasive Species (Centre for Agriculture and Bioscience International [CABI], 2024);
- National Exotic Marine and Estuarine Species Information System [NEMESIS] (Fofonoff et al., 2023);
- National Biodiversity Network [NBN] (NBN, 2024);
- Non-native Species Secretariat [NNSS] (NNSS, 2024);
- Delivering Alien Invasive Species Inventories for Europe [DAISIE] (Roy et al., 2020);
- WoRMS (WoRMS Editorial Board, 2024).

4. Results

4.1 2023

Data from a study of the DBD undertaken in 2023 (Fugro, 2024a) have been presented with respect to the array area and station ST141 at the Client's request. Station ST141 has been included in the analysis due to the close proximity to the array and therefore within the potential zone of influence of the project. The data from the 2023 study are presented for information but not further discussed.

4.1.1 Field Operations

4.1.1.1 Seafloor Photography

Photographic data was successfully acquired at all required stations (Table 4.1).

At selected stations, transects were re-run owing to underwater currents and/or visibility at the time of the survey. The re-run transects were denoted with the suffix A.

Photographic data was also acquired at reserve station ST126.

Figure 4.1 illustrates the completed survey locations.

4.1.1.2 Seafloor Sampling

Table 4.2 presents the completed sediment sampling stations.

A single sample for sediment PSD was acquired at reserve station ST126. At the remaining stations, grab sampling for macrofaunal and sediment PSD analysis was successfully acquired at all stations.

Samples for chemistry analysis were successfully acquired at all proposed stations.

Figure 4.1 illustrates the completed survey locations.

Table 4.1: Completed video transects, Dogger Bank D Array 2023

Geodetic Parameters: WGS 84, UTM 31N [m]							
Station	SOL		EOL		Depth [m BSL]	Length [m]	Data Acquisition
	Easting	Northing	Easting	Northing			
ST105	481 647.4	6 107 714.5	481 635.9	6 107 633.1	23.9	82.2	3 min 0 secs 12 stills
ST106	483 418.2	6 106 681.3	483 363.1	6 106 634.8	24.4	72.1	2 min 35 secs 16 stills
ST109	488 240.0	6 104 830.1	488 243.8	6 104 783.0	22.9	47.2*	9 min 19 secs 11 stills
ST110	489 382.6	6 105 996.7	489 386.3	6 105 929.8	23.6	67.0	2 min 39 secs 11 stills
ST111	489 747.7	6 101 373.5	489 835.8	6 101 347.2	22.3	92.0	1 min 59 secs 18 stills
ST112	490 242.9	6 103 414.4	490 249.2	6 103 399.2	22.1	16.5*	8 min 56 secs 13 stills
ST113	490 274.2	6 104 974.8	490 239.1	6 104 944.4	23.6	46.4*	3 min 28 secs 15 stills
ST114	490 569.4	6 106 593.2	490 541.3	6 106 526.7	25.9	72.2	4 min 23 secs 13 stills
ST116	491 851.3	6 105 716.0	491 778.2	6 105 724.0	23.8	73.5	1 min 43 secs 11 stills
ST117	492 197.6	6 104 681.8	492 239.3	6 104 621.5	17.9	73.3	3 min 16 secs 21 stills
ST119	492 360.5	6 100 259.9	492 373.7	6 100 173.4	22.8	87.5	1 min 41 secs 18 stills
ST120	493 168.6	6 098 003.5	493 223.7	6 098 046.9	24.1	70.2	3 min 0 secs 13 stills
ST121	493 493.9	6 106 769.1	493 449.7	6 106 730.2	26.8	58.9	1 min 47 secs 15 stills
ST122	493 503.7	6 102 990.2	493 477.9	6 102 947.0	25.1	50.4	3 min 4 secs 5 stills
ST123	493 833.2	6 104 603.0	493 829.0	6 104 544.5	25.0	58.7	1 min 57 secs 18 stills
ST124	494 340.9	6 105 403.4	494 330.9	6 105 460.6	31.3	58.0	1 min 7 secs 10 stills
ST126	494 714.8	6 103 006.6	494 711.1	6 102 887.0	27.9	119.7	2 min 20 secs 10 stills
ST126A	494 724.2	6 103 024.8	494 732.7	6 102 902.3	27.7	122.8	2 min 48 secs 13 stills
ST127	494 837.6	6 107 484.3	494 760.9	6 107 456.1	30.0	81.8	2 min 46 secs 25 stills
ST129	494 941.2	6 103 720.7	494 907.4	6 103 651.9	26.7	76.6	2 min 18 secs 12 stills
ST130	494 936.8	6 105 972.3	494 943.2	6 105 917.5	27.4	55.2	1 min 42 secs 17 stills
ST131	495 696.4	6 102 185.0	495 780.4	6 102 207.0	28.3	86.8	2 min 38 secs 18 stills
ST132	495 715.4	6 099 595.8	495 792.5	6 099 598.1	26.4	77.1	2 min 9 secs 16 stills
ST133	495 985.9	6 106 594.2	495 973.3	6 106 527.5	28.6	67.9	1 min 41 secs 16 stills
ST134	496 447.1	6 107 115.3	496 451.2	6 107 056.9	28.9	58.5	2 min 19 secs 19 stills
ST136	496 476.0	6 102 840.6	496 533.8	6 102 889.3	26.6	75.6	2 min 30 secs 17 stills
ST137	496 469.3	6 093 573.2	496 557.5	6 093 568.9	30.4	88.3	3 min 6 secs 23 stills
ST138	497 077.0	6 104 400.8	497 052.1	6 104 260.8	28.7	142.2	4 min 1 secs 14 stills
ST139	497 099.5	6 101 773.0	497 159.2	6 101 814.8	27.8	72.9	2 min 7 secs 14 stills
ST140	497 113.7	6 092 490.4	497 185.0	6 092 483.6	24.4	71.7	2 min 11 secs 17 stills
ST141†	497 174.9	6 089 175.0	497 256.3	6 089 174.0	22.0	81.4	2 min 29 secs 17 stills
ST142	497 382.9	6 095 507.4	497 474.0	6 095 513.4	29.7	91.3	2 min 50 secs 18 stills

Station	SOL Easting	SOL Northing	EOL Easting	EOL Northing	Depth [m BSL]	Length [m]	Data Acquisition
Geodetic Parameters: WGS 84, UTM 31N [m]							
ST143	497 539.1	6 099 603.4	497 512.9	6 099 547.0	26.1	62.1	2 min 3 secs 16 stills
ST144	497 547.2	6 093 857.3	497 619.5	6 093 880.6	25.4	76.0	2 min 55 secs 17 stills
ST145	498 252.6	6 099 649.2	498 208.3	6 099 589.3	27.2	74.5	1 min 47 secs 18 stills
ST147	498 779.6	6 102 658.0	498 726.9	6 102 620.1	28.5	64.9	2 min 8 secs 15 stills
ST148	499 333.4	6 097 014.9	499 408.1	6 096 982.5	23.9	81.5	2 min 13 secs 19 stills
ST149	499 454.1	6 103 959.9	499 428.1	6 103 893.9	26.1	70.9	2 min 11 secs 14 stills
ST150	500 022.0	6 096 686.9	499 967.4	6 096 635.8	23.9	74.8	2 min 34 secs 19 stills
ST151	500 154.9	6 101 109.0	500 251.1	6 101 115.8	25.0	96.4	2 min 21 secs 16 stills
ST152	500 301.1	6 104 657.9	500 291.0	6 104 589.0	26.7	69.6	2 min 40 secs 14 stills
ST154	501 143.4	6 094 755.7	501 076.6	6 094 778.1	22.1	70.5	1 min 59 secs 14 stills
ST155	501 993.7	6 092 380.1	502 071.1	6 092 380.2	21.8	77.4	2 min 38 secs 16 stills
ST156	502 245.8	6 100 969.7	502 187.5	6 100 986.0	23.6	60.5	1 min 27 secs 1 still
ST156A	502 200.6	6 101 033.0	502 199.4	6 100 945.4	24.6	87.5	1 min 52 secs 12 stills
ST158	502 456.6	6 096 411.0	502 442.2	6 096 403.0	22.2	16.4	3 min 9 secs 23 stills
ST159	503 189.7	6 106 118.4	503 127.1	6 106 033.1	25.6	105.8	2 min 56 secs 16 stills
ST160	504 851.1	6 105 830.9	504 794.4	6 105 753.3	25.4	96.1	2 min 32 secs 13 stills
ST165	481 672.2	6 105 599.9	481 633.5	6 105 526.6	23.2	82.9	1 min 55 secs 14 stills
ST216	479 531.2	6 107 665.6	479 578.6	6 107 624.7	25.8	62.6	1 min 36 secs 12 stills

Notes
BSL = Below sea level SOL = Start of line EOL = End of line * = Transect was not linear due to tidal constraints, but the total line length > 50 m
† = Included due to client request

Table 4.2: Completed sediment sampling stations, Dogger Bank D Array 2023

Station	Easting	Northing	Offset from Proposed [m]	Depth [m BSL]	Sample Acquisition
Geodetic Parameters: WGS 84, UTM 31N [m]					
ST105	481 639.4	6 107 664.3	15.2	24.1	FA, PSD
ST106	483 391.5	6 106 656.1	15.2	24.1	FA, PSD
	483 378.4	6 106 673.4	10.3	42.0	SC
ST109	488 243.4	6 104 773.6	6.4	23.9	FA, PSD
ST110	489 385.1	6 105 970.8	3.2	24.8	FA, PSD
ST111	489 805.6	6 101 372.5	14.6	23.3	FA, PSD
ST112	490 248.5	6 103 383.7	9.8	25.2	FA, PSD
ST113	490 289.4	6 104 947.1	20.6	24.8	FA, PSD
ST114	490 558.3	6 106 576.2	16.8	28.1	FA, PSD
ST116	491 803.7	6 105 707.4	2.7	24.4	FA, PSD
ST117	492 198.9	6 104 656.4	23.7	17.9	FA, PSD
ST119	492 369.5	6 100 227.9	18.0	23.3	FA, PSD
ST120	493 225.7	6 098 017.5	12.9	24.0	FA, PSD
	493 221.4	6 098 021.8	8.6	24.5	SC
ST121	493 479.3	6 106 753.6	11.8	26.8	FA, PSD
ST122	493 506.4	6 102 994.8	8.0	25.2	FA, PSD
ST123	493 829.7	6 104 586.3	6.4	25.0	FA, PSD
ST124	494 337.9	6 105 408.8	18.8	30.7	FA, PSD

Geodetic Parameters: WGS 84, UTM 31N [m]					
Station	Easting	Northing	Offset from Proposed [m]	Depth [m BSL]	Sample Acquisition
ST126	494 705.8	6 102 945.1	15.3	27.8	PSD
ST127	494 808.4	6 107 462.7	20.7	31.2	FA, PSD
ST129	494 935.0	6 103 690.5	16.7	27.5	FA, PSD
ST130	494 909.6	6 105 949.6	20.4	26.7	FA, PSD
ST131	495 733.7	6 102 188.7	14.6	29.7	FA, PSD
ST132	495 763.8	6 099 616.3	12.5	25.7	FA, PSD
ST133	495 965.0	6 106 578.8	9.3	30.7	FA, PSD
ST134	496 439.2	6 107 088.7	8.3	29.6	FA, PSD
ST136	496 501.8	6 102 868.5	14.0	27.9	FA, PSD
	496 497.7	6 102 866.4	16.6	28.0	SC
ST137	496 531.9	6 093 589.0	10.2	32.3	FA, PSD
ST138	497 071.5	6 104 295.1	18.2	29.5	FA, PSD
ST139	497 144.8	6 101 773.1	5.7	29.8	FA, PSD
ST140	497 172.2	6 092 500.2	18.3	24.2	FA, PSD
ST141[†]	497 229.9	6 089 203.5	24.0	22.7	FA, PSD
ST142	497 452.8	6 095 519.6	11.8	29.9	FA, PSD
ST143	497 527.4	6 099 559.9	10.1	28.1	FA, PSD
ST144	497 611.2	6 093 877.8	18.0	27.0	FA, PSD
ST145	498 236.3	6 099 637.4	17.7	28.2	FA, PSD
ST147	498 764.0	6 102 639.9	7.0	30.9	FA, PSD
ST148	499 369.3	6 097 009.3	9.3	24.7	FA, PSD
ST149	499 437.6	6 103 933.6	5.7	27.7	FA, PSD
ST150	499 994.9	6 096 665.8	16.0	25.4	FA, PSD
ST151	500 207.9	6 101 112.1	9.3	25.0	FA, PSD
ST152	500 280.1	6 104 606.8	8.7	26.7	FA, PSD
ST154	501 109.6	6 094 759.7	7.6	23.0	FA, PSD
ST155	502 043.4	6 092 392.8	2.8	21.2	FA, PSD
	502 029.5	6 092 410.1	24.2	18.6	SC
ST156	502 190.4	6 100 963.6	17.7	24.2	FA, PSD
ST158	502 464.5	6 096 394.4	15.0	23.2	FA, PSD
ST159	503 165.0	6 106 048.0	14.1	26.7	FA, PSD
ST160	504 831.0	6 105 782.3	11.2	25.5	FA, PSD
	504 833.7	6 105 785.0	14.6	25.5	SC
ST165	481 661	6 105 566	14.4	24.6	FA, PSD
ST216	479 566	6 107 653	16.6	26.7	FA, PSD

Notes
BSL = Below sea level
FA = Faunal sample A
SC = Sediment chemistry
PSD = Particle size distribution
† = Included due to client request

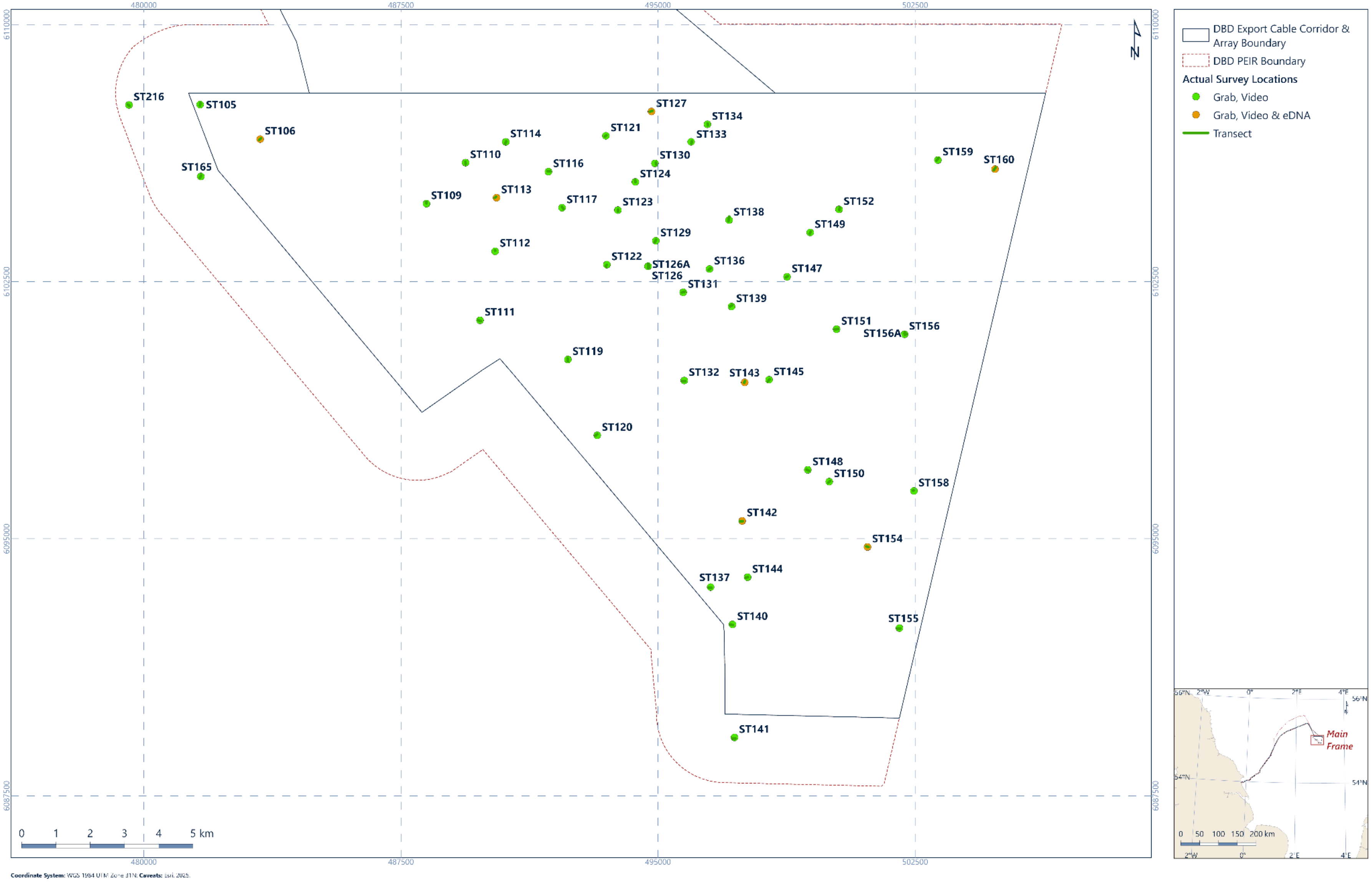


Figure 4.1: Completed survey locations, Dogger Bank Array 2023

4.1.1.3 Water Sampling for eDNA Analysis

Water samples for eDNA analysis were successfully acquired at all proposed stations (Table 4.3).

Table 4.3: Completed water sampling stations, Dogger Bank D Array 2023

Geodetic Parameters: WGS 84, UTM 31N [m]					
Station	Sampling Depth	Easting	Northing	Water Depth [m BSL]	Sample Acquisition
ST106	TOP	483 398.3	6 106 658.8	1.0	eDNA
	BOT	483 403.9	6 106 662.9	42.1	eDNA
ST113	TOP	490 284.2	6 104 953.6	1.0	eDNA
	BOT	490 276.1	6 104 962.8	19.7	eDNA
ST127	TOP	494 794.8	6 107 476.5	1.0	eDNA
	BOT	494 810.5	6 107 470.4	28.4	eDNA
ST142	TOP	497 460.1	6 095 506.8	1.0	eDNA
	BOT	497 455.8	6 095 529.5	24.3	eDNA
ST143	TOP	497 541.6	6 099 584.9	1.0	eDNA
	BOT	497 525.5	6 099 584.2	27.2	eDNA
ST154	TOP	501 115.5	6 094 777.7	1.0	eDNA
	BOT	501 115.8	6 094 779.2	23.0	eDNA
ST160	TOP	504 836.3	6 105 788.0	1.0	eDNA
	BOT	504 838.7	6 105 788.7	20.5	eDNA

Notes
BSL = Below sea level
eDNA = Environmental deoxyribonucleic acid sample
TOP = Near-surface
BOT = Near-seafloor

4.1.2 Sediment Characterisation

4.1.2.1 Univariate Analysis

Table 4.4 presents the sediment characteristics and Table 4.5 presents the sediment particle distribution across the DBD survey area from grab sample data. Figure 4.2 provides an overview of the variations of the fractional composition of the sediment. Figure 4.3 illustrates the spatial variations of percentage sand, gravel and fines. Figure 4.4 illustrates the spatial variation of the median sediment particle size. Figure 4.5 illustrates the percentage contribution of the Folk (BGS modified) sediment classes and Figure 4.6 illustrates the percentage contribution of the Wentworth (1922) sediment descriptions. Appendix D presents the details of particle size distribution for individual stations and the analysis certificates.

Gravel ranged from 0.13 % at station ST113 to 73.36 % at station ST127, with a mean of 8.64 % and a median of 3.25 %.

Sand content ranged from 24.97 % at station ST127 to 99.87 % at station ST113, with a mean of 89.86 % and a median of 95.98 %.

Fines were absent from 34 stations. At the remaining stations, the fines content ranged from 0.28 % at station ST119 to 26.97 % at station ST133. The mean value of fines content was 1.50 % and the median 0.00 %.

Four sediment classes were identified using the Folk (BGS modified) classification (Table 4.4 and Figure 4.5), including:

- 'Sand', which typified 30 stations;
- 'Gravelly sand', which typified 12 stations;
- 'Sandy gravel', which typified 4 stations;
- 'Gravelly muddy sand', which typified 2 stations.

Of the 48 stations investigated, 38 had unimodal distributions, 7 had bimodal distributions and 3 had polymodal distributions. Investigation of the particle size histograms (Appendix D) indicated that the most frequently occurring peak in the first mode was the 213 µm sediment particle size (fine sand) followed by the 38 250 µm (very coarse pebble). The 13 600 µm sediment particle size (medium pebble) was the most frequently occurring peak in the second mode, followed by the 213 µm (fine sand) and then 19 200 µm (coarse pebble). The 13 600 µm (medium pebble), 4800 µm (fine pebble) and 5 µm (very fine silt) sediment particle sizes were the only ones occurring in the third mode.

The median sediment particle size ranged from 161 µm (fine sand) at station ST144 to 17 852 µm (fine pebble) at station ST127, with a mean of 631 µm (coarse sand) and a median of 209 µm (fine sand).

The mean sediment particle size underpinned the Wentworth (1922) description, through which five grain size classes were identified (Table 4.5 and Figure 4.6):

- 'Fine sand', which typified 41 stations;
- 'Very coarse sand', which typified 3 stations;
- 'Medium sand', which typified 2 stations;
- 'Coarse sand', which typified 1 station;
- 'Fine pebble', which typified 1 station.

When considering the sorting coefficient (Table 4.5), the sediment was:

- 'Moderately well sorted' at 26 stations;
- 'Poorly sorted' at 10 stations;
- 'Very poorly sorted' at 6 stations;
- 'Moderately sorted' at 6 stations.

In terms of skewness (Table 4.5), the sediment particle distribution was:

- 'Symmetrical' at 27 stations;
- 'Very coarse skewed' at 13 stations;
- 'Coarse skewed' at 4 stations;
- 'Very fine skewed' at 3 stations;
- 'Fine skewed' at 1 station.

Table 4.4: Summary of sediment characteristics, Dogger Bank D Array 2023

Station	Fractional Composition			Fines		Folk Description (BGS modified)
	Gravel [%]	Sand [%]	Fines [%]	Silt [%]	Clay [%]	
Array Area						
ST105	4.56	95.44	0.00	0.00	0.00	Sand
ST106	5.41	94.59	0.00	0.00	0.00	Gravelly sand
ST109	3.38	96.62	0.00	0.00	0.00	Sand
ST110	0.88	99.12	0.00	0.00	0.00	Sand
ST111	3.84	96.16	0.00	0.00	0.00	Sand
ST112	0.18	99.82	0.00	0.00	0.00	Sand
ST113	0.13	99.87	0.00	0.00	0.00	Sand
ST114	0.29	99.71	0.00	0.00	0.00	Sand
ST116	5.53	94.47	0.00	0.00	0.00	Gravelly sand
ST117	2.44	97.56	0.00	0.00	0.00	Sand
ST119	4.91	94.82	0.28	0.20	0.08	Sand
ST120	1.37	98.63	0.00	0.00	0.00	Sand
ST121	1.87	98.13	0.00	0.00	0.00	Sand
ST122	0.92	99.08	0.00	0.00	0.00	Sand
ST123	43.57	56.43	0.00	0.00	0.00	Sandy gravel
ST124	46.31	53.22	0.47	0.32	0.15	Sandy gravel
ST126	0.47	99.53	0.00	0.00	0.00	Sand
ST127	73.36	24.97	1.67	1.22	0.45	Sandy gravel
ST129	3.11	96.89	0.00	0.00	0.00	Sand
ST130	6.91	93.09	0.00	0.00	0.00	Gravelly sand
ST131	2.84	97.16	0.00	0.00	0.00	Sand
ST132	2.21	97.40	0.39	0.28	0.11	Sand
ST133	15.75	57.28	26.97	16.30	10.67	Gravelly muddy sand
ST134	2.63	97.04	0.33	0.22	0.12	Sand
ST136	0.50	99.50	0.00	0.00	0.00	Sand
ST137	49.59	46.57	3.84	3.04	0.79	Sandy gravel
ST138	0.58	94.98	4.44	3.67	0.78	Sand
ST139	15.67	82.15	2.18	1.71	0.47	Gravelly sand
ST140	2.36	97.64	0.00	0.00	0.00	Sand
ST141	10.54	89.46	0.00	0.00	0.00	Gravelly sand
ST142	8.09	82.81	9.10	5.33	3.77	Gravelly sand
ST143	1.08	98.25	0.67	0.52	0.15	Sand
ST144	2.77	93.20	4.03	3.23	0.80	Sand
ST145	2.99	97.01	0.00	0.00	0.00	Sand
ST147	6.10	76.77	17.13	10.32	6.81	Gravelly muddy sand
ST148	4.20	95.80	0.00	0.00	0.00	Sand
ST149	9.19	90.81	0.00	0.00	0.00	Gravelly sand
ST150	13.87	85.53	0.60	0.43	0.18	Gravelly sand
ST151	6.73	93.27	0.00	0.00	0.00	Gravelly sand
ST152	2.92	97.08	0.00	0.00	0.00	Sand
ST154	8.68	91.32	0.00	0.00	0.00	Gravelly sand
ST155	19.04	80.96	0.00	0.00	0.00	Gravelly sand
ST156	0.91	99.09	0.00	0.00	0.00	Sand
ST158	4.89	95.11	0.00	0.00	0.00	Sand
ST159	1.94	98.06	0.00	0.00	0.00	Sand
ST160	1.84	98.16	0.00	0.00	0.00	Sand
ST165	5.28	94.72	0.00	0.00	0.00	Gravelly sand
ST216	1.91	98.09	0.00	0.00	0.00	Sand
Minimum	**0.13**	**24.97**	**0.00**	**0.00**	**0.00**	–
Maximum	**73.36**	**99.87**	**26.97**	**16.30**	**10.67**	
Median	**3.25**	**95.98**	**0.00**	**0.00**	**0.00**	
Mean	**8.64**	**89.86**	**1.50**	**0.97**	**0.53**	
Standard Deviation	**14.66**	**15.92**	**4.74**	**2.89**	**1.87**	
RSD [%]	**172**	**18**	**312**	**293**	**349**	

Notes:
BGS = British Geological Survey
Fines = Silt and clay content
RSD = Relative Standard Deviation
Silt = < 4.0 phi to +8.0 phi (< 62.5 µm to 3.9 µm)
Clay = Clay = < 8.0 phi to +10.0 phi (< 3.9 µm to 0.98 µm)

Table 4.5: Summary of particle size distribution, Dogger Bank D Array 2023

Station	Modality	Median [µm]	Mean Particle Size			Sorting Coefficient		Skewness	
			[µm]	[phi]	Wentworth (1922) Description	[µm]	Description	[µm]	Description
Array Area									
ST105	Unimodal	201	204	2.29	Fine sand	1.84	Moderately sorted	0.29	Coarse skewed
ST106	Unimodal	206	209	2.26	Fine sand	1.99	Moderately sorted	0.32	Very coarse skewed
ST109	Unimodal	211	213	2.23	Fine sand	1.52	Moderately well sorted	0.10	Symmetrical
ST110	Unimodal	216	217	2.21	Fine sand	1.49	Moderately well sorted	0.05	Symmetrical
ST111	Unimodal	210	213	2.23	Fine sand	1.54	Moderately well sorted	0.09	Symmetrical
ST112	Unimodal	207	208	2.27	Fine sand	1.44	Moderately well sorted	0.00	Symmetrical
ST113	Unimodal	235	235	2.09	Fine sand	1.46	Moderately well sorted	0.02	Symmetrical
ST114	Unimodal	234	236	2.09	Fine sand	1.42	Moderately well sorted	0.03	Symmetrical
ST116	Unimodal	209	212	2.24	Fine sand	2.03	Poorly sorted	0.34	Very coarse skewed
ST117	Unimodal	207	208	2.26	Fine sand	1.51	Moderately well sorted	0.06	Symmetrical
ST119	Unimodal	210	212	2.23	Fine sand	1.89	Moderately sorted	0.29	Coarse skewed
ST120	Unimodal	210	211	2.24	Fine sand	1.48	Moderately well sorted	0.04	Symmetrical
ST121	Unimodal	215	216	2.21	Fine sand	1.56	Moderately well sorted	0.05	Symmetrical
ST122	Unimodal	205	206	2.28	Fine sand	1.49	Moderately well sorted	0.03	Symmetrical
ST123	Bimodal	348	1324	−0.40	Very coarse sand	9.42	Very poorly sorted	0.70	Very coarse skewed
ST124	Bimodal	826	1487	−0.57	Very coarse sand	7.66	Very poorly sorted	0.33	Very coarse skewed
ST126	Unimodal	232	232	2.11	Fine sand	1.47	Moderately well sorted	0.02	Symmetrical
ST127	Polymodal	17852	6111	−2.61	Fine pebble	7.80	Very poorly sorted	−0.68	Very fine skewed
ST129	Unimodal	204	207	2.27	Fine sand	1.56	Moderately well sorted	0.08	Symmetrical
ST130	Unimodal	213	217	2.20	Fine sand	2.60	Poorly sorted	0.38	Very coarse skewed
ST131	Unimodal	194	197	2.34	Fine sand	1.56	Moderately well sorted	0.08	Symmetrical
ST132	Unimodal	205	207	2.27	Fine sand	1.57	Moderately well sorted	0.05	Symmetrical
ST133	Polymodal	193	131	2.94	Fine sand	15.31	Very poorly sorted	−0.13	Fine skewed
ST134	Unimodal	203	206	2.28	Fine sand	1.61	Moderately well sorted	0.07	Symmetrical
ST136	Unimodal	218	218	2.20	Fine sand	1.54	Moderately well sorted	0.03	Symmetrical
ST137	Bimodal	1975	1174	−0.23	Very coarse sand	3.81	Poorly sorted	−0.54	Very fine skewed
ST138	Unimodal	193	194	2.37	Fine sand	1.56	Moderately well sorted	−0.05	Symmetrical
ST139	Polymodal	285	437	1.20	Medium sand	3.74	Poorly sorted	0.53	Very coarse skewed
ST140	Unimodal	177	179	2.48	Fine sand	1.48	Moderately well sorted	0.05	Symmetrical
ST141	Bimodal	208	218	2.20	Fine sand	2.69	Poorly sorted	0.42	Very coarse skewed
ST142	Unimodal	182	183	2.45	Fine sand	3.56	Poorly sorted	−0.01	Symmetrical
ST143	Unimodal	209	210	2.25	Fine sand	1.57	Moderately well sorted	0.03	Symmetrical
ST144	Unimodal	161	160	2.64	Fine sand	1.53	Moderately well sorted	−0.03	Symmetrical
ST145	Unimodal	276	281	1.83	Medium sand	1.61	Moderately well sorted	0.09	Symmetrical
ST147	Unimodal	192	137	2.86	Fine sand	5.40	Very poorly sorted	−0.31	Very fine skewed
ST148	Unimodal	201	205	2.29	Fine sand	1.66	Moderately sorted	0.15	Coarse skewed
ST149	Bimodal	212	217	2.21	Fine sand	2.61	Poorly sorted	0.39	Very coarse skewed
ST150	Bimodal	218	246	2.02	Fine sand	2.77	Poorly sorted	0.49	Very coarse skewed
ST151	Unimodal	205	210	2.25	Fine sand	2.43	Poorly sorted	0.39	Very coarse skewed
ST152	Unimodal	206	208	2.26	Fine sand	1.56	Moderately well sorted	0.06	Symmetrical
ST154	Unimodal	221	226	2.15	Fine sand	2.51	Poorly sorted	0.40	Very coarse skewed
ST155	Bimodal	253	517	0.95	Coarse sand	4.68	Very poorly sorted	0.69	Very coarse skewed
ST156	Unimodal	207	207	2.27	Fine sand	1.47	Moderately well sorted	0.02	Symmetrical
ST158	Unimodal	218	220	2.18	Fine sand	1.87	Moderately sorted	0.30	Coarse skewed
ST159	Unimodal	207	208	2.26	Fine sand	1.50	Moderately well sorted	0.05	Symmetrical
ST160	Unimodal	198	199	2.33	Fine sand	1.45	Moderately well sorted	0.01	Symmetrical
ST165	Unimodal	200	204	2.29	Fine sand	1.98	Moderately sorted	0.32	Very coarse skewed
ST216	Unimodal	201	203	2.30	Fine sand	1.53	Moderately well sorted	0.05	Symmetrical
Minimum	–	161	131	0.95	–	1.42	–	−0.68	–
Maximum		17852	6111	2.94		15.31		0.70	
Median		209	211	2.26		1.59		0.08	
Mean		631	412	2.22		2.70		0.19	
Standard Deviation		2550	885	0.31		2.57		0.20	
RSD		405	215	-		95		102	

Notes
Statistics based on Folk and Ward (1957) method derived in Gradistat (Blott, 2010)
RSD = Relative Standard Deviation

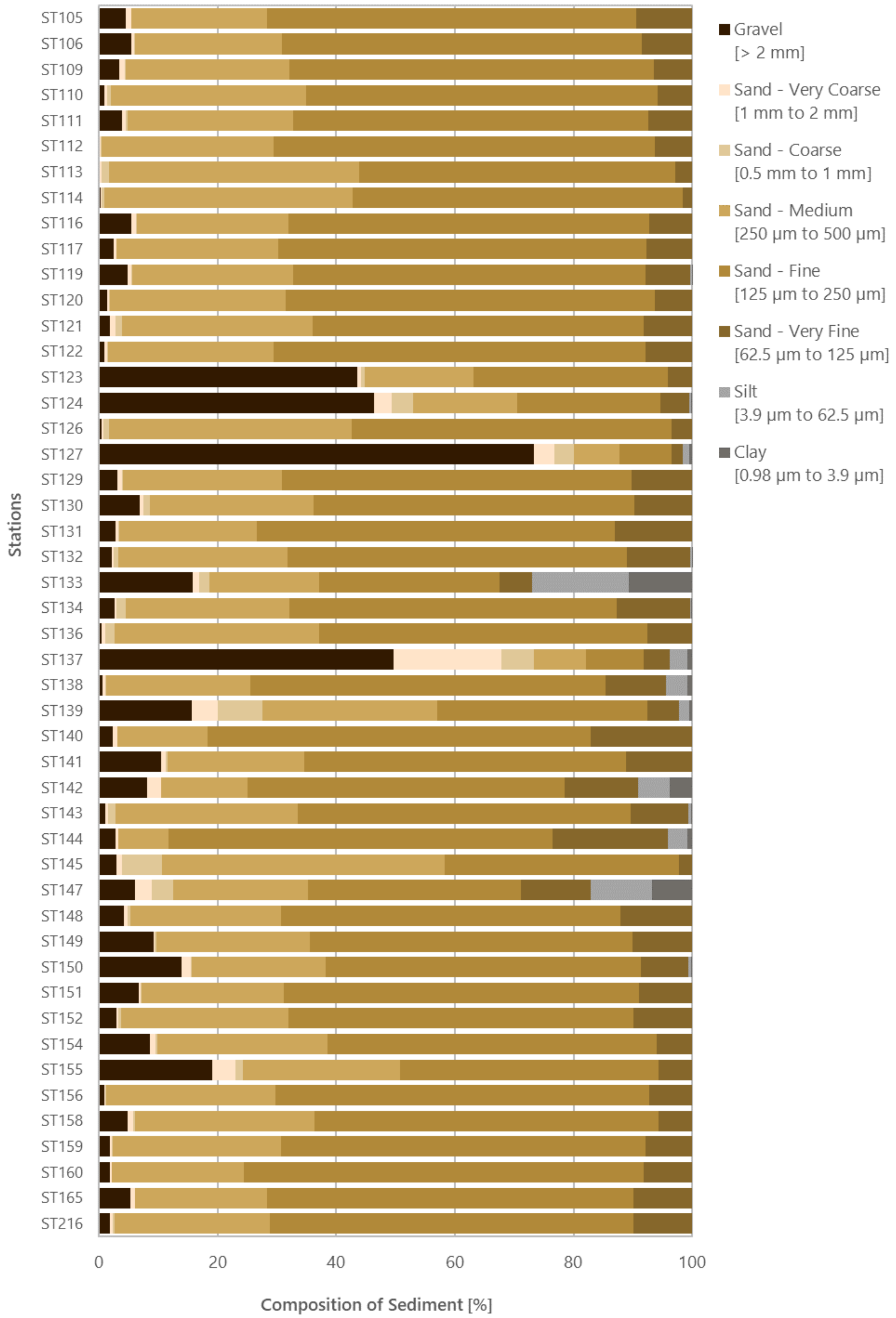


Figure 4.2: Sediment fractional composition, Dogger Bank Array 2023

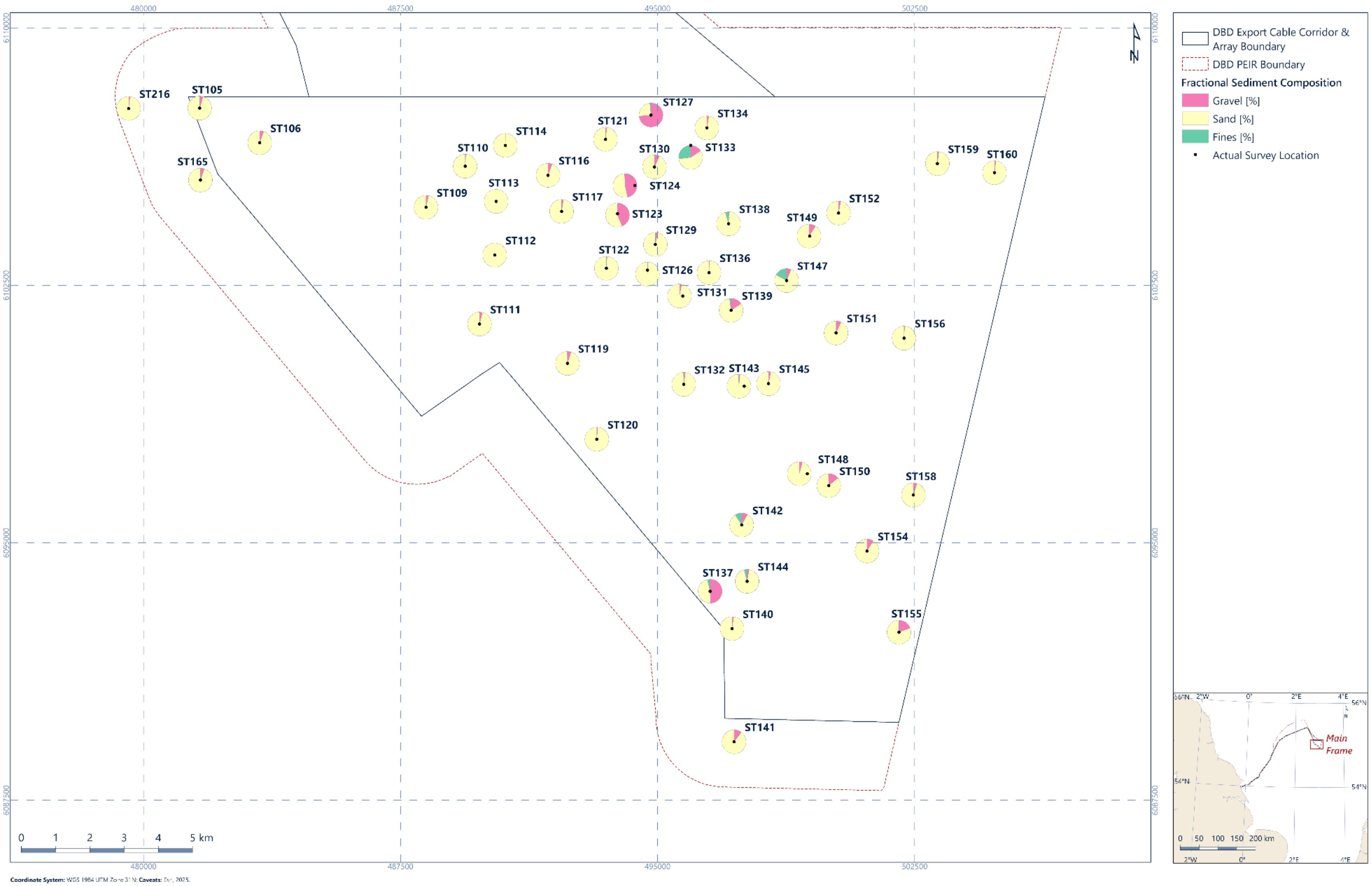


Figure 4.3: Spatial variations of percentage of sand, gravel and fines, Dogger Bank Array 2023

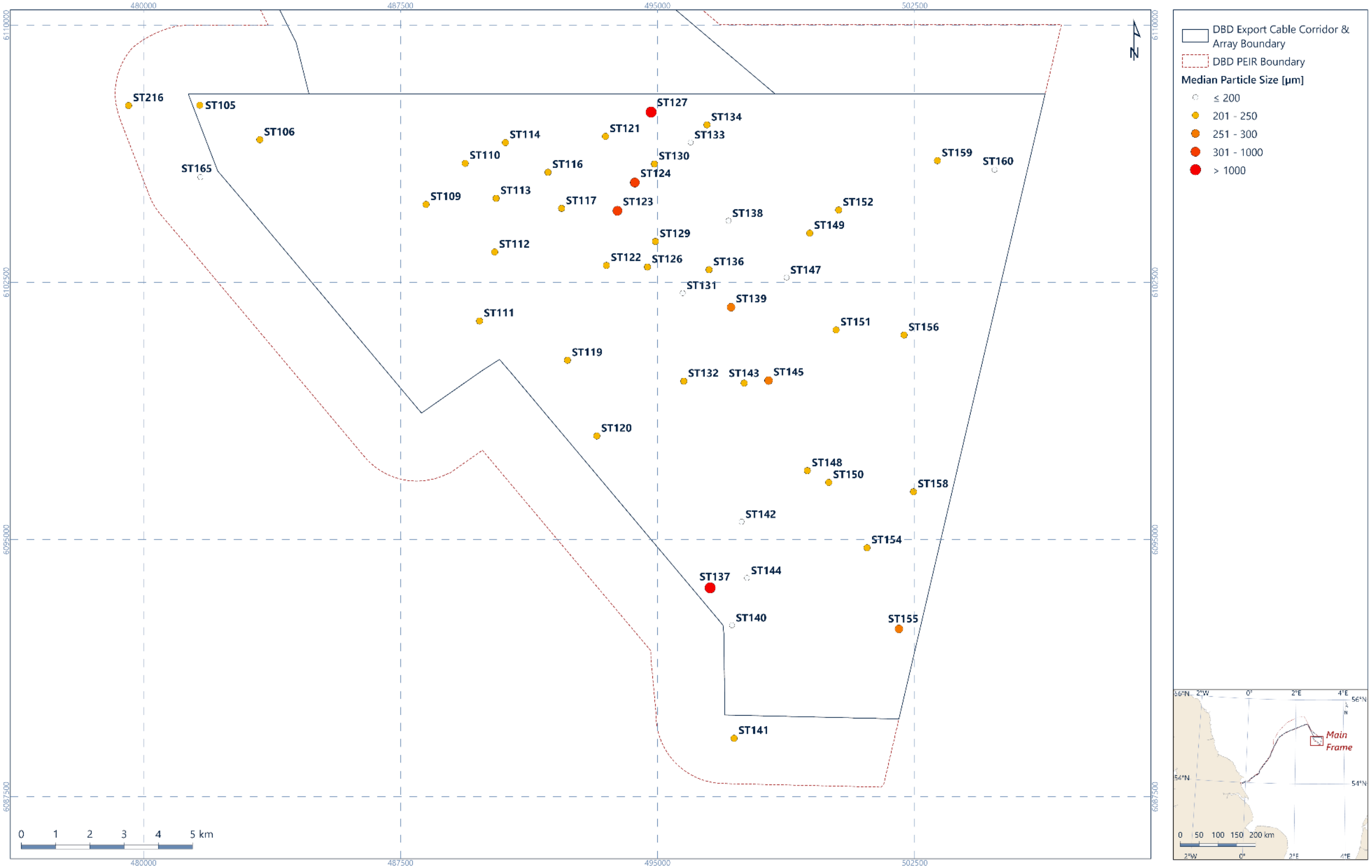
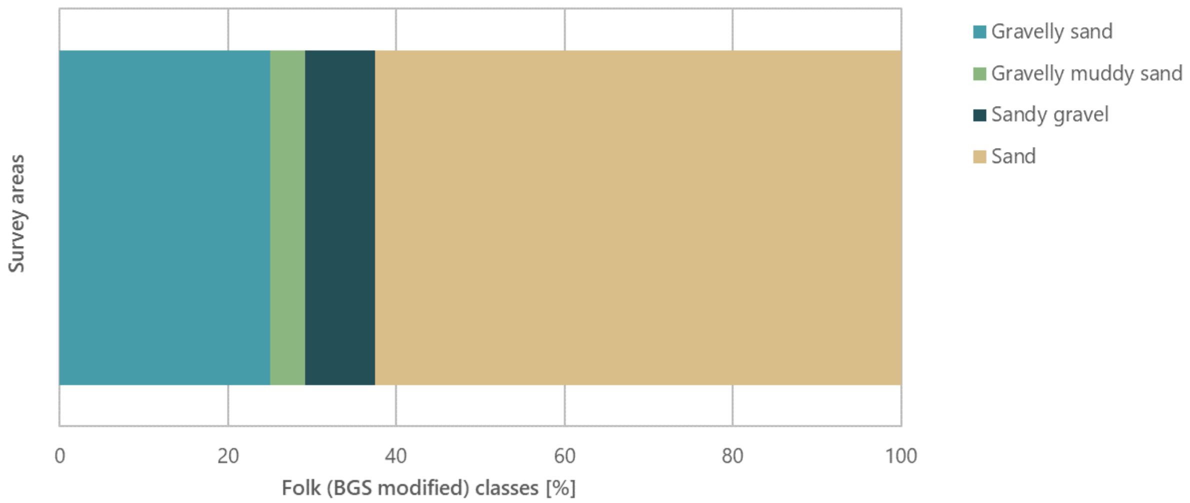


Figure 4.4: Spatial variations of the median [µm] sediment particle size, Dogger Bank Array 2023



Notes
BGS = British Geological Survey

Figure 4.5: Folk (BGS modified) sediment description, Dogger Bank Array 2023

Figure 4.6: Wentworth (1922) sediment description, Dogger Bank Array 2023

4.1.2.2 Investigation of Granulometric Similarities

The cluster analysis, using Euclidean distance, was applied to the sediment PSD dataset to investigate sedimentological characteristics. Data were fourth root transformed, to reduce the degree of skewness and allow optimal performance of the multivariate analysis. The SIMPROF test, undertaken in conjunction with the cluster analysis, was interpreted in ecological terms and, where appropriate, coarser groups were created. Figure 4.7, Figure 4.8 present the dendrogram and the nMDS of the Euclidean distance matrix of sediment particle size, respectively. The good correspondence between the dendrogram and the 2D nMDS (Figure 4.9), indicates that the latter is representative of the granulometric similarities between stations.

Two multivariate groups (A and B) were identified at the Euclidean distance of 4.

Table 4.6 summarises the physical characteristics of the sediment groups identified through the multivariate analysis and further assessed by means of the SIMPER analysis, and detailed as follows:

- Group A comprised 42 stations and had an average Euclidean distance of 2.27. Group A was characterised by poorly sorted ‘sand’ (Folk BGS) with median sediment particle size ranging from 161 µm (fine sand) to 826 µm (coarse sand), in water depths of 17.9 m to 31.3 m (mean 24.9 m). The mean gravel content of group A was 5.86 %, with 38 stations classified as ‘fine sand’. Station ST124 had the highest gravel content of 46.31 % and was classified as ‘very coarse sand’. The fines content was ≤ 4.44 % and most stations were devoid of fines;
- Group B comprised 6 stations and had an average Euclidean distance of 4.92. Group B was characterised by very poorly sorted ‘sand’ (Folk BGS), with median sediment particle size ranging from 182 µm (fine sand) to 17 852 µm (coarse pebble), (mean 3447 µm, granule), in water depths of 27.8 m to 30.4 m (mean 29.2 m). The mean gravel content of group B was 28.09 %. The fines content ranged from 1.67 % to 26.97 % with a mean of 10.15 %.

Figure 4.9 displays the sediment particle sizes driving the separation of the multivariate groups, including the 125.00 µm (fine sand), the 707.11 µm (coarse sand), the 8000 µm (medium pebble) and the 16 000 µm (coarse pebble) sediment particle size.

Figure 4.10 displays the spatial distribution of the sediment groups identified through the multivariate analysis.

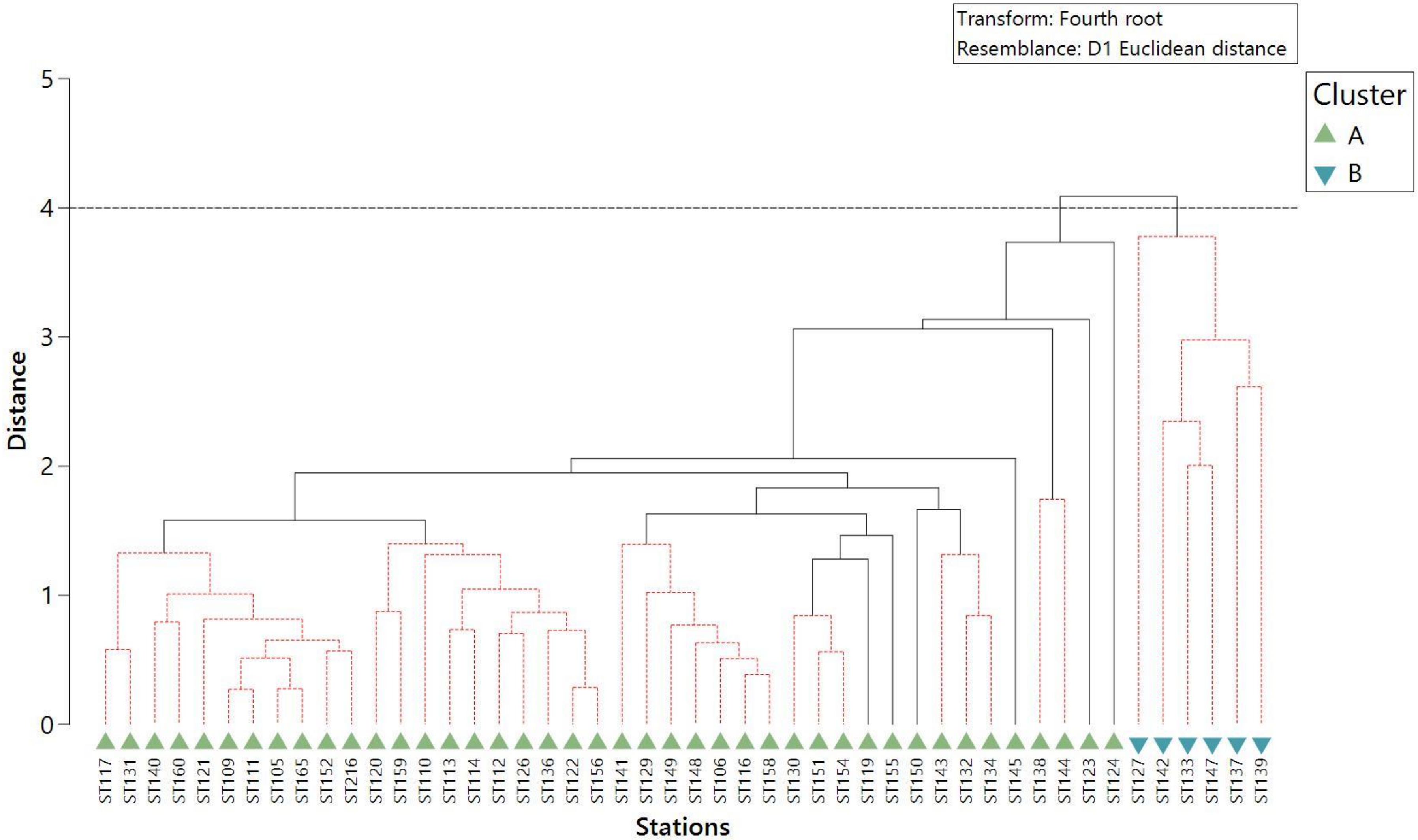


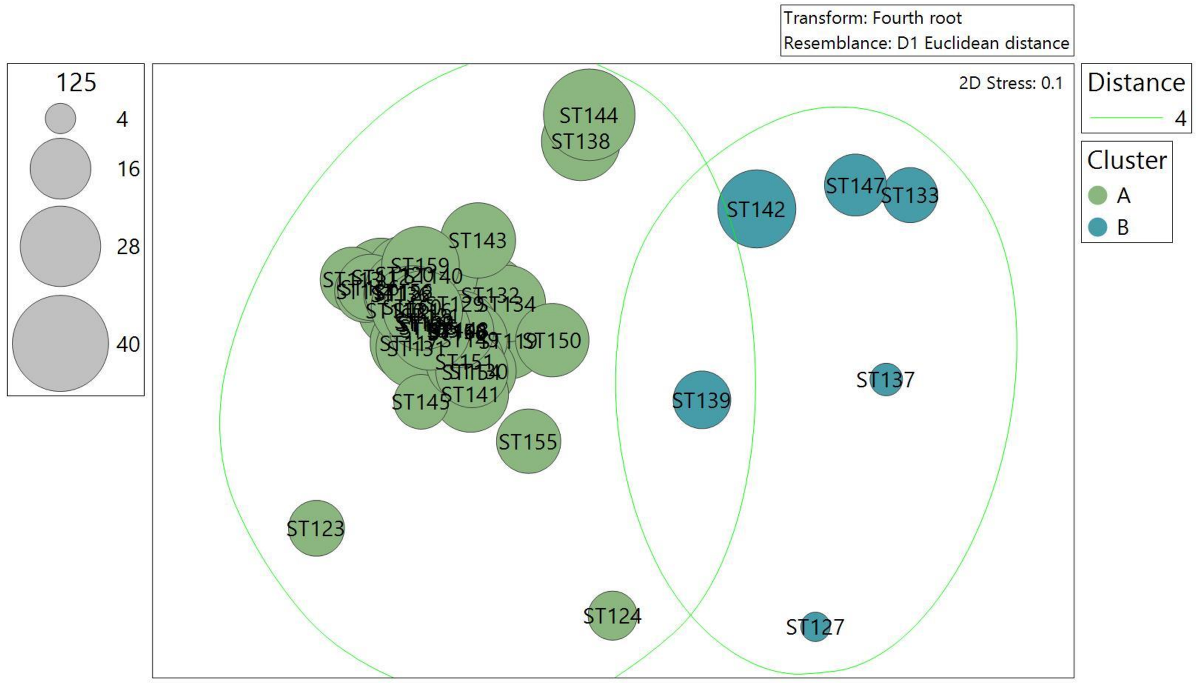
Figure 4.7: Dendrogram of hierarchical clustering analysis of sediment particle size, Dogger Bank Array 2023

Figure 4.8: nMDS of hierarchical clustering analysis of sediment particle size, Dogger Bank Array 2023

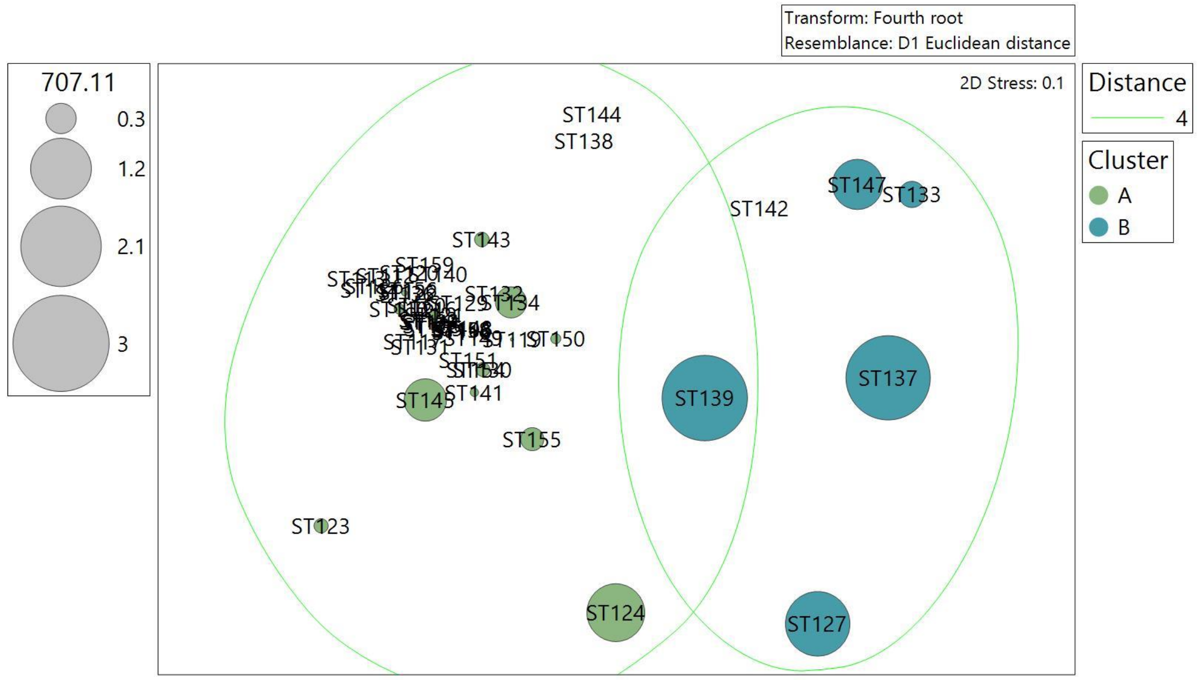
Table 4.6: Summary of physical characteristics of sediment groups identified through the cluster analysis, Dogger Bank D Array 2023

Multivariate Group	Location and stations	Depth [m BSL]	Median Particle Size [µm]	Fractional Composition [%]			Sorting	
				Gravel	Sand	Fines	[µm]	Description*
A ▲ Average Euclidean distance^2: 2.27	ST105, ST106, ST109, ST110, ST111, ST112, ST113, ST114, ST116, ST117, ST119, ST120, ST121, ST122, ST123, ST124, ST126, ST129, ST130, ST131, ST132, ST134, ST136, ST138, ST140, ST143, ST144, ST145, ST148, ST149, ST150, ST151, ST152, ST154, ST155, ST156, ST158, ST159, ST160, ST165	24.9	228	5.86	93.88	0.27	2.15	Poorly sorted
B ▼ Average Euclidean distance^2: 4.92	ST127, ST133, ST137, ST139, ST142, ST147	29.2	3447	28.09	61.76	10.15	6.60	Very poorly sorted

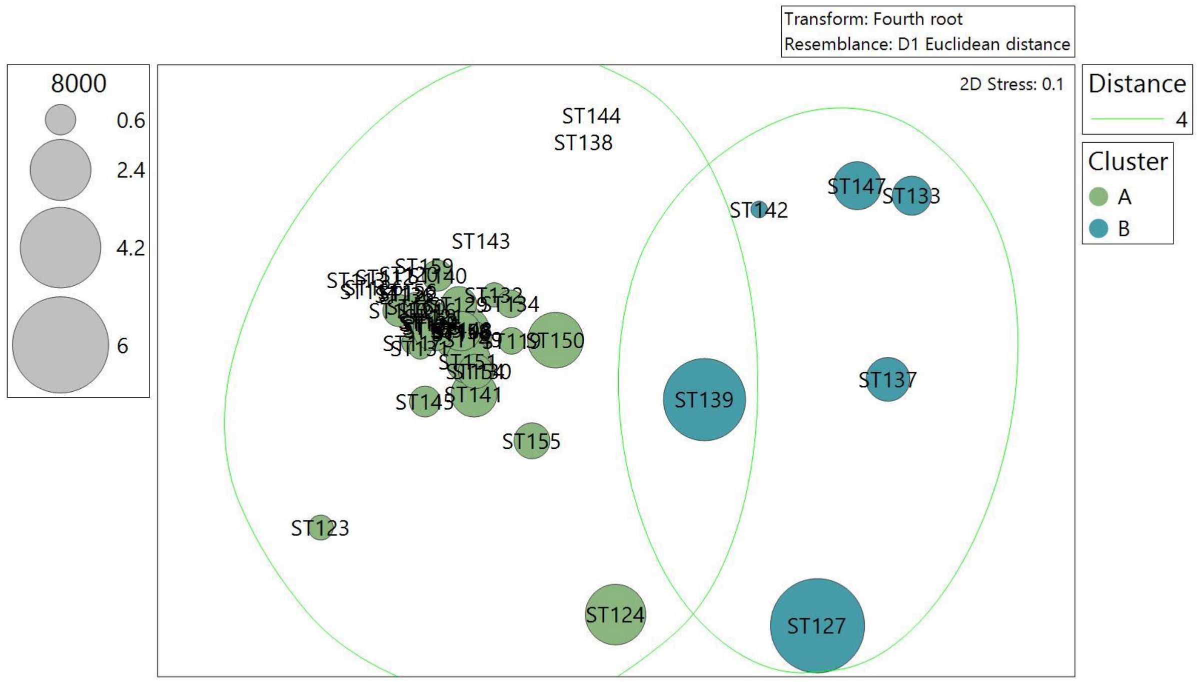
Notes
* = Description based on mean sorting value [µm]
BSL = Below sea level



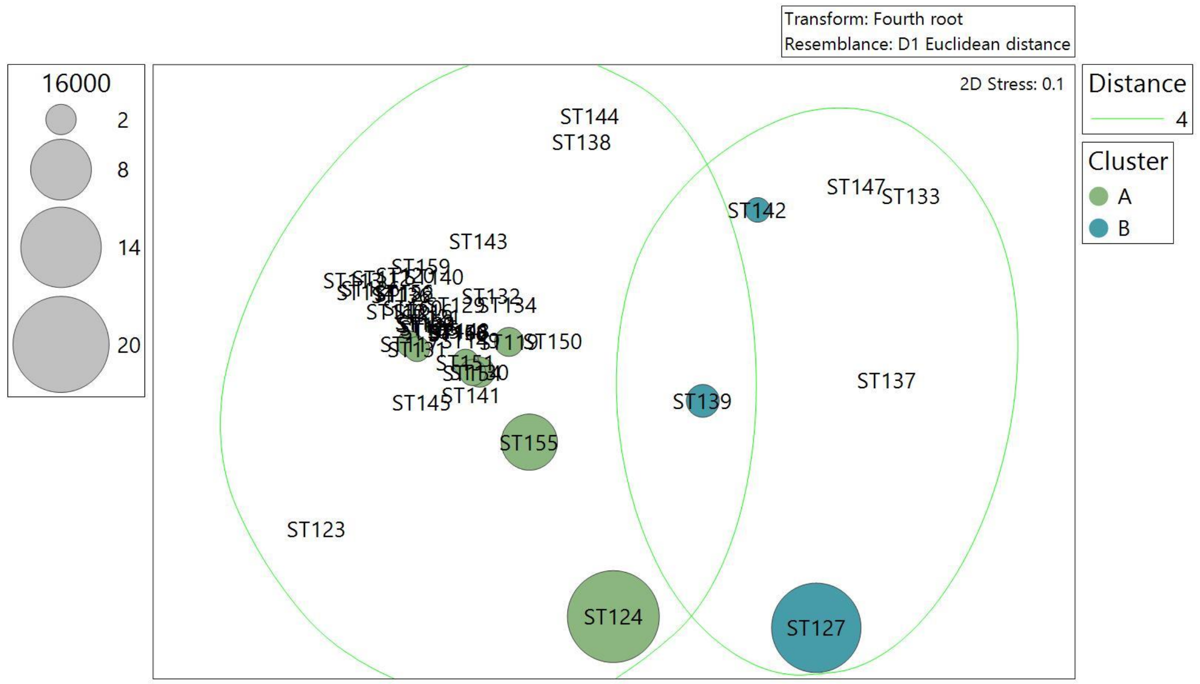
Notes
Circles proportional in diameter to the 125.00 µm sediment particle size (fine sand)



Notes
Circles proportional in diameter to the 707.11 µm sediment particle size (coarse sand)



Notes
Circles proportional in diameter to the 8000 µm sediment particle size (medium pebble)



Notes
Circles proportional in diameter to the 16 000 µm sediment particle size (coarse pebble)

Figure 4.9: nMDS ordination of hierarchical clustering analysis of PSD with superimposed circles proportional in diameter to percentage of particles driving the separation of groups, Dogger Bank Array 2023

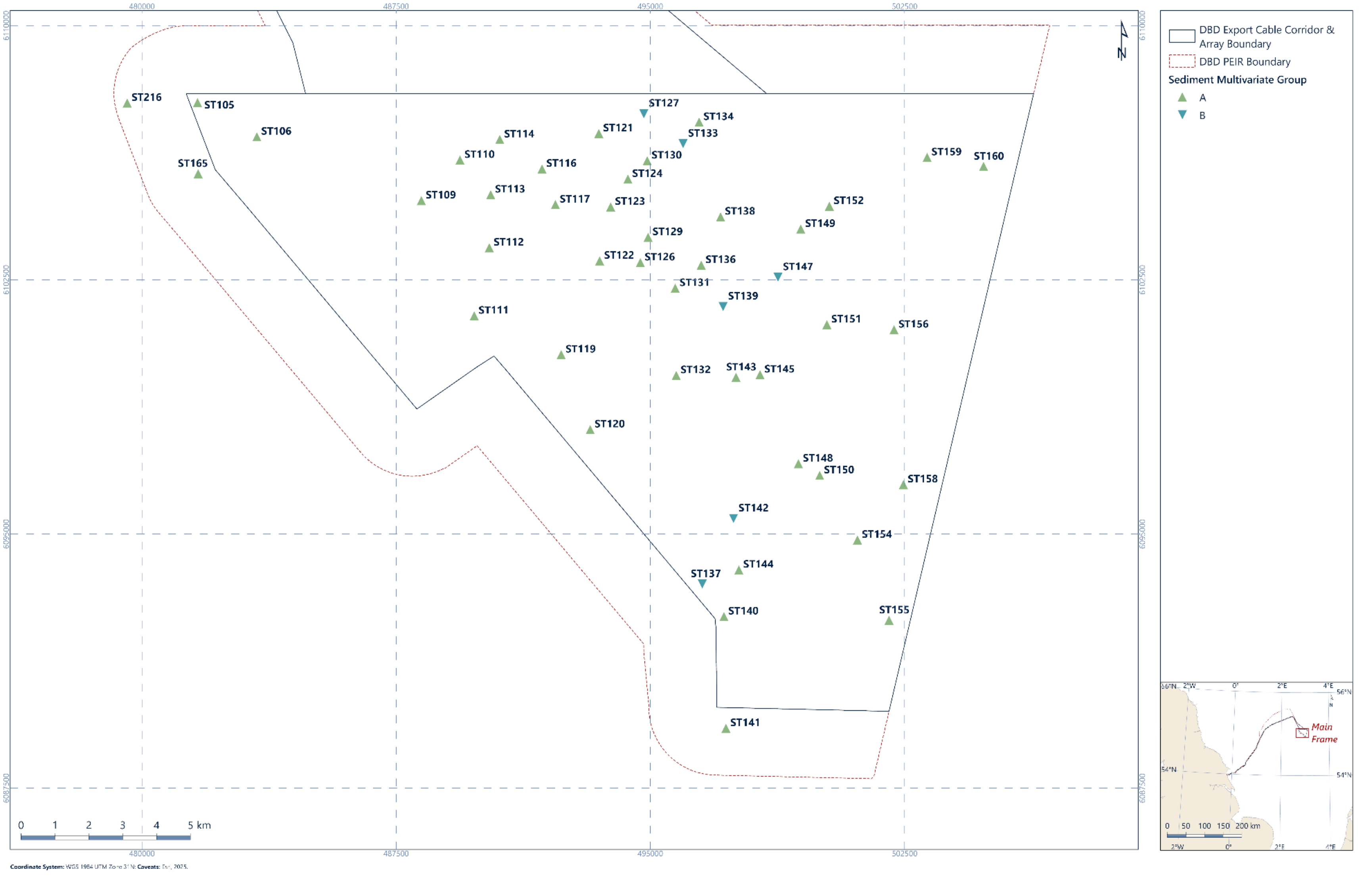


Figure 4.10: Spatial distribution of the sediment groups identified through the multivariate analysis, Dogger Bank Array 2023

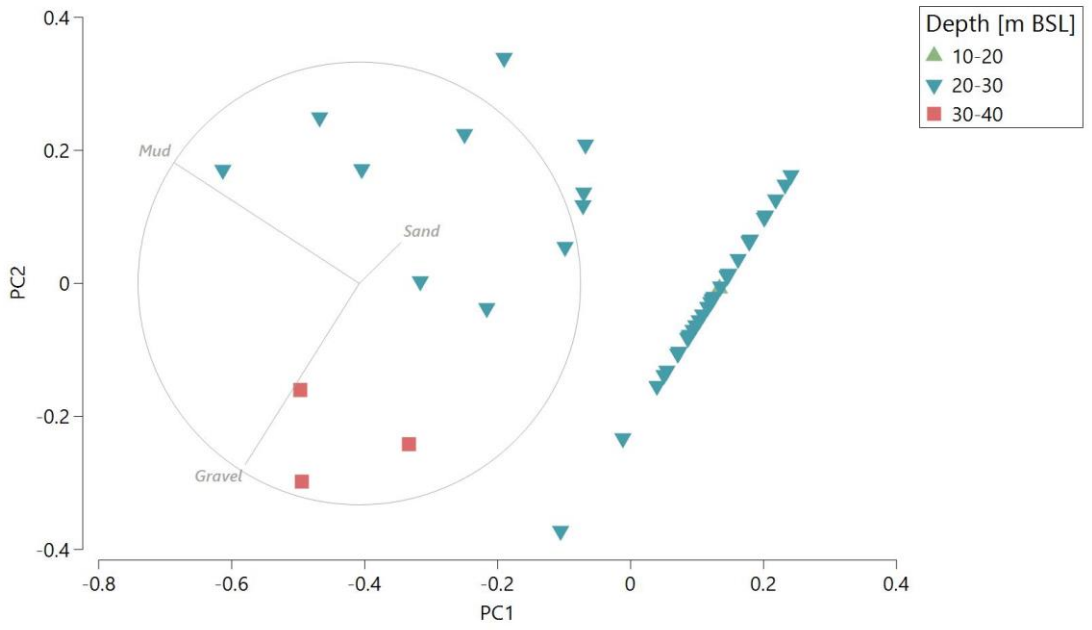
4.1.2.3 Principal Component Analysis (PCA)

The PCA was used on the main sediment fractions, namely gravel, sand and fines (mud) to highlight any patterns within the data. The PCA results also allowed visual representation of the association between sediment type, multivariate groups and depth. Data were fourth root transformed to reduce the degree of skewness and allow optimal performance of the multivariate analysis.

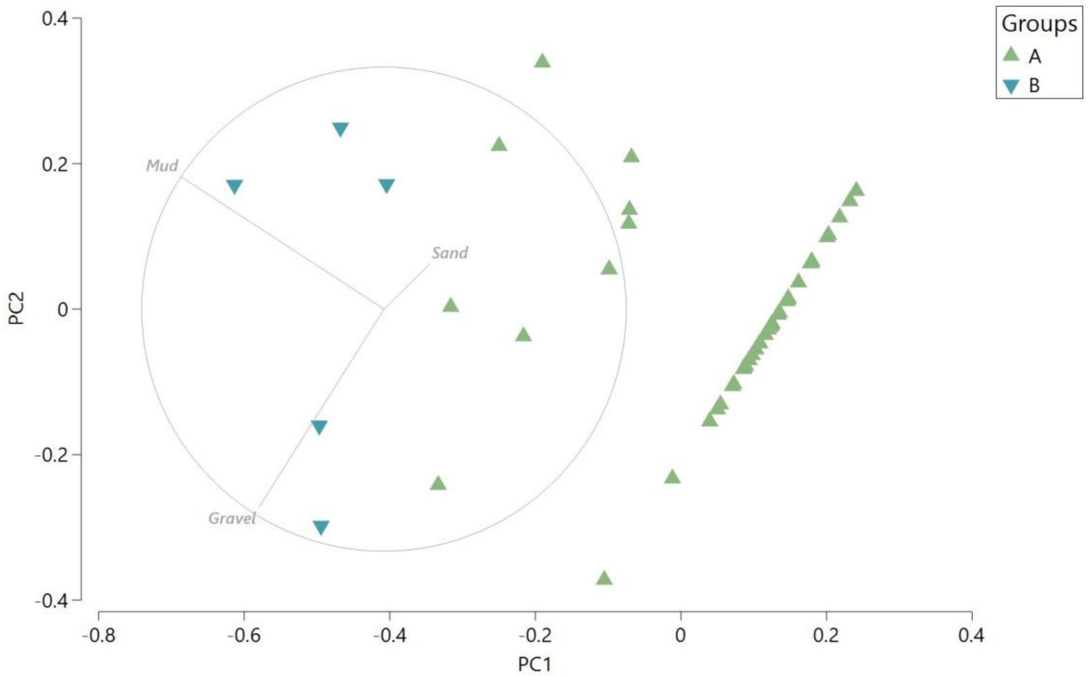
Results of the PCA indicated that the first two principal components accounted for 99.0 % of the variation within the data (Table 4.7). Figure 4.11 illustrates the PCA results with superimposed depth range and the groups identified through the multivariate analysis. Both mud and gravel had a large negative loading on PC1, and gravel had a large positive loading on PC2. The figures highlights coarse sediments were found in the deeper samples. Samples within group A were associated with sandier sediment, whilst group B was associated with more muddy gravelly sediment.

Table 4.7: Summary of PCA results, Dogger Bank D Array 2023

Principal component (PC)	Variation [%]	Cumulative Variation [%]
1	69.9	69.9
2	29.1	99.0
3	1.0	100.0



A



B

Notes
BSL = Below sea level
PC = Principal component

Figure 4.11: 2D PCA of sediment composition with superimposed (A) depth range and (B) multivariate groups, Dogger Bank Array 2023

4.1.3 Sediment Chemistry

Results of the sediment chemistry analysis were assessed in terms of descriptive statistics, including the relative standard deviation (RSD) to indicate the extent of variation in the dataset. The RSD is defined as the ratio of the standard deviation to the mean and is expressed as a percentage. For this report, RSD values of less than 30 % were considered low variation, 30 % to 70 % were considered moderate variation and more than 70 % were considered high variation.

Appendix E presents the analysis certificates.

4.1.3.1 Sediment Hydrocarbons

4.1.3.1.1 Total Hydrocarbon and Content (THC)

Table 4.7 presents the concentrations of THC reported from the surface sediment across the DBD survey area.

The THC value was below the LOD (< 1 mg/kg) and the Cefas AL1 (100 mg/kg) at all stations.

Table 4.8: Summary of sediment hydrocarbon analysis, Dogger Bank D Array 2023

Station	THC
Array Area	
ST106	< 1
ST120	< 1
ST136	< 1
ST155	< 1
ST160	< 1
Minimum	**< 1**
Maximum	**< 1**
Cefas Guideline Action Levels	
AL1	**100**

Notes
Concentrations expressed in mg/kg
AL1 = Action Level 1
Cefas = Centre for Environmental Fisheries & Aquaculture Science
THC = Total hydrocarbon content

4.1.3.1.2 Sediment Polycyclic Aromatic Hydrocarbons (PAHs)

Table 4.8 presents the results of the PAHs and the marine SQGs (details in Section 1.5).

The total PAH concentrations were calculated as the sum of individual PAH concentrations. Some of the individual PAH concentrations were less than the LOD, and as such are unlikely to significantly influence the total 2 to 6 ring PAH concentrations. For this report, PAH concentrations less than the LOD have been treated as being equal to their respective LODs to calculate the total PAHs concentrations. Consequently, the total PAH concentrations where one or more analytes were < LOD resulted in a less than value.

The concentration of most PAHs at stations was below their respective LOD except for C2-naphthalene, which had concentrations between 1.77 µg/kg and 3.85 µg/kg and C1- naphthalene which had a concentration of 1.45 µg/kg at station ST155.

All concentrations were below their respective Canadian SQGs including their respective TEL and PEL values.

Table 4.9: Summary of sediment polycyclic aromatic hydrocarbons analysis, Dogger Bank D Array 2023

Analyte	Station					CEMP (OSPAR, 2014)	NOAA (Long et al., 1995)	Canadian SQGs (CCME, 2024)	
	Array Area					ERL	ERM	TEL	PEL
	ST106	ST120	ST136	ST155	ST160				
Acenaphthene	< 1	< 1	< 1	< 1	< 1	–	500	6.71	88.9
Acenaphthylene	< 1	< 1	< 1	< 1	< 1	–	640	5.87	128
Anthracene	< 1	< 1	< 1	< 1	< 1	85	1100	46.9	245
Benzo[a]anthracene	< 1	< 1	< 1	< 1	< 1	261	1600	74.8	693
Benzo[a]pyrene	< 1	< 1	< 1	< 1	< 1	430	1600	88.8	763
Benzo[b]fluoranthene	< 1	< 1	< 1	< 1	< 1	–	–	–	–
Benzo[e]pyrene	< 1	< 1	< 1	< 1	< 1	–	–	–	–
Benzo[ghi]perylene	< 1	< 1	< 1	< 1	< 1	85	–	–	–
Benzo[k]fluoranthene	< 1	< 1	< 1	< 1	< 1	–	–	–	–
C1-naphthalenes	< 1	< 1	< 1	1.45	< 1	155	–	–	–
C1-phenanthrene	< 1	< 1	< 1	< 1	< 1	170	–	–	–
C2-naphthalenes	1.89	1.77	1.82	3.85	1.78	150	–	–	–
C3-naphthalenes	< 1	< 1	< 1	< 1	< 1	–	–	–	–
Chrysene	< 1	< 1	< 1	< 1	< 1	384	2800	108	846
Dibenzo[ah]anthracene	< 1	< 1	< 1	< 1	< 1	–	260	6.22	135
Fluoranthene	< 1	< 1	< 1	< 1	< 1	600	5100	113	1494
Fluorene	< 1	< 1	< 1	< 1	< 1	–	540	21.2	144
Indeno[1,2,3-cd]pyrene	< 1	< 1	< 1	< 1	< 1	240	–	–	–
Naphthalene	< 1	< 1	< 1	< 1	< 1	160	2100	34.6	391
Perylene	< 1	< 1	< 1	< 1	< 1	–	–	–	–
Phenanthrene	< 1	< 1	< 1	< 1	< 1	240	1500	86.7	544
Pyrene	< 1	< 1	< 1	< 1	< 1	665	2600	153	1398
Total	< 22.9	< 22.8	< 22.8	< 25.3	< 22.8	–	–	–	–

Notes
Concentrations expressed in µg/kg dry sediment
CCME = Canadian Council of Ministers of the Environment
CEMP = Coordinated Environmental Monitoring Programme
ERL = Effects range low
ERM = Effects range median
NOAA = National Oceanic and Atmospheric Administration
OSPAR = Oslo and Paris Commission
PEL = Probable Effects Level
SQG = Sediment quality guidelines
TEL = Threshold Effects Level
Effects ranges were developed for NOAA to evaluate the potential toxicological effects of a concentration of a contaminant in sediment; some ERLs are adopted by OSPAR CSEMP for the assessment of monitoring data of hazardous substances in the environment

4.1.3.2 Sediment Metals

Table 4.9 summarises the concentrations of the extractable metals in the sediment samples.

Metals concentrations were lower than the environmental quality standards (Cefas ALs, OSPAR ERLs, NOAA ERMs and Canadian SQGs) for all metals.

All metals had low variation (RSD ≤ 20 %), with no obvious spatial patterns observed for all metals analysed.

Table 4.10: Summary of sediment metals analysis, Dogger Bank D Array 2023

Stations	As	Cd	Cr	Cu	Hg	Ni	Pb	Sn	Zn
Array Area									
ST106	1.80	< 0.04	3.50	1.10	0.01	2.40	2.30	< 0.5	8.20
ST120	1.50	< 0.04	2.30	0.70	< 0.01	1.90	1.60	< 0.5	8.00
ST136	1.70	< 0.04	3.10	1.20	< 0.01	2.60	1.80	< 0.5	9.70
ST155	1.50	< 0.04	3.20	1.00	< 0.01	2.10	2.00	< 0.5	8.00
ST160	1.60	< 0.04	3.30	0.90	0.04	2.00	1.60	< 0.5	6.30
Minimum	1.50	< 0.04	2.30	0.70	< 0.01	1.90	1.60	< 0.5	6.30
Maximum	1.80	< 0.04	3.50	1.20	0.04	2.60	2.30	< 0.5	9.70
Median	1.60	-	3.20	1.00	-	2.10	1.80	-	8.00
Mean	1.62	-	3.08	0.98	-	2.20	1.86	-	8.04
Standard Deviation	0.130	-	0.460	0.192	-	0.292	0.297	-	1.21
RSD	8	-	15	20	-	13	16	-	15
Cefas Guideline Action Levels									
AL1	20	0.4	40	40	0.3	20	50	–	130
AL2	100	5	400	400	3	200	500	–	800
CEMP Assessment Criteria (OSPAR, 2014)									
ERL	–	1.20	81.0	34.0	0.150	–	47.0	–	150
NOAA Effects Ranges (Long et al., 1995)									
ERM	70	9.6	370	270	0.71	51.6	218	–	410
Canadian SQGs (CCME, 2024)									
TEL	7.24	0.7	52.3	18.7	0.13	–	30.2	–	124
PEL	41.6	4.2	160	108	0.70	–	112	–	271

Notes
Concentrations expressed in mg/kg dry sediment
CEFAS actions levels available at https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans
As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Hg = Mercury
Ni = Nickel; Pb = Lead; Sn = Tin; Zn = Zinc
AL1 = Action level 1; AL2 = Action level 2; ERL = Effects range low; ERM = Effects range median
TEL = Threshold effects level; PEL = Probable effects level; Cefas = Centre for Environment, Fisheries and Aquaculture Science
CEMP = Coordinated Environmental Monitoring Programme; OSPAR = Oslo and Paris Commission
NOAA = National Oceanic and Atmospheric Administration; SQGs = Sediment quality guidelines; RSD = Relative Standard Deviation

Key	Below Cefas AL1	Above Cefas AL1	Above Cefas AL2

4.1.3.3 Sediment Polychlorinated Biphenyls

Table 4.10 summarises the concentrations of PCBs in the sediment samples. The concentrations of the individual PCB congeners analysed were below the LOD (< 0.00008 mg/kg) at all stations except station ST136. For this report, PCB concentrations less than LOD have been treated as being equal to their respective LODs when calculating the total PCB concentrations. Consequently, the total PCB concentrations where one or more analytes were < LOD resulted in a less than value. The sum of the 25 congeners ranged from < 0.00200 mg/kg to < 0.00439 mg/kg, with all values below the Cefas AL1 (0.02 mg/kg) and AL2 (0.2 mg/kg).

Table 4.11: Summary of polychlorinated biphenyls (PCBs) analysis, Dogger Bank D Array 2023

Station	PCB 101	PCB 105	PCB 110	PCB 118	PCB 128	PCB 138	PCB 141	PCB 149	PCB 151	PCB 153	PCB 156	PCB 158	PCB 170
Array Area													
ST106	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST120	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST136	0.00016	0.00013	0.00015	0.00017	0.00013	0.00015	0.00021	0.00021	0.00023	0.00015	0.00020	0.00015	0.00020
ST155	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST160	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Minimum	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**
Maximum	**0.00016**	**0.00013**	**0.00015**	**0.00017**	**0.00013**	**0.00015**	**0.00021**	**0.00021**	**0.00023**	**0.00015**	**0.00020**	**0.00015**	**0.00020**
Cefas Guidelines Action Levels													
AL1	–	–	–	–	–	–	–	–	–	–	–	–	–
AL2	–	–	–	–	–	–	–	–	–	–	–	–	–

Stations	PCB 18	PCB 180	PCB 183	PCB 187	PCB 194	PCB 28	PCB 31	PCB 44	PCB 47	PCB 49	PCB 52	PCB 66	Total
Array Area													
ST106	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST120	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST136	< 0.00008	0.00017	0.00023	0.00023	0.00013	0.00014	0.00016	0.00020	0.00018	0.00019	0.00021	0.00023	**< 0.00439**
ST155	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST160	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
Minimum	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00008**	**< 0.00200**
Maximum	**< 0.00008**	**0.00017**	**0.00023**	**0.00023**	**0.00013**	**0.00014**	**0.00016**	**0.00020**	**0.00018**	**0.00019**	**0.00021**	**0.00023**	**< 0.00439**
Cefas Guidelines Action Levels													
AL1	–	–	–	–	–	–	–	–	–	–	–	–	**0.02**
AL2	–	–	–	–	–	–	–	–	–	–	–	–	**0.2**

Notes
AL1 = Action Level 1
AL2 = Action Level 2
Concentrations expressed as mg/kg dry weight
Cefas = Centre for Environment, Fisheries and Aquaculture Science
Cefas action levels available at https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans

4.1.3.4 Sediment Organotins

Table 4.11 summarises the concentrations of organotins in the sediment samples. The organotins analysed were dibutyltin (DBT) and tributyltin (TBT), the concentrations of which were below the LOD (< 0.001 mg/kg) and below the Cefas AL1 (0.1 mg/kg) and AL2 (1 mg/kg) across the DBD array area.

