Environmental Impact Assessment Report

Volume 4

Appendix 8.3 Benthic Baseline Report

codling wind park

Codling Wind Park Benthic Baseline Report

16 February 2023

Codling Wind Park Limited (CWPL)

Document history

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Table 1.3: Abbreviations used with the text

Acronym	Definition
ANOSIM	Analysis of Similarity
CWP	Codling Wind Park
DGPS	Differential Geographic Positioning System
EMODnet	European Marine Observation and Data Network
GPS	Global Positioning System
LOI	Loss on Ignition
JNCC	Joint Nature Conservation Committee
MARLIN	Marine Life Information Network
NMBAQC	North Eastern Atlantic Marine Biological Analytical Quality Control
NMDS	Non-Metric Multi-Dimensional Scaling
OECC	Offshore export cable corridor
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated biphenyl
PSA	Particle Size Analysis
SIMPER	Similarity Percentages Analysis
SIMPROF	Similarity Profile Analysis
TOC	Total Organic Carbon
UKBAP	United Kingdom Biodiversity Action Plan
WORMS	World Register of Marine Species

1. Introduction

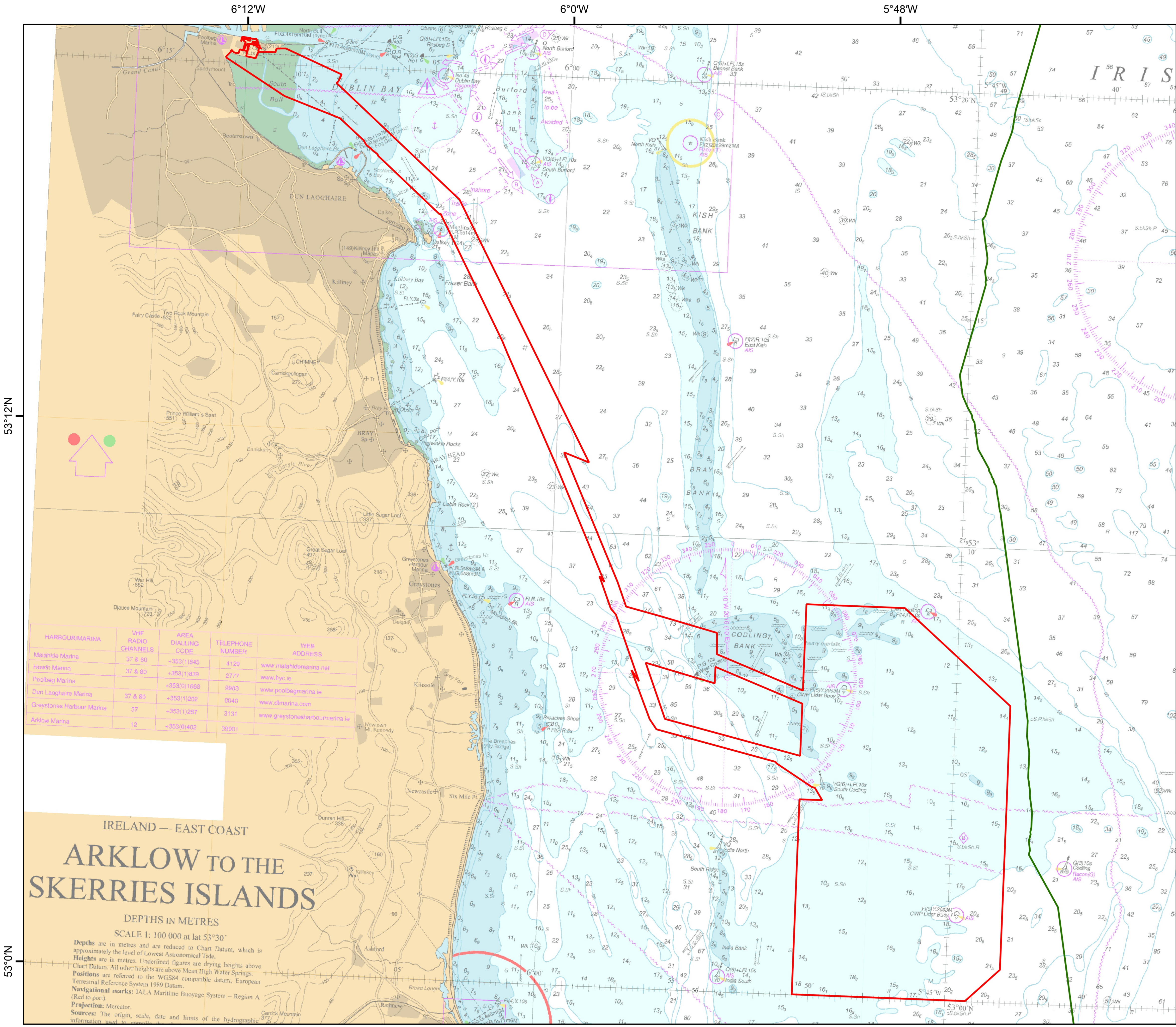
1.1. Project Background

Codling Wind Park Limited (CWPL) are pursuing the development of an offshore wind farm (OWF) located 13-22 km from the east coast of Ireland between Greystones and Wicklow. The OWF will be connected via submarine cables to a power grid in Dublin Bay. In 2021, CWPL commissioned a benthic baseline survey of the array site and offshore export cable corridor (Figure 1.1).

1.2. Document Purpose

This report has been produced in order to present the findings of the benthic intertidal and subtidal ecological survey covering the Codling Wind Park (CWP) array site and offshore export cable corridor (OECC) in order to meet two specific objectives of the survey:

- To characterise the benthic intertidal and subtidal environment that is present across the footprint of the CWP array site and the OECC; and
- To identify the occurrence and distribution of any habitats or species of conservation.



Project:

Codling Wind Park

Title:

Figure 1.1: Codling Wind Park Location

Key

- Codling Wind Park
- 12 nautical mile (NM) Irish limit

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Scale @ A3: 1:155,000

Map projection: ETRS89 UTM Zone 30N
Graticules: WGS 84

0 2 4 6 8 km

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2. Baseline Survey Methodology

2.1. Intertidal Survey

The Intertidal survey was performed on low spring tides, with a date chosen to maximise daylight over the low water period (Table 2.1).

Table 2.1: Tide times and heights for Dublin Port

Date	Low Tide Time	Tidal height (m)
25/06/21	06:02	0.3
25/06/21	18:22	0.5

Predetermined sampling stations were positioned in a grid format across the landfall area of the cable corridor. Sampling stations were selected which were representative of upper, mid, and lower shore environments. In addition, sampling stations were also taken where significant changes in sediment type were observed.

Locations of sampling stations can be found in Appendix A (Table A1). The extent and distribution of biotopes were recorded using a GPS device and marked on OS maps / aerial photographs of the shore. The methodology was based on the Procedural Guidance No 3-2 - in situ ACE biotope mapping techniques and Procedural Guidance No 3-1 - in situ biotope recording techniques of the Marine Monitoring Handbook (Hiscock 2001; Wyn & Brazier, 2001; respectively).

2.2. Subtidal Benthic Grab Survey

2.2.1. Summary of Existing Data

Prior to the benthic baseline survey, geophysics and technical surveys were conducted for the CWP offshore development area and cable corridors as part of the regulatory planning process, to assess ground suitability for engineering works. A desked-based review of publicly available data shows a diverse range of sediment and predicted habitat types within the CWP offshore development area including coarse and mixed sediments, sand and muddy sand.

A carefully designed stratified sampling programme, was developed based on geophysical survey data and other publicly available data on benthic habitats. The following publicly available seabed habitat and sediment type datasets were reviewed:

- INFOMAR Seabed Substrate (2018);
- EMODNET samples (2019); and
- EUSeamap EUNIS (2018) Habitats.

Sample stations were selected using a pattern which was adapted to ensure:

- The samples are representative of the full range of potential habitats and acoustic ground types in the area of interest identified from the segmentation approach;
- Samples have been focused on potentially important habitats or features;

- There is replication within each ground type to ensure that the final interpretation is statistically robust to an agreed measure of confidence;
- The samples are geographically spread to be representative;
- Samples have been located to assess the level of spatial heterogeneity of a habitat; and

Samples have been placed to avoid conflict (200 m distance) with existing infrastructure. The grab survey was to be undertaken at 46 planned sampling stations throughout the array site and the OECC.

2.2.2. **Methodology**

The grab survey was undertaken at 46 sampling stations, in order to collect information on the physical nature of the seafloor and the composition of the infauna, as per as per Limpenny *et al.,* (2010), Coggan *et al*., (2007), and JNCC Marine Monitoring Handbook Procedural Guidance 3-5 (Holt & Sanderson, 2001). Benthic sampling was undertaken using a 0.1 m^2 Day grab, weighted with an additional 40kg for penetration into coarser sediment. Where sediments were very coarse, a 0.1 m^2 Smyth-McIntyre grab was deployed. On arrival at each sampling station, the vessel location was recorded using DGPS (Lat/Long). Additional information such as date, time, site name, sample code, depth, sampler, anchorage, weather, sea state and exposure were recorded on data sheets.

At each station, two grab samples were to be taken, one sample for faunal analysis and one sample for sediment analysis. Upon retrieval of the grab, penetration depth was measured and recorded in the sample data sheet. Only grab samples that contained a depth of >7 cm for sand and >10 cm for mud were retained. Where repeated failed grabs occurred due to hard ground, the station was abandoned, and the vessel moved to the next station.

Each acceptable benthic fauna sample was sieved on-board through a 1 mm sieve, with care being taken during the sieving process in order to minimise damage to taxa such as spionids, scale worms, phyllodocids and amphipods. The sample residue was carefully flushed into a pre-labelled (internally and externally) container, with each label containing the sample code and date. The samples were stained immediately with Eosin-Briebrich scarlet and fixed immediately in with 4 % w/v buffered formaldehyde solution. These samples were ultimately preserved in 70 % alcohol upon return to the laboratory.

At each station a separate grab was deployed for collecting samples for Particle Size Analysis (PSA) and, where sediment type allowed for Total Organic Carbon (TOC).

A subset of 8 stations were sampled for contaminants analysis. Sampling stations selected were in areas of finer sediment (required for the analyses) and focused in nearshore areas where higher levels or contamination are expected. Samples were taken from an undisturbed sediment surface, with the appropriate metal or plastic scoop and transferred to appropriate containers for analysis. The samples were stored in accordance with the guidelines for sampling / storage of sediments for chemical analyses (from OSPAR JAMP guidelines for monitoring contaminants in sediments) (Cronin *et al*., 2006).

3. Sample Analysis

3.1. Sample Analysis

3.1.1. Fauna

All biota was extracted and identified according to the NMBAQC Taxonomic Discrimination Protocol (Worsfold *et al*., 2010).

Samples were washed with through sieves to remove the preserving agent and placed in an illuminated shallow white tray. The sample was sorted first by eye to remove large specimens and then sorted under a stereo microscope (x10 magnification). Following the removal of larger specimens, the samples were placed into Petri dishes, approximately one-half teaspoon at a time and sorted using a binocular microscope at x25 magnification.

Fauna were identified to the lowest taxonomic level practicable using appropriate keys and references and enumerated. Species that were present as juveniles were differentiated from adults where possible. Colonial organisms were recorded as present or absent. Broken or damaged specimens that may not be fully identified were described as ‘Taxa Indet.’ (indeterminate). Juvenile specimens not displaying adult characteristics necessary for identification to species were described as ‘Taxa juv.’, and groups not generally identified to species because of taxonomic or morphological reasons were recorded as Taxa sp.

Biomass measurements were taken of the major phyla groups (Annelida, Arthropoda, Mollusca and Echinodermata) at each station. Epifaunal and colonial taxa as well as minor phyla were not weighed.

3.1.2. Sediment

3.1.2.1. PSA

PSA analysis was determined to fractions ranging between <63 µm to >256 mm. Approximately 100 g of dried sediment was weighed out and underwent peroxide treatment to remove any organic material. Sediment samples were then processed through stacked sieves at particle size diameters of 0.5 phi intervals over the range 63 µm to <8 mm (Wentworth Scale), sieve sizes are provided in Table 3.1. The sieves were shaken, and the contents of each sieve subsequently weighed. The total silt/clay fraction was determined by subtracting all weighed fractions from the initial starting weight of sediment as the less than 63µm fraction was lost during the various washing stages. The weights were used to calculate the percentage of each particle size range contained in the sample.

Table 3.1: The classification of sediment particle size ranges into size classes (adapted from Buchanan, 1984).

Range of Particle Size	Classification	Phi Unit
<63µm	Silt/Clay	>4 Ø
63-125 µm	Very Fine Sand	4 Ø, 3.5 Ø
125-250 µm	Fine Sand	3 Ø, 2.5 Ø
250-500 µm	Medium Sand	2 Ø, 1.5 Ø
500-1000 µm	Coarse Sand	1 Ø, 1.5 Ø
1000-2000 µm (1 – 2mm)	Very Coarse Sand	0 Ø, -0.5 Ø
2000 – 4000 µm (2 – 4mm)	Very Fine Gravel	-1 Ø, -1.5 Ø
4000 -8000 µm (4 – 8mm)	Fine Gravel	-2 Ø, -2.5 Ø

Range of Particle Size	Classification	Phi Unit
8 -64 mm	Medium, Coarse & Very Coarse Gravel	-3 Ø to -5.5 Ø
64 – 256 mm	Cobble	-6 Ø to -7.5 Ø
>256 mm	Boulder	< -8 Ø

3.1.2.2. **TOC**

All samples were analysed for TOC via Loss on Ignition (LOI) whereby each sample is weighed before being heated to a high temperature (100 ^{o}C) until all the carbon dioxide from carbonates is burned off and the sample is weighed again. The difference in weights is the LOI organic content of the sample, expressed as a percentage of the weight of the sediment after ignition, over the initial weight of the sediment.

3.1.2.3. **Moisture Content**

Moisture content was taken as the percentage weight difference between the wet and dried sediment.

3.1.2.4. **Contaminant Analyses**

Samples were analysed for the Marine Institute full suite of analyses as detailed in the Material Analysis Reporting Form by a UKAS accredited laboratory and the results compared against Irish guideline limits and Cefas Action levels (Appendix G).

4. Data Analysis

4.1. Intertidal

All data collected during the intertidal surveys were transcribed and information on habitats and species collated in an excel spreadsheet (including up to date species nomenclature, abundance, and physical parameters such as PSA, and depth of anoxic layer).

The data was examined in order to identify any species or habitats of conservation interest. This includes, Habitats Directive Annex I habitats, UK Priority Marine Habitats and Species[1] UKBAP List species, rare/scarce species and habitats) using the Marine Life Information Network (MarLIN) resource.

Intertidal biotopes were assigned according to the Marine Habitat Classification (Connor *et al.,* 2004) from the walk over surveys, aerial imagery and infaunal data, depending on the substrate sampled, using expert judgement in line with the relevant guidance (Parry, 2019) and JNCC comparative tables[2].

4.2. Subtidal

4.2.1. Benthic Grab

All data collected from surveys, including up to date species nomenclature in accordance with the WORMS database, abundance, and physical parameters such as PSA, and depth were collated in excel spreadsheets. Based on PSA results, each sampling station was assigned a folk classification using the Folk Ternary diagram provided in the JNCC guidance (Parry, 2015). The percentage composition of gravel, sand and mud was calculated for each sampling station.

