Deep Green Project
Holyhead Deep

Benthic technical report

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Front Cover Photo: Boulder and cobble with dahlia anemone Urticina sp. (Station 28, Deep Green CMACS Survey)

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1. INTRODUCTION

1.1 Project background

The Deep Green Project proposed by Minesto Ltd. is a tidal power project to be located in the Holyhead Deep approximately 6km west of Holy Island, Anglesey. The Project will consist of three tidal generation units anchored to the seabed along with infrastructure such as an export cable to transfer power to shore and a subsea transformer. The Project Development Area (PDA) and associated export cable, which is planned to be located within a cable route corridor (CRC) area and make landfall at Penrhos Beach, are displayed in Figure 1.

As part of the application for consent to install the Project, an Environmental Impact Assessment (EIA) is required. Xodus Group on behalf of Minesto Ltd. has contracted the Centre for Marine & Coastal Studies Ltd. (CMACS) to characterise the main benthic habitats and sediments of the PDA and the CRC to inform this assessment.

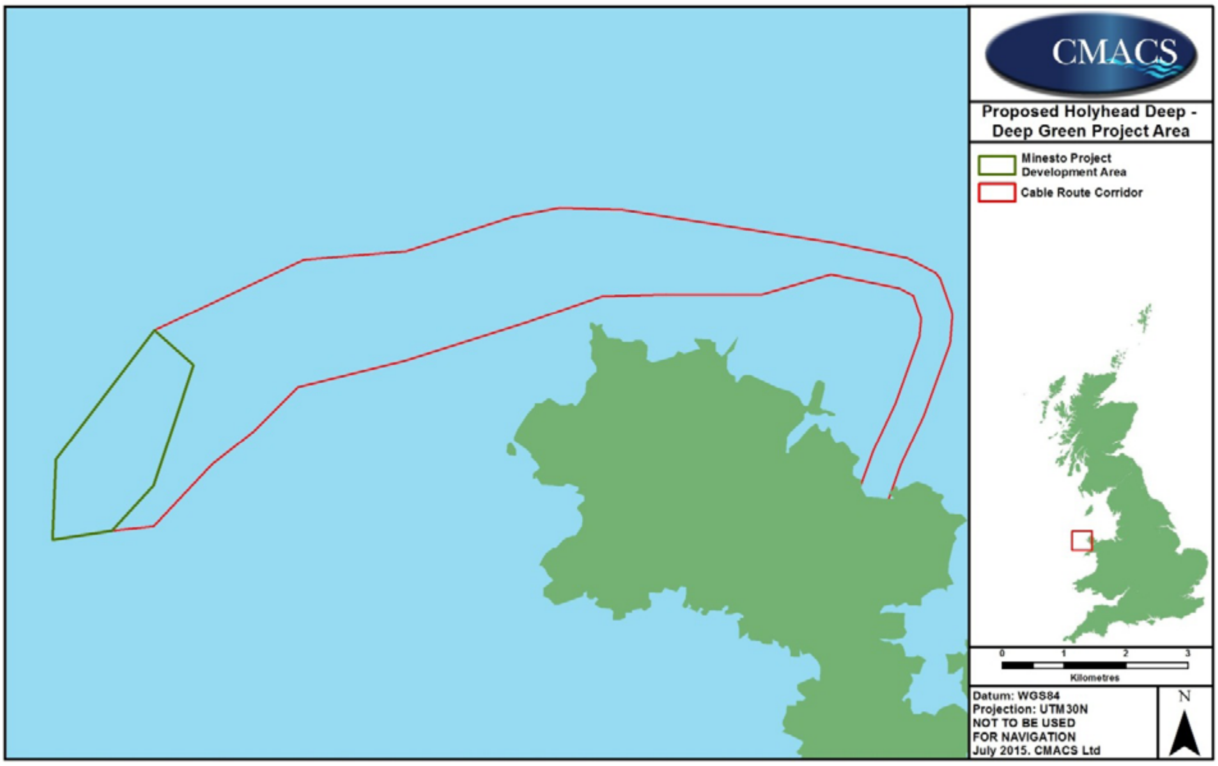

Figure 1. Deep Green Project Development Area.

1.2 Environmental characterisation

The objectives of the benthic ecological characterisation survey were:

- To characterise and describe the spatial distribution of seabed habitats in the Deep Green Holyhead Deep PDA and along the proposed export cable corridor (as defined in Figure 1);
- To document the presence of any seabed features or species of conservation interest, e.g. Annex I and map their extent within the Deep Green Holyhead Deep PDA and along the proposed export cable corridor;
- To quantify any contaminants present in the surface sediments of the Deep Green Holyhead Deep PDA and along the export cable corridor.

The above objectives were pursued through a combination of benthic grab and underwater camera survey. A geophysical survey was completed by Bibby Hydromap in June 2015 and was important in providing broad scale information on seabed habitats to allow the benthic survey to be refined; however, the results from this survey were reported separately (Bibby HydroMap, 2015) and this report focuses on the benthic ecological survey.

2. METHODS

2.1 Field survey

2.1.1 Station selection

Side-scan sonar mosaics and bathymetric data derived from the geophysical survey of the PDA and CRC undertaken by Bibby Hydromap in June 2015 were used to differentiate seabed habitats. The large majority of the surveyed seabed was identified to be coarse sediment with the remainder consisting of bedrock and areas that had a ‘texture’ that suggested seabed features such as biogenic reef may be present.