Table 4.12: Summary of organotins analysis, Dogger Bank D Array 2023

Station	Dibutyltin (DBT)	Tributyltin (TBT)
Array Area		
ST106	< 0.001	< 0.001
ST120	< 0.001	< 0.001
ST136	< 0.001	< 0.001
ST155	< 0.001	< 0.001
ST160	< 0.001	< 0.001
Cefas Guideline Action Levels		
AL1	**0.1**	**0.1**
AL2	**1**	**1**

Notes
Concentrations expressed in mg/kg
AL1 = Action Level 1
AL2 = Action Level 2
Cefas = Centre for Environmental Fisheries & Aquaculture Science
Cefas action levels available at https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans

4.1.4 Sediment Macrofauna

The macrofauna from the grab samples included infauna and epifauna, the latter comprising solitary and colonial organisms. The infauna and solitary epifauna were enumerated and were analysed together in terms of phyletic composition, species diversity, abundance and distribution. The colonial epifauna, recorded as present (P), was removed from the enumerated dataset and assessed for taxa composition and distribution (detailed in Section 4.5.2). Macrofaunal data was reanalysed with the inclusion of station ST141 as per client request.

4.1.4.1 Infaunal and Solitary Epifauna from the Grab Samples

4.1.4.1.1 Phyletic Composition

Following rationalisation, the enumerated macrofaunal dataset comprised 178 taxa and 5112 individuals. The excluded taxa comprised juveniles, meiofauna, pelagic and parasitic taxa, damaged fauna and fish. Fish were represented by taxa of the family Gobiesocidae.

Juveniles comprised 27 taxa and 733 individuals, of which bivalves of the superfamily Thracioidea with 192 individuals were numerically dominant, followed by echinoderms of the family Amphiuridae with 122 individuals, crustacea of the genus *Upogebia* and echinoderms of the order Spatangoida with 100 and 56 individuals, respectively.

Table 4.13 summarises the phyletic composition of the enumerated fauna from the grab samples. Figure 4.21 illustrates the phyletic composition of taxa and individuals of the enumerated macrofauna.

Table 4.13: Taxonomic groups of enumerated fauna from the grab samples, Dogger Bank D Array 2023

Taxonomic group	Number of Taxa	Composition of Taxa [%]	Abundance	Composition of Individuals [%]
Annelida	81	45.5	2490	48.7
Arthropoda	50	28.1	716	14.0
Mollusca	29	16.3	1069	20.9
Echinodermata	11	6.2	438	8.6
Other phyla	7	3.9	399	7.8
Total	**178**	**100**	**5112**	**100**

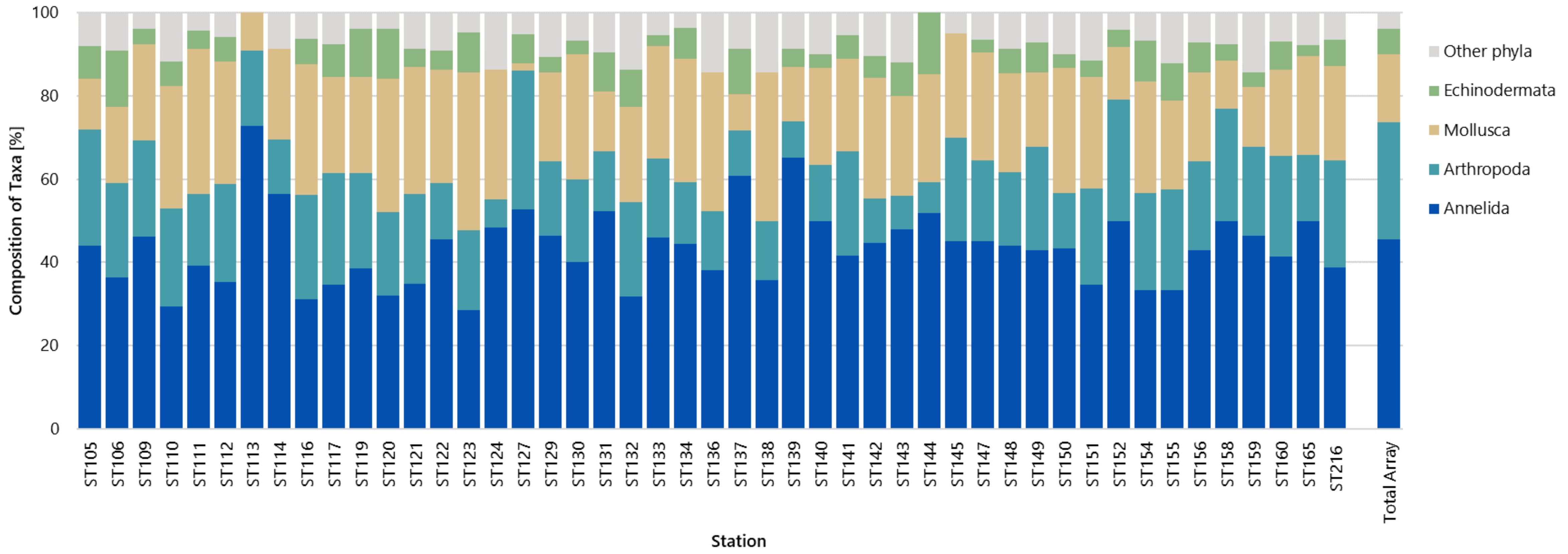
Notes
Macrofaunal samples were processed through a 1 mm mesh sieve
Other phyla included: Chordata, Cnidaria, Hemichordata, Nemertea, Phoronida and Platyhelminthes

Annelida comprised most of the enumerated taxa composition (45.5 %), followed by Arthropoda (28.1 %) Mollusca (16.3 %), and Echinodermata (6.2 %). Other phyla comprised 3.9 % of the enumerated taxa and were represented by Chordata (*Branchiostoma lanceolatum)*, Cnidaria (species of the order Actiniaria and the family Edwardsiidae), Hemichordata (Enteropneusta), Nemertea, Phoronida and Platyhelminthes.

When assessed on a station basis, Annelida were dominant in terms of taxa composition at most stations across the survey area. Mollusca comprised most of the enumerated taxa at station ST123.

Annelida also comprised most of the enumerated macrofaunal abundance (48.7 %), followed by Mollusca (20.9 %), Arthropoda (14.0 %), and Echinodermata (8.6 %), whereas other phyla comprised 7.8 % of the enumerated macrofaunal abundance.

When assessed on a station basis, Annelida were numerically dominant at most stations across the survey area. Mollusca dominated at 6 stations whereas at station ST112, Annelida and Mollusca had equal abundances.



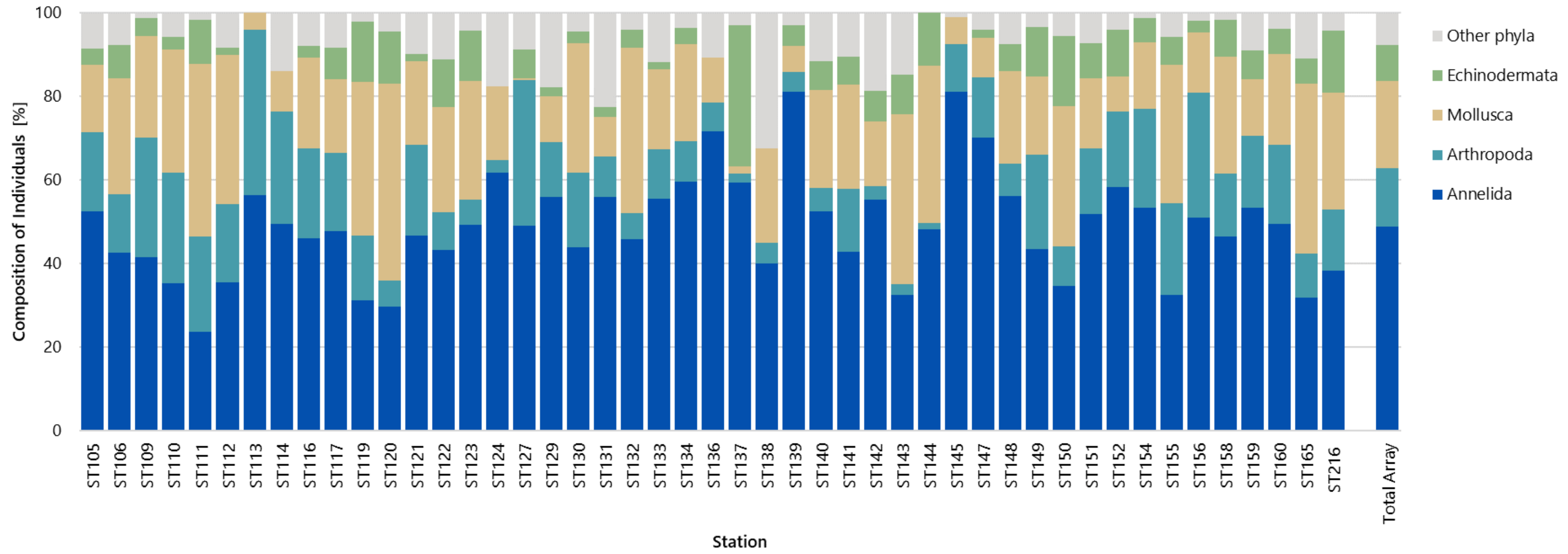


Figure 4.12: Phyletic composition of enumerated macrofaunal (A) taxa and (B) individuals from the grab samples, Dogger Bank D Array 2023

4.1.4.1.2 Community Statistics

Table 4.14 presents the results of the univariate analysis of the enumerated macrofaunal dataset, which provided information on faunal richness and diversity, and allowed geographical contextualisation of the results. Univariate indices included faunal richness (Margalef's index d), diversity (Shannon-Wiener Index $H'Log_2$), evenness (Pielou's index J'), and dominance (Simpson's index λ).

Figure 4.13 illustrates the spatial distribution of the number of taxa whilst Figure 4.14 illustrates the spatial distribution of the number of individuals.

The number of taxa ranged from 11 at station ST113 to 57 at station ST127, with a mean of 27 and a median of 26.

The number of individuals ranged from 34 at station ST110 to 374 at station ST137, with a mean of 109 and a median of 97.

Values of richness reflected the number of individuals per taxa recorded, with values ranging from 2.6 at station ST113 to 10.0 at station ST127, with a mean of 5.7 and a median of 5.6.

The Shannon-Wiener Diversity, assessed in line with the Dauvin et al. (2012) criteria, was:

- high ($H'Log_2$ > 4.00) at 12 stations;
- good ($H'Log_2$ of 3.00 to 4.00) at 33 stations;
- moderate ($H'Log_2$ of 2.00 to 3.00) at 2 stations.

The mean diversity across survey area, with a value of 3.76 was good.

The evenness ranged from 0.597 (station ST145) to 0.911 (station ST134) with a mean of 0.797 and a median of 0.818.

In general, values of dominance were generally low owing to the generally high values of evenness.

Table 4.14: Community statistics of enumerated fauna from the grab samples (0.1 m^2), export cable corridor and array, Dogger Bank D Array 2023

Station	Numbers		Richness	Diversity	Evenness	Dominance
	Taxa	Individuals	Margalef [d]	Shannon-Wiener [H'Log$_2$]	Pielou [J']	Simpson [λ]
ST105	25	80	5.5	3.89	0.838	0.112
ST106	22	101	4.6	3.80	0.852	0.102
ST109	26	70	5.9	4.11	0.875	0.080
ST110	17	34	4.5	3.55	0.869	0.119
ST111	23	114	4.6	3.45	0.763	0.132
ST112	17	59	3.9	3.41	0.834	0.130
ST113	11	48	2.6	2.83	0.818	0.183
ST114	23	93	4.9	3.76	0.832	0.103
ST116	16	37	4.2	3.55	0.887	0.119
ST117	26	107	5.4	3.96	0.842	0.106
ST119	26	90	5.6	3.84	0.817	0.103
ST120	25	111	5.1	3.33	0.717	0.167
ST121	23	60	5.4	3.87	0.856	0.108
ST122	22	88	4.7	3.69	0.827	0.105
ST123	21	67	4.8	3.83	0.873	0.092
ST124	29	102	6.1	4.00	0.823	0.099
ST127	57	278	10.0	5.01	0.859	0.047
ST129	28	100	5.9	3.79	0.787	0.129
ST130	30	107	6.2	4.20	0.856	0.084
ST131	21	84	4.5	3.51	0.798	0.139
ST132	22	94	4.6	3.14	0.704	0.203
ST133	37	110	7.7	4.44	0.852	0.082
ST134	27	52	6.6	4.33	0.911	0.074
ST136	21	74	4.6	3.31	0.752	0.166
ST137	46	374	7.6	3.61	0.654	0.154
ST138	28	80	6.2	3.78	0.786	0.131
ST139	23	63	5.3	3.34	0.737	0.217
ST140	30	162	5.7	3.57	0.728	0.169
ST141	36	133	7.2	4.14	0.801	0.106
ST142	38	181	7.1	3.79	0.721	0.153
ST143	25	74	5.6	3.95	0.850	0.087
ST144	27	133	5.3	3.40	0.714	0.163
ST145	20	79	4.3	2.58	0.597	0.357
ST147	31	97	6.6	3.95	0.797	0.126
ST148	34	185	6.3	3.66	0.719	0.178
ST149	28	85	6.1	4.17	0.867	0.079
ST150	30	179	5.6	3.49	0.710	0.153
ST151	26	108	5.3	3.89	0.828	0.122
ST152	24	72	5.4	3.81	0.832	0.122
ST154	30	139	5.9	3.62	0.738	0.175
ST155	33	151	6.4	4.06	0.805	0.101
ST156	28	104	5.8	3.51	0.731	0.174
ST158	26	114	5.3	3.40	0.723	0.169
ST159	28	88	6.0	3.89	0.810	0.125
ST160	29	101	6.1	4.11	0.845	0.088
ST165	38	182	7.1	4.02	0.767	0.117
ST216	31	68	7.1	4.31	0.869	0.078
Minimum	**11**	**34**	**2.6**	**2.58**	**0.597**	**0.047**
Maximum	**57**	**374**	**10.0**	**5.01**	**0.911**	**0.357**
Median	**26**	**97**	**5.6**	**3.79**	**0.818**	**0.122**
Mean	**27**	**109**	**5.7**	**3.76**	**0.797**	**0.130**
Standard Deviation	**7.7**	**60.1**	**1.19**	**0.414**	**0.0674**	**0.0503**

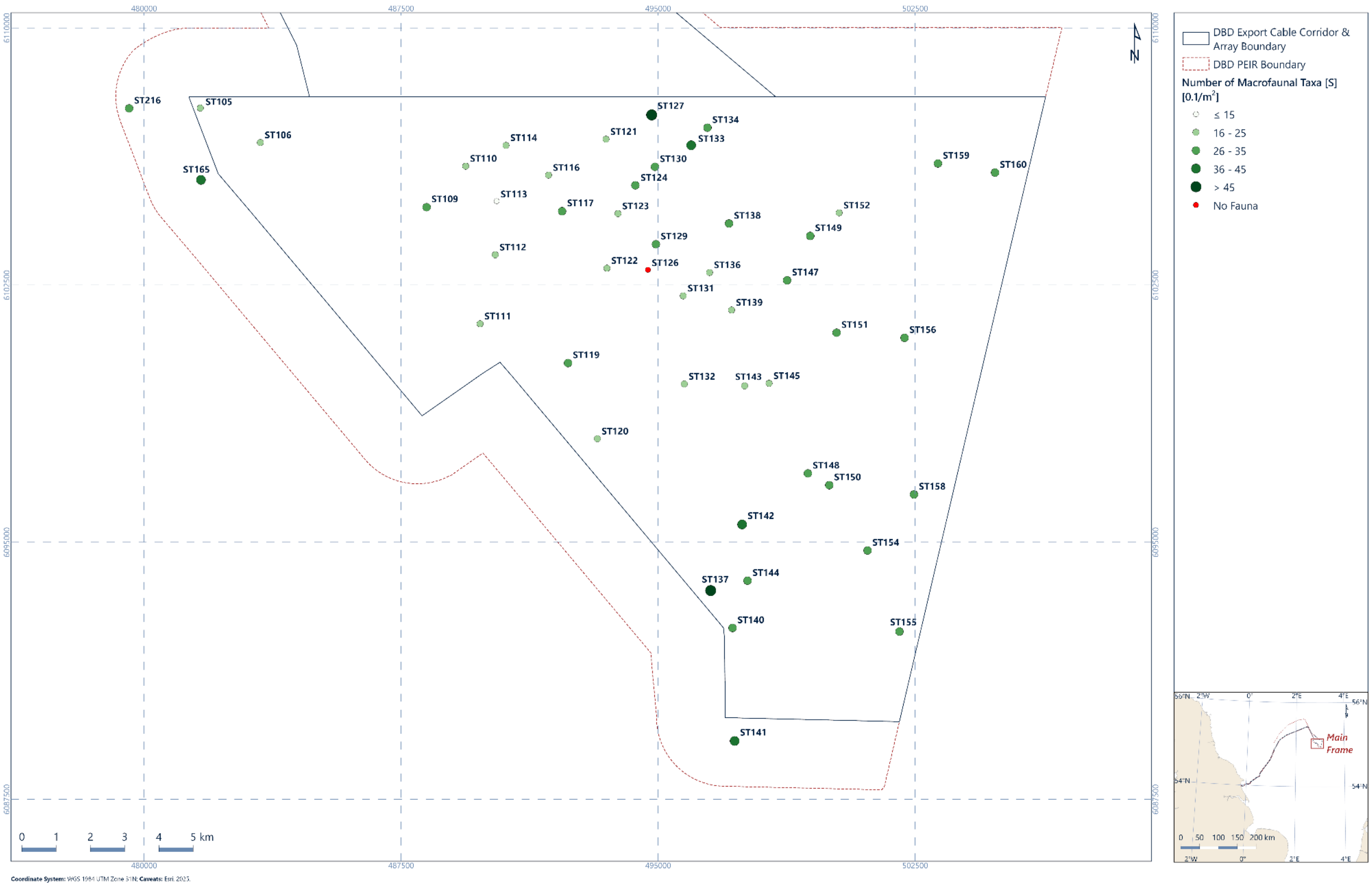


Figure 4.13: Spatial variations of the number of taxa (0.1 m^2), Dogger Bank D Array 2023

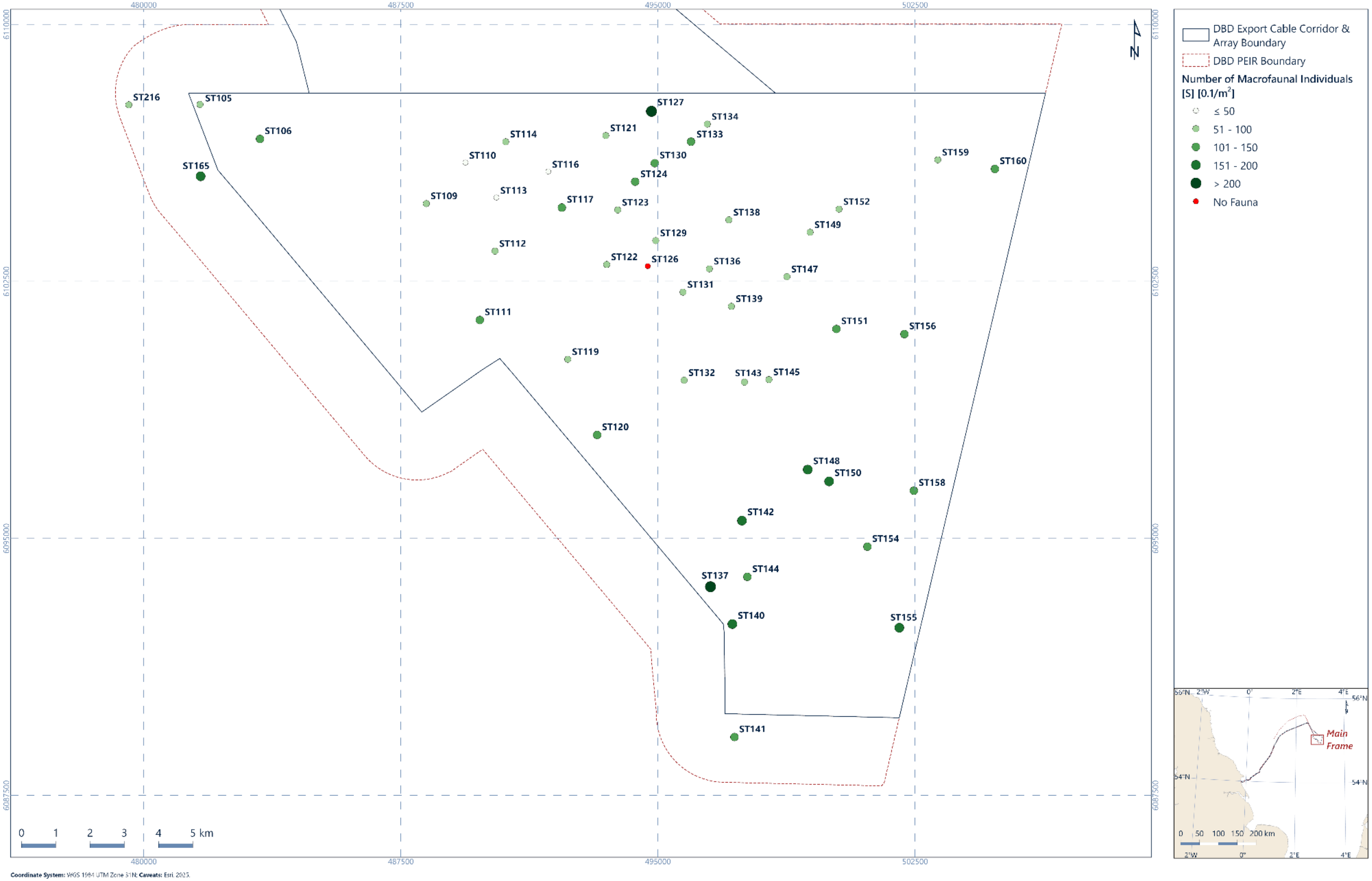


Figure 4.14: Spatial variations of the number of individuals (0.1 m²), Dogger Bank D Array 2023

4.1.4.1.3 Investigation of Faunal Similarities

The enumerated macrofaunal dataset was transformed prior to multivariate analysis. A fourth root transformation provided the best assessment, down weighting the numerically dominant species and allowing more detailed interrogation of less abundant taxa and the underlying community.

Faunal similarities were investigated using the hierarchical clustering analysis, results of which are illustrated in Figure 4.15. The SIMPROF test, undertaken in conjunction with the cluster analysis, was interpreted in ecological terms and, where appropriate, coarser groups were created. Owing to a stress coefficient of 0.18, the nMDS was deemed not representative of the stations' two-dimensional ordination.

Two groups of stations (A and B) were identified at a similarity of 20 %.

The groups identified through the multivariate analysis were further assessed by means of the SIMPER analysis. Table 4.15 presents the top ten characterising taxa identified through the SIMPER analysis, along with a summary of the physical variables characterising each multivariate group; the average abundance of the characterising taxa refers to untransformed data. The characteristics of the multivariate groups were as follow:

- Group A comprised 45 stations and had an average similarity of 35.5 %. Group A was characterised by poorly sorted 'sand' (Folk BGS), with mean median sediment particle size of 227 μm (fine sand), in mean water depth of 25.2 m BSL. Group A had mean numbers of 26 taxa and 99 individuals, of which the polychaetes *Spiophanes bombyx*, *Lagis koreni* and species of *Owenia* were amongst the top ten characterising taxa, along with the echinoderm *Acrocnida brachiata*, the bivalves *Fabulina fabula, Chamelea striatula* and *Kurtiella bidentata*, the amphipods *Bathyporeia guilliamsoniana* and *Phtisica marina* and species of the genus *Phoronis*. The faunal diversity (H'Log_2) of group A, with a mean value of 3.73, was 'good';
- Group B comprised 2 stations and had an average similarity of 21.3 %. Group B was characterised by very poorly sorted 'sand' (Folk BGS), with mean median sediment particle size of 9914 μm (medium pebble), in mean water depth of 30.2 m BSL. Group B had mean numbers of 52 taxa and 326 individuals, of which the echinoderm *Echinocyamus pusillus,* annelids of the phylum Nemertea and the crustacean *Phtisica marina* were amongst the top ten characterising taxa, along with the polychaetes *Glycera lapidum*, *Eteone longa*, *Aonides paucibranchiata, Pholoe baltica* and species of *Owenia*, *Polycirrus* and *Harmothoe*. The faunal diversity (H'Log_2) of group B, with a mean value of 4.31, was 'high'.

4.1.4.1.4 Relationships Between Physical and Biological Variables

The combination of physical variables (percentages of sediment fractions and depth) that best explained the observed pattern of macrofaunal distribution included the 2800 µm (granule), the 707 µm (coarse sand), the 177 µm (fine sand), the 63 µm (very fine sand) and the 31 µm (medium silt) sediment particle sizes as identified through the BIOENV analysis, which returned the highest value of rho of 0.712 at a significance level of 1 % for this combination of variables.

Figure 4.56 illustrates the relationships between sediment type and the macrofaunal groups identified through the multivariate analysis, highlighting an increase in enumerated faunal diversity (H'Log_2), with increased sediment coarseness and heterogeneity.

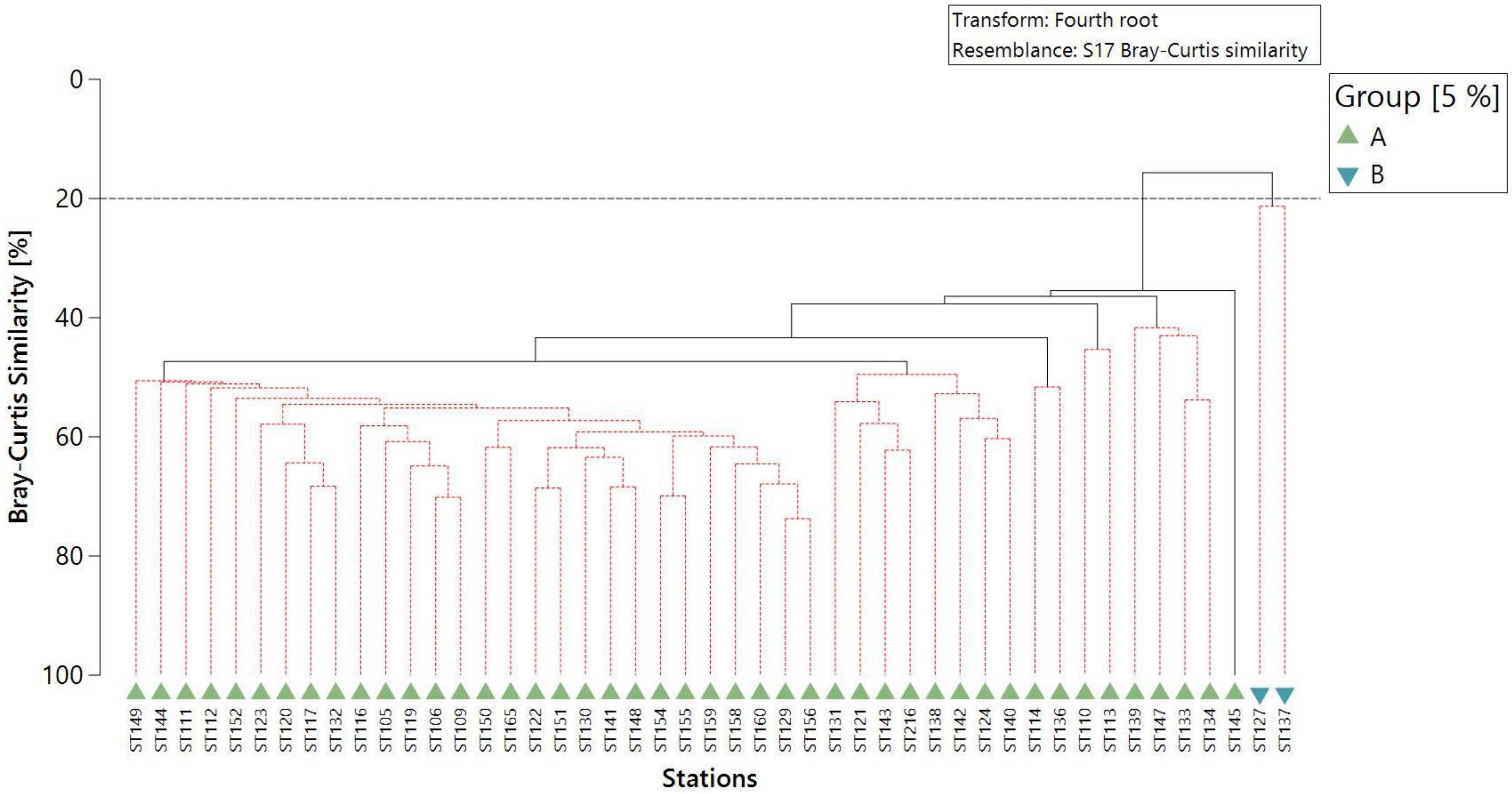


Figure 4.15: Dendrogram of hierarchical clustering analysis of enumerated fauna from the grab samples, Dogger Bank D Array 2023

Table 4.15: Summary of attributes of multivariate groups of enumerated macrofauna from the grab samples, Dogger Bank D Array 2023

Group	Location and Station	Characterising Features	Characterising Taxa	Abundance [N]	Frequency [%]	Contribution to Similarity [%]
A Average similarity: 35.5 %	ST105, ST106, ST109, ST110, ST111, ST112, ST113, ST114, ST116, ST117, ST119, ST120, ST121, ST122, ST123, ST124, ST129, ST130, ST131, ST132, ST133, ST134, ST136, ST138, ST139, ST140, ST141, ST142, ST143, ST144, ST145, ST147, ST148, ST149, ST150, ST151, ST152, ST154, ST155, ST156, ST158, ST159, ST160, ST165, ST216	Taxa: 26 Individuals: 99 Depth [m BSL]: 25.2 Gravel [%]: 6.47 Sand [%]: 92.05 Fines [%]: 1.48 Median [µm]: 227 Sorting [µm]: 2.59	*Spiophanes bombyx*	26	100	13.3
			Fabulina fabula	6.4	93.3	7.8
			Owenia	4.8	91.1	7.0
			Phoronis	5.8	91.1	6.9
			Bathyporeia guilliamsoniana	3.4	80.0	5.2
			Phtisica marina	2.5	84.4	5.1
			Acrocnida brachiata	5.6	75.6	5.0
			Kurtiella bidentata	9.8	73.3	4.8
			Lagis koreni	2.8	68.9	3.6
			Chamelea striatula	1.5	68.9	3.2
B Average similarity: 21.3 %	ST127, ST137	Taxa: 52 Individuals: 326 Depth [m BSL]: 30.2 Gravel [%]: 61.48 Sand [%]: 35.77 Fines [%]: 2.76 Median [µm]: 9914 Sorting [µm]: 5.81	Nemertea	13	100	11.5
			Pholoe baltica	18	100	11.2
			Echinocyamus pusillus	64	100	10.7
			Glycera lapidum	19	100	9.0
			Polycirrus	4	100	8.2
			Phtisica marina	3	100	8.2
			Harmothoe	4	100	6.9
			Eteone longa	4	100	6.9
			Aonides paucibranchiata	13	100	6.9
			Owenia	1	100	6.9

Notes
Values refer to mean of untransformed data within each multivariate group
Taxa listed are the top ten identified by the SIMPER analysis (85 % percentage contribution)
Frequency refers to number of stations within each multivariate group
BSL = Below sea level
Abundance refers to mean values of individuals within the multivariate group
Taxa listed in decreasing order of percentage contribution to similarity

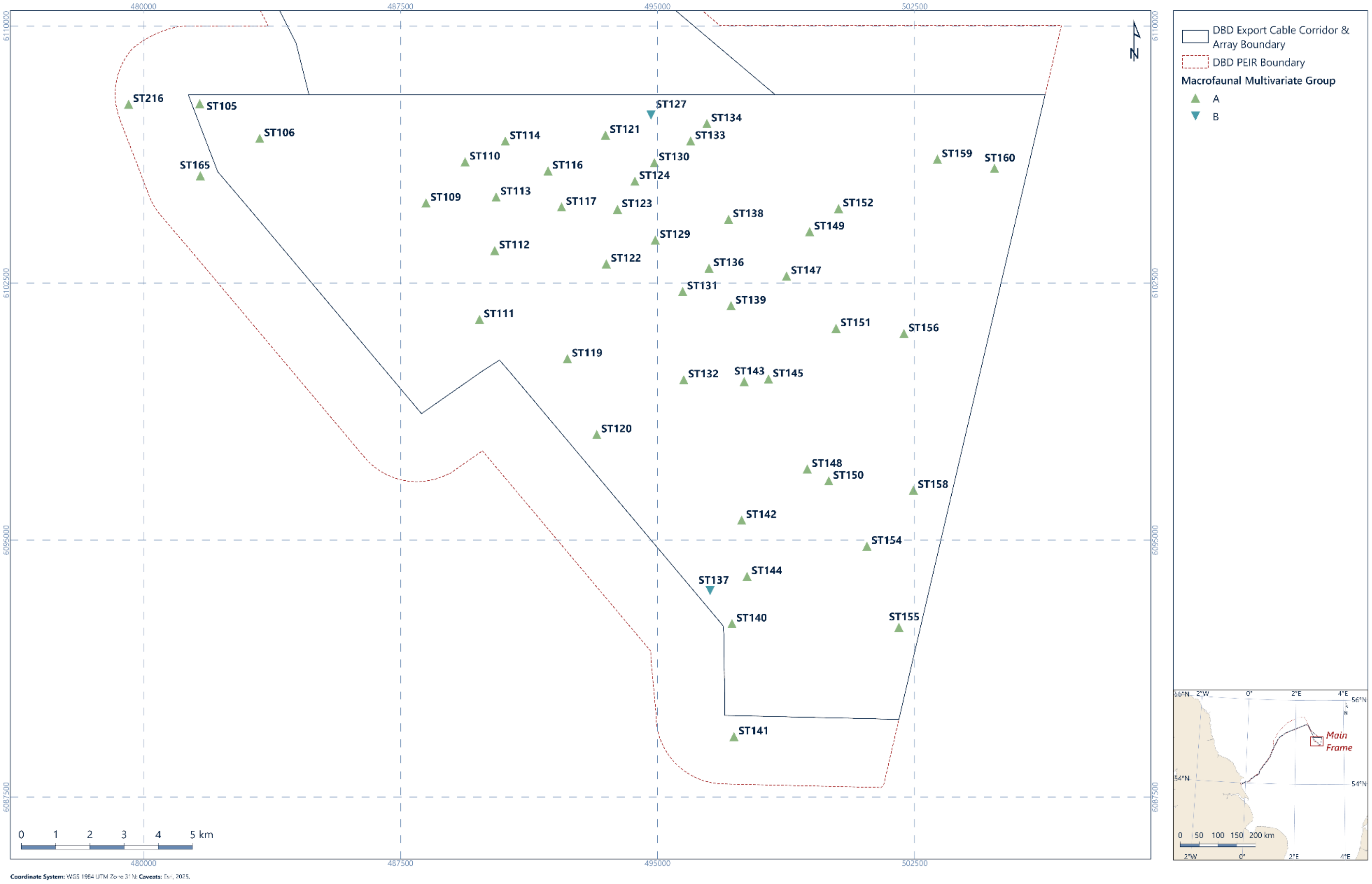
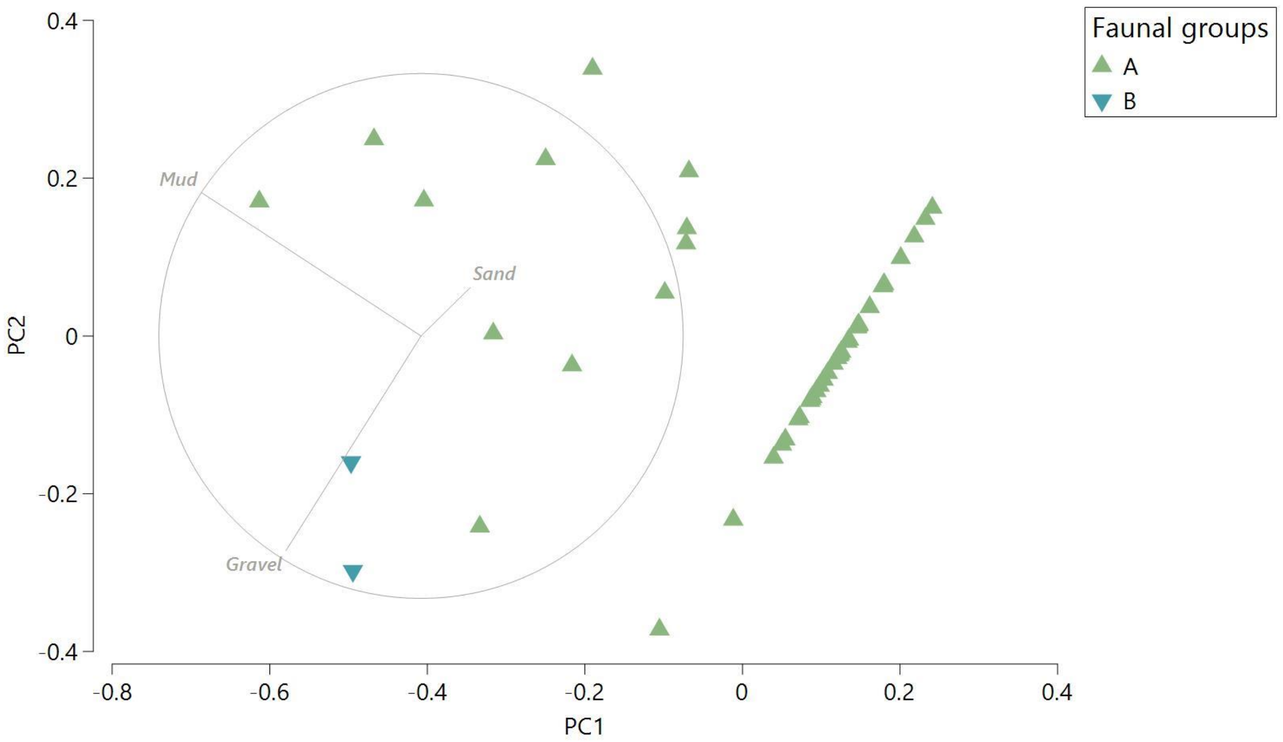
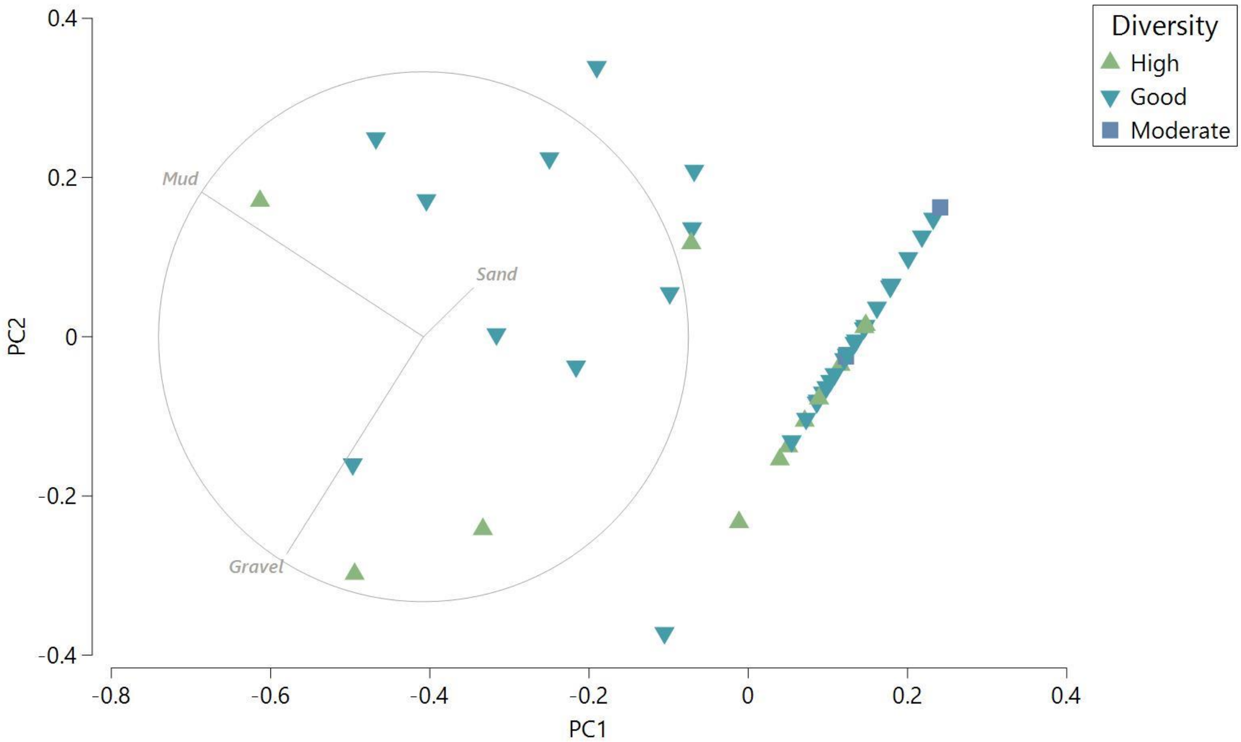


Figure 4.16: Spatial distribution of macrofaunal groups identified through the multivariate analysis, Dogger Bank D Array 2023





Notes

PC = Principal component

Figure 4.17: 2D PCA of sediment composition with superimposed macrofaunal (A) multivariate groups and (B) Shannon-Wiener [H'Log_2] index of diversity of enumerated macrofauna from the grab samples, Dogger Bank D Array 2023

4.1.4.1.5 Biomass

Table 4.16 presents the percentage contribution of phyla to biomass across the DBD array. It is worth noting that the biomass of Arthropoda comprises only invertebrates of the subphylum Crustacea. The biomass of the Arthropoda subphylum Chelicerata is reported within the biomass of other phyla. Table 4.17 presents the biomass of major taxonomic groups at each station. Figure 4.18 illustrates the phyletic composition of the biomass at each station. Figure 4.19 illustrates the spatial variations of infaunal biomass across the DBD array. Figure 4.20 illustrates the association of the major faunal groups with sediment type.

Table 4.16: Taxonomic groups of macrofaunal biomass from the grab samples, Dogger Bank D Array 2023

Phylum	Biomass [AFDW g/0.1 m^2]	Biomass [%]
Array Area		
Annelida	3.5757	7.0
Arthropoda	18.548	36.4
Mollusca	5.1023	10.0
Echinodermata	23.246	45.6
Other phyla	0.4687	0.9
Total	**50.941**	**100**
Notes Macrofaunal samples were processed through a 1 mm mesh sieve Arthropoda comprises only invertebrates of the subphylum Crustacea Other phyla included: Chordata, Cnidaria, Hemichordata, Nemertea, Phoronida and Platyhelminthes		

Echinodermata comprised most of the macrofaunal abundance (45.6 %), followed by Arthropoda (36.4 %), Mollusca (10.0 %) and Annelida (7.0 %), whereas other phyla comprised 0.9 %.

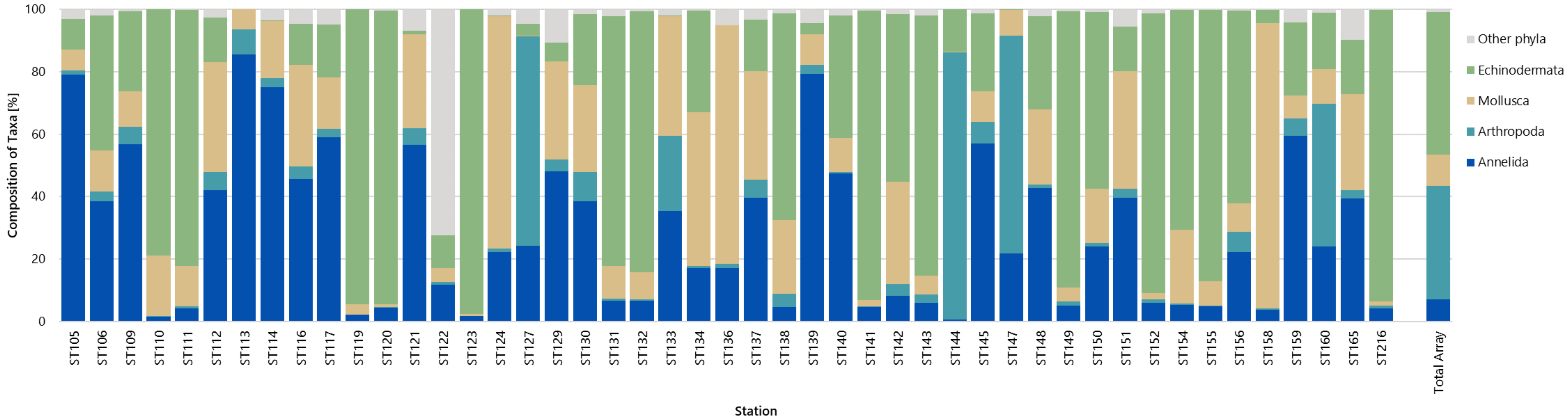
The total biomass ranged from 0.0294 AFDW g/0.1 m^2 at station ST116 to 20.222 AFDW g/0.1m^2 at station ST144, with a mean of 1.0838 AFDW g/0.1m^2 and a median of 0.3571 AFDW g/0.1m^2.

The high value of biomass at station ST144 was associated with Arthropoda and analysis of the species list indicated the presence of the amphipods *Leucothoe incisa* and *Phtisica marina* as well as one juvenile of the genus *Liocarcinus*. The biomass at station ST123, with the second highest value of 2.6355 AFDW g/0.1 m^2, was associated with echinoderms, specifically *Acrocnida brachiata* and *Echinocardium cordatum*, which comprised seven and one individuals, respectively.

Table 4.17: Phyletic composition of macrofaunal biomass from the grab samples (0.1 m²), Dogger Bank D Array 2023

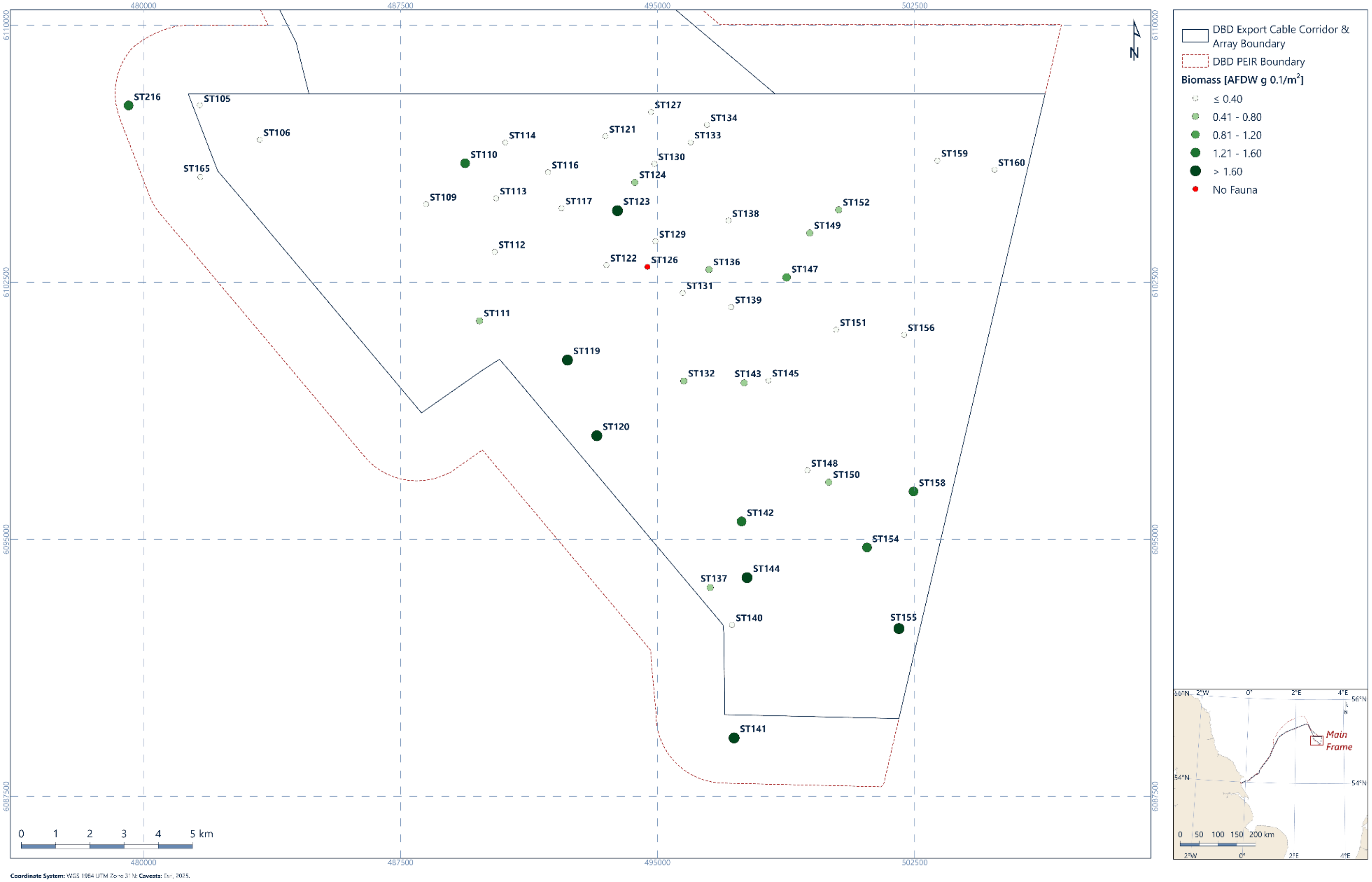
Station	Biomass					
	Annelida	Arthropoda	Mollusca	Echinodermata	Other Phyla	Total
ST105	0.1122	0.0020	0.0094	0.0140	0.0044	**0.1419**
ST106	0.0645	0.0052	0.0220	0.0722	0.0033	**0.1672**
ST109	0.0500	0.0048	0.0101	0.0226	0.0005	**0.0878**
ST110	0.0220	0.0028	0.2710	1.0954	0.0005	**1.3917**
ST111	0.0280	0.0055	0.0859	0.5525	0.0014	**0.6733**
ST112	0.0358	0.0050	0.0300	0.0120	0.0023	**0.0851**
ST113	0.0451	0.0042	0.0034	0.00002	0.0000	**0.0527**
ST114	0.1967	0.0072	0.0480	0.0006	0.0092	**0.2616**
ST116	0.0134	0.0012	0.0096	0.0038	0.0014	**0.0294**
ST117	0.0853	0.0041	0.0239	0.0243	0.0071	**0.1446**
ST119	0.0541	0.0038	0.0821	2.4141	0.0000	**2.5542**
ST120	0.1148	0.0052	0.0224	2.4146	0.0109	**2.5678**
ST121	0.0298	0.0029	0.0158	0.0006	0.0036	**0.0527**
ST122	0.0315	0.0024	0.0118	0.0283	0.1944	**0.2684**
ST123	0.0465	0.0011	0.0154	2.5711	0.0014	**2.6355**
ST124	0.0915	0.0047	0.3048	0.0014	0.0076	**0.4099**
ST127	0.0503	0.1381	0.0005	0.0080	0.0094	**0.2063**
ST129	0.0712	0.0057	0.0462	0.0091	0.0157	**0.1479**
ST130	0.0392	0.0095	0.0283	0.0232	0.0016	**0.1017**
ST131	0.0220	0.0027	0.0347	0.2667	0.0071	**0.3331**
ST132	0.0399	0.0029	0.0523	0.5034	0.0036	**0.6021**
ST133	0.0653	0.0443	0.0707	0.0004	0.0036	**0.1843**
ST134	0.0642	0.0023	0.1831	0.1212	0.0018	**0.3727**
ST136	0.0795	0.0065	0.3547	0.0007	0.0232	**0.4645**
ST137	0.2186	0.0323	0.1916	0.0904	0.0184	**0.5513**
ST138	0.0167	0.0152	0.0846	0.2361	0.0046	**0.3571**
ST139	0.0510	0.0019	0.0064	0.0022	0.0029	**0.0644**
ST140	0.1529	0.0016	0.0345	0.1263	0.0065	**0.3219**
ST141	0.1204	0.0058	0.0540	2.4167	0.0091	**2.6060**
ST142	0.1150	0.0544	0.4583	0.7522	0.0209	**1.4008**
ST143	0.0403	0.0179	0.0394	0.5581	0.0131	**0.6688**
ST144	0.1303	17.3250	0.0372	2.7294	0.0000	**20.222**
ST145	0.0639	0.0077	0.0112	0.0279	0.0015	**0.1121**
ST147	0.1920	0.6100	0.0720	0.0018	0.0004	**0.8761**
ST148	0.1640	0.0042	0.0922	0.1148	0.0083	**0.3835**
ST149	0.0285	0.0065	0.0243	0.4834	0.0039	**0.5465**
ST150	0.1046	0.0051	0.0749	0.2460	0.0035	**0.4342**
ST151	0.0872	0.0060	0.0831	0.0313	0.0119	**0.2196**
ST152	0.0319	0.0055	0.0102	0.4698	0.0073	**0.5247**
ST154	0.0757	0.0077	0.3389	1.0127	0.0014	**1.4365**
ST155	0.1239	0.0066	0.1981	2.2217	0.0028	**2.5531**
ST156	0.0549	0.0158	0.0227	0.1518	0.0009	**0.2462**
ST158	0.0578	0.0068	1.4012	0.0639	0.0032	**1.5329**
ST159	0.0804	0.0077	0.0097	0.0318	0.0057	**0.1352**
ST160	0.0583	0.1113	0.0273	0.0436	0.0028	**0.2433**
ST165	0.0994	0.0065	0.0776	0.0435	0.0246	**0.2517**
ST216	0.0553	0.0123	0.0169	1.2304	0.0015	**1.3164**
Minimum	**0.0134**	**0.0011**	**0.0005**	**0.0000**	**0.0000**	**0.0294**
Maximum	**0.2186**	**17.3250**	**1.4012**	**2.7294**	**0.1944**	**20.222**
Median	**0.0639**	**0.0057**	**0.0372**	**0.0722**	**0.0036**	**0.3571**
Mean	**0.0761**	**0.3946**	**0.1086**	**0.4946**	**0.0100**	**1.0838**
Standard deviation	**0.0492**	**2.5249**	**0.2195**	**0.8197**	**0.0282**	**2.9556**

Notes
Biomass expressed as ash free dry weight [AFDW] g/0.1 m² grab sample
Arthropoda comprises only invertebrates of the subphylum Crustacea
Other phyla included: Chordata, Cnidaria, Hemichordata, Nemertea, Phoronida and Platyhelminthes



Notes
Biomass expressed as ash free dry weight in g/0.1 m^2 grab sample

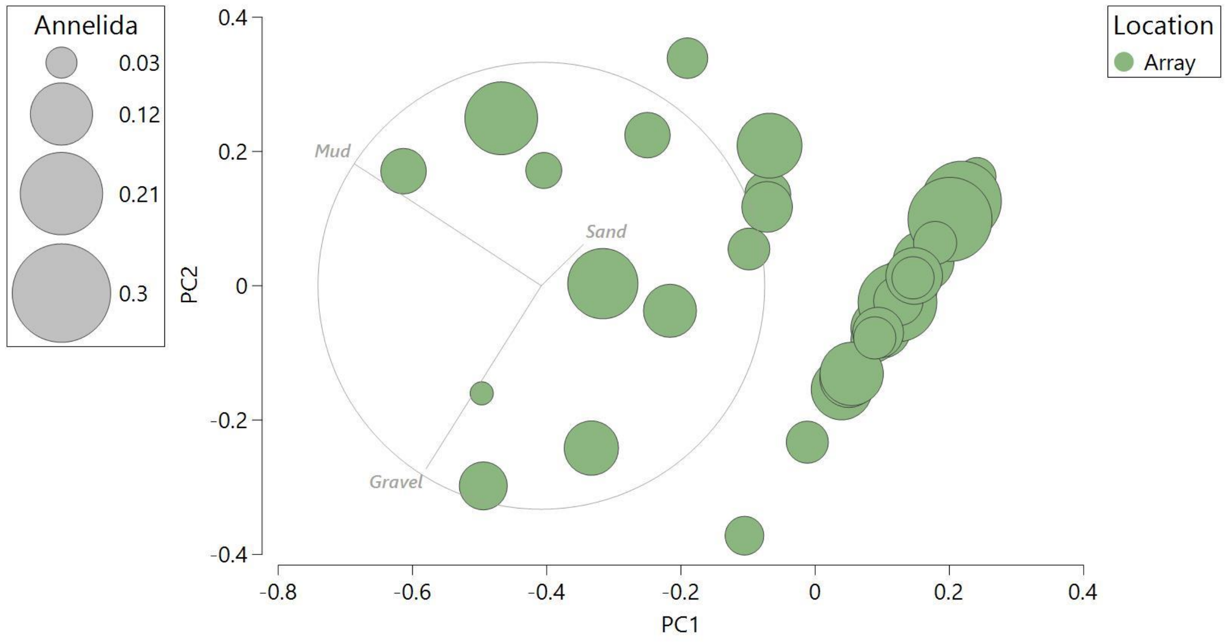
Figure 4.18: Phyletic composition of macrofaunal biomass from the grab samples, Dogger Bank D Array 2023



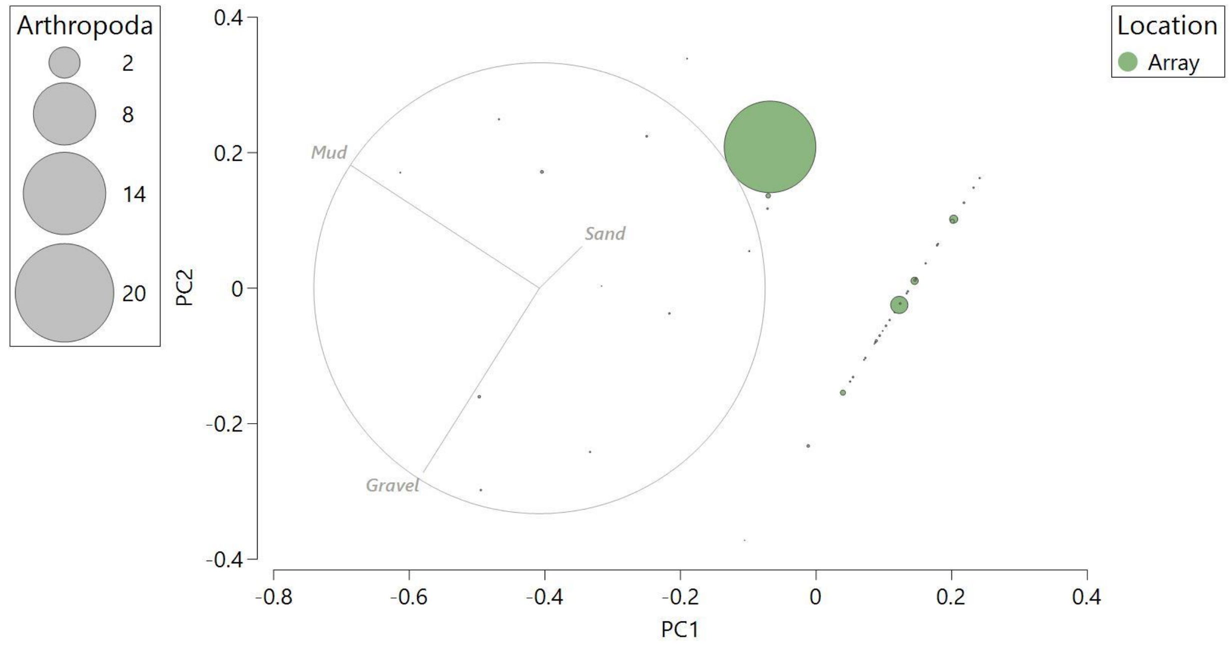
Notes

Biomass expressed as ash free dry weight [AFDW] in g/0.1 m^2 grab sample

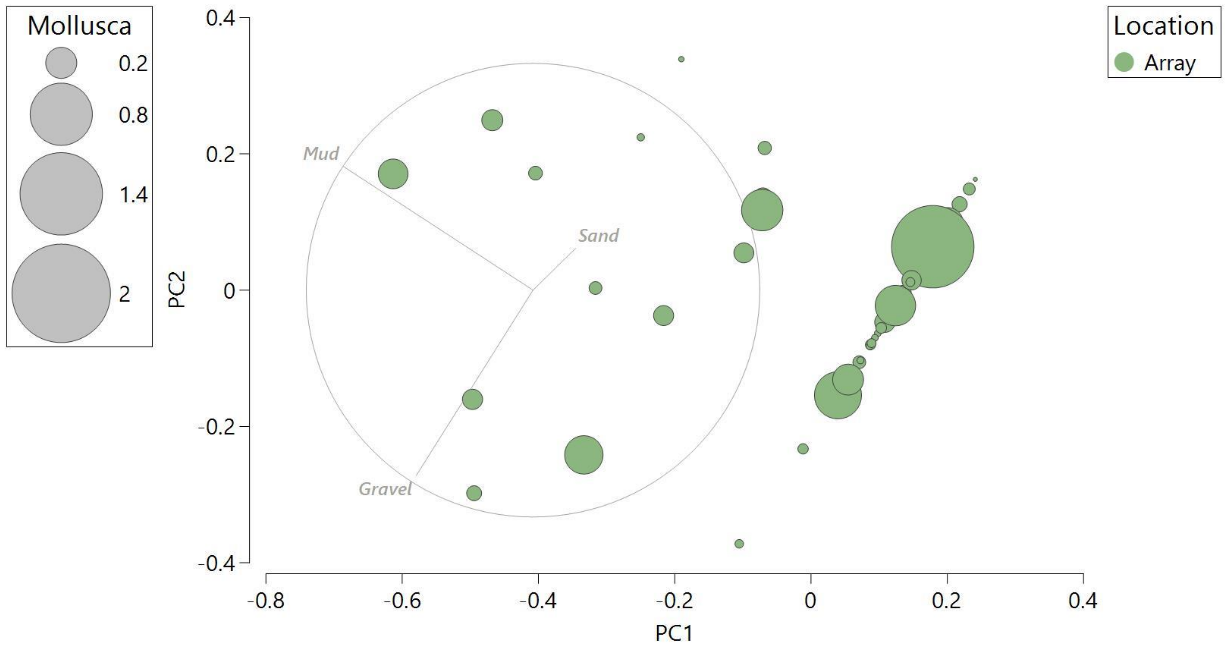
Figure 4.19: Spatial variations of total macrofaunal biomass from the grab samples, Dogger Bank D Array 2023



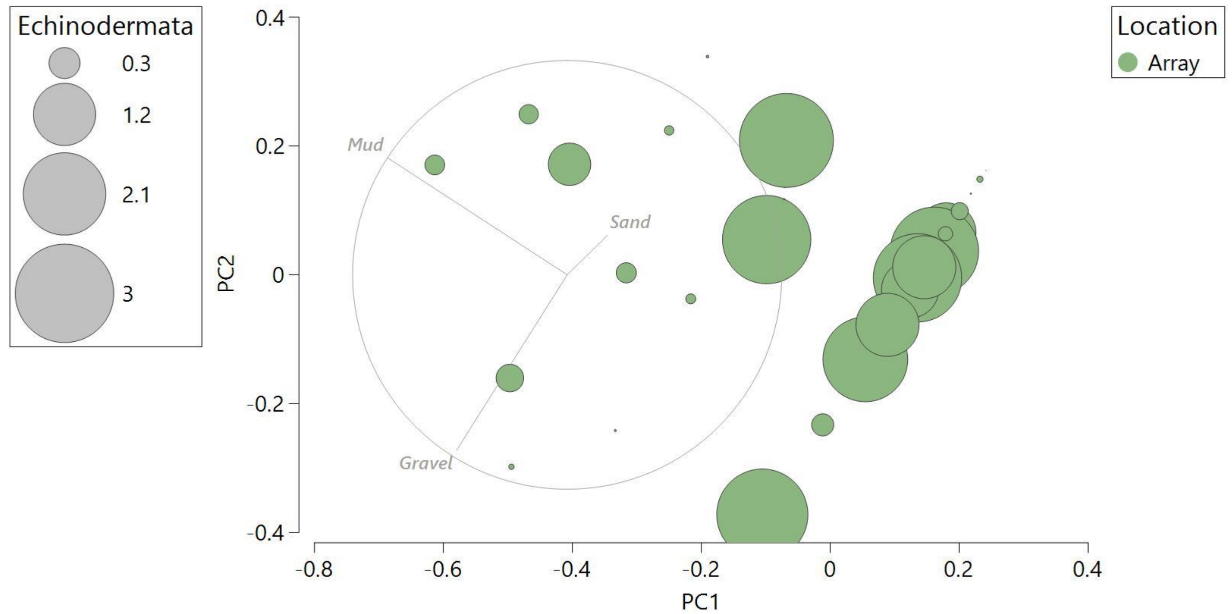
Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m²of Annelida



Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m²of Arthropoda



Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m²of Mollusca



Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m² of Echinodermata

Figure 4.20: 2D PCA of sediment composition with superimposed location and circles proportional in diameter to the abundance of major taxonomic groups of enumerated fauna from the grab samples, Dogger Bank D Array 2023

4.1.4.2 Colonial Epifauna

Colonial epifauna within the array was recorded at 41 of the 47 stations sampled by grab sampling.

4.1.4.2.1 Phyletic Composition

Table 4.18 presents the community structure of sessile colonial epifauna and Table 4.19 presents the top ten most frequently occurring colonial epifaunal taxa from the grab samples. Figure 4.21 illustrates the association of colonial epifauna occurrence with sediment. Figure 4.22 illustrates the colonial epifaunal community structure at single stations. Figure 4.23 illustrates the spatial variations of the number of epifaunal taxa.

Table 4.18: Taxonomic groups of colonial epifauna from the grab samples, Dogger Bank D Array 2023

Taxonomic Group	Number of Taxa	Composition of Taxa [%]
Porifera	4	5.0
Cnidaria	19	23.8
Bryozoa	50	62.5
Chordata	3	3.8
Other phyla	4	5.0
Total	**80**	**100**

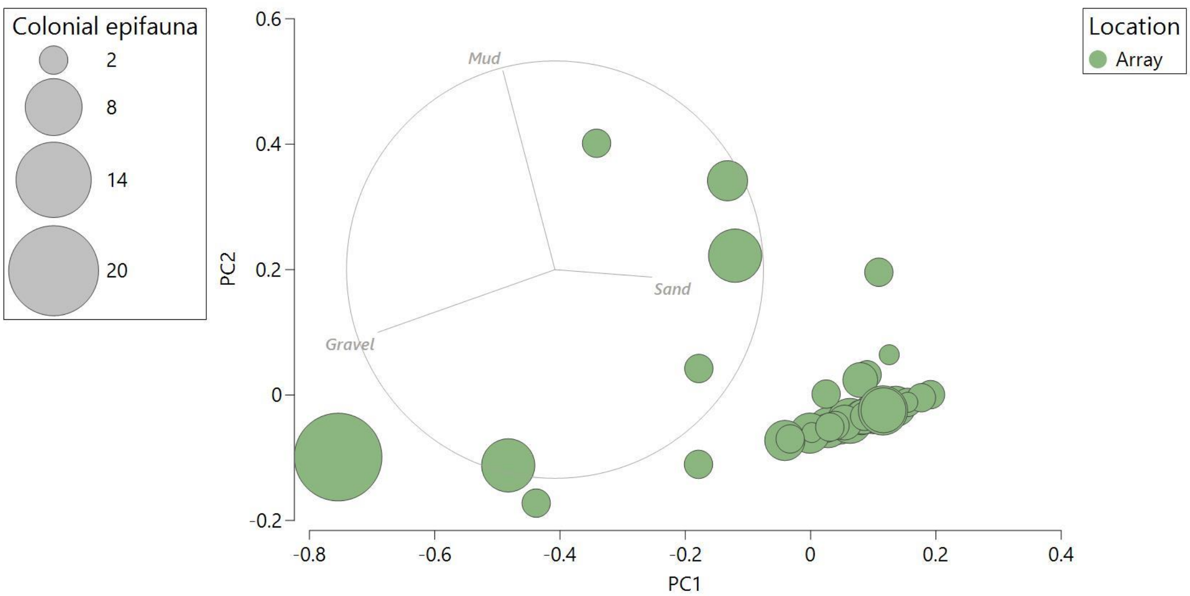
Notes
Macrofaunal samples were processed through a 1 mm mesh sieve
Other phyla include: Chromista, Entoprocta

Five main phyla of colonial epifauna were recorded across the DBD survey area, of these, Bryozoa comprised most of the taxa composition (62.5 %), followed by Cnidaria (23.8 %), Porifera (5.0 %) and Chordata (3.8 %). Other phyla comprised 5.0 % of the colonial epifauna and were represented by Chromista, including ciliates of the family Folliculinidae, and Entoprocta, namely *Loxosomella phascolosomata* and species of the genus *Pedicellina*.

Hydroids of the family Tubulariidae were the most frequently occurring, followed by *Lovenella clausa*, and species of the family Folliculinidae.

Table 4.19: Top ten most frequently occurring colonial epifaunal taxa from the grab samples, Dogger Bank D Array 2023

Taxon	Frequency [%]
Tubulariidae	32.5
Lovenella clausa	18.8
Folliculinidae	17.5
Clytia hemisphaerica	13.8
Campanulariidae	11.3
Filifera	7.5
Crisularia plumosa	7.5
Cribrilina punctata	7.5
Cliona	6.3
Penetrantiidae	5.0



Notes
PC = Principal component

Figure 4.21: 2D PCA of sediment composition with superimposed location and circles proportional in diameter to the number of colonial epifauna from the grab samples, Dogger Bank D Array 2023

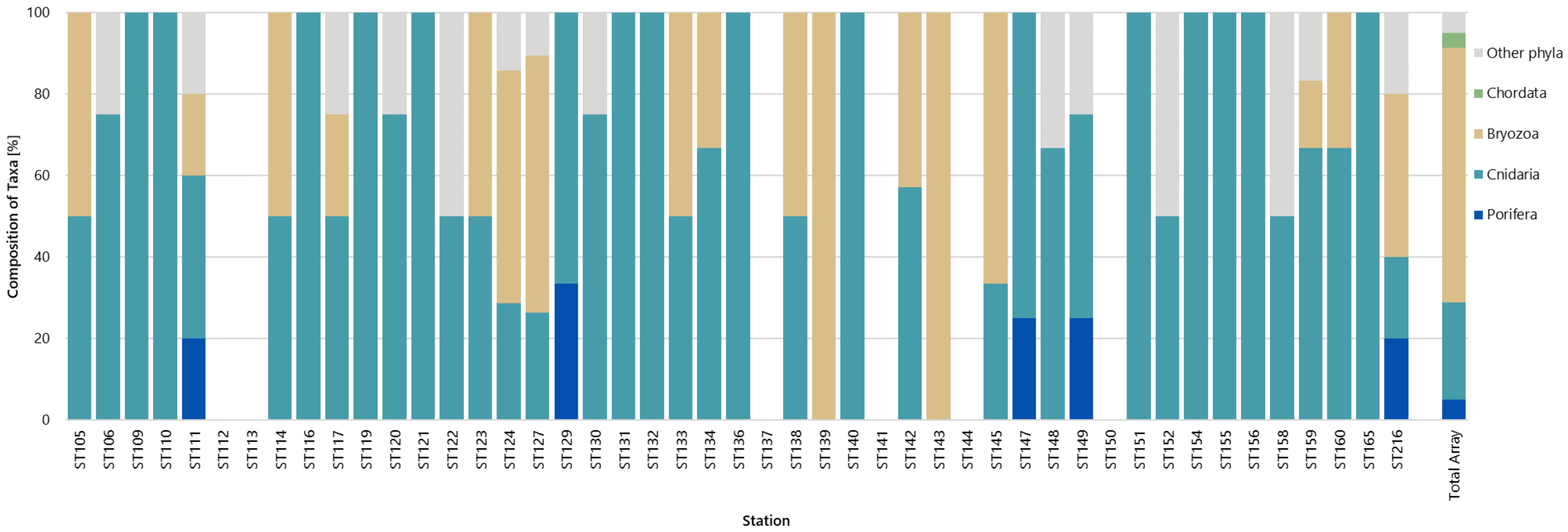


Figure 4.22: Phyletic composition of epifaunal taxa from the grab samples, Dogger Bank D Array 2023

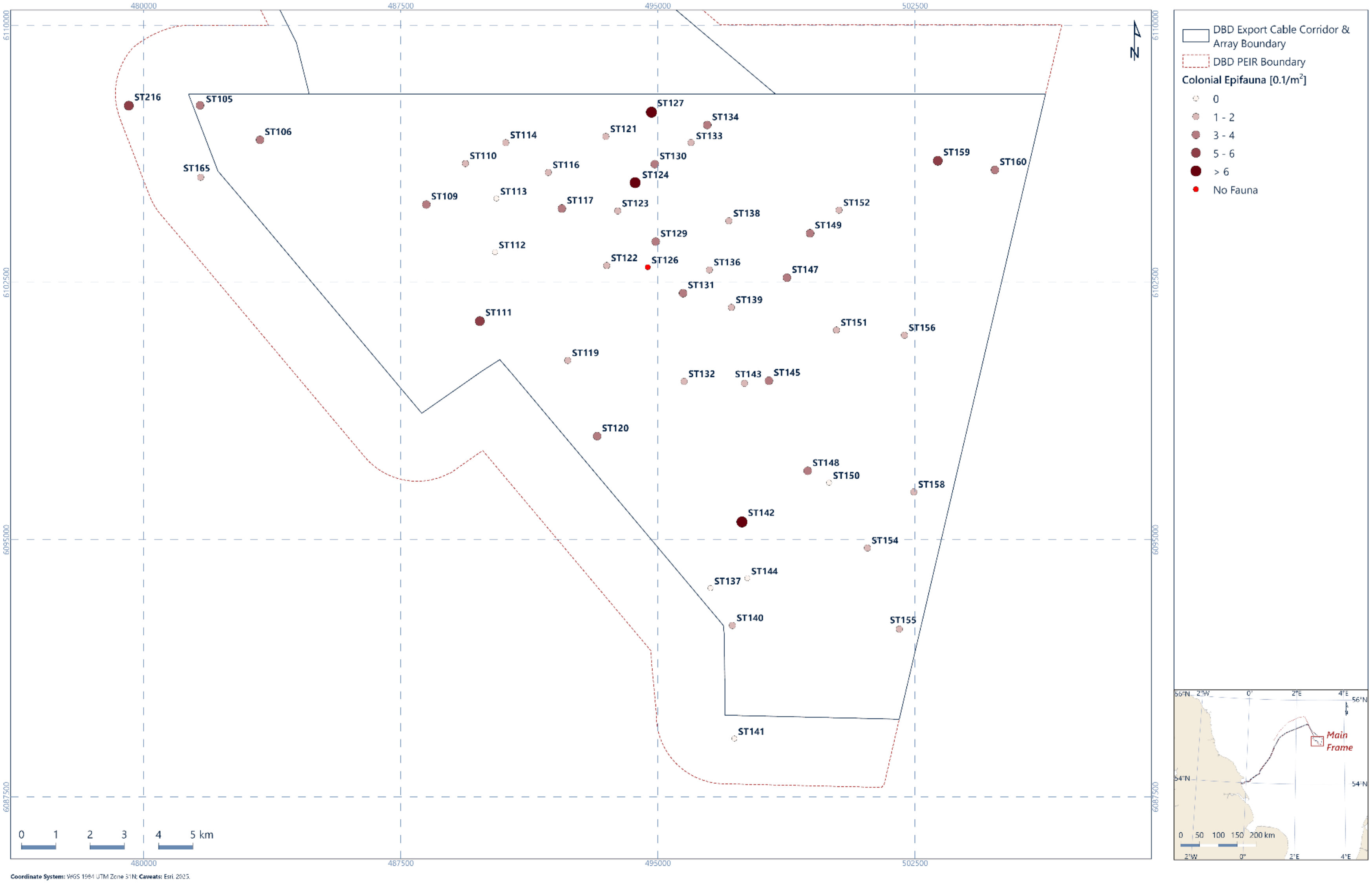


Figure 4.23: Spatial variations of colonial epifauna from the grab samples, array, Dogger Bank D Array 2023

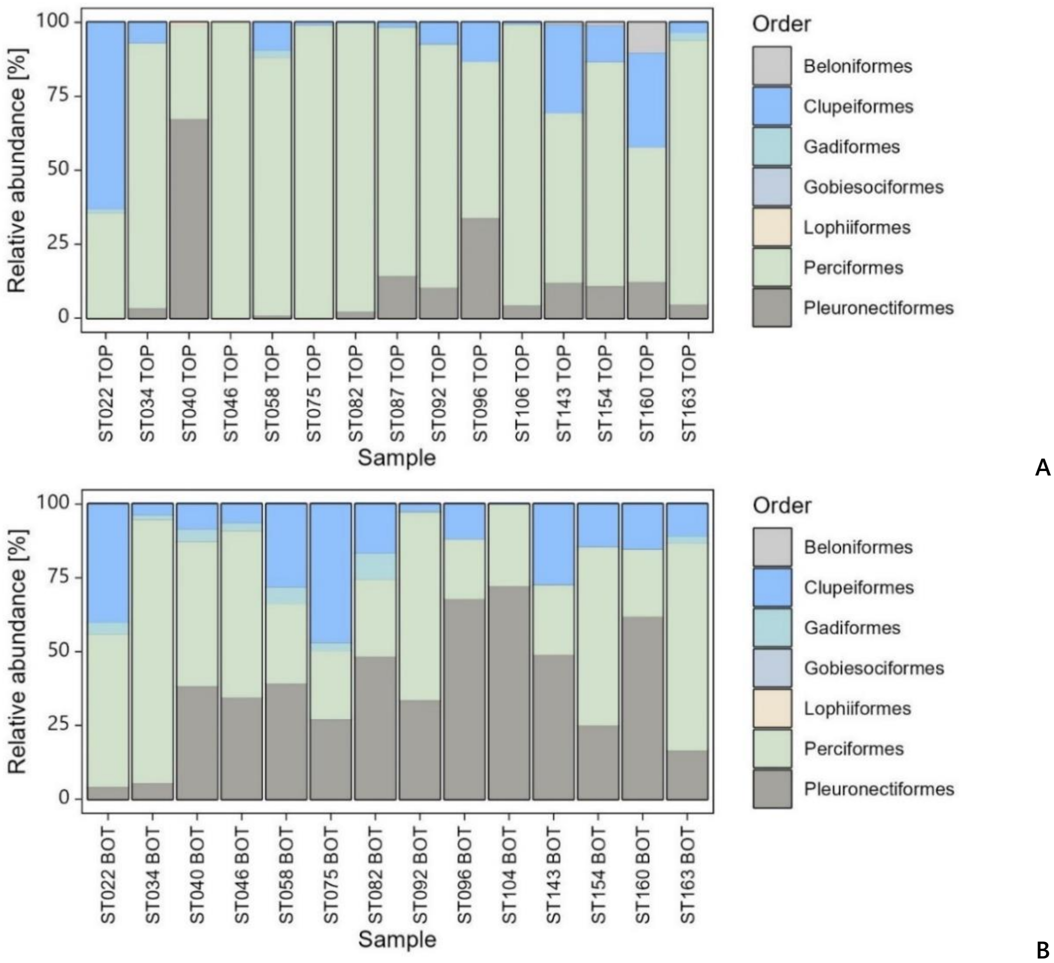
4.1.5 Environmental DNA Analysis

High-quality bony fish taxa sequence data were obtained for 30 of the 40 eDNA samples analysed. Bony fish taxa eDNA metabarcoding was not successful for 10 samples (ST087 BOT, ST104 TOP, ST106 BOT, ST113 TOP and BOT, ST115 BOT, ST127 TOP and BOT, ST142 TOP and BOT), as the DNA detected was not amplifiable, due to insufficient target DNA in the sample, and no species were reported. These samples were excluded from analysis.

4.1.5.1 Phyletic Composition

Figure 4.24 presents bar plots of the relative proportions of OTUs of the bony fish taxa detected by eDNA sampling rationalised to 'order' taxonomic level for TOP and BOT samples.

A total of 43 bony fish taxa were detected and 76.7 % (33 taxa) were at least 99 % similar to a species in the GBIF databases. The remaining 3 taxa (7.1 %) were identified to genus level. Taxa recorded in the TOP and BOT samples were largely comparable, with a higher proportion of bottom-dwelling taxa such as flatfish (Pleuronectiformes) in the BOT samples.



Notes

Non-target taxa (cartilaginous fish) were excluded from the plot

Figure 4.24: Bar plot of relative proportions of OTUs of target bony fish taxa detected to order level in the near-surface (~1 m below surface) (TOP) (A) and near-seafloor (~1 m from seafloor) (BOT) (B) eDNA water samples, Dogger Bank D Array 2023

Figures 4.25and 4.26present bubble plots of the relative proportions of OTUS of the bony fish taxa detected by eDNA sampling and IUCN red list category for TOP and BOT samples. Atlantic mackerel (*Scomber scombrus*) presented the highest relative proportions of OTUS detected in the TOP samples across the survey area. Other commonly detected taxa included Clupeidae, such as sprat (*Sprattus sprattus*) and Pleuronectiformes such as plaice (*Pleuronectes platessa*).

Other bony fish taxa identified across the survey area and in both TOP and BOT samples, included sand eels (Ammodytidae), in 21 samples, Atlantic horse mackerel (*Trachurus trachurus*), in 14 samples, haddock (*Melanogrammus aeglefinus*), in 5 samples, and Atlantic cod (*Gadus morhua*) in 2 samples.

The Atlantic horse mackerel (*T. trachurus*), the haddock (*M. aeglefinus*) and the Atlantic cod (*G. morhua*) are listed as 'vulnerable' on the IUCN red list and Atlantic cod (*G. morhua*) is also listed as an OSPAR 'Threatened and/or declining species'. The family Ammodytidae indicates the potential presence of the sand eel *A. marinus*, which is listed as 'least concern' on the IUCN red list.

Notes
Non-target taxa (cartilaginous fish) were excluded from the plot

Figure 4.25: Bubble plot of relative proportions of OTUs and International Union for Conservation of Nature (IUCN) red list category of bony fish taxa detected in the TOP (~1 m below surface) eDNA water samples, export cable corridor and array, Dogger Bank D Array 2023

Notes

Non-target taxa (cartilaginous fish) were excluded from the plot

Figure 4.26: Bubble plot of relative proportions of OTUs and International Union for Conservation of Nature (IUCN) red list category of bony fish taxa detected in the BOT (~5 m off seafloor) eDNA water samples, export cable corridor and array, Dogger Bank D Array 2023

4.1.5.2 Fish taxa: eDNA vs. photographic habitat data

Figure 4.28 illustrates the overlap between bony fish taxa, identified to family or higher taxonomic level, detected by eDNA and seafloor photographic data analysis for habitat assessment by comparing the number of taxa identified by each method.

The total number of bony fish taxa identified by eDNA analysis was 22, whilst the number of bony fish taxa identified by the photographic data analysis (habitat assessment) was 12. The overall number of bony fish taxa identified for the survey area was 25, with 9 taxa (36 %) being identified by both methods. These included Agonidae, Soleidae, Ammodytidae, Clupeidae, Gadidae, Triglidae, Callionymidae, Pleuronectidae and the order Pleuronectiformes. The eDNA samples analysis detected a further 13 taxa (56 %), including the families Belonidae, Lotidae, Gobiesocidae, Lophiidae, Carangidae, Gobiidae, Mullidae, Pholidae, Scombridae, Stichaeidae, Trachinidae, Scophthalmidae and Cottidae, whilst the photographic data analysis detected further 3 taxa (12 %), including the classes Actinopterygii and Osteichthyes and the order Pleuronectiformes.