A suite of statistical analyses on the data collected from the grab survey work were undertaken using the “vegan” package in R, with some univariate indices calculated manually in R. R packages used in the statistical analysis and production of outputs were: "tidyverse", "magrittr", "ggpubr", "janitor”, taxize", "rstatix", "readxl", "bookdown", "pander", "plotrix", "cluster", “clustig”, "factoextra", "ggrepel", "dendextend", and "patchwork".

4.2.1.1. Univariate Statistics

The following species diversity indices were calculated for the benthic infaunal and epibenthic species data:

- Number of Species (S): the number of species present in a sample, with no indication of relative abundances;
- Number of individuals (n): total number of individuals counted;
- Species Diversity - Shannon-Wiener index (H’): measures the uncertainty in predicting the identity of the next species withdrawn from a sample;
- Species Richness - Margalef’s index (d): a measure of the number of species present for a given number of individuals. The higher the index, the greater the diversity;
- Simpson’s indexes (1-λ): a measure of the probability of choosing two individuals from a sample that are different species. D = 0 (minimum diversity), D = 1.0 (maximum diversity); and
- Pielou’s evenness (J’): shows how evenly the individuals in a sample are distributed. J’ is a range of zero to one. The less variation in the samples, the higher J’ is.

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[1] Available from https://jncc.gov.uk/our-work/uk-bap-priority-habitats/

[2] Available from https://hub.jncc.gov.uk/assets/62a16757-e0d1-4a29-a98e-948745804aec

These univariate indices enable the reduction of large datasets into useful metrics, which can be used to describe community structures.

4.2.1.2. **Multivariate Statistics**

Multivariate analysis is an effective method for detecting subtle changes in benthic community datasets. Multivariate analysis was undertaken in R, on the whole dataset, including individual replicates. Due to the partially skewed nature of the fauna data, and its varying abundances, a square root transformation was applied to normalise the data distribution, reducing dominant effects of highly abundant taxa.

A Bray-Curtis resemblance matrix was applied to the transformed infaunal data. Non-Metric Multidimensional Scaling (NMDS) plots were produced to examine the similarity between sampling stations. The similarity profile analysis (SIMPROF) routine was utilised to determine the statistically significant groups (i.e., samples that would naturally group as communities). One-way Analysis of Similarity (ANOSIM) revealed whether there were any statistically significant results and, if significant, the Similarity Percentages (SIMPER) was used to provide information on the main species driving the groupings, which would aid in determining community structure and biotopes.

4.2.1.3. **Biotope Assignment**

Infauna survey results groupings and characterising species were identified through the SIMPROF, NMDS and SIMPER analyses and these were used in combination with the PSA results and physical characteristics (such as depth and zone) to classify the grab sample station biotopes according to the Marine Habitat Classification for Britain and Ireland (Connor *et al.*, 2004).

Infauna (grab) biotope classifications were incorporated into an Excel spreadsheet alongside physical characteristics such as depth and PSA, and final benthic habitats assigned to each sampling station. Classification was supported by use of JNCC comparative tables and guidance (Parry, 2019).

5. Results

5.1. Intertidal

This intertidal area of the export cable corridor is a large sandy shore, named Sandymount Strand located east of Dublin. Twenty-three sampling stations were spread across the shore in order to cover the entire intertidal area (Figure 5.1). Stations 22 and 26 were re-located due to channels, and although sampling was planned in the area to the east of station 31, this area was subtidal and as such could not be accessed even at low water on a spring tide. Locations of all stations provided in Appendix A (Table A1).

5.1.1. Fauna

Faunal diversity and abundance within the sediments was generally very low across most of the sampling stations. Nine (out of 19) sampling stations did not yield any fauna. A total of 22 species were found across the site, with most of this diversity coming from stations 35, 36 and 37. The maximum number of individuals found was 718 at station 35, this accounted for 13 of the species recorded. Stations 36 and 37 were similar with abundances of 54 and 52 individuals, respectively (Appendix B).

The lower shore stations (19, 20, 21, 22A, 24, 25, 26A 28, 29, 30, 31 and 34) were all very similar, with fine wave rippled sand present (see Appendix C; Figures C1 - C3). A few worm casts of *Arenicola marina* were present, alongside patches of *Ulva* sp. and brown filamentous algae. The anoxic layer was approximately 4-10 cm depth at the few stations where it was visible.

Higher on the shore at station 32, no worm casts or fauna were present.

Station 33 was on compact area of sand next to the main channel. Patches of *Ulva* sp. occurred in areas closer to the channel (Figure 5.2). Occasional worm casts were present with the faunal sample containing a single polychaete worm (*Pygospio elegans*) and an amphipod (*Bathyporeia pilosa*).

6°12'W 6°11'W 6°10'W

53°20'N

53°19'N

Project:

Codling Wind Park

Title:

Figure 5.1: Poolbeg Intertidal Survey Stations

Key

● Surveyed sample station

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Scale @ A3: 1:12,000

Map projection: ETRS89 UTM Zone 30N
Graticules: WGS 84

0 150 300 450 600 m

N

Date: 09-01-23	Prepared by: JO	Checked by: ME
Ref: IE200091_M_534_B		

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Figure 5.2: Station 33 at Poolbeg (left: sandy area showing channel; right: sandy area showing channel and green algae)

Station 35 was close to the main channel with pools of standing water. Numerous worm casts were visible, along with large patches of *Ulva* sp. (Figure 5.3).

Figure 5.3: Station 35 at Poolbeg (left: sandy area showing mats of *Ulva* sp.; right: faunal sample)

Station 36 consisted of firm wave rippled very fine sand with green algae and broken shells present. (Appendix C; Figure C4) The occasional worm cast was present with an abundance of mud snail (*Peringia ulvae*), these made up the majority of individuals with the faunal sample. The remaining species present were nematode and polychaete worms, green shore crab (*Carcinus maenas*), common cockle (*Cerastoderma edule*) and Baltic macoma (*Limecola balthica*).

Station 37 was similar in terms of fauna to that of station 36 but with slightly coarser sediment (Appendix C; Figure C4). Many worm casts of *Arenicola marina* were present, along with small patches of the green seaweed, *Ulva* sp. Like station 36, most of the faunal sample consisted of an abundance of mud snail (*P. ulvae*), along with polychaete worms, brown shrimp (*Crangon crangon*), common cockle (*C. edule*), thin tellin (*Macomangulus tenuis*) and the glossy furrow shell *(Abra nitida*).

Station 38 had fine compact sediment with large patches of *Ulva* sp. and frequent worm casts of *Arenicola marina*. The anoxic layer was at the surface (1 mm). No fauna was present in the sample taken.

Station 39 was the upper most station and had similar sediment to that of station 38 but with dead cockle shells (Appendix C; Figure C4). The faunal sample taken contained mud snail (*P. ulvae*), a polychaete worm (*Nephtys hombergii*) and the common cockle (*C. edule*).

5.1.2. **Sediment**

PSA results confirmed visual descriptions of sediment with samples consisting of very fine sand and fine sand at all sites except stations 35 and 39 which were coarser in nature (Figure 5.4). Site 35 contained greater percentages of coarse sand and gravel. Site 39 contained the largest percentage of silt-clay across the survey area and a much smaller percentage of very fine sand than the other stations (apart from 35). TOC results were universally low (<1.0 %) across most sampling stations. Stations 35 and 39 were slightly higher, 2.76 % and 1.47 % respectively.

The sediment across all stations (apart from 35 and 39) were classified as sand. Station 35 and 39 were classified as coarse and mixed sediment, respectively. See Appendix C; Figure C4 for sample photos.

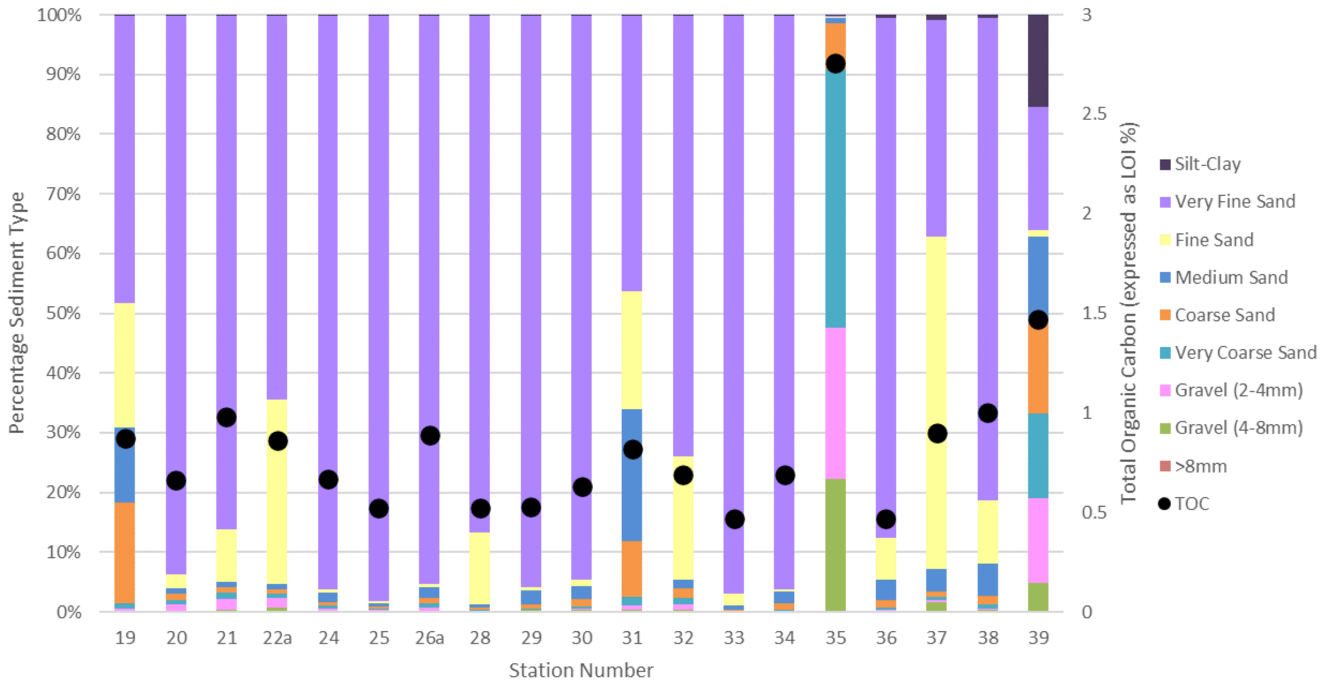
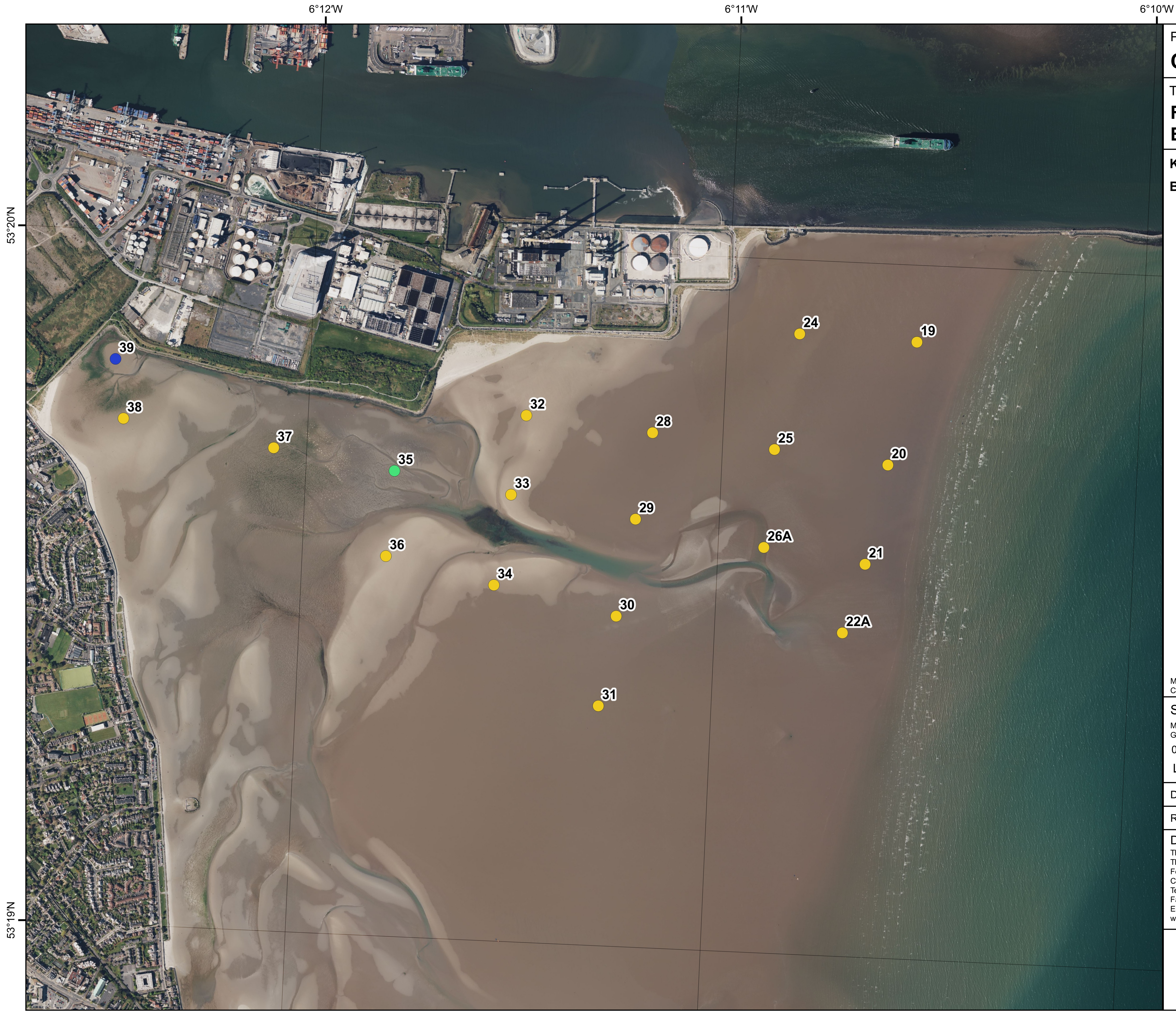


Figure 5.4: Poolbeg PSA and TOC

5.1.3. **Biotope Assignment**

The majority of the shore at Poolbeg was classified as Littoral Sand (LS.LSa) apart from two small areas which was classified as Littoral Coarse Sediment (LS.LCS) and Littoral Mixed Sediment (LS.LMx) (Figure 5.5). The mixed sediment was found at the top of the shore where more cobbles and boulders were present. Full biotope descriptions can be found in Appendix D.



Project:

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Title:

Figure 5.5: Poolbeg Intertidal Biotopes

Key

Biotope

- Littoral coarse sediment (LS.LCS)
- Littoral mixed sediment (LS.LMx)
- Littoral sand (LS.LSa)

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Scale @ A3: 1:12,000

Map projection: ETRS89 UTM Zone 30N
Graticules: WGS 84

0 150 300 450 600 m

N

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5.2. **Subtidal**

The benthic survey campaign was carried out between the 29 June and the 5 July 2021. Grab samples were recovered at 41 of the 46 stations for faunal analysis and sediment PSA. The sediment was found to be too hard at the remaining five stations for suitable grabs to be obtained. Samples for TOC were taken at 17 stations, where the sediment type allowed. Sediment grab samples were also recovered at eight stations for chemistry analysis.