For general seabed habitat classification purposes, stations were spread throughout the PDA and CRC to ensure a representative coverage of all predicted habitats (based upon the geophysical data). Areas identified from the review of the geophysical data as having potential for Annex I habitats were targeted directly. In addition, some stations were added outside the PDA and CRC areas, which could provide sample stations for any future monitoring as near-field reference stations, since they were within a tidal excursion.

A total of forty-one sample stations were selected for both drop down camera survey and grab sampling. Of these, six were intended for camera survey only owing to the likely presence of bedrock or very large particles (as identified from the geophysical survey results). All stations were surveyed using drop down camera prior to grabbing to ensure that: a) there were no species or habitats of conservation concern that may be damaged or killed at the station; b) the seabed was suitable for grabbing. Figure 2 and Figure 3 below display the camera and grab stations respectively.

In accordance with the methodology specified by Xodus Ltd., a single grab sample for faunal analysis was proposed for each sample station along with a second grab for sediment particle size and contaminant analysis.

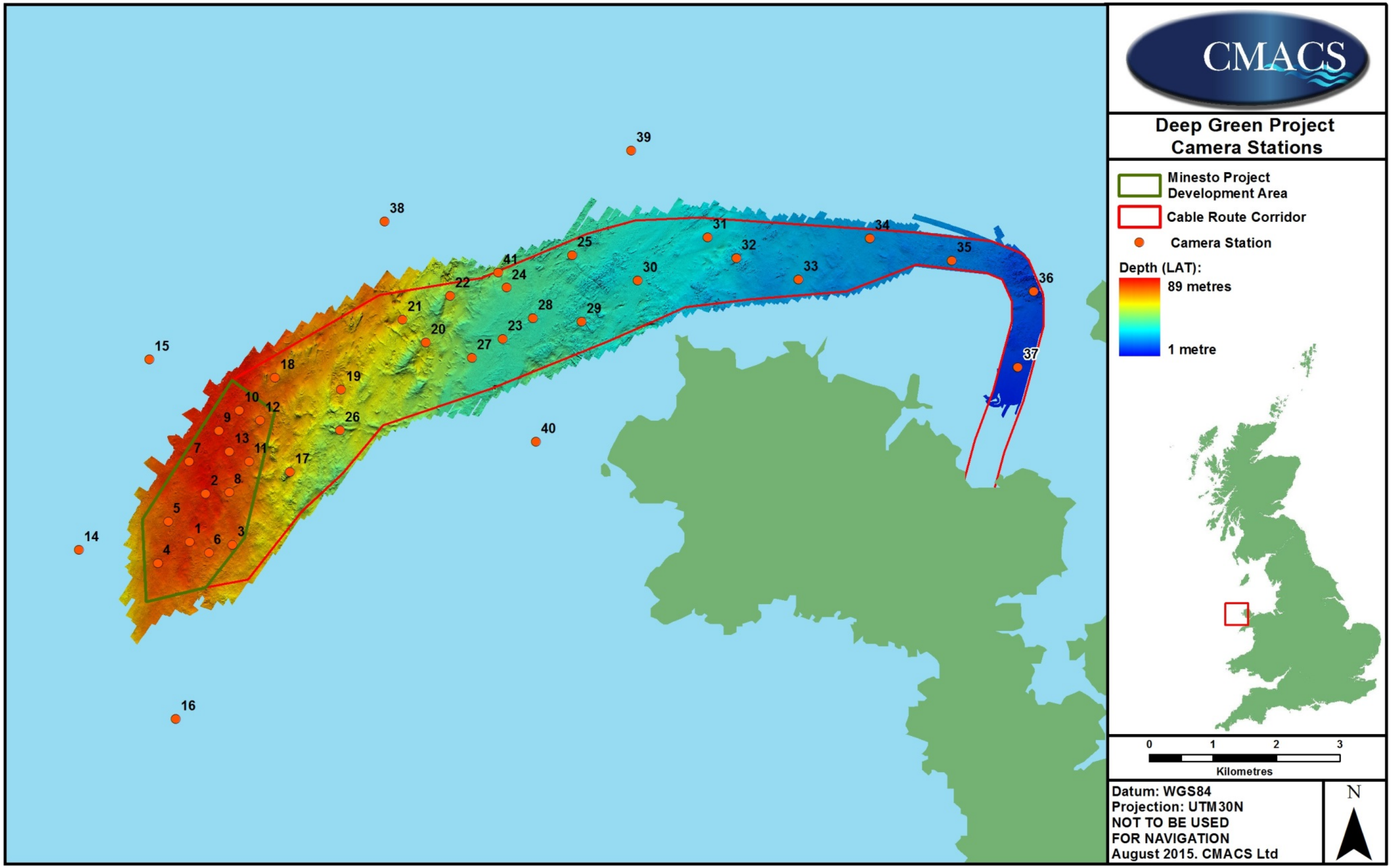

Figure 2. Location of camera survey stations with PDA and CRC bathymetry.