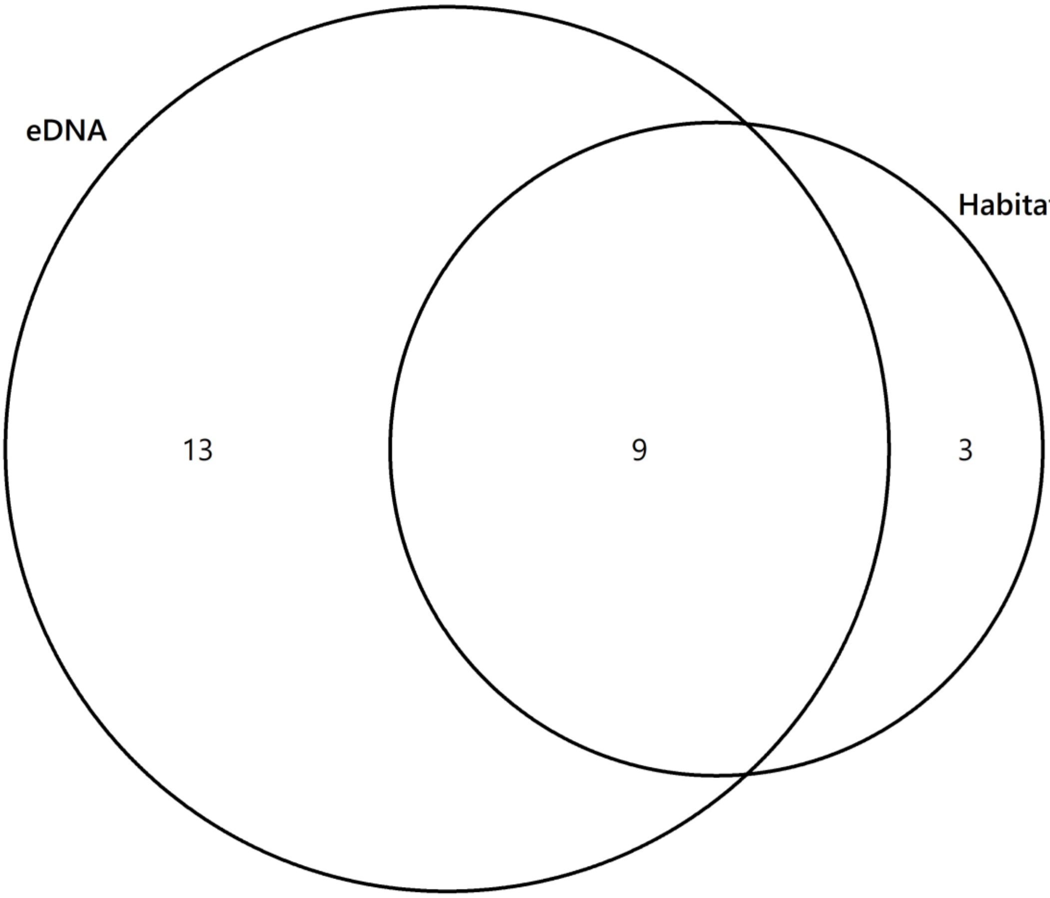


Figure 4.27: Venn diagram comparing bony **fish families identified by eDNA and photographic habitat data analysis across the survey area, export cable corridor and array, Dogger Bank D Array 2023**

4.1.6 Seafloor Habitat Types

The physical and biological characteristics of the multivariate groups identified through the multivariate analysis (Section 4.5.1.2) were evaluated in conjunction with the results of the photographic data analysis, to provide a comprehensive habitat assessment.

4.1.6.1 Biotope Classifications

Table 4.41 presents the EUNIS hierarchical classification and equivalent JNCC classification of the habitat types identified across the DBD array in 2023.

Table 4.20: Habitat classifications, Dogger Bank D Array 2023

EUNIS Habitat Classification (EEA, 2022)					Equivalent JNCC (2022) Classification
Environment Level 1	Biological Zone and Substrate Level 2	Biogeographical Marine Region Level 3	Biotope Complex Level 4	Biotope Level 5	
M Marine benthic habitats	MB3 Infralittoral coarse sediment	MB32 Atlantic Infralittoral coarse sediment	MB323 Atlantic infralittoral coarse sediment	MB3231 Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)	SS.SCS.ICS.SSh Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)
				MB3235 *Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand	SS.SCS.ICS.Glap *Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand
	MB5 Infralittoral sand	MB52 Atlantic infralittoral sand	MB523 Faunal communities of full salinity Atlantic infralittoral sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand	SS.SSa.IMuSa.FfabMag *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand
	MC1 Circalittoral rock	MC12 Atlantic circalittoral rock	MC125 Communities on Atlantic circalittoral soft rock	MC1251 Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay	CR.MCR.SfR.Pid Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
	MC5 Circalittoral sand	MC52 Atlantic circalittoral sand	MC521 Faunal communities of Atlantic circalittoral sand	MC5215 *Amphiura brachiata** with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	SS.SSa.CMuSa.AbraAirr *Acrocnida brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand

Notes
* = *Amphiura brachiata* is currently *Acrocnida brachiata*, but the EUNIS biotope name has retained the species' former name
EEA = European Environment Agency
EUNIS = European Nature Information System
JNCC = Joint Nature Conservation Committee

4.1.6.1.1 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand (MB5236)

The biotope '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236) is described as compacted sands and slightly muddy sands in the infralittoral and littoral fringe characterised by the bivalve *F. fabula* and polychaetes of the genus *Magelona*. Other taxa include mobile amphipods and robust polychaetes (EEA, 2022).

This biotope was assigned to most stations. Characterising taxa comprised polychaetes such as *S. bombyx*, and species of *Owenia* and *Magelona*, bivalves such as *F. fabula*, *K. bidentata* and species of *Abra*, and amphipods of the genus *Bathyporeia*.

Colonial epifauna from the grab samples comprised 80 taxa of which the hydroids *L. clausa*, *C. hemisphaerica* and species of the families Tubulariidae and Campanulariidae were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis indicated a sediment featuring small-scale rippled sand with a varying proportion of shell fragments and gravel. Pebbles were recorded at station ST113; pebbles and cobbles at stations ST139 and ST147, the latter also featuring boulders (assessed in Section 4.1.6.2 for potential 'Stony reef'). Clay with piddock holes covered in a veneer of sediment were also observed on stations ST139, ST142, ST145 and ST147, which were assigned the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' (MC1251), detailed in Section 4.1.6.1.5. Epibiota was generally sparse and comprised starfish (*Astropecten irregularis*, *Asterias rubens* and *Luidia ciliaris*), brittlestars (Ophiuroidea), crabs (*Corystes cassivelaunus*, *Necora puber, Liocarcinus sp.*), hermit crabs (*Pagurus bernhardus*), anemones (*Urticina felina*), soft coral (*Alcyonium digitatum*) and faunal turf (Hydrozoa/Bryozoa). Fish (Osteichthyes) included catshark (*Scyliorhinus canicula*), plaice (*P. platessa*), solenette (*Buglossidium luteum*), red mullet (*Mullus surmuletus*), dragonet (*Callionymus* sp.), flatfish (Pleuronectiformes), gurnards (Triglidae), sand eels (Ammodytidae) and gobies (Gobiidae).

4.1.6.1.2 *Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand (MC5215)

The biotope '*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand' (MC5215) is described as circalittoral non-cohesive muddy sand characterised by the echinoderms *Acrocnida* (formerly *Amphiura) brachiata, Astropecten irregularis*, *Asterias rubens, Echinocardium cordatum* and species of *Ophiura* (EEA, 2022).

This biotope was assigned to 34 stations, as an epibiotic biotope overlaying the biotope '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236). Typical taxa comprised *A. brachiata*, *Echinocyamus pusillus* and *Spiophanes bombyx* recorded in the grab samples

Epibiota was generally sparse and comprised starfish (*A. irregularis*, *A. rubens, L. ciliaris* and *Luidia sarsii*), brittlestars (Ophiuroidea), crabs (*C. cassivelaunus*, *Liocarcinus sp.*), hermit crabs (*P. bernhardus*), soft coral (*A. digitatum*) and faunal turf (Hydrozoa/Bryozoa). Fish (Osteichthyes) included catshark (*S. canicula*), plaice (*P. platessa*), solenette (*B. luteum*), red mullet (*M. surmuletus*), dragonet (*Callionymus* sp.), flatfish (Pleuronectiformes), gurnards (Triglidae), sand eels (Ammodytidae) and gobies (Gobiidae).

4.1.6.1.3 *Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand (MB3235)

The biotope '*Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand' (MB3235) is described as slightly gravelly sand featuring impoverished communities characterised by the species complex *G. lapidum* (agg.).

This biotope was assigned to station ST137, characterised by poorly sorted 'sandy gravel' (Folk, 1954) and featured polychaetes such as *G. lapidum, A. paucibranchiata* and species of *Notomastus*.

Results of the seafloor photographic analysis indicated a sediment featuring gravelly sand or sandy gravel. Clay outcrops with piddock holes were also recorded at station ST137, which were assigned the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' (MC1251), detailed in Section 4.2.6.1.12. Epibiota was generally sparse and comprised starfish (*A. rubens* and *A. irregularis*), crabs (*Liocarcinus* sp.), hermit crab (Paguroidea), calcareous tube worms (Serpulidae), scallops (Pectinidae) and faunal turf (Hydrozoa/Bryozoa). Fish (Osteichthyes) included flatfish (Pleuronectiformes), red mullet (*M. surmuletus*) and sand eel (Ammodytidae).

4.1.6.1.4 Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles) (MB3231)

The biotope 'Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)' (MB3231) is described as unstable coarse sediment (e.g. pebbles lying on or embedded in other sediment) that are strongly affected by tidal steams and/or wave action can support few animals and are consequently faunally impoverished. The species composition of this biotope may be highly variable seasonally and is likely to comprise low numbers of robust polychaetes or bivalves. In more settled periods there may be colonisation by anemones of hydroids and bryozoans (EEA, 2022). This biotope covers a depth range of 5 m to 50 m (JNCC, 2022).

This biotope was assigned to station ST127, characterised by very poorly sorted 'sandy gravel' (Folk, 1954), at a depth of 30.0 m BSL. The fauna at this station comprised motile taxa such as *Pisidia longicornis*, along with amphipods such as *Ampelisca diadema* and species of *Monocorophium*, robust polychaetes such as *P. inornata* and bivalves such as *T. flexuosa*.

Colonial epifauna from the grab samples at this station was well represented with 19 taxa and comprised bryozoans, including *Electra pilosa*, and hydroids, including *Alcyonium digitatum*.

Results of the seafloor photographic analysis indicated a sediment featuring sandy gravel with pebbles and cobbles. Epibiota comprised starfish (Asteroidea including *A. rubens* and *A. irregularis*), crab (Brachyura including *C. cassivelaunus*), hermit crab (Paguroidea), calcareous tube worms (Serpulidae), soft coral (*A. digitatum*), bryozoans (Bugulidae and *Flustra foliacea*) and faunal turf (Hydrozoa/Bryozoa). The only fish observed was a sand eel (Ammodytidae).

4.1.6.1.5 Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251).

The biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' (MC1251) is reported to occur on circalittoral soft rock, such as soft chalk or clay, in moderately exposed tide-swept conditions. The softness of chalk and firm clay results in an impoverished epifauna particularly on upward-facing surfaces. The rock is sufficiently soft to be bored by bivalves such as *Pholas dactylus*, which is the most widespread borer (EEA, 2022).

This biotope was assigned to areas of firm clay, with burrows of piddocks (Imparidentia), recorded through the photographic data at station ST137, where it occurred as a mosaic with other habitat types. Clay with piddock holes covered in a veneer of sediment were also observed from an additional four stations (stations ST139, ST142, ST145 and ST147) and these stations have also been assigned a biotope mosaic.

Figure 4.28 illustrates the EUNIS habitat types distribution in the DBD array in 2023.

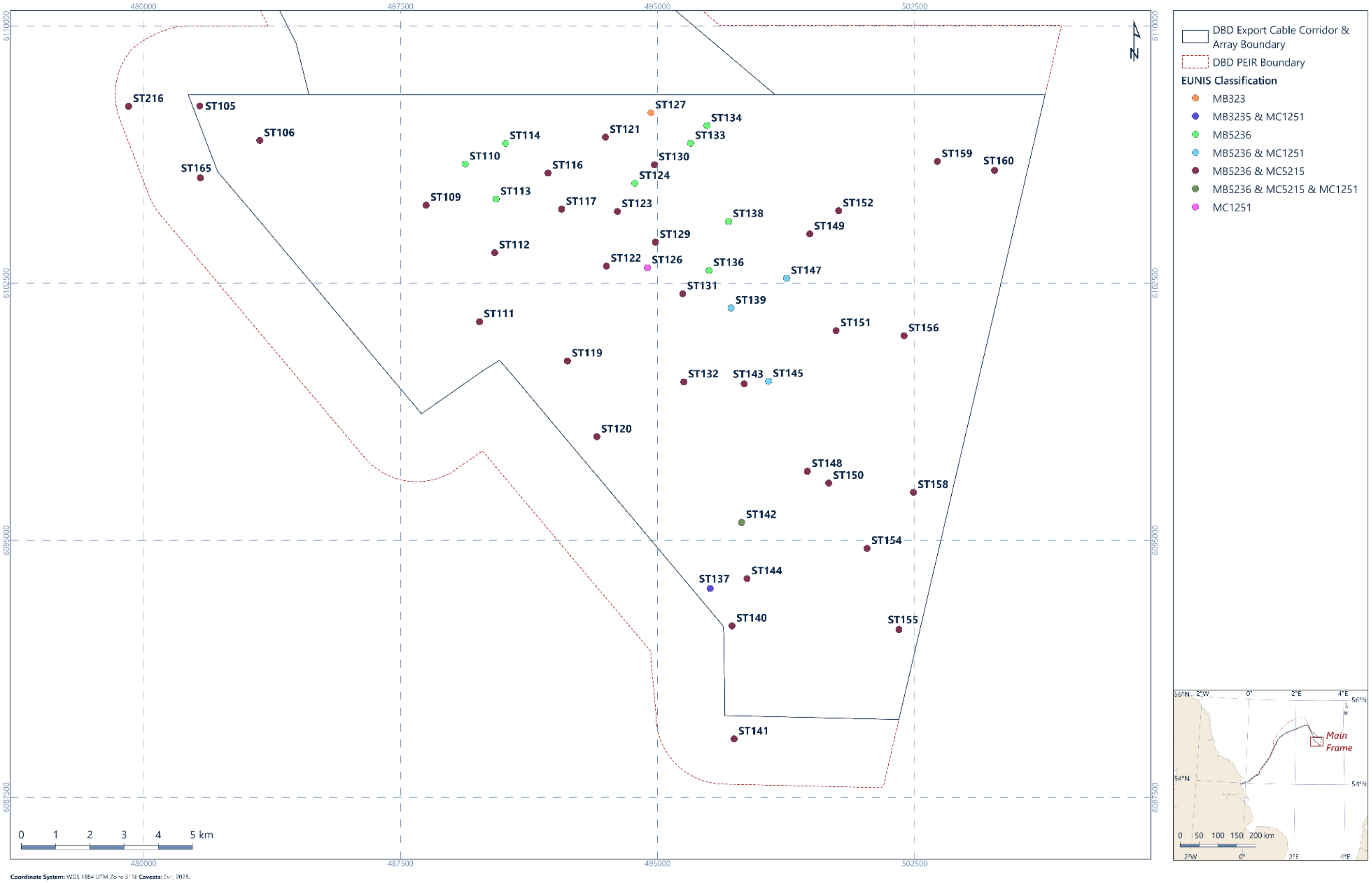


Figure 4.28: Spatial distribution of EUNIS habitat types, Dogger Bank D Array 2023

4.1.6.2 Stony Reef Habitat

Owing to the presence of cobbles and sporadic boulders, four stations were assessed in relation to the presence of the Annex I habitat 'Reef', specifically, 'stony reef'. The results of assessment are detailed in Table 4.21. At all stations cobbles and boulders were low-lying, embedded in sediment and subject to sediment disturbance. The epifaunal assemblage associated with the cobble and boulder component was generally comparable to that of the surrounding seafloor. Where the low-lying cobbles and boulders were classified within the elevation criteria of 64 mm to 5 m, the elevation was at the lower end of the range.

Along sections of transects at stations ST127, ST139 and ST147 the cobble and boulder component, was classified as 'not a reef'.

At station ST142 and along sections of transects at stations ST127, ST139 and ST147, the cobble and boulder component was classified as 'low resemblance to a stony reef'.

Table 4.21: Summary of 'Stony reef' classifications, export cable corridor and array, Dogger Bank D Array 2023

Geodetic Parameters: WGS 84, UTM 31N [m]								
Station		Easting	Northing	Area Observed [m²]	Stony Reef Characteristic			Overall Assessment
					Composition [% Cover Cobbles and Boulders]	Elevation	Biota [Epibiota % Cover]	
ST127	SOL	494 837.6	6 107 484.3	27	< 10	< 64 mm	< 80	Low
	EOL	494 827.5	6 107 483.1					
	SOL	494 827.5	6 107 483.1	90	10 – 40	< 64 mm	< 80	Low
	EOL	494 800.2	6 107 464.0					
	SOL	494 800.2	6 107 464.0	15	< 10	< 64 mm	< 80	Low
	EOL	494 794.6	6 107 465.1					
	SOL	494 794.6	6 107 465.1	94	None	NA	NA	None
	EOL	494 760.9	6 107 456.1					
ST139	SOL	497 100.5	6 101 775.3	14	10 – 40	< 64 mm	< 80	Low
	EOL	497 105.5	6 101 776.6					
	SOL	497 105.5	6 101 776.6	14	< 10	< 64 mm	< 80	Not a Reef
	EOL	497 110.2	6 101 778.8					
	SOL	497 110.2	6 101 778.8	11	10 – 40	< 64 mm	< 80	Low
	EOL	497 114.3	6 101 777.9					
	SOL	497 114.3	6 101 777.9	56	< 10	< 64 mm	< 80	Not a Reef
	EOL	497 135.2	6 101 779.2					
	SOL	497 135.2	6 101 779.2	3	10 – 40	< 64 mm	< 80	Low
	EOL	497 135.8	6 101 780.0					
	SOL	497 135.8	6 101 780.0	113	None	NA	NA	None
	EOL	497 159.2	6 101 814.8					

Geodetic Parameters: WGS 84, UTM 31N [m]									
Station		Easting	Northing	Area Observed [m²]	Stony Reef Characteristic			Overall Assessment
					Composition [% Cover Cobbles and Boulders]	Elevation	Biota [Epibiota % Cover]	
ST142	SOL	497 382.9	6 095 507.4	17	10 – 40	< 64 mm	< 80	Low
	EOL	497 396.3	6 095 513.3					
	SOL	497 396.3	6 095 513.3	23	None	NA	NA	None
	EOL	497 416.3	6 095 512.1					
	SOL	497 416.3	6 095 512.1	7	10 – 40	< 64 mm	< 80	Low
	EOL	497 422.3	6 095 510.0					
	SOL	497 422.3	6 095 510.0	59	None	NA	NA	None
	EOL	497 474.0	6 095 513.4					
ST147	SOL	498 779.6	6 102 658.0	72	< 10	< 64 mm	< 80	Not a Reef
	EOL	498 758.1	6 102 642.1					
	SOL	498 758.1	6 102 642.1	16	10 – 40	< 64 mm	< 80	Low
	EOL	498 753.5	6 102 638.4					
	SOL	498 758.1	6 102 642.1	102	None	NA	NA	None
	EOL	498 726.9	6 102 620.1					

Notes
SOL = Start of line
EOL = End of line

4.1.7 Potentially Sensitive Habitats and Species

Several of the habitats and species recorded in the 2023 study were of conservation importance:

- 'Subtidal sands and gravel', which encompass most of the habitat types recorded;
- 'Stony Reef,' which encompass the aggregations of cobbles and boulders;
- 'Sandbanks which are slightly covered by sea water all the time', for which the Dogger Bank SAC is designated;
- 'Peat and Clay Exposures with Piddocks', which encompass the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' (MC1251);
- *Ammodytes marinus*, which is part of the family Ammodytidae;
- *Edwardsia timida*, which is part of the family Edwardsiidae.

4.2 2024

4.2.1 Field Operations

4.2.1.1 Seafloor Photography

Stills and video data were successfully acquired at 104 proposed stations and 7 reserve stations (Table 4.22 and Figure 4.29)

Stations ST004 and ST093 were rerun due to poor video quality and renamed ST004A and ST093A, respectively. Station ST104 was rerun due to technical issues and was renamed ST104A. Sampling was not attempted at the proposed station ST105 due to the presence of fishing gear: the station was relocated approximately 100 m east and renamed ST105A.

4.2.1.2 Seafloor Sampling

Table 4.23 presents the completed sediment sampling stations.

Grab samples were acquired at 97 proposed stations and 7 contingency stations. A complete suite of samples (one macrofaunal, one sediment PSD and where requested by the client one contaminants sample) was retained at 92 of these stations (Table 4.23 and Figure 4.29).

Four client predefined stations, ST001, ST002, ST003 and ST105 were revised and relocated approximately 1000 m east of their original positions prior to data collection as the shallow water depths were unsuitable for the vessel.

Contingency stations ST105, ST106, ST107, ST108, ST118, ST119 and ST121 were sampled after no acceptable samples were collected at stations ST001, ST011, ST014, ST025, ST048, ST049 and ST084, respectively. The contingency station ST105 was relocated approximately 100 m east due to the presence of fishing gear at the proposed location and was renamed ST105A. During the acquisition of photographic data, boulders were identified along the transect at station ST016 and, therefore, the grab position was relocated 50 m northeast of the proposed sampling location. The revised grab location was determined using the video data to locate the nearest area of seafloor suitable for sediment grab sampling.

Insufficient grab volumes for a full suite of samples were obtained at stations ST004, ST008, ST012, ST033, ST041, ST050, ST069, ST071, ST086, ST087 and ST105A. No samples for macrofaunal analysis (FA) were collected at these stations. No sample for chemistry analysis was acquired at station ST119 due to sediment washout (Table 4.23). Samples less than 4 L were accepted at stations ST002, ST006, ST009, ST010, ST031, ST034, ST038, ST073, ST074, ST077, ST078, ST080, ST081, ST085 and ST089, where three attempts showed that a larger sample was not practicable.

4.2.1.3 Water Sampling for eDNA Analysis

Water samples were successfully acquired at all 17 proposed stations (Table 4.24 and Figure 4.29). Two samples were successfully taken from each station, one near the seafloor (bottom) and one from near the surface (top).

Table 4.22: Completed transects, Dogger Bank D 2024

Geodetic Parameters: WGS 84, UTM 31N [m]							
Station	SOL		EOL		Depth [m BSL]	Length [m]	Data Acquisition
	Easting	Northing	Easting	Northing			
Export Cable Corridor							
ST001	292 201.6	5 985 336.7	292 200.2	5 985 416.8	18.3	80.1	Video: 5 min 21 sec 10 stills
ST002	292 261.3	5 986 159.2	292 295.6	5 986 260.1	18.6	106.6	Video: 8 min 35 sec 14 stills
ST003	292 804.2	5 984 631.2	292 859.9	5 984 704.1	17.6	91.7	Video: 9 min 7 sec 13 stills
ST004A	292 783.0	5 985 366.6	292 854.5	5 985 445.6	18.6	106.6	Video: 6 min 47 sec 14 stills
ST005	292 985.9	5 986 597.8	293 032.5	5 986 674.3	19.9	89.6	Video: 6 min 30 sec 10 stills
ST006	293 761.0	5 985 373.0	293 809.3	5 985 446.4	19.7	87.9	Video: 5 min 45 sec 10 stills
ST007	296 433.3	5 986 357.5	296 385.8	5 986 283.5	17.7	87.9	Video: 5 min 33 sec 10 stills
ST008	297 651.8	5 986 539.6	297 624.3	5 986 390.8	18.4	151.2	Video: 9 min 57 sec 20 stills
ST009	298 079.8	5 987 453.2	298 152.9	5 987 506.5	18.6	90.5	Video: 5 min 44 sec 10 stills
ST010	298 863.1	5 987 655.5	298 883.1	5 987 569.6	17.9	88.2	Video: 5 min 39 sec 8 stills
ST011	300 228.4	5 988 254.1	300 195.4	5 988 169.4	20.2	90.8	Video: 5 min 54 sec 9 stills
ST012	301 521.1	5 990 173.1	301 556.5	5 990 041.7	21.6	136.1	Video: 9 min 7 sec 15 stills
ST013	302 886.0	5 990 385.0	302 987.9	5 990 476.1	26.1	136.7	Video: 9 min 13 sec 14 stills
ST014	303 377.1	5 991 050.4	303 380.5	5 990 964.5	27.1	86.1	Video: 5 min 51 sec 10 stills
ST015	303 847.3	5 990 475.8	303 833.4	5 990 587.1	32.5	112.1	Video: 7 min 27 sec 14 stills
ST016	304 627.0	5 990 736.1	304 642.2	5 990 886.2	36.5	150.9	Video: 10 min 57 sec 18 stills
ST017	305 814.5	5 991 294.0	305 813.7	5 991 445.2	40.7	151.3	Video: 9 min 37 sec 15 stills
ST018	307 847.3	5 990 537.0	307 863.4	5 990 411.4	44.7	126.7	Video: 7 min 57 sec 12 stills
ST019	310 109.8	5 991 112.1	310 234.0	5 991 081.9	43.5	127.8	Video: 9 min 2 sec 14 stills
ST020	311 454.0	5 991 655.2	311 522.8	5 991 778.4	53.3	141.1	Video: 10 min 2 sec 12 stills
ST021	314 037.1	5 993 051.4	314 037.5	5 993 159.3	55.1	108	Video: 7 min 44 sec 8 stills
ST022	314 686.8	5 995 250.6	314 668.3	5 995 328.4	55.4	80	Video: 5 min 42 sec 9 stills
ST023	319 075.6	5 999 035.1	319 086.0	5 998 955.4	56.5	80.4	Video: 5 min 58 sec 9 stills
ST024	322 641.5	6 001 278.4	322 702.2	6 001 216.5	56.5	86.6	Video: 5 min 45 sec 9 stills
ST025	326 086.7	6 003 839.9	326 154.0	6 003 791.4	57.7	83	Video: 5 min 45 sec 10 stills
ST026	327 425.6	6 003 987.1	327 459.4	6 004 066.8	57.4	86.5	Video: 5 min 46 sec 11 stills
ST027	340 010.8	6 016 002.3	339 949.3	6 016 100.6	65.2	116	Video: 12 min 56 sec 10 stills
ST028	358 146.6	6 043 102.2	358 245.7	6 043 106.5	61.7	99.2	Video: 6 min 25 sec 10 stills
ST029	370 973.3	6 063 656.3	371 048.9	6 063 616.8	59.1	85.3	Video: 5 min 31 sec 9 stills
ST030	378 494.1	6 082 501.1	378 572.6	6 082 462.7	51.6	87.5	Video: 5 min 35 sec 11 stills
ST031	384 178.0	6 093 090.1	384 131.5	6 093 029.8	51.6	76.1	Video: 5 min 12 sec 10 stills
ST032	388 434.1	6 100 840.6	388 382.4	6 100 732.0	49.6	120.3	Video: 8 min 12 sec 11 stills
ST033	391 909.0	6 106 541.6	391 783.4	6 106 509.1	42.8	129.7	Video: 8 min 49 sec 10 stills
ST034	394 874.0	6 109 863.3	394 788.0	6 109 957.7	37.9	127.7	Video: 9 min 58 sec 10 stills

Geodetic Parameters: WGS 84, UTM 31N [m]							
Station	SOL		EOL		Depth [m BSL]	Length [m]	Data Acquisition
	Easting	Northing	Easting	Northing			
ST035	397 697.7	6 111 728.4	397 683.5	6 111 779.8	35.3	53.3	Video: 9 min 23 sec 12 stills
ST036	400 440.9	6 114 035.4	400 458.3	6 113 912.9	40.8	123.7	Video: 8 min 16 sec 11 stills
ST037	403 723.9	6 116 097.5	403 700.9	6 116 220.0	38.2	124.6	Video: 8 min 19 sec 11 stills
ST038	404 429.2	6 116 528.3	404 443.9	6 116 625.5	38.3	98.3	Video: 8 min 59 sec 12 stills
ST039	406 173.3	6 116 758.9	406 224.4	6 116 866.3	38.7	118.9	Video: 9 min 25 sec 13 stills
ST040	406 336.0	6 117 802.7	406 347.5	6 117 918.8	38.0	116.7	Video: 7 min 30 sec 12 stills
ST041	407 579.1	6 118 198.7	407 592.1	6 118 325.1	36.5	127.1	Video: 8 min 7 sec 10 stills
ST042	412 219.6	6 120 969.4	412 211.2	6 121 096.5	41.8	127.4	Video: 8 min 13 sec 11 stills
ST043	418 529.3	6 123 898.7	418 419.9	6 123 963.0	38.1	126.9	Video: 7 min 58 sec 10 stills
ST044	420 127.8	6 124 442.2	420 045.1	6 124 348.8	38.7	124.8	Video: 8 min 18 sec 13 stills
ST045	432 263.4	6 129 512.1	432 260.2	6 129 389.7	36.8	122.4	Video: 8 min 56 sec 12 stills
ST046	433 957.9	6 130 001.5	434 021.9	6 130 109.6	38.1	125.7	Video: 8 min 22 sec 12 stills
ST047	438 047.6	6 131 921.2	438 009.5	6 132 037.8	43.4	122.7	Video: 8 min 2 sec 12 stills
ST048	442 293.4	6 132 827.1	442 224.6	6 132 923.1	38.8	118.1	Video: 7 min 38 sec 11 stills
ST049	448 499.7	6 135 617.4	448 379.3	6 135 684.2	40.1	137.7	Video: 8 min 49 sec 13 stills
ST050	451 954.6	6 137 724.5	452 029.7	6 137 615.2	41.1	132.6	Video: 8 min 52 sec 17 stills
ST051	462 357.8	6 141 469.5	462 397.8	6 141 507.4	35.4	55.2	Video: 9 min 39 sec 13 stills
ST052	471 267.5	6 136 284.5	471 323.2	6 136 298.4	36.7	57.5	Video: 10 min 25 sec 13 stills
ST053	471 997.9	6 134 860.0	472 057.4	6 134 861.2	35.7	59.5	Video: 10 min 23 sec 12 stills
ST054	474 623.4	6 129 796.4	474 707.5	6 129 791.2	29.0	84.3	Video: 14 min 12 sec 12 stills
ST055	482 974.9	6 120 049.8	483 037.9	6 120 079.8	29.1	69.8	Video: 11 min 53 sec 15 stills
ST056	481 894.8	6 115 185.6	481 935.9	6 115 214.9	31.3	50.4	Video: Video:8 min 9 sec 9 stills
ST057	488 213.0	6 114 539.1	488 240.6	6 114 581.8	29.6	50.9	Video: Video:8 min 14 sec 8 stills
ST058	489 959.3	6 113 789.4	489 992.6	6 113 828.1	29.4	51	Video: 8 min 19 sec 9 stills
ST059	492 234.3	6 111 253.7	492 281.8	6 111 270.0	25.8	50.2	Video: 8 min 12 sec 8 stills
ST060	488 917.3	6 108 628.2	488 964.6	6 108 645.9	31.9	50.5	Video: 8 min 09 sec 9 stills
ST061	494 640.6	6 108 742.3	494 633.1	6 108 794.9	30.8	53.1	Video: 8 min 31 sec 9 stills
ST062	496 089.8	6 108 660.4	496 062.7	6 108 705.4	60.9	52.5	Video: 8 min 13 sec 8 stills
ST105A*	292 625.3	5 984 872.8	292 687.1	5 984 942.0	17.9	92.8	Video: 5 min 53 sec 11 stills
ST106*	308 647.0	5 990 859.5	308 722.1	5 990 724.3	45.6	154.7	Video: 11 min 15 sec 14 stills
ST107*	316 535.4	5 997 236.6	316 500.1	5 997 318.3	55.9	89	Video: 5 min 52 sec 9 stills
ST108*	347 507.4	6 028 693.3	347 601.6	6 028 683.6	66.9	94.8	Video: 10 min 37 sec 13 stills
Array Area							
ST090	481 613.9	6 107 657.2	481 663.1	6 107 670.3	26.4	50.9	Video: 8 min 15 sec 9 stills
ST091	494 822.2	6 107 433.8	494 796.1	6 107 485.2	29.9	57.6	Video: 9 min 49 sec 14 stills
ST092	484 758.3	6 104 277.6	484 868.3	6 104 286.9	22.9	110.5	Video: 18 min 39 sec 24 stills

Geodetic Parameters: WGS 84, UTM 31N [m]							
Station	SOL		EOL		Depth [m BSL]	Length [m]	Data Acquisition
	Easting	Northing	Easting	Northing			
ST093a	490 247.3	6 104 954.5	490 311.9	6 104 942.0	23.2	65.8	Video: 11 min 50 sec 17 stills
ST094	494 942.7	6 105 930.7	494 890.4	6 105 961.2	27.7	60.6	Video: 10 min 56 sec 14 stills
ST095	504 804.1	6 105 777.2	504 857.1	6 105 784.5	27.6	53.5	Video: 8 min 41 sec 8 stills
ST096	487 276.6	6 101 350.4	487 285.5	6 101 408.4	22.5	58.7	Video: 10 min 23 sec 14 stills
ST097	487 040.7	6 103 188.8	487 127.1	6 103 214.0	26.7	90	Video: 15 min 53 sec 22 stills
ST098	492 359.6	6 100 205.9	492 381.8	6 100 250.8	25.5	50	Video: 7 min 50 sec 9 stills
ST099	498 768.2	6 102 611.4	498 765.2	6 102 662.8	32.7	51.5	Video: 8 min 19 sec 10 stills
ST100	498 209.8	6 099 633.7	498 261.6	6 099 639.0	26.9	52.1	Video: 8 min 23 sec 9 stills
ST101	497 424.3	6 095 521.1	497 477.9	6 095 520.2	26.6	53.6	Video: 8 min 33 sec 11 stills
ST102	499 969.4	6 096 669.9	500 019.4	6 096 664.6	22.1	50.3	Video: 8 min 08 sec 8 stills
ST103	497 204.5	6 092 498.9	497 149.9	6 092 500.8	25.5	54.6	Video: 9 min 44 sec 14 stills
ST104A	502 057.5	6 092 402.7	502 013.0	6 092 367.5	23.5	56.7	Video: 9 min 40 sec 15 stills
Characterisation Area							
ST063	379 136.4	6 097 204.4	379 085.5	6 097 219.4	35.4	53	Video: 8 min 33 sec 11 stills
ST064	380 610.8	6 094 174.7	380 676.1	6 094 234.8	57.8	88.7	Video: 5 min 52 sec 11 stills
ST065	381 876.8	6 095 263.6	381 942.2	6 095 333.9	57.3	96.1	Video: 6 min 34 sec 8 stills
ST066	388 784.5	6 113 577.4	388 739.9	6 113 610.2	61.3	55.4	Video: 9 min 3 sec 12 stills
ST067	394 277.5	6 111 595.6	394 239.2	6 111 638.3	40.7	57.3	Video: 9 min 49 sec 13 stills
ST068	396 235.4	6 116 075.1	396 207.3	6 116 129.3	44.9	61	Video: 13 min 26 sec 14 stills
ST069	396 863.1	6 124 110.5	396 977.1	6 124 022.6	58.6	144	Video: 10 min 0 sec 13 stills
ST070	397 509.5	6 112 235.7	397 492.1	6 112 286.4	35.3	53.6	Video: 9 min 16 sec 10 stills
ST071	404 402.9	6 118 055.1	404 436.3	6 118 178.1	39.9	127.5	Video: 8 min 37 sec 10 stills
ST072	403 637.8	6 125 438.0	403 564.8	6 125 555.6	53.3	138.4	Video: 9 min 24 sec 13 stills
ST073	407 382.7	6 121 098.4	407 340.7	6 121 211.4	37.0	120.6	Video: 7 min 37 sec 11 stills
ST074	410 025.8	6 124 743.3	409 989.4	6 124 859.2	37.5	121.5	Video: 7 min 51 sec 13 stills
ST075	411 259.2	6 131 005.9	411 377.7	6 131 048.6	45.6	125.9	Video: 8 min 58 sec 12 stills
ST076	420 205.5	6 141 821.9	420 145.9	6 141 705.6	60.5	130.7	Video: 8 min 38 sec 10 stills
ST077	420 228.0	6 132 847.4	420 354.2	6 132 807.9	45.7	132.2	Video: 9 min 11 sec 12 stills
ST078	422 284.8	6 135 949.6	422 363.4	6 135 853.5	46.2	124.1	Video: 8 min 2 sec 12 stills
ST079	425 335.9	6 131 008.5	425 309.8	6 130 879.0	40.0	132.1	Video: 8 min 26 sec 11 stills
ST080	429 172.4	6 150 812.3	429 047.2	6 150 804.4	71.8	125.4	Video: 8 min 13 sec 10 stills
ST081	431 005.6	6 131 927.5	430 981.2	6 131 803.4	38.9	126.5	Video: 8 min 4 sec 11 stills
ST082	433 749.4	6 130 939.1	433 824.4	6 131 034.5	39.0	121.4	Video: 8 min 5 sec 12 stills
ST083	434 108.8	6 144 326.4	434 133.0	6 144 370.4	56.6	50.2	Video: 8 min 11 sec 10 stills
ST084	441 320.7	6 151 360.8	441 388.9	6 151 466.0	67.3	125.4	Video : 7 min 59 sec 8 stills
ST085	446 927.2	6 158 025.2	446 960.2	6 158 061.0	74.8	48.7	Video: 8 min 30 secs 10 stills

Geodetic Parameters: WGS 84, UTM 31N [m]							
Station	SOL		EOL		Depth [m BSL]	Length [m]	Data Acquisition
	Easting	Northing	Easting	Northing			
ST086	448 929.7	6 145 157.8	449 024.8	6 145 236.8	47.8	123.6	Video: 9 min 59 sec 11 stills
ST087	446 879.6	6 140 433.2	447 009.4	6 140 400.9	43.3	133.8	Video: 9 min 30 sec 13 stills
ST088	457 259.6	6 146 533.9	457 307.9	6 146 566.7	42.5	58.4	Video: 10 min 07 sec 14 stills
ST089	457 943.0	6 153 944.8	457 994.1	6 153 980.4	59.7	62.3	Video: 11 min 02 sec 15 stills
ST118*	434 953.8	6 131 285.4	434 973.6	6 131 370.9	37.7	87.7	Video: 14 min 23 sec 18 stills
ST119*	438 368.0	6 139 603.9	438 394.0	6 139 647.4	46.4	50.7	Video: 8 min 9 sec 10 stills
ST121*	442 087.3	6 158 757.2	442 111.9	6 158 804.2	76.7	53.1	Video: 8 min 35 sec 11 stills

Notes
* = Contingency station
BSL = Below sea level
EOL = End of line
SOL = Start of line

Table 4.23: Completed sediment sampling stations, Dogger Bank D 2024

Geodetic Parameters: WGS 84, UTM 31N [m]				
Station	Easting	Northing	Depth [m BSL]	Sample Acquisition
Export Cable Corridor				
ST002	292 284.1	5 986 224.1	19.0	FA, PSD
ST003	292 825.8	5 984 659.4	18.4	FA, PSD
ST004	292 836.9	5 985 425.3	17.9	PSD
ST005	293 013.2	5 986 645.5	19.9	FA, PSD
ST006	293 786.9	5 985 412.5	19.8	FA, PSD
ST007	296 410.8	5 986 322.5	13.0	FA, PSD
ST008	297 635.4	5 986 445.4	18.1	PSD
ST009	298 128.6	5 987 485.9	17.9	FA, PSD, Contaminants
ST010	298 870.7	5 987 611.6	17.0	FA, PSD
ST012	301 551.6	5 990 075.3	22.0	PSD
ST013	302 957.0	5 990 444.8	27.4	FA, PSD
ST015	303 847.0	5 990 504.9	32.3	FA, PSD
ST016	304 643.0	5 990 876.3	36.2	FA, PSD
ST017	305 818.8	5 991 385.6	39.9	FA, PSD
ST018	307 857.6	5 990 476.4	44.7	FA, PSD
ST019	310 169.9	5 991 094.5	44.8	FA, PSD
ST020	311 494.3	5 991 724.6	53.8	FA, PSD
ST021	314 027.9	5 993 109.3	54.0	FA, PSD
ST022	314 670.8	5 995 289.8	52.9	FA, PSD
ST023	319 081.8	5 998 995.7	55.4	FA, PSD
ST024	322 663.5	6 001 249.6	56.5	FA, PSD
ST026	327 439.9	6 004 018.2	58.3	FA, PSD
ST027	339 973.6	6 016 060.6	64.9	FA, PSD, Contaminants
ST028	358 205.8	6 043 102.9	61.7	FA, PSD, Contaminants
ST029	371 002.6	6 063 632.4	56.8	FA, PSD
ST030	378 529.0	6 082 487.0	51.3	FA, PSD
ST031	384 150.4	6 093 052.0	53.0	FA, PSD, Contaminants
ST032	388 408.9	6 100 779.9	50.0	FA, PSD
ST033	391 838.7	6 106 524.1	43.3	PSD
ST034†	394 827.5	6 109 914.9	33.6	FA, PSD, Contaminants
ST035	397 690.8	6 111 755.8	38.2	FA, PSD
ST036	400 453.4	6 113 960.8	41.4	FA, PSD
ST037	403 705.6	6 116 160.8	39.7	FA, PSD
ST038	404 438.8	6 116 597.7	39.0	FA, PSD
ST039	406 204.6	6 116 827.2	39.9	FA, PSD

Geodetic Parameters: WGS 84, UTM 31N [m]				
Station	Easting	Northing	Depth [m BSL]	Sample Acquisition
ST040	406 343.9	6 117 873.8	40.3	FA, PSD
ST041	407 585.0	6 118 274.3	38.3	PSD, Contaminants
ST042	412 223.8	6 121 038.4	42.4	FA, PSD
ST043	418 470.7	6 123 923.1	39.4	FA, PSD, Contaminants
ST044	420 087.2	6 124 382.4	39.5	FA, PSD
ST045	432 261.5	6 129 444.6	37.5	FA, PSD
ST046	433 991.4	6 130 064.1	38.4	FA, PSD
ST047	438 027.4	6 131 993.1	42.1	FA, PSD
ST050	452 000.7	6 137 661.7	41.9	PSD
ST051	462 381.1	6 141 490.5	40.9	FA, PSD, Contaminants
ST052	471 299.0	6 136 291.8	38.7	FA, PSD
ST053	472 033.4	6 134 860.6	39.4	FA, PSD, Contaminants
ST054	474 685.9	6 129 791.2	37.9	FA, PSD
ST055	483 016.5	6 120 069.2	30.3	FA, PSD
ST056	481 914.0	6 115 198.5	29.0	FA, PSD
ST057	488 224.9	6 114 560.0	31.3	FA, PSD
ST058	489 975.5	6 113 809.6	29.8	FA, PSD
ST059	492 258.4	6 111 261.9	26.4	FA, PSD
ST060	488 940.3	6 108 635.7	26.3	FA, PSD
ST061	494 637.8	6 108 766.1	30.7	FA, PSD
ST062	496 076.2	6 108 682.6	30.7	FA, PSD
ST105A*	292 675.3	5 984 939.1	17.6	PSD
ST106*	308 686.2	5 990 774.5	45.8	FA, PSD
ST107*	316 516.0	5 997 276.2	55.4	FA, PSD
ST108*	347 570.3	6 028 690.0	65.7	FA, PSD
Array Area				
ST090	481 637.5	6 107 664.3	26.4	FA, PSD
ST091	494 806.1	6 107 465.0	32.3	FA, PSD
ST092	484 845.6	6 104 286.5	25.3	FA, PSD
ST093	490 280.5	6 104 947.5	27.2	FA, PSD, Contaminants
ST094	494 911.8	6 105 949.7	30.6	FA, PSD
ST095	504 830.9	6 105 782.5	27.8	FA, PSD
ST096	487 281.9	6 101 383.9	25.1	FA, PSD
ST097	487 101.4	6 103 208.6	24.9	FA, PSD
ST098	492 369.4	6 100 226.7	32.5	FA, PSD
ST099	498 762.5	6 102 639.5	32.5	FA, PSD
ST100	498 236.2	6 099 638.5	29.8	FA, PSD
ST101	497 453.6	6 095 520.5	27.2†	FA, PSD
ST102	499 993.4	6 096 666.0	22.4†	FA, PSD
ST103	497 172.8	6 092 499.5	25.5	FA, PSD
ST104	502 047.9	6 092 394.2	23.5	FA, PSD
Characterisation Area				
ST063	379 109.5	6 097 209.6	60.7	FA, PSD
ST064†	380 643.1	6 094 204.3	58.4	FA, PSD
ST065	381 912.9	6 095 308.4	57.6	FA, PSD
ST066	388 759.7	6 113 594.5	63.1	FA, PSD
ST067	394 254.0	6 111 619.0	43.4	FA, PSD
ST068	396 216.8	6 116 105.4	47.3	FA, PSD, Contaminants
ST069	396 933.8	6 124 050.8	60.4	PSD
ST070	397 501.9	6 112 267.8	38.6	FA, PSD, Contaminants
ST071	404 421.0	6 118 127.8	41.9	PSD
ST072	403 600.8	6 125 501.7	55.1	FA, PSD
ST073	407 352.1	6 121 168.7	37.7	FA, PSD
ST074	410 009.5	6 124 816.6	38.5	FA, PSD, Contaminants

Geodetic Parameters: WGS 84, UTM 31N [m]				
Station	Easting	Northing	Depth [m BSL]	Sample Acquisition
ST075	411 329.0	6 131 032.0	46.2	FA, PSD
ST076	420 175.4	6 141 757.8	61.0	FA, PSD
ST077	420 302.9	6 132 826.0	46.6	FA, PSD
ST078	422 335.1	6 135 889.0	46.7	FA, PSD
ST079	425 320.4	6 130 931.5	40.9	FA, PSD
ST080	429 107.0	6 150 813.7	71.6	FA, PSD, Contaminants
ST081	430 993.7	6 131 856.5	39.3	FA, PSD
ST082	433 790.5	6 131 000.6	40.0	FA, PSD
ST083	434 113.7	6 144 337.5	56.8	FA, PSD
ST085	446 944.4	6 158 043.0	74.8	FA, PSD, Contaminants
ST086	448 980.5	6 145 200.0	49.3	PSD
ST087	446 960.1	6 140 408.3	45.1	PSD
ST088	457 291.2	6 146 551.0	45.8	FA, PSD
ST089	457 974.1	6 153 965.8	61.9	FA, PSD
ST118*	434 967.9	6 131 346.7	40.4	FA, PSD
ST119*	438 377.2	6 139 612.5	46.3	FA, PSD
ST121*	442 105.7	6 158 792.6	77.0	FA, PSD

Notes
* = Contingency station
† = Coordinates presented for the first successful grab sample
BSL = Below sea level
FA = Faunal sample
PSD = Particle size distribution

Table 4.24: Completed water sampling stations, Dogger Bank D 2024

Geodetic Parameters: WGS 84, UTM 31N [m]					
Station	Easting*	Northing*	Depth [m BSL]		Sample Acquisition
			Top	Bottom	
Export Cable Corridor					
ST004	292 824.3	5 985 415.3	6.4	14.8	eDNA
ST019	310 177.5	5 991 088.3	4.5	38.5	eDNA
ST023	319 070.0	5 999 015.9	4.7	47.6	eDNA
ST027	339 981.7	6 016 054.3	3.3	60.2	eDNA
ST028	358 210.8	6 043 090.2	5.7	55.2	eDNA
ST031	384 148.4	6 093 056.3	1.3	37.7	eDNA
ST033	391 838.3	6 106 522.8	5.3	44.2	eDNA
ST036	400 448.0	6 113 946.5	3.0	36.0	eDNA
ST049	448 435.0	6 135 645.5	4.6	40.6	eDNA
ST054†	474 688.2	6 129 790.5	1.0	37.9	eDNA
ST060†	488 941.0	6 108 635.4	1.0	26.2	eDNA
Array Area					
ST093†	490 291.0	6 104 945.8	1.0	27.7	eDNA
ST095†	504 830.4	6 105 782.4	1.0	27.8	eDNA
ST101†	497 452.8	6 095 519.7	1.0	29.8	eDNA
Characterisation Area					
ST077	420 302.5	6 132 808.4	1.3	43.9	eDNA
ST083†	434 121.4	6 144 351.7	1.0	56.8	eDNA
ST085†	446 943.9	6 158 043.2	1.0	74.6	eDNA

Notes
* = Coordinates from bottom sample
† = Bottom depth taken from vessel position
eDNA = Environmental deoxyribonucleic acid

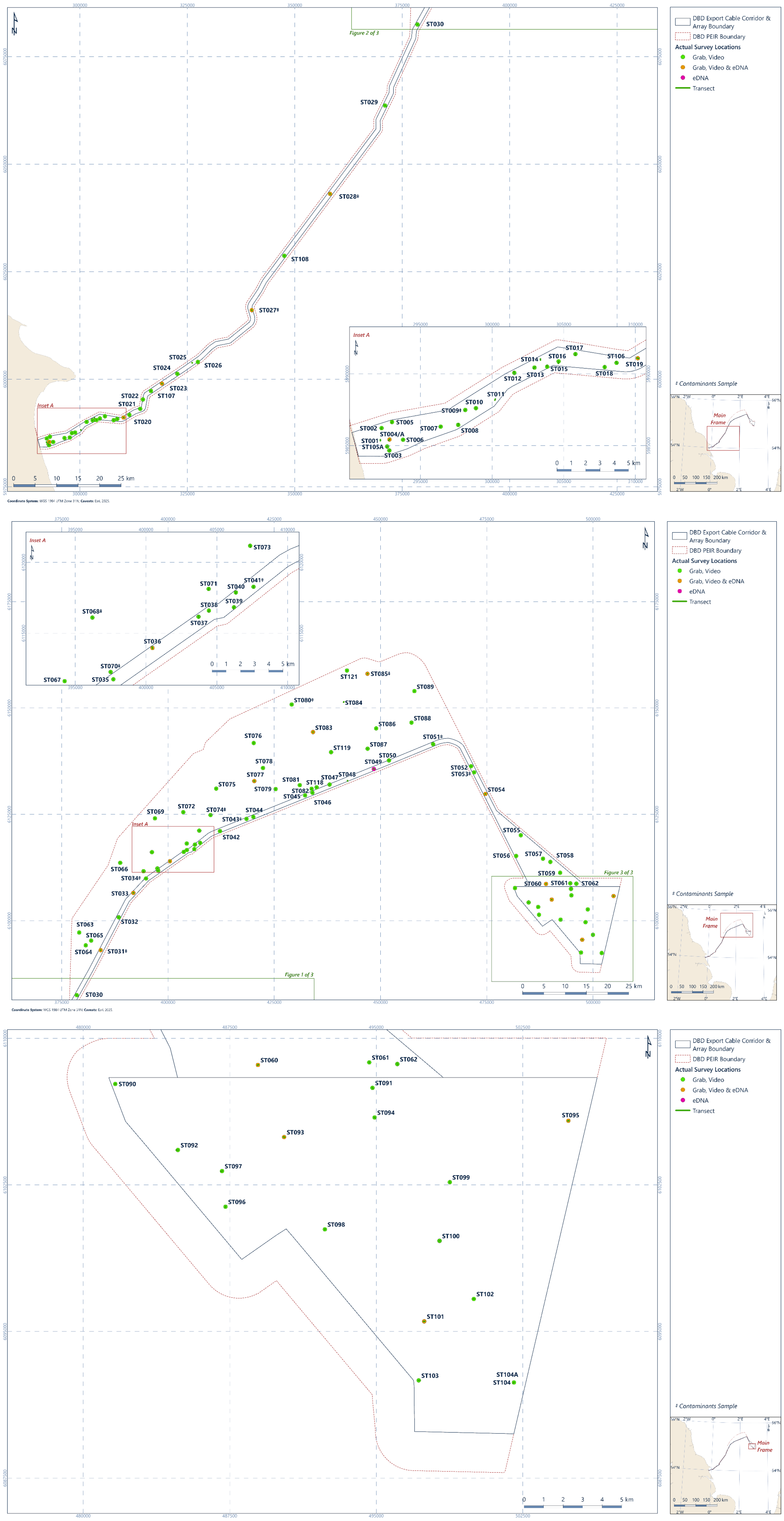
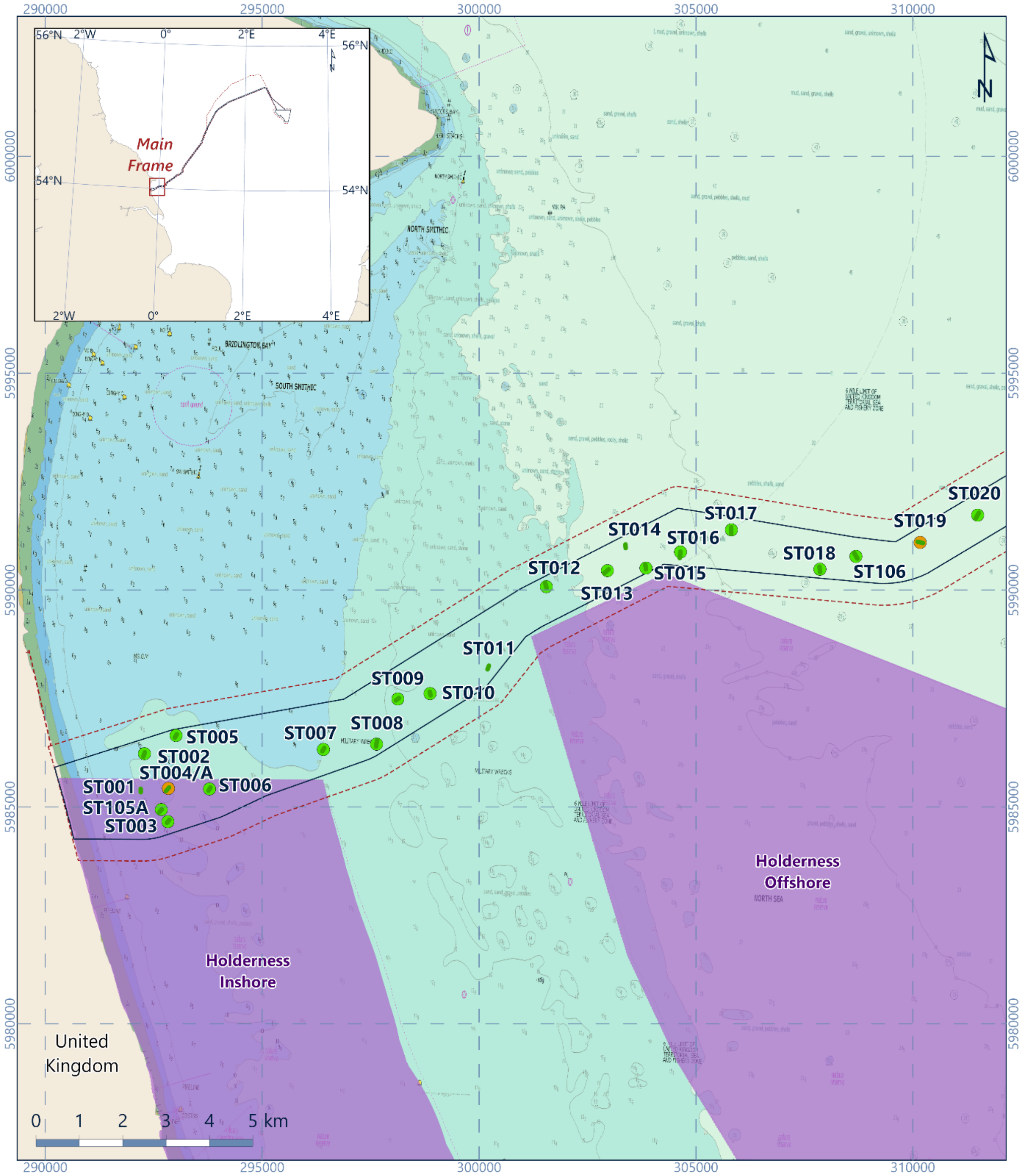


Figure 4.29: Completed survey locations, Dogger Bank D 2024



DBD Export Cable Corridor & Array Boundary
DBD PEIR Boundary
Protected Areas
Marine Conservation Zone

Coordinate System: WGS 1984 UTM Zone 31N; **Caveats:** Esri, 2025; © Natural England. Contains Ordnance Survey data © Crown copyright and database right 2025; SevenCs' electronic navigation charts. SevenCs explicitly state that the data are not certified by an official authority and that the data may not be used for navigation or other safety related purposes.

Figure 4.30: Completed survey locations and Marine Conservation Zones, Dogger Bank D 2024

4.2.2 Sediment Characterisation

4.2.2.1 Univariate Analysis

Table 4.25 presents the sediment characteristics and Table 4.26 presents the sediment particle distribution across the DBD survey area from grab sample data. Figures 4.31, 4.32 and 4.33 provide an overview of the variations of the fractional composition of the sediment across the survey area. Figure 4.34 illustrates the spatial variations of percentage sand, gravel and fines across the survey area. Figure 4.35 illustrates the spatial variation of the median sediment particle size across the survey area. Figure 4.36 illustrates the percentage contribution of the Folk (BGS modified) sediment classes and Figure 4.37 illustrates the percentage contribution of the Wentworth (1922) sediment descriptions. Appendix D presents the details of particle size distribution for individual stations and the analysis certificates.

The fractional composition of the sediments was variable across the survey area, with the majority of stations dominated by the sand fraction and several stations along the EEC dominated by the gravel fraction.

Gravel, where present, ranged from 0.00 % at stations ST063, ST066, ST085 and ST121, all within the characterisation area, to 81.78 % at station ST016, along the ECC, with a mean of 13.83 % and a median of 2.84 %.

Sand content ranged from 15.00 % at station ST016, along the ECC, to 99.94 % at station ST071, in the characterisation area, with a mean of 83.40 % and a median of 94.53 %.

Fines were absent from 51 stations. At the remaining stations, the fines content ranged from 0.01 % at stations ST007 and ST008, along the ECC, to 16.71 % at station ST106, in the array area. The mean value of fines content was 2.77 % and the median 0.01 %.

Seven sediment classes were identified using the Folk (BGS modified) classification (Table 4.25 and Figure 4.37), including:

- ‘Sand’, which typified 67 stations;
- ‘Gravelly sand’, which typified 12 stations;
- ‘Sandy gravel’, which typified 11 stations;
- ‘Muddy sandy gravel’, which typified 7 stations;
- ‘Gravelly muddy sand’, which typified 4 stations;
- ‘Gravel’, which typified 1 station;
- ‘Muddy sand’, which typified 1 station.

Of the 104 stations investigated, 77 had unimodal distributions, 16 had polymodal distributions and 11 had bimodal distributions. Investigation of the particle size histograms (Appendix D) indicated that the most frequently occurring peak in the first mode was the 213 µm sediment particle size (fine sand) followed by the 151 µm (fine sand) and the 26 950 µm (coarse pebble) sediment particle sizes. The 26 950 µm was the most frequently occurring peak in the second mode, followed by the 13 600 µm (medium pebble) and 2400 µm (granule) sediment particle sizes, which had same frequency of occurrence. The 2400 µm sediment particle size was also the most frequently occurring in the third mode, followed by the 9600 µm (medium pebble) sediment particle size.

The median sediment particle size ranged from 136 µm (fine sand) at station ST085, in the characterisation area to 25 474 µm (fine pebble) at station ST008, along the ECC, with a mean of 1215 µm (very coarse sand) and a median of 215 µm (fine sand).

The mean sediment particle size underpinned the Wentworth (1922) description, through which seven grain size classes were identified (Table 4.26 and Figure 4.36):

- 'Fine sand', which typified 75 stations;
- 'Coarse sand', which typified 10 stations;
- 'Granule', which typified 6 stations;
- 'Very coarse sand', which typified 5 stations;
- 'Fine pebble', which typified 4 stations;
- 'Medium sand', which typified 3 stations;
- 'Medium pebble', which typified 1 station.

When considering the sorting coefficient (Table 4.26), the sediment was:

- 'Moderately well sorted' at 42 stations;
- 'Very poorly sorted' at 22 stations;
- 'Moderately sorted' at 20 stations;
- 'Poorly sorted' at 19 stations;
- 'Well sorted" at 1 station.

In terms of skewness (Table 4.26), the sediment particle distribution was;

- 'Symmetrical' at 53 stations;
- 'Very fine skewed' at 19 stations;
- 'Very coarse skewed' at 12 stations;
- 'Coarse skewed' at 11 stations;
- 'Fine skewed' at 9 stations.

Table 4.25: Summary of sediment characteristics, Dogger Bank D 2024

Station	Fractional Composition			Fines		Folk Description (BGS modified)
	Gravel [%]	Sand [%]	Fines [%]	Silt [%]	Clay [%]	
Export Cable Corridor						
ST002	0.18	96.06	3.76	2.95	0.81	Sand
ST003	0.23	99.75	0.02	0.02	0.00	Sand
ST004	72.93	21.04	6.04	4.53	1.50	Muddy sandy gravel
ST005	0.21	96.58	3.22	2.68	0.53	Sand
ST006	0.06	97.49	2.44	2.44	0.00	Sand
ST007	0.20	99.79	0.01	0.01	0.00	Sand
ST008	71.75	28.24	0.01	0.01	0.00	Sandy gravel
ST009	59.32	40.48	0.20	0.17	0.04	Sandy gravel
ST010	61.20	36.51	2.29	1.73	0.56	Sandy gravel
ST012	75.38	24.51	0.11	0.10	0.01	Sandy gravel
ST013	63.60	33.55	2.85	2.21	0.64	Sandy gravel
ST015	63.06	33.76	3.18	2.49	0.69	Sandy gravel
ST016	81.78	15.00	3.22	2.40	0.82	Gravel
ST017	68.35	26.07	5.57	4.26	1.32	Muddy sandy gravel
ST018	38.83	49.13	12.04	8.78	3.26	Muddy sandy gravel
ST019	33.25	53.78	12.97	9.55	3.42	Muddy sandy gravel
ST020	22.22	63.39	14.39	10.41	3.98	Gravelly muddy sand
ST021	30.75	62.36	6.89	5.02	1.87	Sandy gravel
ST022	42.25	51.31	6.44	4.66	1.79	Muddy sandy gravel
ST023	17.56	71.90	10.54	7.68	2.86	Gravelly muddy sand
ST024	27.60	67.94	4.46	3.32	1.15	Gravelly sand
ST026	5.49	89.09	5.42	4.48	0.94	Gravelly sand
ST027	0.16	99.84	0.00	0.00	0.00	Sand
ST028	0.02	93.28	6.70	5.80	0.90	Sand
ST029	0.06	93.69	6.26	5.23	1.02	Sand
ST030	0.05	94.97	4.98	4.23	0.75	Sand
ST031	0.01	94.52	5.47	4.68	0.79	Sand
ST032	0.05	94.18	5.77	4.86	0.91	Sand
ST033	2.70	92.88	4.41	3.85	0.56	Sand
ST034	7.28	92.72	0.00	0.00	0.00	Gravelly sand
ST035	0.08	99.92	0.00	0.00	0.00	Sand
ST036	0.95	99.05	0.00	0.00	0.00	Sand
ST037	47.10	51.53	1.37	1.23	0.14	Sandy gravel
ST038	0.22	99.78	0.00	0.00	0.00	Sand
ST039	0.11	99.89	0.00	0.00	0.00	Sand
ST040	1.35	98.65	0.00	0.00	0.00	Sand
ST041	1.11	98.89	0.00	0.00	0.00	Sand
ST042	0.37	99.63	0.00	0.00	0.00	Sand
ST043	3.74	96.26	0.00	0.00	0.00	Sand
ST044	50.37	48.67	0.95	0.84	0.11	Sandy gravel
ST045	4.49	95.51	0.00	0.00	0.00	Sand
ST046	16.84	83.16	0.00	0.00	0.00	Gravelly sand
ST047	61.56	37.45	1.00	0.86	0.13	Sandy gravel
ST050	4.02	95.98	0.00	0.00	0.00	Sand
ST051	3.42	96.58	0.00	0.00	0.00	Sand
ST052	1.05	98.95	0.00	0.00	0.00	Sand
ST053	1.41	98.59	0.00	0.00	0.00	Sand
ST054	0.78	99.22	0.00	0.00	0.00	Sand
ST055	3.58	96.42	0.00	0.00	0.00	Sand
ST056	5.55	94.45	0.00	0.00	0.00	Gravelly sand
ST057	3.47	96.53	0.00	0.00	0.00	Sand
ST058	2.15	97.85	0.00	0.00	0.00	Sand
ST059	2.66	97.34	0.00	0.00	0.00	Sand
ST060	0.33	99.67	0.00	0.00	0.00	Sand
ST061	3.25	93.08	3.67	2.95	0.72	Sand
ST062	2.08	95.73	2.20	1.72	0.48	Sand
ST105A*	80.44	18.50	1.07	0.83	0.23	Gravel
ST106*	35.90	47.39	16.71	13.28	3.42	Muddy sandy gravel
ST107*	29.20	61.50	9.29	6.96	2.33	Gravelly muddy sand
ST108*	0.01	94.81	5.18	4.66	0.52	Sand
Array Area						
ST090	2.97	97.03	0.00	0.00	0.00	Sand
ST091	12.95	87.05	0.00	0.00	0.00	Gravelly sand
ST092	1.69	98.31	0.00	0.00	0.00	Sand
ST093	16.88	83.12	0.00	0.00	0.00	Gravelly sand
ST094	0.41	99.59	0.00	0.00	0.00	Sand
ST095	4.21	95.79	0.00	0.00	0.00	Sand

Station	Fractional Composition			Fines		Folk Description (BGS modified)
	Gravel [%]	Sand [%]	Fines [%]	Silt [%]	Clay [%]	
ST096	2.65	97.35	0.00	0.00	0.00	Sand
ST097	1.87	98.13	0.00	0.00	0.00	Sand
ST098	7.16	92.84	0.00	0.00	0.00	Gravelly sand
ST099	35.47	50.23	14.30	8.62	5.68	Muddy sandy gravel
ST100	0.42	99.58	0.00	0.00	0.00	Sand
ST101	1.41	98.14	0.45	0.32	0.13	Sand
ST102	4.66	95.34	0.00	0.00	0.00	Sand
ST103	2.67	97.33	0.00	0.00	0.00	Sand
ST104	3.30	96.70	0.00	0.00	0.00	Sand
Characterisation Area						
ST063	0.00	93.53	6.47	5.02	1.44	Sand
ST064	0.46	91.64	7.90	6.53	1.37	Sand
ST065	0.04	93.95	6.01	4.91	1.10	Sand
ST066	0.00	93.09	6.91	5.98	0.93	Sand
ST067	4.68	95.32	0.00	0.00	0.00	Sand
ST068	0.22	98.67	1.11	1.00	0.11	Sand
ST069	0.60	92.67	6.72	5.96	0.76	Sand
ST070	1.02	98.98	0.00	0.00	0.00	Sand
ST071	0.06	99.94	0.00	0.00	0.00	Sand
ST072	24.16	75.76	0.07	0.07	0.00	Gravelly sand
ST073	1.63	98.37	0.00	0.00	0.00	Sand
ST074	3.38	96.62	0.00	0.00	0.00	Sand
ST075	0.23	99.77	0.00	0.00	0.00	Sand
ST076	0.01	94.13	5.86	5.22	0.64	Sand
ST077	1.58	98.42	0.00	0.00	0.00	Sand
ST078	1.28	98.72	0.00	0.00	0.00	Sand
ST079	33.95	66.05	0.00	0.00	0.00	Sandy gravel
ST080	0.02	92.20	7.78	6.41	1.37	Sand
ST081	4.04	95.96	0.00	0.00	0.00	Sand
ST082	7.01	92.99	0.00	0.00	0.00	Gravelly sand
ST083	0.30	94.54	5.15	4.64	0.52	Sand
ST085	0.00	88.41	11.59	9.99	1.60	Muddy sand
ST086	9.07	90.93	0.00	0.00	0.00	Gravelly sand
ST087	3.05	96.95	0.00	0.00	0.00	Sand
ST088	4.59	95.41	0.00	0.00	0.00	Sand
ST089	0.07	94.17	5.76	5.00	0.76	Sand
ST118*	9.22	90.78	0.00	0.00	0.00	Gravelly sand
ST119*	14.52	70.20	15.28	13.10	2.17	Gravelly muddy sand
ST121*	0.00	93.98	6.02	5.07	0.95	Sand
Minimum	**0.00**	**15.00**	**0.00**	**0.00**	**0.00**	–
Maximum	**81.78**	**99.94**	**16.71**	**13.28**	**5.68**	
Median	**2.84**	**94.53**	**0.01**	**0.01**	**0.00**	
Mean	**13.83**	**83.40**	**2.77**	**2.21**	**0.56**	
Standard Deviation	**22.38**	**23.41**	**4.07**	**3.18**	**0.99**	
RSD [%]	**162**	**28**	**147**	**144**	**176**	

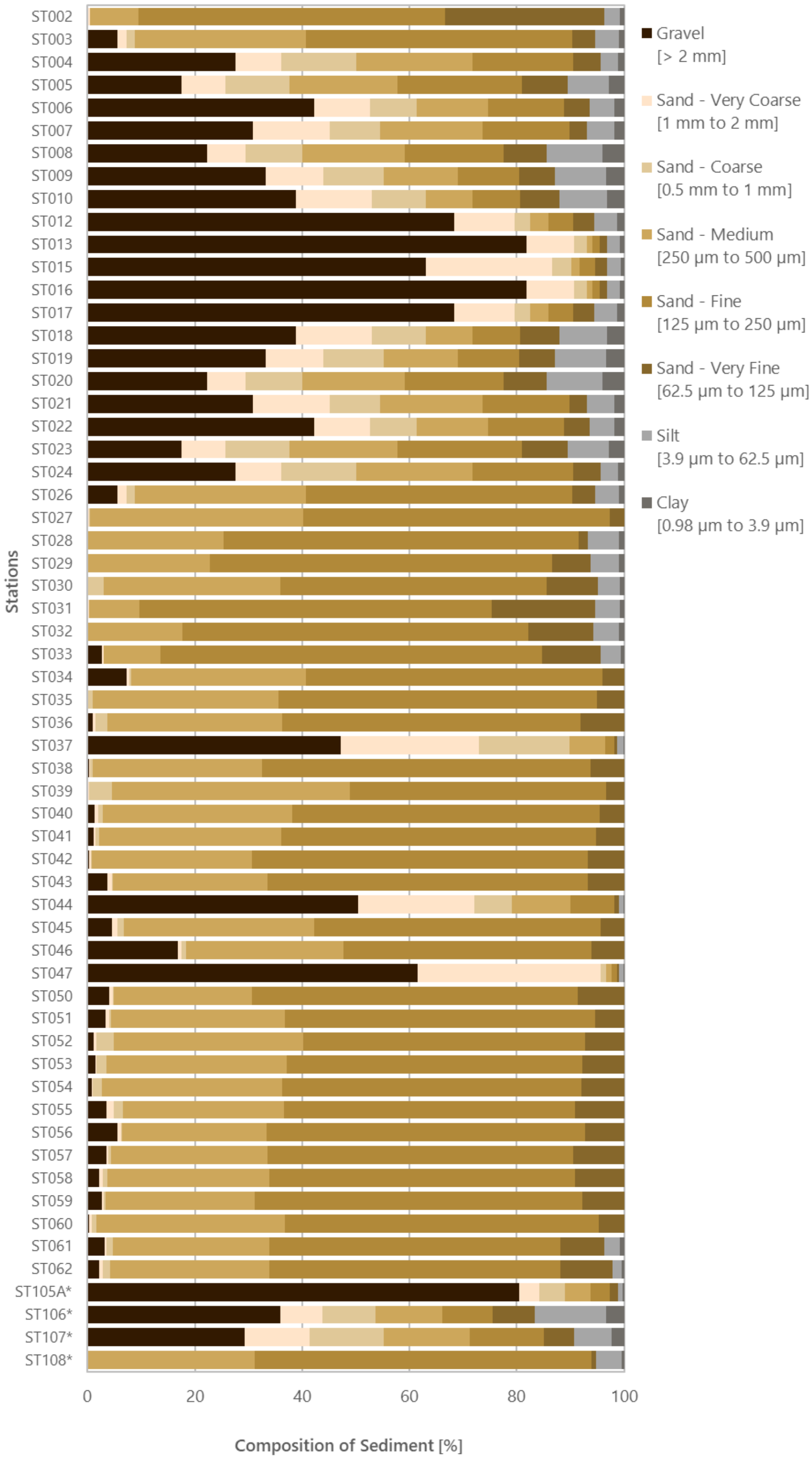
Notes:
* = Contingency station
BGS = British Geological Survey
RSD = Relative Standard Deviation
Fines = Silt and clay content
Silt = < 4.0 phi to +8.0 phi (< 62.5 µm to 3.9 µm)
Clay = Clay = < 8.0 phi to +10.0 phi (< 3.9 µm to 0.98 µm)

Table 4.26: Summary of particle size distribution, Dogger Bank D 2024

Station	Modality	Median [µm]	Mean Particle Size			Sorting Coefficient		Skewness	
			[µm]	[phi]	Wentworth (1922) Description	[µm]	Description	[µm]	Description
Export Cable Corridor									
ST002	Unimodal	149	148	2.75	Fine sand	1.56	Moderately well sorted	-0.04	Symmetrical
ST003	Unimodal	187	191	2.39	Fine sand	1.69	Moderately sorted	0.10	Symmetrical
ST004	Unimodal	19004	5378	-2.43	Fine pebble	8.48	Very poorly sorted	-0.85	Very fine skewed
ST005	Unimodal	150	149	2.75	Fine sand	1.54	Moderately well sorted	-0.05	Symmetrical
ST006	Unimodal	140	140	2.84	Fine sand	1.48	Moderately well sorted	-0.05	Symmetrical
ST007	Unimodal	167	168	2.58	Fine sand	1.55	Moderately well sorted	0.07	Symmetrical
ST008	Bimodal	25474	5787	-2.53	Fine pebble	9.34	Very poorly sorted	-0.83	Very fine skewed
ST009	Bimodal	5299	2511	-1.33	Granule	6.24	Very poorly sorted	-0.51	Very fine skewed
ST010	Polymodal	5280	2895	-1.53	Granule	7.90	Very poorly sorted	-0.39	Very fine skewed
ST012	Polymodal	9287	6220	-2.64	Fine pebble	4.55	Very poorly sorted	-0.43	Very fine skewed
ST013	Polymodal	2931	1800	-0.85	Very coarse sand	4.75	Very poorly sorted	-0.44	Very fine skewed
ST015	Polymodal	2535	2945	-1.56	Granule	3.65	Poorly sorted	0.00	Symmetrical
ST016	Unimodal	6284	5194	-2.38	Fine pebble	3.41	Poorly sorted	-0.42	Very fine skewed
ST017	Polymodal	4228	2862	-1.52	Granule	6.69	Very poorly sorted	-0.36	Very fine skewed
ST018	Polymodal	1199	749	0.42	Coarse sand	7.18	Very poorly sorted	-0.44	Very fine skewed
ST019	Bimodal	657	624	0.68	Coarse sand	7.54	Very poorly sorted	-0.18	Fine skewed
ST020	Polymodal	340	429	1.22	Medium sand	7.56	Very poorly sorted	0.01	Symmetrical
ST021	Polymodal	654	728	0.46	Coarse sand	5.26	Very poorly sorted	-0.06	Symmetrical
ST022	Polymodal	1229	1448	-0.53	Very coarse sand	9.22	Very poorly sorted	-0.01	Symmetrical
ST023	Polymodal	318	422	1.25	Medium sand	5.80	Very poorly sorted	0.06	Symmetrical
ST024	Polymodal	501	731	0.45	Coarse sand	5.01	Very poorly sorted	0.30	Coarse skewed
ST026	Unimodal	225	227	2.14	Fine sand	2.45	Poorly sorted	0.05	Symmetrical
ST027	Unimodal	228	228	2.13	Fine sand	1.44	Moderately well sorted	0.02	Symmetrical
ST028	Unimodal	207	204	2.30	Fine sand	1.80	Moderately sorted	-0.35	Very fine skewed
ST029	Unimodal	194	192	2.38	Fine sand	1.84	Moderately sorted	-0.31	Very fine skewed
ST030	Unimodal	210	210	2.25	Fine sand	1.73	Moderately sorted	-0.10	Fine skewed
ST031	Unimodal	159	157	2.67	Fine sand	1.77	Moderately sorted	-0.27	Fine skewed
ST032	Unimodal	180	176	2.50	Fine sand	1.81	Moderately sorted	-0.30	Very fine skewed
ST033	Unimodal	175	175	2.51	Fine sand	1.44	Moderately well sorted	-0.01	Symmetrical
ST034	Unimodal	228	230	2.12	Fine sand	2.18	Poorly sorted	0.36	Very coarse skewed
ST035	Unimodal	218	218	2.20	Fine sand	1.47	Moderately well sorted	0.05	Symmetrical
ST036	Unimodal	215	217	2.21	Fine sand	1.56	Moderately well sorted	0.05	Symmetrical
ST037	Bimodal	1839	1869	-0.90	Very coarse sand	2.86	Poorly sorted	0.00	Symmetrical
ST038	Unimodal	212	212	2.24	Fine sand	1.48	Moderately well sorted	0.03	Symmetrical
ST039	Unimodal	247	249	2.01	Fine sand	1.52	Moderately well sorted	0.03	Symmetrical
ST040	Unimodal	223	223	2.16	Fine sand	1.49	Moderately well sorted	0.06	Symmetrical
ST041	Unimodal	218	219	2.19	Fine sand	1.48	Moderately well sorted	0.06	Symmetrical
ST042	Unimodal	208	209	2.26	Fine sand	1.47	Moderately well sorted	0.02	Symmetrical
ST043	Unimodal	212	215	2.22	Fine sand	1.54	Moderately well sorted	0.09	Symmetrical
ST044	Polymodal	2030	2288	-1.19	Granule	5.60	Very poorly sorted	0.06	Symmetrical
ST045	Unimodal	231	232	2.11	Fine sand	1.79	Moderately sorted	0.27	Coarse skewed
ST046	Bimodal	243	536	0.90	Coarse sand	5.29	Very poorly sorted	0.72	Very coarse skewed
ST047	Polymodal	2334	3499	-1.81	Granule	2.80	Poorly sorted	0.54	Very coarse skewed
ST050	Unimodal	206	208	2.26	Fine sand	1.56	Moderately well sorted	0.10	Symmetrical
ST051	Unimodal	219	221	2.18	Fine sand	1.51	Moderately well sorted	0.08	Symmetrical
ST052	Unimodal	224	225	2.15	Fine sand	1.57	Moderately well sorted	0.04	Symmetrical
ST053	Unimodal	217	218	2.20	Fine sand	1.55	Moderately well sorted	0.04	Symmetrical
ST054	Unimodal	216	217	2.21	Fine sand	1.54	Moderately well sorted	0.03	Symmetrical
ST055	Unimodal	215	218	2.20	Fine sand	1.74	Moderately sorted	0.19	Coarse skewed
ST056	Unimodal	211	214	2.22	Fine sand	2.02	Poorly sorted	0.33	Very coarse skewed
ST057	Unimodal	209	211	2.24	Fine sand	1.57	Moderately well sorted	0.07	Symmetrical
ST058	Unimodal	210	212	2.24	Fine sand	1.56	Moderately well sorted	0.06	Symmetrical
ST059	Unimodal	208	209	2.26	Fine sand	1.52	Moderately well sorted	0.07	Symmetrical
ST060	Unimodal	220	221	2.18	Fine sand	1.47	Moderately well sorted	0.05	Symmetrical
ST061	Unimodal	209	210	2.25	Fine sand	1.62	Moderately sorted	0.02	Symmetrical
ST062	Unimodal	208	210	2.25	Fine sand	1.61	Moderately well sorted	0.03	Symmetrical
ST105A*	Polymodal	15731	8469	-3.08	Medium pebble	5.52	Very poorly sorted	-0.57	Very fine skewed
ST106*	Polymodal	622	759	0.40	Coarse sand	12.68	Very poorly sorted	-0.02	Symmetrical
ST107*	Bimodal	627	679	0.56	Coarse sand	6.36	Very poorly sorted	-0.10	Symmetrical
ST108*	Unimodal	216	215	2.22	Fine sand	1.65	Moderately sorted	-0.30	Fine skewed
Array Area									
ST090	Unimodal	199	201	2.31	Fine sand	1.53	Moderately well sorted	0.08	Symmetrical
ST091	Bimodal	294	410	1.29	Medium sand	2.98	Poorly sorted	0.48	Very coarse skewed
ST092	Unimodal	199	201	2.31	Fine sand	1.50	Moderately well sorted	0.05	Symmetrical
ST093	Bimodal	497	682	0.55	Coarse sand	2.92	Poorly sorted	0.47	Very coarse skewed
ST094	Unimodal	206	207	2.27	Fine sand	1.54	Moderately well sorted	0.03	Symmetrical
ST095	Unimodal	198	201	2.31	Fine sand	1.55	Moderately well sorted	0.11	Coarse skewed
ST096	Unimodal	199	202	2.31	Fine sand	1.52	Moderately well sorted	0.07	Symmetrical

Station	Modality	Median [µm]	Mean Particle Size			Sorting Coefficient		Skewness	
			[µm]	[phi]	Wentworth (1922) Description	[µm]	Description	[µm]	Description
ST097	Unimodal	204	205	2.28	Fine sand	1.50	Moderately well sorted	0.05	Symmetrical
ST098	Unimodal	226	235	2.09	Fine sand	2.28	Poorly sorted	0.37	Very coarse skewed
ST099	Polymodal	332	649	0.62	Coarse sand	12.06	Very poorly sorted	0.17	Coarse skewed
ST100	Unimodal	213	213	2.23	Fine sand	1.54	Moderately well sorted	0.02	Symmetrical
ST101	Unimodal	174	175	2.52	Fine sand	1.50	Moderately well sorted	0.03	Symmetrical
ST102	Unimodal	211	214	2.22	Fine sand	1.89	Moderately sorted	0.28	Coarse skewed
ST103	Unimodal	180	184	2.44	Fine sand	1.52	Moderately well sorted	0.11	Coarse skewed
ST104	Unimodal	222	224	2.16	Fine sand	1.62	Moderately well sorted	0.16	Coarse skewed
Characterisation Area									
ST063	Unimodal	160	160	2.64	Fine sand	2.09	Poorly sorted	-0.21	Fine skewed
ST064	Unimodal	157	154	2.70	Fine sand	2.03	Poorly sorted	-0.31	Very fine skewed
ST065	Unimodal	176	175	2.51	Fine sand	2.07	Poorly sorted	-0.22	Fine skewed
ST066	Unimodal	215	210	2.25	Fine sand	2.04	Poorly sorted	-0.30	Fine skewed
ST067	Unimodal	202	205	2.29	Fine sand	1.86	Moderately sorted	0.28	Coarse skewed
ST068	Unimodal	215	217	2.21	Fine sand	1.63	Moderately sorted	0.03	Symmetrical
ST069	Unimodal	208	205	2.29	Fine sand	1.88	Moderately sorted	-0.31	Very fine skewed
ST070	Unimodal	202	203	2.30	Fine sand	1.46	Moderately well sorted	0.03	Symmetrical
ST071	Unimodal	213	214	2.22	Fine sand	1.48	Moderately well sorted	0.03	Symmetrical
ST072	Bimodal	717	1051	-0.07	Very coarse sand	3.24	Poorly sorted	0.48	Very coarse skewed
ST073	Unimodal	209	210	2.25	Fine sand	1.47	Moderately well sorted	0.06	Symmetrical
ST074	Unimodal	211	213	2.23	Fine sand	1.52	Moderately well sorted	0.09	Symmetrical
ST075	Unimodal	512	504	0.99	Coarse sand	1.51	Moderately well sorted	-0.07	Symmetrical
ST076	Unimodal	192	190	2.40	Fine sand	1.78	Moderately sorted	-0.29	Fine skewed
ST077	Unimodal	199	201	2.31	Fine sand	1.53	Moderately well sorted	0.04	Symmetrical
ST078	Unimodal	185	184	2.44	Fine sand	1.41	Well sorted	-0.01	Symmetrical
ST079	Bimodal	315	1205	-0.27	Very coarse sand	9.06	Very poorly sorted	0.72	Very coarse skewed
ST080	Unimodal	162	158	2.66	Fine sand	1.94	Moderately sorted	-0.35	Very fine skewed
ST081	Unimodal	230	232	2.11	Fine sand	1.62	Moderately well sorted	0.14	Coarse skewed
ST082	Unimodal	227	229	2.13	Fine sand	2.23	Poorly sorted	0.36	Very coarse skewed
ST083	Unimodal	170	168	2.58	Fine sand	1.73	Moderately sorted	-0.26	Fine skewed
ST085	Unimodal	136	132	2.93	Fine sand	2.02	Poorly sorted	-0.39	Very fine skewed
ST086	Unimodal	211	226	2.14	Fine sand	2.47	Poorly sorted	0.40	Very coarse skewed
ST087	Unimodal	203	205	2.28	Fine sand	1.57	Moderately well sorted	0.07	Symmetrical
ST088	Unimodal	220	221	2.18	Fine sand	1.80	Moderately sorted	0.23	Coarse skewed
ST089	Unimodal	140	137	2.87	Fine sand	1.69	Moderately sorted	-0.34	Very fine skewed
ST118*	Unimodal	222	232	2.11	Fine sand	2.34	Poorly sorted	0.38	Very coarse skewed
ST119*	Bimodal	208	209	2.26	Fine sand	4.80	Very poorly sorted	0.05	Symmetrical
ST121*	Unimodal	145	143	2.80	Fine sand	1.75	Moderately sorted	-0.32	Very fine skewed
Minimum	–	**136**	**132**	**-3.08**	–	**1.41**	–	**-0.85**	-
Maximum		**25474**	**8469**	**2.93**		**12.68**		**0.72**	
Median		**215**	**216**	**2.21**		**1.76**		**0.03**	
Mean		**1220**	**754**	**1.54**		**2.94**		**-0.01**	
Standard Deviation		**3610**	**1430**	**1.47**		**2.45**		**0.28**	
RSD [%]		**297**	**189**	**96**		**83**		**3500**	

Notes
Statistics based on Folk and Ward (1957) method derived in Gradistat (Blott, 2010)
* = Contingency station
RSD = Relative Standard Deviation