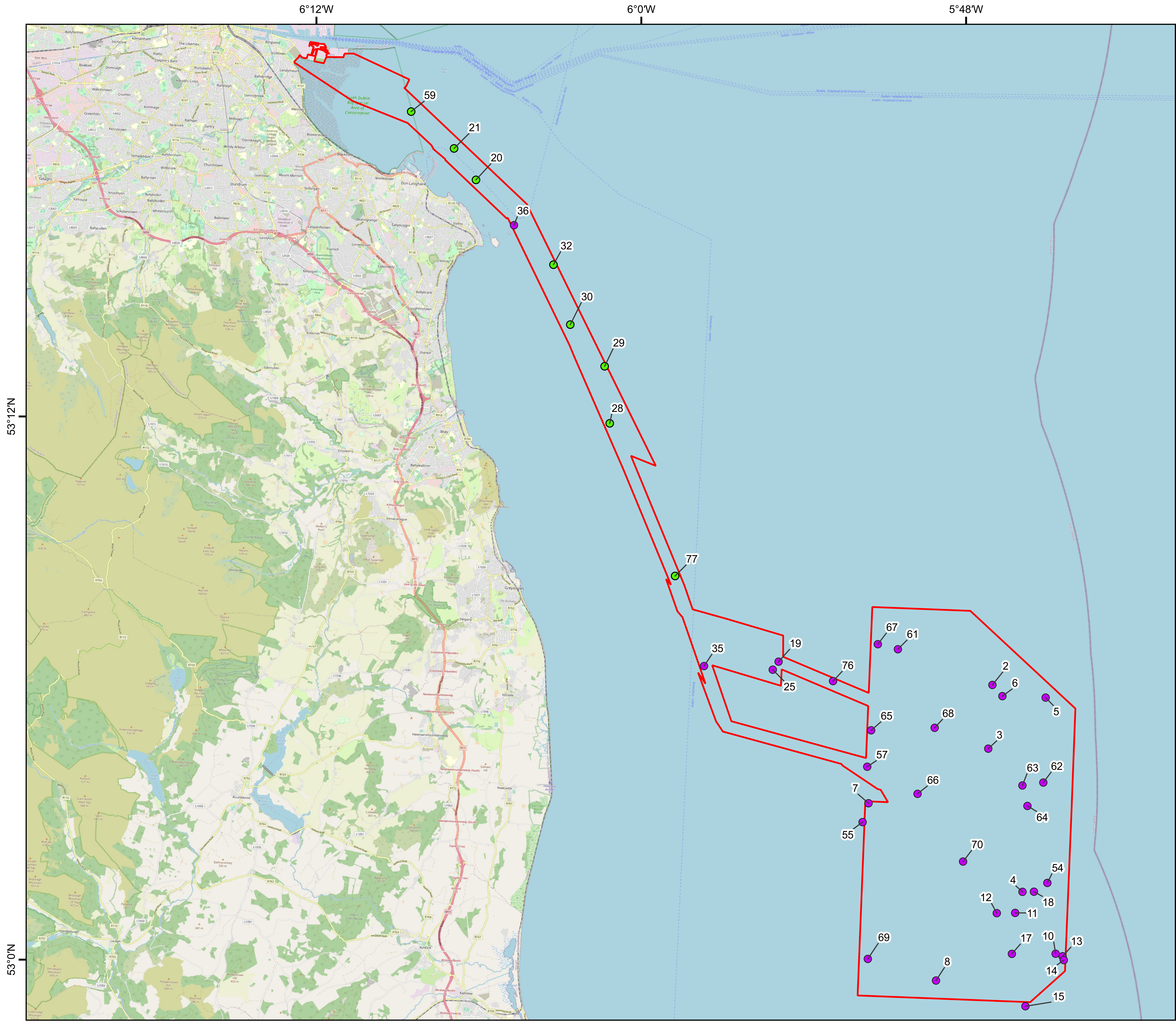
All stations sampled can be seen in Figure 5.6 while the station coordinates and depths are shown in Appendix A (Table A2).

5.2.1. **Infauna**

In total 10,591 individuals were found within the 41 infaunal samples, representing 420 unique aphiaIDs (the full species list is provided in Appendix B: Table B2). Henceforth, where 'species' is referred to, this is in relation to a unique aphiaID. The most abundant species across the survey area was the keelworm (*Spirobranchus lamarcki)* which was present within 68 % of the sampling stations, followed by the phylum Nematoda, present in 80 % of sampling stations and *Hiatella artica*, present in 70 % of stations (Table 5.1).

Table 5.1: Ten most abundant species and stations at which they were present

Species	Total Abundance	Stations
Spirobranchus lamarcki	1340	2, 4, 5, 6, 7, 8, 10, 11, 12, 15, 17, 18, 25, 28, 29, 32, 35, 36, 54, 55, 57, 61, 63, 65, 67, 70, 76, 77
Nematoda	830	3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 17, 18, 19, 20, 25, 28, 29, 32, 35, 36, 55, 57, 59, 61, 62, 63, 64, 65, 66, 69, 70, 76, 77
Hiatella arctica	560	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 17, 18, 19, 25, 32, 35, 36, 54, 55, 57, 63, 64, 65, 68, 70, 76
Spirobranchus sp.	448	5, 6, 7, 8, 10, 11, 12, 14, 17, 18, 25, 29, 32, 35, 36, 54, 55, 57, 61, 62, 64, 65, 66, 67, 76, 77
Nucula nucleus	326	28, 32, 36, 77
Dipolydora flava	283	3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 17, 35, 54, 55, 76
Circeis spirillum	260	4, 11, 12, 17, 18, 35, 57
Nephasoma (Nephasoma) minutum	215	3, 4, 6, 7, 8, 10, 11, 12, 14, 17, 35, 36, 54, 55, 57, 66, 76, 77
Dipolydora sp.	188	5, 6, 7, 8, 11, 12, 25, 32, 35, 55, 64, 76
Golfingiidae	178	6, 10, 11, 12, 14, 17, 18, 25, 35, 54, 55, 76, 77



Project:

Codling Wind Park

Title:

Figure 5.6: Benthic Grab Sampling Stations

Key

- Codling Wind Park
- Benthic grab station
- Benthic grab and contaminant station

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Scale @ A3: 1:155,000

Coordinate System: ETRS89 UTM Zone 30N
Graticules: WGS84

0 2 4 6 8 km

N

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5.2.2. Diversity

Number of taxa ranged from 12 (Station 69) to 108 (Station 17). Number of individuals ranged from 23 (Station 69) to 1194 (Station 11). Species richness and diversity varied across the survey area however was generally higher in areas of coarser sediment. Evenness was also variable across the survey area, reflecting the heterogeneity of the benthic environment. Diversity Indices results are shown in Figure 5.7 and Appendix E (Table E1).

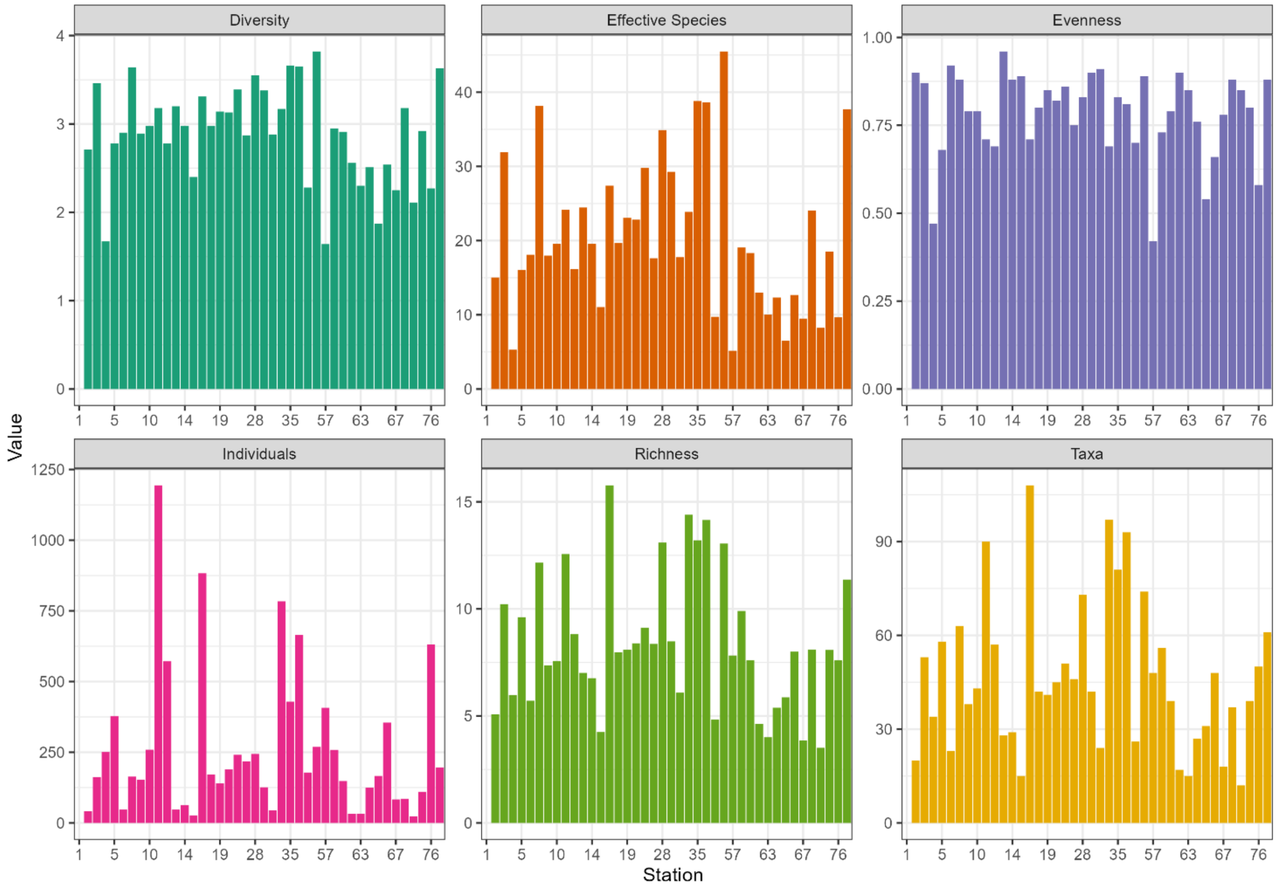
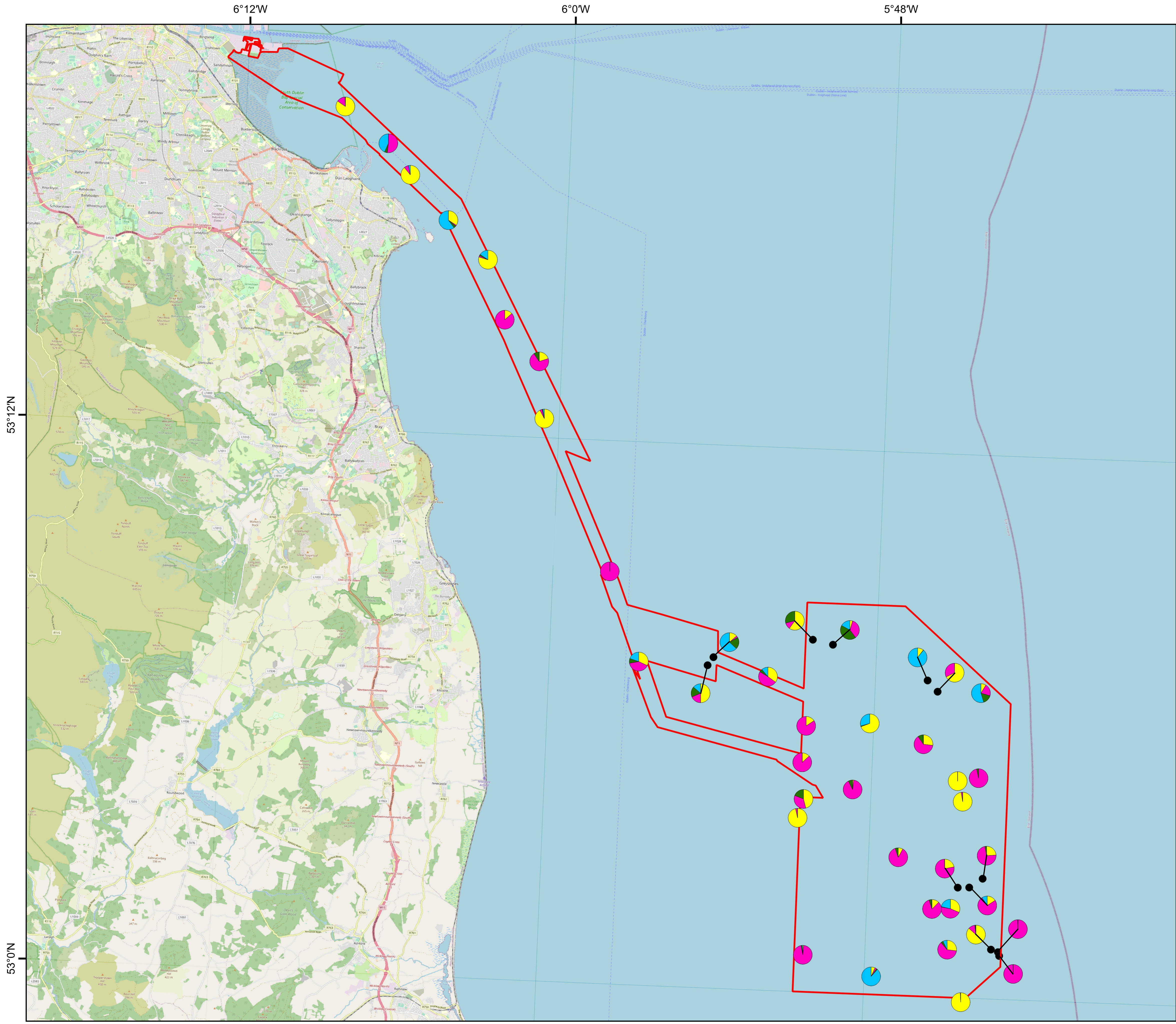


Figure 5.7: Univariate diversity indices at benthic grab sampling stations

5.2.3. Biomass

Taxa from all stations sampled were separated in the main faunal groupings for biomass measurements to be made (Annelida, Arthropoda, Mollusca and Echinodermata). For each benthic grab faunal station, the biomass of each major faunal groups, as a proportion of overall biomass, is shown in Figure 5.8. The majority of stations were dominated in terms of biomass by wither Annelida or Mollusca. However, Echinodermata account for over half of the sample biomass at stations 2, 5, 8, 21 and 36.