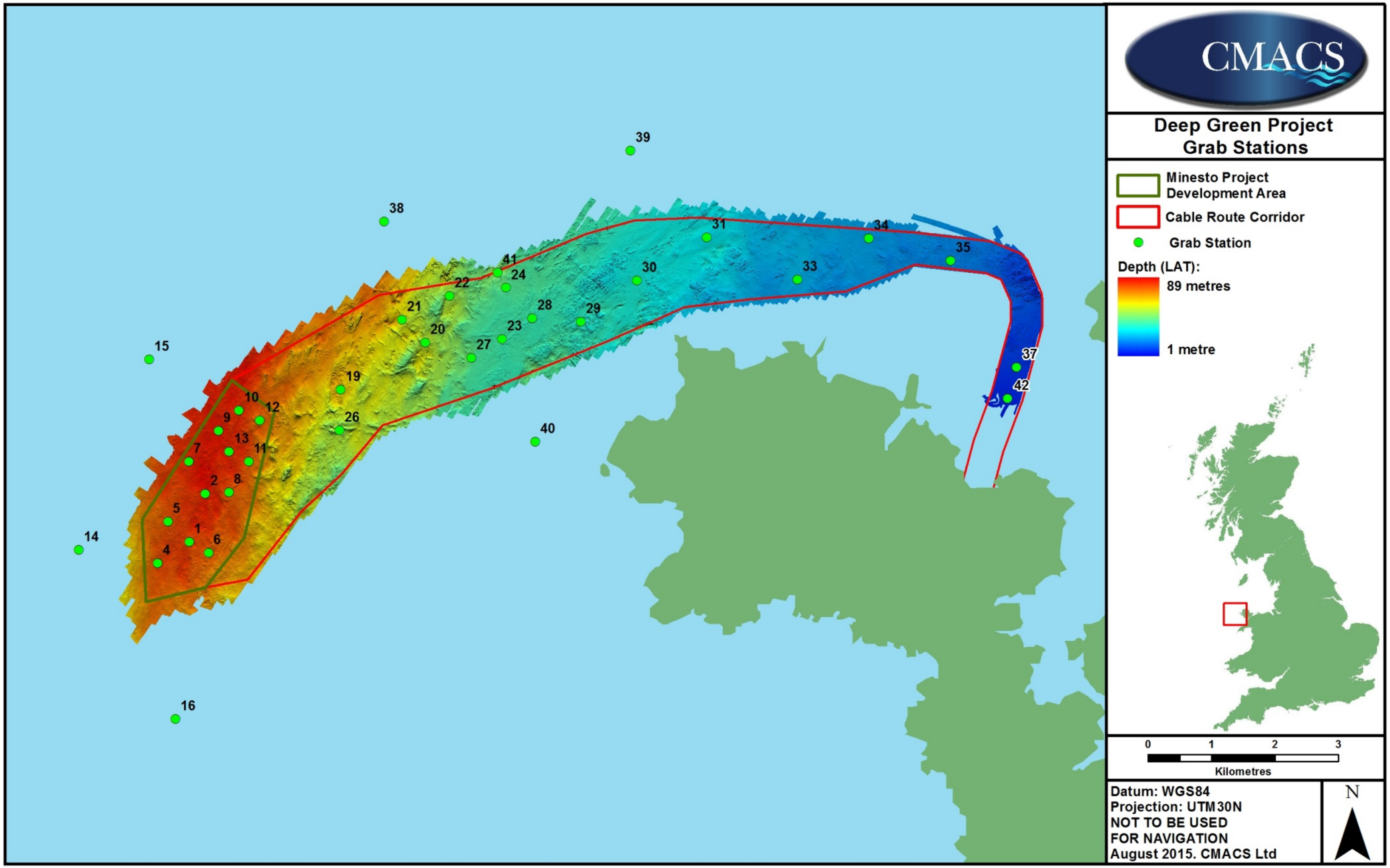

Figure 3. Location of grab survey stations with PDA and CRC bathymetry.

2.1.2 Data acquisition

All benthic survey work was completed from the Bibby Hydromap *Chartwell*, a 26.5m purpose-built survey vessel with 24hr survey capability and an endurance of five days at sea (see Plate 1). The survey was completed between 24th June and 1st July 2015 operating out of Holyhead port on a twelve hour basis.

Plate 1. The survey vessel, *Chartwell*

2.1.3 Drop down camera

A Seaspyder drop down camera (see Plate 2) was deployed slowly to the seabed whilst the vessel drifted over the target. An ultra-short baseline (USBL) was attached to the camera so that the surveyors could ensure that the camera landed on the seabed within a 50m zone around the target. The lead biologist captured and logged camera stills and video footage from each station in addition to associated data such as water depth, time and brief notes on the sediment type and any identifiable epifauna (Appendix 2 Field notes from Camera survey).

A single position fix was obtained when the camera was first deployed to the seabed. On a subset of inshore stations, the camera was re-deployed on four further occasions at each station by lifting off the seabed then lowering again within a few metres of the original target position. This approach became untenable at the majority of stations, however, as the depth of water combined with the strength of the current did not allow for the camera to be repositioned within the 50m zone.

Particular attention was paid to the potential presence of any habitats or species of conservation interest e.g. Annex I habitat.

Video was obtained at all but one of the sample stations; no survey was attempted at Station 40 owing to the vessel master’s reservations regarding vessel safety on deploying equipment to the seabed close to the coast in strong tidal currents.

Stills images were obtained at thirty nine sample stations. Owing to equipment failure, a still image could not be obtained at Station 12 and habitat characterisation was undertaken using the video footage.

Plate 2. Seaspyder drop down camera system provided by STR.