Notes

* = Contingency station

Figure 4.31: Sediment fractional composition, Dogger Bank D ECC 2024

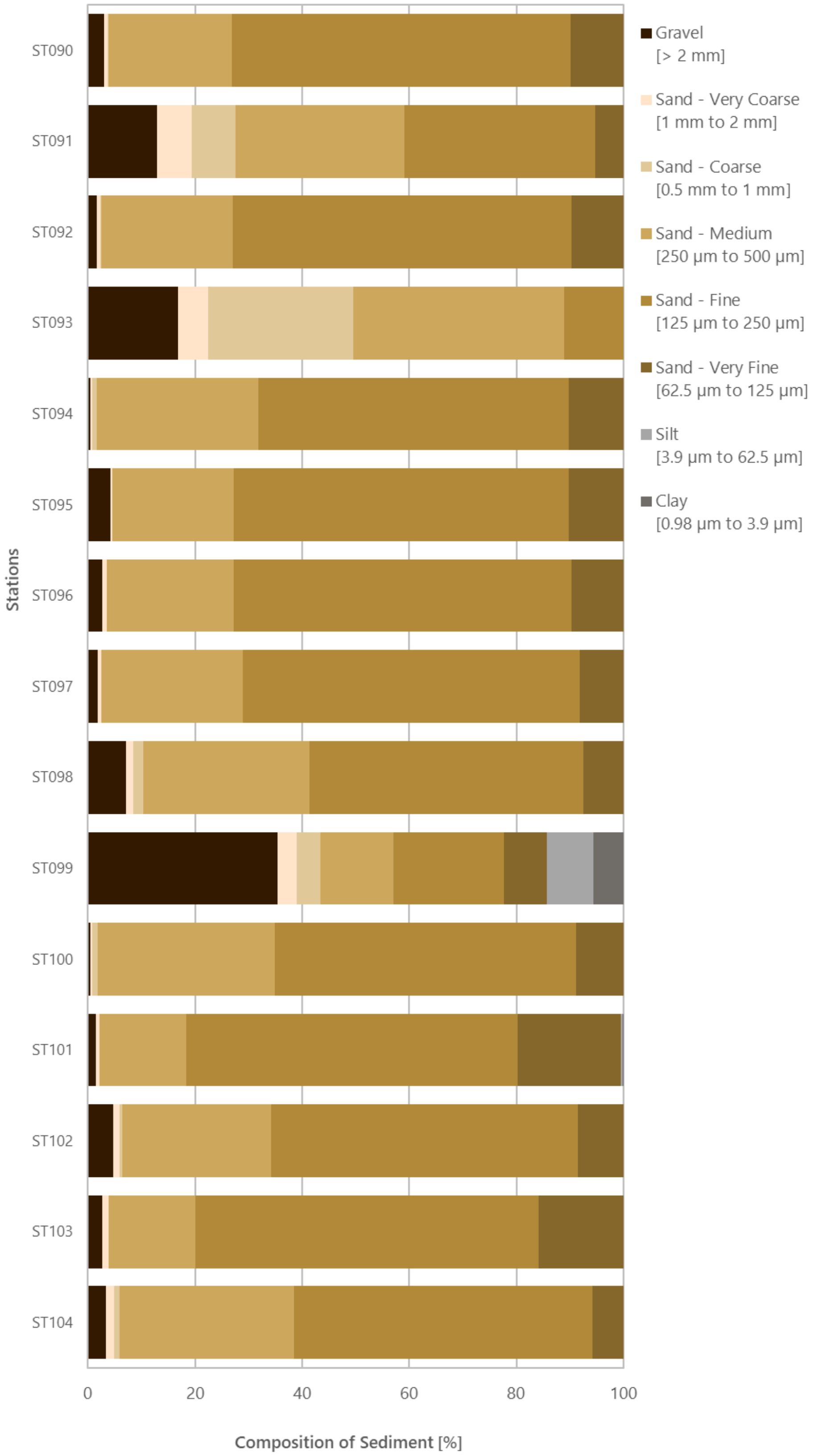
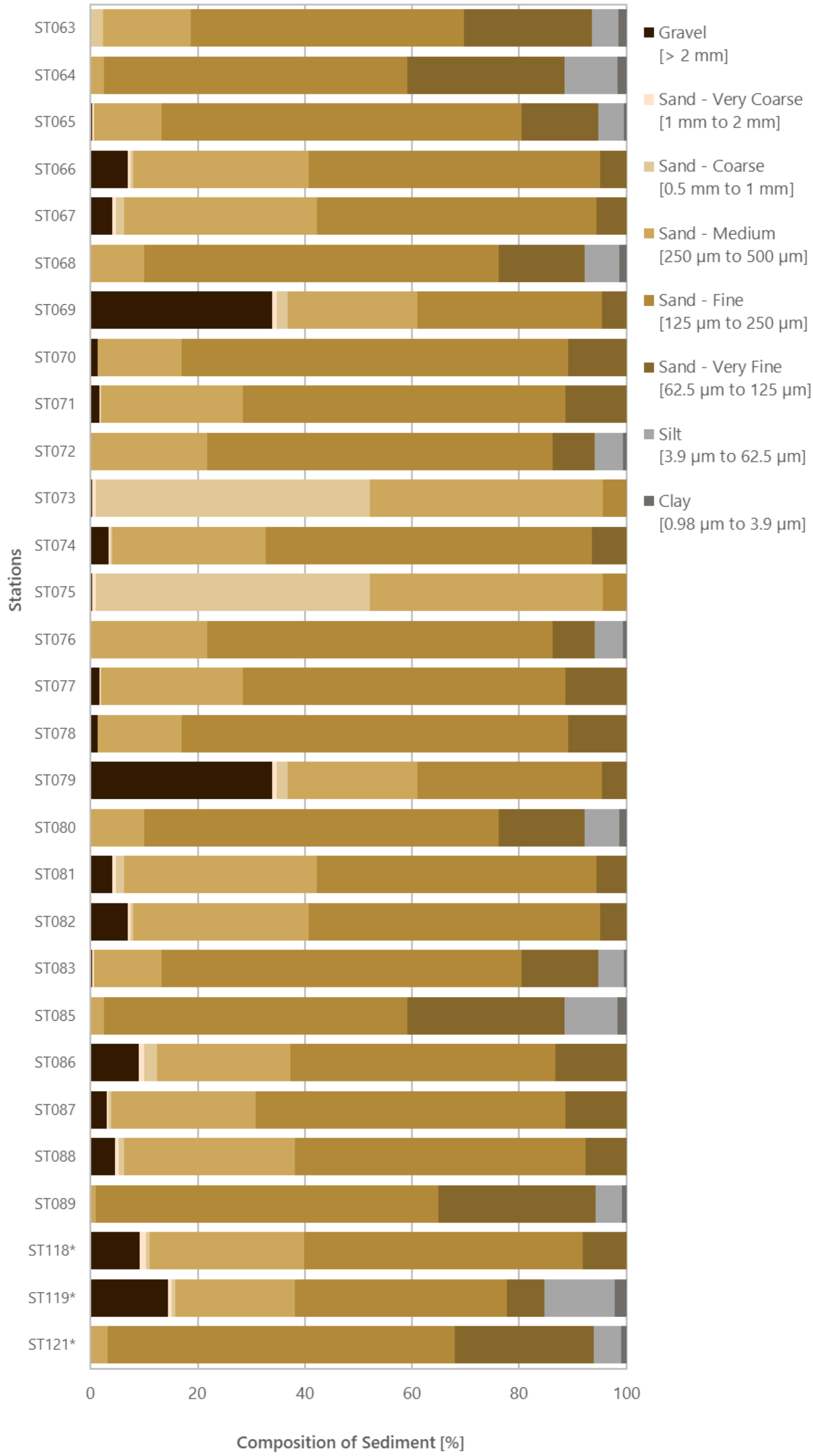


Figure 4.32: Sediment fractional composition, Dogger Bank D Array 2024



Notes
* = Contingency station

Figure 4.33: Sediment fractional composition, Dogger Bank D Characterisation area 2024

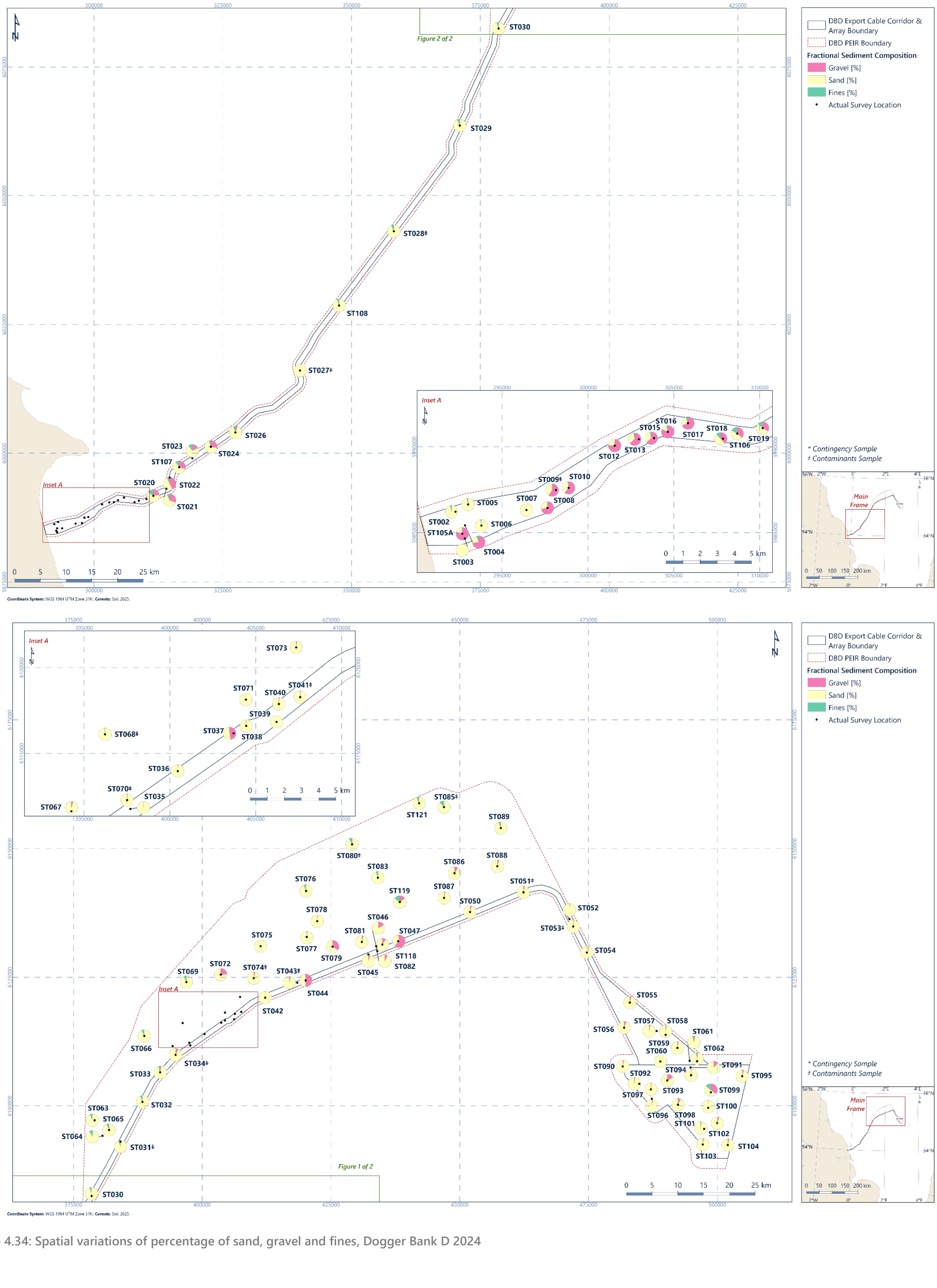
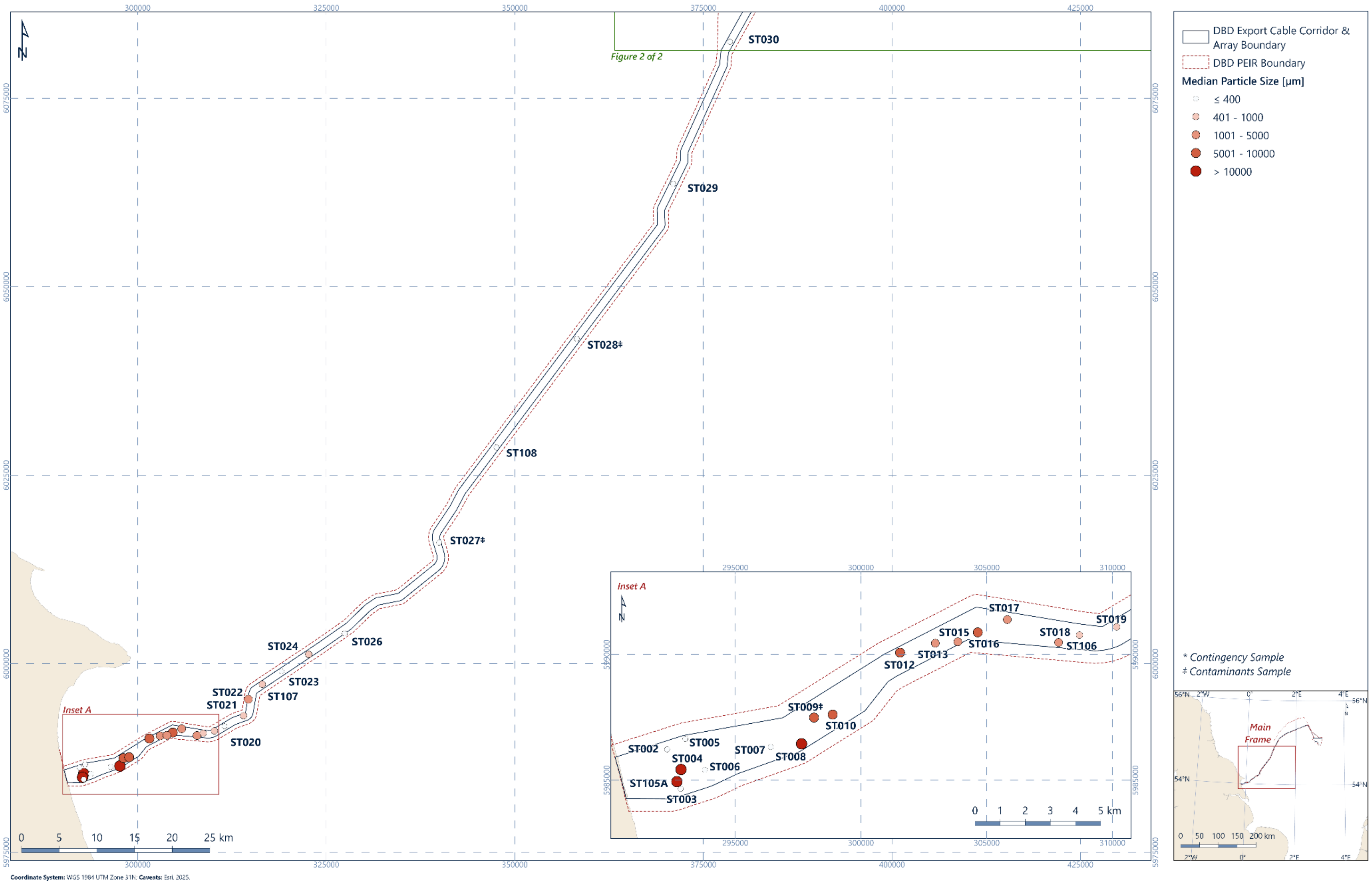


Figure 4.34: Spatial variations of percentage of sand, gravel and fines, Dogger Bank D 2024



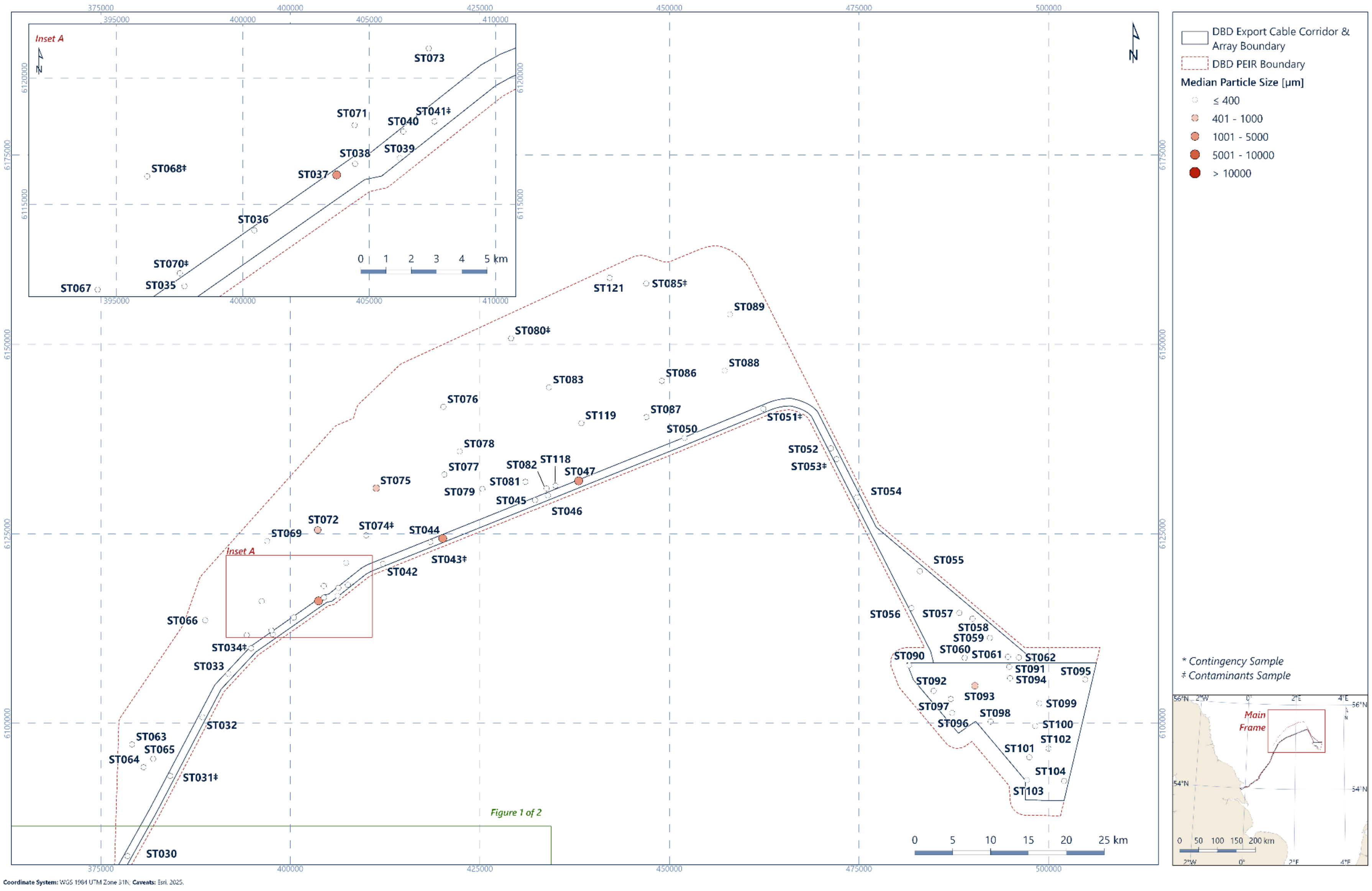
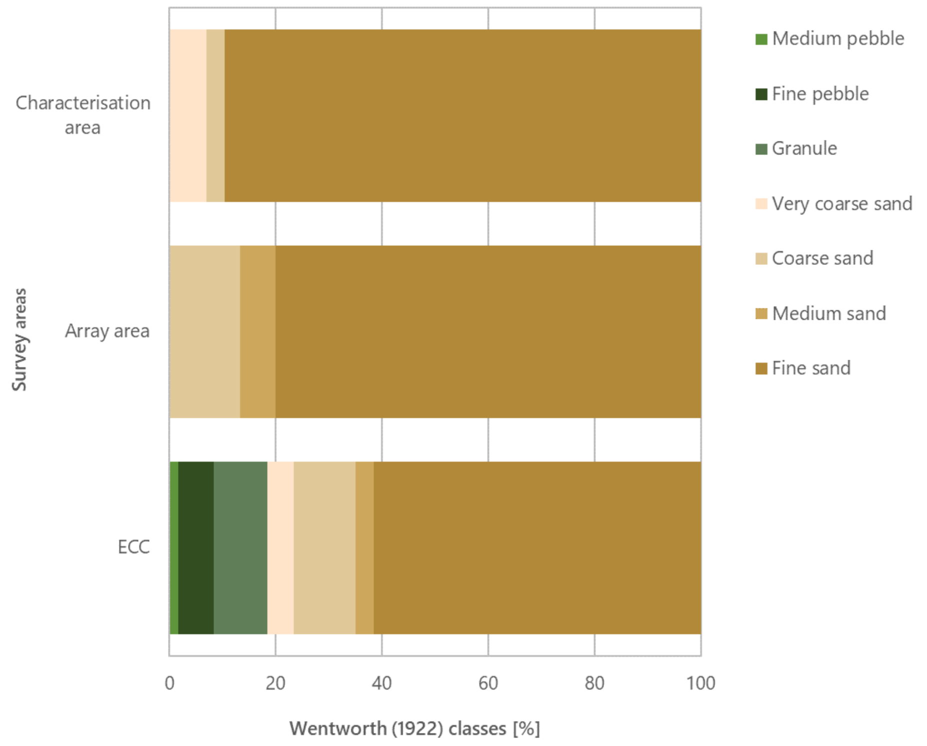
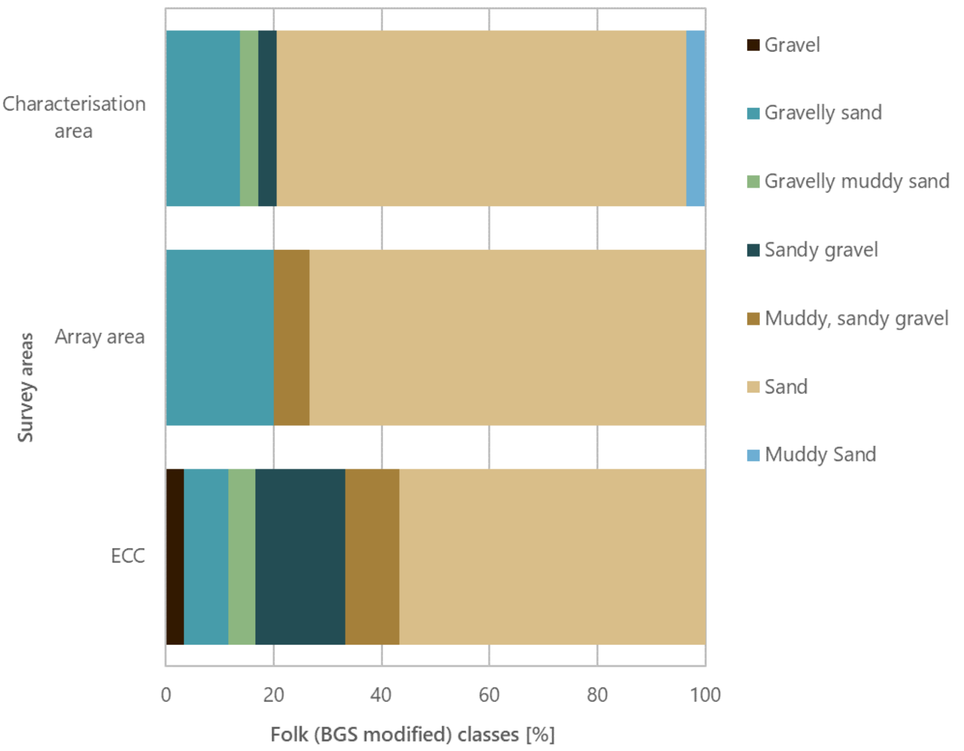


Figure 4.35: Spatial variations of the median [µm] sediment particle size, Dogger Bank D 2024



Notes
ECC = export cable corridor

Figure 4.36: Wentworth (1922) sediment description, Dogger Bank D 2024



Notes
BGS = British Geological Survey
ECC = export cable corridor

Figure 4.37: Folk (BGS modified) sediment description, Dogger Bank D 2024

4.2.2.2 Investigation of Granulometric Similarities

The cluster analysis, using Euclidean distance, was applied to the sediment PSD dataset to investigate sedimentological characteristics. Data were fourth root transformed, to reduce the degree of skewness and allow optimal performance of the multivariate analysis. The SIMPROF test was undertaken in conjunction with the cluster analysis. The cluster analysis grouped samples based on the nearest neighbour sorting of a matrix of sample similarities using Euclidean distance measure. The SIMPROF test identified statistically significant clusters and where appropriate, coarser groups were created if the resulting groups were supersets of the similarity profile clusters (see Section 3.3.5). Figures 4.38 and 4.39 present the dendrogram and the nMDS of the Euclidean distance matrix of sediment particle size, respectively. The good correspondence between the dendrogram and the 2D nMDS (Figure 4.40), indicates that the latter is representative of the granulometric similarities between stations (details in Section 3.3.5).

Six multivariate groups (A to F) were identified at the Euclidean distance of 3.3, in addition to station ST075, which was statistically different to all the groups.

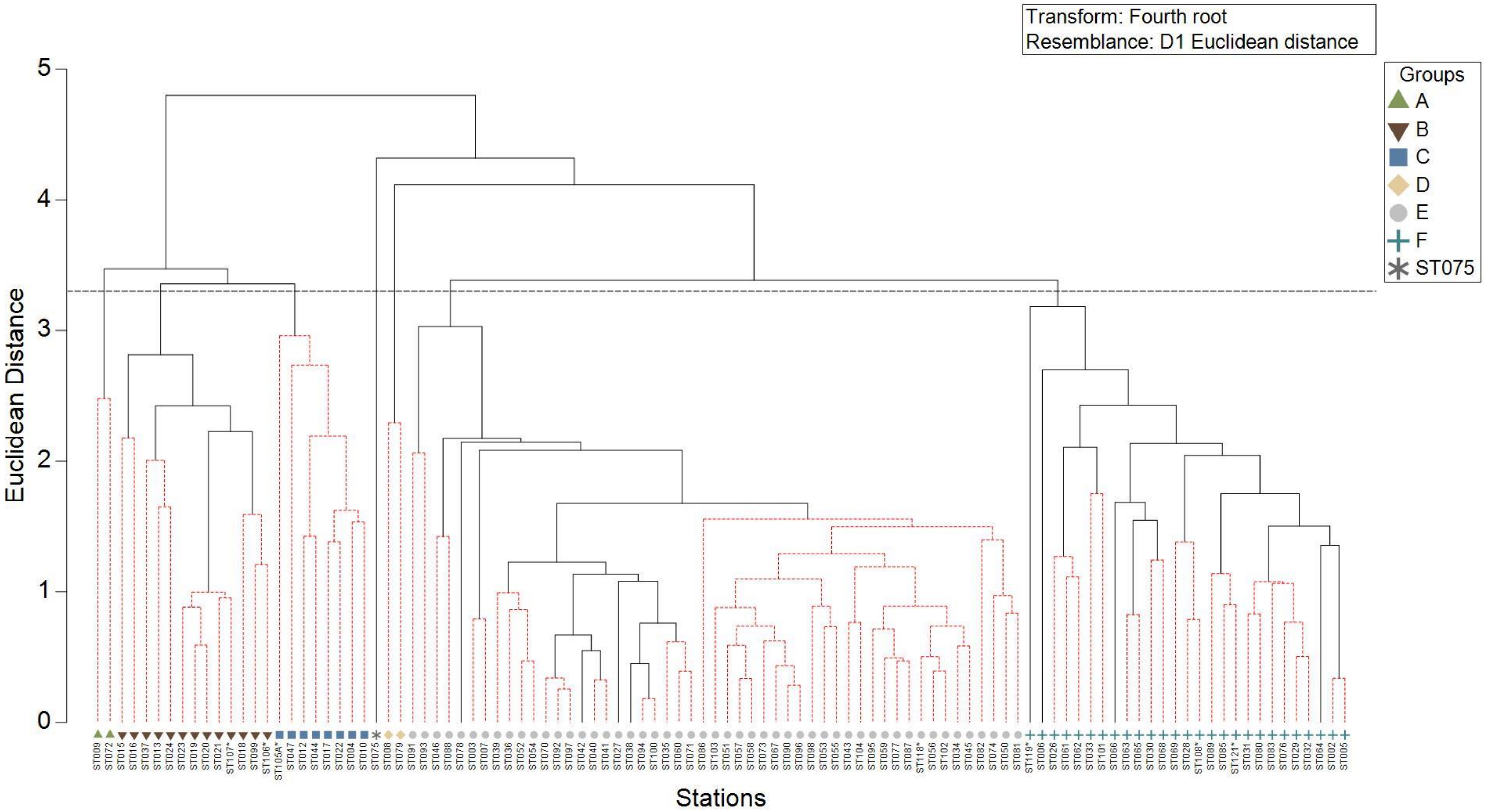
Table 4.27 summarises the physical characteristics of the sediment groups identified through the multivariate analysis and further assessed by means of the SIMPER analysis, and detailed as follows:

- Group A comprised 2 stations, consisting of stations ST009 along the ECC and ST072 in the array area, and had an average Euclidean distance of 3.07. Group A was characterised by ‘coarse sand’ and ‘fine pebble’, with a median sediment particle size ranging from 717 µm (coarse sand) to 5299 µm (fine pebble), (mean of 3008 µm; granule), in water depths of 17.9 m to 55.1 m (mean of 36.5 m). The mean gravel content of group A was 41.74 % and classified as ‘sandy gravel’ and ‘gravelly sand’ respectively. The fines content was ≤ 0.20 %;
- Group B comprised 13 stations, including 12 along the ECC and 1 in the array area, and had an average Euclidean distance of 2.79. Group B was characterised by very poorly sorted ‘sand gravel’, ‘muddy, sandy gravel’ and ‘gravelly muddy sand’ (Folk BGS), with a median sediment particle size ranging from 1449 µm (medium sand) to 6284 µm (fine pebble) (mean of 1352 µm; coarse sand), in water depth of 27.4 m to 56.5 m (mean of 44.5 m). The mean gravel content of group B was 40.49 %, with one station (ST016) > 80 % gravel and classified as ‘gravel’. The fines content ranged from 1.37 % to 16.71% with a mean of 8.63 %;
- Group C comprised 8 stations along the ECC and had an average Euclidean distance of 2.92 %. It was characterised by very poorly sorted ‘sandy gravel’ (Folk BGS), with a median sediment particle size ranging from 1129 µm (very coarse sand) to 19 004 µm (coarse pebble) (mean of 7390 µm; fine pebble) in water depth of 17.0 m to 52.9 m (mean of 31.1 m). The mean gravel content of group C was 64.06 %, with one station (ST105A) > 80 % gravel and classified as ‘medium pebble’. The fines content ranged from 0.11 % to 6.44 % with a mean of 2.93 %;

- Group D comprised 2 stations, consisting of station ST008 along the ECC and station ST079 in the characterisation area, and had an average Euclidean distance of 2.63. Group D was characterised by very poorly sorted 'sandy gravel' (Folk BGS), with a median sediment particle size ranging from 315 μm (medium sand) to 25 474 μm (coarse pebble), (mean of 12 894 μm; medium pebble), in water depths of 18.1 m to 40.9 m (mean 29.5 m). Both stations had a fines content ≤ 0.01 %;
- Group E comprised 51 stations, consisting of 25 along the ECC, 13 in the array area and 13 in the characterisation area, and had an average Euclidean distance of 1.62. Group E was characterised by moderately well sorted 'sand' (Folk BGS), with a median sediment particle size ranging from 167 μm (fine sand) to 682 μm (coarse sand), (mean of 219 μm; medium sand), in water depths of 13.0 m to 64.9 m (mean of 35.4 m). Gravel content ranged from 0.06 % to 16.88 % with a mean of 3.49 %. Nine stations were classified as 'gravelly sand'. Fines were absent from 49 stations with the remaining two stations (ST003 and ST007) displaying fine content ≤ 0.02 %;
- Group F comprised 27 stations, consisting of 13 along the ECC, 13 in the characterisation area and 1 in the array area, and had an average Euclidean distance of 2.57. Group F was characterised by moderately well sorted 'sand' (Folk BGS), with a median sediment particle size ranging from 136 μm (fine sand) to 225 μm (fine sand), (mean of 181 μm; fine sand), in water depths of 19.0 m to 77.0 m (mean of 51.3 m). Gravel content ranged from 0.00 % to 14.52 % with a mean of 1.18 %. Two stations were classified as 'gravelly sand'. Fines content ranged from 0.45 % to 15.28 %, with a mean of 5.65 %. Two stations had fine contents > 10 % (stations ST085 and ST119) and were classified as 'muddy sand' and 'gravelly muddy sand' respectively;
- Station ST075, located in the characterisation area, was separated from other stations by a Euclidean distance of 4.3. It was characterised by moderately well sorted 'sand' (Folk BGS), with a median sediment particle size of 512 μm (coarse sand) in a water depth of 46.2 m;

Figure 4.40 displays the sediment particle sizes driving the separation of the multivariate groups, including the 125.00 μm (fine sand), the 707.11 μm (coarse sand), the 8000 μm (medium pebble) and the 16 000 μm (coarse pebble) sediment particle sizes.

Figure 4.41 displays the spatial distribution of the sediment groups identified through the multivariate analysis.



Notes
* = Contingency station

Figure 4.38: Dendrogram of hierarchical clustering analysis of sediment particle size, Dogger Bank D 2024

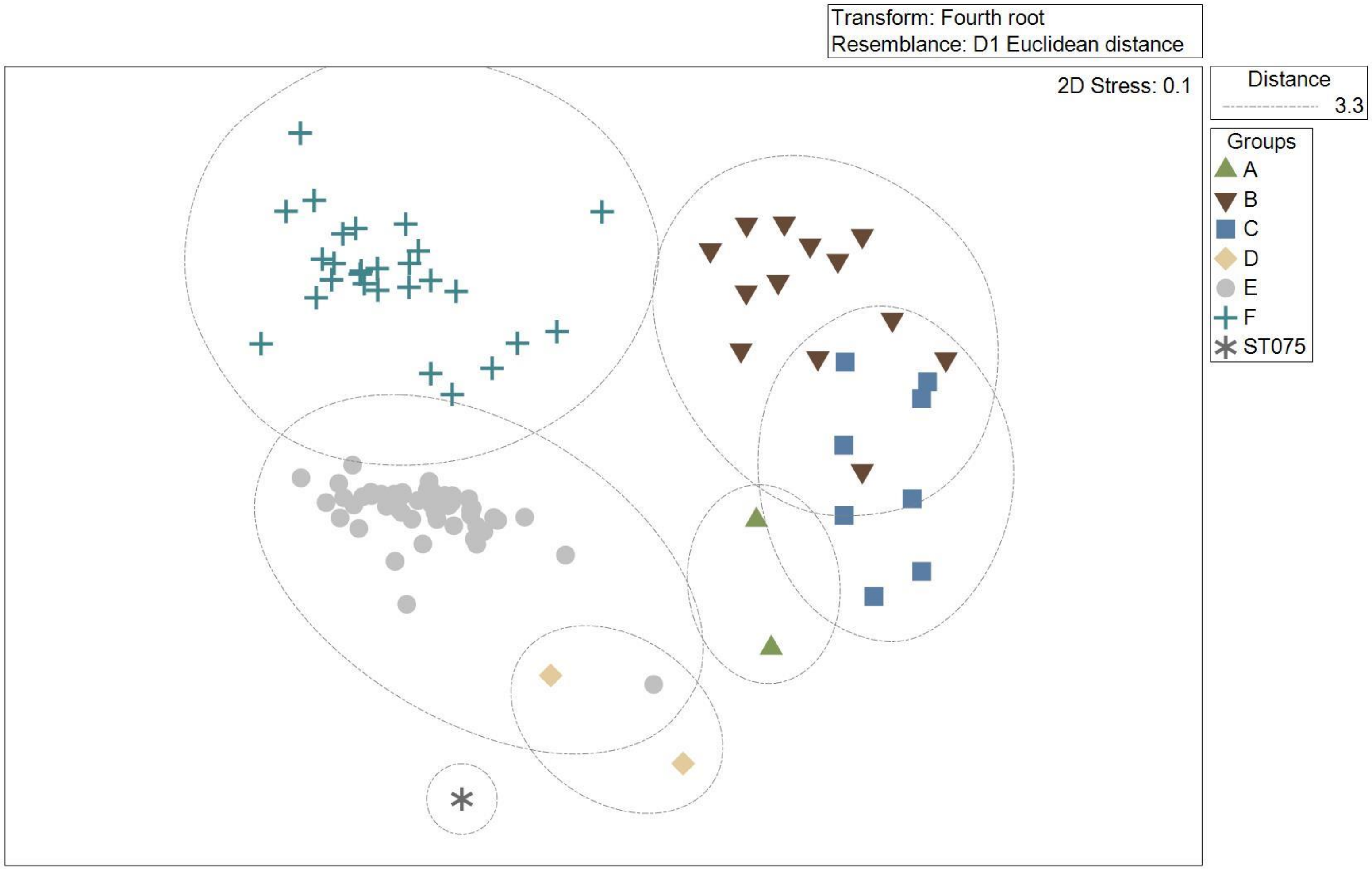


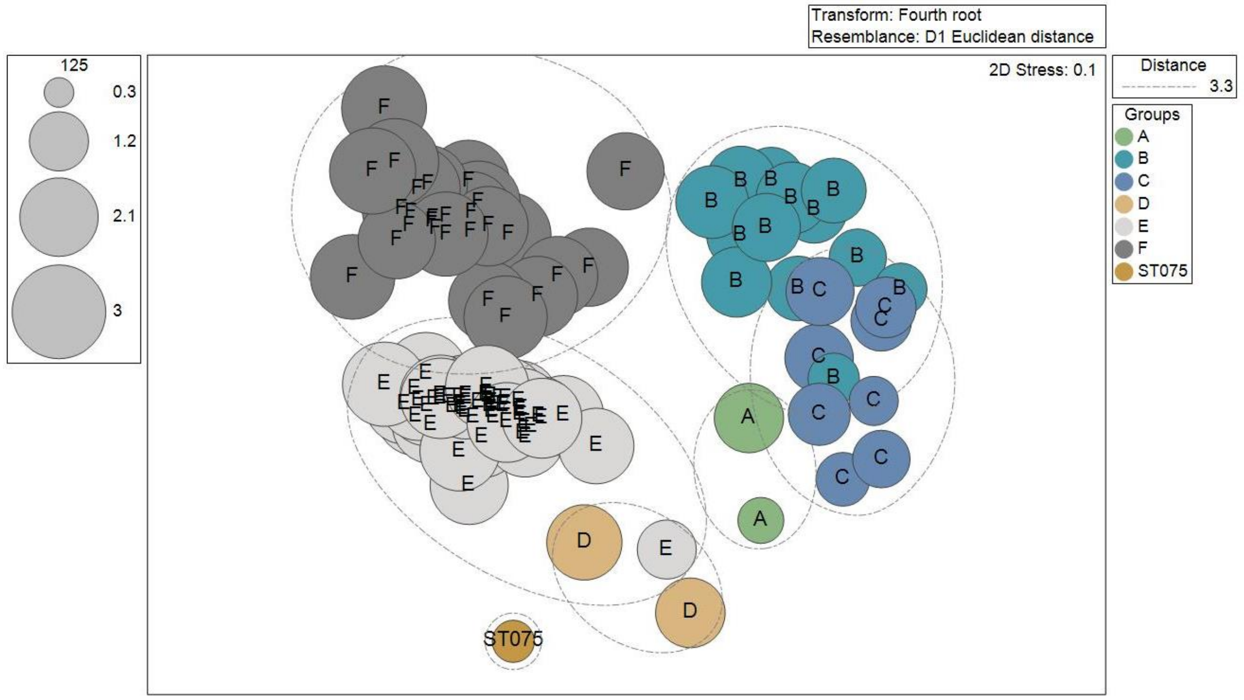
Figure 4.39: nMDS of hierarchical clustering analysis of sediment particle size, Dogger Bank D 2024

Table 4.27: Summary of physical characteristics of sediment groups identified through the cluster analysis, Dogger Bank D 2024

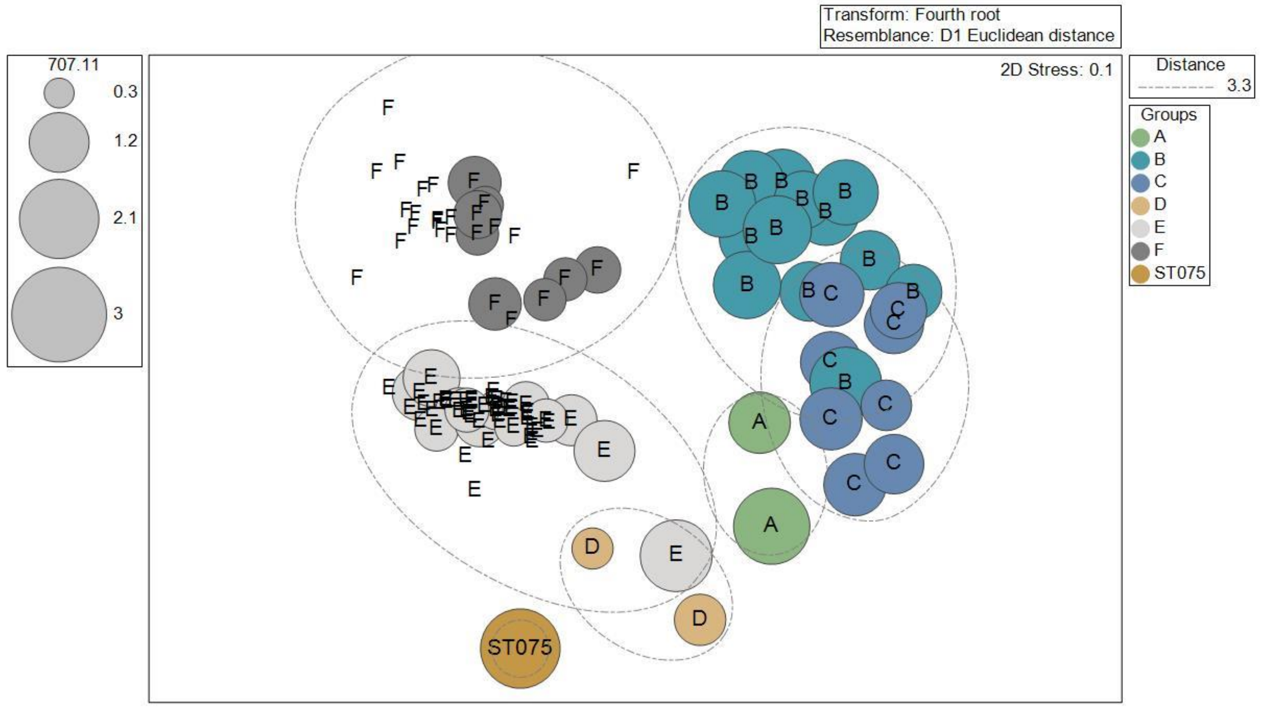
Multivariate Group	Location and stations	Depth [m BSL]	Median Particle Size [µm]	Fractional Composition [%]			Sorting	
				Gravel	Sand	Fines	[µm]	Description†
A Average Euclidean distance²: 3.07	**ECC** (ST009) **Characterisation area** (ST072)	36.5	3008	41.74	58.12	0.14	4.74	Poorly sorted
B Average Euclidean distance²: 2.79	**ECC** (ST013, ST015, ST016, ST018, ST019, ST020, ST021, ST023, ST024, ST037, ST106, ST107) **Array area** (ST099)	44.5	1449	40.49	50.88	8.63	6.47	Very poorly sorted
C Average Euclidean distance²: 2.92	**ECC** (ST004, ST010, ST012, ST017, ST022, ST044, ST047) **Array area** (ST105A)	31.1	7390	64.06	33.01	2.93	6.35	Very poorly sorted
D Average Euclidean distance²: 2.63	**ECC** (ST008) **Characterisation area** (ST079)	29.5	12894	52.85	47.15	0.00	9.20	Very poorly sorted

Multivariate Group	Location and stations	Depth [m BSL]	Median Particle Size [µm]	Fractional Composition [%]			Sorting	
				Gravel	Sand	Fines	[µm]	Description†
E Average Euclidean distance[2]: 1.62	**ECC** (ST003, ST007, ST027, ST034, ST035, ST036, ST038, ST039, ST040, ST041, ST042, ST043, ST045, ST046, ST050, ST051, ST052, ST053, ST054, ST055, ST056, ST057, ST058, ST059, ST060) **Array area** (ST090, ST091, ST092, ST093, ST094, ST095, ST096, ST097, ST098, ST100, ST102, ST103, ST104) **Characterisation area** (ST067, ST070, ST071, ST073, ST074, ST077, ST078, ST081, ST082, ST086, ST087, ST088, ST118*)	35.4	219	3.49	96.51	0.00	1.77	Moderately well sorted
F Average Euclidean distance[2]: 2.57	**ECC** (ST002, ST005, ST006, ST026, ST028, ST029, ST030, ST031, ST032, ST033, ST061, ST062, ST108*) **Array area** (ST101) **Characterisation area** (ST063, ST064, ST065, ST066, ST068, ST069, ST076, ST080, ST083, ST085, ST089, ST119*, ST121*)	51.3	181	1.18	93.17	5.65	1.90	Moderately well sorted
ST075	**Characterisation area**	46.2	512	0.23	99.77	0.00	1.51	Moderately well sorted

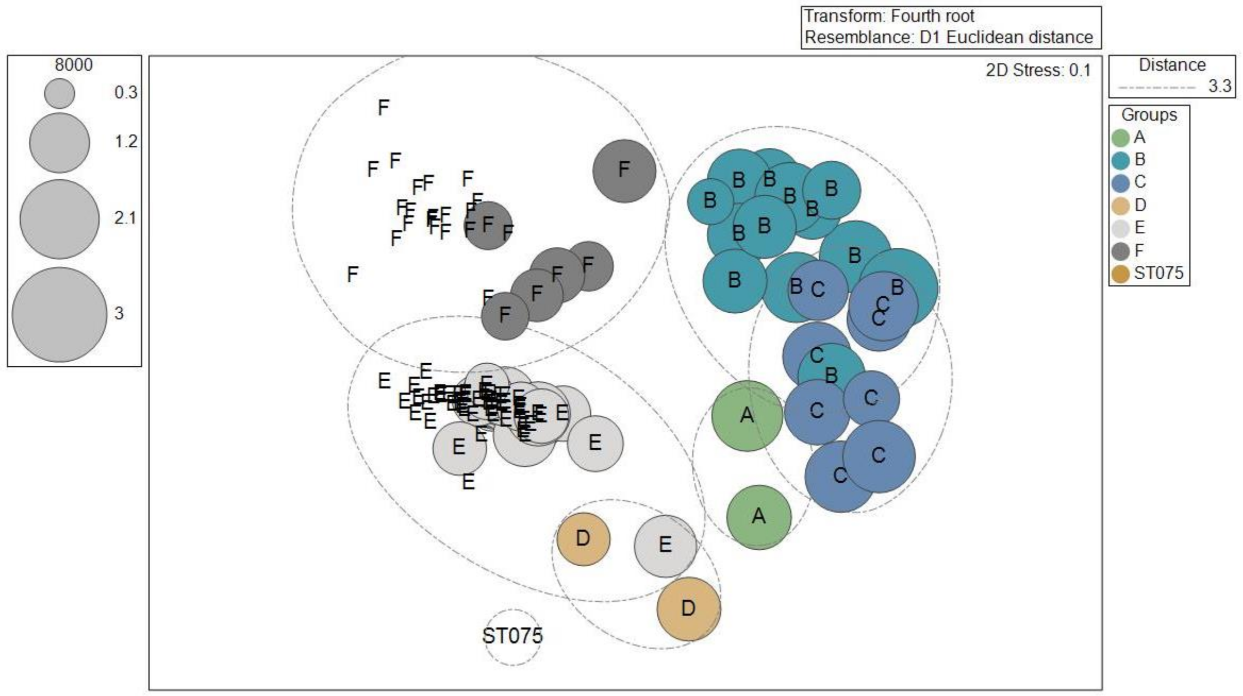
Notes
BSL = Below sea level
ECC = Export cable corridor
* = Contingency station
† = Description based on mean sorting value [µm]



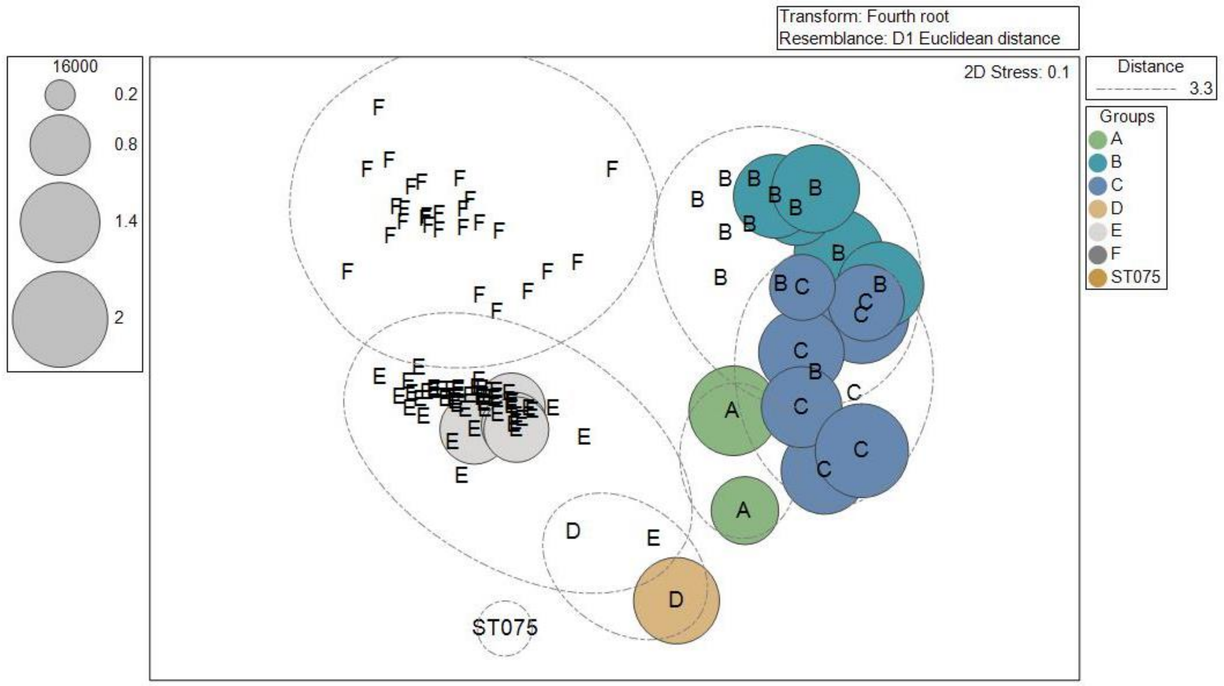
Notes
Circles proportional in diameter to the 125.00 µm sediment particle size (fine sand)



Notes
Circles proportional in diameter to the 707.11 µm sediment particle size (coarse sand)



Notes
Circles proportional in diameter to the 8000 µm sediment particle size (medium pebble)



Notes
Circles proportional in diameter to the 16 000 µm sediment particle size (coarse pebble)

Figure 4.40: nMDS ordination of hierarchical clustering analysis of PSD with superimposed circles proportional in diameter to percentage of particles driving the separation of groups, Dogger Bank D 2024

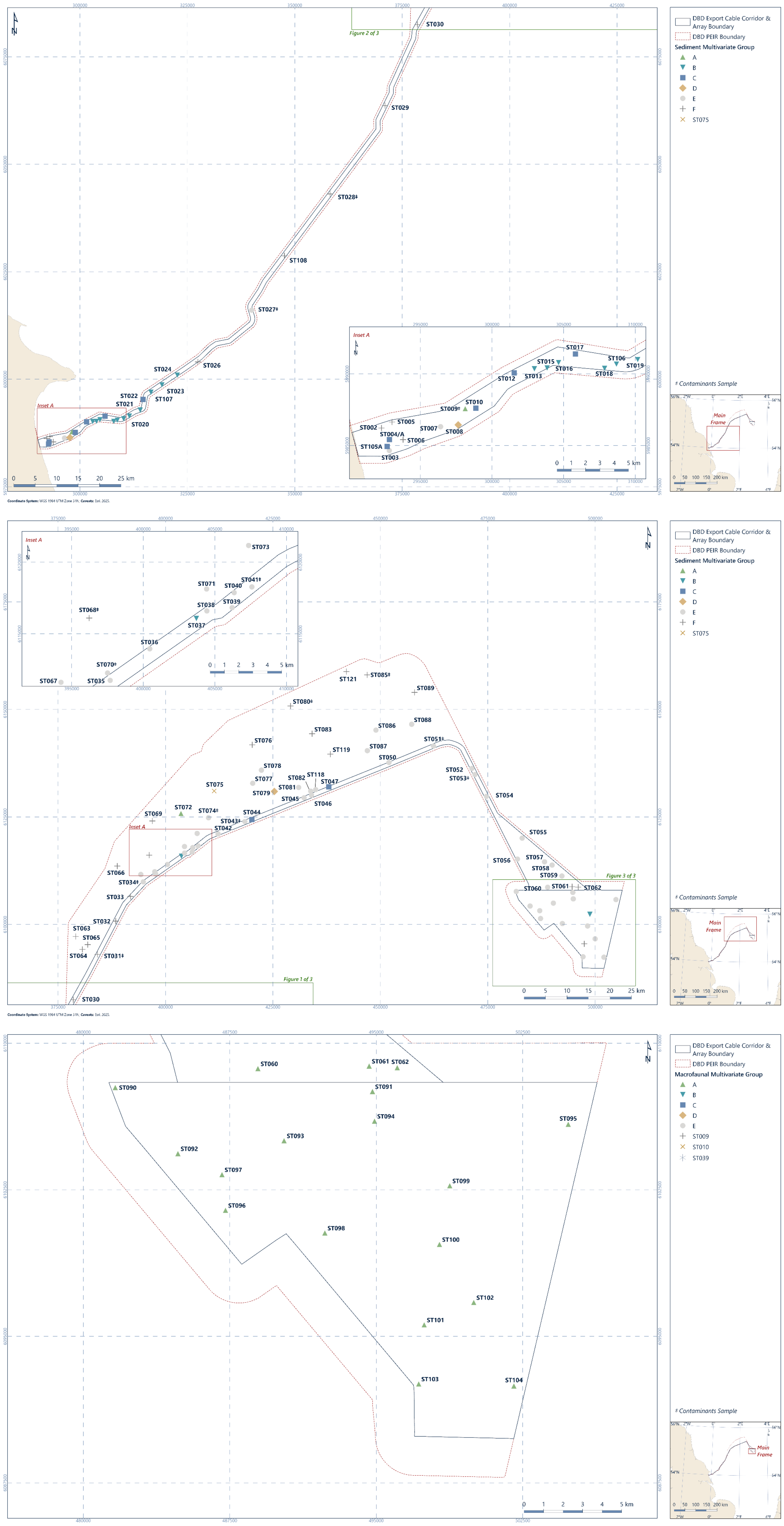


Figure 4.41: Spatial distribution of the sediment groups identified through the multivariate analysis, Dogger Bank D 2024

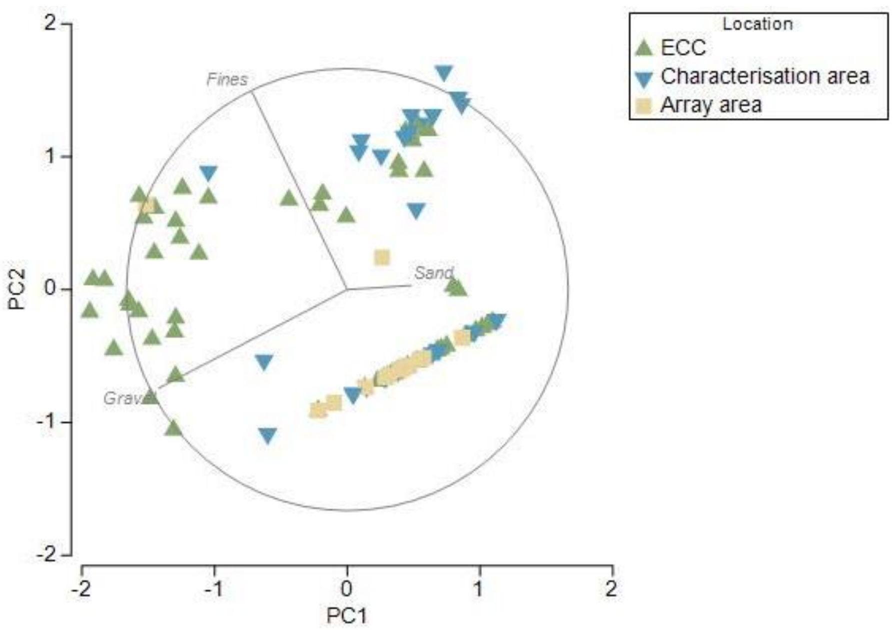
4.2.2.3 Principal Component Analysis (PCA)

The PCA was used on the main sediment fractions, namely gravel, sand and fines (mud) to highlight any variables influencing the sediment groups across the survey area. The PCA results also allowed visual representation of the association between sediment type, location, multivariate groups and depth. Data were fourth root transformed to reduce the degree of skewness and allow optimal performance of the multivariate analysis..

Results of the PCA indicated that the first two principal components accounted for 98.8 % of the variation (Table 4.28). Figure 4.42 illustrates the PCA results with superimposed the ECC, characterisation area and array, whereas Figure 4.43 illustrates the PCA results with superimposed depth range and the groups identified through the multivariate analysis. Both fines and gravel had a large negative loading on PC1, and fines had a large positive loading on PC2. Together the figures highlight the sediment heterogeneity across the survey area. There were no consistent patterns with depth and sediment composition.

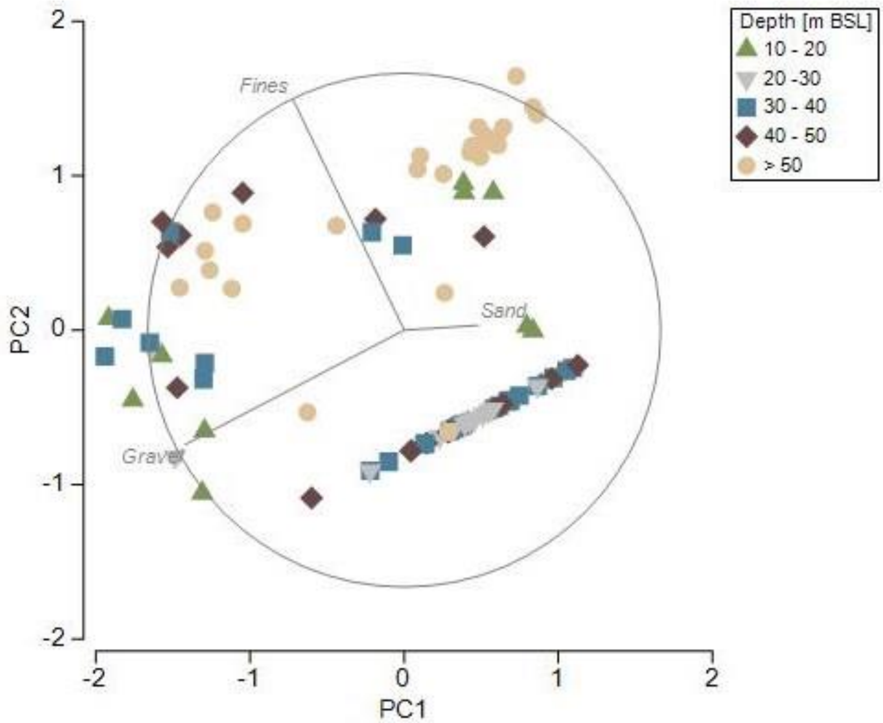
Table 4.28: Summary of PCA results, Dogger Bank D 2024

PC	Variation [%]	Cumulative Variation [%]
1	57.7	57.7
2	41.1	98.8
3	1.2	100.0

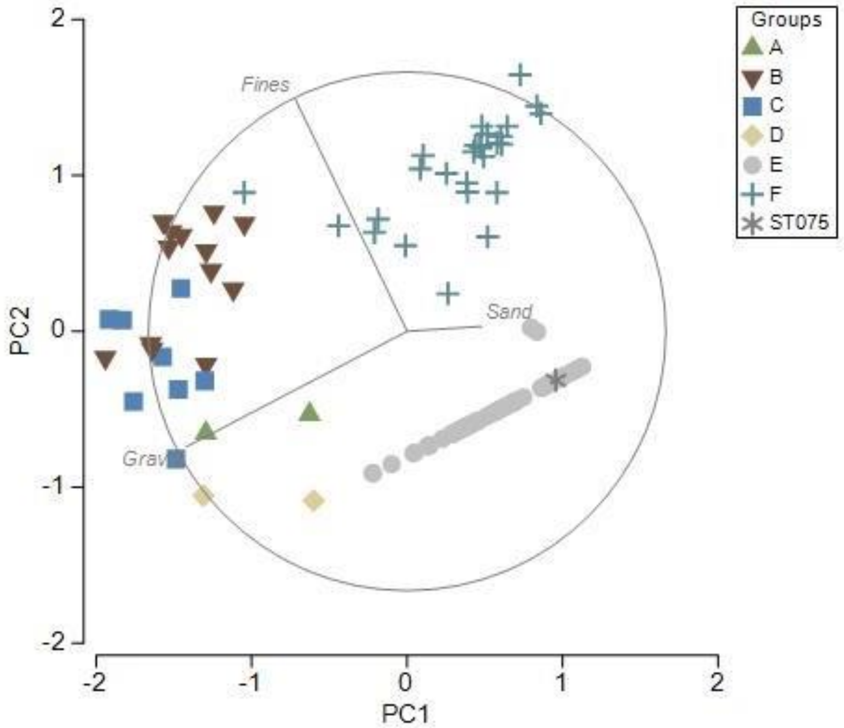


Notes
ECC = Export cable corridor PC = Principal component

Figure 4.42: 2D PCA of sediment composition with superimposed ECC, characterisation area and array, Dogger Bank D 2024



A



B

Notes
BSL = Below sea level PC = Principal component

Figure 4.43: 2D PCA of sediment composition with superimposed (A) depth range and (B) multivariate groups, Dogger Bank D 2024

4.2.3 Sediment Chemistry

Results of the sediment chemistry analysis were assessed in terms of descriptive statistics, including the relative standard deviation (RSD) to indicate the extent of variation in the dataset. Appendix E presents the analysis certificates.

4.2.3.1 Sediment Hydrocarbons

4.2.3.1.1 Total Hydrocarbon and Content (THC)

Table 4.29 presents the concentrations of THC reported from the surface sediment across the DBD survey area. The THC value was below the LOD (< 1 mg/kg) at all stations, except station ST009, which had a THC value of 21.2 mg/kg. All values were below the Cefas AL1 (100 mg/kg). Station ST009 was situated along the ECC and was characterised by 'sandy gravel' (Folk, BGS), with a water depth of 17.9 m.

Table 4.29: Summary of sediment hydrocarbon analysis, Dogger Bank D 2024

Station	THC
Export Cable Corridor	
ST009	21.2
ST027	< 1
ST028	< 1
ST031	< 1
ST034	< 1
ST041	< 1
ST043	< 1
ST051	< 1
ST053	< 1
Array Area	
ST093	< 1
Characterisation Area	
ST068	< 1
ST070	< 1
ST074	< 1
ST080	< 1
ST085	< 1
Minimum	**< 1**
Maximum	**21.2**
Cefas Guideline Action Levels	
AL1	**100**

Notes
Concentrations expressed in mg/kg
AL1 = Action Level 1
Cefas = Centre for Environmental Fisheries & Aquaculture Science
THC = Total hydrocarbon content

4.2.3.1.2 Sediment Polycyclic Aromatic Hydrocarbons (PAHs)

Table 4.30 presents the results of the PAHs and the marine SQGs (details in Section 1.5).

The total PAH concentrations were calculated as the sum of individual PAH concentrations. Some of the individual PAH concentrations were less than the LOD, and as such are unlikely to significantly influence the total 2 to 6 ring PAH concentrations. For this report, PAH concentrations less than the LOD have been treated as being equal to their respective LODs to calculate the total PAHs concentrations. Consequently, the total PAH concentrations where one or more analytes were < LOD resulted in a less than value.

Concentrations of all PAHs above the LOD were recorded at station ST009, specifically anthracene, benzo[a]anthracene and phenanthrene which had concentrations of 7.09 µg/kg, 20.0 µg/kg and 38.8 µg/kg, respectively and no values were above sediment guidelines.

C2-naphthalene concentrations above the LOD were recorded at all stations ranging from 1.41 µg/kg (station ST070 in the characterisation area) to 82.0 µg/kg (station ST009, along the ECC). Stations ST027, ST028 and ST031 along the ECC and ST080 and ST085 in the characterisation area had recorded concentrations of most of the PAHs above the LOD.

Station ST009 had the highest concentration of total PAHs and was located along the ECC. The lowest value of total PAHs was recorded at station ST070 in the characterisation area, where all PAHs, except the C2-naphthalenes had concentrations below their respective LODs.

All concentrations were below their respective Canadian SQGs including their respective TEL and PEL values.

Table 4.30: Summary of sediment polycyclic aromatic hydrocarbon analysis, Dogger Bank D 2024

Analyte	Station															CEMP (OSPAR, 2014)	NOAA (Long et al., 1995)	Canadian SQGs (CCME, 2024)	
	ST009	ST027	ST028	ST031	ST034	ST041	ST043	ST051	ST053	ST068	ST070	ST074	ST080	ST085	ST093				
Project Area	Export Cable Corridor									Characterisation Area					Array Area	ERL	ERM	TEL	PEL
Acenaphthene	3.51	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	–	500	6.71	88.9
Acenaphthylene	3.14	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	–	640	5.87	128
Anthracene	7.09	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1.57	< 1	85	1100	46.9	245
Benzo[a]anthracene	20.0	1.38	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1.52	1.88	< 1	261	1600	74.8	693
Benzo[a]pyrene	14.6	1.67	< 1	1.55	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2.04	2.39	< 1	430	1600	88.8	763
Benzo[b]fluoranthene	17.9	3.34	1.82	3.55	< 1	< 1	< 1	< 1	< 1	1.7	< 1	< 1	5.70	8.38	< 1	–	–	–	–
Benzo[e]pyrene	16.3	2.72	< 1	2.48	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	4.02	4.90	< 1	85	–	–	–
Benzo[ghi]perylene	14.4	3.35	2.54	4.42	< 1	< 1	< 1	< 1	< 1	1.96	< 1	< 1	7.93	9.83	< 1	–	–	–	–
Benzo[k]fluoranthene	14.1	2.14	1.55	2.76	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	4.56	6.48	< 1	–	–	–	–
C1-naphthalenes	70.3	25.6	1.88	5.01	< 1	< 1	< 1	< 1	< 1	1.59	< 1	< 1	2.76	4.54	< 1	155	–	–	–
C1-phenanthrene	53.2	8.81	1.42	2.28	< 1	< 1	1.57	< 1	< 1	< 1	< 1	< 1	3.76	4.06	< 1	170	–	–	–
C2-naphthalenes	82.0	21.2	2.38	7.25	1.58	1.81	2.05	1.99	3.47	2.60	1.41	1.74	5.08	5.68	2.19	150	–	–	–
C3-naphthalenes	91.5	16.9	< 1	3.85	< 1	< 1	1.62	< 1	< 1	< 1	< 1	< 1	3.35	3.41	< 1	–	–	–	–
Chrysene	24.6	2.75	< 1	1.86	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2.37	2.77	< 1	384	2800	108	846
Dibenzo[ah]anthracene	3.23	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	–	260	6.22	135
Fluoranthene	36.9	3.04	< 1	2.51	< 1	< 1	< 1	< 1	< 1	1.43	< 1	< 1	3.52	5.25	< 1	600	5100	113	1494
Fluorene	4.30	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	–	540	21.2	144
Indeno[1,2,3-cd]pyrene	9.06	2.53	2.38	4.09	< 1	< 1	< 1	< 1	< 1	2.11	< 1	< 1	8.98	9.76	< 1	240	–	–	–
Naphthalene	16.5	7.79	< 1	2.29	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1.80	2.33	< 1	160	2100	34.6	391
Perylene	3.32	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	–	–	–	–
Phenanthrene	38.8	7.76	< 1	2.33	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2.45	3.45	< 1	240	1500	86.7	544
Pyrene	32.0	2.71	< 1	1.99	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	2.64	4.40	< 1	665	2600	153	1398
Total	576	< 120	< 29.0	< 55.2	< 22.6	< 22.8	< 24.2	< 23.0	< 24.5	< 27.4	< 22.4	< 22.7	< 68.5	< 86.1	< 23.2	–	–	–	–

Notes

Concentrations expressed in µg/kg dry sediment
ERL = Effects range low
OSPAR = Oslo and Paris Commission
TEL = Threshold Effects Level
AA = Array area
CA = Characterisation area
ECC = Export cable corridor
CCME = Canadian Council of Ministers of the Environment
ERM = Effects range median
PEL = Probable Effects Level
CEMP = Coordinated Environmental Monitoring Programme
NOAA = National Oceanic and Atmospheric Administration
SQG = Sediment quality guidelines
Effects ranges were developed for NOAA to evaluate the potential toxicological effects of a concentration of a contaminant in sediment; some ERLs are adopted by OSPAR CSEMP for the assessment of monitoring data of hazardous substances in the environment

4.2.3.2 Sediment Metals

Table 4.31 summarises the concentrations of the extractable metals in the sediment samples. Figure 4.44 illustrates the spatial distribution of arsenic along the ECC and in the array.

Metals concentrations were lower than the environmental quality standards (Cefas ALs, OSPAR ERLs, NOAA ERMs and Canadian SQGs) for all metals except arsenic.

Arsenic concentrations above the Canadian SQGs TEL (7.24 mg/kg) were recorded at four stations in the characterisation area (ST070, ST074, ST080, and ST085) and one station in the array area (ST093). Arsenic concentrations were below the Cefas AL1 and AL2 values at all stations. The concentration of arsenic at these stations ranged from 9.00 mg/kg at station ST085 to 11.7 mg/kg at station ST080.

All metals had moderate to high variation, with the highest variation for metal concentrations recorded for mercury, which had an RSD of 102 %. Mercury concentrations ranged from < 0.01 mg/kg (five stations in the ECC and one in the characterisation area) to 0.07 mg/kg (station ST074 in the characterisation area) with a mean of 0.02 mg/kg and a median of 0.01 mg/kg.

The lowest variation was recorded for chromium, which had an RSD of 30 % and concentrations ranging from 6.80 mg/kg to 18.6 mg/kg, with a mean of 9.81 mg/kg and a median of 8.80 mg/kg.

Table 4.31: Summary of sediment metals analysis, Dogger Bank D 2024

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Sn	Zn
Export Cable Corridor									
ST009	5.20	< 0.04	8.80	3.30	< 0.01	4.30	4.80	< 0.5	14.0
ST027	4.90	< 0.04	8.70	2.90	0.01	4.10	4.30	< 0.5	13.0
ST028	5.00	< 0.04	9.30	2.90	0.01	3.90	4.10	< 0.5	12.0
ST031	5.80	< 0.04	10.1	2.40	< 0.01	4.10	4.50	< 0.5	13.2
ST034	5.60	< 0.04	9.20	2.20	0.01	3.80	4.60	< 0.5	12.2
ST041	5.50	< 0.04	8.10	1.90	0.04	3.40	4.20	< 0.5	11.9
ST043	5.00	< 0.04	8.30	1.80	< 0.01	3.10	3.50	< 0.5	10.4
ST051	5.30	< 0.04	8.20	2.10	< 0.01	3.30	4.20	< 0.5	10.8
ST053	5.30	< 0.04	7.60	1.90	< 0.01	3.10	4.00	< 0.5	9.90
Array Area									
ST093	11.3	< 0.04	8.10	1.80	0.02	6.70	6.40	< 0.5	20.8
Characterisation Area									
ST068	5.30	< 0.04	10.7	3.40	< 0.01	4.50	4.60	< 0.5	12.0
ST070	10.7	0.08	13.7	4.60	0.06	10.1	16.0	0.6	35.7
ST074	10.7	0.10	18.6	8.00	0.07	15.0	28.4	0.9	56.3
ST080	11.7	< 0.04	6.80	2.20	0.03	6.10	8.40	< 0.5	21.9
ST085	9.00	0.04	11.0	4.40	0.04	9.20	12.3	< 0.5	29.2
Minimum	**4.90**	**< 0.04**	**6.80**	**1.80**	**0.01**	**3.10**	**3.50**	**< 0.5**	**9.90**
Maximum	**11.7**	**0.10**	**18.6**	**8.00**	**0.07**	**15.0**	**28.40**	**0.90**	**56.3**
Median	**5.50**	**–**	**8.80**	**2.40**	**0.01**	**4.10**	**4.60**	**–**	**13.0**
Mean	**7.09**	**–**	**9.81**	**3.05**	**0.02**	**5.65**	**7.62**	**–**	**18.9**
Standard Deviation	**2.70**	**–**	**2.95**	**1.64**	**0.022**	**3.37**	**6.76**	**–**	**12.8**
RSD	**38**	**–**	**30**	**54**	**102**	**60**	**89**	**–**	**68**
Cefas Guideline Action Levels									
AL1	**20**	**0.4**	**40**	**40**	**0.3**	**20**	**50**	**–**	**130**
AL2	**100**	**5**	**400**	**400**	**3**	**200**	**500**	**–**	**800**
CEMP Assessment Criteria (OSPAR, 2014)									
ERL	**-**	**1.20**	**81.0**	**34.0**	**0.150**	**–**	**47.0**	**–**	**150**
NOAA Effects Ranges (Long et al., 1995)									
ERM	**70**	**9.6**	**370**	**270**	**0.71**	**51.6**	**218**	**–**	**410**
Canadian SQGs (CCME, 2024)									
TEL	**7.24**	**0.7**	**52.3**	**18.7**	**0.13**	**–**	**30.2**	**–**	**124**
PEL	**41.6**	**4.2**	**160**	**108**	**0.70**	**–**	**112**	**–**	**271**

Notes
Concentrations expressed in mg/kg dry sediment
Cefas actions levels available at https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans
For datasets with less than 50 % values below the limit of detection (LOD) these have been treated as equal to ½ the value of LOD to derive the summary statistics
As = Arsenic Cd = Cadmium Cr = Chromium Cu = Copper Hg = Mercury
Ni = Nickel Pb = Lead Sn = Tin Zn = Zinc
AL1 = Action level 1 AL2 = Action level 2 ERL = Effects range low ERM = Effects range median
TEL = Threshold effects level PEL = Probable effects level Cefas = Centre for Environment, Fisheries and Aquaculture Science
CEMP = Coordinated Environmental Monitoring Programme OSPAR = Oslo and Paris Commission
NOAA = National Oceanic and Atmospheric Administration SQGs = Sediment quality guidelines RSD = Relative Standard Deviation

Key	Below Cefas AL1	Above Cefas AL1	Above Cefas AL2

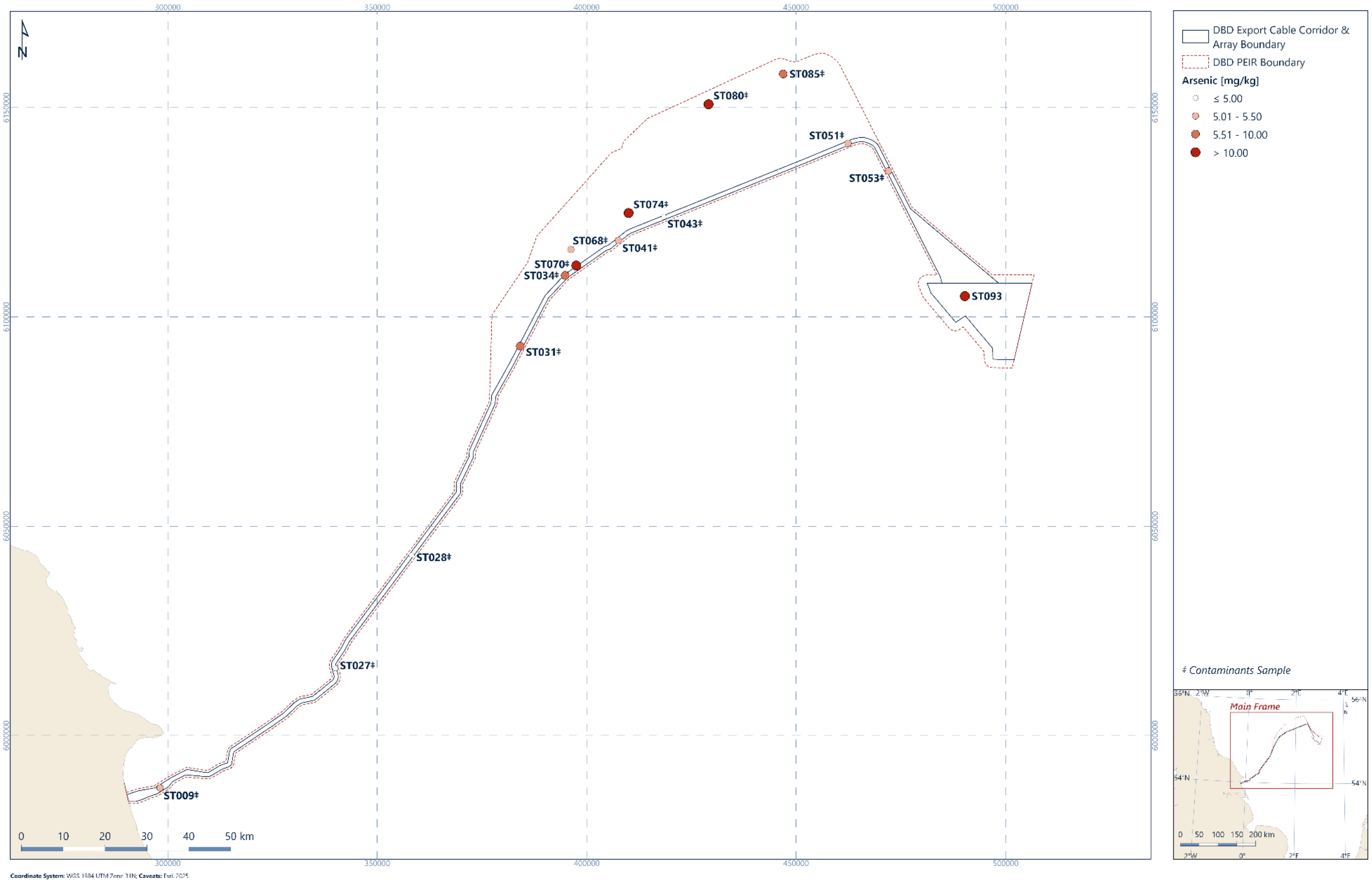


Figure 4.44: Spatial variations of arsenic concentrations, Dogger Bank D 2024

4.2.3.3 Sediment Polychlorinated Biphenyls

Table 4.32 summarises the concentrations of PCBs in the sediment samples. The concentrations of the individual PCB congeners analysed were below the LOD (< 0.00008 mg/kg) at all stations. For this report, PCB concentrations less than LOD have been treated as being equal to their respective LODs when calculating the total PCB concentrations. Consequently, the total PCB concentrations resulted in a less than value. The sum of the 25 congeners was < 0.00200 mg/kg for all stations, which is below the Cefas AL1 (0.02 mg/kg) and AL2 (0.2 mg/kg).

Table 4.32: Summary of polychlorinated biphenyls (PCBs) analysis, Dogger Bank D 2024

Station	PCB 101	PCB 105	PCB 110	PCB 118	PCB 128	PCB 138	PCB 141	PCB 149	PCB 151	PCB 153	PCB 156	PCB 158	PCB 170
Export Cable Corridor													
ST009	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST027	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST028	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST031	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST034	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST041	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST043	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST051	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST053	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Array Area													
ST093	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
Characterisation Area													
ST068	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST070	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST074	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST080	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
ST085	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008
CEFAS Guidelines Action Levels													
AL1	–	–	–	–	–	–	–	–	–	–	–	–	–
AL2	–	–	–	–	–	–	–	–	–	–	–	–	–

Stations	PCB 18	PCB 180	PCB 183	PCB 187	PCB 194	PCB 28	PCB 31	PCB 44	PCB 47	PCB 49	PCB 52	PCB 66	Total
Export Cable Corridor													
ST009	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST027	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST028	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST031	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST034	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST041	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST043	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST051	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST053	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
Array Area													
ST093	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
Characterisation Area													
ST068	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST070	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST074	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST080	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST085	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
ST093	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	< 0.00008	**< 0.00200**
CEFAS Guidelines Action Levels													
AL1	–	–	–	–	–	–	–	–	–	–	–	–	**0.02**
AL2	–	–	–	–	–	–	–	–	–	–	–	–	**0.2**

Notes
AL1 = Action Level 1
AL2 = Action Level 2
ECC = Export cable corridor
Concentrations expressed as mg/kg dry weight
Cefas = Centre for Environment, Fisheries and Aquaculture Science
Cefas action levels available at https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans

4.2.3.4 Sediment Organotins

Table 4.33 summarises the concentrations of organotins in the sediment samples. The organotins analysed were dibutyltin (DBT) and tributyltin (TBT), the concentrations of which were below the LODs (< 0.001 mg/kg or < 0.005 mg/kg) and below the Cefas AL1 (0.1 mg/kg) and AL2 (1 mg/kg) across the entire DBD survey area.

Table 4.33: Summary of organotins analysis, Dogger Bank D 2024

Station	Dibutyltin (DBT)	Tributyltin (TBT)
Export Cable Corridor		
ST009	< 0.001	< 0.001
ST027	< 0.001	< 0.001
ST028	< 0.001	< 0.001
ST031	< 0.005	< 0.005
ST034	< 0.001	< 0.001
ST041	< 0.001	< 0.001
ST043	< 0.001	< 0.001
ST051	< 0.001	< 0.001
ST053	< 0.005	< 0.005
Array Area		
ST093	< 0.001	< 0.001
Characterisation Area		
ST068	< 0.005	< 0.005
ST070	< 0.005	< 0.005
ST074	< 0.005	< 0.005
ST080	< 0.005	< 0.005
ST085	< 0.005	< 0.005
AL1	**0.1**	**0.1**
AL2	**1**	**1**

Notes
Concentrations expressed in mg/kg
ECC = Export cable corridor
AL1 = Action Level 1
AL2 = Action Level 2
Cefas = Centre for Environmental Fisheries & Aquaculture Science
Cefas action levels available at https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans

4.2.4 Sediment Macrofauna

The macrofauna from the grab samples included infauna and epifauna, the latter comprising solitary and colonial organisms. The infauna and solitary epifauna were enumerated and were analysed together in terms of phyletic composition, species diversity, abundance and distribution. The colonial epifauna, recorded as present (P), was removed from the enumerated dataset and assessed for taxa composition and distribution (detailed in Section 4.5.2). Appendix F presents the full species list.

4.2.4.1 Infaunal and Solitary Epifauna from the Grab Samples

4.2.4.1.1 Phyletic Composition

Following rationalisation (details in Section 3.2.6), the enumerated macrofaunal dataset comprised 290 taxa and 6948 individuals (Table 4.34). The excluded taxa comprised juveniles, meiofauna, pelagic taxa, damaged fauna and fish. Fish were represented by *Ammodytes marinus*, *Callionymus reticulatus* and *Merluccius merluccius* as well as taxa of the family Gobiidae and taxa of the superclass Osteichthyes. In addition, two species of *Leiochone* and two species of *Cheirocratus* were aggregated to their respective genera.

Juveniles comprised 55 taxa and 1773 individuals, of which echinoderms of the family Amphiuridae with 482 individuals were numerically dominant, followed by bivalves of the family Anomiidae with 210 individuals, chordates of the class Ascidiacea and echinoderms of the class Ophiuroidea with 189 and 177 individuals, respectively.

Table 4.34 summarises the phyletic composition of the enumerated fauna from the grab samples. Figures 4.13 and 4.14illustrate the phyletic composition of taxa and individuals of the enumerated macrofauna along the ECC, the characterisation area, and the array, respectively.