Project:

Codling Wind Park

Title:

Figure 5.8: Percentage Biomass of Major Faunal Groups

Key

Codling Wind Park

% Faunal grouping

- Mollusca
- Annelida
- Athropoda
- Echinoderm

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Scale @ A3: 1:155,000

Map projection: ETRS89 UTM Zone 30N
Graticules: WGS 84

0 2 4 6 8 km

N

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Ref: IE200091_M_530_D		

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5.2.4. **PSA and TOC**

PSA was undertaken on a sample from each sampling station and TOC analysis performed on finer sediments. The array site consisted of mainly coarse gravel with cobbles and boulders with several stations in the middle of the array site being of sandier nature (Folk, 1954) (Figure 5.9). Figure 5.10 shows the sediment type across the OECC. The sediment at these stations consists of greater portions of very fine sand and medium sand than those of the array site (Figure 5.11). The full list of the percentages of each particle size and TOC results is provided in Appendix F (Table F1).

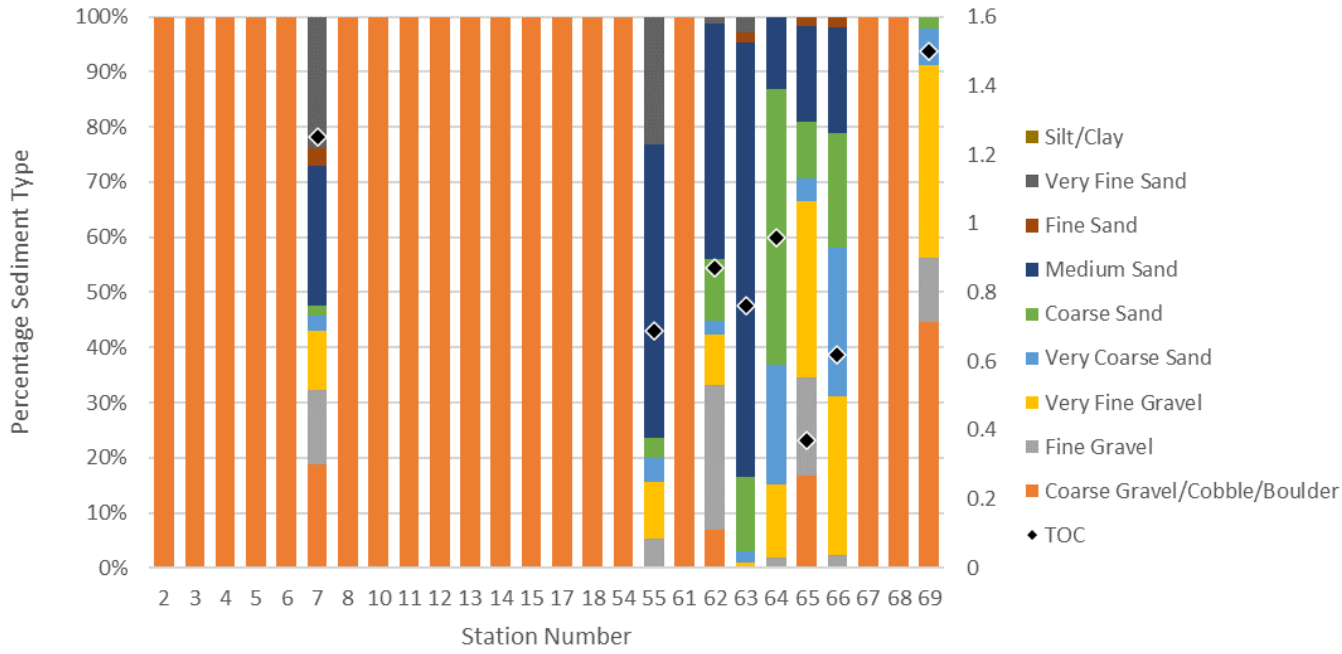


Figure 5.9: PSA results based on Folk Classification for benthic stations at the array site

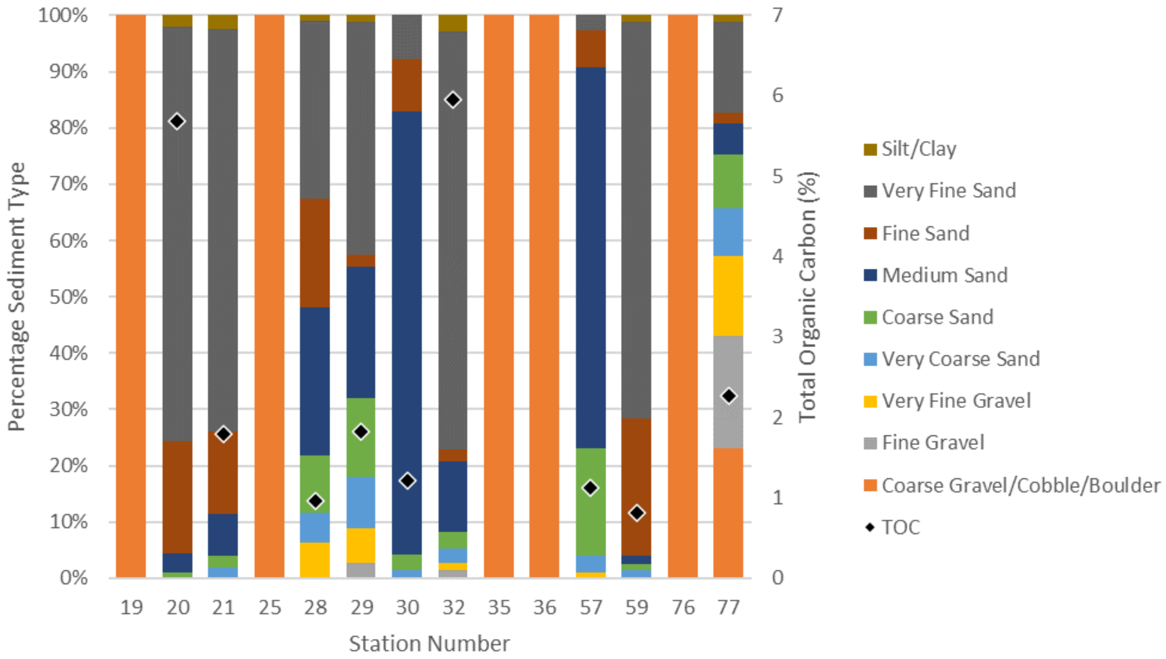
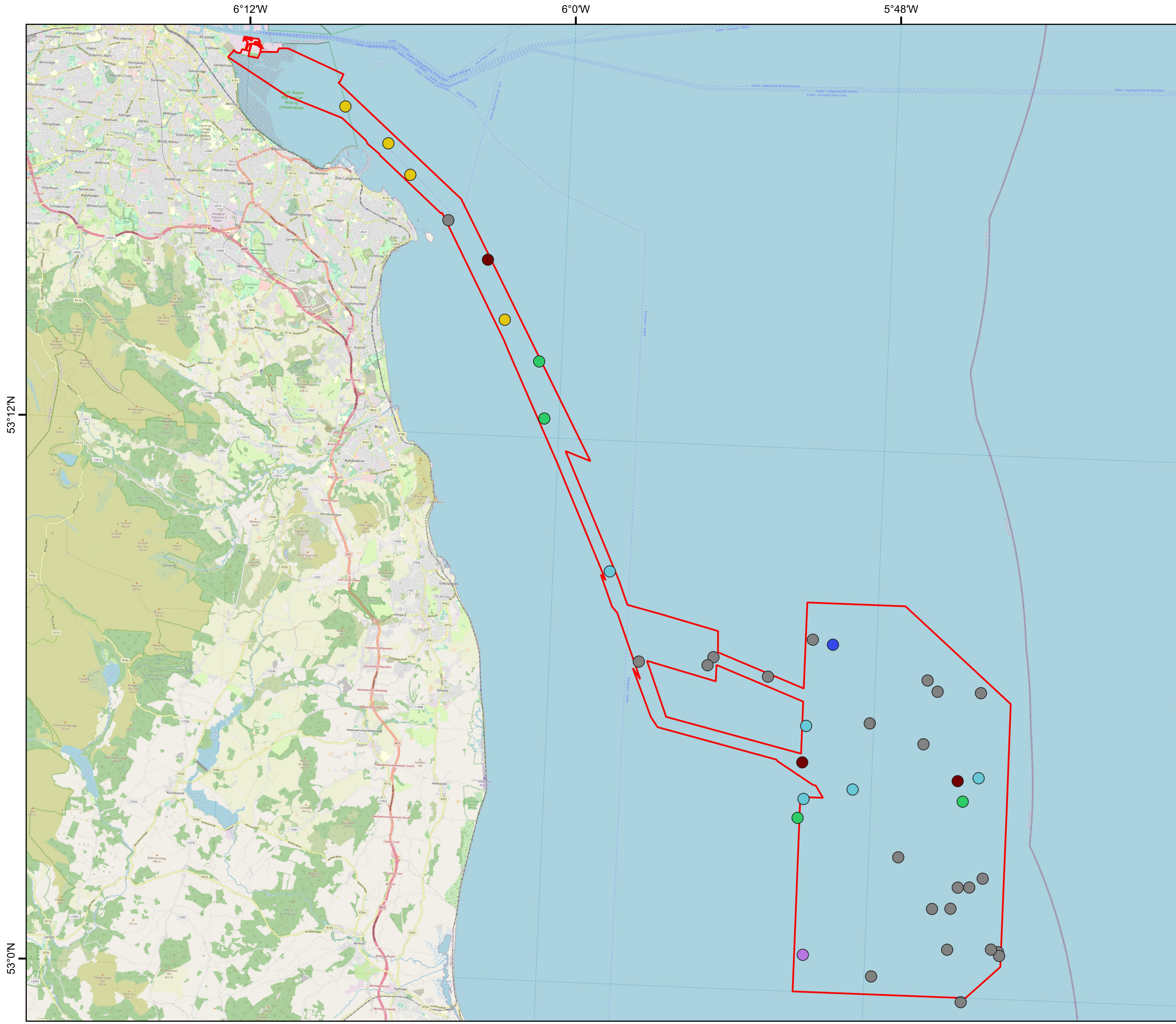


Figure 5.10: PSA results based on Folk Classification and TOC results for benthic stations at the OECC and surrounding area



Project:

Codling Wind Park

Title:

Figure 5.11: Particle Size Analysis Folk Classficiation

Key

Codling Wind Park

PSA folk classification

- Boulders & sand
- Gravel
- Gravel & cobbles
- Gravelly sand
- Sand
- Sandy gravel
- Slightly gravelly sand

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Scale @ A3: 1:155,000

Map projection: ETRS89 UTM Zone 30N
Graticules: WGS 84

0 2 4 6 8 km

N

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5.2.5. Contaminants

At eight stations, samples were collected and analysed for a range of contaminants. Contaminants levels were assessed against Irish (Cronin *et al.,* 2006) and Cefas action levels. When assessed against Irish guidelines, stations 28, 30 and 77 had Arsenic levels above the Lower action level (AL) but below the Upper AL. Cadmium levels at station 59 were also between the Upper and Lower AL. When assessed against Cefas guidelines, levels of Cadmium, Chromium and Zinc at station 59 were slightly above action level one (AL1) but below action level two (AL2). No other contaminants assessed were above Irish Lower ALs or Cefas AL1. A full breakdown of contaminant results can be found in Appendix G.

5.2.6. Community Analysis

SIMPROF found16 statistically significant groups of stations (P<0.05) based on relatedness of species composition (Figure 5.12, Table 5.2). Groups c, g, j, k and m contain a single sampling station and groups b, e, land n consist of only two sampling stations (Table 5.2). It is unlikely that each grouping represents a distinct biotope type, however the relatively large number of groupings may be reflective of the heterogeneity of the environment and the transitional change from one habitat to another across the offshore development area.

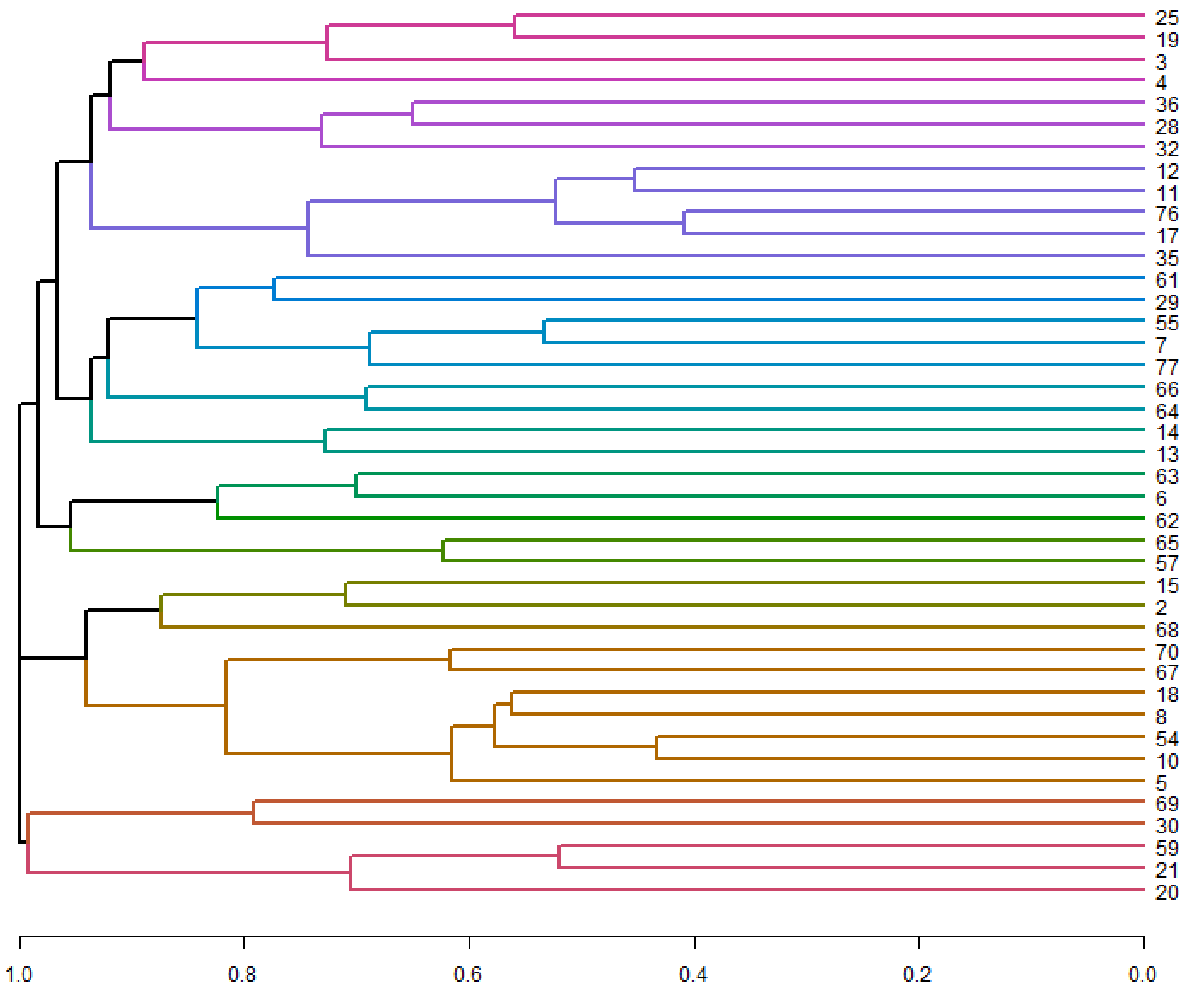


Figure 5.12: Bray-Curtis cluster analysis dendrogram of sampled stations

Table 5.2: Station groupings determined through cluster analysis of benthic sampling stations.