2.1.4 Grab survey

A standard weighted mini-Hamon grab with a 0.1m^2 sample area was used for all the sediment sampling (see Plate 3). All samples were collected from within 50m of the target location.

Upon contact with the seabed, the Ultra Short Baseline (USBL) was used to derive a positional fix. Upon retrieval of each sample, the date, time and water depth were recorded, along with a description of the volume of sample. A digital photograph of each faunal grab sample was taken then notes were made on sediment type, colour, volume and any species of note prior to washing over a 1mm sieve. Samples were then gently backwashed into suitable containers prior to fixing in 4% formalin solution as soon as possible, ready for subsequent faunal analysis. Field notes are provided within Appendix 3. Field notes from Grab survey

At each sample station, a second grab was then collected for sediment analysis (both contaminants testing and particle size analysis). After initial observations and photographs, a representative subsample of approximately 500g was removed for particle size analysis (PSA) and total organic carbon (TOC) analysis. Subsamples were then taken as per standard methodology (e.g. JNCC, 2001); a plastic trowel and plastic tubs were utilised to collect a sample for metal contaminants analysis (so as to avoid possible contamination from metallic tools etc.) and a metal trowel and glass jars were used to collect a sample for hydrocarbon analysis. All PSA and contaminants samples were frozen immediately upon collection on board the survey vessel.

Grab samples of less than 5 litres (or 2.5 litres on hard-packed substrates) in volume were rejected. Samples were also rejected if the grab jaw was not properly closed upon retrieval.

Grab samples were obtained from 23 of the 41 targeted stations. Many failures were due to the very coarse nature of the seabed sediments, which often prevented a suitable volume of sediment from being collected or particles became trapped in the jaw of the grab, leading to repeated sample rejection. At Station 41, a hand-held Van Veen grab was used to obtain a sediment sample (owing to the shallow nature of the station, it was sampled using Bibby's shallow draught catamaran). The Van Veen grab was used to ground truth the side-scan data but a suitable sample for sediment PSA was also taken; unfortunately, a sample suitable for faunal analysis could not be obtained from this station.

The success of grab sampling is summarised in Figure 4 (see also Appendix 4).

Plate 3. Mini-Hamon grab used for grab survey

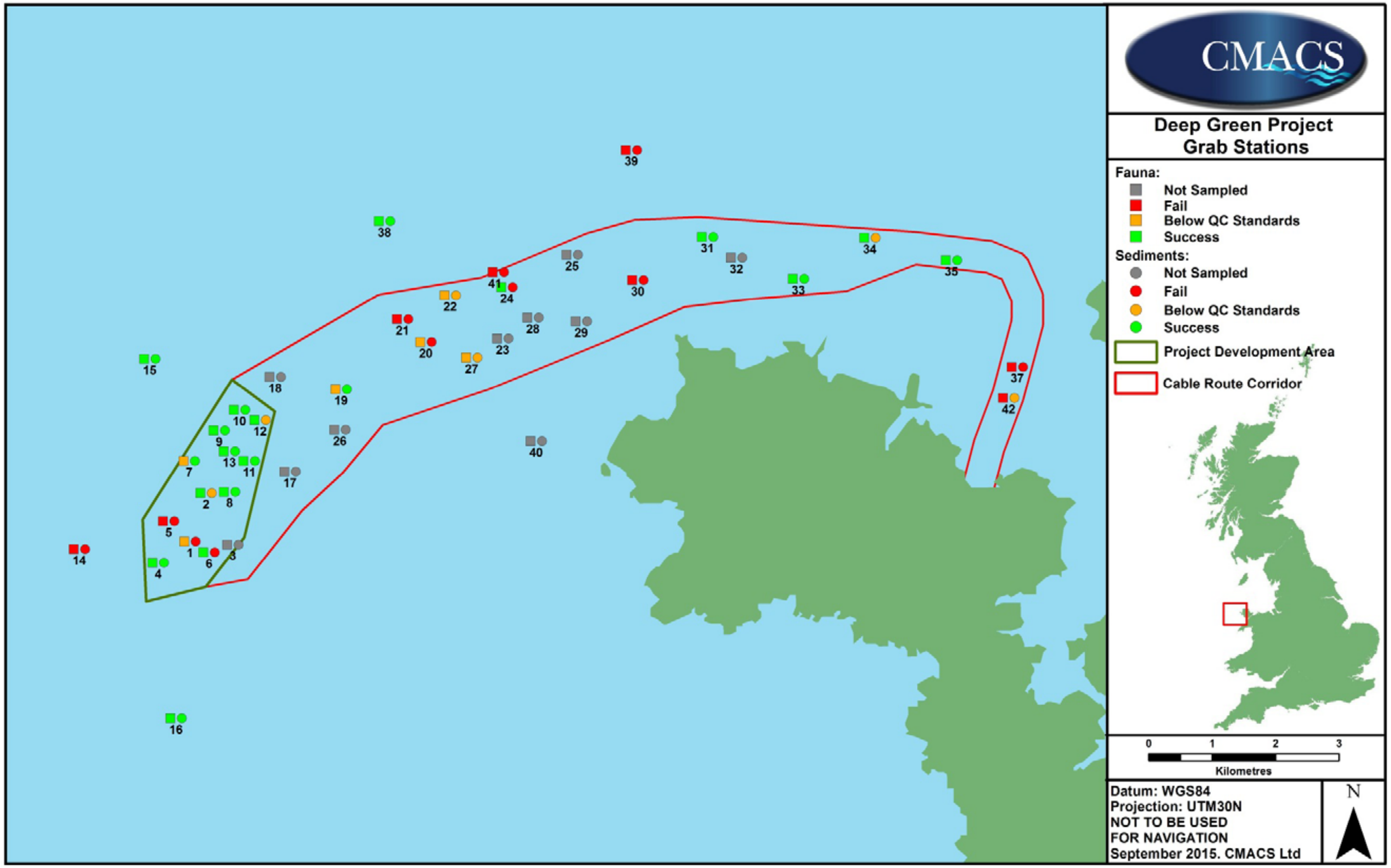

Figure 4. Fauna and sediment grab success and failures.