Table 4.34: Taxonomic groups of enumerated fauna from the grab samples

Taxonomic group	Number of Taxa	Composition of Taxa [%]	Abundance	Composition of Individuals [%]
Annelida	130	44.8	3754	54.0
Arthropoda	81	27.9	1234	17.8
Mollusca	55	19.0	1138	16.4
Echinodermata	13	4.5	274	3.9
Other phyla	11	3.8	548	7.9
Total	**290**	**100**	**6948**	**100**

Notes
Macrofaunal samples were processed through a 1 mm mesh sieve
Other phyla included: Chordata, Cnidaria, Foraminifera, Hemichordata, Nemertea, Phoronida and Platyhelminthes

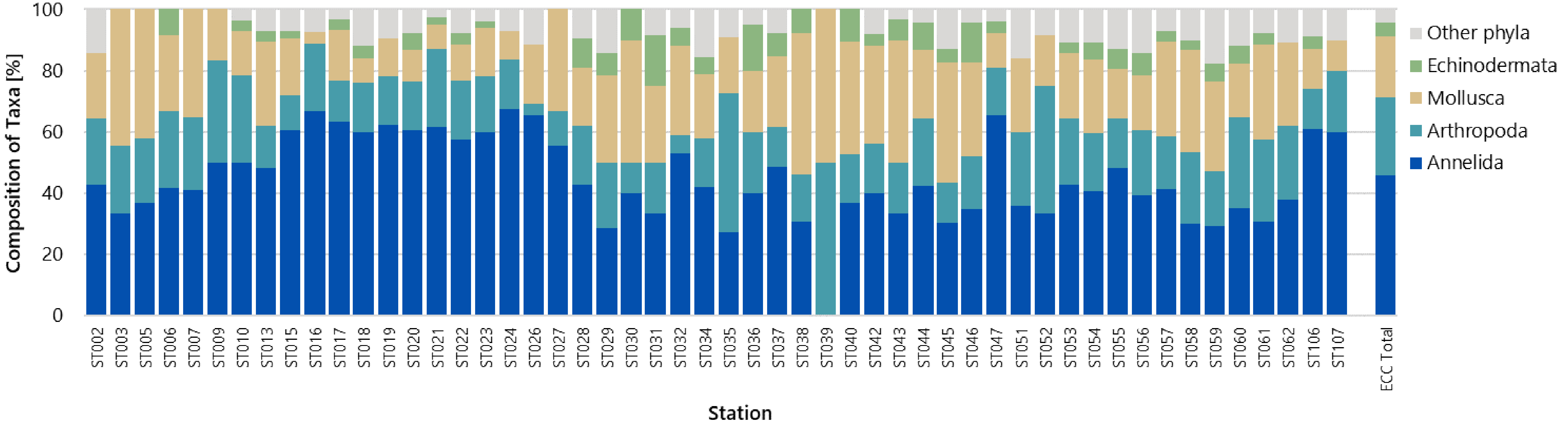
Annelida comprised most of the enumerated taxa composition (44.8 %), followed by Arthropoda (27.9 %), Mollusca (19.0 %), and Echinodermata (4.5 %). Other phyla comprised

3.8 % of the enumerated taxa and were represented by Chordata (*Branchiostoma lanceolatum* and *Dendrodoa grossularia)*, Cnidaria (*Virgularia mirabilis*, species of the orders Actiniaria and Ceriantharia, and the family Edwardsiidae), Foraminifera (*Astrorhiza*), Hemichordata (Enteropneusta), Nemertea, Phoronida and Platyhelminthes.

When assessed on a station basis, Annelida were dominant in terms of taxa composition at most stations across the entire DBD survey area. Mollusca comprised most of the enumerated taxa at six stations along the ECC and five stations in the characterisation area, whereas Arthropoda had the highest number of taxa at three stations along the ECC and five stations within the array. Equal dominance of the number of phyla occurred between Annelids and Molluscs at five stations along the ECC and four stations in the characterisation area, between Annelids and Arthropods at station ST097 in the array and between Arthropods and Molluscs at station ST039 along the ECC.

Annelida comprised most of the enumerated macrofaunal abundance (54.0 %), followed by Arthropoda (17.8 %), Mollusca (16.4 %), and Echinodermata (3.9 %), whereas other phyla comprised 7.9 % of the enumerated macrofaunal abundance.

When assessed on a station basis, Annelida were numerically dominant at most stations across the entire DBD survey area. Mollusca had highest abundances at 10 stations along the ECC, at 4 stations in the characterisation area and at station ST102 in the array, Arthropoda had highest abundances at 5 stations along the ECC, station ST074 in the characterisation area and station ST099 in the array. Equal abundance of phyla occurred between Annelids and Molluscs at stations ST030 along the ECC, 3 stations in the characterisation area and station ST103 in the array and between Arthropods and Molluscs at station ST039.



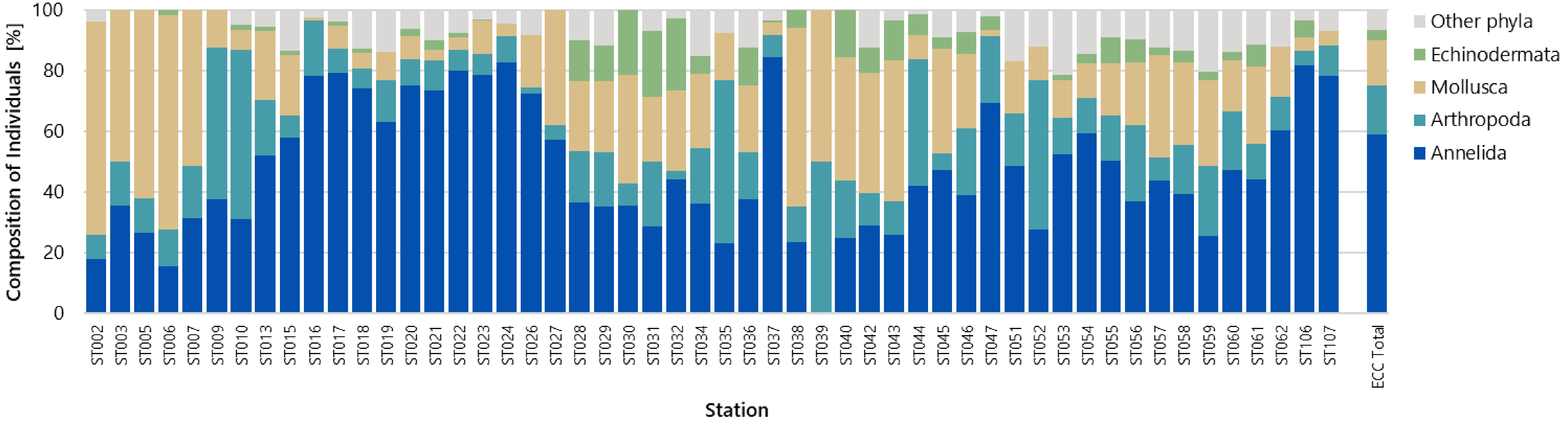


Figure 4.45: Phyletic composition of enumerated macrofaunal taxa and individuals from the grab samples, export cable corridor (ECC) Dogger Bank D 2024

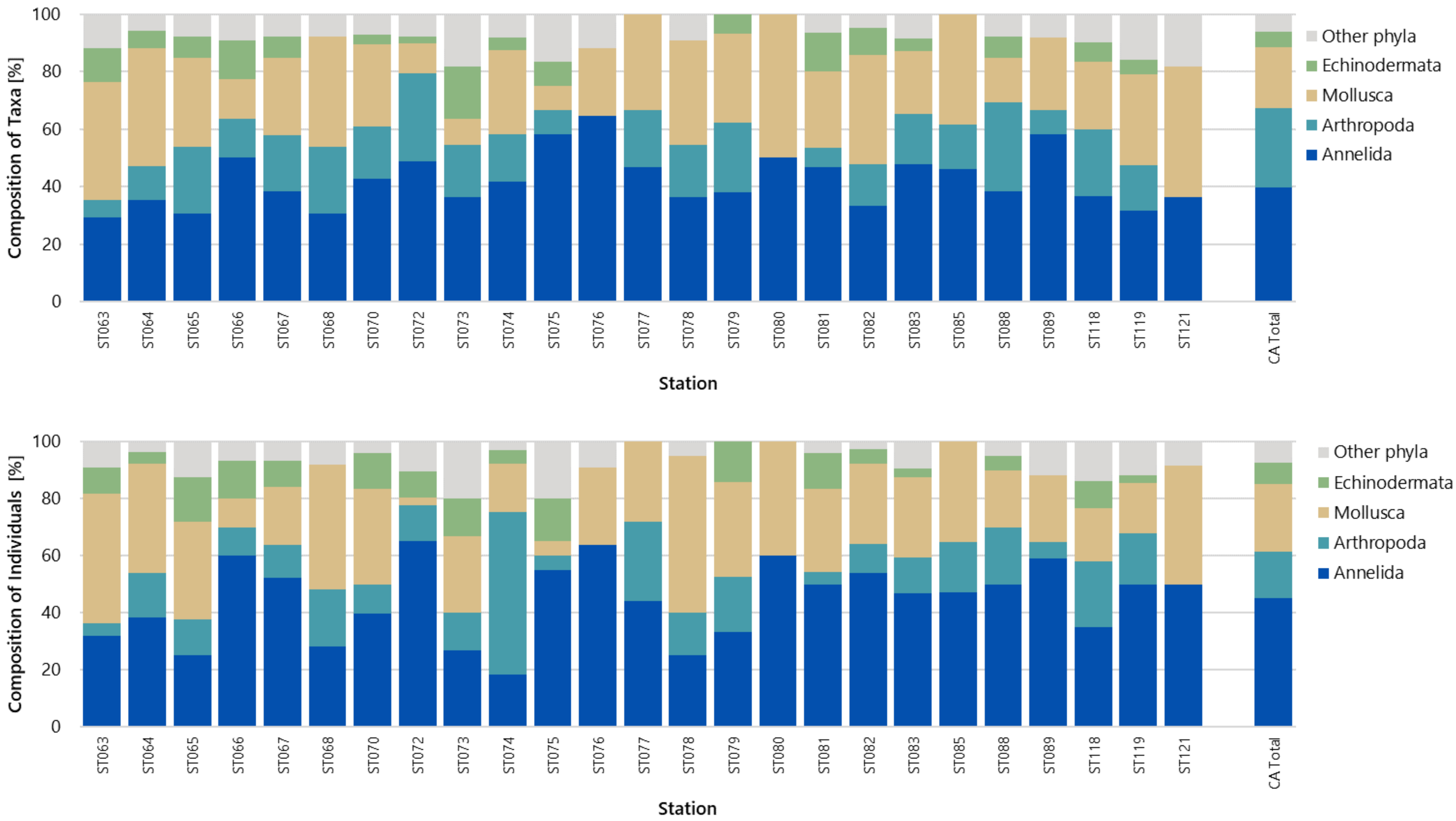


Figure 4.46: Phyletic composition of enumerated macrofaunal taxa and individuals from the grab samples, characterisation area (CA) Dogger Bank D 2024

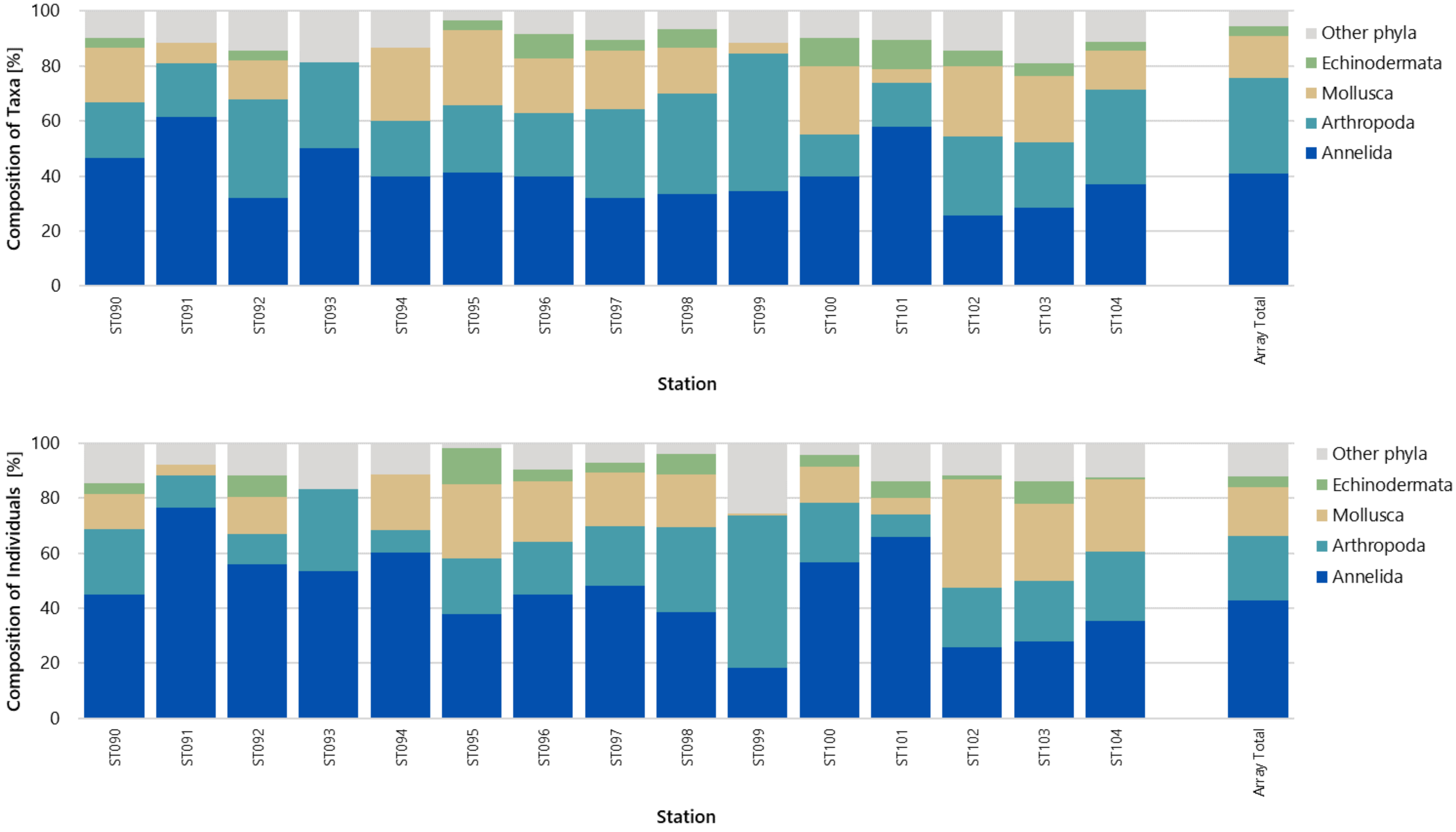


Figure 4.47: Phyletic composition of enumerated macrofaunal taxa and individuals from the grab samples, array Dogger Bank D 2024

4.2.4.1.2 Community Statistics

Table 4.35 presents the results of the univariate analysis of the enumerated macrofaunal dataset.

Figures 4.48 and 4.49 illustrate the spatial distribution of the number of taxa along the ECC, characterisation area and in the array, respectively.

Figures 4.50 and 4.51illustrate the spatial distribution of the number of individuals along the ECC, characterisation area and in the array, respectively.

The number of taxa ranged from 6 at stations ST009 and ST039 to 60 at station ST107, with a mean of 24 and a median of 23. The number of individuals ranged from 6 at station ST039 to 552 at station ST044, with a mean of 75 and a median of 48.

Values of richness reflected the number of individuals per taxa recorded, with values ranging from 2.40 at station ST009 to 10.2 at station ST107, with a mean of 5.57 and a median of 5.53.

The Shannon-Wiener Diversity, assessed in line with the Dauvin et al. (2012) criteria (details in Section 3.2.6), was:

- high (H'Log_2 > 4.00) at 41 stations;
- good (H'Log_2 of 3.00 to 4.00) at 45 stations;
- moderate (H'Log_2 of 2.00 to 3.00) at 7 stations;

The mean diversity across the DBD survey area, with a value of 3.87 was good.

The evenness ranged from 0.642 at station ST099 to 1.000 station ST039, with a mean of 0.880 and a median of 0.911. The value of evenness at station ST039 was associated with equal numbers of taxa and individuals (6 taxa and 6 individuals). The value of evenness at station ST099 was associated with the low number of taxa (26), in relation to the number of individuals (163), of which the arthropod *Upogebia deltaura,* with 71 individuals was the most abundant.

In general, values of dominance were generally low owing to the generally high values of evenness.

Table 4.35: Community statistics of enumerated fauna from the grab samples (0.1 m^2) Dogger Bank D 2024

Station	Numbers		Richness	Diversity	Evenness	Dominance
	Taxa	Individuals	Margalef [d]	Shannon-Wiener [H'Log$_2$]	Pielou [J']	Simpson [λ]
Export Cable Corridor						
ST002	14	50	3.32	2.50	0.656	0.335
ST003	9	14	3.03	2.99	0.942	0.143
ST005	19	79	4.12	3.16	0.743	0.183
ST006	12	58	2.71	2.35	0.657	0.348
ST007	17	35	4.50	3.86	0.945	0.079
ST009	6	8	2.40	2.41	0.931	0.219
ST010	28	61	6.57	3.92	0.816	0.139
ST013	29	71	6.57	4.53	0.932	0.052
ST015	43	95	9.22	4.94	0.911	0.046
ST016	27	82	5.90	3.94	0.828	0.097
ST017	30	77	6.68	3.98	0.810	0.115
ST018	25	77	5.53	3.77	0.813	0.115
ST019	32	87	6.94	4.35	0.869	0.069
ST020	38	93	8.16	4.34	0.828	0.109
ST021	39	120	7.94	4.30	0.814	0.103
ST022	52	220	9.46	4.56	0.800	0.078
ST023	50	163	9.62	4.85	0.860	0.051
ST024	43	192	7.99	4.25	0.783	0.099
ST026	26	47	6.49	4.39	0.934	0.059
ST027	9	21	2.63	2.89	0.911	0.156
ST028	21	30	5.88	4.23	0.963	0.060
ST029	14	17	4.59	3.73	0.981	0.080
ST030	10	14	3.41	3.18	0.958	0.122
ST031	12	14	4.17	3.52	0.982	0.092
ST032	17	34	4.54	3.75	0.917	0.099
ST034	19	33	5.15	4.09	0.963	0.065
ST035	11	13	3.90	3.39	0.981	0.101
ST036	20	32	5.48	4.12	0.953	0.066
ST037	39	458	6.20	3.44	0.650	0.167
ST038	13	17	4.24	3.50	0.946	0.107
ST039	6	6	2.79	2.58	1.000	0.167
ST040	19	32	5.19	4.02	0.945	0.072
ST042	25	48	6.20	4.33	0.932	0.061
ST043	30	54	7.27	4.59	0.935	0.052
ST044	45	552	6.97	3.98	0.725	0.107
ST045	23	55	5.49	4.21	0.931	0.068
ST046	23	41	5.92	4.15	0.917	0.074
ST047	26	221	4.63	3.57	0.760	0.136
ST051	25	41	6.46	4.47	0.963	0.051
ST052	24	65	5.51	3.99	0.870	0.098
ST053	28	65	6.47	4.26	0.886	0.071
ST054	37	152	7.17	4.24	0.813	0.112
ST055	31	141	6.06	3.86	0.780	0.132
ST056	28	132	5.53	3.94	0.819	0.100
ST057	29	80	6.39	4.30	0.884	0.074
ST058	30	81	6.60	4.37	0.891	0.068
ST059	17	39	4.37	3.70	0.905	0.094
ST060	17	36	4.46	3.61	0.884	0.113
ST061	26	70	5.88	4.30	0.914	0.067
ST062	37	98	7.85	4.19	0.805	0.115
ST106*	23	88	4.91	3.42	0.757	0.185
ST107*	60	328	10.2	4.92	0.834	0.055

Station	Numbers		Richness	Diversity	Evenness	Dominance
	Taxa	Individuals	Margalef [d]	Shannon-Wiener [H'Log2]	Pielou [J']	Simpson [λ]
ST108*	17	31	4.66	3.81	0.931	0.086
Array Area						
ST090	30	102	6.27	4.05	0.826	0.098
ST091	26	51	6.36	4.01	0.853	0.120
ST092	28	127	5.57	3.96	0.824	0.103
ST093	16	30	4.41	3.67	0.918	0.098
ST094	30	88	6.48	3.67	0.748	0.186
ST095	29	100	6.08	4.17	0.859	0.079
ST096	35	145	6.83	4.28	0.834	0.088
ST097	28	83	6.11	4.20	0.873	0.080
ST098	30	52	7.34	4.57	0.932	0.053
ST099	26	163	4.91	3.02	0.642	0.239
ST100	20	46	4.96	3.79	0.876	0.100
ST101	19	50	4.60	3.48	0.820	0.152
ST102	35	120	7.10	4.15	0.808	0.100
ST103	21	36	5.58	4.13	0.940	0.068
ST104	35	127	7.02	4.16	0.811	0.093
Characterisation Area						
ST063	17	22	5.18	3.94	0.963	0.074
ST064	17	26	4.91	3.89	0.952	0.077
ST065	13	32	3.46	3.44	0.929	0.105
ST066	22	30	6.17	4.32	0.969	0.056
ST067	26	44	6.61	4.32	0.920	0.072
ST068	13	25	3.73	3.48	0.940	0.104
ST070	28	48	6.97	4.50	0.937	0.056
ST072	39	143	7.66	4.13	0.781	0.119
ST073	11	15	3.69	3.24	0.937	0.129
ST074	24	65	5.51	3.32	0.725	0.230
ST075	12	20	3.67	3.45	0.961	0.100
ST076	17	22	5.18	4.00	0.980	0.066
ST077	15	25	4.35	3.64	0.931	0.098
ST078	11	20	3.34	3.28	0.949	0.115
ST079	29	63	6.76	4.35	0.896	0.066
ST080	8	10	3.04	2.85	0.949	0.160
ST081	15	24	4.41	3.69	0.944	0.090
ST082	21	39	5.46	3.93	0.894	0.093
ST083	23	32	6.35	4.35	0.962	0.057
ST085	13	17	4.24	3.62	0.977	0.087
ST088	13	20	4.01	3.31	0.894	0.140
ST089	12	17	3.88	3.45	0.964	0.100
ST118*	30	43	7.71	4.72	0.962	0.044
ST119*	19	34	5.10	3.87	0.912	0.092
ST121*	11	24	3.15	3.05	0.883	0.163
Minimum	6	6	2.40	2.35	0.642	0.044
Maximum	60	552	10.2	4.94	1.000	0.348
Median	23	48	5.53	3.94	0.911	0.098
Mean	24	75	5.57	3.87	0.880	0.106
Standard Deviation	10.7	84.7	1.64	0.549	0.0839	0.0538

Notes
* = Contingency station
ECC = Export Cable Corridor
CA = Characterisation Area

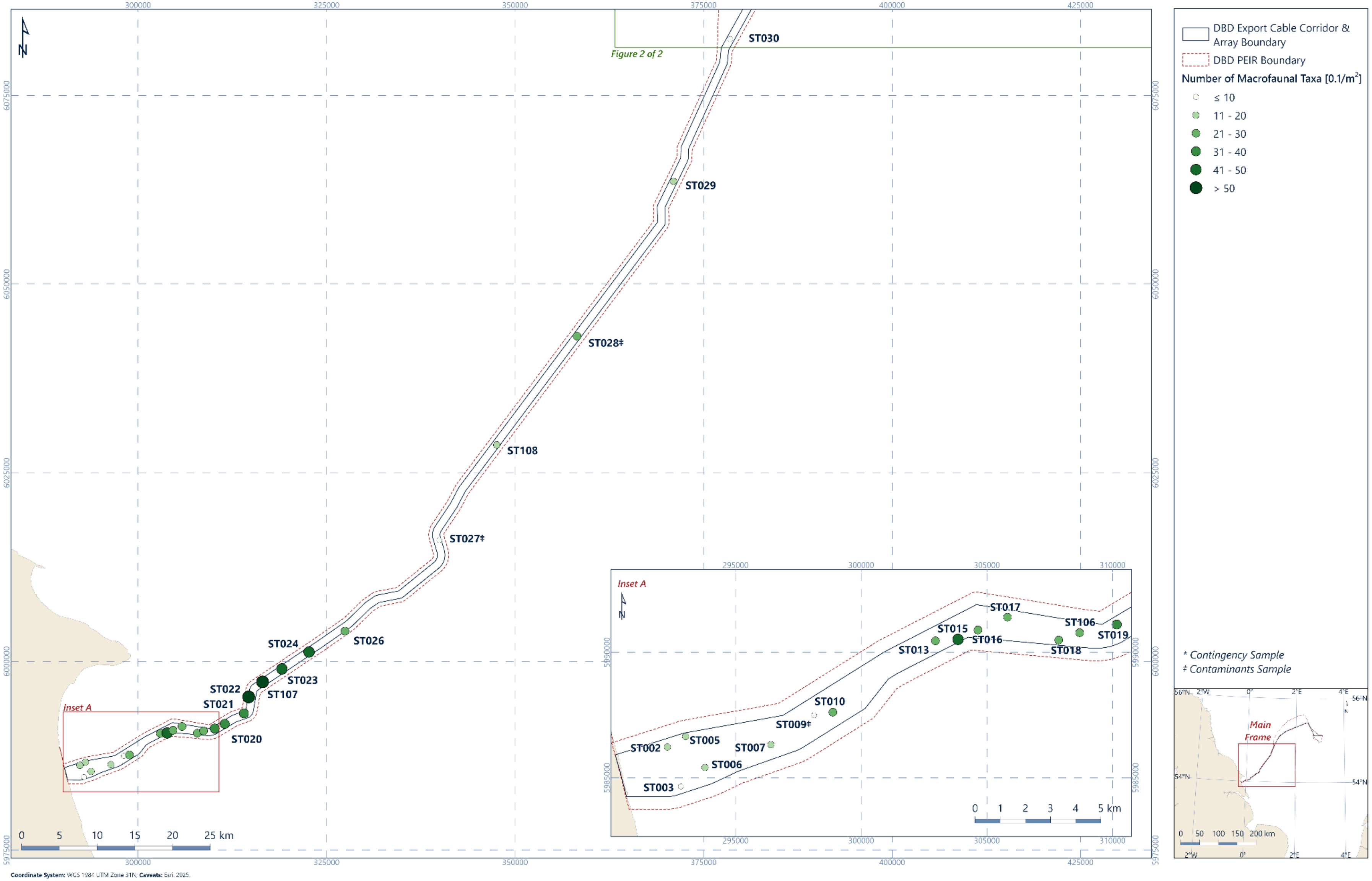


Figure 4.48: Spatial variations of the number of taxa (0.1 m^2), nearshore section of export cable corridor, Dogger Bank D 2024

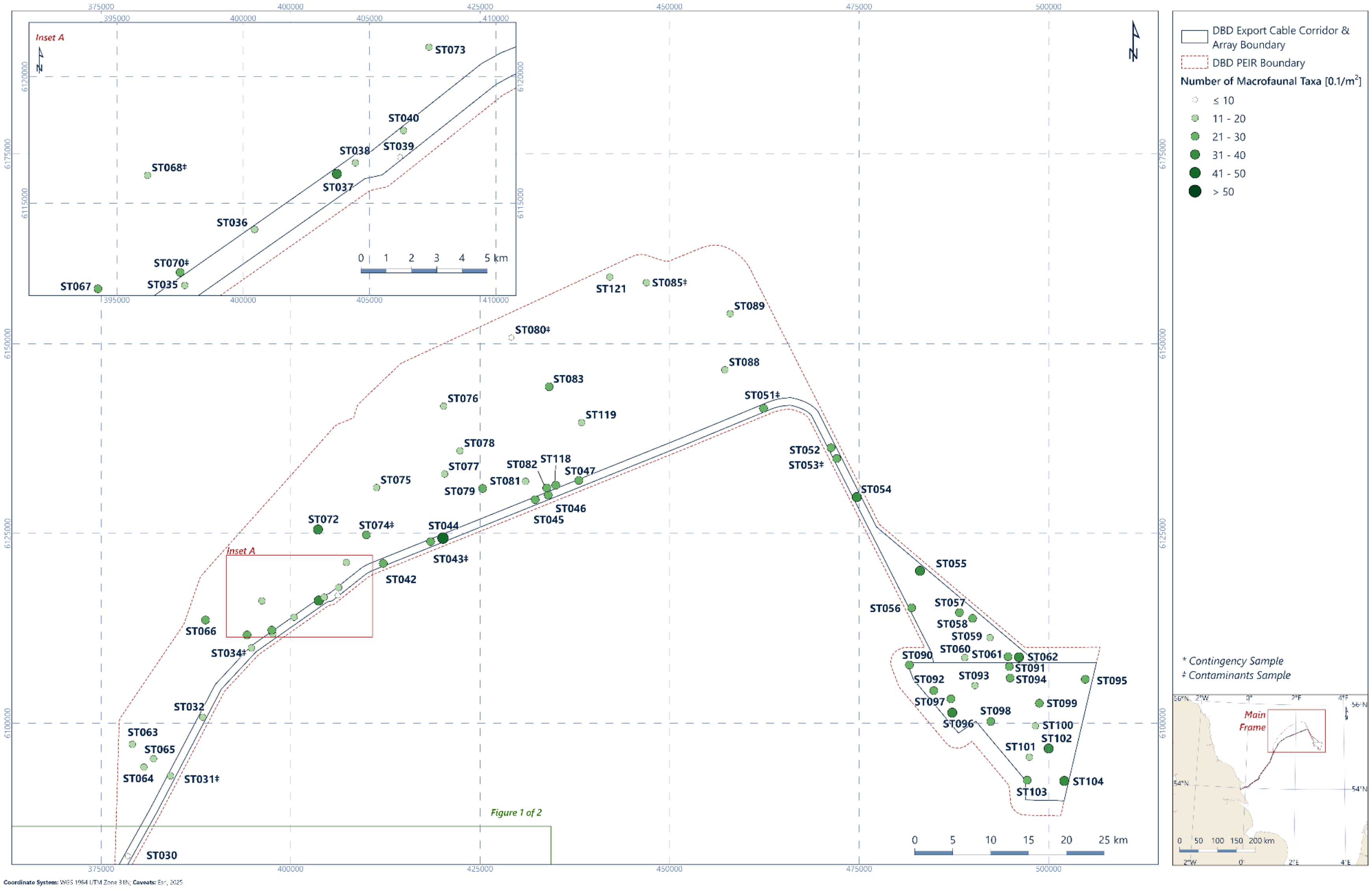


Figure 4.49: Spatial variations of the number of taxa (0.1 m²) offshore section of export cable route, characterisation area and array, Dogger Bank D 2024

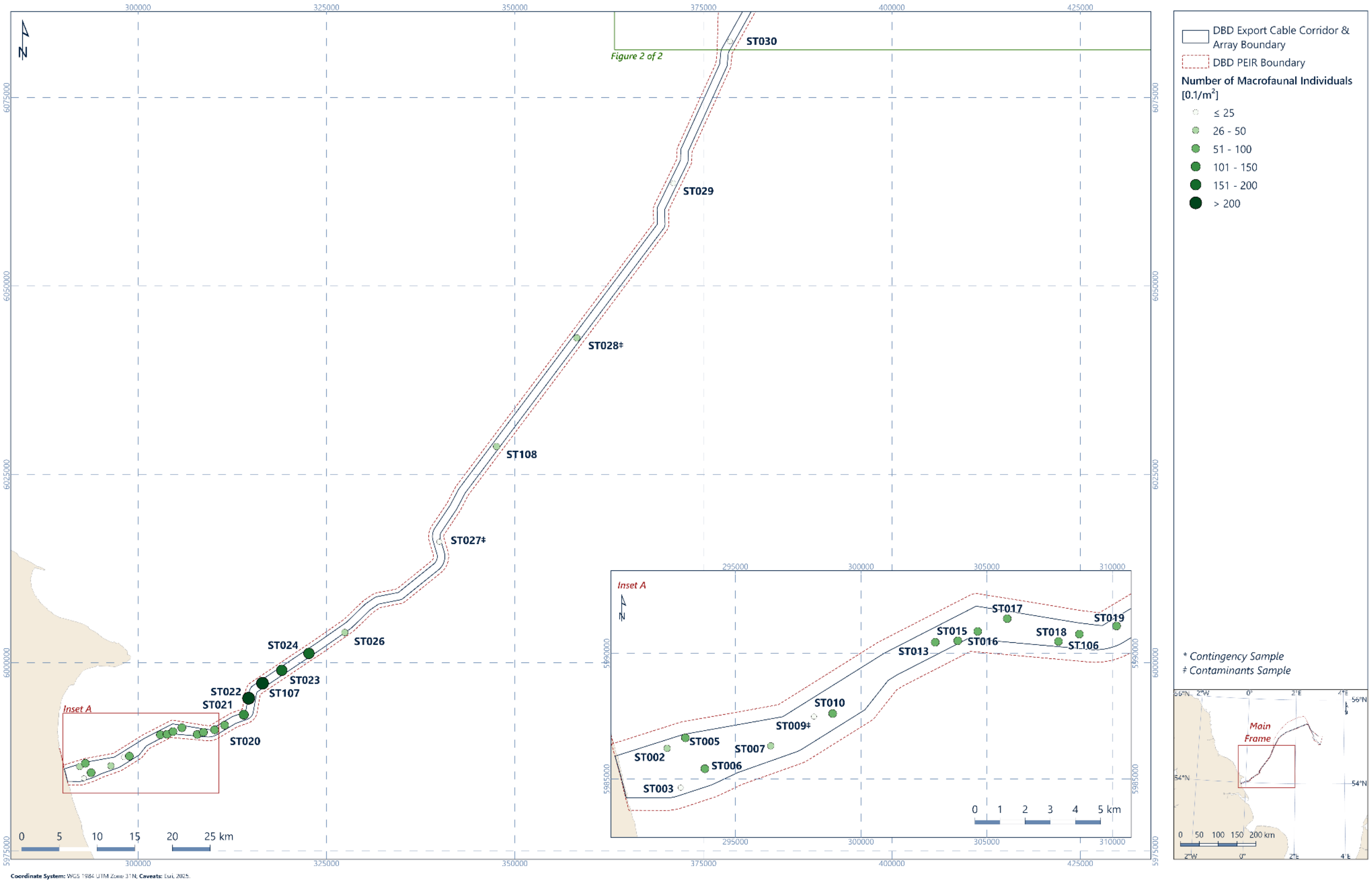


Figure 4.50: Spatial variations of the number of individuals (0.1 m²), nearshore section of export cable corridor, Dogger Bank D 2024

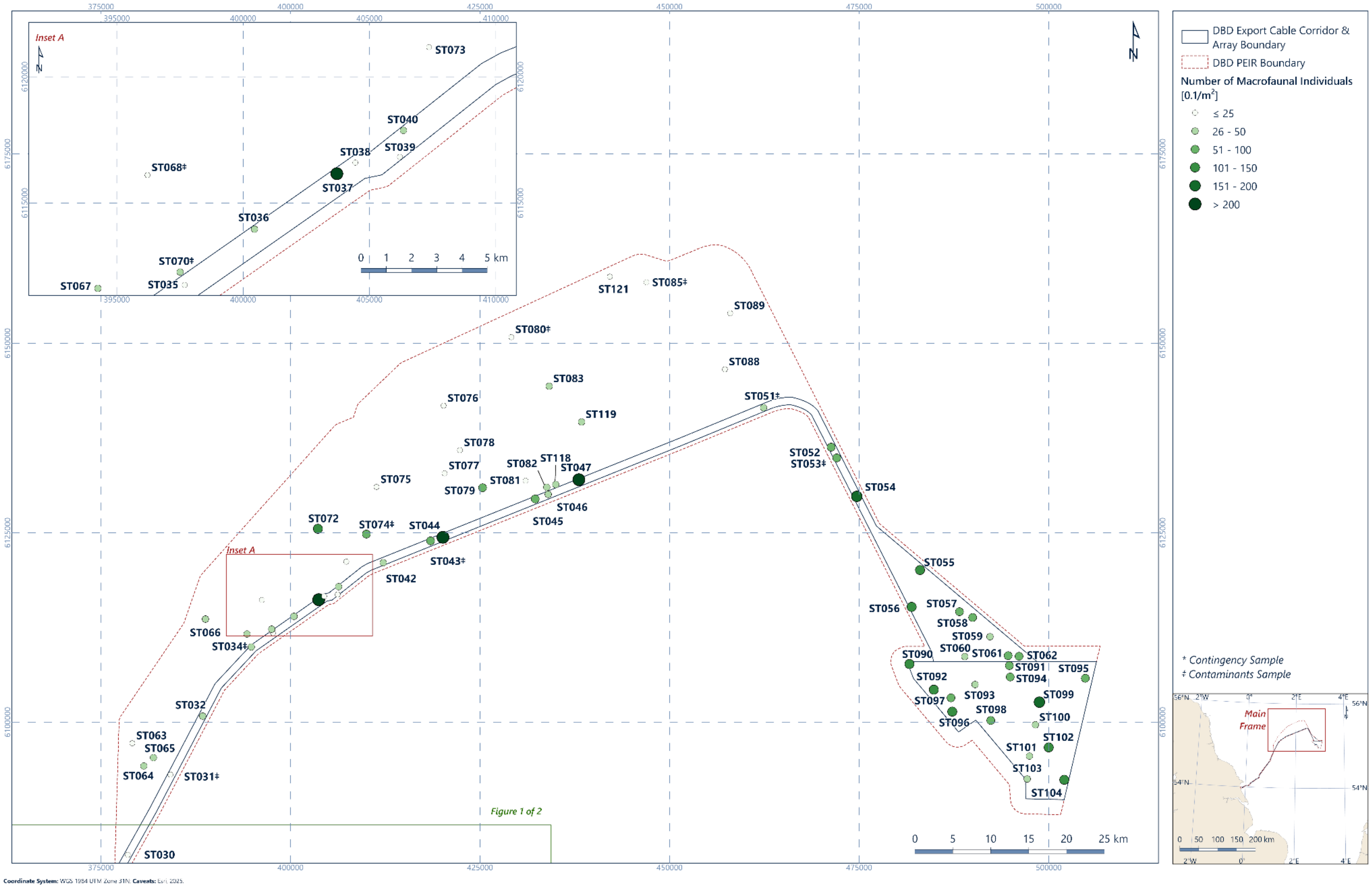


Figure 4.51: Spatial variations of the number of individuals (0.1 m^2), offshore section of export cable route, characterisation area and array, Dogger Bank D 2024

4.2.4.1.3 Investigation of Faunal Similarities

The enumerated macrofaunal dataset was transformed prior to multivariate analysis. A fourth root transformation provided the best assessment, down weighting the numerically dominant species and allowing more detailed interrogation of less abundant taxa and the underlying community.

Faunal similarities were investigated using the hierarchical clustering analysis, results of which are illustrated in Figure 4.52. The SIMPROF test, undertaken in conjunction with the cluster analysis, was interpreted in ecological terms. Owing to a stress coefficient of 0.2, the nMDS was deemed not representative of the stations' two-dimensional ordination.

Five groups of stations (A to E) were identified at a similarity of 20 % and three stations (stations ST009, ST010 and ST039) were different enough to separate. Figures 4.53, 4.54 and 4.55 illustrates the spatial distribution of the macrofaunal groups identified through the multivariate analysis.

The groups identified through the multivariate analysis were further assessed by means of the SIMPER analysis. Table 4.36 presents the top ten characterising taxa identified through the SIMPER analysis, along with a summary of the physical variables characterising each multivariate group; the average abundance of the characterising taxa refers to untransformed data. The characteristics of the multivariate groups were as follow:

- Group A comprised 53 stations, including 15 from the array, 14 in the characterisation area and 24 along the ECC and had an average similarity of 29.8 %. Group A was characterised by poorly sorted 'sand' (Folk BGS), with mean median sediment particle size of 228 µm (fine sand), in mean water depth of 35.5 m BSL. Group A had mean numbers of 23 taxa and 61 individuals, of which the polychaetes *Spiophanes bombyx*, *Magelona filiformis, Sthenelais limicola* and species of *Owenia* were amongst the top ten characterising taxa, along with the bivalves *Abra prismatica, Fabulina fabula* and *Phaxas pellucidus*, the amphipod *Phtisica marina*, species of the genus *Phoronis* and species of the phylum Nemertea. In addition, analysis of the species list indicated that along the ECC one individual of *Merluccius merluccius* was recorded at station ST057 and three individuals of *Ammodytes* were recorded at stations ST040 and ST060, with one individual at station ST060 identified to species level *Ammodytes marinus*. In the array one individual of *Callionymus reticulatus* was identified at station ST091. The faunal diversity (H'Log_2) of group A, with a mean value of 3.95, was 'good';
- Group B comprised 16 stations, including 6 from the array and 10 in the characterisation area and had an average similarity of 30.6 %. Group B was characterised by moderately sorted 'sand' (Folk BGS), with mean median sediment particle size of 176 µm (fine sand), in mean water depth of 61.2 m BSL. Group B had mean numbers of 15 taxa and 23 individuals, of which the polychaetes *Sthenelais limicola, Galathowenia oculata* and *Scoloplos armiger* and the species of the genus *Phoronis* were amongst the top ten characterising taxa, along with the echinoderm *Amphiura filiformis,* the bivalve

Thyasira flexuosa and the gastropod *Cylichna cylindracea*. The faunal diversity (H'Log_2) of group B, with a mean value of 3.70, was 'good';

- Group C comprised four stations along the ECC and had an average similarity of 47.0 %. Group C was characterised by moderately well sorted 'sand' (Folk BGS), with mean median sediment particle size of 157 μm (fine sand), in mean water depth of 19.1 m BSL. Group C had mean numbers of 14 taxa and 50 individuals, of which the bivalves *Nucula nitidosa, Mactra stultorum* and *Abra alba* were amongst the top ten characterising taxa, along with the crustacean *Bathyporeia tenuipes* and the polychaete *Leiochone*. The faunal diversity (H'Log_2) of group C, with a mean value of 2.75, was 'moderate';
- Group D comprised 13 stations along the ECC and had an average similarity of 40.7 %. Group D was characterised by very poorly sorted 'muddy, sandy gravel' (Folk BGS), with mean median sediment particle size of 1702 μm (very coarse sand), in mean water depth of 46.3 m BSL. Group D had mean numbers of 38 taxa and 130 individuals, of which the polychaetes *Lumbrineris* cf. *cingulata, Mediomastus fragilis, Spiophanes kroyeri, Sabellaria spinulosa, Glycera lapidum, Galathowenia oculata* and *Chaetozone zetlandica* were amongst the top ten characterising taxa, along with the crustacean *Ampelisca spinipes* and species from the phyla Nemertea. The faunal diversity (H'Log_2) of group D, with a mean value of 4.32, was 'high;
- Group E comprised stations ST037, ST044 and ST047 along the ECC and station ST072 in the characterisation area. The group had an average similarity of 39.4 %. Group E was characterised by poorly sorted 'sandy gravel' (Folk BGS) with mean median sediment particle size of 1730 μm (very coarse sand), in mean water depth of 44.1 m BSL. Group E had mean numbers of 37 taxa and 344 individuals of which the polychaetes *Protodorvillea kefersteini, Pisione remota and Glycera lapidum* and species of the genera *Polygordius*, *Notomastus* and *Grania* were amongst the top ten characterising taxa along with the echinoderm *Amphipholis squamata* and species of Nemertea. Analysis of the species list indicated that five individuals of the genus *Ammodytes* were recorded at stations ST037, ST044 and ST072, three individuals were identified to species *Ammodytes marinus*., and one individual of Gobiidae was identified at station ST037. The faunal diversity (H'Log_2) of group E, with a mean value of 3.78, was 'good';
- Station ST009 along the ECC separated at a similarity of 13.5 % and was characterised by very poorly sorted 'sandy gravel' (Folk, BGS), with median sediment particle size of 5299 μm (fine pebble) in water depth of 18.6 m BSL. Station ST009 had 6 taxa and 8 individuals, of which the arthropod *Diastylis bradyi*, with 3 individuals, was the most abundant followed by the polychaetes *Malmgrenia darbouxi, Eumida bahusiensis* and *C. zetlandica*. The faunal diversity (H'Log_2) of station ST009, with a value of 2.41 was 'moderate;
- Station ST010 separated at a similarity of 13.8 % and was characterised by very poorly sorted 'sandy gravel' (Folk BGS), with median sediment particle size of 5280 μm (fine pebble), in water depth of 17.9 m BSL. Station ST010 had 28 taxa and 61 individuals, of which *Balanus crenatus*, with 21 individuals, was the most abundant, followed by

Euclymene oerstedii, *Achelia echinata, Urothoe elegans, Dendrodoa grossularia*, species of Polygordius, *S. spinulosa* and *Synchelidium maculatum,* which were present in the top ten most abundant taxa for the station. The faunal diversity (H'Log_2) of station ST056, with a value of 3.92, was 'good';

- Station ST039 separated at a similarity of 11.0 % and was characterised by moderately well sorted 'sand' (Folk BGS), with median sediment particle size of 247 µm (fine sand) in water depth of 38.7 m BSL. Station ST039 had 6 taxa and 6 individuals, which were *Perioculodes longimanus, Urothoe poseidonis, Ampelisca brevicornis, Phaxas pellucidus, Chamelea striatula* and *Thracia phaseolina*. The faunal diversity (H'Log_2) of station ST127, with a value of 2.58, was 'moderate';

4.2.4.1.4 Relationships Between Physical and Biological Variables

The combination of physical variables (percentages of sediment fractions and depth) that best explained the observed pattern of macrofaunal distribution included depth, the 2000 µm (granule), the 1400 µm (very coarse sand), the 177 µm (fine sand), and 63 µm (very fine sand) sediment particle sizes as identified through the BIOENV analysis, which returned the highest value of rho of 0.736 at a significance level of 1 % for this combination of variables.

Figure 4.56 illustrates the relationships between sediment type and the macrofaunal groups identified through the multivariate analysis, highlighting an increase in enumerated faunal diversity (H'Log_2), with increased sediment coarseness and heterogeneity.

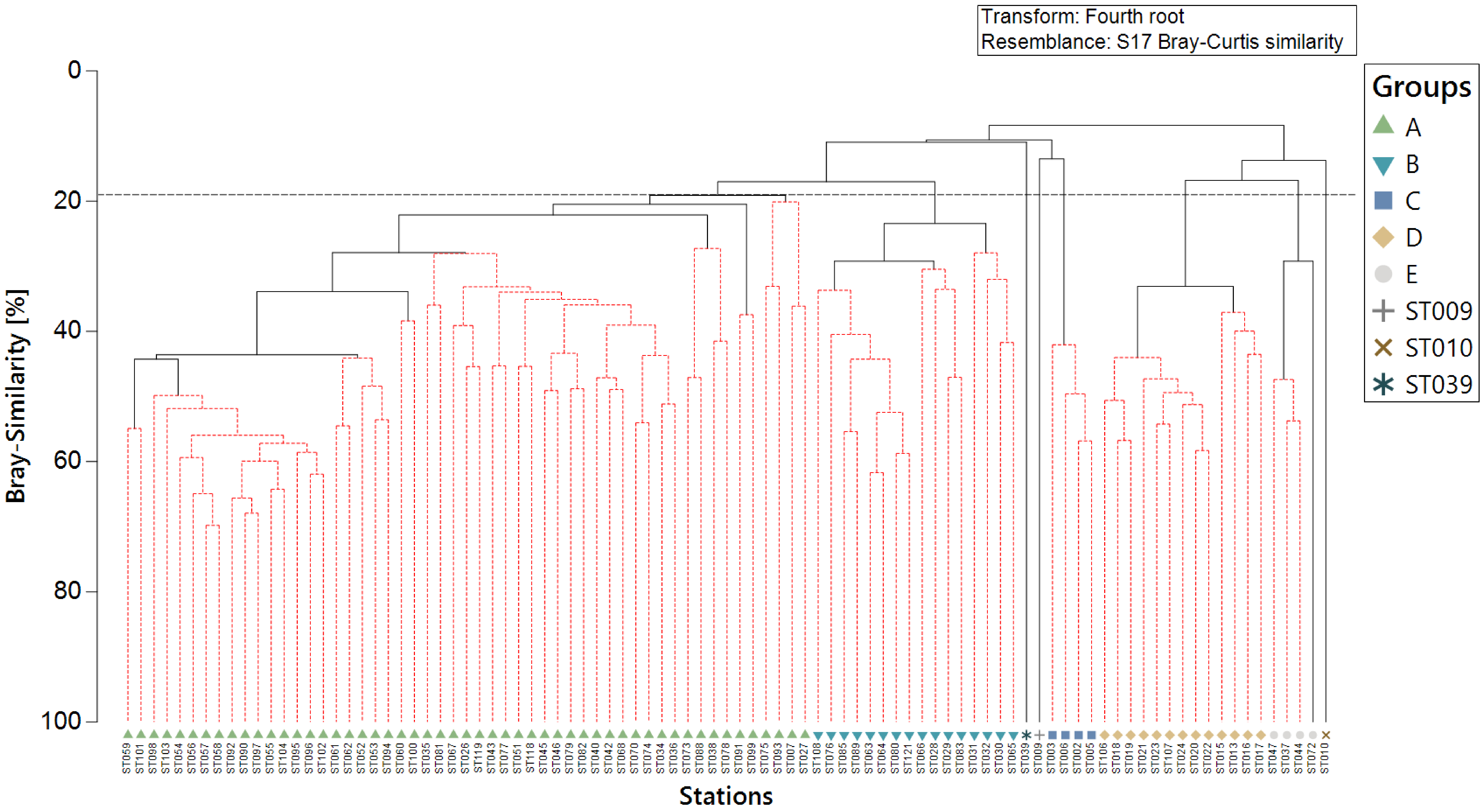


Figure 4.52: Dendrogram of hierarchical clustering analysis of enumerated fauna from the grab samples, export cable corridor, characterisation area and array Dogger Bank D 2024

Table 4.36: Summary of attributes of multivariate groups of enumerated macrofauna from the grab samples, export cable corridor, characterisation area and array Dogger Bank D 2024

Group	Location and Station	Characterising Features	Characterising Taxa	Abundance [N]	Frequency [%]	Contribution to Similarity [%]
A Average similarity: 29.8 %	**ECC** (ST007, ST026, ST027, ST034, ST035, ST036, ST038, ST040, ST042, ST043, ST045, ST046, ST051, ST052, ST053, ST054, ST055, ST056, ST057, ST058, ST059, ST060, ST061, ST062) **Characterisation Area** (ST067, ST068, ST070, ST073, ST074, ST075, ST077, ST078, ST079, ST081, ST082, ST088, ST118, ST119) **Array** (ST090, ST091, ST092, ST093, ST094, ST095, ST096, ST097, ST098, ST099, ST100, ST101, ST102, ST103, ST104)	Taxa: 23 Individuals: 61 Depth [m BSL]: 35.5 Gravel [%]: 4.85 Sand [%]: 94.35 Fines [%]: 0.80 Median [µm]: 228 Sorting [µm]: 2.16	*Spiophanes bombyx*	8.5	69.8	7.5
			Phoronis	3.4	69.8	6.7
			Abra prismatica	1.5	66.0	6.4
			Owenia	2.2	69.3	6.3
			Fabulina fabula	2.0	58.5	4.7
			Magelona filiformis	1.2	60.4	4.5
			Nemertea	1.2	56.6	3.7
			Sthenelais limicola	0.9	50.9	3.6
			Phaxas pellucidus	1.1	49.1	3.5
			Phtisica marina	2.3	52.8	3.4
B Average similarity: 30.6 %	**ECC** (ST028, ST029, ST030, ST031, ST032, ST108) **Characterisation Area** (ST063, ST064, ST065, ST066, ST076, ST080, ST083, ST085, ST089, ST121)	Taxa: 15 Individuals: 23 Depth [m BSL]: 61.2 Gravel [%]: 0.07 Sand [%]: 93.44 Fines [%]: 6.49 Median [µm]: 176 Sorting [µm]: 1.86	*Sthenelais limicola*	1.3	81.3	13.1
			Galathowenia oculata	1.1	75.0	11.4
			Scoloplos armiger	2.0	68.8	10.6
			Phoronis	1.0	68.8	9.0
			Amphiura filiformis	1.8	62.5	7.8
			Thyasira flexuosa	1.4	56.3	6.8
			Cylichna cylindracea	0.6	50.0	5.6
			Diplocirrus glaucus	0.9	50.0	5.0
			Nephtys hombergii	0.5	43.8	3.6
C Average similarity: 47.0 %	**ECC** (ST002, ST003, ST005, ST006)	Taxa: 14 Individuals: 50 Depth [m BSL]: 19.1 Gravel [%]: 0.17 Sand [%]: 97.47 Fines [%]: 2.36 Median [µm]: 156 Sorting [µm]: 1.57	*Nucula nitidosa*	23	100	23.3
			Mactra stultorum	2.8	100	16.7
			Bathyporeia tenuipes	3.3	100	14.3
			Leiochone	5.3	75.0	8.8
			Abra alba	4.5	75.0	8.3
D Average similarity: 40.1 %	**ECC** (ST013, ST015, ST016, ST017, ST018, ST019, ST020, ST021, ST022, ST023, ST024, ST106, ST107)	Taxa: 38 Individuals: 130 Depth [m BSL]: 46.3 Gravel [%]: 42.64 Sand [%]: 49.01 Fines [%]: 8.35 Median [µm]: 1702 Sorting [µm]: 6.55	*Lumbrineris* cf. *cingulata*	20	100	9.4
			Mediomastus fragilis	17	100	9.2
			Ampelisca spinipes	3.3	100	6.9
			Spiophanes kroyeri	4.9	92.3	5.7
			Nemertea	4.5	92.3	5.5
			Sabellaria spinulosa	4.1	84.6	4.5
			Timoclea ovata	2.5	84.6	4.1
			Glycera lapidum	1.5	84.6	3.8
			Galathowenia oculata	5.9	69.2	3.4
			Chaetozone zetlandica	3.0	69.2	3.3

Group	Location and Station	Characterising Features	Characterising Taxa	Abundance [N]	Frequency [%]	Contribution to Similarity [%]
E Average similarity: 39.4 %	**ECC** (ST037, ST044, ST047, ST072)	Taxa: 37 Individuals: 344 Depth [m BSL]: 44.1 Gravel [%]: 45.80 Sand [%]: 53.35 Fines [%]: 0.85 Median [µm]: 1730 Sorting [µm]: 3.62	*Protodorvillea kefersteini*	70	100	10.5
			Glycera lapidum	13	100	8.8
			Pisione remota	33	100	8.3
			Polygordius	34	100	8.0
			Nemertea	6.5	100	7.1
			Aonides paucibranchiata	9.3	100	6.5
			Grania	7.5	100	6.1
			Nototropis vedlomensis	3.0	100	5.9
			Galathea intermedia	33	100	4.8
			Notomastus	5.8	100	3.5
ST009	**ECC**	Taxa: 6 Individuals: 8 Depth [m BSL]: 18.4 Gravel [%]: 59.32 Sand [%]: 40.48 Fines [%]: 0.20 Median [µm]: 5299 Sorting [µm]: 6.24	*Diastylis bradyi*	3	–	–
			Achelia echinata	1	–	–
			Chaetozone zetlandica	1	–	–
			Malmgrenia darbouxi	1	–	–
			Eumida bahusiensis	1	–	–
			Mactra stultorum	1	–	–
ST010	**ECC**	Taxa: 28 Individuals: 61 Depth [m BSL]: 17.9 Gravel [%]: 61.20 Sand [%]: 36.51 Fines [%]: 2.29 Median [µm]: 5280 Sorting [µm]: 7.90	*Balanus crenatus*	21	–	–
			Euclymene oerstedii	4	–	–
			Achelia echinata	3	–	–
			Urothoe elegans	3	–	–
			Dendrodoa grossularia	3	–	–
			Polygordius	2	–	–
			Aoridae	2	–	–
			Sabellaria spinulosa	2	–	–
			Synchelidium maculatum	2	–	–
			Chaetozone zetlandica	1	–	–
ST039	**ECC**	Taxa: 6 Individuals: 6 Depth [m BSL]: 38.7 Gravel [%]: 0.11 Sand [%]: 99.89 Fines [%]: 0.00 Median [µm]: 247 Sorting [µm]: 1.52	*Ampelisca brevicornis*	1	–	–
			Perioculodes longimanus	1	–	–
			Urothoe poseidonis	1	–	–
			Phaxas pellucidus	1	–	–
			Chamelea striatula	1	–	–
			Thracia phaseolina	1	–	–

Notes

Values refer to mean of untransformed data within each multivariate group, except for single stations ST009, ST010 and ST039 which refers to total abundance

Frequency refers to number of stations within each multivariate group

Taxa listed are the top ten identified by the SIMPER analysis (70 % percentage contribution)

Taxa listed in decreasing order of percentage contribution to similarity

BSL = Below sea level

ECC = Export cable corridor

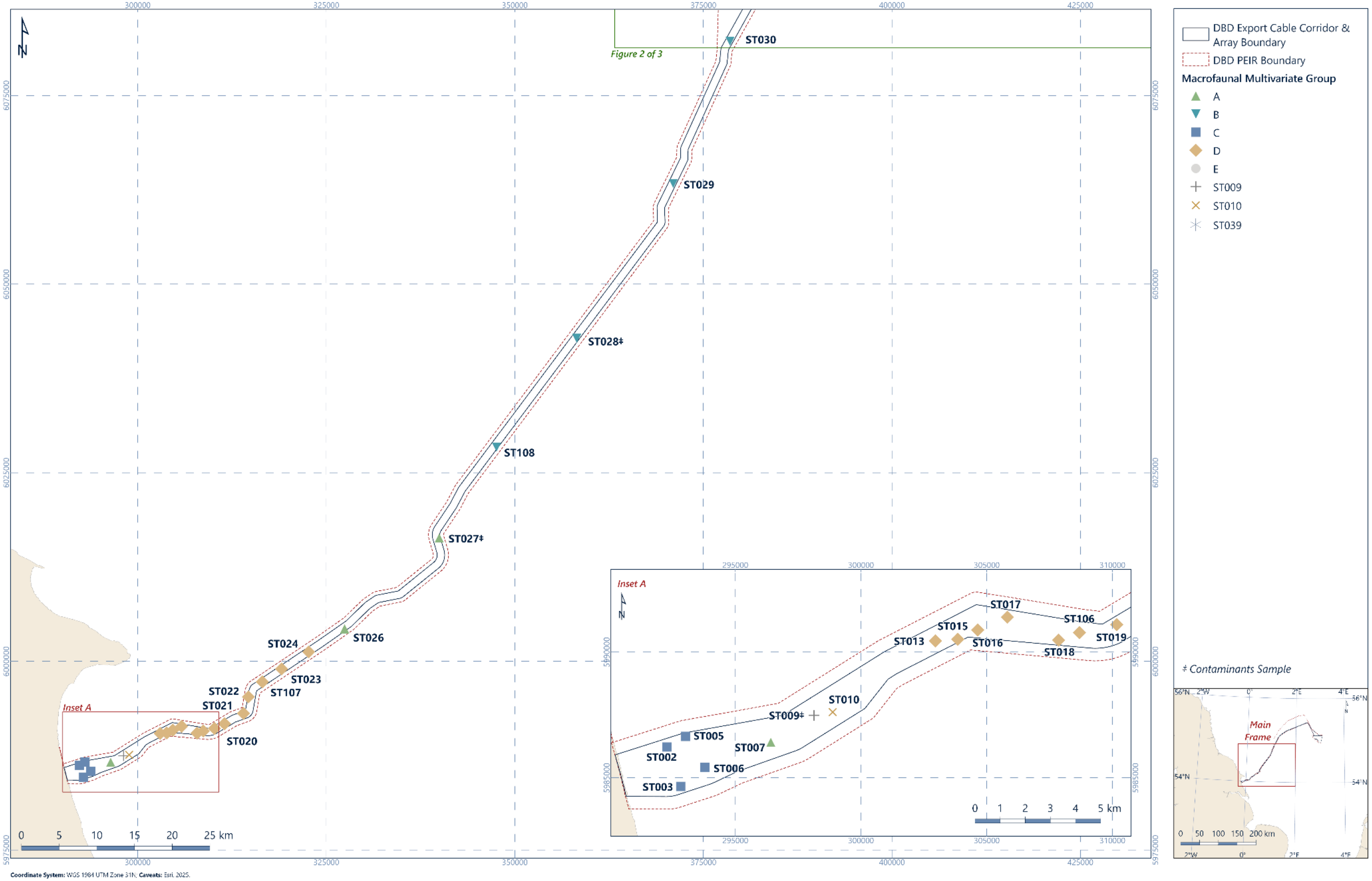


Figure 4.53: Spatial distribution of macrofaunal groups identified through the multivariate analysis, nearshore section of export cable corridor, Dogger Bank D 2024

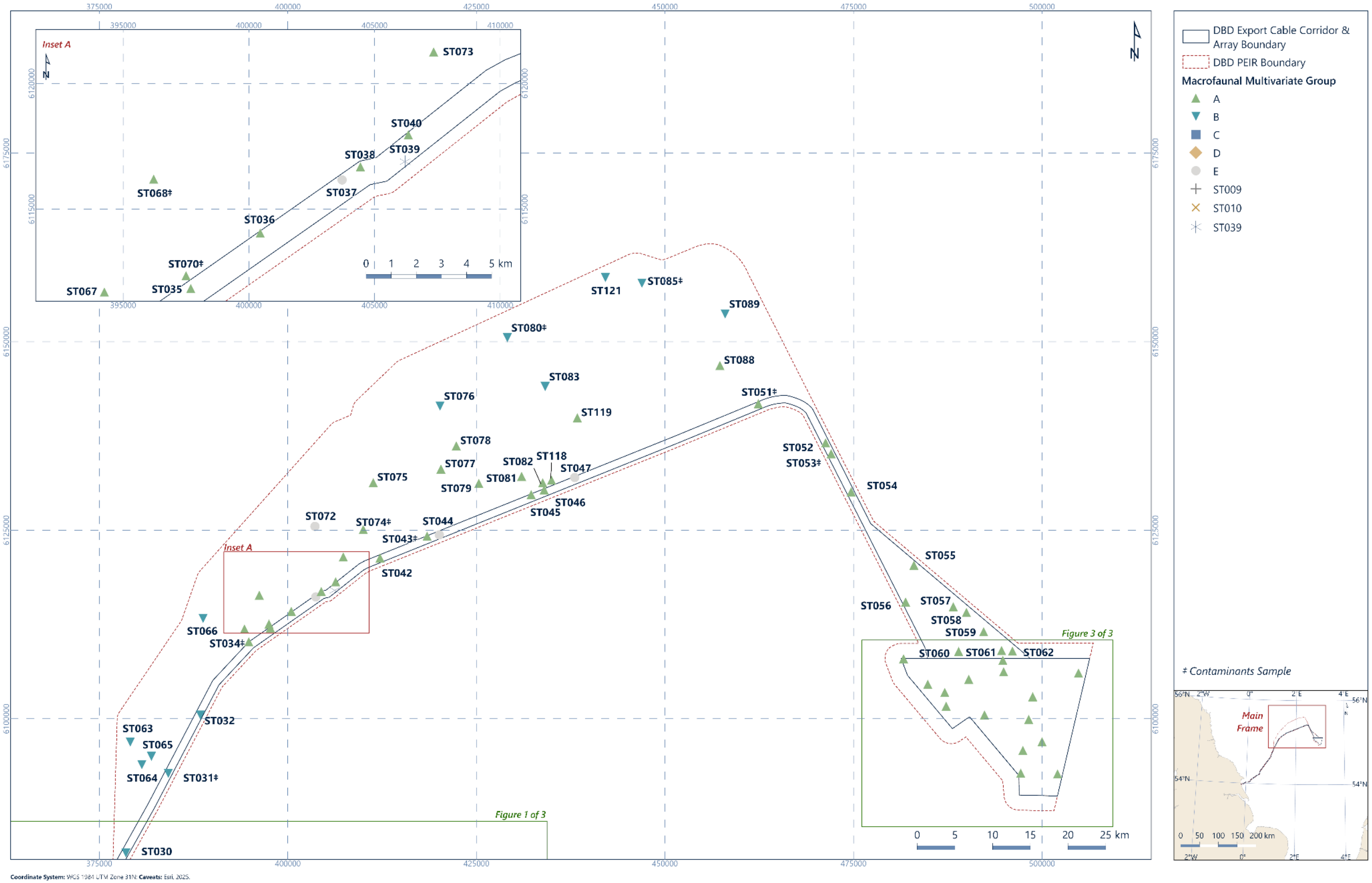


Figure 4.54: Spatial distribution of macrofaunal groups identified through the multivariate analysis, ECC, characterisation area and array, Dogger Bank D 2024

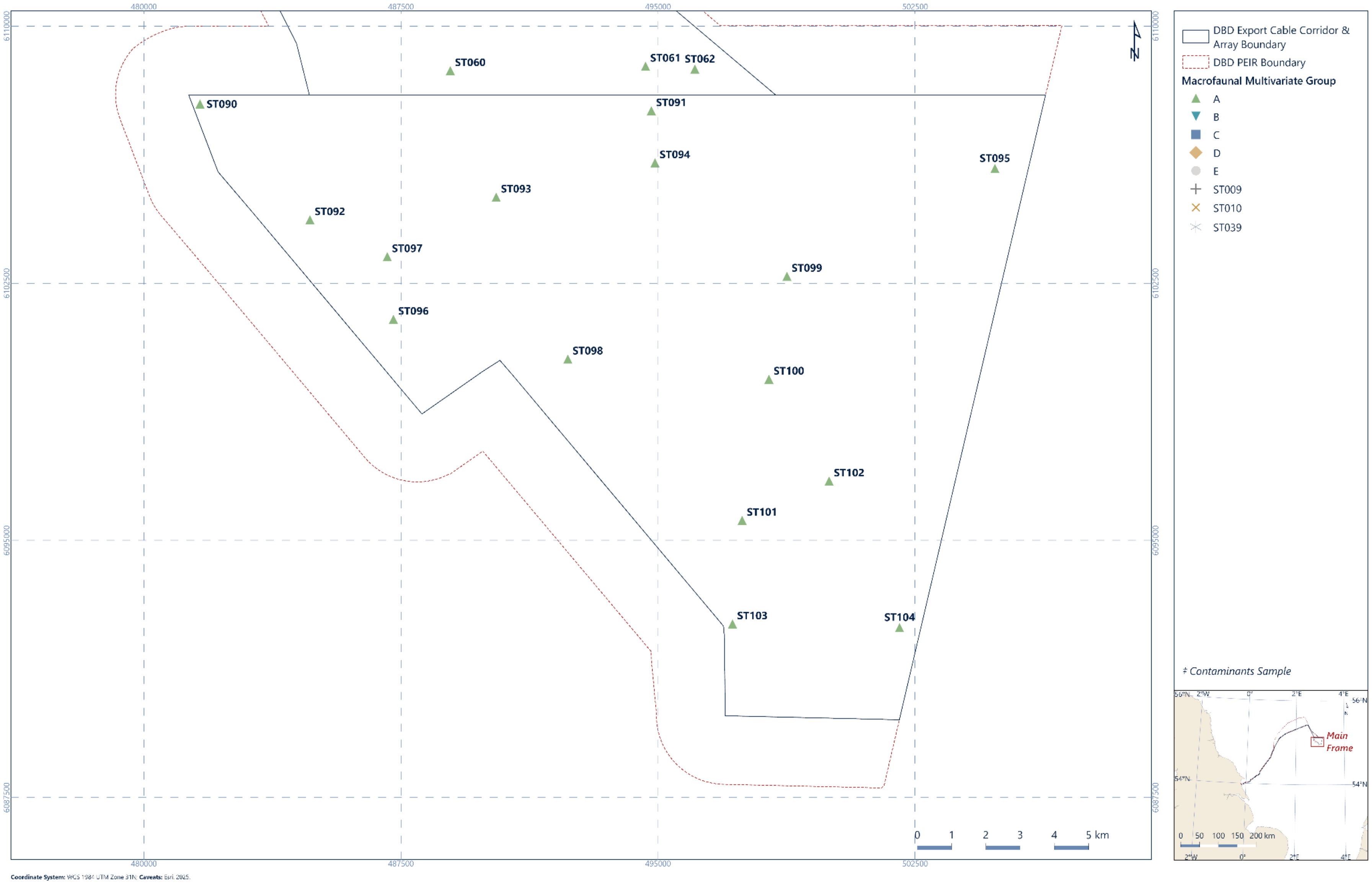
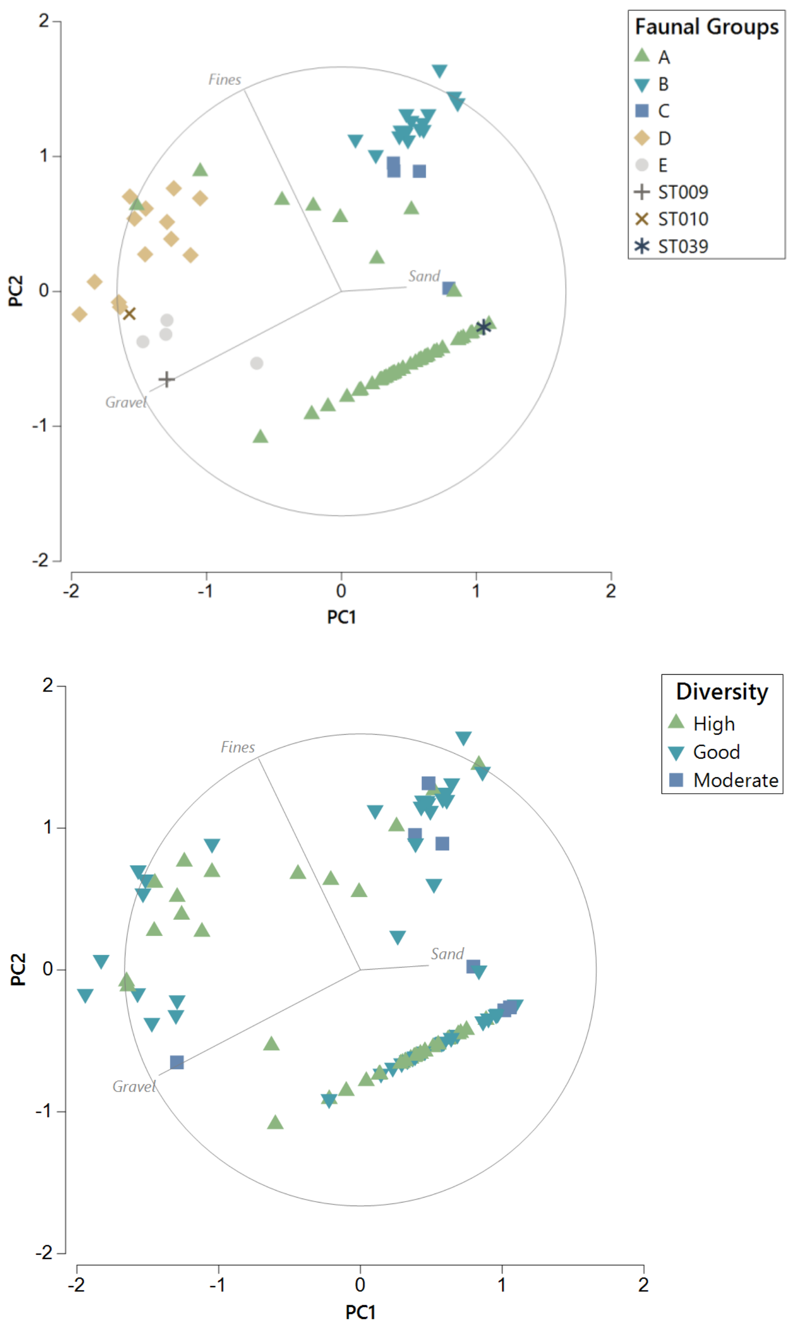


Figure 4.55: Spatial distribution of macrofaunal groups identified through the multivariate analysis, array, Dogger Bank D 2024



Notes
PC = Principal component

Figure 4.56: 2D PCA of sediment composition with superimposed macrofaunal multivariate groups and Shannon-Wiener [H'Log$_2$] index of diversity of enumerated macrofauna from the grab samples, export cable corridor, characterisation area and array, Dogger Bank D 2024

4.2.4.1.5 Biomass

Table 4.37 presents the percentage contribution of phyla to biomass across the DBD survey area. It is worth noting that the biomass of Arthropoda comprises only invertebrates of the subphylum Crustacea. Table 4.37 presents the biomass of major taxonomic groups at each station. Figures 4.57 and 4.58 illustrate the phyletic composition of the biomass at each station along the ECC, the characterisation area and in the array, respectively. Figures 4.59 and 4.60illustrate the spatial variations of infaunal biomass across the DBD survey area and Figure 4.61 illustrates the association of the major faunal groups with sediment type. In general, echinoderms attained higher biomass in sandy sediments whereas molluscs attained higher biomass in more diverse and compact sediments.

Table 4.37: Taxonomic groups of macrofaunal biomass from the grab samples, Dogger Bank D 2024

Phylum	Biomass [AFDW g/0.1 m^2]	Biomass [%]
Annelida	0.1845	0.4
Arthropoda	1.7223	4.0
Mollusca	13.0184	30.4
Echinodermata	21.6450	50.6
Other phyla	6.2073	14.5
Total	**42.7775**	**100**

Notes
Macrofaunal samples were processed through a 1 mm mesh sieve
Arthropoda comprises only invertebrates of the subphylum Crustacea
Other phyla included: Chordata, Cnidaria, Foraminifera, Hemichordata, Nemertea, Phoronida and Platyhelminthes

Echinodermata comprised most of the macrofaunal abundance (50.6 %), followed by Mollusca (30.4 %), Arthropoda (4.0 %), and Annelida (0.4 %), whereas other phyla comprised 14.5 %.

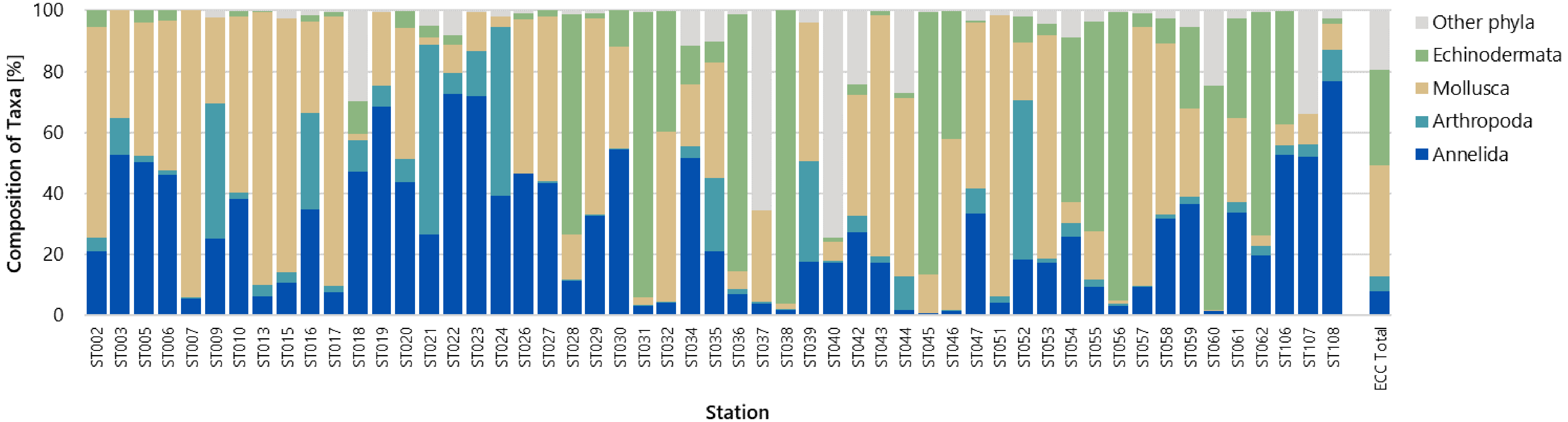
The total biomass ranged from 0.0039 AFDW g/0.1m^2 at station ST009, along the ECC, to 7.6446 AFDW g/0.1m^2 at station ST044 along the ECC, with a mean of 0.4990 AFDW g/0.1m^2 and a median of 0.1747 AFDW g/0.1m^2. The high value of biomass at station ST044 was associated with Molluscs.