Groupings	Stations
a	20, 21, 59
b	30, 69
c	62
d	61, 64, 65, 66
e	13, 14
f	3, 4, 6, 19, 25, 57, 63, 67, 70
g	29
h	28, 32, 36
i	11, 12, 17
j	8
k	35
l	5, 76
m	18
n	10, 54
o	7, 55, 77
p	2, 15, 68

Stations were grouped by the Folk classification to determine whether species composition varied between Folk classes (Figure 5.13). When species assemblages were compared between Folk classifications by ANOSIM (Figure 5.14), a significant result was found ($p = 0.001$, $R = 0.481$). The clustering of stations in Gravel and Cobbles (Figure 5.14) illustrates the species composition at these stations differs significantly from that of stations in Sand and Slightly Gravelly Sand.

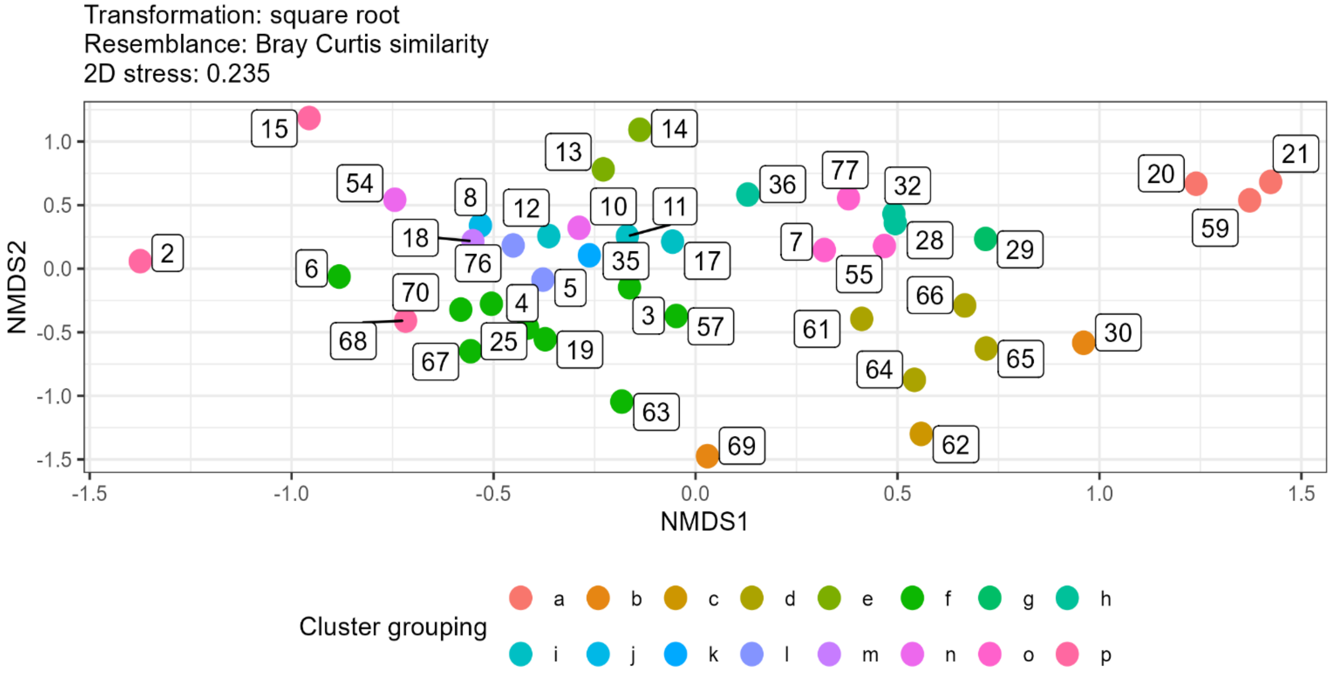


Figure 5.13: NMDS plot showing clustering of stations based on species composition.

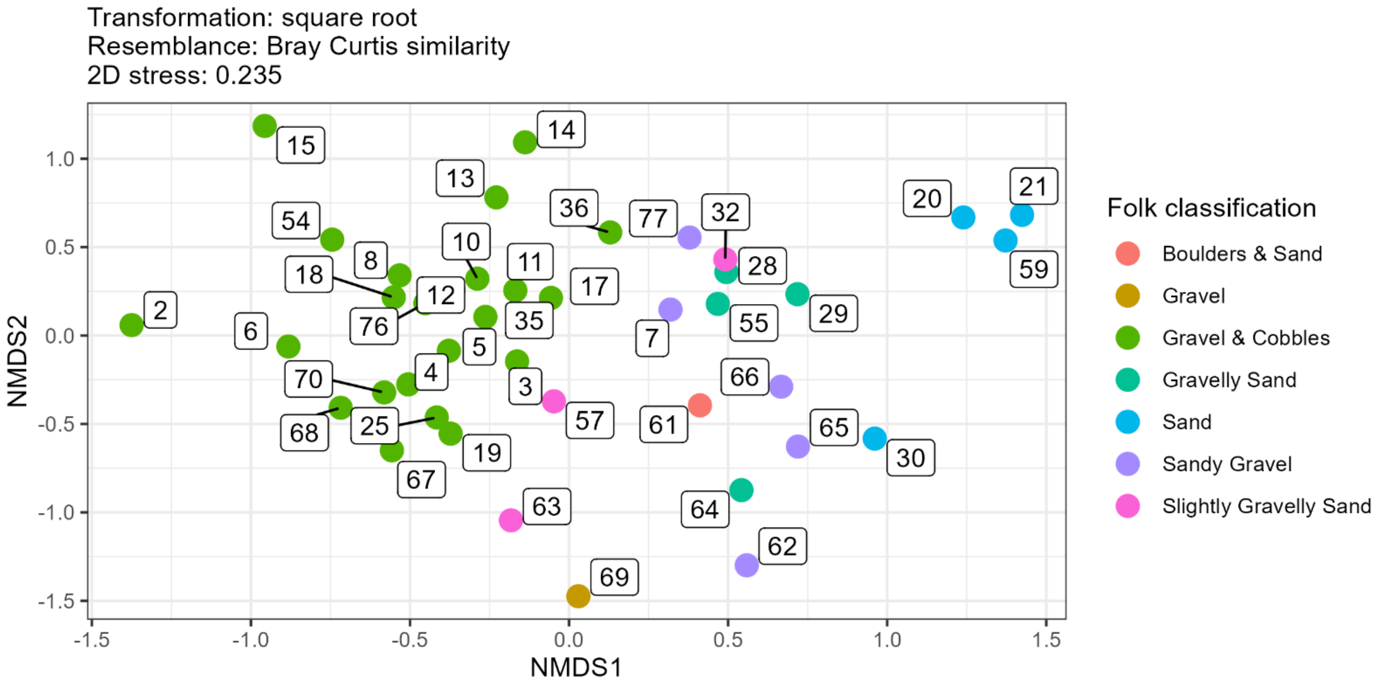


Figure 5.14: NMDS plot showing clustering of stations based on species composition, coloured by the Folk Classification of the station.

5.2.7. Biotope Assignment

SIMPER was run to determine species contributing greatest variation between Folk classifications and the five top contributors to the SIMPROF station groupings are provided in Table 5.3.

Table 5.3: Average contributions of species most similar between station groupings, according to SIMPER

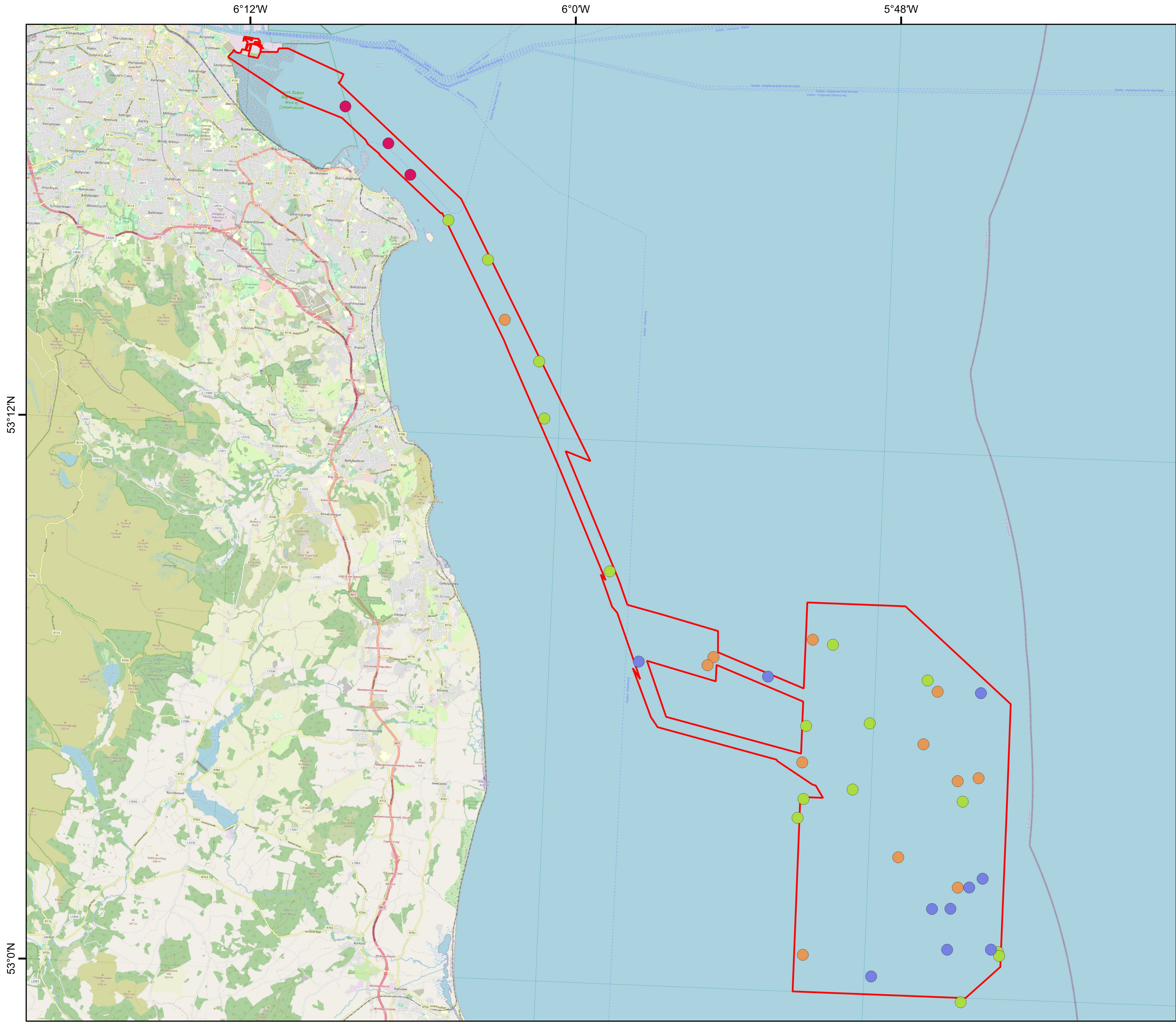
Station Grouping	Most Influential Species Driving Similarity	Folk Sediment Classification	Average Depth (m)
a	*Galathowenia oculata, Chaetozone christiei, Kurtiella bidentata, Nucula nitidosa, Abra alba*	Sand	11
b	*Spisula elliptica, Nephtys cirrosa, Pholoe baltica, Polycirrus sp., Abra sp.*	Sand/ Gravel	22.5
c	*Nematoda, Notomastus latericeus. Travisia forbesii, Cheirocratus sp., Glycera sp.*	Sandy gravel	15.5
d	*Nematoda, Manayunkia aestuarina, Fabriciidae, Syllis pontxioi, Pisione remota*	Boulders & Sand/ Gravelly sand/ Sandy gravel	14
e	*Golfingiidae, Amphipholis squamata, Dipolydora flava, Nemertea, Fabriciidae*	Gravel & cobbles	25.5
f	*Nematoda, Circeis spirillum, Hiatella arctica, Caprella septentrionalis, Spirobranchus lamarcki*	Gravel & cobbles/ Slightly gravelly sand	14.5
g	*Nemertea, Mya sp., Mediomastus fragilis, Photis longicaudata, Ophiura albida*	Gravelly sand	30
h	*Nucula nucleus, Ampelisca spinipes, Abra alba, Ampelisca sp., Spirobranchus lamarcki*	Slightly gravelly sand/ Gravelly sand/ Gravel & cobbles	29
i	*Spirobranchus lamarcki, Hiatella arctica, Spirobranchus sp., Dipolydora coeca, Nephasoma (Nephasoma) minutum*	Gravel & Cobbles	21.5
j	*Spirobranchus lamarcki, Dipolydora flava, Hiatella arctica, Ophiothrix fragilis, Balanus crenatus*	Gravel & Cobbles	20
k	*Dipolydora flava, Ophiothrix fragilis, Balanus crenatus, Hiatella arctica, Nematoda*	Gravel & Cobbles	28
l	*Spirobranchus lamarcki,* Spirobranchus *sp., Hiatella arctica, Nematoda, Dipolydora flava*	Gravel & Cobbles	14
m	*Spirobranchus lamarcki, Hiatella arctica, Spirobranchus sp., Nematoda, Balanus crenatus*	Gravel & Cobbles	21.5
n	*Spirobranchus lamarcki, Spirobranchus sp., Sabellaria spinulosa, Sphenia binghami, Dipolydora flava,*	Gravel & Cobbles	23.5
o	*Dipolydora flava, Polycirrus sp., Nemertea, Sabellaria spinulosa, Spirobranchus lamarcki,*	Gravelly sand/ Sandy gravel	30
p	*Hiatella arctica, Mya sp., Spirobranchus lamarcki, Mya arenaria, Balanus crenatus*	Gravel & Cobbles	18

5.2.7.1. **Biotope Classification**

Infauna (grab) characterising species were incorporated into an Excel spreadsheet alongside physical characteristics such as depth and PSA, and benthic habitats assigned to each sampling station. A total of four biotopes were classified across the CWP survey area. The most common biotope found was *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen). All biotopes are provided in Table 5.4 and Figure 5.15, and full biotope descriptions are given in Appendix D.

Table 5.4: Biotope assignment.