2.2 Laboratory methods

2.2.1 Particle size analysis

Particle size analysis (PSA) was undertaken at the CMACS laboratory in Eastham, which participates in the National Marine Biological Analytical Quality Control (NMBAQC) scheme.

With the exception of any samples that obviously contained a high proportion of silt, sediment samples were dried for 24 hours at 80^0C before fractionation by sieving. Samples were separated with a half-phi sieve series (see Table 1) on a Retsch AS200 sieve shaker.

Samples with a high proportion of fine sediment (e.g. more than 5% retained on the <63µm fraction) were wet-sieved at 2mm to separate out coarse sediment, with the two fractions subsequently treated as follows:

- The fraction of particles 2mm in diameter and larger was dried at 80ºC for at least 24 hours and then dry-sieved over a half-phi sieve series (see Table 1 below) for twenty minutes with a Retsch AS 200 sieve shaker. Once the fractions had been separated, each one was weighed to a hundredth of a gram.

- The fraction of particles 2mm and smaller was transferred to a bottle and left to stand to allow the very fine particles to settle out of suspension. Once the liquid and solid had separated, the excess water was siphoned off the top of the sample (taking care not to disturb the fine sediments). Prior to analysis, the sample was homogenized as best as possible before a sub-sample was taken and the sediment analysed with a Coulter Laser Sizer. Once the data had been generated from the laser sizer, the less than 2mm fraction was also dried and weighed to a hundredth of a gram.

- Using the percentages of the laser size data, it was then possible to estimate masses of each fine grain fraction and then re-calculate percentage of the sample with the mass of the coarse fraction included.

Proportional masses and volumes of sediment were then used to calculate mean and median particle sizes, and the determination of sorting index by calculating the standard deviation of Phi. Sediment analysis (PSA) was completed using the statistical analysis package Gradistat (Blott & Pye, 2001). Data were then used to determine sediment type according to the definitions of Buchanan (1984) (see Table 2 & Table 3) and also the Folk and Ward classification system as used by the British Geological Survey (BGS) (Long, 2006) (see Figure 5).

Table 1. Sieve series used for analysis.

Half-phi mesh sizes (coarse sediment in mm)												
63.0	45.0	31.5	22.4	16.0	11.2	8.0	5.6	4.0	2.8	2.0	1.4	1.0
Half-phi mesh sizes (fine sediment in µm)												
710	500	355	250	180	125	90	63					

Table 2.Classification used for defining sediment type (from Buchanan, 1984).

Wentworth Scale (mm)	Phi units	Sediment types
>256mm	<-8	Boulders
64 - 256 mm	-8 to -6	Cobble
4 - 64 mm	-6 to -2	Pebble
2 - 4 mm	-2 to -1	Granule
1 - 2 mm	-1 to -0	Very coarse sand
0.5 - 1 mm	0 - 1	Coarse sand
250 - 500 µm	1 - 2	Medium sand
125 - 250 µm	2 - 3	Fine sand
63 - 125 µm	3 - 4	Very fine sand
4 - 63 µm	4 – 8	Silt
1 – 4 µm	8 – 10	Clay
<1 µm	>10	Colloids

Table 3.Classification used to define the degree of sediment sorting (from Buchanan, 1984).

Standard Deviation of mean Phi	Classification
<0.35	Very well sorted
0.35 - 0.5	Well sorted
0.5 - 0.71	Moderately well sorted
0.71 - 1	Moderately sorted
1 - 2	Poorly sorted
2 - 4	Very poorly sorted
>4	Extremely poorly sorted