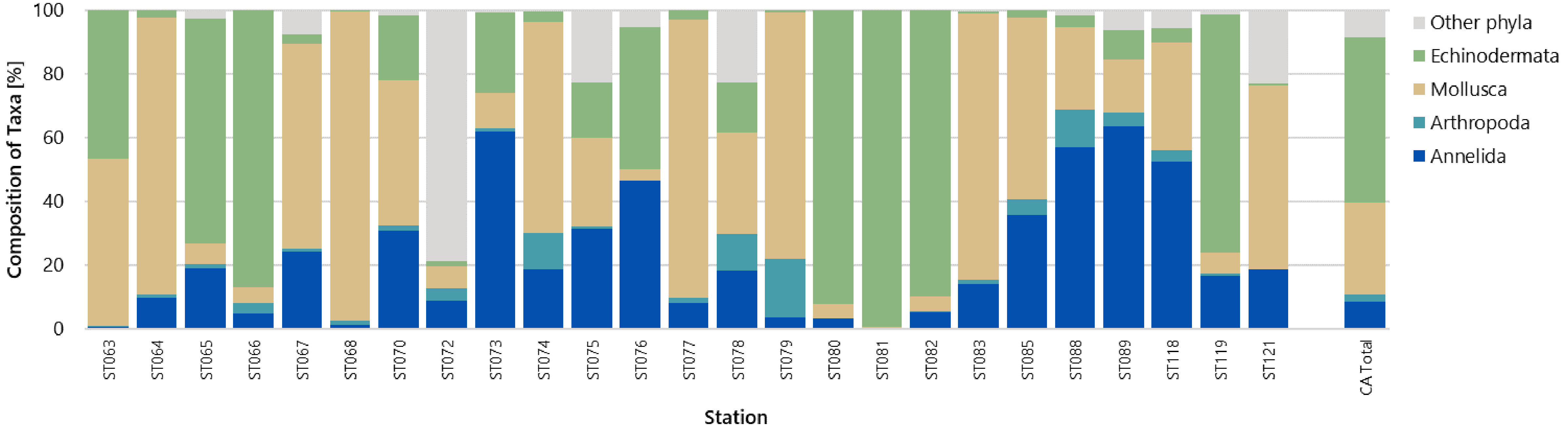
Table 4.38: Phyletic composition of macrofaunal biomass from the grab samples (0.1 m²), Dogger Bank D 2024

Station	Biomass					
	Annelida	Arthropoda	Mollusca	Echinodermata	Other Phyla	Total
Export Cable Corridor						
ST002	0.0129	0.0029	0.0424	0.0033	-	0.0614
ST003	0.0076	0.0018	0.0051	-	-	0.0144
ST005	0.0370	0.0016	0.0324	0.0028	-	0.0738
ST006	0.0289	0.0008	0.0308	0.0020	-	0.0625
ST007	0.0111	0.0010	0.1918	-	-	0.2040
ST009	0.0010	0.0018	0.0011	-	0.0001	0.0039
ST010	0.0299	0.0017	0.0454	0.0014	0.0001	0.0785
ST013	0.0142	0.0081	0.1969	0.0006	0.0004	0.2201
ST015	0.0228	0.0069	0.1765	0.0001	0.0052	0.2116
ST016	0.0216	0.0197	0.0188	0.0012	0.0010	0.0624
ST017	0.0143	0.0035	0.1630	0.0028	0.0009	0.1846
ST018	0.0213	0.0047	0.0009	0.0049	0.0134	0.0452
ST019	0.0866	0.0088	0.0306	-	0.0006	0.1266
ST020	0.0720	0.0125	0.0712	0.0092	0.0002	0.1651
ST021	0.0407	0.0946	0.0038	0.0053	0.0079	0.1522
ST022	0.1338	0.0126	0.0175	0.0056	0.0147	0.1842
ST023	0.0517	0.0105	0.0092	0.0001	0.0003	0.0718
ST024	0.0613	0.0864	0.0051	0.0004	0.0029	0.1561
ST026	0.0514	0.0002	0.0558	0.0025	0.0008	0.1108
ST027	0.0230	0.0004	0.0285	0.0010	-	0.0529
ST028	0.0196	0.0008	0.0249	0.1241	0.0022	0.1716
ST029	0.0608	0.0005	0.1189	0.0034	0.0015	0.1851
ST030	0.0400	0.0002	0.0244	0.0087	-	0.0732
ST031	0.0166	0.0014	0.0128	0.4917	0.0035	0.5260
ST032	0.0186	0.0023	0.2479	0.1760	0.0002	0.4450
ST034	0.0265	0.0020	0.0105	0.0066	0.0059	0.0515
ST035	0.0022	0.0025	0.0039	0.0007	0.0011	0.0104
ST036	0.0193	0.0043	0.0158	0.2304	0.0036	0.2734
ST037	0.1295	0.0235	1.0277	0.0010	2.2432	3.4249
ST038	0.0129	0.0005	0.0125	0.6365	-	0.6623
ST039	0.0017	0.0032	0.0044	-	0.0004	0.0098
ST040	0.0422	0.0017	0.0150	0.0030	0.1817	0.2436
ST042	0.0068	0.0014	0.0099	0.0008	0.0061	0.0251
ST043	0.0803	0.0101	0.3674	0.0053	0.0015	0.4645
ST044	0.1425	0.8378	4.4810	0.1220	2.0613	7.6446
ST045	0.0281	0.0004	0.3867	2.6716	0.0174	3.1042
ST046	0.0128	0.0024	0.5051	0.3773	0.0004	0.8981
ST047	0.1091	0.0268	0.1774	0.0018	0.0106	0.3258
ST051	0.0115	0.0055	0.2515	0.0003	0.0040	0.2728
ST052	0.0111	0.0321	0.0114	0.0053	0.0012	0.0611
ST053	0.0417	0.0037	0.1771	0.0095	0.0101	0.2421
ST054	0.0321	0.0059	0.0084	0.0675	0.0108	0.1247
ST055	0.0177	0.0045	0.0298	0.1288	0.0070	0.1878
ST056	0.0391	0.0114	0.0105	1.1984	0.0078	1.2672
ST057	0.0673	0.0032	0.6209	0.0326	0.0066	0.7307
ST058	0.0808	0.0032	0.1434	0.0202	0.0070	0.2546
ST059	0.0236	0.0015	0.0187	0.0172	0.0034	0.0645
ST060	0.0329	0.0009	0.0049	1.6812	0.5635	2.2835
ST061	0.0673	0.0073	0.0543	0.0653	0.0054	0.1998
ST062	0.1086	0.0181	0.0187	0.4043	0.0029	0.5526
ST106*	0.0237	0.0014	0.0030	0.0167	0.0001	0.0449
ST107*	0.1112	0.0094	0.0210	0.0000	0.0726	0.2143
ST108*	0.0190	0.0026	0.0021	0.0004	0.0006	0.0247
Array Area						
ST090	0.0610	0.0075	0.0210	0.2163	0.0092	0.3150
ST091	0.0206	0.0022	0.0020	0.0004	0.0216	0.0468
ST092	0.1590	0.0026	0.0225	0.0538	0.0166	0.2545
ST093	0.0174	0.0012	0.0002	0.0030	0.0040	0.0257
ST094	0.0300	0.0025	0.0529	0.0042	0.0018	0.0914
ST095	0.0925	0.0035	0.0346	0.2044	0.0023	0.3372
ST096	0.0669	0.0184	0.0180	4.2885	0.0081	4.3998

Station	Biomass					
	Annelida	Arthropoda	Mollusca	Echinodermata	Other Phyla	Total
ST097	0.0594	0.0016	0.0236	0.0149	0.0048	0.1044
ST098	0.0573	0.0061	0.0025	3.3528	0.0010	3.4197
ST099	0.0444	0.1304	0.0001	0.0002	0.0166	0.1917
ST100	0.0379	0.0041	0.0102	0.0023	0.0027	0.0573
ST101	0.0391	0.0014	0.0022	0.0136	0.0024	0.0588
ST102	0.0889	0.0073	0.0995	0.1428	0.0066	0.3451
ST103	0.0109	0.0026	0.0450	0.0145	0.0018	0.0748
ST104	0.0688	0.0055	0.0754	0.0023	0.0201	0.1721
Characterisation Area						
ST063	0.0061	0.0002	0.4814	0.4286	0.0004	0.9167
ST064	0.0211	0.0023	0.1897	0.0047	0.0003	0.2181
ST065	0.0485	0.0035	0.0167	0.1815	0.0072	0.2574
ST066	0.0081	0.0061	0.0084	0.1518	0.0002	0.1747
ST067	0.0156	0.0008	0.0415	0.0020	0.0050	0.0648
ST068	0.0040	0.0050	0.3546	0.0004	0.0003	0.3644
ST070	0.0189	0.0010	0.0283	0.0125	0.0011	0.0619
ST072	0.0796	0.0365	0.0636	0.0156	0.7271	0.9225
ST073	0.0735	0.0011	0.0130	0.0302	0.0007	0.1185
ST074	0.0416	0.0260	0.1493	0.0072	0.0010	0.2251
ST075	0.0139	0.0002	0.0123	0.0078	0.0100	0.0442
ST076	0.0338	-	0.0029	0.0325	0.0039	0.0731
ST077	0.0136	0.0024	0.1467	0.0046	0.0002	0.1675
ST078	0.0029	0.0018	0.0052	0.0025	0.0036	0.0161
ST079	0.0202	0.1030	0.4340	0.0034	-	0.5606
ST080	0.0058	0.0001	0.0083	0.1726	-	0.1868
ST081	0.0048	0.0000	0.0060	2.0712	0.0003	2.0823
ST082	0.0665	0.0028	0.0601	1.1552	0.0005	1.2851
ST083	0.0818	0.0088	0.4934	0.0033	0.0019	0.5892
ST085	0.0134	0.0018	0.0215	0.0009	-	0.0376
ST088	0.0084	0.0017	0.0038	0.0005	0.0002	0.0147
ST089	0.0104	0.0007	0.0028	0.0015	0.0010	0.0164
ST118*	0.0437	0.0031	0.0281	0.0038	0.0047	0.0834
ST119*	0.1077	0.0037	0.0422	0.4839	0.0081	0.6456
ST121*	0.0145	-	0.0454	0.0005	0.0179	0.0783
Minimum	**0.0010**	**0.0000**	**0.0001**	**0.0000**	**0.0001**	**0.0039**
Maximum	**0.1590**	**0.8378**	**4.4810**	**4.2885**	**2.2432**	**7.6446**
Median	**0.0289**	**0.0029**	**0.0244**	**0.0061**	**0.0035**	**0.1747**
Mean	**0.0410**	**0.0189**	**0.1400**	**0.2460**	**0.0757**	**0.4990**
Standard deviation	**0.0355**	**0.0895**	**0.4837**	**0.7034**	**0.3460**	**1.0833**

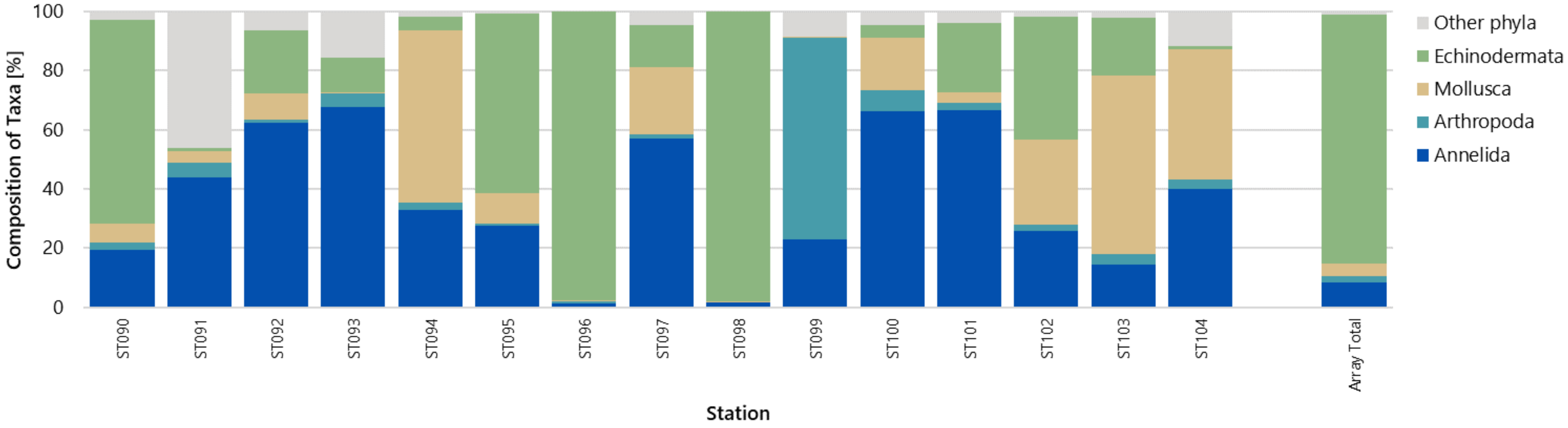
Notes
Biomass expressed as ash free dry weight [AFDW] g/0.1 m^2 grab sample
Arthropoda comprises only invertebrates of the subphylum Crustacea
Other phyla included: Chordata, Cnidaria, Foraminifera, Hemichordata, Nemertea, Phoronida and Platyhelminthes





Notes
Biomass expressed as ash free dry weight in g/0.1 m^2 grab sample

Figure 4.57: Phyletic composition of macrofaunal biomass from the grab samples, export cable corridor (ECC) and characterisation area (CA), Dogger Bank D 2024



Notes

Biomass expressed as ash free dry weight in g/0.1 m^2 grab sample

Figure 4.58: Phyletic composition of macrofaunal biomass from the grab samples, array, Dogger Bank D 2024

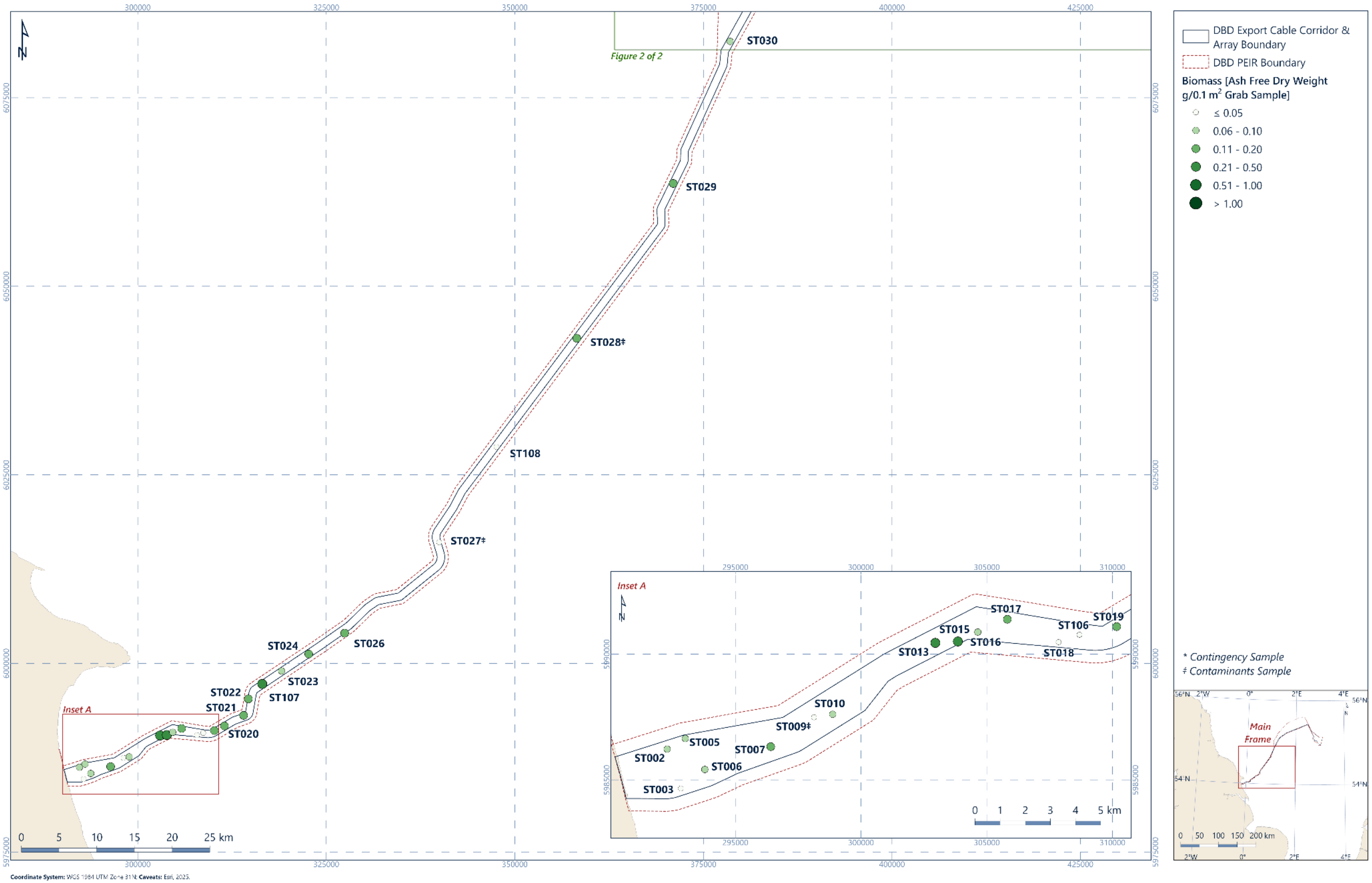
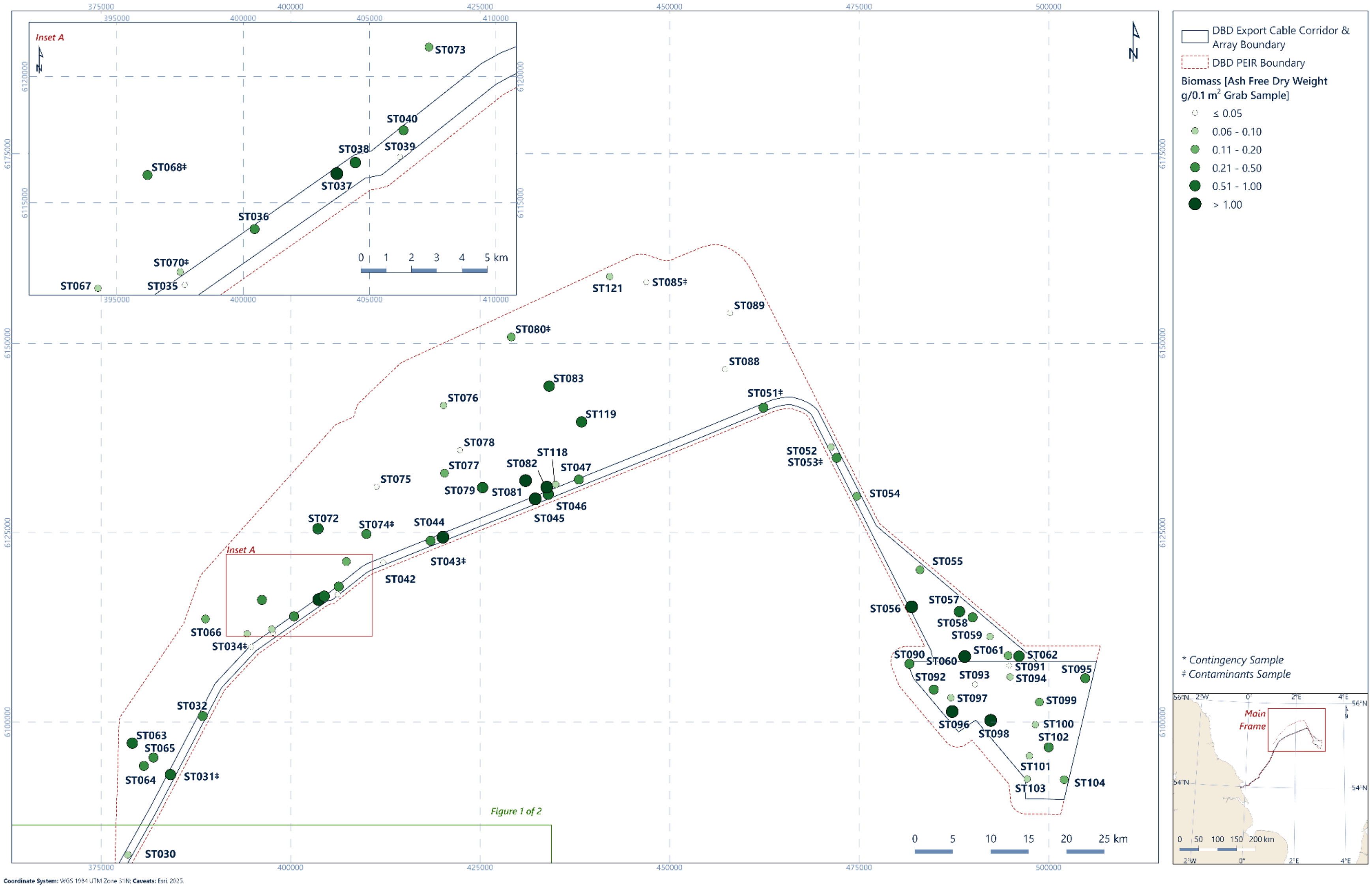


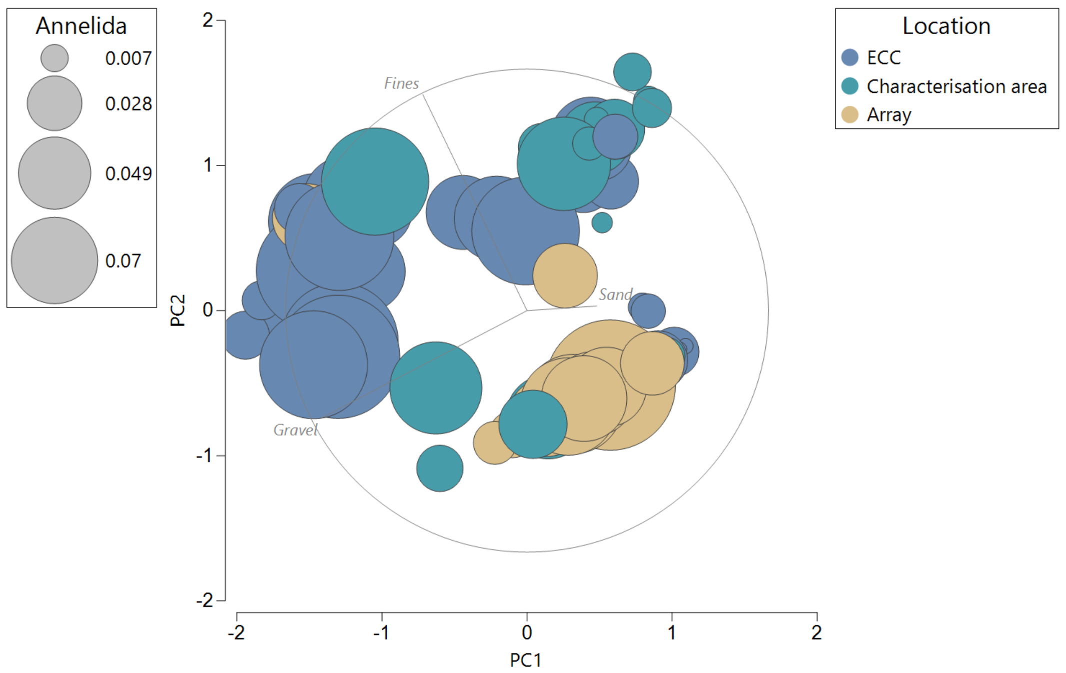
Figure 4.59: Spatial variations of total macrofaunal biomass from the grab samples, nearshore section of export cable corridor, Dogger Bank D 2024



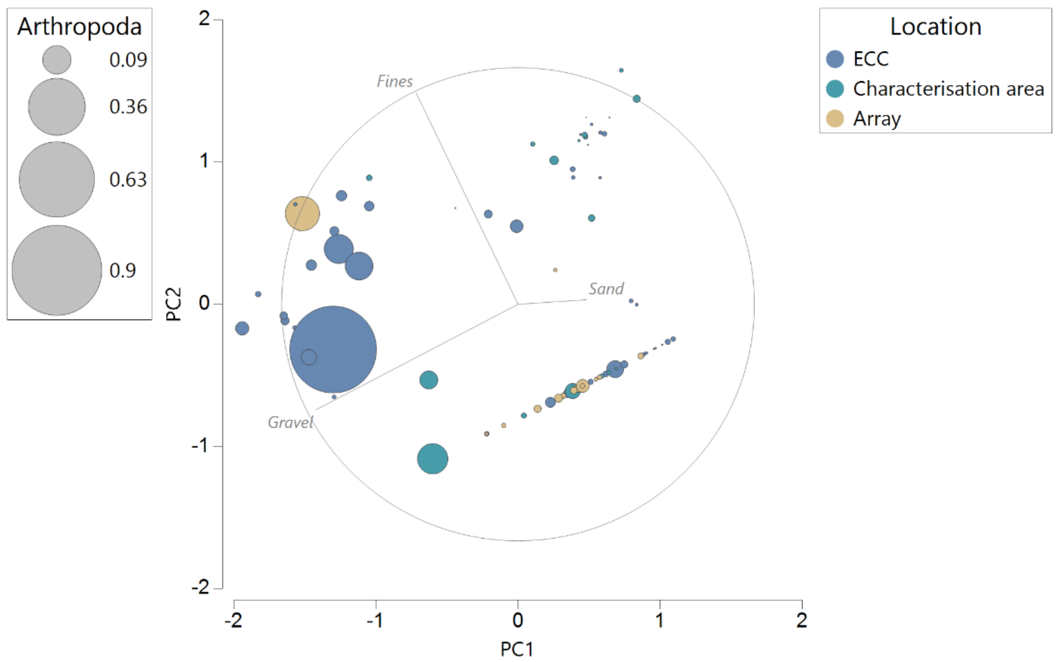
Notes

Biomass expressed as ash free dry weight [AFDW] in g/0.1 m^2 grab sample

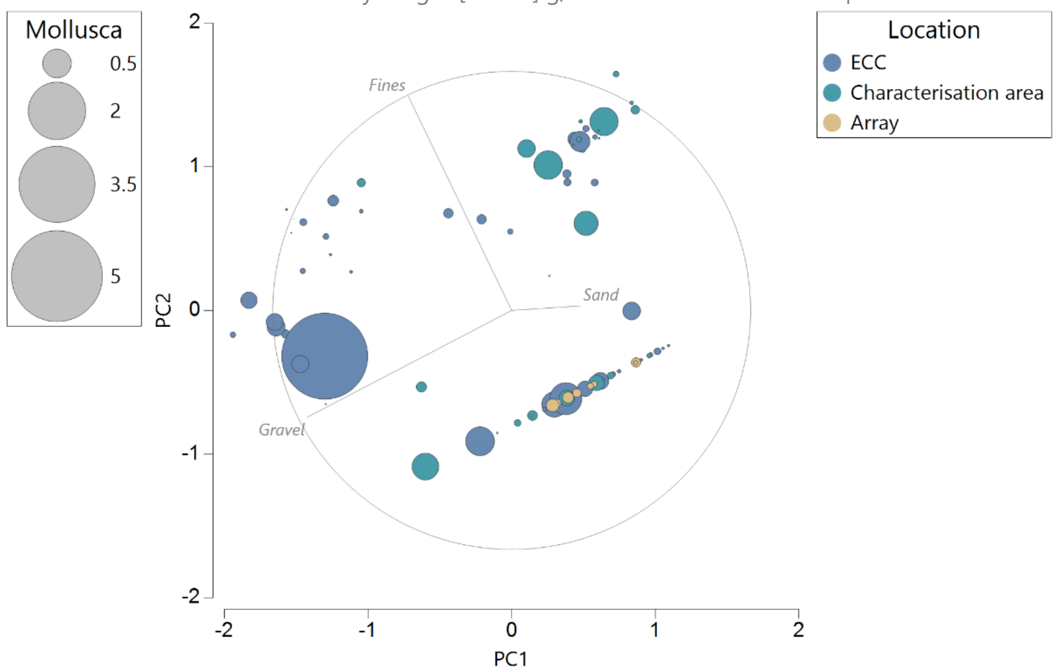
Figure 4.60: Spatial variations of total macrofaunal biomass from the grab samples offshore section of export cable route, characterisation area and array, Dogger Bank D 2024



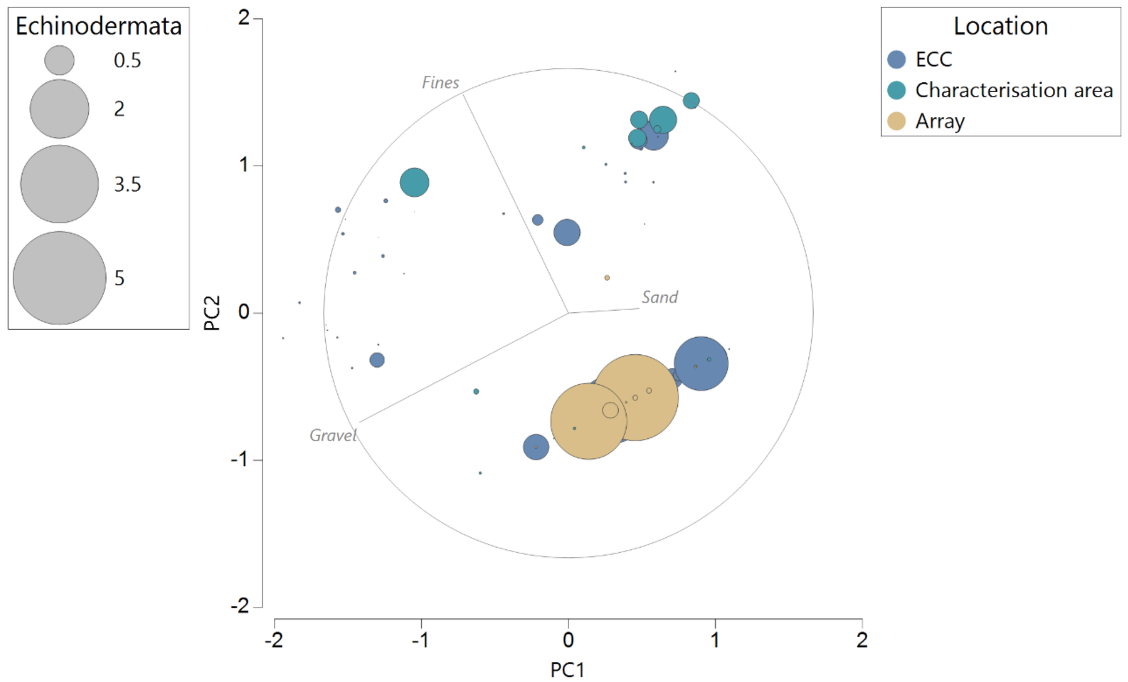
Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m^{2}of Annelida ECC = Export cable corridor



Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m^{2}of Arthropoda ECC = Export cable corridor



Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m^{2}of Mollusca ECC = Export cable corridor



Notes
Circles proportional in diameter to the biomass ash free dry weight [AFDW] g/0.1 m^2 of Echinodermata ECC = Export cable corridor

Figure 4.61: 2D PCA of sediment composition with superimposed location and circles proportional in diameter to the abundance of major taxonomic groups of enumerated fauna from the grab samples, ECC, characterisation area and array, Dogger Bank D 2024

4.2.4.2 Colonial Epifauna

Colonial epifauna was recorded at 83 of the 93 stations sampled by grab sampling.

4.2.4.2.1 Phyletic Composition

Table 4.39 presents the community structure of sessile colonial epifauna and Table 4.40 presents the top ten most frequently occurring colonial epifaunal taxa from the grab samples. Figure 4.62 illustrates the relationships between sediment type and the occurrence of colonial epifauna, highlighting generally higher number of colonial epifauna at stations with coarse and diverse sediment. Figures 4.63, 4.64 and 4.65 illustrate the colonial epifaunal community structure at single stations along the ECC, in the characterisation area and in the array.

Table 4.39: Taxonomic groups of colonial epifauna from the grab samples, export cable corridor, characterisation area and array, Dogger Bank D 2024

Taxonomic Group	Number of Taxa	Composition of Taxa [%]
Porifera	3	4.6
Cnidaria	22	33.8
Bryozoa	37	56.9
Other phyla	3	4.6
Total	**65**	**100**

Notes
Macrofaunal samples were processed through a 1 mm mesh sieve
Other phyla include: Chromista, Entoprocta

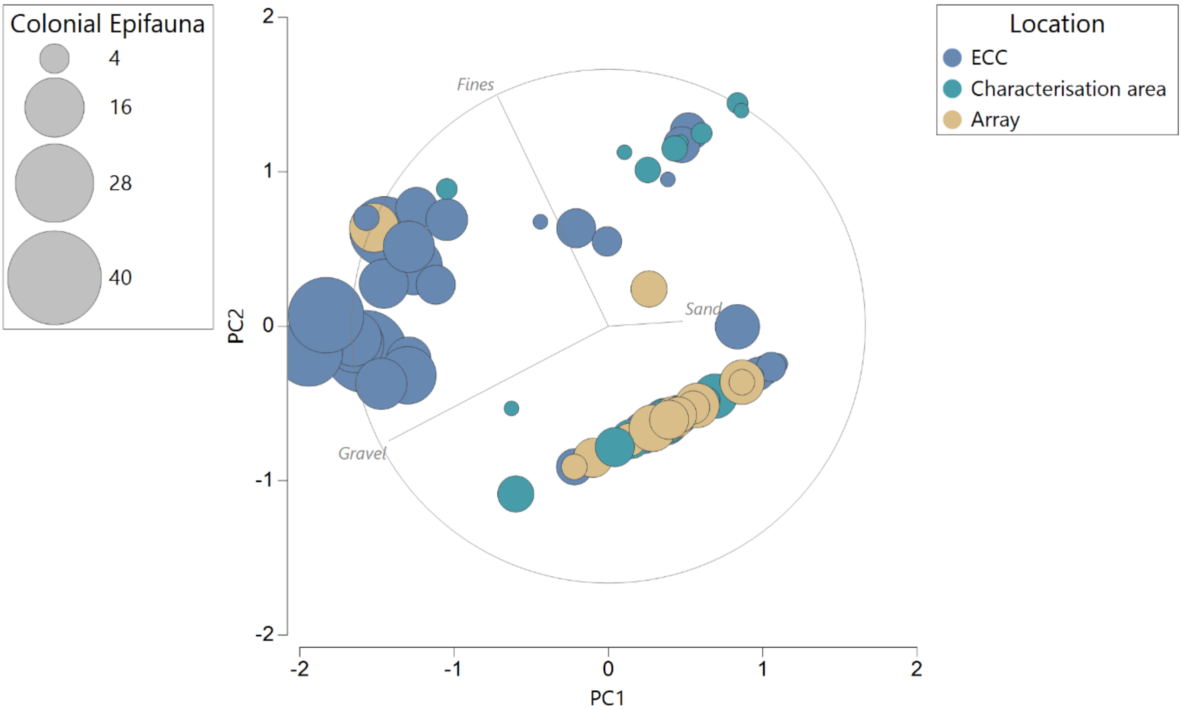
Four main phyla of colonial epifauna were recorded across the DBD survey area, of these, Bryozoa comprised most of the taxa composition (56.9 %), followed by Cnidaria (33.8 %) and Porifera (4.6 %). Other phyla comprised 4.6 % of the colonial epifauna and were represented by species from the families Barentsiidae, Folliculinidae and Pedicellinidae.

The family Folliculinidae was the most frequently occurring, along with the Cnidaria *Lovenella clausa*, *Clytia hemisphaerica*, species from the family Tubulariidae and hydroids from the order Anthoathecata.

Folliculinidae, the cnidarians *Lovenella clausa, Clytia hemisphaerica,* species from the families Campanulariidae, Tubulariidae and the order Anthoathecata were amongst the top ten most frequently occurring epifauna. Bryozoans *Electra Pilosa, Escharella immersa* had equal frequency of occurrence.

Table 4.40: Top ten most frequently occurring colonial epifaunal taxa from the grab samples, export cable corridor, characterisation area and array, Dogger Bank D 2024

Taxon	Frequency [%]
Folliculinidae	57.0
Lovenella clausa	50.5
Clytia hemisphaerica	49.5
Tubulariidae	43.0
Anthoathecata	40.9
Ctenostomatida	32.3
Cribrilinidae	29.0
Campanulariidae	21.5
Cliona	19.4
Electra pilosa	16.1
Escharella immersa	16.1



Notes
PC = Principal component
ECC = Export cable corridor

Figure 4.62: 2D PCA of sediment composition with superimposed location and circles proportional in diameter to the number of colonial epifauna from the grab samples, ECC, characterisation area and array, Dogger Bank D 2024

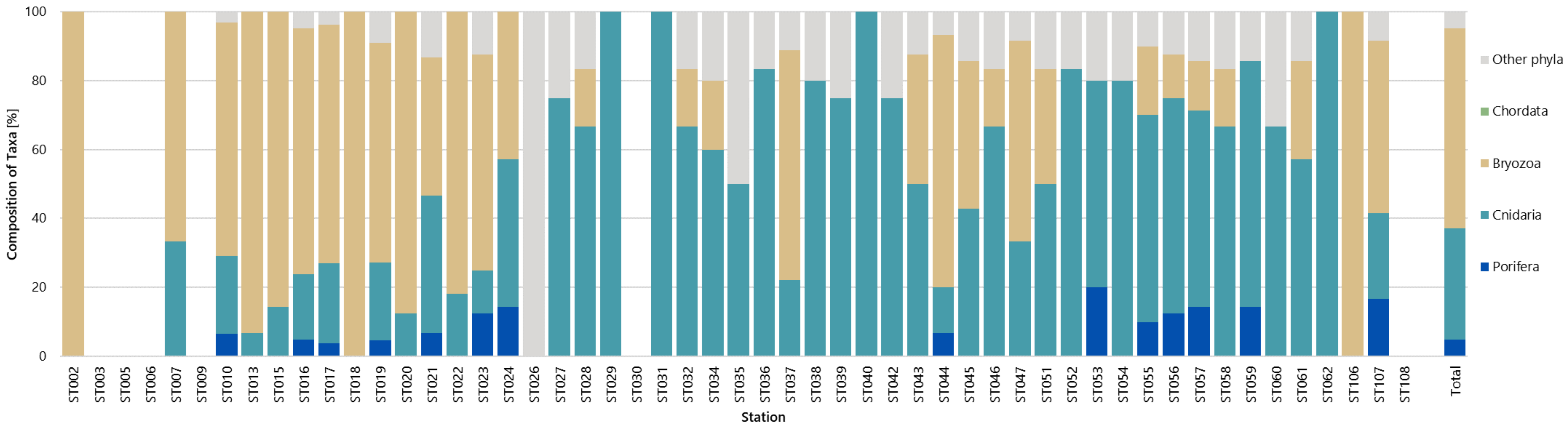


Figure 4.63: Phyletic composition of epifaunal taxa from the grab samples, export cable corridor (ECC), Dogger Bank D 2024

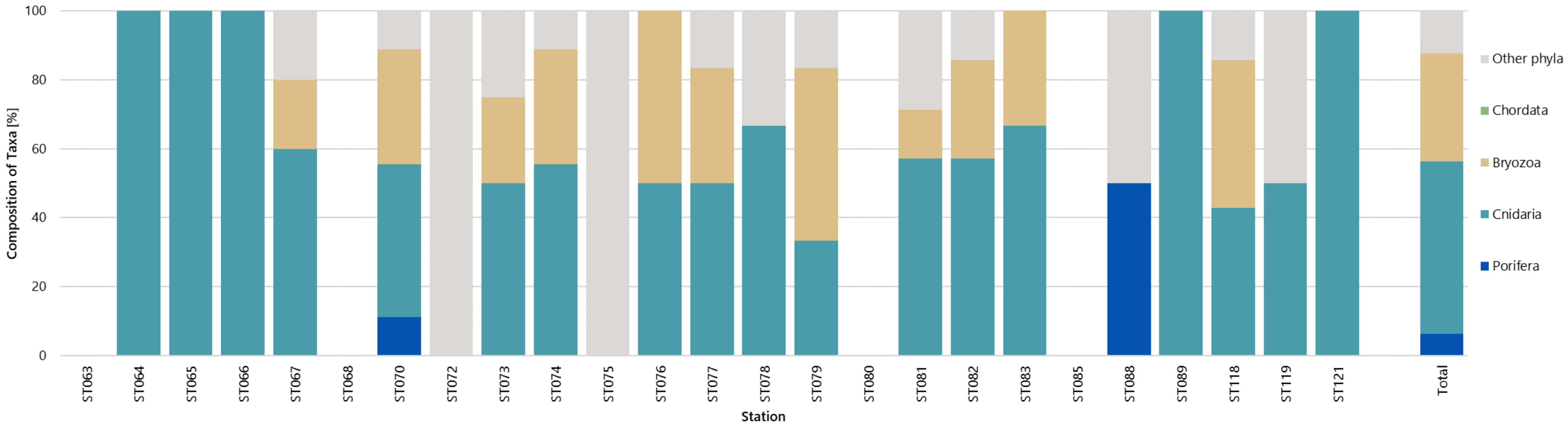


Figure 4.64: Phyletic composition of epifaunal taxa from the grab samples, characterisation area, Dogger Bank D 2024

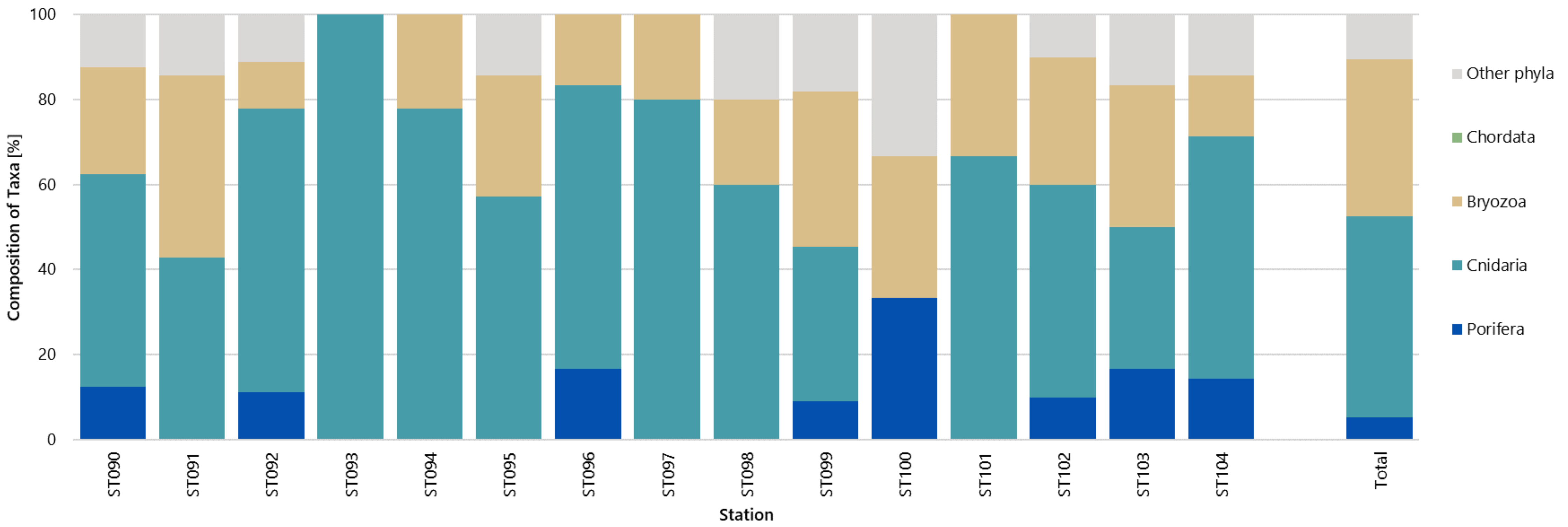


Figure 4.65: Phyletic composition of epifaunal taxa from the grab samples, array, Dogger Bank D 2024

4.2.5 Environmental DNA Analysis

High-quality bony fish taxa sequence data were obtained for 32 of the 34 eDNA samples analysed. For two samples (ST004 TOP and ST033 TOP), no taxa were reported. For ST004 TOP, this was due to no target OTUs detected, while for ST033 TOP the data quality was insufficient. These samples were excluded from analysis.

4.2.5.1 Phyletic composition

Figure 4.66 presents bar plots of the relative proportions of OTUs of the bony fish taxa detected by eDNA sampling rationalised to 'order' taxonomic level for TOP and BOT samples.

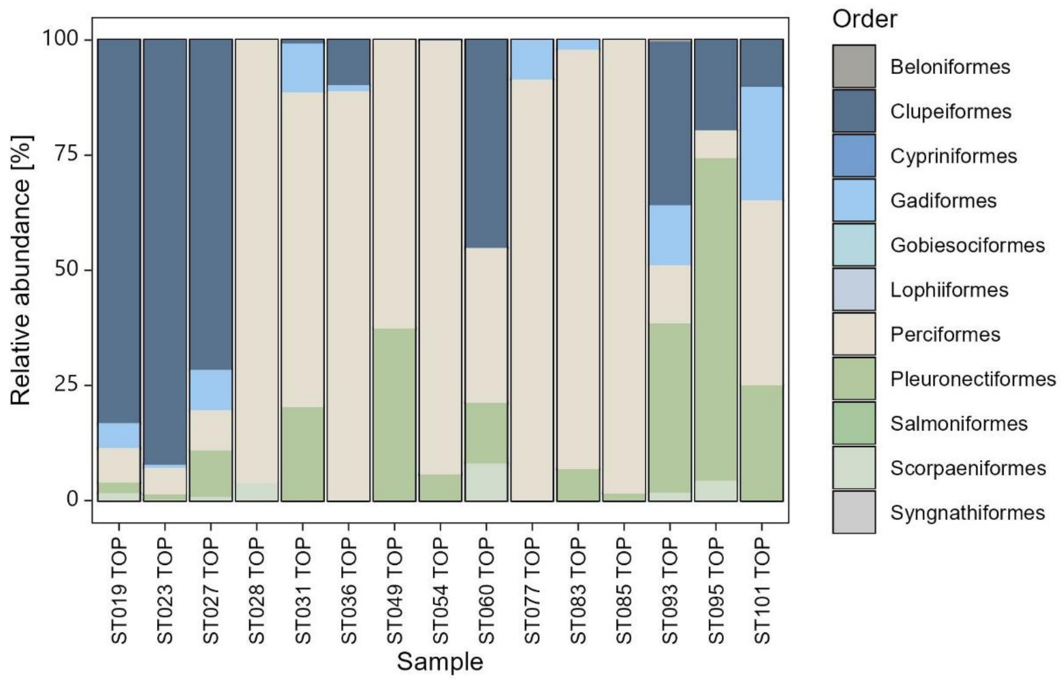
A total of 50 bony fish taxa were detected, with 68 % (34) at least 99 % similar to a species in the GBIF databases. Of the OTUs detected, 50 (100 %) were successfully classified to order level, 49 (98 %) to family level, 43 (86 %) to genus level, and 34 (68 %) to species level. The taxa belonged to 13 orders, 26 families, and 37 genera. Taxa recorded in the TOP and BOT samples were largely comparable, with a higher proportion of bottom-dwelling taxa such as flatfish (Pleuronectiformes) in the BOT samples.

Figures 4.67and 4.68present bubble plots of the relative proportions of OTUs of bony fish taxa detected by eDNA sampling, as well as the IUCN red list category for TOP and BOT samples.

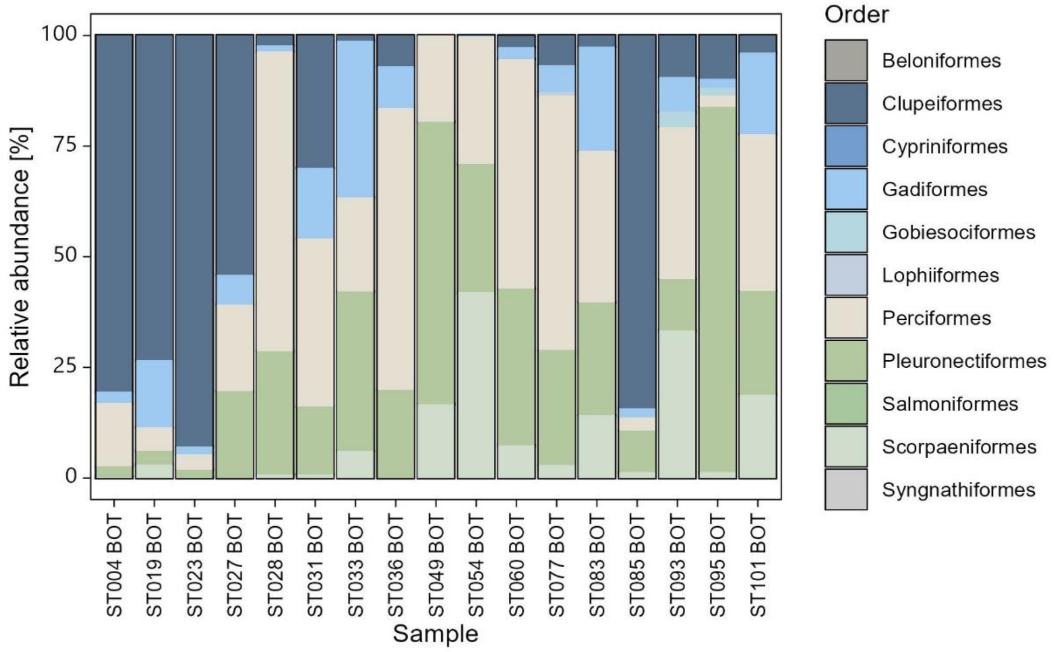
The taxon with the highest relative proportions of OTUs in both the TOP and BOT samples was Atlantic mackerel (*S. scrombus*). Other commonly detected taxa by eDNA analysis included Clupeiformes such as European sprat (*S. sprattus*) and Atlantic herring (*Clupea harengus*), alongside Pleuronectiformes such as common dab (*Limanda limanda*) and lemon sole (*Microstomus kitt*).

Of the bony fish OTUs detected by eDNA analysis, eight matched UK BAP species (Atlantic mackerel (*S. scombrus*), whiting (*Merlangius merlangus*), Atlantic herring (*C. harengus*), European plaice (*P. platessa*), Atlantic cod (*G. morhua*), common sole (*Solea solea),* European hake (*M. merluccius*), and Atlantic horse mackerel (*T. trachurus*)), three matched species listed as 'vulnerable' on the IUCN red list (haddock (*M. aeglefinus*), Atlantic cod (*G. morhua*), and Atlantic horse mackerel (*T. trachurus*)), and two matched species listed by OSPAR as 'Threatened and/or declining species' (Atlantic cod (*G. morhua*) and Atlantic salmon (*Salmo salar*)). In addition, OTUs matching the family Ammodytidae (sand eels) were detected, and therefore there is the potential for the presence of the UK BAP species *A. marinus*.

The freshwater fish species *Leucaspius delineatus* was detected in the survey area. This species is listed on the Global Register of Introduced and Invasive Species (GRIIS) for the UK.



A

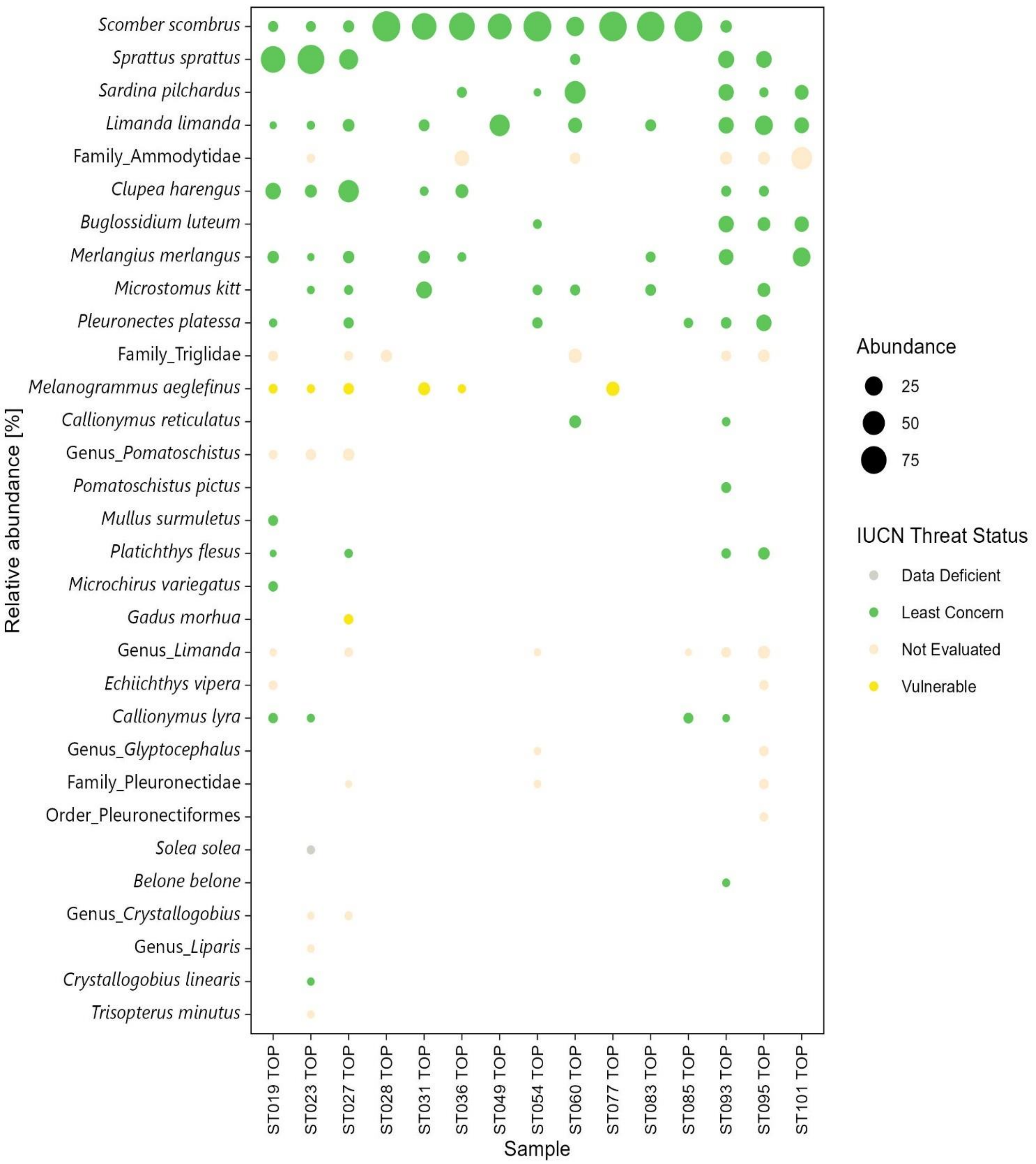


B

Notes

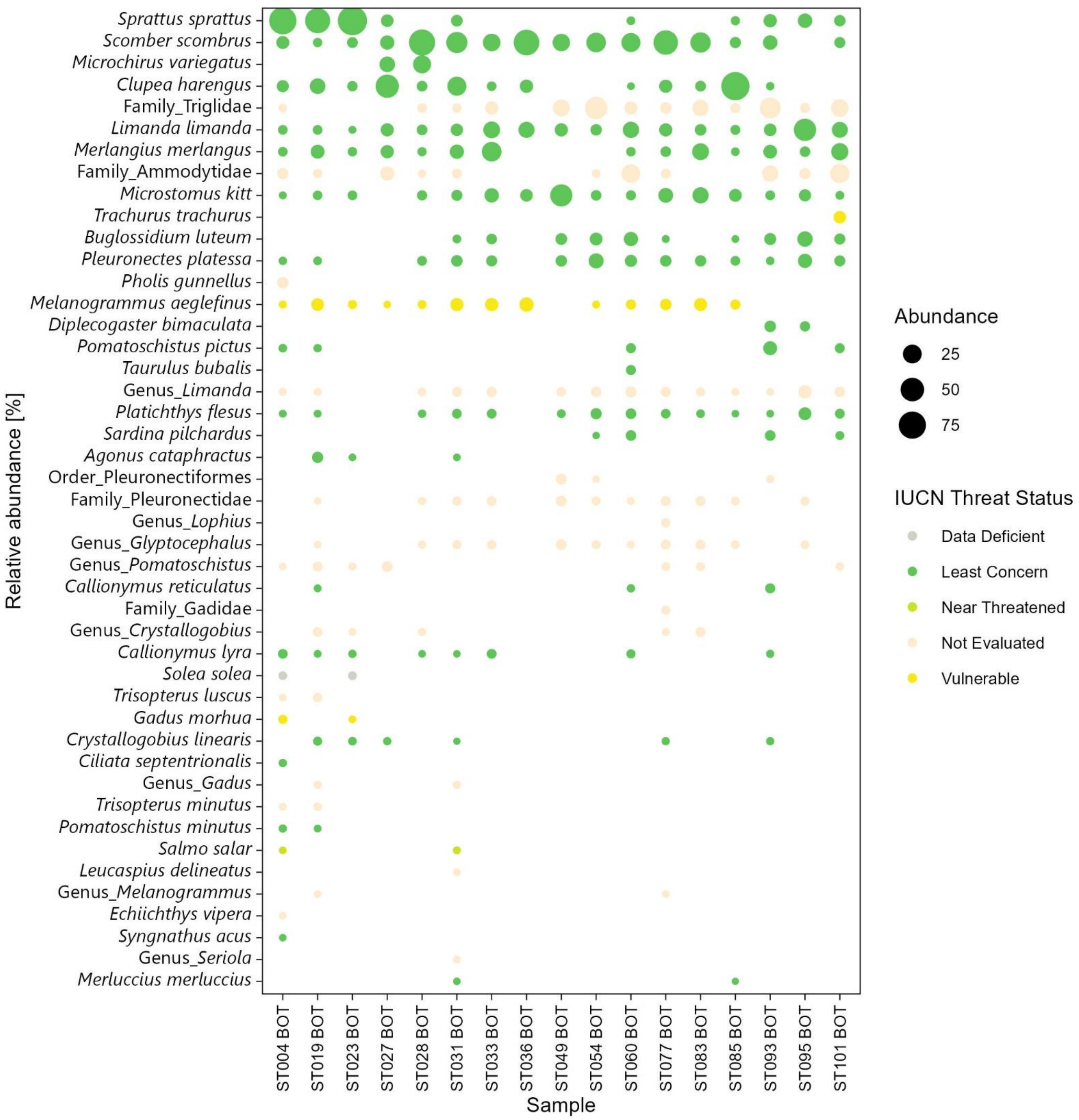
Non-target taxa (cartilaginous fish) were excluded from the plot

Figure 4.66: Bar plot of relative proportions of OTUs of target bony fish taxa detected to order level in the near-surface (~1 m below surface) (TOP) (A) and near-seafloor (~1 m from seafloor) (BOT) (B) eDNA water samples, Dogger Bank D 2024



Notes
Non-target taxa (cartilaginous fish) were excluded from the plot

Figure 4.67: Bubble plot of relative proportions of OTUs and International Union for Conservation of Nature (IUCN) red list category of bony fish taxa detected in the TOP (~1 m below surface) eDNA water samples, Dogger Bank D 2024



Notes

Non-target taxa (cartilaginous fish) were excluded from the plot

Figure 4.68: Bubble plot of relative proportions of OTUs and International Union for Conservation of Nature (IUCN) red list category of bony fish taxa detected in the BOT (~1 m off seafloor) eDNA water samples, Dogger Bank D 2024

4.2.5.2 Fish taxa: eDNA vs. photographic habitat data

Figure 4.69 illustrates the overlap between fish taxa, identified to family or higher taxonomic level, detected by eDNA compared to seafloor photographic and macrofaunal data analyses.

The number of bony fish taxa identified by eDNA analysis was 25, whilst the number of bony fish taxa identified by the photographic habitat data analysis and macrofaunal data analysis was 12. The total number of bony fish taxa identified for the survey area was 27, with 10 taxa (37 %) being identified by all sampling methods. These comprised of Pholidae, Triglidae, Callionymidae, Gadidae, Pleuronectidae, Soleidae, Ammodytidae, Merluccidae, Gobiidae, and the order Pleuronectiformes. The eDNA samples analysis detected a further 15 taxa (56 %), including the families Belonidae, Clupeidae, Cyprinidae, Lotidae, Gobiesocidae, Lophiidae, Carangidae, Mullidae, Scombridae, Trachinidae, Salmonidae, Agonidae, Cottidae, Liparidae, and Syngnathidae, whilst the photographic and macrofaunal data analyses detected a further 2 taxa (7 %), comprising of the order Cottoidei and the class Osteichthyes.

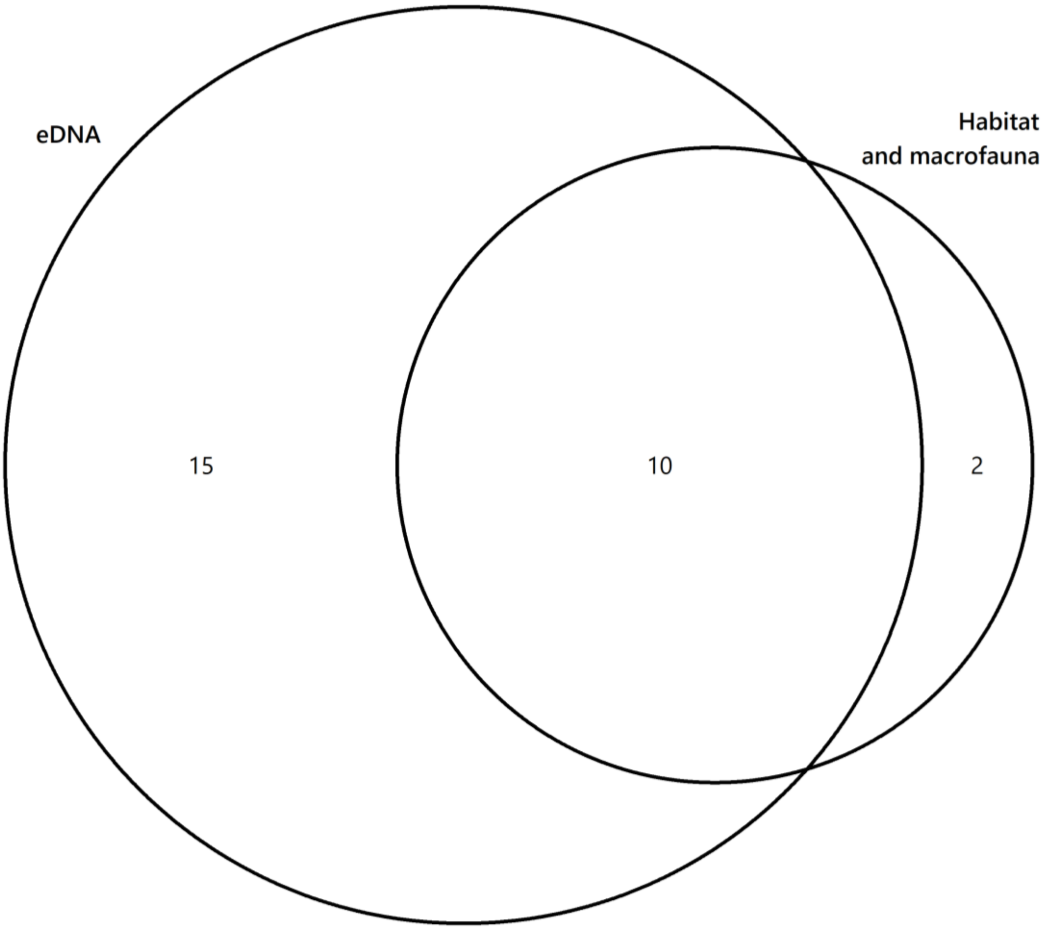


Figure 4.69: Venn diagram comparing bony fish families identified by eDNA compared to photographic habitat data analysis and macrofaunal data analysis across the survey area Dogger Bank D 2024

4.2.6 Seafloor Habitats and Biotopes

The physical and biological characteristics of the multivariate groups identified through the multivariate analysis (section 4.2.4.1.3) were evaluated in conjunction with the results of the photographic data analysis, to provide a comprehensive habitat assessment. The video provides an overview of the seafloor over a wider area and can identify isolated features such as cobbles and/or boulders. By comparison, grab sampling provides detailed information of the sediment composition and associated fauna at a single point source and is essential for the biotope classification of sedimentary habitats.

The average similarity of the multivariate groups ranged from 29.8 % to 47.0 %, therefore, the communities within each multivariate group were also assessed per station where deemed pertinent. The sediment description for the biotope allocation follows the Folk (1954) sediment classification in line with the EUNIS and JNCC Marine Habitat Classifications (JNCC, 2022).

4.2.6.1 Biotope Classifications

Table 4.41 presents the EUNIS hierarchical classification and equivalent JNCC classification of the habitat types identified across the DBD survey area.

Table 4.42 presents the biotopes identified considering the attributes of the macrofaunal multivariate groups and the photographic data analysis. Example stills from the photographic data are also provided. Additional stills are provided in Appendix G.

Table 4.41: Habitat classifications, export cable corridor, array and characterisation area, Dogger Bank D 2024

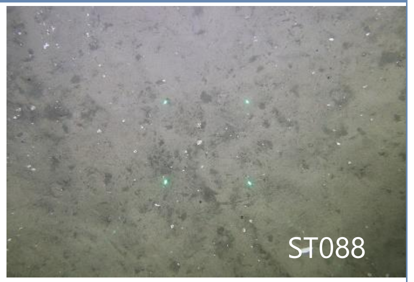
EUNIS Habitat Classification (EEA, 2022)					Equivalent JNCC (2022) Classification
Environment Level 1	Biological Zone and Substrate Level 2	Biogeographical Marine Region Level 3	Biotope Complex Level 4	Biotope Level 5	
M Marine benthic habitats	MB3 Infralittoral coarse sediment	MB32 Atlantic infralittoral coarse sediment	MB323 Atlantic infralittoral coarse sediment	MB3231 Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)	SS.SCS.ICS.SSh Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)
	MB4 Infralittoral mixed sediment	MB42 Atlantic infralittoral mixed sediment.	–	–	SS.SMx.IMx Infralittoral mixed sediment
	MB5 Infralittoral sand	MB52 Atlantic infralittoral sand	MB523 Faunal communities of full salinity Atlantic infralittoral sand	MB5233 *Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand	SS.SSa.IFiSa.NcirBat *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
				MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand	SS.SSa.IMuSa.FfabMag *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand
	MC3 Circalittoral coarse sediment	MC32 Atlantic circalittoral coarse sediment	MC321 Faunal communities of Atlantic circalittoral coarse sediment	MC3212 *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
				MC3213 *Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand	SS.SCS.CCS.Pkef *Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand
	MC4 Circalittoral mixed sediment	MC42 Atlantic circalittoral mixed sediment	MC421 Faunal communities of Atlantic circalittoral mixed sediment	–	SS.SMX.CMx Circalittoral mixed sediment
	MC5 Circalittoral sand	MC52 Atlantic circalittoral sand	MC521 Faunal communities of Atlantic circalittoral sand	–	SS.SSa.CFiSa Circalittoral fine sand
				MC5211 *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	SS.SSa.CFiSa.EpusOborApri *Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand
				MC5212 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand
				MC5214 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	SS.SSa.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment
				MC5215 *Amphiura brachiata** with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	SS.SSa.CMuSa.AbraAirr *Acrocnida brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand
	MD5 Offshore circalittoral sand	MD52 Atlantic offshore circalittoral sand	MD521 Faunal communities in Atlantic offshore circalittoral sand	–	SS.SSa.OSa Offshore circalittoral sand

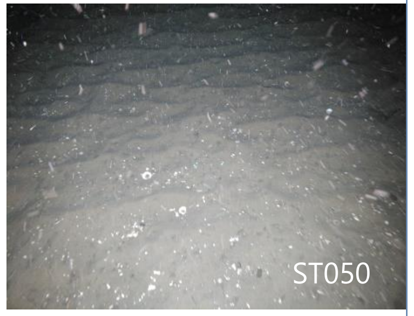
Notes
* = *Amphiura brachiata* is currently *Acrocnida brachiata*, but the EUNIS biotope name has retained the species' former name
EEA = European Environment Agency
EUNIS = European Nature Information System
JNCC = Joint Nature Conservation Committee

Table 4.42: Summary of EUNIS habitat classifications, export cable corridor, array and characterisation area, Dogger Bank D 2024

EUNIS Habitat Classification (EEA, 2022)	Multivariate Faunal Group	Physical characteristics	Epibiota (from photographic habitat data)	Characterising Taxa (from grab samples)		Representative photographic data analysis
				Infaunal	Epifaunal	
MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	Group A (ST054, ST055, ST056, ST057, ST058, ST059, ST090, ST092, ST095, ST096, ST097, ST098, ST101, ST102, ST103, ST104)	Moderately sorted slightly gravelly (fine) sand Depth range: 22.4 m to 37.9 m	*Astropecten irregularis*	*Spiophanes bombyx*	*Clytia hemisphaerica*	
			Asterias rubens	*Phoronis*	*Lovenella clausa*	
			Pleuronectiformes	*Phtisica marina*	*Tubulariidae*	
			Paguroidea	*Acrocnida brachiata*	*Folliculinidae*	
			Hydrozoa/Bryozoa	*Fabulina fabula*	Anthoathecata	
MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand	Group A (ST052, ST053, ST061, ST062, ST094)	Moderately well sorted slightly gravelly (fine) sand Depth range: 30.6 m to 39.4 m	*Asterias rubens*	*Spiophanes bombyx*	*Lovenella clausa*	
			Astropecten irregularis	*Phoronis*	*Clytia hemisphaerica*	
			Paguroidea	Nemertea	*Tubulariidae*	
			Pleuronectiformes	*Fabulina fabula*	*Folliculinidae*	
			Polybius sp.	*Owenia*	Anthoathecata	
MC5211 *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	Group A (ST026, ST034, ST035, ST036, ST040, ST042, ST043, ST045, ST046, ST051, ST067, ST068, ST070, ST074, ST077, ST079, ST081, ST082, ST118, ST119)	Poorly Sorted gravelly (fine) sand Depth range: 33.6 m to 58.3 m	*Alcyonidium diaphanum*	*Phaxas pellucidus*	*Folliculinidae*	
			Astropecten irregularis	*Abra prismatica*	*Lovenella clausa*	
			Pleuronectiformes	*Owenia*	*Clytia hemisphaerica*	
			Paguroidea	*Magelona filiformis*	*Tubulariidae*	
			Hydrozoa/Bryozoa	*Chaetozone christiei*	Ctenostomatida	
MC5212 *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand	Group A (ST027, ST075, ST093)	Moderately sorted gravelly (medium) sand Depth range: 27.2 m to 64.9 m	*Pleuronectiformes*	*Nephtys cirrosa*	*Folliculinidae*	
			Paguroidea	*Bathyporeia elegans*	*Tubulariidae*	
			Astropecten irregularis	*Magelona filiformis*	*Lovenella clausa*	
			Polybius sp	*Abra prismatica*	*Clytia hemisphaerica*	
			Ammodytidae	*Spiophanes bombyx*	Anthoathecata	

EUNIS Habitat Classification (EEA, 2022)	Multivariate Faunal Group	Physical characteristics	Epibiota (from photographic habitat data)	Characterising Taxa (from grab samples)		Representative photographic data analysis
				Infaunal	Epifaunal	
MC3212 *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	Group A (ST091, ST099)	Poorly and very poorly sorted gravelly (medium) sand and sandy gravel Depth: 32.3 m and 32.5 m	*Asterias rubens*	*Notomastus*	*Folliculinidae*	
			Alcyonium digitatum	Nemertea	*Clytia hemisphaerica*	
			Serpulidae	*Lanice conchilega*	Ctenostomatida	
			Hydrozoa/Bryozoa	*Pholoe baltica*	*Escharella immersa*	
			Flustridae	*Eteone longa*	*Lovenella clausa*	
	Group D 13 stations	Very poorly sorted muddy sandy gravel Depth range: 27.4 m to 56.5 m	*Alcyonidium diaphanum*	*Lumbrineris cf. cingulata*	*Schizomavella*	
			Alcyonium digitatum	*Mediomastus fragilis*	CTENOSTOMATIDA	
			Asterias rubens	*Ampelisca spinipes*	*Bicellariella ciliata*	
			Flustra foliacea	*Spiophanes kroyeri*	*Escharella immersa*	
			Urticina sp.	Nemertea	Leucosolenida	
MD521 Faunal communities in Atlantic offshore circalittoral sand	Group B 16 stations	Moderately sorted slightly gravelly (fine) sand Depth range: 50.0 m to 77.0 m	*Asterias rubens*	*Sthenelais limicola*	Anthoathecata	
			Epizoanthus sp.	*Galathowenia oculata*	Leptothecata	
			Hydrozoa/Bryozoa	*Scoloplos armiger*	*Lovenella clausa*	
			Pennatula phosphorea	Phoronis	*Tubulariidae*	
			Pleuronectiformes	*Amphiura filiformis*	*Folliculinidae*	
MC5214 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	Group C 4 stations	Moderately well sorted slightly gravelly (fine) sand Depth range: 18.4 m to 19.8 m	*Lanice conchilega*	*Nucula nitidosa*	*Alcyonidium diaphanum*	
			Callionymus sp.	*Mactra stultorum*	-	
			Triglidae	*Bathyporeia tenuipes*		
			Polybius sp.	*Leiochone*		
			Alcyonidium diaphanum	*Abra alba*		

EUNIS Habitat Classification (EEA, 2022)	Multivariate Faunal Group	Physical characteristics	Epibiota (from photographic habitat data)	Characterising Taxa (from grab samples)		Representative photographic data analysis
				Infaunal	Epifaunal	
MC521 Faunal communities of Atlantic circalittoral sand	Group A (ST038, ST073, ST078, ST088)	Moderately well sorted slightly gravelly (fine) sand Depth range: 37.7 m to 46.7 m	*Alcyonidium diaphanum*	*Abra prismatica*	Folliculinidae	
			Epizoanthus sp.	*Sthenelais limicola*	Anthoathecata	
			Hydrozoa/Bryozoa	*Nephtys cirrosa*	*Lovenella clausa*	
			Paguroidea	*Echinocyamus pusillus*	*Epizoanthus papillosus*	
			Polybius sp.	-	*Cliona*	
	Ungrouped station ST039	Moderately well sorted slightly gravelly (fine) sand Depth: 39.9 m	*Astropecten irregularis*	*Ampelisca brevicornis*	Folliculinidae	
			Hydrozoa/Bryozoa	*Perioculodes longimanus*	Anthoathecata	
			Pleuronectes platessa	*Urothoe poseidonis*	Leptothecata	
			Pleuronectiformes	*Phaxas pellucidus*	*Lovenella clausa*	
			Spatangoida	*Chamelea striatula*	-	
MB5233 *Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand	Group A (ST007, ST060, ST100)	Moderately well sorted slightly gravelly (fine) sand Depth range: 13.0 m to 29.8 m	*Astropecten irregularis*	*Nephtys cirrosa*	Folliculinidae	
			Polybius sp.	*Spiophanes bombyx*	*Clytia hemisphaerica*	
			Paguroidea	*Eteone longa*	*Cliona*	
			Pleuronectiformes	*Spio symphyta*	*Lovenella clausa*	
			Hydrozoa/Bryozoa	*Bathyporeia guilliamsoniana*	*Sertularella*	
MC3213 *Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand	Group E 4 stations	Poorly sorted sandy gravel (granule/coarse) Depth range: 39.5 m to 42.1 m	*Alcyonidium diaphanum*	*Protodorvillea kefersteini*	Folliculinidae	
			Asteroidea	*Glycera lapidum*	Campanulariidae	
			Hydrozoa/Bryozoa	*Pisione remota*	Tubuliporidae	
			Cancer pagurus	*Polygordius*	Cribrilinidae	
			Pleuronectiformes	Nemertea	*Escharella immersa*	

EUNIS Habitat Classification (EEA, 2022)	Multivariate Faunal Group	Physical characteristics	Epibiota (from photographic habitat data)	Characterising Taxa (from grab samples)		Representative photographic data analysis
				Infaunal	Epifaunal	
MB3231 Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)	Station ST009 +	Very poorly sorted sandy gravel (fine pebble) Depth: 17.9 m	*Alcyonidium diaphanum*	*Diastylis bradyi*	-	
			Flustra foliacea	*Achelia echinata*		
			Lanice conchilega	*Chaetozone zetlandica*		
			Hydrozoa/Bryozoa	*Malmgrenia darbouxi*		
			Rhodophyta	*Eumida bahusiensis*		
	Station ST010 ✕	Very poorly sorted sandy gravel (fine pebble) Depth: 17.0 m	*Alcyonidium diaphanum*	*Balanus crenatus*	Porifera	
			Flustra foliacea	*Euclymene oerstedii*	Leucosolenida	
			Hydrozoa/Bryozoa	*Achelia echinata*	*Calycella syringa*	
			Necora puber	*Urothoe elegans*	Haleciidae	
			Rhodophyta	*Dendrodoa grossularia*	*Sertularia*	
MC52 Atlantic circalittoral sand	Stations ST033[‡], ST037[#], ST041[‡], ST044[#], ST048[‡], ST049[‡], ST050[‡], ST071[‡], ST086[‡], ST087[‡], ST099[#]	Moderately well sorted (fine) sand Depth range: 36.1 m to 42.3 m	*Astropecten irregularis*	-	-	
			Paguroidea			
			Hydrozoa/Bryozoa			
			Pleuronectiformes			
			Alcyonidium diaphanum			
MD52 Atlantic offshore circalittoral sand[‡]	Stations ST025, ST069, ST084	Moderately sorted (fine) sand Depth range: 57.4 m to 69.1 m	*Astropecten irregularis*	-	-	
			Alcyonidium diaphanum			
			Epizoanthus sp.			
			Paguroidea			
			Pleuronectiforms			
MB32 Atlantic infralittoral coarse sediment[‡]	Stations ST04A, ST008, ST012, ST105A	Very poorly sorted sandy gravel (fine / medium pebble) Depth range: 17.3 m to 22.1 m	*Alcyonidium diaphanum*	-	-	
			Asteroidea			
			Hydrozoa/Bryozoa			
			Urticina felina			
			Homarus gammarus			

EUNIS Habitat Classification (EEA, 2022)	Multivariate Faunal Group	Physical characteristics	Epibiota (from photographic habitat data)	Characterising Taxa (from grab samples)		Representative photographic data analysis
				Infaunal	Epifaunal	
MB42 Atlantic infralittoral mixed sediment	Stations ST001‡, ST002#, ST003#, ST005#, ST011‡, ST014‡	Gravelly sand with pebbles, cobbles and boulders† Depth range: 18.4 m to 20.0 m	*Alcyonidium diaphanum* *Flustra foliacea* Hydrozoa/Bryozoa Asteroidea Actiniaria	-	-	
MC42 Atlantic circalittoral mixed sediment‡	Station ST014	Gravelly sand with pebbles, cobbles and boulders† Depth: 27.7 m	*Alcyonidium diaphanum* *Alcyonium digitatum* Hydrozoa/Bryozoa *Henricia* sp. *Munida* sp.	-	-	

Notes
* = *Amphiura brachiata* is currently *Acrocnida brachiata*, but the EUNIS biotope name has retained the species' former name
† = Qualitative description from photographic data analysis
‡ = Classifications based on particle size distribution and photographic data analysis
# = Sections of the transect classified based on photographic data analysis
EEA = European Environment Agency
Sediment classification based on Folk (1954) in line with classification used in the EUNIS and JNCC Marine Habitat Classification
Epifauna from the grab samples lists the most frequently occurring taxa
Epibiota from photographic habitat data lists the most frequently occurring taxa
EUNIS = European Nature Information System
Description based on Wentworth (1922) scale
Depth is below sea level (BSL)
Multivariate groups identified by hierarchical clustering analysis of enumerated fauna
Characterising taxa from grab samples are from the top five identified through the similarity percentage analysis (SIMPER) with a 70 % cut off for percentage contribution to similarity; for stations ST009, ST010, ST039 and ST072, the top five most abundant taxa are presented

4.2.6.1.1 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand (MB5236)

The biotope '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236) is described as compacted sands and slightly muddy sands in the infralittoral and littoral fringe characterised by the bivalve *F. fabula* and polychaetes of the genus *Magelona*. Other taxa include mobile amphipods and robust polychaetes (EEA, 2022).

This biotope was assigned to 21 stations in macrofaunal multivariate group A. These stations were characterised by moderately to moderately well sorted slightly gravelly sand (Folk, 1954). Characterising taxa comprised polychaetes such as *S. bombyx*, and species of *Owenia*, *Magelona*, bivalves such as *F. fabula*, *K. bidentata* and species of *Abra* and amphipods of the genus *Bathyporeia*. At 16 stations, this biotope occurred in combination with '*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand' (MC5215), detailed in Section 4.6.1.2.

Colonial epifauna from the grab samples comprised 18 taxa of which the hydroids *L. clausa*, *C. hemisphaerica*, the order Anthoathecata and species of the family Tubulariidae were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small-scale rippled sand with a varying proportion of shell fragments. Epibiota was generally sparse and comprised the echinoderms *A. irregularis*, *A. rubens*, *L. sarsii,* and species of the family Ophiuroidea, the crustaceans *C. cassivelaunus*, species of the superfamily Paguroidea, and the genus *Polybius* and faunal turfs of hydrozoans and bryozoans. Fish included a variety of Pleuronectiformes such as species of the families Soleidae, Triglidae and Gadidae, and species of the genus *Callionymus*. Faunal burrows were recorded at most stations.

4.2.6.1.2 *Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand (MC5215)

The biotope '*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand' (MC5215) is described as circalittoral non-cohesive muddy sand characterised by the echinoderms *Acrocnida* (formerly *Amphiura) brachiata, Astropecten irregularis*, *Asterias rubens, Echinocardium cordatum* and species of *Ophiura* (EEA, 2022).

This biotope was assigned to 16 stations in macrofaunal multivariate group A, as an epibiotic biotope overlaying the biotope '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236). Typical taxa comprised *A. brachiata*, *K. bidentata, L. conchilega, M. filiformis* and *E. cordatum* recorded in the grab samples. Through the photographic data analysis A. *irregularis*, *A. rubens,* and species of *Ophiura* were recorded, along with *A. digitatum* and species of the genus *Pagurus* which are amongst the charactering taxa of this biotope.

4.2.6.1.3 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (MC5212)

The biotope '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' (MC5212) is described as circalittoral and offshore medium to fine sands communities characterised by the bivalve *A. prismatica*, the amphipod *B. elegans*, polychaetes and echinoderms (EEA, 2022).

This biotope was assigned to 3 stations in macrofaunal multivariate group A. These stations were characterised by moderately sorted 'sand' (Folk, 1954). Characterising taxa included *A. prismatica*, *B. elegans* and polychaetes such as *N. cirrosa* and *S. bombyx* in addition to *E. pusillus* and species of *Phoronis*.

Colonial epifauna from the grab samples comprised six taxa of which the hydroid *L. clausa, C. hemisphaerica* and species of the families Tubulariidae, and Folliculinidae were the most frequently occurring.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small-scale rippled sand and gravelly sand with shell fragments. Epibiota was generally sparse and comprised the echinoderms *A. rubens*, *A. irregularis*, *L. sarsii*, crustaceans of the superfamily Paguroidea and the genus *Polybius*, the bryozoan *A. diaphanum* and faunal turfs of hydrozoans and bryozoans. Fish included species of the families Ammodytidae and Triglidae and the order Pleuronectiformes.

4.2.6.1.4 Echinocyamus pusillus, Ophelia borealis and Abra prismatica in circalittoral fine sand (MC5211)

The biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211) is described as circalittoral and offshore medium to fine sand characterised by the urchin *E. pusillus*, the polychaete *O. borealis* and the bivalve *A. prismatica* (EEA, 2022).

This biotope was assigned to 20 stations in macrofaunal multivariate group A. These stations were characterised by poorly sorted gravelly sand (Folk, 1954). Charactering taxa comprised *E. pusillus*, *O. borealis* and *A. prismatica*, as well as polychaetes including *S. bombyx, M. filiformis* and the genus *Owenia*.

Colonial epifauna from the grab samples comprised 16 taxa of which the bryozoan of the order Ctenostomatida, hydroids *L. clausa*, *C. hemisphaerica* and species of the families Tubulariidae were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small-scale rippled sand with shell fragments. Epifauna comprised the echinoderms *A. irregularis* ,*A. rubens* and L. *ciliaris*, cnidarians *A. digitatum* and species of the genus *Urticina*, crustaceans *C. pagurus,* the family *Paguroidea,* species of *Ebalia* and species of the genus *Polybius*, the bryozoan A. *diaphanum* and faunal turfs of hydrozoans and bryozoans. Fish of the families Gadidae, Triglidae and Soleidae, in addition to species of the genus

Callionymus. The order Pleuronectiformes including the species *Buglossidium luteum* were also observed. Faunal burrows were recorded at most stations.

4.2.6.1.5 *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (MC3212)

The biotope '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (MC3212) is described as gravels, coarse to medium sands, and shell gravels with small percentage of silt in the circalittoral zones. Faunal communities are characterised by polychaetes such as *M. fragilis* and species of *Lumbrineris*, along with Nemertea, amphipod crustaceans, and venerid bivalves, although the latter are often under-sampled in benthic grab surveys (EEA, 2022).

This biotope was assigned to stations ST091 and ST099 in macrofaunal multivariate group A. These stations were characterised by poorly and very poorly sorted gravelly sand and sandy gravel (Folk, 1954) featuring polychaetes such as the species *L. conchilega*, *P. baltica*, *E. longa* and the genus *Notomastus*, which were amongst the characterising taxa. The polychaetes *M. fragilis* and *S. bombyx* and the species of Nemertea were also recorded.

This biotope was also assigned to all stations in macrofaunal multivariate group D. These stations were characterised by very poorly sorted, muddy sandy gravel (Folk, 1954) and featured polychaetes such as *L. cf. cingulata*, *M. fragilis*, *S. spinulosa*, *G. lapidum* along with Nemertea. The bivalve *T. ovata* and the arthropods *Ampelisca spinipes* were also present within the top 10 most abundant species.

Colonial epifauna from the grab samples that was assigned this biotope comprised 55 taxa of which the hydroids *L. clausa*, *C. hemisphaerica*, the bryozoans *E. immersa*, *B. ciliata* and species of the genus *Schizomavella* and the order Ctenostomatida were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring muddy gravelly sand with shell fragments and varying number of pebbles, cobbles and infrequent boulders. Epibiota was generally more diverse and abundant than the sand dominated sediments. Epibiota comprised the bryozoans *F. foliacea*, *A. diaphanum* and *S. securifrons*, the echinoderms *E. esculentus, A. rubens* and species of the genus *Henricia*, the family Ophiuridae, the crustaceans *N. puber*, and species of the genera *Munida* and *Polybius,* the cnidarian *A. digitatum* and species of the genus *Nemertesia*, anemones of the genus *Urticina,* encrusting polychaetes of the family Serpulidae, the bivalve *P. maximus*, and fish of the order Pleuronectiformes. Faunal turfs of hydrozoans and bryozoans were also recorded.

4.2.6.1.6 Abra alba and Nucula nitidosa in circalittoral muddy sand or slightly mixed sediment (MC5214)

The biotope '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (MC5214) is described as muddy sands or gravelly muddy sand sediments. Faunal communities are typified by population of *A. alba and Nucula nitidosa*. Other conspicuous infauna may include *Nephtys sp.*, *S.* bombyx, *Chaetozone setosa*. Epifauna can include *Ophiura albida* and *Asterias rubens* (EEA, 2022).

This biotope was assigned to all stations in macrofaunal multivariate group C, characterised by moderately well sorted slightly gravelly sand (Folk, 1954) and featured *N. nitidosa*, *A. alba* and *B. tenuipes* amongst the characterising taxa.

Colonial epifauna from the grab samples comprised the bryozoan *Alcyonidium diaphanum*

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small scaled rippled sand with shell fragments alongside gravelly sand with pebbles, cobbles and boulders recorded at station ST002. Epibiota was generally sparse and comprised crustaceans of the genus *Polybius,* the bryozoans *F. foliacea* and *A. diaphanum*, faunal turfs of hydrozoans and bryozoans, cnidarians of the genus *Urticina*, the polychaete *L. conchilega* and fish of the family Triglidae, the order Pleuronectiformes and the genus *Callionymus*. Red algae in the phylum of Rhodophyta were also recorded.

4.2.6.1.7 *Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand (MB5233)

The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) is described as well-sorted medium and fine sand sediments in shallow, high energy environments. Faunal communities are characterised by population of *Nephtys cirrosa* and *Bathyporeia* sp. Other infauna may include *Magelona mirabilis* and *Chaetozone setosa* (EEA, 2022).

This biotope was assigned to stations ST007, ST060 and ST100 in macrofaunal multivariate group A. These stations were characterised by moderately well sorted slightly gravelly sand (Folk, 1954). Infauna featured an abundance of the polychaetes *N. cirrosa, S. bombyx* and *E. longa* along with the amphipod *Bathyporeia guilliamsoniana*.

Colonial epifauna from all the grab samples in this biotope comprised 9 taxa of which hydroids *L. clausa*, *C. hemisphaerica* and the genus *Sertularella,* the bryozoan *E. immersa*, *B. ciliata,* porifera of the genus *Cliona* were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small scale rippled muddy sand with shell fragments and a small area with sparse cobbles. Epibiota was generally sparse and comprised echinoderms which included A. *irregularis*, A. *rubens*, crustaceans of the genus *Polybius* and the family Paguroidea, the bryozoan *Bugulina flabellata*, faunal turfs of hydrozoans and bryozoans, the polychaete *L. conchilega* and fish of the families Gadidae and Soleidae, and the order Pleuronectiformes including *P. platessa*. Faunal burrows were recorded at most stations.

4.2.6.1.8 *Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand (MC3213)

The biotope '*Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand' (MB5233) is described as coarse gravelly / shelly sand sediments in depths of 10 m to 30 m. Faunal communities are characterised by population of *Protodorvillea kefersteini*. Other associated infauna may include species of Nemertea, *G. lapidum* and range of other polychaetes including *Sabellaria spinulosa* which occur at low abundances (EEA, 2022).

This biotope was assigned to all stations in macrofaunal multivariate group E, characterised by poorly sorted sandy gravel (Folk, 1954) and featured the polychaetes *P. kefersteini*, *G. lapidum*, *Pisione remota* and species of Nemertea.

Colonial epifauna from the stations to which this biotope was assigned, comprised 19 taxa of which hydroids of the families Campanulariidae and Tubuliporidae, bryozoans of the family Cribrilinidae were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small-scale rippled sand with shell fragments alongside gravelly sand with pebbles, cobbles and shell fragments recorded at station ST047. Epibiota was generally sparse and comprised echinoderms including *A. rubens*, the crustacean *C. pagurus*, the bryozoan *A. diaphanum*, faunal turfs of hydrozoans and bryozoans, fish of the family Triglidae and the genus of *Callionymus*. Faunal burrows were recorded at most stations.

4.2.6.1.9 Faunal communities in Atlantic offshore circalittoral sand (MD521)

The biotope complex 'Faunal communities in Atlantic offshore circalittoral sand (MD521) is described as a stable habitat with fine/muddy sands. The fauna is represented by a diverse range of polychaetes, bivalves, echinoderms and amphipods (EEA, 2022).

This biotope complex was assigned to the stations in macrofaunal multivariate group B, characterised by, moderately sorted sand (Folk, 1954) in water depth greater than 50.0 m. Infauna featured polychaetes such as *Sthenelais limicola, Galathowenia oculata, Scoloplos armiger* and the echinoderm *Amphiura filiformis*.

Colonial epifauna from the grab samples comprised 12 taxa of which the hydroids *L. clausa*, and species of the order Anthoathecata and the family Tubulariidae and cnidarians of the order Leptothecata were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small scale rippled muddy sand with shell fragments. Epibiota comprised echinoderms such as *A. irregularis*, *A. rubens*, *L. sarsii* alongside crustaceans including species of the superfamily Paguroidea and the genus *Ebalia,* Cnidaria including *A. digitatum, Pennatula phosphorea,* species of the genus *Epizoanthus,* the polycheate *Oxydromus flexuosus* and faunal turfs of hydrozoans and bryozoans. Fish of the family Gadidae including *Melanogrammus aeglefinus* and species of the family Triglidae, the order Pleuronectiformes including the family Soleidae and *M. kitt* were also recorded.

4.2.6.1.10 Faunal communities of Atlantic circalittoral sand (MC521)

The biotope complex 'Faunal communities of Atlantic circalittoral sand' (MC521) is described as non-cohesive muddy sands with a silt content of 5 % to 20 % supporting communities characterised by polychaetes, bivalves and echinoderms. These circalittoral habitats tend to be more stable than their infralittoral counterparts and as such support a richer infaunal community (EEA, 2022).

This biotope complex was assigned to stations ST038, ST073, ST078 and ST088 in macrofaunal multivariate group A, characterised by moderately well sorted slightly gravelly sand (Folk, 1954). Infaunal taxa featured the echinoderm *E. pusillus*, the polychaetes *N. cirrosa, Chaetozone christiei, S. limicola, Eudorellopsis deformis*, and the bivalves *Cochlodesma praetenue, A. prismatica* and *Phaxas pellucidus* which were amongst the top ten most abundant taxa.

This biotope complex was also assigned to the ungrouped station ST039, characterised by moderately well sorted slightly gravelly sand (Folk, 1954). Infauna was represented by the following Arthropoda, *Ampelisca brevicornis*, *Perioculodes longimanus*, *Urothoe poseidonis* and species of Mollusca included *Phaxas pellucidus*, *Chamelea striatula* and *Thracia phaseolina,* each comprising one individual.

Colonial epifauna from stations ST038, ST073, ST078 and ST088 comprised 8 taxa and the ungrouped station ST039 comprised 4. Taxa included hydroids *L. clausa*, the order Anthoathecata, the cnidarian *Epizoanthus papillosus* and species of the order Leptothecata and Porifera of the genus *Cliona* were the most frequently occurring, along with ciliates of the family Folliculinidae.

Results of the seafloor photographic analysis (Appendix C.3) indicated a sediment featuring small scale rippled sand with shell fragments. Epibiota was generally sparse and included the crustaceans *Paguroidea*, the echinoderms *A. rubens*, A. *irregularis* and species of the order Spatangoida, cnidarians of the genus *Epizoanthus* and faunal turfs of hydrozoans and bryozoans. Fish included species of the order Pleuronectiformes, including the species of the family Soleidae and *P. platessa*. Faunal burrows were recorded at most stations.

4.2.6.1.11 Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles) (MB3231)

The biotope 'Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)' (MB3231) is described as unstable coarse sediment (e.g. pebbles lying on or embedded in other sediment) that are strongly affected by tidal steams and/or wave action which can support few animals and are consequently faunally impoverished. The species composition of this biotope may be highly variable seasonally and is likely to comprise low numbers of robust polychaetes or bivalves. In more settled periods there may be colonisation by anemones of hydroids and bryozoans (EEA, 2022). This biotope covers a depth range of 5 m to 50 m (JNCC, 2022).

This biotope was assigned to the ungrouped station ST009 characterised by very poorly sorted sandy gravel (Folk, 1954), in a water depth of 17.9 m BSL. Infauna at station ST009 comprised the Anthropoda *Diastylis bradyi* and *A. echinata*, the polycheates *Malmgrenia darbouxi, C. zetlandica* and *Eumida bahusiensis* with a single Bivalvia species of *Mactra stultorum*.