Final Biotope	MNCR Classification Description	Stations
SS.SCS.CCS	Circalittoral coarse sediment	3, 4, 6, 19, 25, 30, 57, 62, 63, 67, 69, 70
SS.SCS.CCS.SpiB	*Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles.	5, 8, 10, 11, 12, 17, 18, 35, 54, 76
SS.SCS.CCS.MedLumVen	*Mediomastus fragilis*, *Lumbrineris spp*. and venerid bivalves in circalittoral coarse sand or gravel.	2, 7, 13, 14, 15, 28, 29, 32, 36, 55, 61, 64, 65, 66, 68, 77
SS.SSa.IMuSa.FfabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	20, 21, 59



Project:

Codling Wind Park

Title:

Figure 5.15: Benthic Biotopes Classification

Key

Codling Wind Park

Biotopes

- SS.SCS.CCS
- SS.SCS.CCS.MedLumVen
- SS.SCS.CCS.SpiB
- SS.SSa.IMuSa.FfabMag

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Map projection: ETRS89 UTM Zone 30N
Graticules: WGS 84

0 2 4 6 8 km

N

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6. **Discussion**

The intertidal area surveyed in South Dublin Bay is reflective of a coastal system with extensive mudflats and sandflats and incipient dune formations. The site-specific intertidal survey found the majority of the sediment type across the lower, middle and upper shore was fine sand or very fine sand, with two sites consisting of coarser sediment in the mid and upper shore. Faunal diversity was low across the majority of stations sampled, with the majority of taxa and individuals found in the mid to upper shore. The lower shore habitat was homogeneous fine sand with worm casts of *Arenicola marina*, patches of *Ulva* sp. and brown filamentous algae. Patches of *Ulva* sp. were frequent at the stations close to landfall at the mid shore. *Ulva sp*. is an opportunistic macroalgal blooming (OMB) species which, can enrich the sediment, which correlates with the large abundance of species found within the faunal sample, but in large quantities can cause the underlying sediment to be anoxic. Biotopes at landfall were classified as Littoral Sand (LS.LSa) apart from two small areas which were classified as Littoral Coarse Sediment (LS.LCS) and Littoral Mixed Sediment (LS.LMx). The mixed sediment was found at the top of the shore where more cobbles and boulders were present.

Contaminated sediments results showed low levels of chemical contaminants at stations sampled within the Development area. The majority of contaminants levels at sampled stations were below the Irish Lower AL and Cefas AL1. Three stations had Arsenic levels slightly above the Irish Lower action level and one station had Cadmium levels above the Irish lower action level, however all were under the Upper AL. Similarly, whilst one station had Zinc, and two stations had Cadmium levels slightly above Cefas AL1, they were well within AL2.

The subtidal benthic ecology survey depicts a heterogenous environment with four biotopes classified across the array site and OECC. The sediment types varied and included gravel and cobbles, boulders, sand, gravel, gravelly sand/sandy gravel and slightly gravelly sand. The typical community structure is characterised by a range of species including polychaetes, bivalves, amphipods, hydroids and bryozoans. The most widespread biotope across the array area is *Mediomastus fragilis*, *Lumbrineris spp*. and venerid bivalves in circalittoral coarse sand or gravel.(SS.SCS.CCS.MedLumVen). No single biotope dominated the cable route area but all most consisted of circalittoral coarse sediment. Nearshore the community was dominated by bivalves and the biotope was identified as *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand (SS.SSa.IMuSa.FfabMag). As the sediment transitions from sand to coarse sediments the community structure is dominated by polychaete species and bivalve species and areas of mixed sediment. Closer to the array area; cobbles, pebbles and boulders become more frequent and the community changes to a more epi-faunal dominated one with the tubeworm, *Spirobranchus sp*. present.

No Annex I habitats or Annex II species were recorded during the site-specific surveys of the Offshore Development area. Whilst the reef forming species *Sabellaria spinulosa* and *Sabellaria alveolata* were found in the array and cable corridor areas, abundances were relatively low, and no stations were classified as *Sabellaria* reef habitat.

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Appendices

A. Locations of Sampling Stations and Type of Sample Taken

Table A1: Intertidal sampling stations at Poolbeg Landfall

Sampling Station	Latitude	Longitude	Surveyed (Y or N)
19	53.3378	-6.1709	Y
20	53.3342	-6.1720	Y
21	53.3313	-6.1729	Y
22	53.3282	-6.1739	N
22A (replaces 22)	53.3293	-6.1738	Y - new site
23	53.3254	-6.1747	N
24	53.3379	-6.1765	Y
25	53.3345	-6.1775	Y
26	53.3318	-6.1783	N
26A (replaces 26)	53.3317	-6.1778	Y - new site
27	53.3288	-6.1791	N
28	53.3348	-6.1834	Y
29	53.3323	-6.1840	Y
30	53.3295	-6.1848	Y
31	53.3269	-6.1854	Y
32	53.3352	-6.1895	Y
33	53.3329	-6.1901	Y
34	53.3302	-6.1907	Y
35	53.3334	-6.1957	Y
36	53.3309	-6.1960	Y
37	53.3339	-6.2016	Y
38	53.3346	-6.2089	Y
39	53.3363	-6.2094	Y
40	53.3227	-6.1756	N
41	53.3261	-6.1800	N

Note: Where the site was not sampled, this was due to the water being too deep at that point.

Table A2: Subtidal Benthic Sampling Staions

Station	Longitude	Latitude	Depth	Sample Taken
1	-5.83689	53.05633	14.5	None (hard ground)
2	-5.76805	53.11636	15	Fauna; PSA
3	-5.76908	53.09282	14.5	Fauna; PSA
4	-5.74476	53.04056	20	Fauna; PSA
5	-5.73515	53.11244	15	Fauna; PSA
6	-5.76167	53.11237	13.7	Fauna; PSA
7	-5.84106	53.07098	20	Fauna; PSA; TOC
8	-5.79553	53.00664	20	Fauna; PSA
9	-5.82278	53.04484	14	None (hard ground)
10	-5.72306	53.01821	25.5	Fauna; PSA
11	-5.74874	53.03268	22	Fauna; PSA
12	-5.75998	53.03233	21	Fauna; PSA
13	-5.71876	53.01737	26	Fauna; PSA
14	-5.71793	53.01599	25	Fauna; PSA
15	-5.74030	52.99844	25	Fauna; PSA
16	-5.72934	53.00539	25	None (hard ground)
17	-5.74979	53.01755	21.5	Fauna; PSA
18	-5.73776	53.04076	21.5	Fauna; PSA
19	-5.89957	53.12181	11	Fauna; PSA
20	-6.09768	53.29461	13	Fauna; PSA; Chemistry; TOC
21	-6.11201	53.30584	12	Fauna; PSA; Chemistry; TOC
22	-5.84821	53.08775	14	None (hard ground)
25	-5.90295	53.11876	11.5	Fauna; PSA
28	-6.00912	53.20704	29	Fauna; PSA; Chemistry; TOC
29	-6.01374	53.22797	30	Fauna; PSA; Chemistry; TOC
30	-6.03592	53.24278	28	Fauna; PSA; Chemistry; TOC
32	-6.04781	53.26460	32	Fauna; PSA; Chemistry; TOC
35	-5.94513	53.11908	28	Fauna; PSA
36	-6.07311	53.27852	26	Fauna; PSA
54	-5.72978	53.04418	21.5	Fauna; PSA
55	-5.84422	53.06394	28	Fauna; PSA; TOC
56	-5.84463	53.06762	28	None (hard ground)
57	-5.84273	53.08442	16	Fauna; PSA; TOC
59	-6.13939	53.31871	8	Fauna; PSA; Chemistry; TOC
61	-5.82680	53.12815	13	Fauna; PSA
62	-5.73459	53.08111	15.5	Fauna; PSA; TOC
63	-5.74731	53.07974	15.5	Fauna; PSA; TOC

Station	Longitude	Latitude	Depth	Sample Taken
64	-5.74376	53.07226	15.5	Fauna; PSA; TOC
65	-5.84121	53.09789	9	Fauna; PSA; TOC
66	-5.81129	53.07516	17	Fauna; PSA; TOC
67	-5.83921	53.12971	11	Fauna; PSA
68	-5.80239	53.09974	13.5	Fauna; PSA
69	-5.83771	53.01362	17	Fauna; PSA; TOC
70	-5.78181	53.05087	18	Fauna
76	-5.86574	53.11546	13.5	Fauna; PSA
77	-5.96513	53.15182	42	Fauna; PSA; Chemistry; TOC

B. Species Lists

Table B1: Intertidal Species List

Species	AphiaID	Sampling Station									
		19	24	25	31	33	34	35	36	37	39
NEMATODA	799										
Nematoda	799							86	2		
ANNELIDA	882										
POLYCHAETA	883										
PHYLLODOCIDA	892										
Phyllodocidae	931										
Eteone longa	130616							4			
Glyceridae	952										
Glycera tridactyla	130130								1		
Nereididae	22496										
Hediste diversicolor	152302							5			
Nephtyidae	956										
Nephtys cirrosa	130357		1	2	1						
Nephtys hombergii	130359							1		2	1
ORBINIIDA	884										
Orbiniidae	902										
Scoloplos armiger	130537						1		3	4	
SPIONIDA	889										
Spionidae	913										
Pygospio elegans	131170					1		314	6	3	
CAPITELLIDA	890										
Capitellidae	921										
Capitella sp. complex	129211							11			
TEREBELLIDA	900										
Cirratulidae	919										
Tharyx sp. (juv)	129249							1			
Terebellidae	982										
Lanice conchilega	131495	1									
OLIGOCHAETA	2036										
HAPLOTAXIDA	2118										
Naididae	2039										
Tubificoides pseudogaster	137582							57			
Tubificoides benedii	137571							220			

Species	AphiaID	Sampling Station									
		19	24	25	31	33	34	35	36	37	39
ARTHROPODA	1065										
CRUSTACEA	1066										
MALACOSTRACA	1071										
AMPHIPODA	1135										
Pontoporeiidae	101406										
Bathyporeia pilosa	103068					1	1				
DECAPODA	1130										
Caridea	106674										
Crangonidae	106782										
Crangon crangon	107552			1						2	
BRACHYURA	106673										
Carcinidae	557511										
Carcinus maenas	107381							1	1		
MOLLUSCA	51										
GASTROPODA	101										
LITTORINIMORPHA	382213										
Hydrobiidae	120										
Peringia ulvae	151628							7	37	31	3
BIVALVIA	105										
CARDIIDA	869602										
Cardiidae	229										
Cerastoderma edule	138998							2	2	8	1
Tellinidae	235										
Macomangulus tenuis	878470									1	
Limecola balthica	880017								2		
Semelidae	1781										
Abra nitida	141435									1	
Scrobicularia plana	141424							9			
Total Individuals		1	1	3	1	2	2	718	54	52	5

C. **Poolbeg Sampling Station Photos**

Figure C1: Poolbeg sampling stations (top left: Station 19 sediment; top right: Station 19 faunal sample; top middle left: Station 20 facing north; top middle right: Station 20 faunal sample; middle bottom left: Station 21 sediment; middle bottom right: Station 21 faunal sample; bottom left: Station 22A facing north; bottom right: Station 22A faunal sample)

Figure C2: Poolbeg sampling stations (top left: Station 24 facing north; top right: Station 24 faunal sample; top middle left: Station 25 facing southwest; middle right: Station 25 faunal sample; middle bottom left: Station 26A facing north; middle bottom right: Station 26A faunal sample; bottom left: Station 28 sediment; bottom right: Station 28 faunal sample)

Figure C3: Poolbeg sampling stations (top left: Station 29 facing north; top right: Station 29 faunal sample; top middle left: Station 30 sediment; middle right: Station 30 faunal sample; middle bottom left: Station 31 sediment; middle bottom right: Station 31 faunal sample; bottom left: Station 34 facing southwest; bottom right: Station 34 faunal sample)

Figure C4: Poolbeg sampling stations (top left: Station 36 sediment; top right: Station 36 faunal sample; middle left: Station 37 facing north; middle right: Station 37 faunal sample; bottom left: Station 39 facing east; bottom right: Station 39 faunal sample)

D. **Full MNCR Biotope Descriptions**

Source - JNCC Marine Habitat Classification (https://mhc.jncc.gov.uk/)

LS.LCS – Littoral coarse sediment

Littoral coarse sediments include shores of mobile pebbles, cobbles and gravel, sometimes with varying amounts of coarse sand. The sediment is highly mobile and subject to high degrees of drying between tides. As a result, few species are able to survive in this environment. Beaches of mobile cobbles and pebbles tend to be devoid of macroinfauna, while gravelly shores may support limited numbers of crustaceans, such as *Echinogammarus incertae sedis planicrurus.*

LS.LMx - Littoral mixed sediment

Shores of mixed sediments ranging from muds with gravel and sand components to mixed sediments with pebbles, gravels, sands and mud in more even proportions. By definition, mixed sediments are poorly sorted. Stable large cobbles or boulders may be present which support epibiota such as fucoids and green seaweeds more commonly found on rocky and boulder shores. Mixed sediments which are predominantly muddy tend to support infaunal communities which are similar to those of mud and sandy mud shores.

LS.LSa - Littoral sand

Shores comprising clean sands (coarse, medium or fine-grained) and muddy sands with up to 25% silt and clay fraction. Shells and stones may occasionally be present on the surface. The sand may be duned or rippled as a result of wave action or tidal currents. Littoral sands exhibit varying degrees of drying at low tide depending on the steepness of the shore, the sediment grade and the height on the shore. The more mobile sand shores are relatively impoverished (MoSa), with more species-rich communities of amphipods, polychaetes and, on the lower shore, bivalves developing with increasing stability in finer sand habitats (FiSa). Muddy sands (MuSa), the most stable within this habitat complex, contain the highest proportion of bivalves.

SS.SCS.CCS - Circalittoral coarse sediment

Tide-swept circalittoral coarse sands, gravel and shingle generally in depths of over 15-20 m. This habitat may be found in tidal channels of marine inlets, along exposed coasts and offshore. This habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g., N*eopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum.*

SS.SCS.CCS.MedLumVen - Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in circalittoral coarse sand or gravel

Circalittoral gravels, coarse to medium sands, and shell gravels, sometimes with a small amount of silt and generally in relatively deep water (generally over 15-20 m), may be characterised by polychaetes such as *Mediomastus fragilis, Lumbrineris* spp., *Glycera lapidum* with the pea urchin *Echinocyamus pusillus*. Other taxa may include *Nemertea* spp., *Protodorvillea kefersteini, Owenia fusiformis, Spiophanes bombyx* and *Amphipholis squamata* along with amphipods such as *Ampelisca spinipes*. This biotope may also be characterised by the presence of conspicuous venerid bivalves, particularly *Timoclea ovata.* Other robust bivalve species such as *Moerella* spp., *Glycymeris glycymeris* and *Astarte sulcata* may also be found in this biotope. *Spatangus purpureus* may be present especially where the interstices of the gravel are filled by finer particles, in which case, *Gari tellinella* may also be prevalent (Glemarec 1973). Venerid bivalves are often under-sampled in benthic grab surveys and as such may not be conspicuous in many infaunal datasets. Such communities in gravelly sediments may be relatively species-rich and they may also contain epifauna such as *Hydroides norvegicus* and *Spirobranchus lamarcki*. In sand wave areas this biotope may also contain elements of the SS.SSa.IMuSa.FfabMag biotope, particularly *Magelona* species. This biotope has previously been described as the 'Deep Venus Community' and the 'Boreal Off-Shore Gravel

Association' (Ford 1923; Jones 1950) and may also be part of the Venus community described by Thorson (1957) and in the infralittoral stage described by Glemarec (1973). SS.SCS.CCS.MedLumVen may be quite variable over time and in fact may be closer to a biotope complex in which a number of biotopes or sub-biotopes may yet be defined. For example, Ford (1923) describes a 'Series A' and a 'Series B' characterised by *Echinocardium cordatum-Chamelea gallina* and *Spatangus purpurea-Clausinella fasciata*. Furthermore, mosaics of cobble and lag gravel often contain ridges of coarse gravelly sand and these localised patches are also characterised by robust veneriid and similar bivalves including *Arcopagia crassa, Laevicardium crassum* and others including *Glycymeris* (E.I.S. Rees pers. comm., 2002). In the presence of pebbles, cobbles or shell, in coarse sandy gravel sediment, the biotope may support encrusting fauna such as hydroids, *Sertularia cupressina* and *Hydrallmania falcata*, bryozoa including *Disporella hispida*, *Schizomavella* spp., and *Escharella immersa* and encrusting polychaetes, *Spirobranchus triqueter* and instances of *Sabellaria spinulosa*. In the presence of these encrusting forms, and with the transition of sediment types to more tidally swept circalittoral mixed sediment, the biotope may form a transition to SS.SMx.CMx.FluHyd. Other variants in gravel, sands and stones in circalittoral waters, from records in the east English Channel, show this biotope may support high densities of polychaetes and copepods, *Nematoda* and *Nemertea*. The biotope may be represented in moderately exposed, shallower areas, with muddy mixed gravel or sand with shell sediments and maerl (*Hapalidiaceae*), supporting the characteristic fauna of *Mediomastus* and *Hilbigneris gracilis*, but absence of venerid bivalves. Furthermore, in impoverished variants of the biotopes, there may be a reduced component of *Mediomastus* and *Hilbigneris gracilis*.