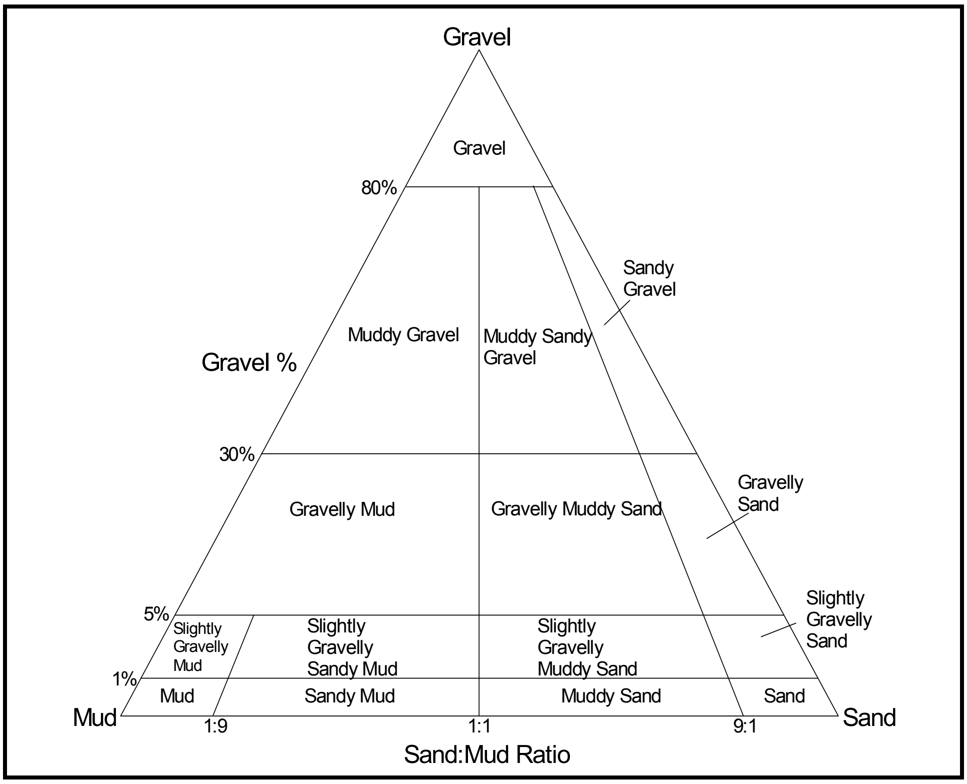

Figure 5. Sediment classification after Folk (1954) as also used by the BGS. "Gravel" is greater than 2mm and "mud" is less than 63µm.

2.2.2 Total organic content

Total organic content of the sediments was determined through loss on ignition (LOI). Dried and pre-weighed sub-samples were placed in a muffle furnace using combustion at 480˚C for 4 hours. Analysis was carried out on the fraction of sediment less than 1 mm to avoid undue influence from large stones.

2.2.3 Sediment contaminants analysis

Analysis for metal contaminants within sediments was performed by RPS Laboratories (Manchester), a UKAS accredited laboratory also participating within the QUASIMEME Proficiency Testing Scheme. All analysis was carried out on the <2mm diameter fraction of the sediment.

The trace and heavy metals requested for detection analysis were tested using inductively coupled plasma mass spectrometry (ICP-MS) analysis following microwave assisted digestion in hydrofluoric acid of the dried (<30°C) and ground sediment. Limits of detection were set at the minimum levels given in Table 4.

Table 4. Trace and heavy metals to be tested and their limits of detection

Metal	Symbol	Detection limits
Aluminium	Al	10 µg.g-1
Arsenic	As	3 µg.g-1
Barium	Ba	1 µg.g-1
Cadmium	Cd	1 µg.g-1
Copper	Cu	1 µg.g-1
Vanadium	V	1 µg.g-1
Chromium	Cr	2 µg.g-1
Nickel	Ni	2 µg.g-1
Zinc	Zn	2 µg.g-1
Lead	Pb	5 ng.g-1
Tin	Sn	5 ng.g-1
Mercury	Hg	0.01 ng.g-1

The hydrocarbon analysis of the sediment samples was also completed by RPS Laboratories (Manchester).

Total hydrocarbon concentration (THC), unresolved complex mixture (UCM) concentration and individual and total n-alkane concentrations were completed using gas chromatography with flame ionisation detection (GC-FID) analysis following extraction of the wet sediment with dichloromethane:methanol by ultrasonic extraction and subsequent partitioning with water (extract cleaned-up with silica and activated copper).

2.2.4 Faunal analysis

Macrofaunal analysis of the benthic grab samples was completed at the CMACS Isle of Man laboratory, which participates in the NMBAQC scheme.

All samples were carefully washed in fresh water over a 1mm mesh until all formalin was removed. The samples were then carefully sorted with the aid of low power microscopes where necessary, and all fauna removed into pots containing the major groups (e.g. Mollusca, Annelida, Crustacea, Echinodermata and “others”) in 70% alcohol. Quality control procedures included the preparation of a reference collection of all taxa and re-sorting of a random selection of the samples (typically 10%) by an experienced taxonomist on the understanding that if specimens equating to more than 5% of the total specimens found (or more than 10% of any one group), then the relevant batch of samples would all be re-sorted.

All the sorted organisms were identified to species level where possible, or the lowest practical taxonomic level, and enumerated (partial specimens were only included in counts if the head of the organism was still present). Juveniles were recorded separately since they may introduce a seasonal bias in the results, which should be accounted for in later data interpretation. Colonial organisms (e.g. bryozoans) were recorded as present and for the purposes of abundance counts, were allocated a numerical value of one. Specimen coding was in accordance with Picton and Howson (2000). Any encrusting organisms or epifauna within the samples were identified and presence/absence noted.

Faunal data was used in conjunction with sediment analysis and image data from the camera survey to classify the seabed into biotopes following Connor *et al.* (2004).

2.3 Statistical analysis

2.3.1 Sediments

Raw sieve and laser size data were combined into Wentworth categories prior to statistical analysis to allow the number of variables to be kept to a meaningful number.

Sediment data was then subject to Principal Components Analysis (PCA) carried out in the Primer 6.0 multivariate analysis package. The sediment data was input as percentages and therefore did not require any pre-treatment as it was already standardised. Analysing data with a small number of variables using PCA has the advantage over Multidimensional Scaling (MDS) of being able to include eigenvectors to indicate which variables are determining the position of samples on the plot.