Colonial epifauna was absent from the grab sample at stations ST009.

This biotope was also assigned to the ungrouped station ST010 characterised by very poorly sorted sandy gravel (Folk, 1954), in a water depth of 17.0 m BSL. Station ST010 was more diverse than station ST009 and comprised of the species of Arthropodas such as *Balanus crenatus*, *A. echinata*, species of the family Aoridae and *Synchelidium maculatum*. The species of polychaete, *Euclymene oerstedii*, S. *spinulosa*, C. zetlandica, *L. conchilega* and the genus *Polygordius* were also present. Species of Mollusca such as *Kurtiella bidentata* and *A. alba* were also recorded but in low abundances.

Colonial epifauna from the grab samples at station ST010 comprised 31 taxa, including Porifera of the order Leucosolenida, cnidarians such as *C. syringa*, and species of the family Haleciidae and the genus *Sertularia,* and Bryozoa including species of *Crisia*, *Amathia*, *Celleporella* and *Bugulina*.

Results of the seafloor photographic analysis (Appendix C.3) at station ST009 indicated a sediment featuring small-scale rippled sand with pebbles, cobbles and shell fragments. Epibiota comprised erect bryozoans, including *F. foliacea, S. securifrons* and *A. diaphanum*; red algae, crustacean species of the genus *Polybius* and the superfamily Paguroidea, calcareous tube worms of the family Serpulidae and faunal turfs of hydrozoans and bryozoan.

Results of the seafloor photographic analysis (Appendix C.3) at station ST010 indicated a sediment featuring sandy gravel with pebbles, cobbles and boulders. Epibiota comprised cnidarians of the genus *Urticina* including *U. felina*; erect bryozoans, including *F. foliacea,* and *A. diaphanum*; red algae, crustacean of the species *N. puber*, echinoderms of the genus *Henricia,* calcareous tube worms of the family Serpulidae, hydrozoan including the species *Tubularia indivisa* and faunal turfs of hydrozoans and bryozoan. Fish of the genus *Callionymus* were also observed.

4.2.6.1.12 Atlantic circalittoral sand (MC52)

The EUNIS level 3 habitat complex ‘Atlantic circalittoral sand’ (MC52) is described as clean fine sand and muddy sand with less than 5 % silt in circalittoral zone. The habitat is more stable their infralittoral sands counterpart, supporting a more diverse community of echinoderms, polychaetes and bivalves. In circalittoral muddy sands with silt content ranging from 5 % to 20 %, infauna can be characterised by polychaetes, bivalves such as *A. alba* and

N. nitidosa, and echinoderms such as those in the genera Ophiura and Amphiura, along with the species of A. *irregularis* (EEA, 2022).

This habitat complex was assigned to stations ST033, ST041, ST050, ST071, ST086, ST087 where only seafloor photographic and sediment PSD data were acquired (details in Section 4.1). These stations were characterised using Folk (BGS) and described as moderately well sorted sand except for station ST086, which was described as poorly sorted sand. Stations ST048, ST049 and sections of stations ST037, ST044 and ST099 where only photographic sampling was undertaken, were also assigned this biotope complex and characterised by small-scale rippled muddy sand with shell fragments. Characteristic epibiota identified in video analysis consisted of species of echinoderms *A. rubens*, *A. irregularis, L. sarsii*, species of cnidarians of the genus *Epizoanthus*, crustaceans of the superfamily Paguroidea, the genus *Polybius* and *C. pagurus*. The bryozoan *A. diaphanum* and faunal turfs of hydrozoans and bryozoan alongside fish of the order Pleuronectiformes, the family Soleidae and the *M. aeglefinus* were also recorded.

4.2.6.1.13 Atlantic infralittoral mixed sediment (MB42)

The EUNIS level 3 habitat complex 'Atlantic infralittoral mixed sediment' (MC52) is described as shallow mixed substrates which may include muddy gravelly sand with varying content of shells or very poorly sorted embedded cobbles and pebbles in mud, sand or gravel. This habitat supports a wide variety of fauna, characterised by bivalves and polychaetes (EEA, 2022).

This habitat complex was assigned to stations ST001, ST011, ST014 and sections of stations ST002, ST003, ST005 where only seafloor photographic data was acquired. Sediment was described as gravelly sand with pebbles, cobbles and boulders. Epibiota was diverse and comprised echinoderms of the class Asteroidea including species of the genus *Henricia*, *E. esculentus*, the crustaceans *Homarus Gammarus*, *N. puber*, species of the genus *Munida*, cnidarians which included *U. felina*, the polychaetes *L. conchilega* and encrusting Serpulidae, the erect bryozoans *A. diaphanum*, *F. foliacea*, *S. securifrons*, the hydroid *T. indivisa* and faunal turfs of hydrozoans and bryozoan. Fish included the species *Pholis gunnellus*.

4.2.6.1.14 Atlantic infralittoral coarse sediment (MB32)

The EUNIS level 3 habitat complex 'Infralittoral coarse sediment' (MB32) is described as being characterised by coarse sand, gravelly sand and gravel in moderately exposed habitats subjected to wave action. Fauna associated with this habitat include polychaetes such as *Chaetozone setosa* and *Lanice conchilega*, crustaceans which include *Iphinoe trispinosa*, *Diastylis bradyi* and a variety of bivalves (EEA, 2022).

This habitat complex was assigned to stations ST04A, ST008, ST012, ST105A where only seafloor photographic and sediment PSD data were acquired. Sediment was classified as very poorly sorted sandy gravel at stations ST008 and ST012, very poorly sorted muddy sandy gravel at station ST004a and very poorly sorted gravel at station ST105a (Folk, BGS). Epibiota included echinoderms of the class Asteroidea including species of the genus *Henricia*, the crustaceans *H. Gammarus*, *N. puber*, *C. pagurus*, species of the genus *Munida* and species of the superfamily Galatheoidea, cnidarians of the genus *Urticina*, encrusting polychaetes of the family Serpulidae, the erect bryozoans *A. diaphanum*, *F. foliacea*, the hydroid *T. indivisa* and faunal turfs of hydrozoans and bryozoan Unidentifiable fish were also recorded and were left at the Parvphylum level of Osteichthyes.

4.2.6.1.15 Atlantic offshore circalittoral sand (MD52)

The EUNIS level 3 habitat complex 'Atlantic offshore circalittoral sand' (MD52) is described as deep circalittoral habitats with fine sands or muddy sands. It is likely this habitat is more stable than their shallower counterparts and can supports a diverse range of echinoderms, polychaetes, amphipods and bivalves (EEA, 2022).

This habitat complex was assigned to station ST069 where only seafloor photographic and sediment PSD data were acquired, characterised by moderately sorted sand (Folk, BGS). Stations ST069, ST084, where only photographic sampling was undertaken, were assigned the same biotope and characterised by small-scale rippled sandy mud / muddy sand with shell fragments. Epifauna observed from photographic data included, echinoderms of the class Asteroidea, including the species of the family Ophiuroidea, the species *L. ciliaris*, *A. rubens*, *A. irregularis*, and species of the order Spatangoida, crustaceans of the superfamily Paguroidea, cnidarians which included *U. felina*, and species of the genus *Epizoanthus* and the seapen *P. phosphorea*, the polychaete *O. flexuosus* and the tube-building *S. spinulosa*, the erect bryozoans *A. diaphanum*, the hydroid *T. indivisa* and faunal turfs of hydrozoans and bryozoan. Fish were recorded and included species of the families Gadidae and Triglidae and species of the order Pleuronectiformes, which included *M. kitt*.

4.2.6.1.16 Atlantic circalittoral mixed sediment (MC42)

The EUNIS level 3 habitat complex 'Atlantic circalittoral mixed sediment' (MC42) is described as habitats below 15 m – 20 m in mixed substrates which may include muddy gravelly sand with varying content of shells or very poorly sorted cobbles and pebbles in mud, sand or gravel. As a result of variability in sediment types, a diverse range of infaunal polychaetes, bivalves, echinoderms and burrowing anemones can be present. On hard substrate, the hydroids of the genus *Nemertesia*, and the species *Hydrallmania falcata* can be observed (EEA, 2022).

This habitat complex was assigned to station ST014 where only seafloor photographic data was acquired characterised by gravelly sand with pebbles, cobbles and boulders. Epibiota observed included the echinoderm *Henricia*, crustaceans such as *N. puber*, species of the genus *Munida*, cnidarians which included *A. digitatum*, species of unidentifiable sponges, polychaetes of the family Serpulidae, the erect bryozoans *A. diaphanum*, *F. foliacea*, *S.securifrons* and faunal turfs of hydrozoans and bryozoan.

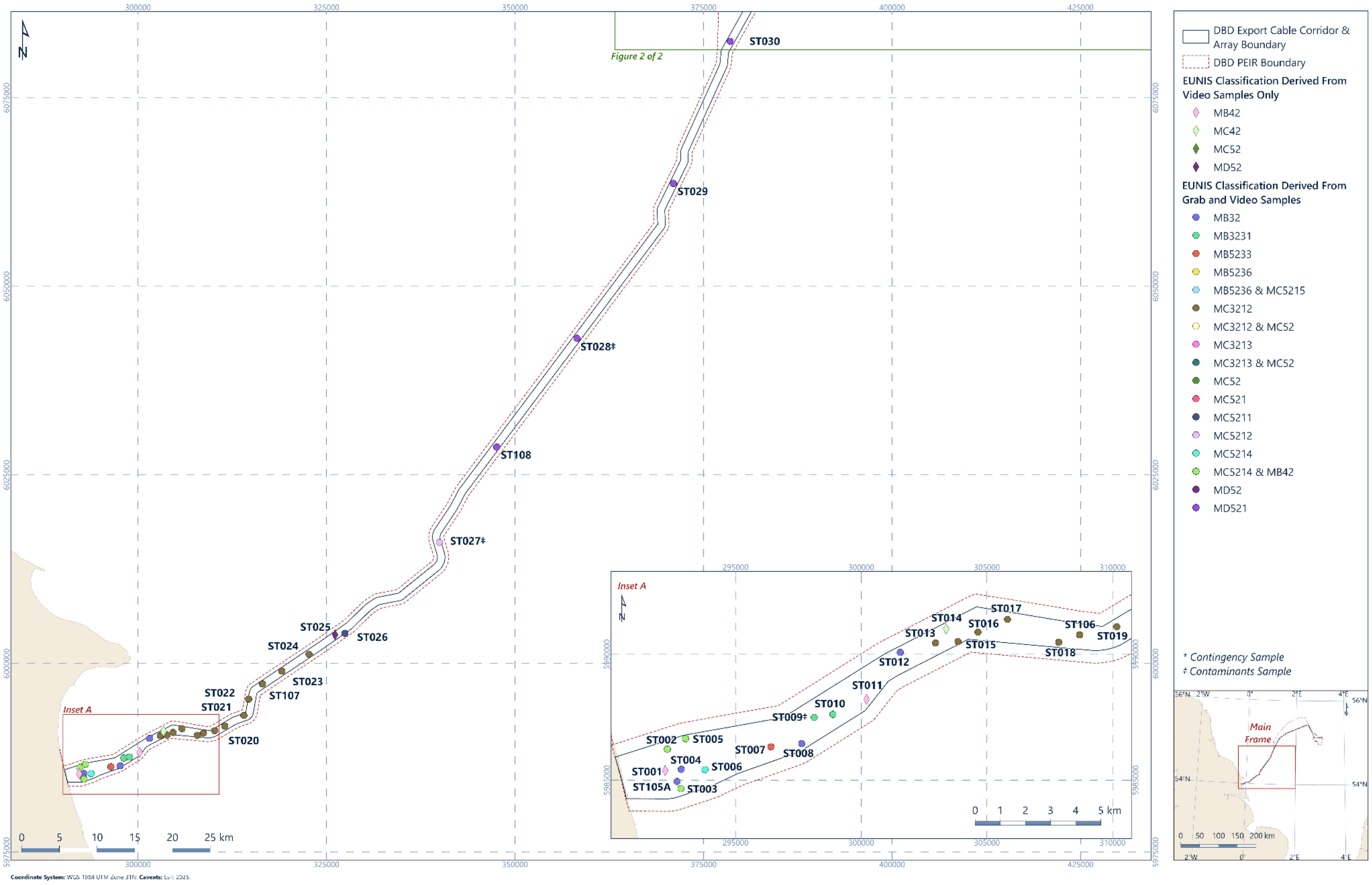


Figure 4.70: Spatial distribution of EUNIS habitat types, export cable corridor, Dogger Bank D 2024

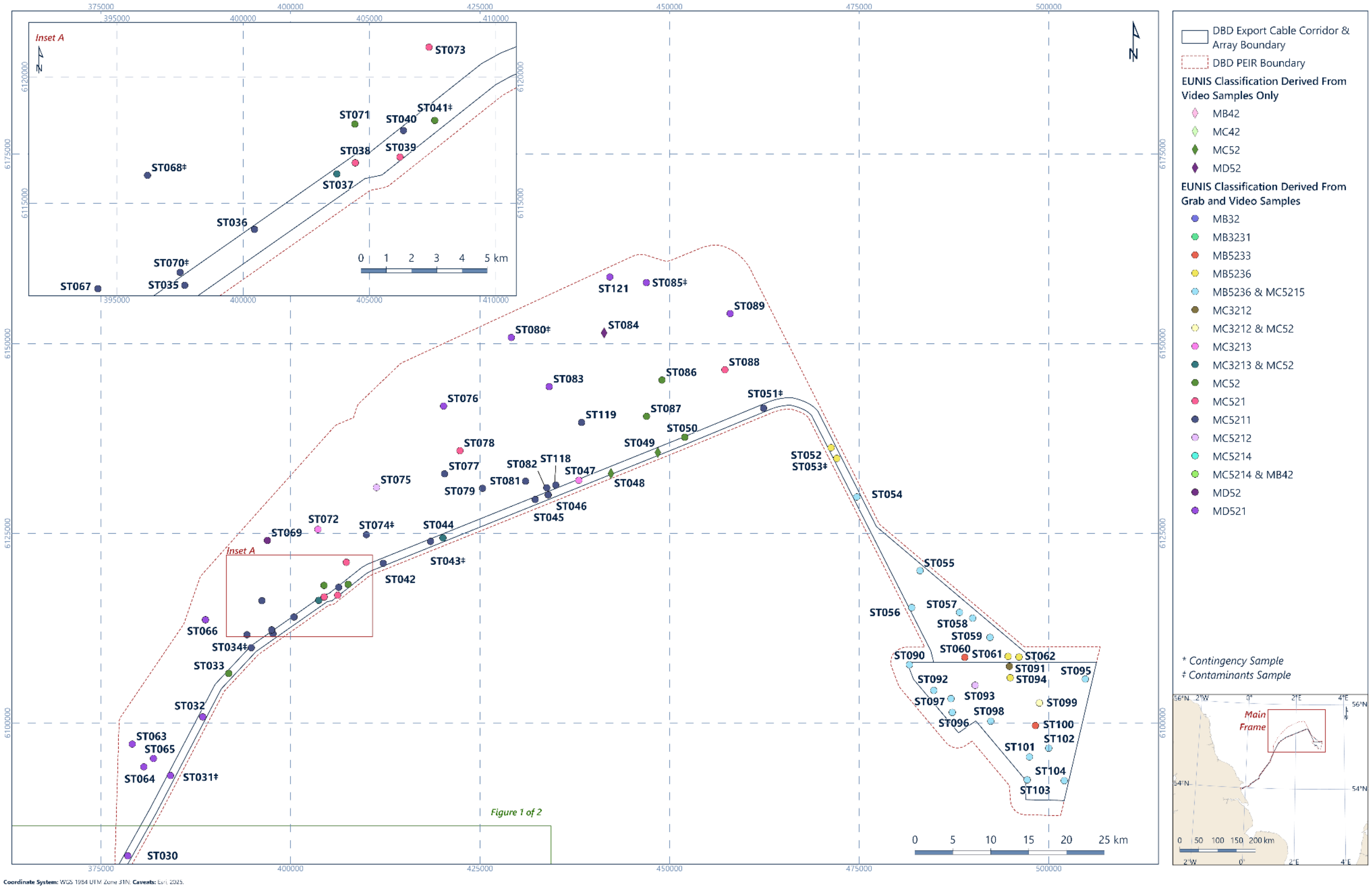


Figure 4.71: Spatial distribution of EUNIS habitat types, ECC, CA and array, Dogger Bank D 2024

4.2.6.2 Stony Reef Habitat

Owing to the presence of cobbles and boulders, 19 stations were assessed in relation to the presence of the Annex I habitat 'Reef', specifically, 'stony reef'. The results of the assessment are detailed in Table 4.43. The cobbles and boulders were generally low-lying, embedded in the sediment and subject to sediment disturbance. The epifaunal assemblage associated with the cobble and boulder component was generally comparable to that of the surrounding seafloor.

Along sections of transects at 10 stations (ST001, ST002, ST003,ST010, ST013, ST014,ST016, ST047, ST091 and ST099) the cobble and boulder component was classified as 'low resemblance to a stony reef'. At four stations the area of the 'low reef' observed from the photographic data did not exceed 25 m^2. However, stations ST010, ST013, ST016, ST047 and ST091 had areas classified as 'low reef' exceeding 25 m^2.

Along sections of transects at 10 stations the cobble and boulder component was classified as 'medium resemblance to a stony reef'. At five stations the area of the 'medium reef' observed from the photographic data did not exceed 25 m^2. However, stations ST004A, ST011, ST012, ST013 and ST014 had areas classified as 'medium reef' exceeding 25 m^2.

Figure 4.78 illustrates the spatial distribution of cobbles and boulders aggregations, with low and medium resemblance to a stony reef.

Table 4.43: Summary of 'Stony reef' classifications

Geodetic Parameters: WGS 84, UTM 31N [m]								
Station		Easting	Northing	Area Observed [m²]	Stony Reef Characteristic			Overall Assessment
					Composition [% Cover Cobbles and Boulders]	Elevation	Biota [Epibiota % Cover]	
ST047	SOL	438 047.60	6 131 921.20	99	10 – 40	< 64 mm	< 80	Low
	EOL	438 021.80	6 131 998.30					
	SOL	438 021.80	6 131 998.30	50	< 10	< 64 mm	< 80	Not a Reef
	EOL	438 009.50	6 132 037.80					
ST0105A	SOL	292 625.20	5 984 873.10	48	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	292 669.50	5 984 922.50					
	SOL	292 669.50	5 984 922.50	7	< 10	< 64 mm	< 80	Not a Reef
	EOL	292 676.00	5 984 930.40					
	SOL	292 676.00	5 984 930.40	11	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	292 686.70	5 984 941.50					
ST001	SOL	292 201.20	5 985 335.80	11	10 – 40	64 mm – 5 m	< 80	Low
	EOL	292 200.90	5 985 356.70					
	SOL	292 200.90	5 985 356.70	8	< 10	< 64 mm	< 80	Not a Reef
	EOL	292 199.80	5 985 372.30					
	SOL	292 199.80	5 985 372.30	23	10 – 40	< 64 mm	< 80	Low
	EOL	292 200.30	5 985 415.10					
ST002	SOL	292 261.30	5 986 159.20	17	10 – 40	64 mm – 5 m	< 80	Low
	EOL	292 269.70	5 986 182.20					
	SOL	292 269.70	5 986 182.20	57	< 10	Flat seabed	< 80	Not a Reef
	EOL	292 295.60	5 986 260.10					
ST003	SOL	292 804.20	5 984 631.20	25	< 10	Flat seabed	< 80	Not a Reef
	EOL	292 830.80	5 984 664.40					
	SOL	292 830.80	5 984 664.40	5	10 – 40	64 mm – 5 m	< 80	Low
	EOL	292 835.80	5 984 670.40					
	SOL	292 835.80	5 984 670.40	17	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	292 853.50	5 984 692.30					
	SOL	292 853.50	5 984 692.30	7	10 – 40	< 64 mm	< 80	Low
	EOL	292 859.50	5 984 703.20					
ST004A	SOL	292 782.70	5 985 366.10	67	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	292 854.40	5 985 445.40					
ST005	SOL	292 987.00	5 986 598.50	5	< 10	Flat seabed	< 80	Not a Reef
	EOL	292 989.80	5 986 606.90					
	SOL	292 989.80	5 986 606.90	17	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	293 006.10	5 986 632.90					
	SOL	293 006.10	5 986 632.90	27	< 10	Flat seabed	< 80	Not a Reef
	EOL	293 032.30	5 986 673.70					
ST009	SOL	298 079.40	5 987 452.80	57	< 10	< 64 mm	< 80	Not a Reef
	EOL	298 152.70	5 987 506.30					
ST010	SOL	298 863.10	5 987 655.90	42	10 – 40	64 mm – 5 m	< 80	Low
	EOL	298 877.40	5 987 592.30					
	SOL	298 877.40	5 987 592.30	14	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	298 883.20	5 987 570.80					
ST011	SOL	300 228.40	5 988 254.10	51	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	300 195.60	5 988 170.00					
ST012	SOL	301 521.10	5 990 173.10	90	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	301 556.50	5 990 042.20					
ST013	SOL	302 885.60	5 990 384.60	35	10 – 40	64 mm – 5 m	< 80	Low
	EOL	302 915.30	5 990 411.20					
	SOL	302 915.30	5 990 411.20	6	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	302 921.00	5 990 415.00					
	SOL	302 921.00	5 990 415.00	46	< 10	< 64 mm	< 80	Not a Reef
	EOL	302 959.70	5 990 450.50					
	SOL	302 959.70	5 990 450.50	33	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	302 987.70	5 990 475.90					
ST014	SOL	303 377.30	5 991 050.80	22	10 – 40	< 64 mm	< 80	Low
	EOL	303 381.10	5 991 016.70					
	SOL	303 381.10	5 991 016.70	33	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	303 380.70	5 990 965.20					
ST015	SOL	303 847.40	5 990 474.90	17	< 10	< 64 mm	< 80	Not a Reef
	EOL	303 846.80	5 990 509.10					
	SOL	303 846.80	5 990 509.10	16	40 – 95	64 mm – 5 m	< 80	Medium
	EOL	303 846.40	5 990 542.10					
	SOL	303 846.40	5 990 542.10	23	< 10	< 64 mm	< 80	Not a Reef
	EOL	303 833.80	5 990 586.30					

Geodetic Parameters: WGS 84, UTM 31N [m]					Stony Reef Characteristic			
Station		Easting	Northing	Area Observed [m²]	Composition [% Cover Cobbles and Boulders]	Elevation	Biota [Epibiota % Cover]	Overall Assessment
ST016	SOL	304 626.50	5 990 733.60	79	10 – 40	< 64 mm	< 80	Low
	EOL	304 642.50	5 990 869.30					
	SOL	304 642.50	5 990 869.30	10	< 10	< 64 mm	< 80	Not a Reef
	EOL	304 642.20	5 990 886.10					
ST017	SOL	305 814.50	5 991 294.00	85	< 10	< 64 mm	< 80	Not a Reef
	EOL	305 813.70	5 991 445.20					
ST024	SOL	322 640.90	6 001 279.00	62	< 10	< 64 mm	< 80	Not a Reef
	EOL	322 701.50	6 001 217.50					
ST099	SOL	498 768.21	6 102 611.38	13	< 10	Flat seabed	< 80	Not a reef
	EOL	498 765.97	6 102 620.72					
	SOL	498 765.97	6 102 620.72	15	< 10	< 64 mm	< 80	Not a reef
	EOL	498 767.16	6 102 631.88					
	SOL	498 767.16	6 102 631.88	3	10 – 40	< 64 mm	< 80	Low
	EOL	498 767.06	6 102 633.97					
	SOL	498 767.06	6 102 633.97	4	10 – 40	< 64 mm	< 80	Low
	EOL	498 766.53	6 102 636.90					
	SOL	498 766.53	6 102 636.90	11	< 10	Flat seabed	< 80	Not a reef
	EOL	498 766.07	6 102 644.88					
	SOL	498 766.07	6 102 644.88	4	40 – 95	< 64 mm	< 80	Medium
	EOL	498 766.28	6 102 648.01					
	SOL	498 766.28	6 102 648.01	20	< 10	Flat seabed	< 80	Not a reef
	EOL	498 765.15	6 102 662.83					
ST091	SOL	494 822.20	6 107 433.74	36	10 – 40	< 64 mm	< 80	Low
	EOL	494 807.71	6 107 461.39					
	SOL	494 807.71	6 107 461.39	7	< 10	Flat seabed	< 80	Not a reef
	EOL	494 805.04	6 107 466.72					
	SOL	494 805.04	6 107 466.72	10	10 – 40	< 64 mm	< 80	Low
	EOL	494 800.93	6 107 474.58					
	SOL	494 800.93	6 107 474.58	2	< 10	Flat seabed	< 80	Not a reef
	EOL	494 800.40	6 107 476.08					
	SOL	494 800.40	6 107 476.08	12	10 – 40	< 64 mm	< 80	Low
	EOL	494 796.10	6 107 485.21					

Notes
SOL = Start of line
EOL = End of line

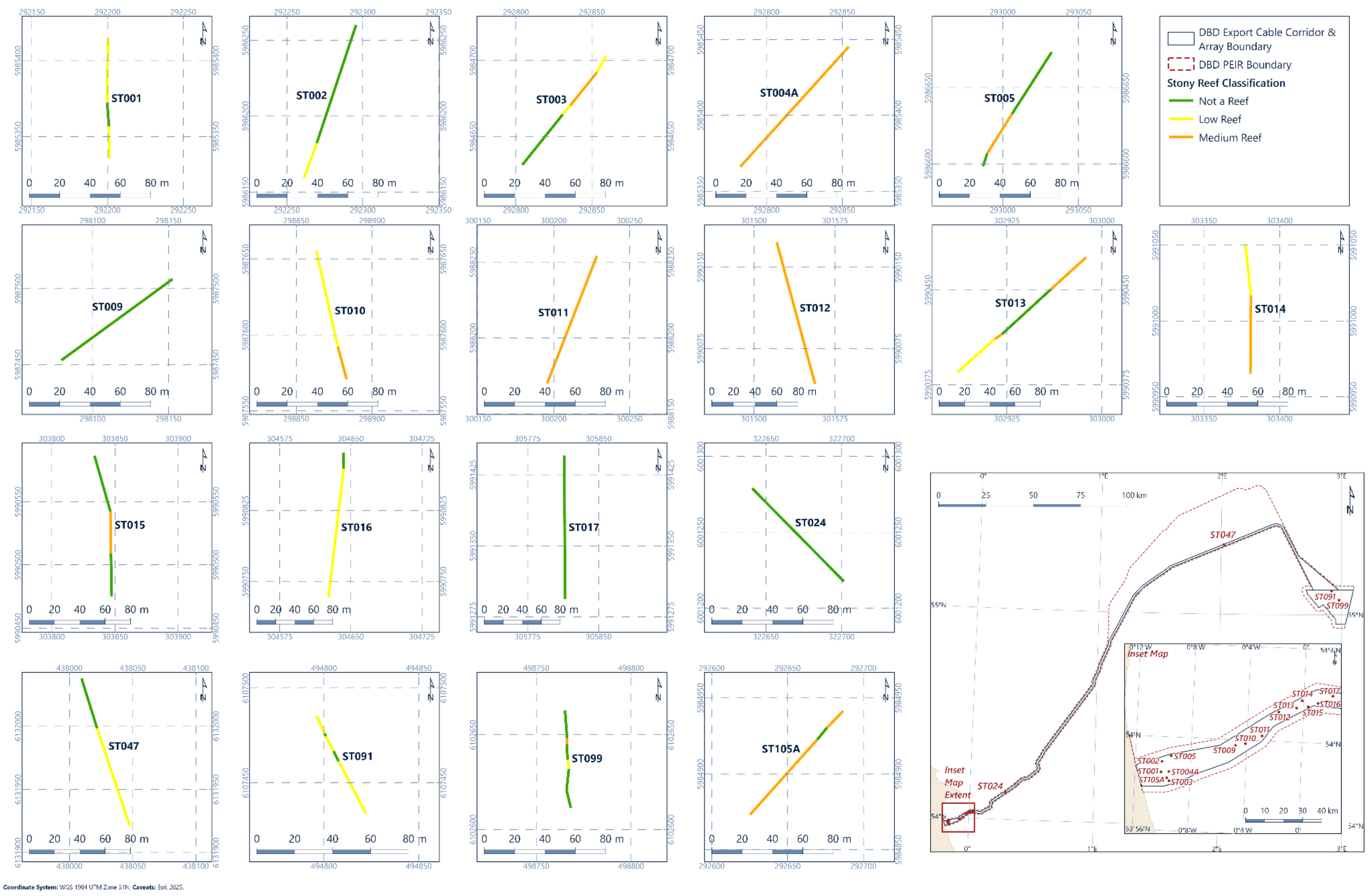


Figure 4.72: Spatial distribution of aggregation of cobbles and pebbles with low to medium resemblance to a stony reef Dogger Bank D 2024

4.2.6.3 *Sabellaria spinulosa* Reefs

Sabellaria spinulosa reefs comprise dense subtidal aggregations of this small, tube-building polychaete worm. High densities of *S. spinulosa* have been found to occur in the UK in the vicinity of the Wash and along the South Coast of the UK (Hendrick, 2007; Hendrick, et al., 2011). They are an Annex I habitat and are protected as an OSPAR threatened and/or declining species or habitat.

The reef building tube worm *S. spinulosa* was observed along the transect at station ST025 and an assessment was undertaken to assess the reefiness of the aggregations. Table 4.44 summarises the results of the proportions of each reefiness classification along the transect. Appendix C.5 provides the detailed *S. spinulosa* assessment.

Sabellaria spinulosa individuals were present in grab samples at stations ST010, ST013, ST015, ST016, ST017, ST018, ST019, ST020, ST021, ST022, ST024 and ST107.

Patches of *S. spinulosa* along station ST025 were classified as 'not a reef'. Figure 4.73 spatially displays the results of the *S. spinulosa* assessment at station ST025.

Table 4.44: Summary of '*Sabellaria spinulosa* reef' classifications

Station	Total Length [m]	% No *Sabellaria spinulosa*	% Not a Reef	% Low Reef	% Medium Reef	% High Reef	% Not Usable Sections
ST025	83	27	73	0	0	0	0

Notes
* = For the purpose of this calculations the total length of transects have been obtained by summing the lengths of all assessed sections. These were calculated using the real-time position of the camera. Therefore, there might be small differences with the values reported in the field logs, as they were derived considering a straight line from the start to the end of line

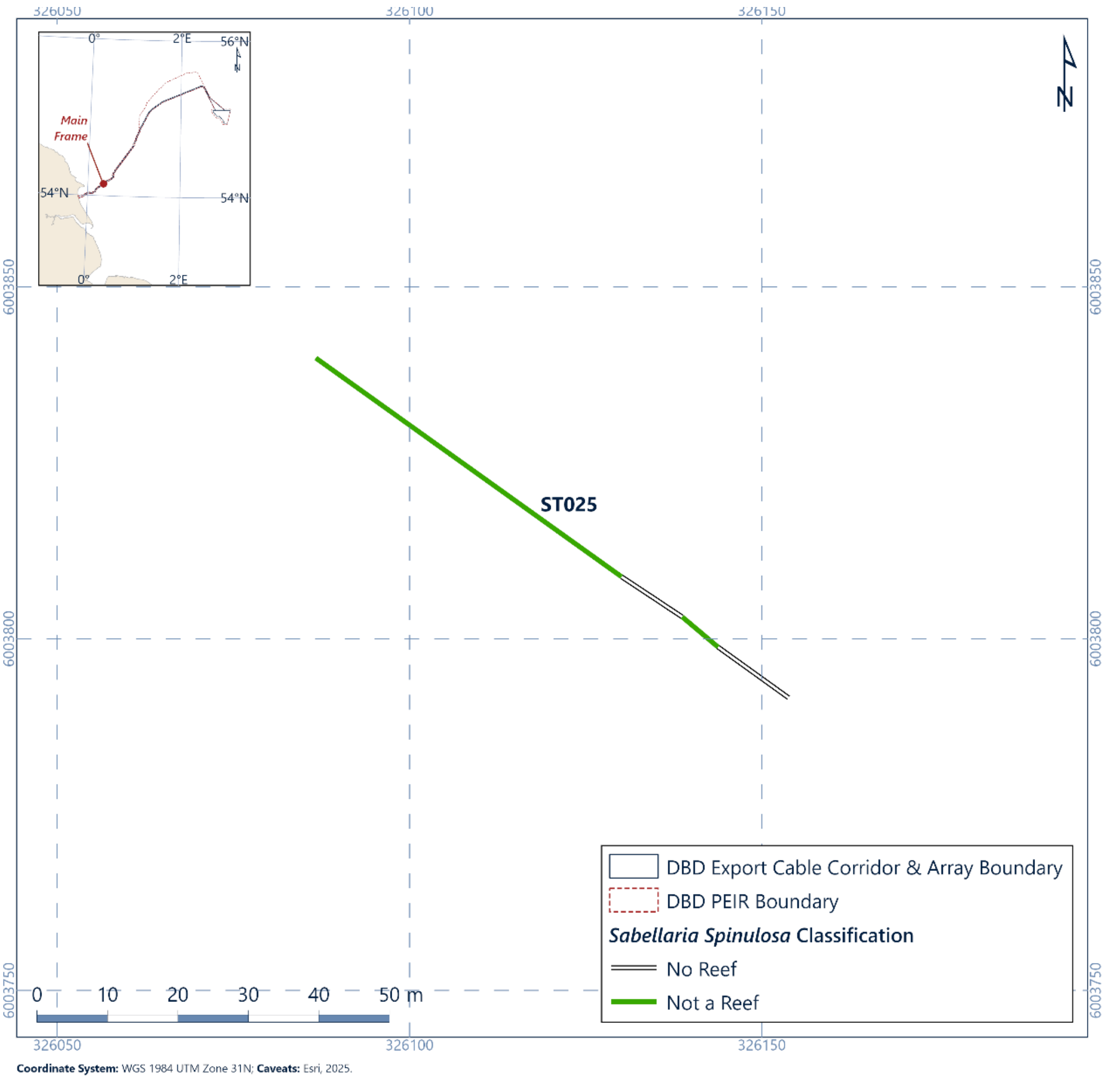


Figure 4.73: Spatial distribution of *Sabellaria spinulosa* assessment Dogger Bank D 2024

4.2.6.4 Sea pen and Burrowing Megafauna Communities

Due to observations of the sea pen *Pennatula phosphorea*, mounds and burrows, the presence of the OSPAR listed threatened and/or declining habitat 'sea pens and burrowing megafauna communities' was considered. The video data were analysed using the assessment criteria detailed in section 3.3.10. Table 4.45 summarises the results of the Seapen and burrowing megafauna assessment. Figure 4.74to Figure 4.79 display the SACFOR abundances of *P. phosphorea*, mounds and burrows, respectively.

Faunal burrows were present along 51 stations, ranging from 'rare' to 'common'. Along the transect at station ST099, the density of burrows was very high based on the video analysis. Subsequently, the analysis was undertaken using the stills images to provide a more accurate count (Figure 4.80). The burrows were classed as 'superabundant' at this station. Mounds were also observed and classified as 'occasional' at station ST041 and 'rare' at station ST118 (Appendix C.6).

The sea pen *Pennatula phosphorea* was recorded as 'occasional' to 'common' along transects at seven stations (ST063, ST066, ST080, ST084, ST085, ST089 and ST121).

Table 4.45: Summary SACFOR assessment for sea pens and burrowing megafauna

Station	Total Surface Area Observed [m²]	Sea Pens	Signs of bioturbation	
		Pennatula phosphorea	Mounds	Burrows (3 cm to 15 cm)
ST028	90	-	-	F
ST029	86	-	-	F
ST030	87	-	-	F
ST031	64	-	-	F
ST032	107	-	-	F
ST035	54	-	-	F
ST036	131	-	-	R
ST037	71	-	-	O
ST038	136	-	-	O
ST041	131	-	O	R
ST044	95	-	-	O
ST046	126	-	-	O
ST048	112	-	-	O
ST049	165	-	-	O
ST051	69	-	-	F
ST052	69	-	-	F
ST053	76	-	-	F
ST054	117	-	-	F
ST055	109	-	-	F
ST056	82	-	-	0
ST057	44	-	-	0
ST060	61	-	-	F
ST063	64	F	-	F
ST064	73	-	-	R
ST065A	95	-	-	C
ST066	57	O	-	F
ST067	62	-	-	F
ST068	72	-	-	O
ST069	136	-	-	F
ST070	65	-	-	F
ST071	136	-	-	F
ST073	127	-	-	R
ST076	107	-	-	O
ST077	107	-	-	O
ST078	117	-	-	O
ST079	177	-	-	O
ST080	132	F	-	R
ST081	125	-	-	F
ST082	124	-	-	O
ST083	69	-	-	F
ST084	114	F	-	O
ST085	65	C	-	O
ST087	145	-	-	O
ST088	75	-	-	F
ST089	85	O	-	F
ST099	17	-	-	S
ST100	38	-	-	F
ST101	65	-	-	C
ST108	90	-	-	O
ST118	102	-	R	C
ST119	80	-	-	F
ST121	69	F	-	F

Notes
SACFOR Classifications: (3 cm to 15 cm)
Superabundant = 1 - 9/0.01 m²
Abundant = 1 - 9/0.1 m²
Common = 1 - 9/1 m²
Frequent = 1 - 9/10 m²
Occasional = 1 - 9/100 m²
Rare = 1 - 9/1000 m²

SACFOR = semi-quantitative abundance scale from Superabundant, Abundant, Common, Frequent, Occasional to Rare
* = SACFOR Classification based on the assumption that adults achieve a size of 3 cm to 15 cm

Key	- = Absent	R = Rare	O = Occasional	F = Frequent	C = Common	A = Abundant	S = Superabundant

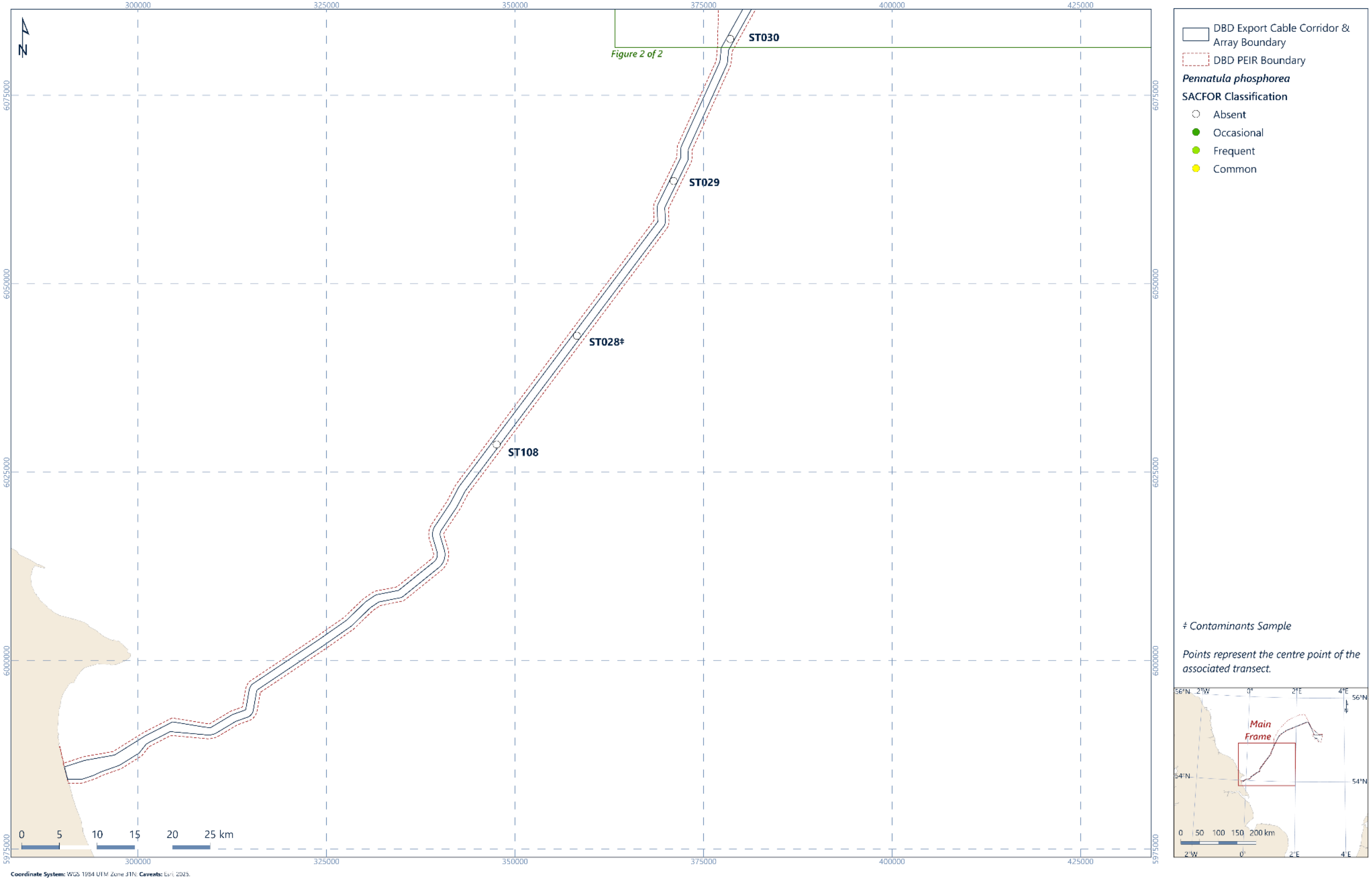


Figure 4.74: Spatial distribution of sea pen assessment, ECC Dogger Bank D 2024

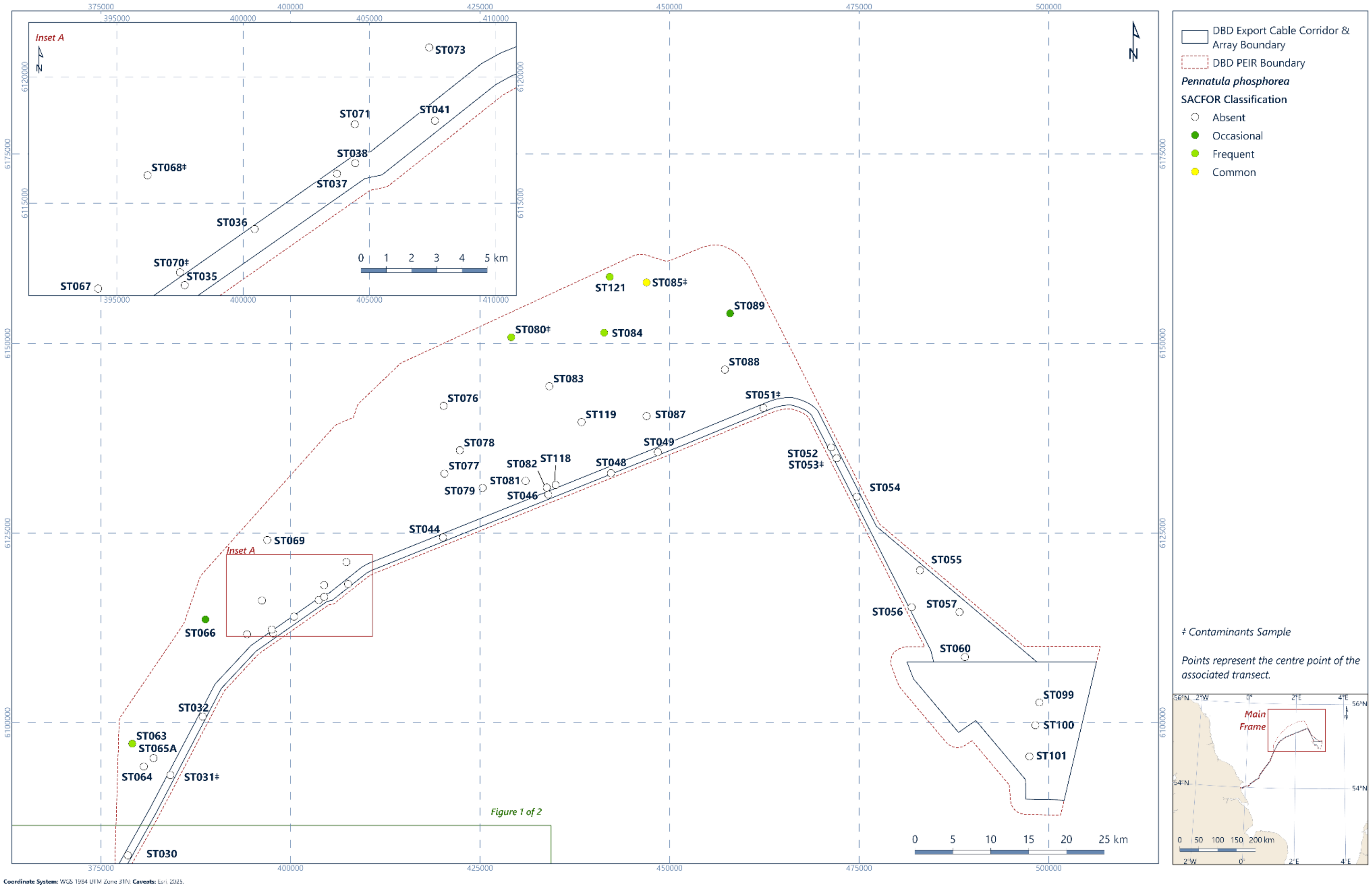


Figure 4.75: Spatial distribution of sea pen assessment, ECC, characterisation area and array Dogger Bank D 2024

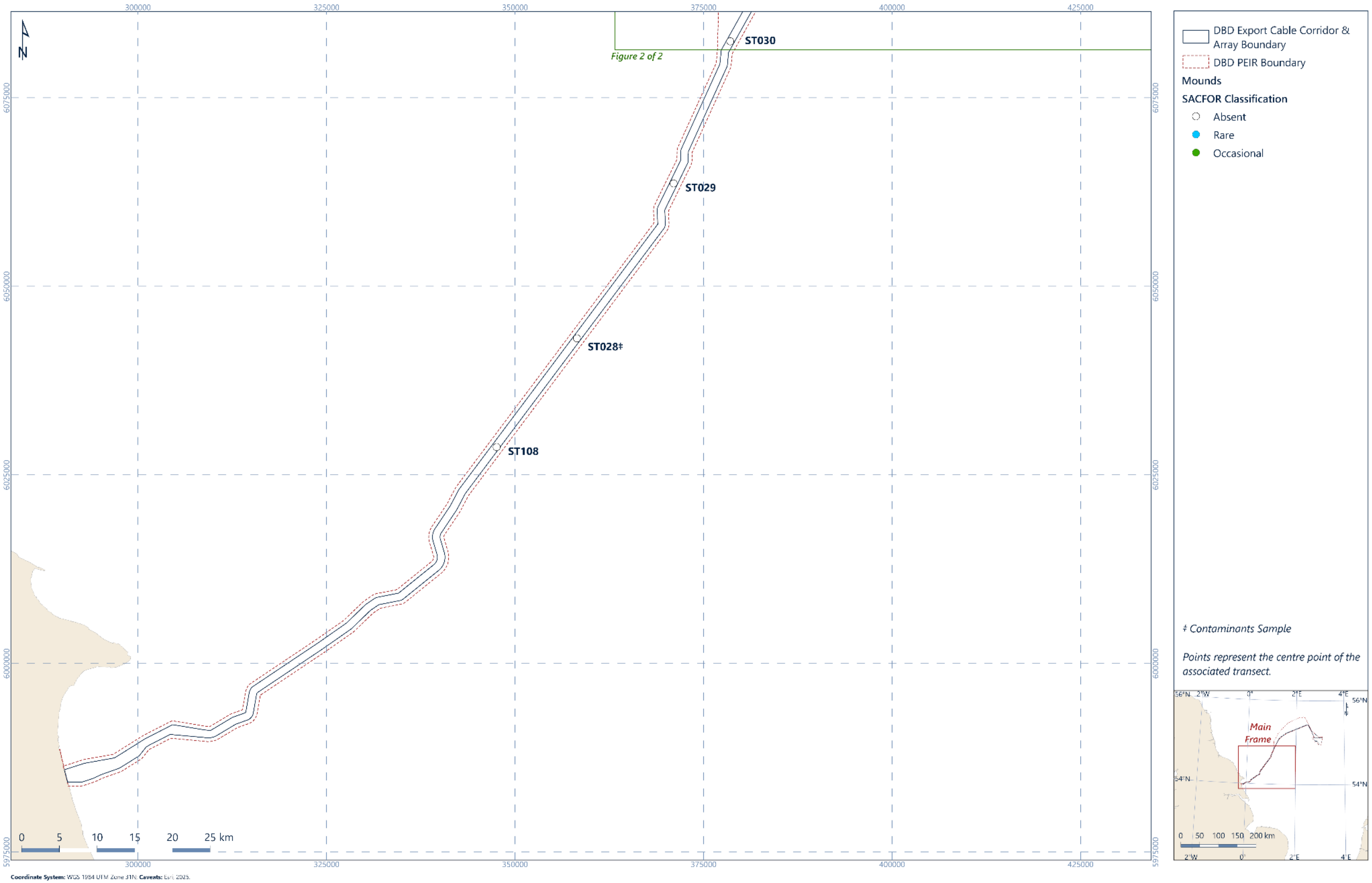


Figure 4.76: Spatial distribution of mounds assessment, ECC Dogger Bank D 2024

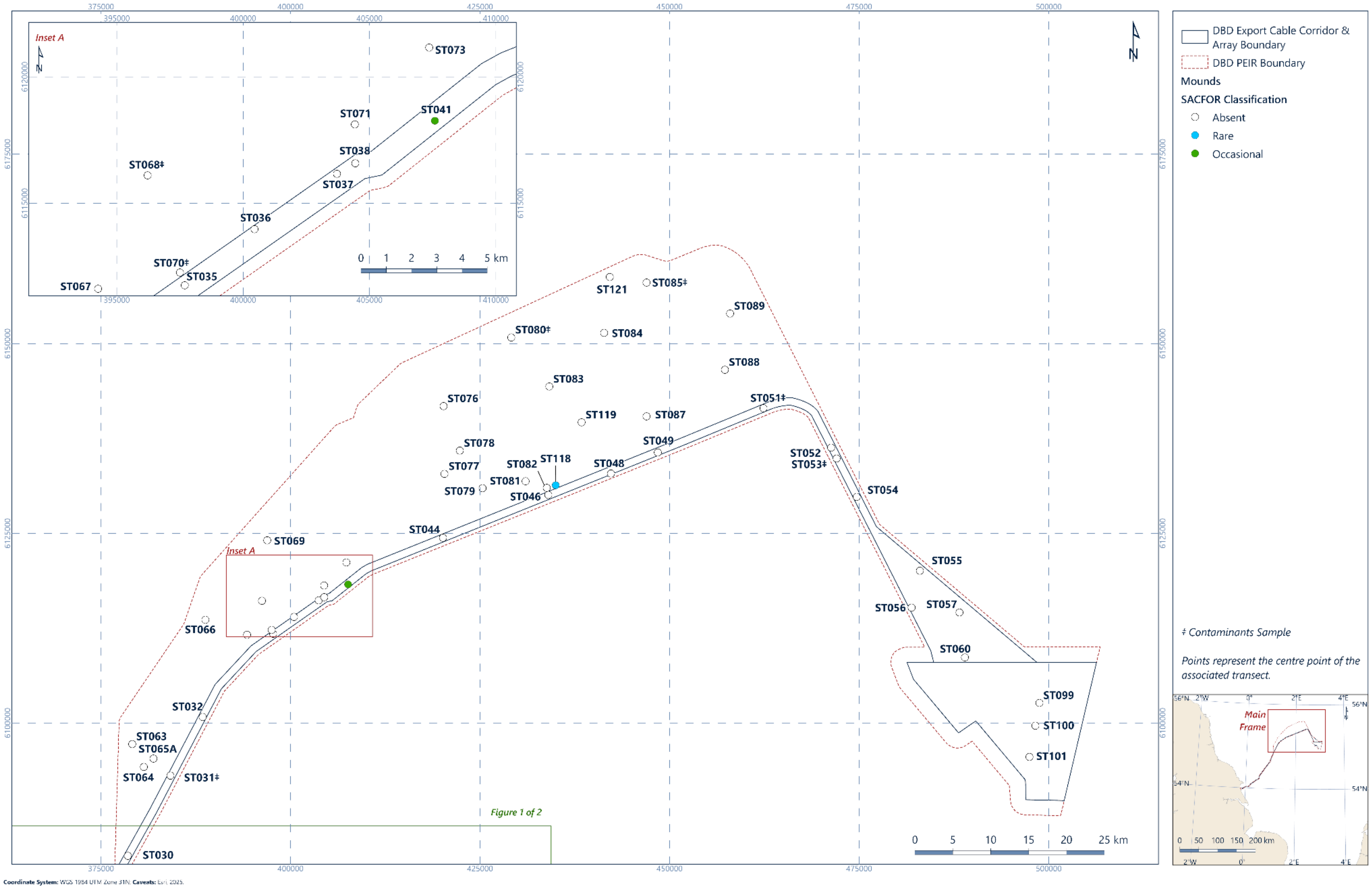


Figure 4.77: Spatial distribution of mounds assessment, ECC, characterisation area and array Dogger Bank D 2024

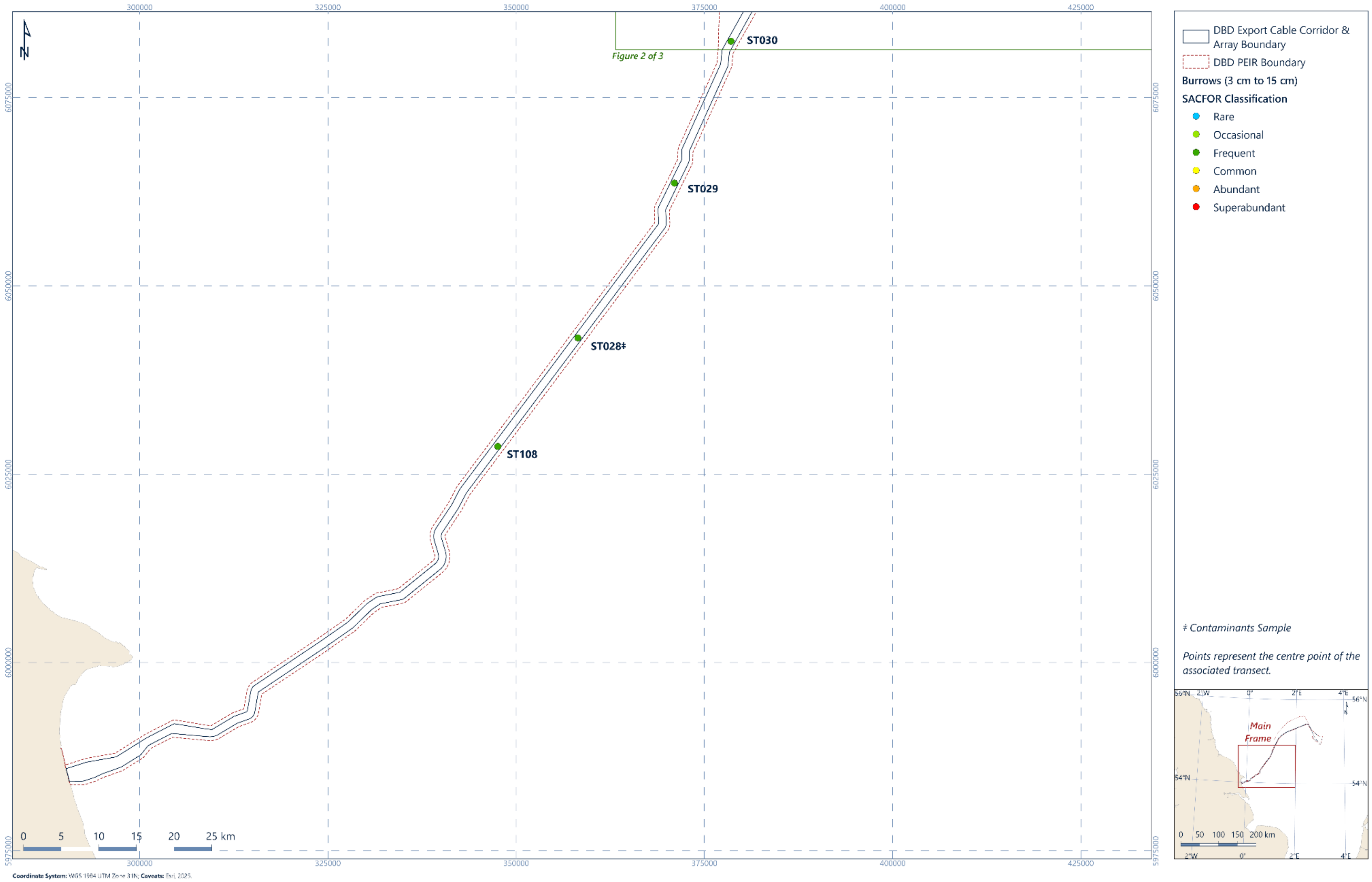


Figure 4.78: Spatial distribution of burrows assessment, ECC Dogger Bank D 2024

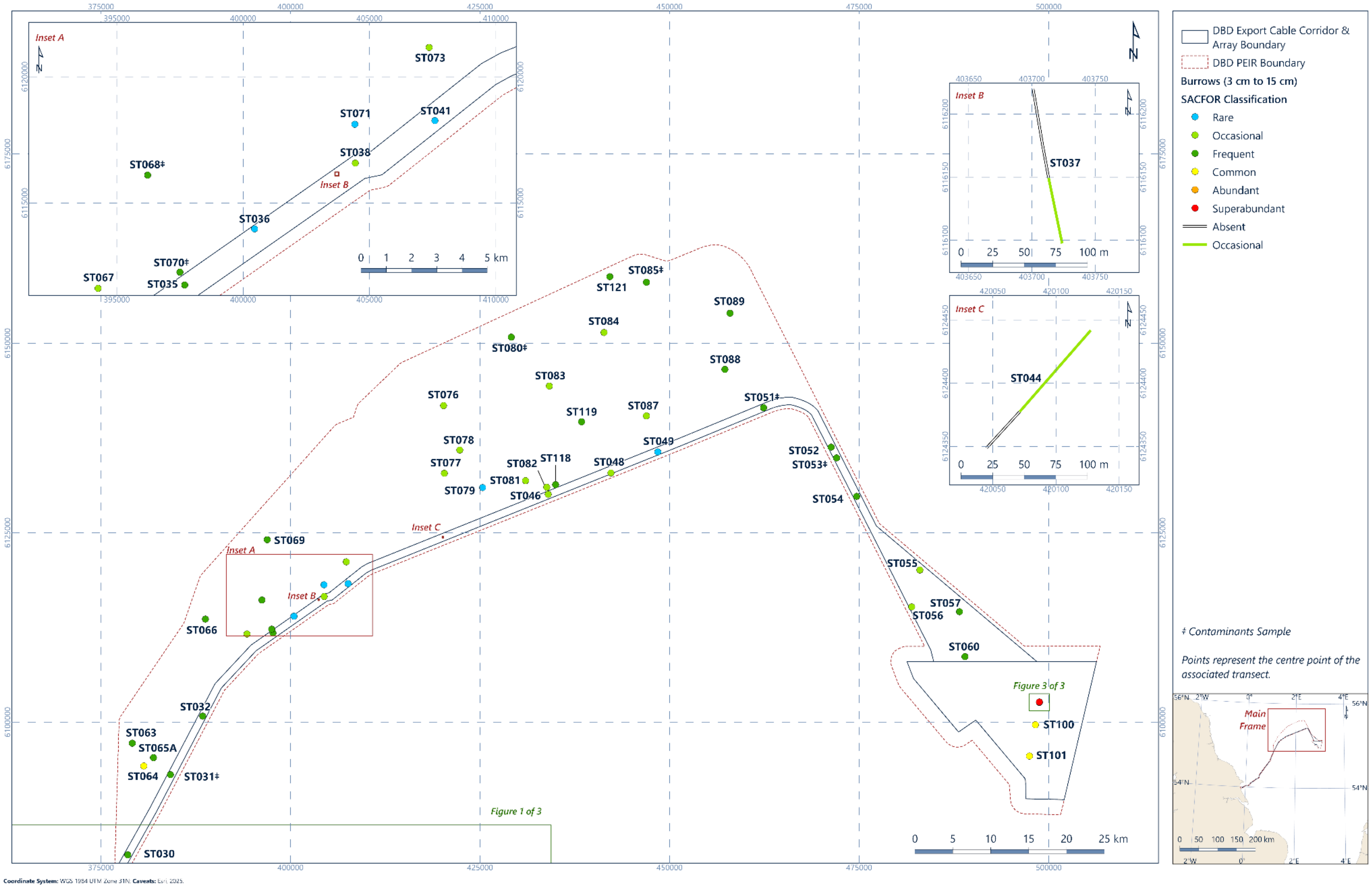


Figure 4.79: Spatial distribution of burrows assessment, ECC, characterisation area and array Dogger Bank D 2024

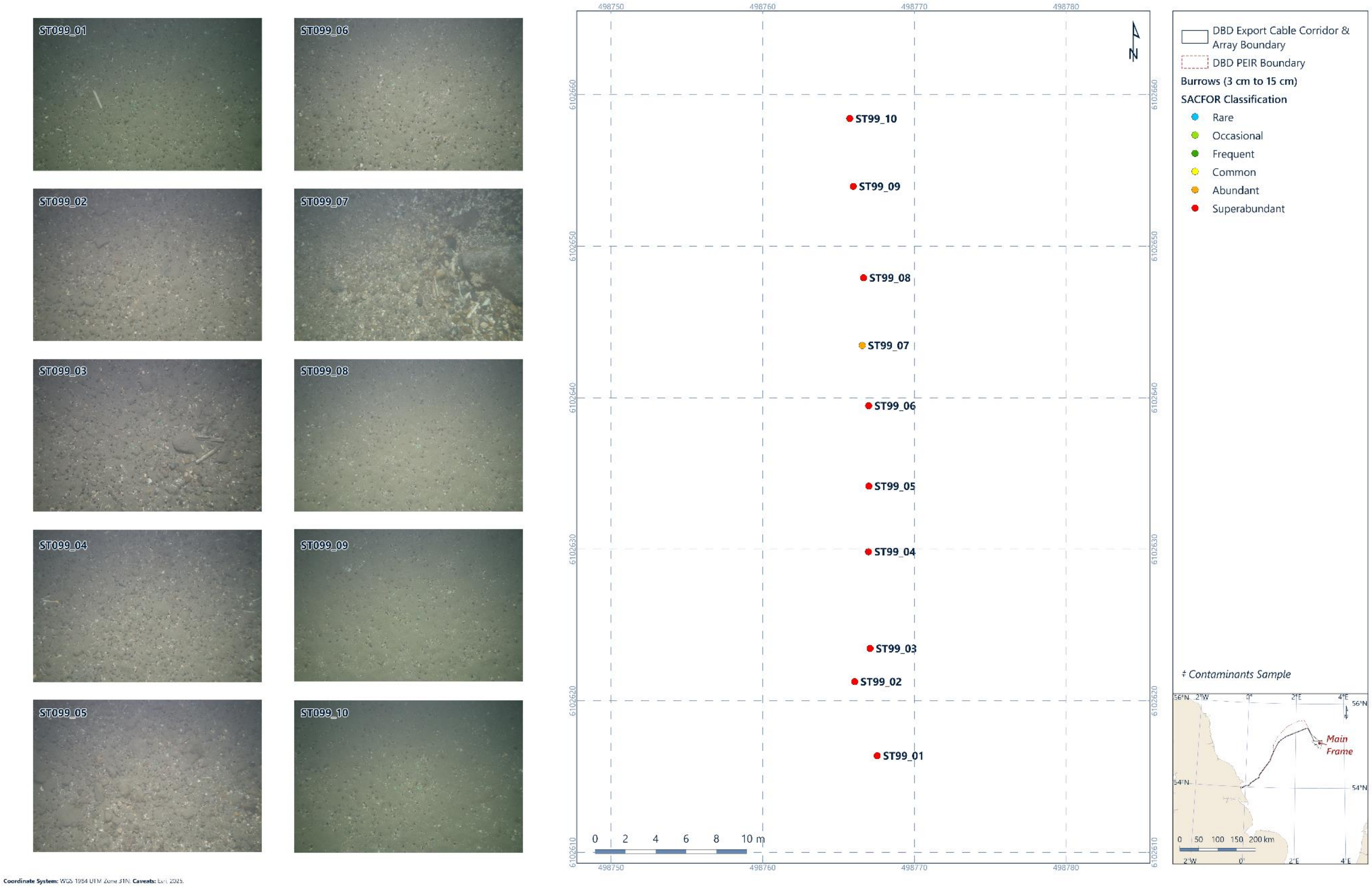


Figure 4.80: Spatial distribution of burrow assessment for Station ST099 Dogger Bank D 2024

4.2.7 Potentially Sensitive Habitats and Species

Several of the habitats and species recorded in this study are of conservation importance (discussed in section 5.5.1) and are:

- 'Stony Reef,' which encompass the aggregations of cobbles and boulders;
- '*Sabellaria spinulosa* reefs';
- 'Sea pens and burrowing megafauna communities';
- Subtidal sands and gravel", which encompass most of the habitat types recorded;
- 'Sandbanks which are slightly covered by sea water all the time', for which the Dogger Bank SAC is designated;
- Single individual of *Arctica Islandica* was recorded as juveniles at stations: ST036, ST046, ST052, ST054, ST100 and from the field logs at stations ST021 and ST022 (8 cm);
- *Ammodytes marinus;*
- *Solea solea*;
- *Clupea harengus;*
- *Gadus morhua*;
- *Melanogrammus aeglefinus*;
- *Merlangius merlangus*;
- *Merluccius merluccius;*
- *Pleuronectes platessa*;
- *Salmo salar*;
- *Scomber scrombrus*;
- *Trachurus trachurus*;
- Edwardsiidae which include *Edwardsia timida*.

4.3 2023 and 2024 Comparison

As requested by the client a direct comparison of the repeated stations from the 2023 survey has been presented.

Twelve stations from the 2023 survey were repeated in the 2024 survey (Figure 4.81). Station names differed between the two surveys and are presented in Table 4.46. This section looks at a temporal comparison of the twelve stations from within the DBD array. It should be noted that going forward the stations will be referred to by the 2024 Station Names.

Table 4.46: Respective station names and coordinates for repeat stations sampled in 2023 and 2024

Geodetic Parameters: WGS 84, UTM 31N [m]					
2024 Stations Names	Easting	Northing	2023 Station Names	Easting	Northing
ST090	481 637.5	6 107 664.3	ST105	481 639.4	6 107 664.3
ST091	494 806.1	6 107 465.0	ST127	494 808.4	6 107 462.7
ST093	490 280.5	6 104 947.5	ST113	490 289.4	6 104 947.1
ST094	494 911.8	6 105 949.7	ST130	494 909.6	6 105 949.6
ST095	504 830.9	6 105 782.5	ST160	504 831.0	6 105 782.3
ST098	492 369.4	6 100 226.7	ST119	492 369.5	6 100 227.9
ST099	498 762.5	6 102 639.5	ST147	498 764.0	6 102 639.9
ST100	498 236.2	6 099 638.5	ST145	498 236.3	6 099 637.4
ST101	497 453.6	6 095 520.5	ST142	497 452.8	6 095 519.6
ST102	499 993.4	6 096 666.0	ST150	499 994.9	6 096 665.8
ST103	497 172.8	6 092 499.5	ST140	497 172.2	6 092 500.2
ST104	502 047.9	6 092 394.2	ST155	502 043.4	6 092 392.8
Notes Coordinates presented for the first successful FA, PSD sample					

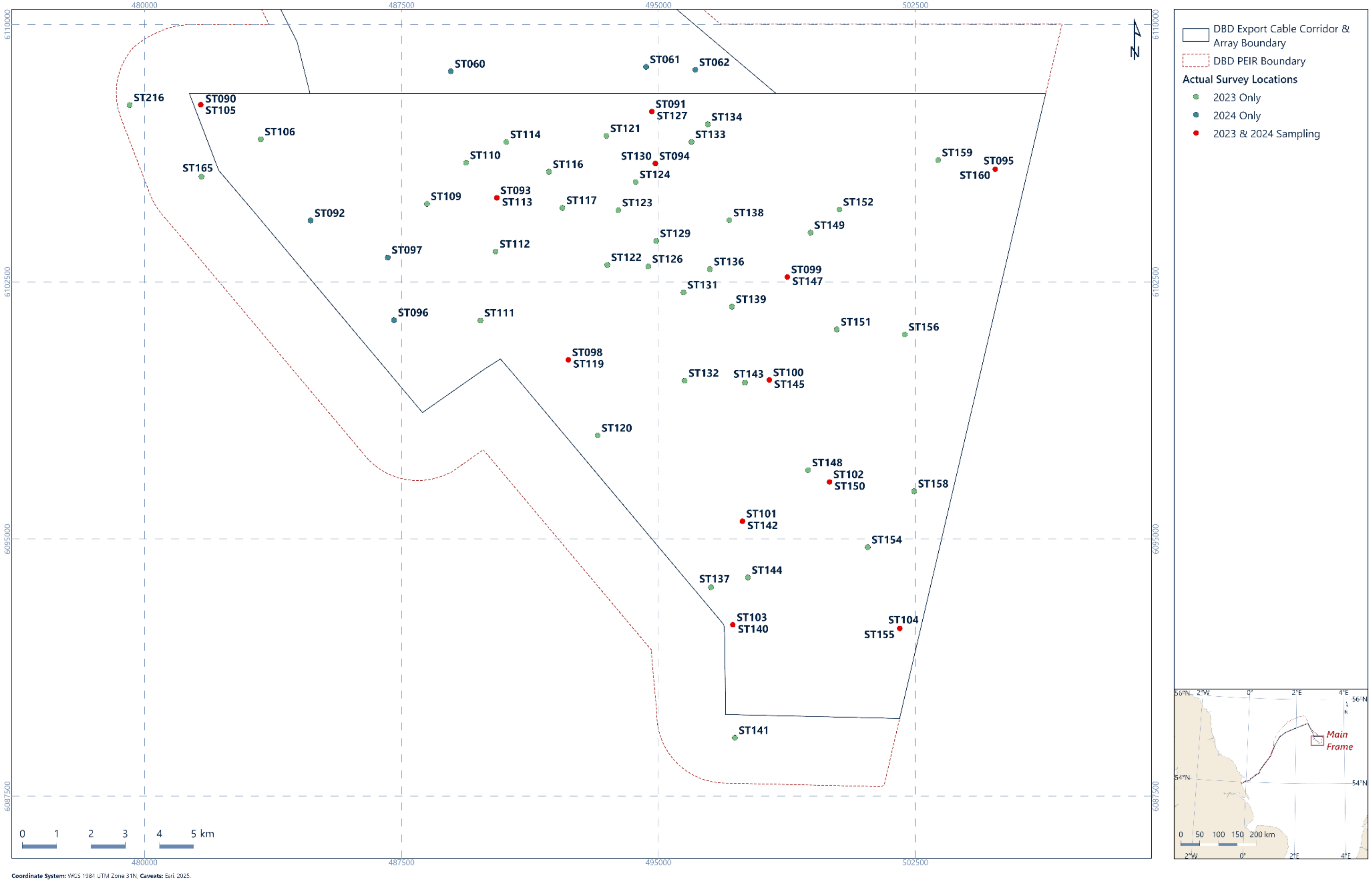


Figure 4.81: Completed survey locations 2023 and 2024 comparison, Dogger Bank Array

4.3.1 Sediment Characterisation

Table 4.47 summarises the sediment composition and presents a temporal comparison for the 12 repeated samples in the DBD array. Gravel content was higher during the 2023 survey compared to the 2024 survey, with station ST091 showing the largest decrease from 2023 to 2024. Sand and fines content were comparable between the 2023 and 2024 survey.

Variability of gravel content and fines content remained high between the 2023 and 2024 surveys. Variability of sand content remained low between the 2023 and 2024 surveys.

Folk classification remained the same at 4 of the 12 stations between the 2023 and 2024 survey. Two stations previously classified as sand in 2023 where classified as gravelly sand in 2024, three stations classified as gravelly sand in 2023 were classified sand in 2024, one station classified as gravelly sand in 2023 was classified as sand in 2024, one station classified as sandy gravel in 2023 was re classified as gravelly sand in 2024 and one station classified as gravelly muddy sand in 2023 was re classified as muddy sandy gravel in 2024.

Table 4.48 summarises the particle size distribution and presents temporal comparison for the 12 repeated samples in the DBD array. Modality was broadly comparable between the 2023 and 2024 survey, where 7 of the 12 stations had the same modality between the two surveys. Median and mean particle size (um) were comparable between the 2023 and 2024 surveys, except for station ST091 where median and mean particle size had a large increase from 2023 to 2024.

Wentworth description remained the same between the 2023 and 2024 survey for 7 of the 12 stations. One station was re-classified from coarse sand in 2023 to fine sand in 2024, one station classified as medium sand in 2023 classified to fine sand in 2024, one station classified as fine sand in 2023 to coarse sand in 2024 and one station classified from fine pebble in 2023 re-classified as medium sand in 2024.

Sorting coefficient ranged from very poorly sorted to moderately well sorted during both the 2023 and 2024 survey.

Skewness distribution varied between the 2023 and 2024 survey, with the distribution at only 2 stations remining the same between 2023 and 2024. Additionally, 2 stations were categorised as ‘very fine skewed’ in 2023, this distribution was not seen within the 12 stations during the 2024 survey.

Table 4.47: Summary of sediment composition comparison between 2023 and 2024, Dogger Bank D Array

Station	Gravel [%]		Sand [%]		Fines [%]		Silt [%]		Clay [%]		Folk Description (BGS modified)	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
ST090	4.56	2.97	95.44	97.03	0.00	0.00	0.00	0.00	0.00	0.00	Sand	Sand
ST091	73.36	12.95	24.97	87.05	1.67	0.00	1.22	0.00	0.45	0.00	Sandy Gravel	Gravelly sand
ST093	0.13	16.88	99.87	83.12	0.00	0.00	0.00	0.00	0.00	0.00	Sand	Gravelly sand
ST094	6.91	0.41	93.09	99.59	0.00	0.00	0.00	0.00	0.00	0.00	Gravelly sand	Sand
ST095	1.84	4.21	98.16	95.79	0.00	0.00	0.00	0.00	0.00	0.00	Sand	Sand
ST098	4.91	7.16	94.82	92.84	0.28	0.00	0.20	0.00	0.08	0.00	Sand	Gravelly sand
ST099	6.10	35.47	76.77	50.23	17.13	14.30	10.32	8.62	6.81	5.68	Gravelly muddy sand	Muddy sandy gravel
ST100	2.99	0.42	97.01	99.58	0.00	0.00	0.00	0.00	0.00	0.00	Sand	Sand
ST101	8.09	1.41	82.81	98.14	9.10	0.45	5.33	0.32	3.77	0.13	Gravelly sand	Sand
ST102	13.87	4.66	85.53	95.34	0.60	0.00	0.43	0.00	0.18	0.00	Gravelly sand	Sand
ST103	2.36	2.67	97.64	97.33	0.00	0.00	0.00	0.00	0.00	0.00	Sand	Sand
ST104	19.04	3.30	80.96	96.70	0.00	0.00	0.00	0.00	0.00	0.00	Gravelly sand	Sand
Minimum	**0.13**	**0.41**	**24.97**	**50.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		
Maximum	**73.36**	**35.47**	**99.87**	**99.59**	**17.13**	**14.30**	**10.32**	**8.62**	**6.81**	**5.68**		
Median	**5.51**	**3.75**	**93.96**	**96.25**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		
Mean	**12.01**	**7.71**	**85.59**	**91.06**	**2.40**	**1.23**	**1.46**	**0.74**	**0.94**	**0.48**		
SD	**20.0**	**10.1**	**20.6**	**13.79**	**5.31**	**4.12**	**3.18**	**2.48**	**2.14**	**1.64**		
RSD	**167**	**131**	**24**	**15**	**222**	**335**	**218**	**333**	**227**	**338**		

Notes
BGS = British Geological Survey
SD = Standard deviation
RSD = Relative standard deviation

Table 4.48: Summary of particle size distribution comparison between 2023 and 2024, Dogger Bank D Array

Station	Modality		Median [µm]		Mean Particle size [µm]		Mean Particle size [phi]		Mean Particle size Wentworth (1922) Description		Sorting Coefficient Description		Skewness Description	
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
ST090	Unimodal	Unimodal	201	199	204	201	2.29	2.31	Fine sand	Fine sand	Moderately sorted	Moderately well sorted	Coarse skewed	Symmetrical
ST091	Polymodal	Bimodal	17852	294	6111	410	-2.61	1.29	Fine pebble	Medium sand	Very poorly sorted	Poorly sorted	Very fine skewed	Very coarse skewed
ST093	Unimodal	Bimodal	235	497	235	682	2.09	0.55	Fine sand	Coarse sand	Moderately well sorted	Poorly sorted	Symmetrical	Very coarse skewed
ST094	Unimodal	Unimodal	213	206	217	207	2.2	2.27	Fine sand	Fine sand	Poorly sorted	Moderately well sorted	Very coarse skewed	Symmetrical
ST095	Unimodal	Unimodal	198	198	199	201	2.33	2.31	Fine sand	Fine sand	Moderately well sorted	Moderately well sorted	Symmetrical	Coarse skewed
ST098	Unimodal	Unimodal	210	226	212	235	2.23	2.09	Fine sand	Fine sand	Moderately sorted	Poorly sorted	Coarse skewed	Very coarse skewed
ST099	Unimodal	Polymodal	192	332	137	649	2.86	0.62	Fine sand	Coarse sand	Very poorly sorted	Very poorly sorted	Very fine skewed	Coarse skewed
ST100	Unimodal	Unimodal	276	213	281	213	1.83	2.23	Medium sand	Fine sand	Moderately well sorted	Moderately well sorted	Symmetrical	Symmetrical
ST101	Unimodal	Unimodal	182	174	183	175	2.45	2.52	Fine sand	Fine sand	Poorly sorted	Moderately well sorted	Symmetrical	Symmetrical
ST102	Bimodal	Unimodal	218	211	246	214	2.02	2.22	Fine sand	Fine sand	Poorly sorted	Moderately sorted	Very coarse skewed	Coarse skewed
ST103	Unimodal	Unimodal	177	180	179	184	2.48	2.44	Fine sand	Fine sand	Moderately well sorted	Moderately well sorted	Symmetrical	Coarse skewed
ST104	Bimodal	Unimodal	253	222	517	224	0.95	2.16	Coarse sand	Fine sand	Very poorly sorted	Moderately well sorted	Very coarse skewed	Coarse skewed
Minimum	-	-	**177**	**174**	**137**	**175**	**-2.61**	**0.55**	-	-	-	-	-	-
Maximum			**17852**	**497**	**6111**	**682**	**2.86**	**2.52**						
Median			**212**	**212**	**215**	**214**	**2.22**	**2.23**						
Mean			**1680**	**246**	**727**	**300**	**1.76**	**1.92**						
SD			**5090**	**91.3**	**1700**	**181**	**1.45**	**0.694**						
RSD			**302**	**37**	**234**	**61**	**82**	**36**						

Notes
SD = Standard deviation
RSD = Relative standard deviation

4.3.2 Sediment Macrofauna

4.3.2.1 Phyletic Composition

Table 4.49 summarises the phyletic composition of the enumerated fauna from the grab samples and presents temporal comparison for the 12 repeated sampling stations in the DBD array.

The number of taxa and individuals were greater in the 2023 survey, Annelids comprised the largest proportion of taxa and individuals for both years, while Arthropods comprised a larger proportion in the 2024 survey than the 2023 survey.

Table 4.49: Taxonomic groups of enumerated fauna from the grab samples, 2023 vs 2024 DBD Array

Taxonomic Group	Number of Taxa		Composition of Taxa [%]		Abundance		Composition of Individuals [%]	
	2024	2023	2024	2023	2024	2023	2024	2023
Annelida	44	60	41.9	44.8	387	758	40.1	48.8
Arthropoda	34	41	32.4	30.6	252	271	26.1	17.5
Mollusca	17	21	16.2	15.7	170	294	17.6	18.9
Echinodermata	4	6	3.8	4.5	32	110	3.3	7.1
Other phyla	6	6	5.7	4.5	124	120	12.8	7.7
Total	**105**	**134**	**100**	**100**	**965**	**1553**	**100**	**100**

Notes
Macrofaunal samples were processed through a 1 mm mesh sieve
Other phyla included: Chordata, Cnidaria, Foraminifera, Hemichordata, Nemertea, Phoronida and Platyhelminthes

4.3.2.2 Univariate Analysis

Table 4.50 presents the results of the univariate analysis of the enumerated macrofaunal dataset, which provided information on faunal richness and diversity for the 2023 and 2024 repeated stations in the DBD array. Univariate indices included faunal richness (Margalef's index d), diversity (Shannon-Wiener Index $H'Log_2$), evenness (Pielou's index J'), and dominance (Simpson's index λ).

The number of taxa and individuals at the repeat stations were higher in the 2023 survey than the 2024 survey, with station ST091 from the current survey showing the largest difference in taxa, individuals (Table 4.50). Diversity was higher in the 2024 survey than in the 2023 survey, while richness, evenness and dominance indices were comparable between the 2023 and 2024 surveys (Table 4.50).

For full analysis of each survey please see sections 0 and 4.2.4.

Table 4.50: Community statistics comparison of repeat stations (2024 vs 2023), DBD Array

Station*	Numbers				Richness		Diversity		Evenness		Dominance	
	Taxa		Individuals		Margalef [d]		Shannon-Wiener [H'Log$_2$]		Pielou [J']		Simpson [λ]	
	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024	2023
Array Area												
ST090	30	25	102	80	6.27	5.48	4.05	3.89	0.826	0.838	0.098	0.112
ST091	26	57	51	278	6.36	9.95	4.01	5.01	0.853	0.859	0.120	0.047
ST093	16	11	30	48	4.41	2.58	3.67	2.83	0.918	0.818	0.098	0.183
ST094	30	30	88	107	6.48	6.21	3.67	4.20	0.748	0.856	0.186	0.084
ST095	29	29	100	101	6.08	6.07	4.17	4.11	0.859	0.845	0.079	0.088
ST098	30	26	52	90	7.34	5.56	4.57	3.84	0.932	0.817	0.053	0.103
ST099	26	31	163	97	4.91	6.56	3.02	3.95	0.642	0.797	0.239	0.126
ST100	20	20	46	79	4.96	4.35	3.79	2.58	0.876	0.597	0.100	0.357
ST101	19	38	50	181	4.60	7.12	3.48	3.79	0.820	0.721	0.152	0.153
ST102	35	30	120	179	7.10	5.59	4.15	3.49	0.808	0.710	0.100	0.153
ST103	21	30	36	162	5.58	5.70	4.13	3.57	0.940	0.728	0.068	0.169
ST104	35	33	127	151	7.02	6.38	4.16	4.06	0.811	0.805	0.093	0.101
Minimum	**16**	**11**	**30**	**48**	**4.41**	**2.58**	**3.02**	**2.58**	**0.642**	**0.597**	**0.053**	**0.047**
Maximum	**35**	**57**	**163**	**278**	**7.34**	**9.95**	**4.57**	**5.01**	**0.940**	**0.859**	**0.239**	**0.357**
Median	**28**	**30**	**70**	**104**	**6.18**	**5.88**	**4.03**	**3.87**	**0.839**	**0.812**	**0.099**	**0.119**
Mean	**26**	**30**	**80**	**129**	**5.93**	**5.96**	**3.91**	**3.78**	**0.836**	**0.783**	**0.116**	**0.140**
Standard Deviation	**6.2**	**10.9**	**42.4**	**63.4**	**1.02**	**1.72**	**0.406**	**0.632**	**0.0835**	**0.0786**	**0.0528**	**0.0787**

Notes:
* = 2024 station names have been used, see Table 4.46 for 2023 station names

4.3.3 Environmental DNA Analysis

Two eDNA sampling stations from the 2023 survey were repeated in the 2024 survey. However, bony fish metabarcoding was unsuccessful for both stations in 2023, as the DNA was not amplifiable, so there were no repeat eDNA stations.

The eDNA results from the 2024 survey were largely comparable to those from 2023, with both showing high relative proportions of OTUs of commercially important bony fish, such as Atlantic mackerel (*S. scombrus*) and European sprat (*S. sprattus*).

4.3.4 Biotope and Habitat Classifications

Table 4.51 summarises the assigned biotopes for the 12 repeated samples in the DBD array. Eight stations were assigned the same biotope as the 2023 study. Stations ST091, ST093, ST099 and ST100 were assigned different biotopes than those observed in the 2023 DBD array.

Table 4.52: Biotope comparison of repeat stations (2024 vs 2023), DBD Array

Station	2023	2024
ST090	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand
ST091	MB3231 Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)	MC3212 *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel
ST093	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand	MC5212 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand
ST094	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand

Station	2023	2024
ST095	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand
ST098	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand
ST099	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand And MC1251 Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay	MC3212 *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel
ST100	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand And MC1251 Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay	MB5233 *Nephtys cirrosa and Bathyporeia* spp. in Atlantic infralittoral sand
ST101	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand And MC1251 Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand

Station	2023	2024
ST102	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand
ST103	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand
ST104	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand	MB5236 *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand with epibiotic MC5215 *Amphiura* brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand

Notes:
* = *Amphiura brachiata* is currently *Acrocnida brachiata*, but the EUNIS biotope name has retained the species' former name

5. Discussion

Seafloor photographic data provided information on the habitats, whereas physico-chemical and biological analysis of sediment samples provided information on sediment, contaminants and biological communities across the DBD survey area. Environmental DNA analysis of water samples provided information on the fish taxa in the pelagic habitat of the survey area. Data gathered are important components of environmental characterisation studies to support engineering design and/or EIA.