SS.SCS.CCS.SpiB - *Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles

This biotope is characterised by a few ubiquitous robust and/or fast growing ephemeral species which are able to colonise pebbles and unstable cobbles and slates which are regularly moved by wave and tidal action. The main cover organisms tend to be restricted to calcareous tube worms such as *Spirobranchus triqueter* or *S. lamarcki*, small barnacles including *Balanus crenatus* and *Balanus balanus*, and a few bryozoan and coralline algal crusts. Scour action from the mobile substratum prevents colonisation by more delicate species. Occasionally in tide-swept conditions tufts of hydroids such as *Sertularia argentea* and *Hydrallmania falcata* are present. Epifauana may include *Asterias rubens, Pachycerianthus multiplicatus, Munida sarsi, Paguroidea, Cerianthus lloydii*, and *Sabellidae*. Bryozoa *Parazoanthus anguicomus*, *Ulva*, *Porania*, and *Porifera* can also be present.

SS.SSa.IMuSa.FfabMag - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand

In stable, fine, compacted sands and slightly muddy sands in the infralittoral and littoral fringe, communities dominated by venerid bivalves such as *Chamelea gallina* occur. This biotope may be characterised by a prevalence of *Fabulina fabula* and *Magelona mirabilis* or other species of *Magelona* (e.g. *M. filiformis*). Other taxa, including the amphipod *Bathyporeia* spp. and polychaetes such as *Chaetozone setosa, Spiophanes bombyx* and *Nephtys* spp. are also commonly recorded. In some areas the bivalve *Spisula elliptica* may also occur in this biotope in low numbers. The community is relatively stable in its species composition, however, numbers of *Magelona* and *F. fabulina* tend to fluctuate. Around the Scilly Isles numbers of *F. fabulina* in this biotope are uncommonly low whilst these taxa are often found in higher abundances in muddier communities (presumably due to the higher organic content). In deeper, offshore variants of this biotope, although still present, there is a reduction in the component species *F. fabula*, whilst *Magelona filiformis, Bathyporeia* spp., annelid and nemertean worms, and *Amphiuridae* may be more common. Consequently, it may be better to revise this biotope on the basis of less ubiquitous taxa such as key amphipod species (E.I.S. Rees pers. comm. 2002) although more data is required to test this. SS.SSa.IMuSa.FfabMag and SS.SCS.ICS.MoeVen are collectively considered to be the 'shallow Venus community' or 'boreal off-shore sand association' of previous workers (see Petersen 1918; Jones 1950; Thorson 1957). These communities have been shown to correlate well with particular levels of current induced 'bed-stress' (Warwick & Uncles 1980). The 'Arctic Venus Community' and 'Mediterranean Venus Community' described to the north and south of the UK (Thorson 1957) probably occur in the same habitat and appears to be the same biotope described as the *Ophelia borealis* community in northern France and the central North Sea (Künitzer *et al*. 1992). Sites with this biotope may undergo transitions in community composition. The epibiotic biotopes SS.SSa.IMUSa.EcorEns and SS.SSa.IMuSa.AreISa may also overlay this biotope in some areas.

E. Faunal Univariate Results

Table E1: Benthic grab sampling stations univariate measures of community structure.

Station	No. Taxa	No. Individuals	Shannon-Wiener Diversity	Richness	Evenness	Effective Species Number
2	20	42	2.71	5.08	0.90	15.03
3	53	162	3.46	10.22	0.87	31.90
4	34	251	1.67	5.97	0.47	5.31
5	58	377	2.78	9.61	0.68	16.05
6	23	47	2.90	5.71	0.92	18.09
7	63	164	3.64	12.16	0.88	38.14
8	38	153	2.89	7.36	0.79	17.98
10	43	259	2.98	7.56	0.79	19.60
11	90	1194	3.18	12.56	0.71	24.16
12	57	572	2.78	8.82	0.69	16.15
13	28	47	3.20	7.01	0.96	24.47
14	29	63	2.98	6.76	0.88	19.60
15	15	27	2.40	4.25	0.89	11.04
17	108	883	3.31	15.77	0.71	27.40
18	42	171	2.98	7.97	0.80	19.66
19	41	140	3.14	8.09	0.85	23.06
20	45	189	3.13	8.39	0.82	22.82
21	51	241	3.39	9.12	0.86	29.81
25	46	218	2.87	8.36	0.75	17.62
28	73	244	3.55	13.10	0.83	34.89
29	42	126	3.38	8.48	0.90	29.27
30	24	44	2.88	6.08	0.91	17.78
32	97	784	3.17	14.40	0.69	23.87
35	81	429	3.66	13.20	0.83	38.81
36	93	665	3.65	14.15	0.81	38.62
54	26	178	2.28	4.82	0.70	9.74
55	74	269	3.82	13.05	0.89	45.49
57	48	407	1.64	7.82	0.42	5.15
59	56	258	2.95	9.90	0.73	19.07
61	39	148	2.91	7.60	0.79	18.33
62	17	32	2.56	4.62	0.90	12.98
63	15	33	2.30	4.00	0.85	10.01
64	27	125	2.51	5.38	0.76	12.34
65	31	166	1.87	5.87	0.54	6.49

Station	No. Taxa	No. Individuals	Shannon-Wiener Diversity	Richness	Evenness	Effective Species Number
66	48	355	2.54	8.00	0.66	12.68
67	18	83	2.25	3.85	0.78	9.50
68	37	85	3.18	8.10	0.88	24.06
69	12	23	2.11	3.51	0.85	8.26
70	39	110	2.92	8.08	0.80	18.51
76	50	631	2.27	7.60	0.58	9.66
77	61	196	3.63	11.37	0.88	37.69

F. Subtidal Benthic PSA Results

Table F1: Benthic PSA Analysis showing percent of sediment classification within each station sample.

Station	>8mm	4-8mm	2-4mm	1-2mm	0.5-1µm	0.25-0.5µm	125-250 µm	62.5 -125µm	<62.5 µm	PSA Folk Classification
Array Site										
2	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
3	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
4	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
5	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
6	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
7	18.8	13.5	10.6	2.8	1.9	25.1	3.2	23.9	0.1	Sandy Gravel
8	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
10	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
11	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
12	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
13	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
14	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
15	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
17	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
18	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
54	100	0	0	0	0	0	0	0	0	Gravel & Cobbles

Station	>8mm	4-8mm	2-4mm	1-2mm	0.5-1µm	0.25-0.5µm	125-250 µm	62.5 -125µm	<62.5 µm	PSA Folk Classification
55	0	5.2	10.4	4.2	3.7	52.9	0.5	23.1	0.1	Gravelly Sand
61	100	-	-	-	-	-	-	-	-	Boulders & Sand
62	6.8	26.1	9.2	2.3	11.3	42.2	0.7	1.3	0.1	Sandy Gravel
63	0	0.2	1.1	1.9	13.4	78.7	1.9	2.8	0	Slightly Gravelly Sand
64	0	2	13	21.7	49.7	13	0.1	0.4	0	Gravelly Sand
65	16.6	17.8	31.9	4.1	10.3	17.3	1.6	0.5	0	Sandy Gravel
66	0	2.4	28.5	27	20.7	19.1	1.8	0.4	0.1	Sandy Gravel
67	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
68	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
69	44.4	11.5	34.9	6.5	2.2	0.4	0.1	0	0	Gravel
Cable Route										
19	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
20	0	0.2	0.4	0.7	1	3.3	19.7	72.8	1.9	Sand
21	0	0.3	0.6	1.8	2.1	7.4	14.6	70.8	2.4	Sand
25	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
28	0	0.6	6.2	5.4	10.1	26.1	19.3	31.3	1	Gravelly Sand
29	0	2.7	6.1	9.1	14.1	23.3	2	41.5	1.1	Gravelly Sand
30	0	0.2	0.4	1.5	2.6	78	9.4	7.6	0.3	Sand
32	0	1.5	1.2	2.5	3.1	12.4	2.2	74.2	2.8	Slightly Gravelly Sand
35	100	0	0	0	0	0	0	0	0	Gravel & Cobbles

Station	>8mm	4-8mm	2-4mm	1-2mm	0.5-1µm	0.25-0.5µm	125-250 µm	62.5 -125µm	<62.5 µm	PSA Folk Classification
36	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
57	0	0.3	1.1	2.9	19.1	67.3	6.6	2.7	0	Slightly Gravelly Sand
59	0	0.2	0.7	1.4	1.1	1.5	24.2	69.7	1.1	Sand
76	100	0	0	0	0	0	0	0	0	Gravel & Cobbles
77	23.1	20	14.1	8.6	9.5	5.5	1.8	16.3	1.1	Sandy Gravel

G. Contaminated sediment results

Table G.1: Metal levels within sediment samples

Metal (mg/kg)	Sampling Station								CEFAS AL1 (ug/Kg)	CEFAS AL2 (ug/Kg)	Irish Lower AL (ug/Kg)	Irish Upper AL (ug/Kg)
	20	21	28	29	30	32	59	77				
Arsenic	5.3	5	10.2	8	17.5	5.8	4.9	10.1	20	100	9	70
Cadmium	0.5	0.4	0.2	0.3	0.3	0.3	0.9	0.3	0.4	5	0.7	4.2
Chromium	22.2	23.1	18.8	17.2	15.7	20.1	42	18.5	40	400	120.0	370
Copper	5.3	5.4	4.6	4.5	3.9	4.8	7	5.8	40	400	40	110
Lead	13.5	12	12.2	10.2	11	12	12.9	13.8	50	500	60	218
Nickel	9.5	10.5	9.3	8.6	9.1	8.7	10.4	10.8	20	200	21	60
Zinc	56.1	44.1	82.9	102	62.6	115	153	47.9	130	800	160	410
Mercury	0.01	0.02	0.01	<0.01	<0.01	<0.01	0.02	0.04	0.3	3	0.2	0.7
Aluminium	16700	16600	15200	14100	11000	15400	14900	14600	none	none	none	none
Lithium	18.8	17.8	17.5	17.3	15	16.8	14.1	18.8	none	none	none	none

Table G.2: Levels of Organotins within sediment samples

Sampling Station	20	21	28	29	30	32	59	77
SOCOTEC Ref:	MAR01061.001	MAR01061.002	MAR01061.005	MAR01061.006	MAR01061.007	MAR01061.008	MAR01061.012	MAR01061.013
Matrix	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment
Dibutyltin (DBT)	<5	<5	<5	<5	<5	<5	<5	<5
Tributyltin (TBT)	<5	<5	<5	<5	<5	<5	<5	<5

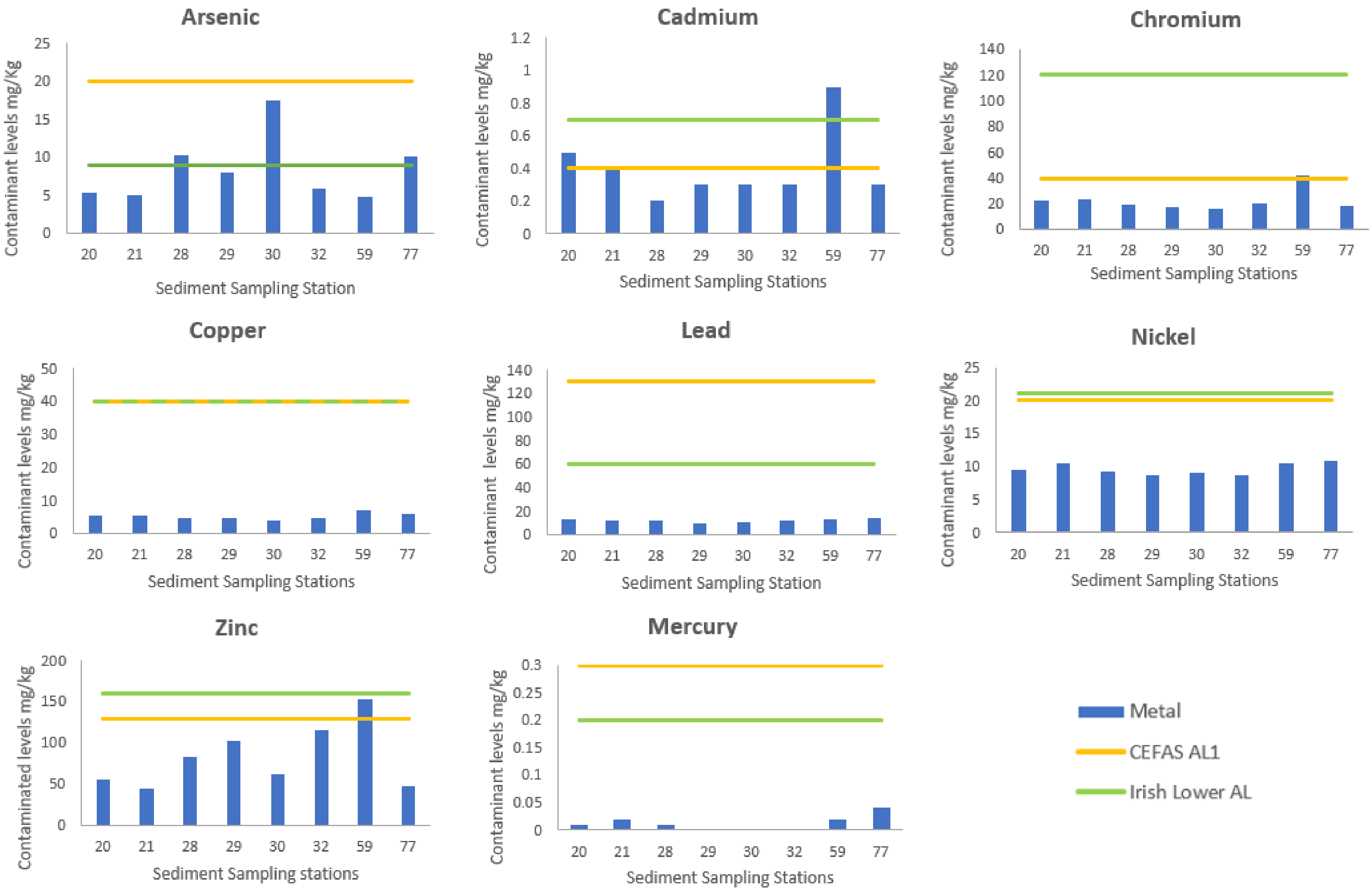

Figure G.1: Metal levels within sediment samples compared to CEFAS Action Level 1 (AL1) and the Irish Lower Action Level (AL