2.3.2 Fauna

Prior to multivariate analysis (using Primer 6.0), data was square-root transformed to reduce the influence of highly abundant taxa. The transformed data was then used to create a similarity matrix with the Bray-Curtis process, which was in turn used to generate a dendrogram (with SIMPROF test for groups that were not significantly different from one another) and MDS plots.

The SIMPROF test was used to assign sample stations into groups with faunal communities that were not significantly different from one another and then these groupings analysed with a SIMPER routine to examine what the differences in groups were. To keep the number of groups to a minimum and to prevent there being any groups with just single sample stations, any isolated sample stations were included in the next most similar group.

Diversity indices were derived from the untransformed data, which included Margalef's, Shannon-Wiener, Simpson's, Pielou's evenness index and rarefaction.

2.3.3 Camera stills analysis

All images were thoroughly reviewed by an experienced marine biologist, with quality checks performed on at least 10% by an equally or more experienced colleague. Image analysis was performed to describe the seabed habitat, estimate the abundance of fauna and flora, which in turn informed an assessment of the presence of Annex I habitat. Organisms such as anemones, decapods and gastropods were enumerated in each image whereas the abundance of organisms such as hydroids and sponges was estimated by percentage cover.

It should be noted that determination of sand size fractions (fine, medium, coarse sand etc.) is not often possible from video or stills images and, moreover, the visible sediment surface does not always accurately reflect what is immediately below the surface; for example, there is sometimes a very thin layer of fine shell, sand or silt overlying rather different sediments. For these reasons, more reliance should be placed on the results of PSA from grab samples when considering sedimentary areas; the main objective of the camera survey was to investigate areas of likely hard substratum which cannot be readily sampled using other survey techniques and to investigate potential areas of Annex I habitat.

The quality of any biogenic reef (as defined by its 'reefiness') was assessed using the criteria of Gubbay (2007) and that of stony reef using the criteria of Irving (2009) but reference was also made to Limpenny *et al*. (2010) when assessing both types of reef habitat.

Habitat and visible fauna were used to classify biotopes (in conjunction with the infaunal grab data) according to Connor *et al*. (2004); the side scan mosaic was then used to extrapolate the boundaries of each biotope within the PDA and CRC.

3. RESULTS

3.1 Sediments

3.1.1 Particle size analysis

Raw data is provided in Appendix 5 with a summary of the results provided in Table 5 below. The majority of sediment samples contained a wide range of sediment particles from cobble to clay.

- ***Sediment Type***

Five sediment types (according to BGS classification) were described across the survey area. These were sandy gravel, muddy sandy gravel, gravel, gravelly sand and muddy sand (see Table 5 and Figure 7). Two stations were characterised by cobble, whereas most other stations had similar sediments to one another with pebble characterising the samples (see Figure 6) and this majority of samples were classified as muddy sandy gravel or sandy gravel. The remaining stations were classified as follows: Station 27 (central CRC) with a low percentage of sand and little mud, which was classified as gravel; Stations 33 and 34 (also within the CRC) which were classified as gravelly sand; and at Station 42 (the closest inshore on the CRC), the sediment was mainly fine sand and mud and therefore was classified as muddy sand (see Figure 7 for classifications and Figure 8 for percentage composition).

- ***Sediment Grain Size***

Sediment particle size data are summarised in Table 5.

Mean particle size was greatest at stations within the PDA which exhibited higher proportions of gravel particles. Smaller grain sizes were recorded from the stations within the CRC and closest inshore and were associated with increased sand composition. Mean phi results reflect these trends and are presented in Figure 9.

The distribution of samples on the PCA plot was mostly driven by the percentage of pebble in the sample with increasing proportion of this grain size towards the right of the plot. Sediments at two stations (4 and 8) were much coarser than those at all other stations and characterised by their cobble content. Stations 33 and 34 were characterised by medium and coarse sands while Station 42 was characterised by very fine sediments.

3.1.2 Total organic matter

Results of LOI analysis are provided in Table 5 with full results provided in Appendix 6.

TOM was found to be below 3% across the survey area (see Figure 10) with relatively higher levels recorded from stations where muddy sands were present and stations which had a greater percentage of mud. This relationship is unsurprising since organic matter is associated with silty and muddy sediments rather than more mobile sediments such as coarse sand.

The mean TOM level was 1.79 ± 0.48% with a maximum of 2.82% at DG12 in the north west of the PDA. Lower TOM levels were recorded from the CRC at stations with coarser sediments and higher proportions of sand.