5.1 Sediment Characterisation

Results of the sediment PSD analysis of the grab samples indicated a predominantly sandy sediment, the mean sand content being 83.40 % and the median 94.53 %.

There was high variation in the gravel content, with 4 stations being devoid of gravel, 31 stations with gravel content between 0 % and 1 %, 40 stations with gravel content between 1 % and 10 %, 17 stations with gravel content between 10 % and 50 % and 12 stations with gravel content between 50 % and 100 %. In general, the variation of gravel content was higher at stations within the characterisation area than at stations in the array area and along the ECC.

The fines content was generally low, with 51 stations being devoid of fines, 9 stations with fines content between 0 % and 1 %, 36 stations with fines content between 1 % and 10 % and 8 stations with fines content between 10 % and 20 %. In general, the variation of fines content was higher at stations in the array area than at stations along the ECC and in the characterisation area.

Seven sediment classes were identified through the Folk (BGS modified) classification. Of these, ‘sand’ typified most stations in the array area, characterisation area and along the ECC, followed by ‘gravelly sand’ ‘sandy gravel’, and ‘muddy sandy gravel. In addition, ‘gravelly muddy sand’, ‘gravel’ and ‘muddy sand’ typified a total of 6 stations in the characterisation area and along the ECC.

The coarseness of the sediment was assessed using the Wentworth (1922) scale, through which seven sediment descriptions were identified. Of these, ‘fine sand’ described most stations in the array area, characterisation area and along the ECC, followed by ‘coarse sand’, ‘granule’, ‘very coarse sand’ and ‘fine pebble’. In addition, ‘medium sand’ and ‘medium pebble’ described a total of four stations in the array area and along the ECC.

The sorting coefficient reflected the diversity of the sediment and ranged from ‘well sorted’ to ‘very poorly sorted’ and most stations had ‘moderately well sorted’ sediments.

The sediment recorded at stations in the array area, characterisation area and along the ECC are typical of this region of the North Sea, where the seafloor is reported to comprise predominantly ‘sand’, with ‘sandy gravel’ and ‘muddy sandy gravel’ (Jones et al., 2004).

The sediment in the DBD array is typical of the Dogger Bank, which is reported to comprise fine sands with shell fragments in the shallow areas and muddy fine sands in the deeper parts (Eggleton et al., 2016; Krönche & Knust, 1995). In this study, shell fragments were recorded through in situ observation of the grab samples. This is of relevance, as the sediment PSD analysis does not discern between shells and gravel and may result in slightly gravelly sand being identified in areas which may represent shelly sand, which is also reported to be typical of the Dogger Bank (Diesing et al., 2009).

Patches of gravelly sediment are reported to occur in topographic depressions in water depth of less than 40 m (Diesing et al., 2009), whereas, above the 30 m depth contour, the sand fraction is reported to be higher than 94 % (Van Moorsel, 2011). In this study, the water depth in the array ranged from 13.0 m BSL to 77.0 m BSL, with 16 of the 60 stations sampled along the ECC and 11 of the 15 stations sampled in the array area, being in water depth < 30.0 m and all of the stations sampled in the characterisation area > 30.0 m. Gravelly sediments are reported as 'gravel', 'sandy gravel', 'gravelly sand', 'gravelly muddy sand', and 'muddy sandy gravel' based on the Folk (1954) classification (Diesing et al., 2009). In this study, gravelly sediment, classified as 'gravel', 'sandy gravel', 'gravelly sand', 'gravelly muddy sand', and 'muddy sandy gravel' (Folk BGS) were recorded at 4 of the 15 stations in the array area, 6 of the 29 stations in the characterisation area and 26 of the 60 stations along the ECC and most stations were classified as 'sand'.

Most stations had unimodal distributions, peaking in the fine sand region. Bimodal and/or polymodal distributions were recorded at 3 stations in the array area, 3 stations in the characterisation area and 21 stations along the ECC, indicating different sediment sources (Hein, 2007). These are likely to be represented by physical disturbance associated with the tidal and storm-induced currents on the Dogger Bank, as well as fluvial sediment input.

Previous studies of the area (Forewind, 2014) identified five Folk (1954) sediment classes across Tranche B, which encompasses DBD, including 'slightly gravelly sand', 'gravelly sand', 'sandy gravel', 'gravel' and 'muddy sandy gravel'. Four of these sediment classes were observed in the current survey.

Sand and fines content was broadly comparable between the 2023 and 2024 surveys and gravel content decreased from the 2023 survey to the 2024 survey.

Folk classification remained the same at 4 of the 12 repeat stations between the 2023 and 2024 survey, with the remaining 8 stations being re-classified in the current survey, suggesting a slight change in the sediment composition. Changes in sediment composition are likely due to regional hydrodynamics and fluvial inputs, as reflected in the modality distribution of sediment particle size.

5.1.1 Granulometric Similarities

In the current survey, six groups and a single station were identified through the multivariate analysis, with each assemblage having an average Euclidean distance of 3.3. Each group was characterised by a different mean particle size, the mean particle sizes corresponded to descriptions ranging from fine sand to medium pebble. This reflects the sediment heterogeneity across the survey area. Similarly, a high diversity was observed in the macrofauna indices, suggesting an impact of the sediment composition on the macrofauna, this is discussed further in Section 5.3.

No obvious spatial patterns were observed in the distinct groups, with each group of the six groups containing stations located in at least two different areas (ECC, characterisation area and array area).

Previous studies of the area (Forewind, 2014) also grouped the sediment composition into different groups, suggesting that the sediment composition across Dogger Bank D is diverse.

5.1.2 Principal Component Analysis (PCA)

In the current survey, a PCA analysis was used to highlight variables driving the variation of sediment composition across the survey area. The PCA results showed that the stations generally did not group by depth suggesting that there could be other factors affecting the sediment composition, such as currents, biological activity and other physical processes.

5.2 Sediment Chemistry

Sediment chemistry analysis was undertaken to identify potential areas of sediment contamination that may be resuspended in the water column during construction activities.

5.2.1 Sediment Hydrocarbons

5.2.1.1 Total Hydrocarbons

Hydrocarbons are components of the organic material that enters the marine environment through atmospheric and aquatic pathways. Although hydrocarbons may derive from natural sources (e.g. biosynthesis from both marine and terrestrial organisms), a large proportion of hydrocarbons is related to anthropogenic activities (Parinos et al., 2013).

The THC concentrations across the DBD survey area were below the LOD (< 1 mg/kg) at all stations except station ST009 along the ECC which had a THC concentration of 21.2 mg/kg. All values were below the Cefas AL1 (100 mg/kg). It is worth noting that the Cefas AL1 for THC is currently used as a guideline in the absence of full data for PAHs to assess whether dredged material can be disposed of to sea by the regulators and their scientific advisors (Mason et al., 2022). The use of THC is limited in that it provides no indication of toxicity and may be conservative as indicated by most sediment failing this threshold; in addition, there is large inter-laboratory method variability (Mason et al., 2022). Overall, results from this study are indicative of localised anthropogenic input, as in general, marine sediments are considered unpolluted if THC is below 10 mg/kg (Farrington & Tripp, 1977; Volkman et al., 1992; Readman et al., 2002). The THC concentration was above 10 mg/kg at station ST009 along the ECC. This may be due to the proximity of station ST009 to the shore, with a higher likelihood of the sediment here being influenced by terrestrial run-off. More stations close to the shore would need to be sampled for THC to verify a spatial pattern.

5.2.1.2 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons are widely spread in the environment (Butler et al., 1984) with natural sources associated with biosynthesis (Neff, 1979; Sims & Overcash, 1983), natural seeps of petroleum (Natural Research Council [NRC], 1983; Kennicutt et al., 1988) and natural forest and prairie fires (Youngblood & Blumer, 1975; Wakeham et al., 1979). Anthropogenic sources of PAHs are mainly associated with fossil fuel combustion (Edwards, 1983; Sims & Overcash, 1983; Haritash & Kaushik, 2009). Polycyclic aromatic hydrocarbons enter marine sediments from atmospheric and riverine inputs and adsorb to suspended inorganic and organic particulate matter, ultimately settling on the seafloor where they can accumulate (Latimer & Zheng, 2003; Culotta et al., 2006).

Monitoring of aromatic hydrocarbon type and content is important due to the toxic nature (mutagenic/carcinogenic) of several PAHs, particularly the heavier weight PAHs. The US EPA has identified 16 priority PAHs to be monitored (Keith, 2015) and the CEMP specifies 9 PAHs of specific concern (OSPAR, 2014), which reflect inputs from man-made combustion sources.

The individual PAH concentrations were below the respective marine SQGs at all stations except station ST009 along the ECC. At this station concentrations of anthracene, benzo[a]anthracene and phenanthrene of 7.09 µg/kg, 20.0 µg/kg and 38.8 µg/kg, were reported, respectively above their respective TELs of 6.71 µg/kg, 5.87 µg/kg and 34.6 µg/kg.

The concentrations of the sum of the 22 PAHs analysed were lower than the range of 303 mg/kg to 640 mg/kg reported for CSEMP station 345 (Cefas, 2012) located offshore the Humber, except for station ST009 where the concentration was within this range. Station ST009 was close to the shore, with a higher likelihood of the sediment here being influenced by terrestrial run-off. More stations close to the shore would need to be sampled for total PAH concentrations to verify a spatial pattern.

5.2.2 Sediment Metals

Metals and metalloids occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Some are essential to marine life while others have no biological function and therefore are toxic to numerous organisms at certain levels (Paez-Osuna & Ruiz-Fernandez, 1995; Boening, 1999). Metals enter the marine environment via natural methods such as riverine transport, coastal discharges, geological weathering and atmospheric fallout (Brady et al., 2015) and anthropogenic activities such as direct discharges from industrial activities.

Trace metal contaminants in the marine environment form associations with the non-residual phases of mineral matter, such as iron and manganese oxides and hydroxides, metal sulphides, clays, organics and carbonates (Warren & Zimmerman, 1993; Dang et al., 2015; Wang et al., 2015). Non-residual trace metals are associated with more reactive and available sediment components through adsorption onto mineral surfaces and organic complexation. Metals associated with these more reactive phases are prone to physical, chemical and biological interactions and transformations potentially increasing their mobility and biological availability (Tessier et al., 1979; Warren & Zimmerman, 1993; Du Laing et al., 2009). Residual trace metals are part of the crystal structure of the component minerals and are generally unavailable to organisms (de Orte et al., 2018). Therefore, in monitoring trace metal contamination of the marine environment, it is important to distinguish the more mobile non-residual trace metals from the residual metals held tightly in the sediment lattice (Chester & Voutsinou, 1981), which are of comparatively lesser environmental significance because of their low reactivity and availability.

Metals concentrations across the DBD survey area were below the marine SQGs for all metals analysed, except for arsenic at 5 stations.

Arsenic concentrations above the Canadian SQGs TEL (7.24 mg/kg) were recorded at stations ST070, ST074, ST080, ST085 and ST093 (10.7 mg/kg, 10.7 mg/kg, 11.7 mg/kg, 9.00 mg/kg and 11.3 mg/kg respectively).

Natural sources of arsenic in the marine environment include mineral erosion, (Neff, 1997), whereas anthropogenic sources include mining, burning of fossil fuels and surface run-off (Neff, 1997; Nriagu, 1990). The arsenic concentrations recorded in this study (4.90 mg/kg to 11.7 mg/kg) were within the range of < 0.15 mg/kg to 135 mg/kg reported for the North Sea, with elevated concentrations along the east coast of England, including the Humber Estuary (Whalley et al., 1999). The high variation in arsenic concentrations recorded in this study is in line with the results of Whalley et al. (1999) who reported high variations in arsenic concentrations throughout the North Sea, with high concentrations of arsenic (> 70 mg/kg) also at some offshore locations.

5.2.3 Sediment Polychlorinated Biphenyls

Polychlorinated biphenyls are a group of industrial chemicals used in electrical equipment. Although the use of PCBs has been banned for many years, they can persist in marine sediments owing to their resistance to degradation (Geyer et al., 1984).

The PCBs analysed in this study had concentrations below their respective LODs at all stations. The total PCB concentration was < 0.00200 mg/kg at all stations and was below the Cefas marine AL1 (0.02 mg/kg) and AL2 (0.2 mg/kg).

5.2.4 Sediment Organotins

Organotin compounds have historically been used in marine antifouling products; however, their use is now prohibited, following evidence of their toxicity to selected marine organisms. However, TBT, one of the most toxic contaminants, may still enter the marine environment through sources such as wastewater, as TBT is used as a biocide in preserving wood, textiles, papers, and stonework (Díez et al., 2005). Amongst the toxic effect of TBT is imposex, that is the imposition of male characteristics on the female gastropod *Nucella lapillus*, following exposure to concentration levels as low as 1 ng/L, with severe cases resulting in sterilisation of the organisms (Bryan et al., 1987).

The TBT degradation results in the production of DBT and monobutyl tin. These are used as stabilisers in polyvinyl chloride (PVC) production (Díez et al., 2005) and, although found to be less toxic than their parent compound, cause toxicity to some aquatic organisms (Huang et al., 2004).

The organotin compounds analysed in this study, namely DBT and TBT, had concentrations below their respective LODs (< 0.001 mg/kg or < 0.005 mg/kg) and below the Cefas AL1 (0.1 mg/kg) and AL2 (1 mg/kg) across the entire DBD survey area.

5.3 Macrofaunal Communities

Macrofaunal communities across the DBD survey area in 2024 were represented mainly by Annelida which dominated in terms of taxa composition and abundance and comprised polychaetes such as *S. bombyx, P. kefersteini, L. cf cingulata* and *M. fragilis* which were the top four most abundant taxa. The most frequent taxa observed were phoronids, nemerteans, polychaetes of the genus *Owenia* and the annelid *S. bombyx*. The polychaete *S. bombyx* has a short life span, high dispersal potential and reproductive rate, which allows this species to be an early coloniser and withstand habitat disturbance (Ager, 2005). Being a tube-building polychaete, *S. bombyx* can modify the sediment making it suitable for later colonization and succession (Ager, 2005).

Arthropoda were the second most represented phylum in terms of taxa composition and abundance across the DBD survey area. Arthropoda comprised crustaceans such as the *B. crenatus, G. intermedia, P. marina* and *Upogebia deltaura.* Arthropoda have also been reported as the second most abundant phylum in terms of overall taxonomic composition from the nearby Tranche A area (Forewind, 2014). *Galathea intermedia* is normally found in up to depths of 100 m on a variety of substrata, including gravels, sands and muds (Tyler-Walters, 2010). The amphipod *P. marina* is widely distributed globally and is found in the North Sea. *Phtisica marina* can be found on many types of substrates, from soft bottom to sponges and algae (Mauro et al, 2020). *Phtisica marina* is also considered an opportunistic species (González et al. 2008) that can tolerate stress associated with hydrodynamics (Guerra-García & García-Gómez, 2001), as well as anthropogenic activities such as trawling (González et al., 2008). Its predatory mode of feeding, coupled with the capability of switching to filter feeding, makes this species successful in different benthic communities (Guerra-García et al., 2002).

Mollusca were the third most represented phylum in terms of taxa composition and abundance. Molluscs comprised bivalves such as *K. bidentata*, *F. fabula*, *N. nitidosa* and *A. prismatica*. Some of these molluscs are opportunistic species, notably bivalves of the genus *Abra*, which are reported to be capable of exploiting newly disturbed substratum through larval recruitment, secondary settlement of post metamorphosis juveniles, and/or redistribution of adults (De-Bastos, 2016). Similarly, *K. bidentata* is reported to occur in association with burrows of brittlestars of the order Ophiuroidea (Gofas & Salas, 2008), which were also recorded in this study. Species of *Nucula*, are reported to occur in muddy sandy habitats exposed to a degree of wave action (Sabatini & Ballerstedt, 2008) and on sandbanks (Roche et al., 2007; Walker & Rees, 1980).

Echinodermata contributed the least to the taxa composition and abundance and comprised brittlestars such as *A. filiformis*, *Acrocnida brachiata* and *Amphipholis squamata* and urchins such as *E. pusillus* and *E. cordatum*, which were amongst the top five most abundant and frequently occurring echinoderms. These taxa are reported to be typical of habitats with mixed coarse sediments exposed to strong tidal currents (Jackson, 2008), with species such as *E. pusillus* inhabiting the interstices of gravelly substrata (Rees et al., 2007) and *A. brachiata* being generally associated with *E. cordatum* (Barnes, 2008). The frequency of occurrence of *A. brachiata* was lower than that of *A. filiformis* with higher abundance at stations along the ECC (8 stations and 15 stations respectively), while in the array *A. brachiata* occurred at 11 stations and *A. filiformis* at one station. This reflects *A. brachiata*'s ability to withstand sediment disturbance as this species buries deeper in the sediment than *A. filiformis*, which is reported to be dominant at deeper depths, where sediment disturbance is less (Wieking & Kröncke, 2003), in line with the results of this study which recorded higher abundance of *A. filiformis* at stations along the ECC than those recorded in the array.

Other phyla were represented mainly by species of *Phoronis*, Nemertea and Ceriantharia, the lancelet *B. lanceolatum*, anemones from the family Edwardsiidae and the ascidian *Dendrodoa grossularia*. Of these taxa, *B. lanceolatum* is reported to be typical of the southern North Sea, where it inhabits the sandy sublittoral zone (Barnes, 2015).

The macrofaunal composition recorded in this study is in line with that reported to be typical of this region of the North Sea (Reiss et al., 2010), including the Dogger Bank (Diesing et al., 2009; Wieking & Kröncke, 2003), characterised by habitats subject to a degree of surface sediment disturbance, as indicated by the widespread occurrence of *S. bombyx* and crustacean amphipods, both of which are adapted to sediment disturbance (Wieking & Kröncke, 2003). Stations on the shallower parts of the Dogger Bank are reported to be inhabited by a *Bathyporeia-Fabulina* community, whereas deeper areas have high abundances of *F. fabula*, *A. brachiata* and polychaetes such as *S. bombyx* and species of *Owenia* (Wieking & Kröncke, 2003). The presence of coarse sediment, including shells, may provide a higher number of microhabitats, including a suitable substrate for the attachment of solitary (e.g. ascidians) and colonial epifaunal taxa (e.g. hydroids and bryozoans), increasing the structural complexity of the habitat by providing important microhabitats (JNCC, 2024).

In general, the faunal diversity, calculated through the Shannon-Wiener (H'Log_2) and assessed in line with the criteria of Dauvin et al. (2012), was good across the DBD survey area, with faunal abundances fairly evenly distributed across the taxa recorded, as indicated by the Pielou's index of evenness.

Five macrofaunal assemblages were identified through the multivariate analysis, each assemblage having an average similarity of ≤ 47.0 % and reflecting the diversity of the sediment. This was further confirmed by the correlation between the observed pattern of macrofaunal distribution and the sediment particle sizes and depth, in line with the literature which reports granulometry and depth as the main physical variables influencing the macrofaunal distribution in the North Sea (Künitzer et al., 1992; Reiss et al., 2010; Callaway et al., 2002; ICES, 2008), including that of the Dogger Bank (Diesing et al., 2009). Thus, coarse sediments featured invertebrates such as *G. lapidum*, *M. fragilis*, and *L.* cf. *cingulata*, which are reported to prefer coarse substrate (Tillin, 2023), and the lancelet *B. lanceolatum*, which is reported to prefer sandy habitats mixed with shells (Barnes, 2015). More compact and finer sediments had a prevalence of opportunist bivalves, including *F. fabula* which is capable of withstanding physical disturbance owing to its flexible feeding method (Rayment, 2008).

The infaunal biomass was represented mainly by echinoderms and molluscs, the former owing to the abundance as well as the size of selected species such as the urchins *E. pusillus*, which can reach 1 cm in diameter (Lumbis, 2008), and *E. cordatum*, which can grow up to 9 cm (Hill, 2008), but also the brittlestar *A. brachiata*, the arms of which can reach up to 18 cm (Barnes, 2008) and the starfish *Astropecten irregularis* which can grow up to 20 cm (Ziemski et al., 2023). The biomass of molluscs was associated with the abundance of this phylum as well as the size of selected bivalves, such as *C. striatula* and *P. pellucidus*, which can reach 4.0 cm and 4.5 cm, respectively (Oliver et al., 2016).

Colonial epifauna was recorded across most of the survey area and was represented mainly by low-lying bryozoans and hydroids capable of colonising small irregular patches on stones and shells (Tyler-Walters, 2005). Larger, erect taxa, such as the bryozoan *Flustra foliacea* were recorded at stations featuring coarse sediment, mostly along the nearshore section of the ECC. *Flustra foliacea* occurs on hard substrata, such as shells, stones, or cobbles, but forms dense aggregations particularly in current swept rocky bottoms, as this species is associated with hard substrata in strong currents and areas subject to sediment abrasion (Tyler-Walters & Ballerstedt, 2007), such as those along the nearshore section of the survey area.

5.4 Environmental DNA

Environmental DNA comprises DNA fragments shed from any living form into the environment, including the water environment. In water, eDNA is sampled by filtration and subsequently analysed to detect the taxa present at a particular location within a short time frame. The average half-life of eDNA is about 48 hours, which varies depending on environmental conditions such as temperature; DNA degradation slows down in cold and dark conditions, or when the DNA is bound to sediment, whilst it accelerates in more acidic environments (Holman et al., 2022).

In terms of abundance, one eDNA genetic sequence extracted from an environmental sample is not equivalent to one individual of a species, due to limitations inherent in the technique (Burian et al., 2020). Moreover, the eDNA signal can be impacted by biological (e.g., biomass, life stage, activity, body condition), environmental (e.g. temperature, pH, salinity, conductivity), and technical factors (e.g. primer bias, PCR stochasticity) (NatureMetrics, 2024) as shown by some studies (e.g. Danziger et al., 2022). However, an increased amount of eDNA does generally equate to an increased presence of the taxa, due to increased sources of eDNA such as skin, faeces etc. released into the environment, though this is not a linear relationship for metabarcoding techniques such as those in this report. Due to the current reference databases available to match the genetic sequences, taxa identified at the species level often are caveated by '*There is lower support for this taxonomic identification as it is based on fewer than three matches to sequences in the reference database, and/or limited geographic occurrence records for the taxon*'. This affects the taxonomic resolution that can be used with confidence during data analysis.

In this survey, water samples collected near the surface (TOP), approximately 1 m below the sea surface, and near the seafloor (BOT), approximately 1 m above the seafloor, were analysed for eDNA taxonomic classification of bony fish taxa. The analysis of eDNA detected more taxa than both seafloor photographic and macrofaunal analyses, with 25 bony fish taxa identified at family or higher level using eDNA, and 12 identified by other methods (Figure 4.69). Overall, the different methods employed to detect bony fish taxa showed to be complementary to each other. Moreover, the eDNA analysis identified many taxa to a lower taxonomic level compared to the photographic data. This is not surprising given that photographic data sampling covers a more limited temporal window, and it carries an intrinsic disturbance effect due to the camera approaching the seafloor, causing the fish to move away from the sampling location. Identifiable features for fish taxa may also not be clearly visible in a video or a photograph, resulting in the need for a higher identification level. As expected, the eDNA analysis was able to provide a more comprehensive dataset whilst avoiding the need to undertake more destructive sampling, such as epibenthic trawling, to obtain taxonomic data.

Overall, results indicated comparable eDNA taxa composition within the TOP and BOT samples, with BOT samples containing higher relative proportions of OTUs associated with bottom-dwelling bony fish taxa (Figures 4.66, 4.67, and 4.68). Differences between the TOP and BOT samples were largely driven by different relative proportions of OTUs for Atlantic mackerel (*Scomber scombrus*), which had higher relative OUTs in the TOP samples, and European sprat (*Sprattus sprattus*), which had a higher relative OTUs in the BOT samples. The distribution of eDNA in the water column was likely related to several factors including the behaviour of the source organism and the hydrology of the area (Harrison et al., 2019; NatureMetrics, 2024).

The taxa identified through eDNA analysis were generally representative of the survey area and the North Sea (Moorsel, 2011; Fugro, 2024a). The bony fish taxa with the highest relative proportion of OTUs detected by eDNA sampling was Atlantic mackerel (*S. scombrus*), followed by European sprat (*S. sprattus*), and Atlantic herring (*Clupea harengus*). These are commercially important species, each with known spawning grounds within Dogger Bank

(Gubbay et al., 2002). The 2024 results were largely comparable to the eDNA results from the 2023 survey, which found Atlantic mackerel (*S. scombrus*) eDNA to be detected with the highest number of OTUs, followed by European sprat (*S. sprattus*) (Fugro, 2024a). Although two eDNA sampling stations from the 2023 survey were repeated in the 2024 survey, metabarcoding was unsuccessful for both stations in 2023, so there were no repeat eDNA stations between the years.

Of the bony fish OTUs detected by eDNA analysis, eight were UK BAP species, three were listed as 'vulnerable' on the IUCN red list, and two were listed by OSPAR as 'Threatened and/or declining species'. All of these were species of commercial importance. The OTUs listed as UK BAP species included several with known spawning grounds in the Dogger Bank area, namely Atlantic mackerel (*S. scrombus*), whiting (*Merlangius merlangus*), Atlantic herring (*C. harengus*), European plaice (*Pleuronectes platessa*), Atlantic cod (*Gadus morhua*), and common sole (*Solea solea*) (Gubbay et al., 2002; Moorsel, 2011). In addition, OTUs of the family Ammodytidae (sand eels) were detected; sand eels have known spawning grounds in Dogger Bank (Moorsel, 2011), and the detection could indicate the potential presence of the UK BAP species *A. marinus*.

eDNA analysis tentatively detected OTUs matching the species *Leucaspius delineatus*, which is listed on GRIIS for the UK. This species is a small, non-native freshwater fish and may have been detected in the eDNA samples due to the influence of nearby freshwater inputs (Britton, 2011). However, the sources of contamination cannot be accurately determined, as there are several likely pathways of introduction including hydrology and coastal birds feeding, as well as discarding at sea.

5.5 Seafloor Habitats and Biotopes

Results of the seafloor photographic data analysis indicated the presence of habitats featuring rippled sand with shell fragments and varying amounts of gravel and mud across most of the survey area. Habitats featuring hard substrates such as pebbles and cobbles were recorded, particularly at stations along the nearshore section of the ECC. The presence of ripples is indicative of sediment disturbance, such as that associated with hydrodynamics. Large areas of rippled sand and other un-cohesive cover comprising superficial sand and silt with various amounts of gravel are ubiquitous throughout much of the North Sea (BGS, 2002).

Characteristic epibenthic species included echinoderms, crustaceans, bivalves, low-lying and erect hydroids and bryozoans and fish, which were observed in the majority of seafloor photographic data acquired within the DBD survey area. The habitat and associated epibiotic communities were comparable to those reported for the shallower sediment areas of the southern North Sea (Callaway et al., 2002; Jennings et al., 1999).

Nine biotopes, two biotope complexes and five habitat complexes were identified in the DBD survey area.

The biotope '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236) was assigned to 21 stations, including 10 along the offshore section of the ECC and 11 stations in the array. This biotope may undergo transitions in community composition and fluctuations in the abundance of the characterising taxa *Magelona* and *F. fabula* and is considered to be part of the 'shallow *Venus* community' or 'boreal off-shore sand association' which are reported to correlate with current induced 'bed-stress' (EEA. 2022).

The biotope '*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand' MC5215 was assigned to 16 stations in combination with '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236). This biotope is reported as an epifaunal overlay which may cover a range of other biotopes and is likely to form part of the non-cohesive/cohesive muddy sand communities, which make up the 'offshore muddy sand association' (EEA, 2022).

The biotopes '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica*' in circalittoral fine sand (MC5211) and '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' (MC5212) were assigned to 20 and three stations, respectively. The biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica*' in circalittoral fine sand (MC5211) was assigned to 10 stations along the ECC and 10 stations in the characterisation area. Each of the three stations assigned to the biotope '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' (MC5212) were located in the ECC, array area and the characterisation area within the DBD survey area. These biotopes are reported to be similar, albeit '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica*' in circalittoral fine sand (MC5211) is reported to occur in finer sand (EEA, 2022). In this study, the median sediment particle size of stations assigned the biotope '*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand' (MC5212) was between 228 µm to 512 µm, mean of 412 µm, whereas that of stations assigned the biotope *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica*' in circalittoral fine sand (MC5211) was 119 µm to 315 µm, mean 223 µm.

The biotope '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (MC3212) was assigned to thirteen stations along the ECC and two stations in the array area. This biotope is reported to be similar to '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211), but it occurs in coarser sediments with a higher proportion of venerid bivalves and has also been reported in the central North Sea (JNCC, 2022). The biotope '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (MC3212), previously described as the 'Deep *Venus* Community' and the 'Boreal Off-Shore Gravel Association', is reported as part of the 'infralittoral étage' described by Glemarec (1973, cited in EEA, 2022) and is reported to be variable over time (EEA, 2022).

The biotope '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (MC6211) was assigned to 4 stations along the nearshore section of the ECC. This biotope is reported to be related to the '*Abra* community' and part of the 'infralittoral étage' described by Glemarec (1973, cited in EEA, 2022).

The biotope '*Nephtys cirrosa and Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) was assigned to stations ST060 and ST007 along the offshore section of the ECC and station ST100 in the array. Habitats containing this biotope are reported to be typical of areas subjected to physical disturbance through tidal streams or wave action. This biotope has reduced diversity in comparison to its more stable counterpart '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236). However swimming amphipods, and sand eels of the genus *Ammodytes* may be more prevalent (JNCC, 2022).

The biotope '*Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand' (MC3213) was assigned to stations four stations, three were located along the offshore section of the ECC and one station in the array. Habitats containing this biotope are reported to be impoverished and faunal communities may be variable both temporally and spatially. As such, the biotope '*Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand' (MC3213) may represent an impoverished, transitional community, which in more settled conditions may develop into the more stable '*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (MC3212) biotope (JNCC, 2022).

The biotope 'Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)' (MB3231) was assigned to the ungrouped stations ST009 and ST010 along the nearshore section of the ECC. The species composition of this biotope is reported to be highly variable seasonally and likely to comprise a low abundance of infauna such as robust polychaetes or bivalves with infrequent epibiota, including echinoderms and crustacea. In more settled periods there may be colonisation by anemones and small populations of hydroids and bryozoans (EEA, 2022).

Two biotope complexes were assigned to stations where the faunal composition did not allow the description of the community to a lower biotope level. These were: 'Faunal communities of Atlantic offshore circalittoral sand' (MD521), assigned to six stations along the ECC and ten stations in the characterisation area, and 'Faunal communities of Atlantic circalittoral sand' (MC521) assigned to station ST038 along the ECC and stations ST073, ST078 and ST088 in the characterisation area.

Five habitat complexes were assigned to 18 stations across the DBD survey area. The habitat classification at these stations was based on photographic data and results of the sediment PSD analysis, as insufficient grab volume did not allow macrofaunal analysis.

The biotope and habitat complexes are deemed to represent the broad habitats characterising the DBD survey area and encompass the biotopes described which may grade into each other in response to local hydrodynamics and subsequent changes of the main sediment fractions composition. The habitat types observed are considered representative of the heterogeneous sediment types and faunal communities present in this region of the southern North Sea.

5.5.1 Potentially Sensitive Habitats and Species

Most of the habitat types recorded across the DBD survey area are part of the BSH 'Subtidal sands and gravel', which is a UK BAP priority habitat (JNCC, 2024) and a habitat of conservation importance (HOCI) in MCZs (JNCC, 2016). Subtidal sands and gravel sediments are the most common habitats found below the level of the lowest low tide around the UK coast. The sands and gravels from the North Sea are largely formed from rock material (JNCC, 2024).

Aggregation of cobbles and boulders, at 19 stations, were assessed for the potential of these aggregations to constitute Annex I habitat 'Reef, specifically 'stony reef', in line with the criteria detailed in Irving (2009) and Golding et al. (2020) for geogenic reefs (detailed in section 4.2.6.2). Along sections of transects at 10 stations, the cobble and boulder component was classified as 'low resemblance to a stony reef'. These areas are a component part of the mixed sediment seafloor type that characterises this region of the North Sea and are unlikely to be considered to represent Annex I habitats, in line with Irving (2009) guidelines, whereby if a 'low' is scored in composition, elevation, extent, or biota, then a strong justification would be required for this area to qualify as Annex I habitat 'Reefs' under the current marine nature conservation legislation.

Aggregation of cobbles and boulders were classified as 'medium resemblance to a stony reef' at stations ST004A, ST011, ST012, ST013 and ST014 exceeding 25 m^2. The actual extent of occurrences of *s*tony reefs could not be determined as no geophysical data were acquired at the time of the survey.

High densities of *S. spinulosa* have been found to occur in the UK in the vicinity of the Wash and along the South Coast of the UK (Hendrick, 2007; Hendrick, et al., 2011). Occurrences of *S. spinulosa* were observed along the transect at station ST024. The maximum reef morphology assessed was 'not a reef'. No other occurrences were present in the photographic data. The actual extent of occurrences of *S. spinulosa* could not be determined as no geophysical data were acquired at the time of the survey. Temporal changes of *S. spinulosa* reef habitat are likely due to the ephemeral nature of *S. spinulosa*, which can be influenced by numerous environmental factors such as wave height, storm events, sand movements and recruitment success (OSPAR, 2008). The near proximity of the Saturn reef may function as a gamete source population resulting in recruitment between reefs in the near area.

Sea pens and faunal burrows were observed across the DBD survey area. On the SACFOR scale, the occurrence of faunal burrows ranged from 'absent' to 'superabundant' and sea pen occurrences ranged from 'absent' to 'common'. The habitat guidelines (JNCC, 2014) state that the seafloor must be 'heavily bioturbated by burrowing megafauna with faunal burrows and mounds forming a prominent feature of the sediment surface' and that burrows should be at least 'frequent' on the SACFOR scale to be classified as a 'Sea pen and burrowing megafauna community'.

At station ST99 faunal burrows were recorded as 'superabundant' and the sediment type was classified as muddy sandy gravel, with cobbles also identified from the photographic data. The biotope assigned to this station was '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (MC3212). Due to the biological community present and the presence of gravel and cobbles, this station was not considered representative of the habitat 'Sea pen and burrowing megafauna communities'.

At the remaining stations where burrows were present as 'frequent' or 'common', the sediment were classified as sand or small scaled rippled sand from the photographic data. Due to the mobility of the sediments and the biological assemblage present, most of these stations were not considered representative of the habitat 'Sea pen and burrowing megafauna communities'. At four of these stations (ST63, ST66, ST89 and ST121), the sea pen *Pennatula phosphorea* was observed in combination with burrows, and therefore the habitat 'Sea pen and burrowing megafauna communities' may be present. However, these stations were characterised by sand and were all within the multivariate group B which was assigned the biotope complex 'Faunal communities in Atlantic offshore circalittoral sand' (MD521).

Several of the habitats and associated fauna recorded through the grab sampling and/or the seafloor photography, are considered characteristic of the Annex I habitat 'Sandbanks which are slightly covered by sea water all the time' for which the Dogger Bank SAC is designated (JNCC, 2023). Typical taxa include polychaete worms, crustaceans, anthozoans, burrowing bivalves, and echinoderms, as well as fish, notably, species of the genera *Callionymus* and *Ammodytes* (European Commission, 2013). Many of the fish and benthic species observed on the sandbanks are widely distributed in other sandy habitats on the continental shelf. Therefore, the fauna of sandbank communities may simply be based on a specialised niche of the sand-associated fauna of the region, rather than being obligate sandbank species, and, as such, occur on other sandy habitats in other regions. It is the local abundance of selected species, such as *E. vipera*, which are potentially indicative of such habitats (Ellis et al., 2011).

In this study, one individual of *Callionymus* was recorded through the photographic analysis at nine stations, namely ST118, ST003, ST005, ST006, ST010, ST022, ST024, ST026 and ST048. Fish of the order Pleuronectiformes, which include *Solea solea*, and of the family Ammodytidae, which includes *Ammodytes marinus,* were recorded through the photographic data at station ST075. Fish of the family Gadidae, which include *Gadus morhua* were recorded through the photographic data at 14 stations. Five *Ammodytes marinus* were also recorded in the grab samples at stations ST037, ST044, ST060 and ST072 for a total of five individuals; a single individual of *Callionymus reticulatus* was recorded in the grab sample at station ST091.

Ammodytes marinus, Solea solea and *Gadus morhua* are UK BAP priority species (JNCC, 2019). *Gadus morhua* is a UK BAP priority species (JNCC, 2007). In addition, *G. morhua* is also on the OSPAR list of threatened and/or declining habitats and species for regions II and III (OSPAR, 2024), the DBD survey area being part of OSPAR region II. This species is also on the IUCN red list of threatened species as 'vulnerable' (IUCN, 2024). OTUs of *G. morhua* were also recorded through the eDNA analysis of water samples, along with OTUs for the UK BAP species *Scomber scombrus*, *Merlangius merlangus*, *Clupea harengus*, *Pleuronectes platessa*, *Solea solea, Merluccius merluccius*, and *Trachurus trachurus*. In addition, OTUs of *Melanogrammus aeglefinus* were detected, which is listed as 'vulnerable' on the IUCN red list alongside *T. trachurus* (IUCN, 2024). OTUs of *Salmo salar*, listed as an OSPAR 'Threatened and/or declining species', were also detected by eDNA analysis.

Anemones of the family Edwardsiidae were recorded from the grab samples at 26 stations, with the highest abundance of 6 individuals at station ST090. This is of relevance in relation to the UK BAP species *Edwardsia timida* (JNCC, 2007), which is part of the family Edwardsiidae, and as such may occur within the DBD survey area.

The ocean quahog *Arctica islandica*, which is a protected feature within the Holderness Offshore MCZ was recorded from visual observation of the grab samples at station ST021 and ST022 and as juveniles in samples from stations ST036; ST047, ST052, ST054 and ST100.

5.6 Cryptogenic and Non-native Species (NNS)

Non-native species are those that have reached the UK by accidental human transport, deliberate human introduction, or which have arrived by natural dispersion from a non-native population in Europe (Government Digital Service [GDS], 2021). Once introduced, some NNSs can become established (grow and reproduce successfully) and their subsequent dispersal from the point of introduction can result in environmental and economic impact (Cottier-Cook et al., 2017). The NNS that have a negative impact on biodiversity, through the spread of disease, competition for resources, or by direct consumption, parasitism, or hybridisation, are termed 'invasive' (GDS, 2021).

Cryptogenic species are those of unknown origin, as such they are not demonstrably native nor introduced (Eno et al., 1997).

The NNS recorded in the grab samples was the polychaete *Goniadella gracilis*. This species was first recorded in 1970 in Liverpool Bay and had been previously reported from South Africa and North America, from where it was originally described. Although the method of introduction is unknown, this species is likely to have been introduced from the United States east coast through trans-Atlantic shipping. In the British Isles, this species is common in Liverpool Bay in sandy gravel at a depth of more than 15 m and widespread in the southern Irish Sea (Eno et al., 1997) and, further in Europe, it has been recorded in the Bay of Douarnenez in France (Ifremer, 2004). In this study, one individual of *G. gracilis* was recorded in the grab samples from station ST015 along the ECC.

eDNA analysis detected the species *L. delineatus*, which is a freshwater fish listed on the Global register of Introduced and Invasive Species [GRIIS] (n.d.) for the UK. The eDNA for this species may have been present following nearby freshwater inputs, or birds feeding and/or discarding at sea.

6. Conclusions

The benthic environment across the DBD survey area was characterised through an environmental survey which comprised the acquisition of seafloor photographic data and grab samples, which were analysed to identify habitats and to evaluate the physico-chemical and biological conditions of the seafloor. The results of the macrofaunal and PSD analysis were used to derive biotopes, in line with the EUNIS habitat classification, which were assessed for conservation importance and contextualised within the geographical setting of the survey area. The results of the chemistry analysis were used to evaluate the contamination status of the sediment. Environmental DNA samples were collected near-surface (TOP) and near-seafloor (BOT) to detect bony fish taxa.

The sediment across the DBD survey area featured mainly sand and to a lesser extent gravel, with a small percentage of fines. The varying percentages of the main sediment fractions resulted in seven sediment classes being identified under the Folk (BGS modified) classification, including ‘sand’, which typified most stations, followed by ‘gravelly sand’, ‘sandy gravel, ‘muddy sandy gravel’, ‘gravelly muddy sand’, ‘gravel’ and ‘muddy gravel’. The coarseness of the sediment resulted in seven sediment descriptions using the Wentworth (1922) scale including ‘fine sand’ which described most stations, followed by ‘coarse sand’, ‘granule’, ‘very coarse sand’, ‘fine pebble’, ‘medium sand’ and ‘medium pebble’, the latter describing one station. The sorting coefficient reflected the diversity of the sediments and ranged from ‘well sorted’ to ‘very poorly sorted’ with most stations having ‘moderately well sorted’ sediments. The sediment disturbance, likely due to regional hydrodynamics and fluvial inputs, was reflected in the bimodal and polymodal distribution of sediment particle size recorded at 27 of the 104 stations sampled. The sediments across the survey area are typical of the Dogger Bank and the marine habitats of the North Sea areas offshore and nearshore of north-east England.

The THC concentrations were below the marine SQG for all stations.

Concentrations of all PAHs analysed were below the marine SQGs at all stations except station ST009, where anthracene, benzo[a]anthracene and phenanthrene were above their respective TELs.

Arsenic concentrations were above the Canadian TEL at four stations in the characterisation area and one station in the array. However, the arsenic concentrations in the current survey were within the range reported previously from this region of the North Sea.

The concentrations of the sum of the 25 PCB congeners analysed and the organotins (DBT and TBT) were below the Cefas ALs at all stations.

Macrofauna from the grab samples comprised infaunal and epifaunal taxa, the latter being represented by solitary and colonial organisms. Annelida represented most of the community structure and composition of the enumerated fauna, which comprised infauna and solitary epifauna. The faunal community structure and composition reflected the sediment diversity and associated hydrodynamics, as typically reported for this region of the North Sea. Macrofaunal richness and diversity were generally higher at stations with coarse and diverse sediment, which had also a higher number of colonial epifaunal taxa, represented mainly by bryozoans, hydroids, and sponges.

The biomass of invertebrates from the grab samples was dominated by echinoderms and molluscs, the former owing to the presence of large species such as urchins and the latter owing to numerical abundance and to a lesser extent the size of selected bivalves.

Macrofauna recorded through the seafloor photographic data comprised large mobile taxa such as crustaceans and fish, as well as colonial epifauna, notably bryozoans and hydroids, which are reported to be typical of the shallow areas of the southern North Sea.

Environmental DNA TOP and BOT water samples presented comparable taxa lists, with BOT samples containing a higher relative proportion of OTUs associated with bottom-dwelling fish taxa. High relative OTUs of several commercial species with known spawning grounds in Dogger Bank were present within the samples. There were no repeat eDNA stations between the 2023 and 2024 surveys, due to unsuccessful bony fish metabarcoding in 2023. However, the eDNA results from the 2024 survey were largely comparable to those from 2023. eDNA analysis was shown to be complementary to the other methods used to detect bony fish taxa in the survey area. Moreover, eDNA analysis was able to provide a more comprehensive dataset whilst avoiding the need to undertake more destructive sampling, such as epibenthic trawling, to obtain taxonomic data.

Nine biotopes, two biotope complexes and five habitat complexes were identified following integration of data from the grab samples and the seafloor photographic data, namely '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236), which typified most stations and occurred in combination with *Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand' (MC5215). The biotope '*Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211) was the second most frequently occurring biotope, followed by '*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (MC3212); '*Abra alba and Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment' (MC5214); '*Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand' (MC5212); '*Nephtys cirrosa and Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233); '*Protodorvillea kefersteini* and other polychaetes in impoverished Atlantic circalittoral mixed gravelly sand' (MC3213) and 'Sparse fauna on highly mobile Atlantic infralittoral shingle (cobbles and pebbles)' (MB3231). The biotope complexes were 'Faunal communities in Atlantic offshore circalittoral sand' (MD521) and 'Faunal communities of 'Atlantic circalittoral sand' (MC521), which were assigned to stations where the faunal composition did not allow the description of the community to a lower biotope level. The five habitat complexes were 'Atlantic circalittoral sand' (MC52); 'Atlantic offshore circalittoral sand (MD52); 'Atlantic infralittoral coarse sediment’ (MB32); Atlantic infralittoral mixed sediment (MB42) and ‘Atlantic circalittoral mixed sediment’ (MC42), which were assigned to stations where the absence of infauna data did not allow refinement to a lower biotope level.

Some of the habitat types recorded are, or are representative of, UK BAP priority habitats and include ‘Subtidal sands and gravel’’.

Aggregations of cobbles at 19 stations were evaluated for the potential of Annex I habitat ‘Reef’ (stony reef). Aggregation of cobbles and boulders were classified as ‘low resemblance to a stony reef’ at four stations and ‘medium resemblance to a stony reef’ at five stations.

Aggregations of *S. spinulosa* at station ST025 were evaluated for the potential of Annex I habitat *‘S. spinulosa* Reef’. The overall assessment for the aggregations of *S. spinulosa* was ‘not a reef’.

Due to the occurrence of faunal burrows and sea pens, 52 stations were assessed for the presence of the OSPAR listed threatened and/or declining habitat 'Sea pen and burrowing megafauna'. Faunal burrows were present along 52 stations, ranging from ‘rare’ to ‘superabundant’. The sea pen *Pennatula phosphorea* was recorded as ‘occasional’ to ‘common’ along seven stations.

Species of conservation importance recorded in this study, by various methods, included the fish *C. harengus, G. morhua*, *M. merlangius*, *M. merluccius*, *P. platessa*, *S. scombrus*, *S. solea*, and *T. trachurus*, which are UK BAP priority species. *G. morhua* is also on the OSPAR list of threatened and/or declining habitats and species, along with the fish *S. salar*, and the IUCN red list of threatened species as ‘vulnerable’ along with the fish *T. trachurus* and *M. aeglefinus*. The species of sand eel, *A. marinus* and anemones of the family Edwardsiidae were recorded.

The OSPAR threatened and/or declining species *A. islandica* was present in the grab samples as juveniles at five stations and from the visual observation of the grab samples at two stations.

One NNS was recorded in the grab samples, namely *G. gracilis*. eDNA analysis tentatively detected OTUs matching *L. delineatus*. However, due to the number of likely pathways of introduction, the origin of its OTUs cannot be accurately determined.

7. References

Ager, O. E. D. (2005). *Spiophanes bombyx* A bristleworm. In Tyler-Walters H. and Hiscock K. (Eds.) *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/1705

Altschul, S.F., Gish, W., Miller, W., Myers, E.W. & Lipman, D.J. (1990). Basic local alignment search tool. *Journal of molecular biology 215*, 403-410

Barnes, M.K.S. (2008a). *Acrocnida brachiata* Sand burrowing brittlestar. In Tyler-Walters H. and Hiscock K. (Eds.) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/134

Barnes, M.K.S. (2008b). *Melanogrammus aeglefinus* Haddock. In Tyler-Walters H. and Hiscock K. (Eds.) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [online]. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/79

Barnes, M.K.S. (2015). *Branchiostoma lanceolatum* Lancelet. In Tyler-Walters H. and Hiscock K. (Eds.) *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/85

Bay-Nouailhat, A. (2007). Description de *Leptosynapta inhaerens*. https://www.mer-littoral.org/30/leptosynapta-inhaerens.php

Blott, S. (2010). *GRADISTAT Version 8.0: A grain size distribution and statistics package for the analysis of unconsolidated sediment by sieving or laser granulometer*. Kenneth Pye Associates.

Boening, D.W. (1999). An evaluation of bivalves as biomonitors of heavy metals pollution in marine waters. *Environmental Monitoring and Assessment*, *55*(3), 459-470. https://doi.org/10.1023/A:1005995217901

Botté, A., Seguin, C., Nahrgang, J., Zaidi, M., Guery, J., Leignel, V. (2022). Lead in the marine environment: concentrations and effects on invertebrates. *Ecotoxicology,* 1-14. https://doi.org/10.1007/s10646-021-02504-4

Brady, J. P., Ayoko, G. A., Martens, W. N., & Goonetilleke, A. (2015). Development of a hybrid pollution index for heavy metals in marine and estuarine sediments. *Environmental Monitoring and Assessment*, *187*(5), 306. https://link.springer.com/article/10.1007/s10661-015-4563-x

British Geological Survey [BGS], (2002). *Strategic Environmental Assessment – SEA 2 and 3.* (Technical Report 008 Rev1 – Geology). Department of Trade and Industry (DTI) https://assets.publishing.service.gov.uk/media/5a7a2a8340f0b66a2fc005f6/TR_SEA3_Geology.pdf

Britton, R., (2011). *Leucaspius delineatus* (sunbleak). CABI Compendium. https://doi.org/10.1079/cabicompendium.77347

Bryan, G. W., Gibbs, P. E., Burt, G. R., & Hummerstone, L. G. (1987). The effects of tributyltin (TBT) accumulation on adult dogwhelks, *Nucella lapillus*: long term field and laboratory experiments. *Journal of the Marine Biological Association of the United Kingdom*, *67*, 525-544. https://doi.org/10.1017/S0025315400027272

Burian, A., Mauvisseau, Q., Bulling, M., Domisch, S., Qian, S., & Sweet, M. (2021). Improving the reliability of eDNA data interpretation. *Molecular Ecology Resources*, *21*, 1422-1433. https://doi.org/10.1111/1755-0998.13367

Butler, J.D., Butterworth, V., Kellow, S.C. & Robinson, H.G. (1984). Some observations on the polycyclic aromatic hydrocarbon (PAH) content of surface soils in urban areas. *The Science of the Total Environment*, *33*, 75-85. https://doi.org/10.1016/0048-9697(84)90382-6

Camacho, C., Coulouris, G., Avagyan, V., Ma, N., Papadopoulos, J., Bealler, K. & Madden, T.L. (2009). BLAST+ architecture and applications. BMC Bioinformatics, 10, 421. DOI https://doi.org/10.1186/1471-2105-10-421

Centre for Agriculture and Bioscience International [CABI] (2024). Compendium Invasive Species. Wallingford, UK: CAB International. www.cabi.org/isc

Callaway, R., Alsvåg J., De Boois, I., Cotter, J., Ford, A., Hinz, H., Jennings, S., Kröncke, I., Lancaseter, J., Piet, G., Prince, P. & Ehrich, S. (2002). Diversity and community structure of epibenthic invertebrates and fish in the North Sea. *ICES Journal of Marine Science*, *59*, 1199-1214. https://doi.org/10.1006/jmsc.2002.1288

Canadian Council of Ministers of the Environment [CCME]. 2024. *Guidelines*. https://ccme.ca/en/current-activities/canadian-environmental-quality-guidelines

Centre for Environment Fisheries and Aquaculture Science [Cefas] (2012). *Monitoring of the quality of the marine environment, 2008–2010*. Science Series Aquatic Environment Monitoring Reports, CEFAS Lowestoft, 63. https://www.cefas.co.uk/publications/aquatic/aemr63.pdf

Centre for Environment, Fisheries and Aquaculture Science [Cefas] (2017). *Contaminant characterisation of the Mid-North Sea High Seismic Area, Strategic Environmental Assessment.* (Cefas contract report C6990). https://assets.publishing.service.gov.uk/media/5a82bf3ced915d74e34035cb/Cefas_-_Contaminants_characterisation_of_the_Mid-North_Sea_High_Seismic_Area.pdf

Chamberlain, S., Barve, V., Mcglinn, D., Oldoni, D., Desmet, P., Geffert, L., & Ram, K. (2023). rgbif: Interface to the Global Biodiversity Information Facility API. https://CRAN.R-project.org/package=rgbif

Chester, R. & Voutsinou, F. G. (1981). The initial assessment of trace metal pollution in coastal sediments. *Marine Pollution Bulletin, 12*, 84-91. https://doi.org/10.1016/0025-326X(81)90198-3

Clarke, K. R., Somerfield, P. J., & Gorley, R. N. (2008). Testing of null hypotheses in exploratory community analyses: similarity profiles and biota-environment linkage. *Journal of Experimental Marine Biology and Ecology*, 366(1–2), 56–69. https://doi.org/10.1016/j.jembe.2008.07.009

Clarke, K.R. & Gorley, R.N. (2015). *PRIMER v7: User manual/tutorial.* PRIMER-E Ltd.

Clarke, K.R., Gorley, R.N., Somerfield, P.J. & Warwick, R.M. (2014). *Change in marine communities: an approach to statistical analysis and interpretation* (3rd ed.). PRIMER-E Ltd.

Cottier-Cook, E. J., Beveridge, C., Bishop, J. D. D., Brodie, J. Clark, P. F., Epstein, G., Jenkins, S. R., Johns, D. J. Loxton, J. MacLeod, A., Maggs, C., Minchinh, D., Mineuri, F., Sewell J. & Wood, C.A. (2017). Non-Native species. *Marine Climate Change Impact Partnership [MCCIP]: Science Review*, 47-61. https:doi.org/10.14465/2017.arc10.005-nns

Culotta, L., De Stefano, C., Gianguzza, A., Mannino, M.R. and Orecchio, S. (2006). The PAH composition of surface sediments from Stagnone coastal lagoon, Marsala (Italy). *Marine Chemistry*, *99*(*1-4*), 117-127. https://doi.org/10.1016/j.marchem.2005.05.010

Dang, D. H., Lenoble, V., Durrieu, G., Omanović, D., Mullot, J. U., Mounier, S. & Garnier, C. (2015). Seasonal variations of coastal sedimentary trace metals cycling: Insight on the effect of manganese and iron (oxy)hydroxides, sulphide and organic matter. *Marine Pollution Bulletin*, *92*(*1-2*), 113-124. https://doi.org/10.1016/j.marpolbul.2014.12.048

Danziger, A.M., Olson, Z.H., & Frederich, M. (2022). Limitations of eDNA analysis for *Carcinus maenas* abundance estimations. *BMC Ecology and Evolution*, *22*(14). https://doi.org/10.1186/s12862-022-01969-z

Dauvin, J. C., Alizier, S., Rolet, C., Bakalem, A., Bellan, G., Gesteira, J. L. G., Grimes, S., de la Ossa-Carretero, J. A., & Del-Pilar-Ruso, Y. (2012). Response of different benthic indices to diverse human pressures. *Ecological Indicators*, *12*(1), 143–153. https://doi.org/10.1016/j.ecolind.2011.03.019

Davies, C. E. & Moss, D. (2004). *EUNIS habitat classification marine habitat types: Revised classification and criteria* (Document No. C02492NEW). Centre for Ecology & Hydrology [CEH]. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=ed94b621def5c41b7c06efa584a60b001ac7d402

de Mora, S., Sheikholeslami, M. R., Wyse, E., Azemard, S. & Cassi, R. (2004). An assessment of metal contamination in coastal sediments of the Caspian Sea. *Marine Pollution* Bulletin, *48*, 61-77. https://doi.org/10.1016/S0025-326X(03)00285-6 de Orte, M.R., Bonnail, E., Sarmiento, A.M., Bautista-Chamizo, E., Basallote, M.D., Riba, I., DelValls, Á. & Nieto, J.M. (2018). Metal fractionation in marine sediments acidified by enrichment of CO2: a risk assessment. *Marine Pollution Bulletin*, *131*, 611-619. https://doi.org/10.1016/j.marpolbul.2018.04.072

De-Bastos, E. S. R. (2016). *Kurtiella bidentata* and *Abra* spp. in infralittoral sandy mud. In Tyler-Walters H. and Hiscock K. (Eds.) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/1094

Diesing, M., Ware, S., Foster-Smith, R., Stewart, H., Long, D., Vanstaen, K., Forster, R. & Morando, A. (2009). *Understanding the marine environment – seabed habitat investigations of the Dogger Bank offshore draft SAC.* Joint Nature Conservation Committee. https://data.jncc.gov.uk/data/363acf33-ab4c-4d6c-8ab1-14d8bae305ea/JNCC-Report-429-FINAL-WEB.pdf

Du Laing, G., Rinklebe, J., Vandecasteele, B., Meers, E. & Tack, F.M.G. (2009). Trace metal behaviour in estuarine and riverine floodplain sediments: a review. *Science of the Total Environment*, *407*, 3972-3985. https://doi.org/10.1016/j.scitotenv.2008.07.025

Edwards, N. T. (1983). Polycyclic aromatic hydrocarbons (PAHs) in the terrestrial environment – a review. *Journal of Environmental Quality*, *12*, 427-441. https://doi.org/10.2134/jeq1983.00472425001200040001x

Eggleton, J., Murray, J., McIlwaine, P., Mason, C., Noble-James, T., Hinchen, H., Nelson, M., McBreen, F., Ware, S. & Whomersley, P. 2016. *Dogger Bank SCI 2014 monitoring R&D survey report*. (JNCC/Cefas Partnership Report, No. 11).

Ellis J., Maxwell T., Schratzberger M. & Rogers S.I. (2011). The benthos and fish of offshore sandbank habitats in the southern North Sea. *Journal of the Marine Biological Association of the UK 91*(6), 1319-1335. https://doi.org/10.1017/S0025315410001062

Eleftheriou, E. & Basford, D. J. (1989). The Macrobenthic Fauna of the Offshore Northern North Sea. *Journal of the Marine Biological Association of the United Kingdom, 69*, 123-143. https://doi.org/10.1017/S0025315400049158

Eno, N.C., Clark, R. A. & Sanderson W. G. (1997). *Non-native marine species in British waters: a review and directory*. Joint Nature Conservation Committee [JNCC].

European Commission [EC] (2013, April). *The interpretation manual of European Union Habitats – EUR28. (Pub. Nature ENV B.3)*. https://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf

European Union (2013). *Council Directive 2013/17/EU*. Official Journal of the European Union.

European Environment Agency [EEA]. (2022). *European Nature Information Service [EUNIS] habitat type hierarchical view* (Marine version 2022 & Terrestrial version 2021). https://eunis.eea.europa.eu/habitats-code-browser-revised.jsp

European Marine Observation Data Network [EMODnet]. (*2023*). *Seabed habitats project.* http://www.emodnet-seabedhabitats.eu

Farrington, J. W., & Tripp, B. W. (1977). Hydrocarbons in western North Atlantic surface sediments. *Geochimica and Cosmochimica Acta*, *41*, 1627-1641. https://doi.org/10.1016/0016-7037(77)90173-9

Fofonoff, P. W., Ruiz, G. M., Steves, B., Simkanin, C. & Carlton, J. T. (2023). *National Exotic Marine and Estuarine Species Information System*. http://invasions.si.edu/nemesis/

Folk, R. L. (1954). The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *The Journal of Geology*, *62*(4), 344–359. https://doi.org/10.1086/626171

Folk, R. L., & Ward, W. C. (1957). Brazos River bar (Texas); a study in the significance of grain size parameters. *Journal of Sedimentary Research*, *27*(1), 3–26. https://doi.org/10.1306/74d70646-2b21-11d7-8648000102c1865d

Forewind (2014). *Dogger Bank Teeside A & B*. Environmental Statements. Chapter 12 Appendix A Tranche B and Export Cable Corridor Benthic Survey. https://doggerbank.com/wp-content/uploads/2021/11/ES-Chapter-12-Appendix-A-Tranche-B-and-Export-Cable-Corridor-Benthic-Survey-Report_Part1.pdf

Fugro (2024a). Dogger Bank D 2023 Benthic Surveys. Benthic Characterisation Report Fugro Document no. 221061-R-002.

Fugro (2024b). Benthic Characterisation Survey 2024. Dogger Bank D Field Report. Fugro Document No. 502822-REP-001.

Geyer, H., Freitag, D., & Korte, F. (1984). Polychlorinated biphenyls (PCBs) in the marine environment, particularly in the Mediterranean. *Ecotoxicology and Environmental Safety, 8*(2), 129-151. https://doi.org/10.1016/0147-6513(84)90056-3

Golding. N., Albrecht. J. & McBreen. F. (2020). *Refining criteria for defining areas with a 'low resemblance' to Annex I stony reef; Workshop Report*. (JNCC Report No. 656). Joint Nature Conservation Committee [JNCC], Peterborough, ISSN 0963-8091. https://data.jncc.gov.uk/data/4b60f435-727b-4a91-aa85-9c0f99b2c596/JNCC-Report-656-FINAL-WEB.pdf

Global Biodiversity Information Facility [GBIF]. (2023). What is GBIF? https://www.gbif.org/what-is-gbif

Global Register of Introduced and Invasive Species [GRIIS]. (n.d.). *Global Register of Introduced and Invasive Species*. https://griis.org/

Gofas, S. & Salas, C. (2008). A review of European '*Mysella*' species (Bivalvia, Montacutidae), with description of Kurtiella new genus. *Journal of Molluscan Studies, 78*, 119-135. https://doi.org/10.1093/mollus/eym053

González, A. R., Guerra-García, J. M., Maestre, M. J., Ruiz-Tabares, A., Espinosa, F., Gordillo, I., & García-Gómez, J. C. (2008) Community structure of caprellids (Crustacea: Amphipoda: Caprellidae) on seagrasses from southern Spain. *Helgoland Marine Research*, *62*, 189–199, https://doi.org/10.1007/s10152-008-0107-x

Government Digital Service [GDS] (2021). *Strategy for England's wildlife and ecosystem services, biodiversity 2020 indicators Trends in pressure on biodiversity - invasive species*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/925441/20_Pressure_from_invasive_species_2020_accessible.pdf

Gubbay, S., Baker, M.C., and Bett, B. J., (2002). The Darwin Mounds and the Dogger Bank - Case studies of the management of two potential Special Areas of Conservation in the offshore environment. *Report to the World Wide Fund for Nature*. https://www.researchgate.net/publication/313310295_The_Darwin_Mounds_and_the_Dogger_Bank_-_Case_studies_of_the_management_of_two_potential_Special_Areas_of_Conservation_in_the_offshore_environment

Guerra-García, J. M., & García-Gómez JC (2001) The spatial distribution of Caprellidea (Crustacea: Amphipoda): a stress bioindicator in Ceuta (North Africa, Gibraltar area). *Marine Ecology*, *22*, 357–367. https://doi.org/10.1046/j.1439-0485.2001.01757.x

Guerra-García, J..M., Corzo. J., & García-Gómez, J. C. (2002) Clinging behaviour of the Caprellidea (Amphipoda) from the Strait of Gibraltar. *Crustaceana*, *75*, 41–50. https://doi.org/10.1163/156854002317373500

Haritash, A.K. & Kaushik, C.P. (2009). Biodegradation aspects of polycyclic aromatic hydrocarbons (PAHs): a review. *Journal of Hazardous Materials*, *169*(1-3), 1-15. https://doi.org/10.1016/j.jhazmat.2009.03.137

Harrison, J.B., Sunday, J.M., & Rogers, S.M., (2019). Predicting the fate of eDNA in the environment and implications for studying biodiversity. *Proceedings of the Royal Society of Biological Sciences, 286*(1915). https://doi.org/10.1098/rspb.2019.1409

Harrower, C., A., Rorke, S., L. &. Roy, H. E. (2021). *England biodiversity indicators 2021. Pressure from invasive species*. Technical background document. Centre for Ecology & Hydrology. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1025357/20_TB_Invasive_spp.pdf

Hein, F. J. (2007). The Size Analyses in Marine Geotechnical Studies. In S. J. P. M. (Eds). *Principles, methods and application of particle size analysis* (pp. 346-362). Cambridge University Press.

Hendrick, V. J., & Foster-Smith, R. L. (2006). *Sabellaria spinulosa* reef: a scoring system for evaluating 'reefiness' in the context of the Habitats Directive. Journal of the Marine Biological Association of the United Kingdom, 86(4), 665-677.

Hendrick VJ (2007) *An appraisal of Sabellaria spinulosa reefs in relation to their management and conservation*. [Thesis, School of Marine Science and Technology, University of Newcastle Upon Tyne]. University of Newcastle Upon Tyne.

Hendrick, V. J., Foster-Smith, R. L., & Davies, A. J. (2011). *Biogenic reefs and the marine aggregate industry. Marine Aggregate Levy Sustainability Fund* [MALSF] Science Monograph Series. No. 3.

Hill, M. O., Beckmann, B. C., Bishop, J. D. D., Fletcher, M. R., Lear, D. B., Marchant, J. H., Maskell, L. C., Noble, D. G., Rehfisch, M. M., Roy, H. E., Roy, S., & Sewell, J. (2009). *Developing an indicator of the abundance, extent and impact of invasive non-native species*. Final report. (Defra WC0718), 49pp.

Holman, L. E., Chng, Y., & Rius, M. (2022). How does eDNA decay affect metabarcoding experiments? *Environmental DNA*, *4*(1), 108-116. https://doi.org/10.1002/edn3.201

Howson, C.M. & Picton, B.E. eds. (1997). *The species directory of the marine fauna and flora of the British Isles and surrounding seas* (Ulster Museum Publication No. 276). Ulster Museum.

Huang, G., Bai, Z., Dai, S., & Xie, Q. (2004). Accumulation and toxic effect of organometallic compounds on algae. *Applied Organometallic CA, 7*(6), 373-380. https://doi.org/10.1002/aoc.590070604

Institut Français de Recherche pour l'Exploitation de la Mer [Ifremer]. (2004). *Benthic subtidal communities in bay of Douarnenez (France).* Direction de l'Environnement et de L'Aménagement Littoral Département d'Écologie Côtière Laboratoire Biodiversité Benthique. https://archimer.ifremer.fr/doc/00431/54254/56103.pdf

International Council for the Exploration of the Sea [ICES]. (2008). G*reater North Sea Ecosystem Overview*. (ICES Advice 2008, Book 6). ICES.

International Union for Conservation of Nature [IUCN]. (2024). *The IUCN red list of threatened species*. Version 2024-2. https://www.iucnredlist.org/

Irving, R. (2009). *The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-27 March 2008* (Report No. 432). Joint Nature Conservation Committee [JNCC]. http://data.jncc.gov.uk/data/21693da5-7f59-47ec-b0c1-a3a5ce5e3139/JNCC-Report-432-FINAL-WEB.pdf

Jackson, A. (2008). *Ophiothrix fragilis* Common brittlestar. In Tyler-Walters H. and Hiscock K. (Eds.) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*.

Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/1198

Jenkins, C., Eggleton, J., Barry, J. & O'Conner, J. (2018). Advances in assessing Sabellaria spinulosa reefs for ongoing monitoring. Ecology and Evolution, 8(15) 7673-7687. https://doi.org/10.1002/ece3.4292

Jennings, S., Lancaster, J., Woolmer, A. & Cotter, J. (1999). Distribution, Diversity and Abundance of Epibenthic Fauna in the North Sea. *Journal of the Marine Biological Association of the UK. 79:* 385-399.

Joint Nature Conservation Committee [JNCC]. (2007). *UK BAP List of UK Priority Species* https://jncc.gov.uk/ our-work /uk-bap

Joint Nature Conservation Committee [JNCC]. (2014). *JNCC clarifications on the habitat definitions of two habitat Features of Conservation Importance: Mud habitats in deep water, and; Sea-pen and burrowing megafauna communities.* https://data.jncc.gov.uk/data/91e7f80a-5693-4b8c-8901-11f16e663a12/3-AdviceDocument-MudHabitats-Seapen-definitions-v1.0.pdf

Joint Nature Conservation Committee [JNCC]. (2015). SACFOR abundance scale used for both littoral and sublittoral taxa from 1990 onwards. http://www.jncc.defra.gov.uk/page-2684

Joint Nature Conservation Committee [JNCC] (2016). *Review of the MCZ features of conservation importance*. JNCC and Natural England. https://data.jncc.gov.uk/data/94f961af-0bfc-4787-92d7-0c3bcf0fd083/MCZ-review-foci-201605-v7.0.pdf

Joint Nature Conservation Committee [JNCC]. (2022). *The marine habitat classification for Britain and Ireland Version 15.03.* https://mhc.jncc.gov.uk/about/

Joint Nature Conservation Committee [JNCC]. (2023). *Dogger Bank MPA*. https://jncc.gov.uk/our-work/dogger-bank-mpa/

Joint Nature Conservation Committee [JNCC] on behalf of the Four Countries' Biodiversity Group (4CBG). 2024. *UK Biodiversity Framework.* JNCC, Peterborough.

Joint Nature Conservation Committee [JNCC]. (n.d). *Annex I habitats list*. https://sac.jncc.gov.uk/habitat/

Joint Nature Conservation Committee [JNCC]. (n.d). *Annex II species list*. https://sac.jncc.gov.uk/species/

Jones, L. A., Davies, H., Coyle, M. D., Evans, D, Gilliland, P. M., Irving, R., & Murray, A.R. (2004). *Mid North Sea marine natural area profile: a contribution to regional planning and management of the seas around England*. English Nature. http://publications.naturalengland.org.uk/publication/30039

Joyce, C. (2008). *Venn diagrams*. https://arbs.nzcer.org.nz/venn-diagrams

Kaskela, A. M., Kotilainen, A. T., Alanen, U., Cooper, R., Green, S., Guinan, J., van Heteren, S., Kihlman, S., Van Lancker, V., & Stevenson, A. (2019). Picking up the pieces—harmonising and collating seabed substrate data for European maritime areas. *Geosciences, 9(2)*, 84. https://doi.org/10.3390/geosciences9020084

Keith, L. H. (2015). The source of U.S. EPA's Sixteen PAH priority pollutants. *Polycyclic Aromatic Compounds*, *35*(2–4), 147–160. https://doi.org/10.1080/10406638.2014.892886

Kennicutt, M. C., Brooks, J. M., Bidigare, R. R., & Denoux, G. J. (1988). Gulf of Mexico hydrocarbon seep communities—I. Regional distribution of hydrocarbon seepage and associated fauna. *Deep Sea Research Part A. Oceanographic Research Papers*, *35*(9), 1639–1651. https://doi.org/10.1016/0198-0149(88)90107-0

Krönche, I. & Knust, R. (1995). The Dogger Bank: a special ecological region in the central North Sea. *Helogolander Meeresunter*, *49,* 335-353. https://hmr.biomedcentral.com/counter/pdf/10.1007/BF02368361.pdf

Künitzer, A., Basford, D., Craeymeersch, J.A., Dewarumez, J.M., Dörjes, J., Duineveld, G.C.A., Eleftheriou, A., Heip, C. Herman, P. Kingston, P., Niermann, U., Rachor, E., Rumohr, H. & De Wilde, P.A.J., 1992. The benthic infauna of the North Sea: species distribution and assemblages. *ICES Journal of Marine Science*, *49*, 127-143. https://doi.org/10.1093/icesjms/49.2.127

Latimer, J.S., & Zheng, J. (2003). The sources, transport and fate of PAHs in the marine environment. In P. E. T. Douben (Ed.) PAHs: An ecotoxicological perspective (pp. 9-29). John Wiley & Sons.

Limpenny, D.S., Foster-Smith, R.L., Edwards, T.M., Hendrick, V.J., Diesing, M., Eggleton, J.D., Meadow, W.J., Crutchfield, Z., Pfeifer, S. and Reach, I.S. (2010). *Best methods for identifying and evaluating Sabellaria spinulosa and cobble reef.* (Aggregate Levy Sustainability Fund Project. MAL0008). Joint Nature Conservation Committee [JNCC].

Long, D. (2006). *BGS Detailed explanation of seabed sediment modified Folk classification*. MESH [Mapping European Seabed Habitats].

Long, E.R, MacDonald, D.D., Smith, S.L. & Calder, F.D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management*, *19*, 81-97. https://link.springer.com/article/10.1007/BF02472006

Lumbis, R. (2008). *Echinocyamus pusillus* A pea urchin. In Tyler-Walters H. and Hiscock K. *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/47

Marine Management Organisation [MMO]. (2015). *High level review of current UK action level guidance.* A report produced for the Marine Management Organisation. (MMO Project No: 1053). Marine Management Organisation.

Mason, C. (2022). *NMBAQC's best practice guidance. Particle size analysis (PSA) for supporting biological analysis*. NE Atlantic Marine Biological AQC Coordinating Committee. https://www.nmbaqcs.org/media/ibzlxdej/psa-guidance_update2022.pdf

Mason, C., Vivian, C., Griffith, A., Warford, L., Hynes, C., Barber, J., Sheahan, D., Bersuder, P., Bakir, A., & Lonsdale, J.-A. (2022) Reviewing the UK's action levels for the management of dredged material. *Geosciences*, *12*(1), 3. https:// doi.org/10.3390/geosciences12010003

Mauro F.M., Nascimento P.S. & Serejo C.S. 2020. New discoveries for the subfamily Phtisicinae Vassilenko,1968 (Crustacea: Senticaudata) from the Brazilian coast. European Journal of Taxonomy 597: 1–17. https://doi.org/10.5852/ejt.2020.597

McKnight, D. T., Huerliman, R., Bower, D. S., Schwarzkopf, L., Alford, R. A., & Zenger, K.R. (2019). Methods for normalizing microbiome data: An ecological perspective. *Methods in Ecology and Evolution British Ecological Society*, *10*, 389-400. https://doi.org/10.1111/2041-210X.13115

Moorsel, G. V., (2011) Species and habitats of the international Dogger Bank. *ecosub*. https://www.researchgate.net/publication/259802329_Species_and_habitats_of_the_international_Dogger_Bank

National Biodiversity Network. [NBN]. (2024). *NBN Atlas*. http://www.nbnatlas.org

National Research Council [NRC]. (1983). *Drilling discharges in the marine environment*. National Academy Press.

NatureMetrics (2024). FAQs. https://www.naturemetrics.com/faqs

Neff, J.M. (1979). *Polycyclic aromatic hydrocarbons in the aquatic environment. Sources, fates and biological effects*. Applied Science Publishers.

Non-native Species Secretariat [NNS]. (2024). *GB non-native species secretariat*. http://www.nonnativespecies.org/home/index.cfm

Nriagu, J.O. (1990). Global metal pollution: Poisoning the biosphere? *Environment: Science and Policy for Sustainability Development, 32*(7), 7-33. https://doi.org/10.1080/00139157.1990.9929037

Oliver, P. G., Holmes, A. M., Killeen, I. J. & Turner, J. A. (2016). *Marine bivalve shells of the British Isles.* Amgueddfa Cymru - National Museum Wales. http://naturalhistory.museumwales.ac.uk/britishbivalves

Oslo and Paris Commission [OSPAR]. (2009). *Background document on CEMP assessment criteria for the QSR 2010*. Monitoring and Assessment Series. (Report No. 978-1-907390-08-1). https://qsr2010.ospar.org/media/assessments/p00390_supplements/p00461_Background_Doc_CEMP_Assessmt_Criteria_Haz_Subs.pdf

Oslo and Paris Commission [OSPAR]. (2009). *Background document on CEMP assessment criteria for the QSR 2010*. Monitoring and Assessment Series. (Report No. 978-1-907390-08-1). https://qsr2010.ospar.org/media/assessments/p00390_supplements/p00461_Background_Doc_CEMP_Assessmt_Criteria_Haz_Subs.pdf

Oslo and Paris Commission [OSPAR]. (2008). *Case Reports for the OSPAR List of Threatened and/or Declining Species and Habitats*. (Report No. 07). https://www.ospar.org/site/assets/files/44271/sabellaria_spinulosa.pdf

Oslo and Paris Commission [OSPAR]. (2014). *Levels and trends in marine contaminants and their biological effects – CEMP assessment report 2013*. Monitoring and Assessment Series. (OSPAR Publication No. 631/2014). OSPAR Commission.

Oslo and Paris Commission [OSPAR]. (2014). *Levels and trends in marine contaminants and their biological effects – CEMP assessment report 2013*. Monitoring and Assessment Series. (OSPAR Publication No. 631/2014). OSPAR Commission.

Oslo and Paris Commission [OSPAR]. (2024). *OSPAR List of threatened and/or declining species and habitats*. Reference Number: 2008-06. https://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats

Paez-Osuna, F. & Ruiz-Fernandez, C. (1995). Comparative bioaccumulation of trace metals in *Penaneus stylirostris* in estuarine and coastal environments. *Estuarine, Coastal and Shelf Science, 40*, 35-44. https://doi.org/10.1016/0272-7714(95)90011-x

Parinos, C., Gogou, A., Bouloubassi, I., Pedrosa-Pàmies, R., Hatzianestis, I., Sanchez-Vidal, A., Rousakis, G., Velaoras, D., Krokos, G., & Lykousis, V. (2013). Occurrence, sources and transport pathways of natural and anthropogenic hydrocarbons in deep-sea sediments of the eastern Mediterranean Sea. *Biogeosciences*, *10*(9), 6069–6089. https://doi.org/10.5194/bg-10-6069-2013

Parry, M. E. V. (2019). *Guidance on assigning benthic biotopes using EUNIS or the marine habitat classification of Britain and Ireland (Revised 2019)* (JNCC Report No. 546). JNCC.

Rayment, W.J. (2008). *Fabulina fabula* Bean-like tellin. In Tyler-Walters H. and Hiscock K. *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/1631

R Core Team. (2024). *R: A language and environment for statistical computing. Version 4.2.3. R* Foundation for Statistical Computing. https://R-project.org/

Readman, J.W., Fillmann. G., Tolosa. I., Bartocci. J., Villeneuve. J. P., Catinni. C., & Mee, L. D. (2002). Petroleum and PAH contamination of the Black Sea. *Marine Pollution Bulletin*, *44*, 48-62. https://doi.org/10.1016/S0025-326X(01)00189-8

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

Reiss, H., Degrarer, S., Duineveld, G.C.A., Kröncke, I., Aldridge, J., Craeymeersch, J.A., Eggleton, J.D., Hillewaert, H., Lavaleye, M.S.S., MolL, A., Pohlmann, T., Rachor, E., Robertson, M., Vanden Berhe, E., van Hoey, G. & Rees, H.L. (2010). Spatial Pattern of Infauna, Epifauna, and Demersal Fish Communities in the North Sea. *ICES Journal of Marine Science*, *67*, 278-293.

Roche, C., Lyons, D.O., Fariñas-Franco, J.M., O'Connor, B. (2007). *Benthic surveys of sandbanks in the Irish Sea* (Irish Wildlife Manuals No. 29). Department of the Environment, Heritage and Local Government.

Roy, D., Alderman, D., Anastasiu, P., Arianoutsou, M., Augustin, S., Bacher, S., Başnou, C., Beisel, J., Bertolino, S., Bonesi, L., Bretagnolle, F., Chapuis, J. L., Chauvel, B., Chiron, F., Clergeau, P., Cooper, J., Cunha, T., Delipetrou, P., Desprez-Loustau, M., Détaint, M., Devin, S., Didžiulis, V., Essl, F., Galil, B. S., Genovesi, P., Gherardi, F., Gollasch, S., Hejda, M., Hulme, P. E., Josefsson, M., Kark, S., Kauhala, K., Kenis, M., Klotz, S., Kobelt, M., Kühn, I., Lambdon, P. W., Larsson, T., Lopez-Vaamonde, C., Lorvelec, O., Marchante, H., Minchin, D., Nentwig, W., Occhipinti-Ambrogi. A., Olenin, S., Olenina, I., Ovcharenko, I., Panov, V. E., Pascal, M., Pergl, J., Perglová, I., Pino, J., Pyšek, P., Rabitsch, W., Rasplus, J., Rathod, B., Roques, A., Roy, H., Sauvard, D., Scalera, R., Shiganova, T. A., Shirley, S., Shwartz, A., Solarz, W., Vilà, M., Winter, M., Yésou, P., Zaiko, A., Adriaens, T., Desmet, P., Reyserhove, L. (2020). DAISIE - *Inventory of alien invasive species in Europe. Version 1.7*. Research Institute for Nature and Forest (INBO). https://doi.org/10.15468/ybwd3x

Roy, H.E., Bacon, J., Beckmann, B., Harrower, C.A., Hill, M.O., Isaac N. J. B., Preston, C. D, Rathod, B., Rorke, S.L., Marchant, J.H., Musgrove, A., Noble, D., Sewell, J., Seeley, B., Sweet, N., Adams, L., Bishop, J., Jukes, A.R., Walker, K.J. & Pearman, D. (2012). *Non-native species in Great Britain: establishment, detection and reporting to inform effective decision making*. Report to Department for Environment Food and Rural Affairs [Defra].

RStudio Team. (2024). RStudio: Integrated Development Environment for R. RStudio Inc. http://www.rstudio.com/

Sabatini, M. & Ballerstedt, S. (2008). *Nucula nitidosa*. A bivalve mollusc. In Tyler-Walters H. and Hiscock K. (Eds.) *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/1700

Sims, R. C. & Overcash, M. R. (1983). Fate of polynuclear aromatic compounds (PNAs) in soil-plant systems. *Residue Reviews*, *88*, 1-68. https://doi.org/10.1007/978-1-4612-5569-7_1

Tessier, A., Campbell, P. G. C., & Bisson, M. (1979). Sequential extraction procedure for the speciation of particulate trace metals. *Analytical Chemistry*, *51*(7), 844–851. https://doi.org/10.1021/ac50043a017

Tillin, H.M., Tyler-Walters, H. & Garrard, S. L. (2019). Infralittoral mobile clean sand with sparse fauna. In Tyler-Walters H. and Hiscock K. (Eds.), *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/262

Tyler-Walters, H. (2005). *Electra pilosa* thorny sea mat. In Tyler-Walters H. and Hiscock K. *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/1694

Tyler-Walters, H., & Ballerstedt, S. (2007). Fl*ustra foliacea Hornwrack*. In Tyler-Walters H. *Marine life information network: Biology and sensitivity key information reviews*. Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/species/detail/1609

Van Moorsel, G. (2011). *Species and habitats of the international Dogger Bank*. EcoSub, Doorn. https://www.researchgate.net/publication/259802329_Species_and_habitats_of_the_international_Dogger_Bank

Volkman, J.K., Holdsworth, D.G., Neill, G.P. and Bavor Jr, H.J. (1992). Identification of natural, anthropogenic and petroleum hydrocarbons in aquatic sediments. *Science of the Total Environment*, *112*(2-3), 203-219. https://doi.org/10.1016/0048-9697(92)90188-X

Wakeham, S.G., Schaffner, C., & Giger, W. (1979). Polycyclic aromatic hydrocarbons in recent lake sediments – I. compounds having anthropogenic origins. *Geochimica et Cosmochimica Acta*, *44,* 403-413. https://doi.org/10.1016/0016-7037(80)90040-x

Walker, A. J. M. & Rees, E.I.S. (1980). Benthic ecology of Dublin Bay in relation to sludge dumping. I*rish Fisheries Investigations. Series B: Marine*, *22*, 1-59. http://oar.marine.ie/handle/10793/146

Wang, Z., Wang, Y., Zhao, P., Chen, L., Yan, C., Yan, Y., & Chi, Q. (2015). Metal release from contaminated coastal sediments under changing pH conditions: Implications for metal mobilization in acidified oceans. *Marine Pollution Bulletin*, *101*(2), 707-715. https://doi.org/10.1016/j.marpolbul.2015.10.026

Warren, L.A., & Zimmerman, A.P. (1993). Trace metal-suspended particulate matter associations in a fluvial system: Physical and chemical influences. In S.S. Rao. (Eds.), *Particulate and matter and aquatic contaminants* (pp. 127–155). Lewis Publishers.

Wentworth, C. K. (1922). A scale of grade and class terms for clastic sediments. *The Journal of Geology*, *30*(5), 377–392. https://doi.org/10.1086/622910

Whalley, C., Rowlatt, S., Bennett, M. & Lavell, D., 1999. Total arsenic in sediments from the Western North Sea and the Humber Estuary. *Marine Pollution Bulletin, 38*(5), 394-400. https://doi.org/10.1016/S0025-326X(98)00158-1

Wieking, G., & Kröncke, I. (2003). Macrofauna communities of the Dogger Bank (central North Sea) in the late 1990s: spatial distribution, species composition and trophic structure.

Helgoland Marine Research volume, *57*, 34–46. https://hmr.biomedcentral.com/articles/10.1007/s10152-002-0130-2

World Register of Marine Species (WoRMS) Editorial Board (2024). *World Register of Marine Species.* https://www.marinespecies.org/

Worsfold, T.M., Hall, D.J., & O'Reilly, M. (Ed.), (2010). *Guidelines for processing marine macrobenthic invertebrate samples: a Processing Requirements Protocol*: Version 1.0, June 2010. Report to the NMBAQC Committee.

Youngblood, W.W., & Blumer, M. (1975). Polycyclic aromatic hydrocarbons in the environment: homologous series in soils and recent marine sediments. *Geochimica et Cosmochimica Acta*, *39*, 1303–1314. https://doi.org/10.1016/0016-7037(75)90137-4

Ziemski, F., André F. Pillon R., & Jeglot S. (05/12/2023). *Astropecten irregularis* (Pennant, 1777). In Données d'Observations pour la Reconnaissance et l'Identification de la faune et la flore Subaquatiques [DORIS]. https://doris.ffessm.fr/ref/specie/884

Appendices

Appendix A

Guidelines on Use of Report

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Appendix B

Methodologies

B.1 Survey Methods

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Appendix B.1 Survey Methods

Appendix C

Logs