Table G.3: Levels of Polycyclic Aromatic Hydrocarbons (PAH) and Total Hydrocarbon Content (THC) within sediment samples

PAH and THC (ug/Kg)	Sampling Station								CEFAS AL1 (ug/Kg)	Ireland's Lower AL (ug/Kg)
	20	21	28	29	30	32	59	77		
ACENAPTH	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-
ACENAPHY	1.00	1.00	1.00	1.00	1.00	2.24	1.00	1.00	-	-
ANTHRACN	1.67	1.62	1.49	1.00	1.00	3.98	1.00	1.39	-	-
BAA	3.60	4.16	3.14	1.72	1.00	7.84	1.35	2.79	-	-
BAP	4.60	5.10	4.01	2.00	1.00	7.63	1.55	3.50	-	-
BBF	6.56	8.31	8.32	4.16	1.00	10.1	2.79	7.18	-	-
BENZGHIP	6.09	6.15	5.89	2.98	1.00	8.06	2.28	5.34	-	-
BKF	4.08	4.09	3.59	1.73	1.00	4.13	1.38	3.12	-	-
CHRYSENE	5.53	5.97	5.92	2.86	1.00	13.9	2.04	5.80	-	-
DBENZAH	1.46	1.37	1.28	1.00	1.00	1.76	1.00	1.20	-	-
FLUORANT	6.19	7.16	6.86	3.30	1.00	9.86	2.49	6.56	-	-
FLUORENE	2.12	1.60	2.35	1.04	1.00	3.87	1.00	3.11	-	-
INDPYR	7.10	6.78	6.51	3.58	1.00	7.43	2.55	5.59	-	-
NAPTH	3.48	3.23	7.11	2.65	1.00	122	1.73	7.86	-	-
PHENANT	6.40	5.98	8.78	3.62	1.00	42.6	2.28	9.25	-	-
PYRENE	6.20	6.89	6.08	2.79	1.00	10.9	2.60	4.98	-	-
Sum of PAH[16]	67	70	73	36	16	257	28	70	3712	4000
THC	12200	11100	23100	8540	1240	14100	6610	16900	100,000	1,000,000

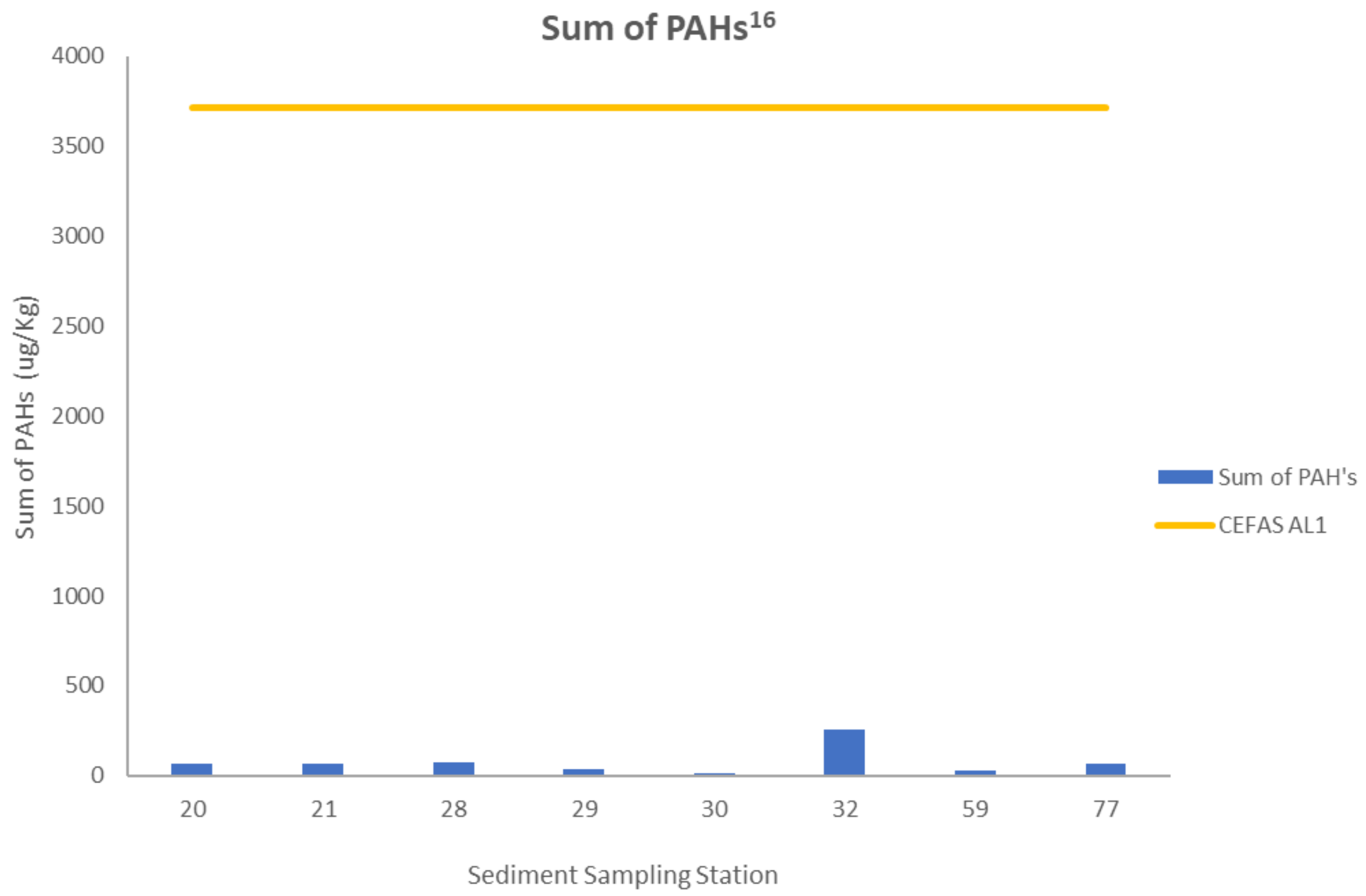

Figure G.2: Sum of PAH[16] within sediment samples compared to CEFAS Action Level 1 (AL1)

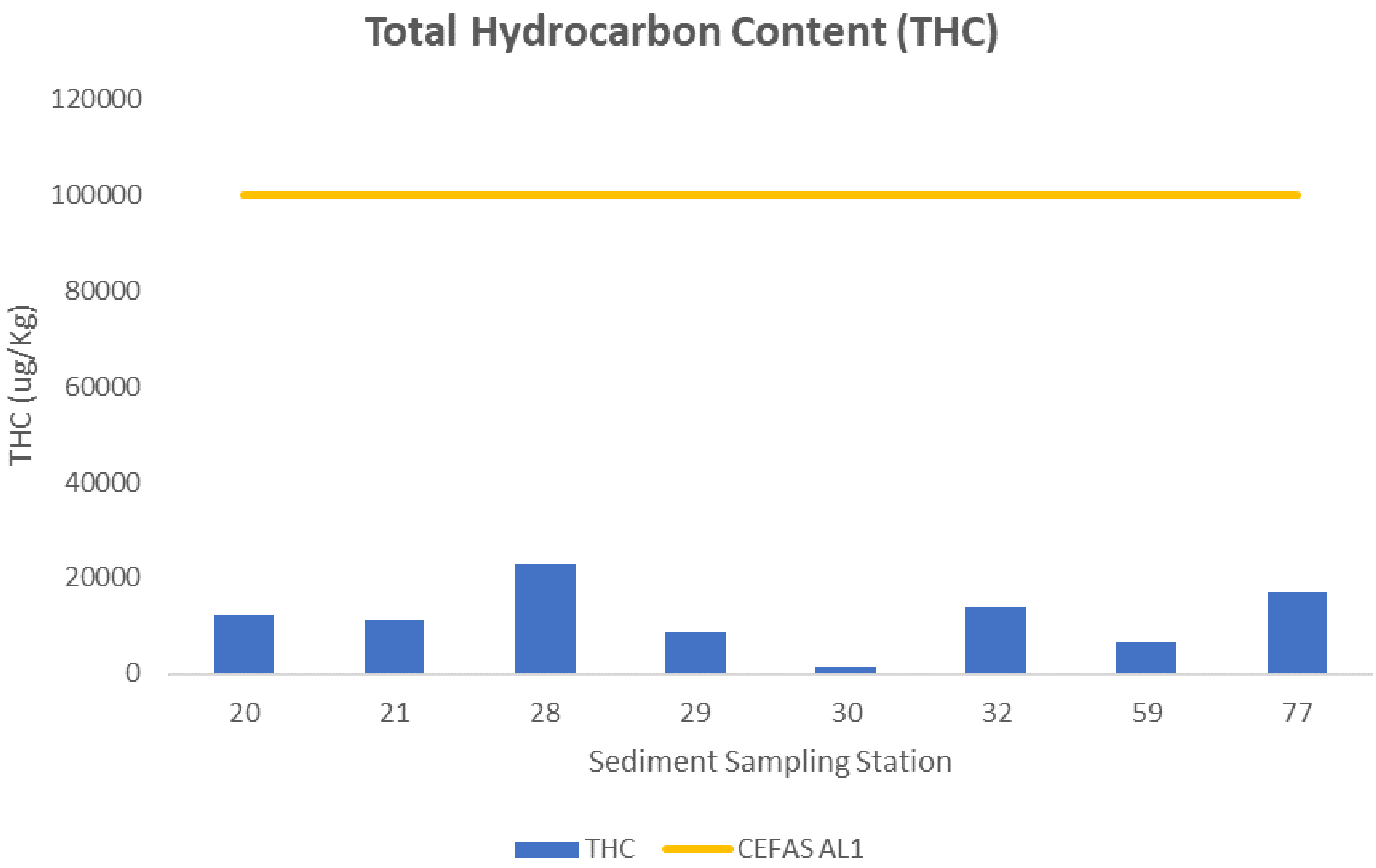

Figure G.3: Total Hydrocarbon Content (THC) within sediment samples

Table G.4: Levels of Polychlorinated Biphenyls (PCB) within sediment samples

PCB (µg/Kg)	Sampling Station								CEFAS AL1 (ug/Kg)	Ireland's Lower AL (ug/Kg)
	20	21	28	29	30	32	59	77		
PCB28	0.14	0.16	0.10	0.08	0.08	0.12	0.08	0.15	-	1
PCB52	0.16	0.18	0.08	0.08	0.08	0.11	0.08	0.13	-	1
PCB101	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	-	1
PCB118	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	-	1
PCB138	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	-	1
PCB153	0.08	0.08	0.08	0.08	0.08	0.1	0.08	0.08	-	1
PCB180	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	-	1
Sum of PCBs	0.70	0.74	0.58	0.56	0.56	0.63	0.56	0.68	10	7

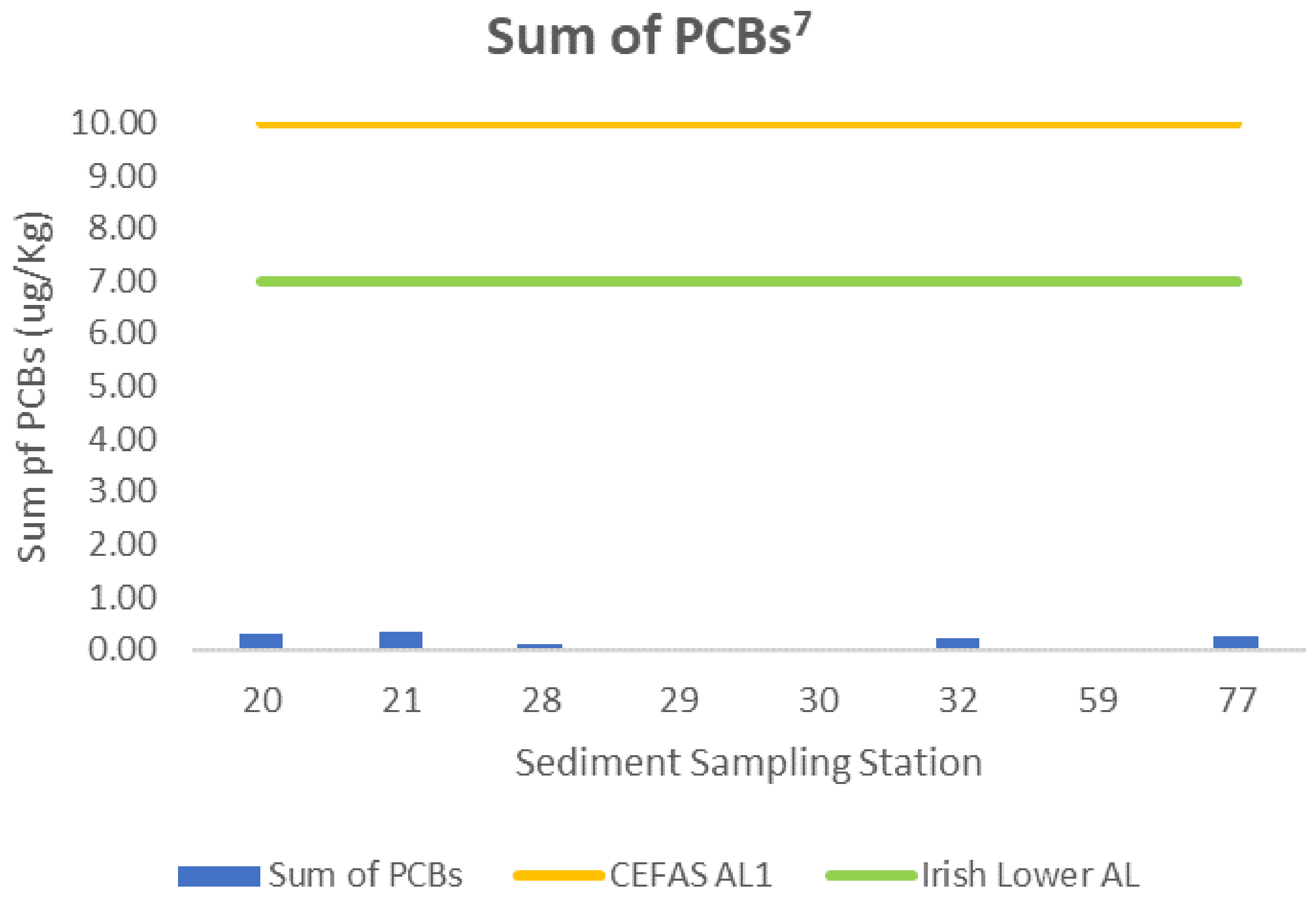

Figure G.4: Sum of PCBs7 within sediment samples compared to CEFAS Action Level 1 (AL1) and the Irish Lower Action Level (AL)

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