Table 5.Sediment analysis according to station

Station	Depth (m)	Mean mm	Mean Phi	%LOI	Gravel (%)	Sand (%)	Mud (%)	Sediment type
DG2	88.3	3.48	-1.798	1.261	48.7	48.9	2.4	Sandy Gravel
DG4	81.6	15.13	-3.919	1.737	76.5	20.6	2.9	Muddy Sandy Gravel
DG7	86.3	10.77	-3.429	1.469	71.1	26.5	2.4	Sandy Gravel
DG8	81.3	11.61	-3.537	1.720	77.6	20.0	2.4	Muddy Sandy Gravel
DG9	88.4	9.72	-3.281	2.213	70.7	24.4	4.9	Muddy Sandy Gravel
DG10	86.3	9.55	-3.255	2.275	69.2	25.3	5.5	Muddy Sandy Gravel
DG11	80.9	12.13	-3.600	2.066	76.5	21.1	2.4	Muddy Sandy Gravel
DG12	77.8	12.67	-3.664	2.821	78.7	17.6	3.7	Muddy Sandy Gravel
DG13	87.4	9.18	-3.198	1.694	63.0	33.9	3.2	Sandy Gravel
DG15	60.2	5.38	-2.429	1.902	59.5	34.5	5.9	Muddy Sandy Gravel
DG16	66.8	8.12	-3.021	1.827	61.3	34.6	4.1	Muddy Sandy Gravel
DG19	68.6	11.41	-3.512	2.474	75.9	19.5	4.6	Muddy Sandy Gravel
DG22	52.2	5.23	-2.388	1.524	58.1	39.8	2.2	Sandy Gravel
DG27	44.9	13.01	-3.702	1.382	81.8	17.8	0.4	Gravel
DG31	30.6	5.49	-2.458	1.218	69.9	29.1	1.0	Sandy Gravel
DG33	24.2	1.07	-0.096	1.271	23.2	75.1	1.6	Gravelly Sand
DG34	22.6	0.98	0.035	1.027	27.6	70.3	2.1	Gravelly Sand
DG35	19.7	4.38	-2.130	1.448	60.5	37.0	2.6	Sandy Gravel
DG38	80.9	7.45	-2.896	2.295	64.6	31.0	4.4	Muddy Sandy Gravel
DG42	10.0	0.06	4.105	2.260	0.0	67.4	32.3	Muddy Sand

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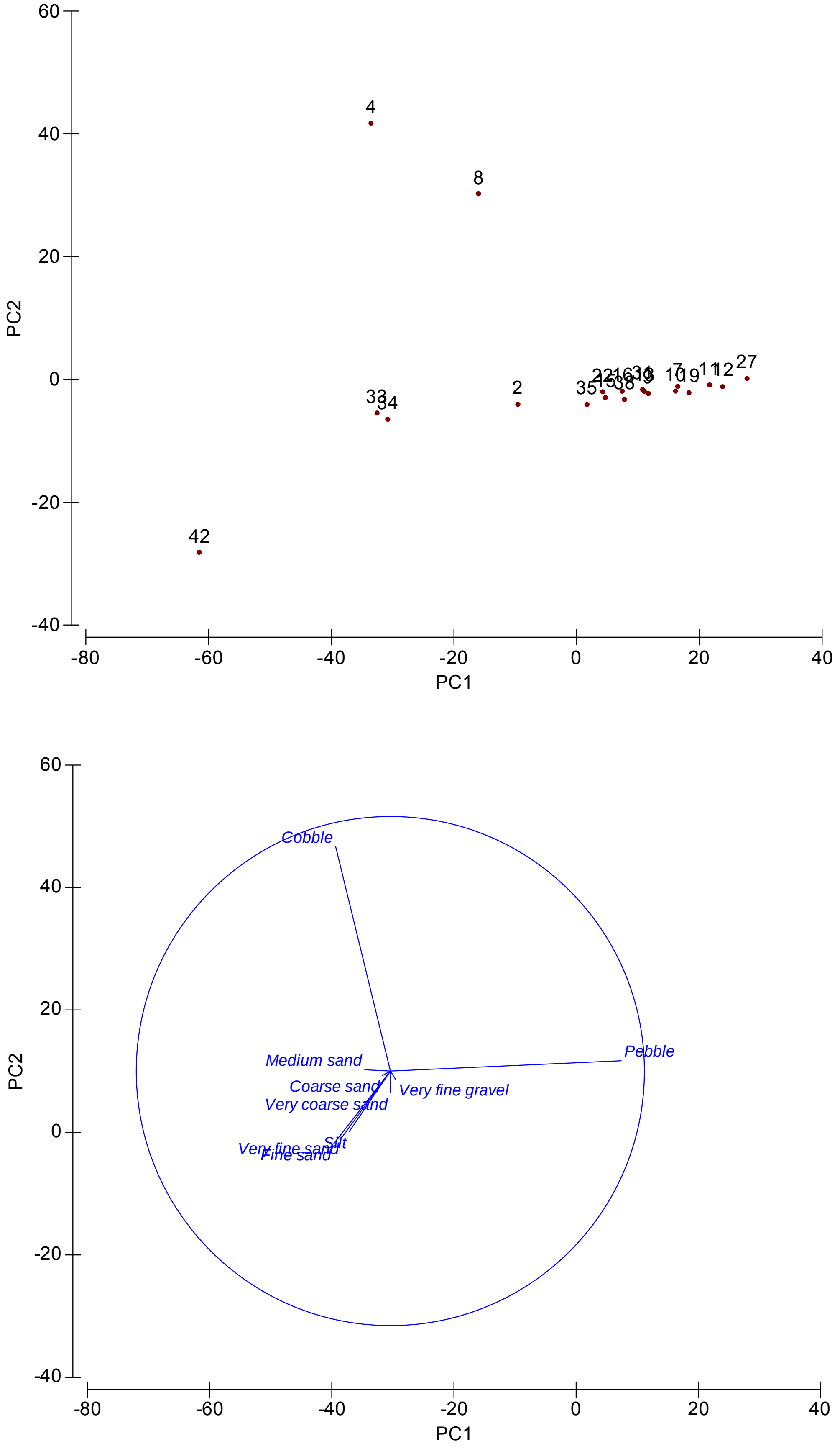


Figure 6. Principal components analysis and associated eigenvector plot of sediments.

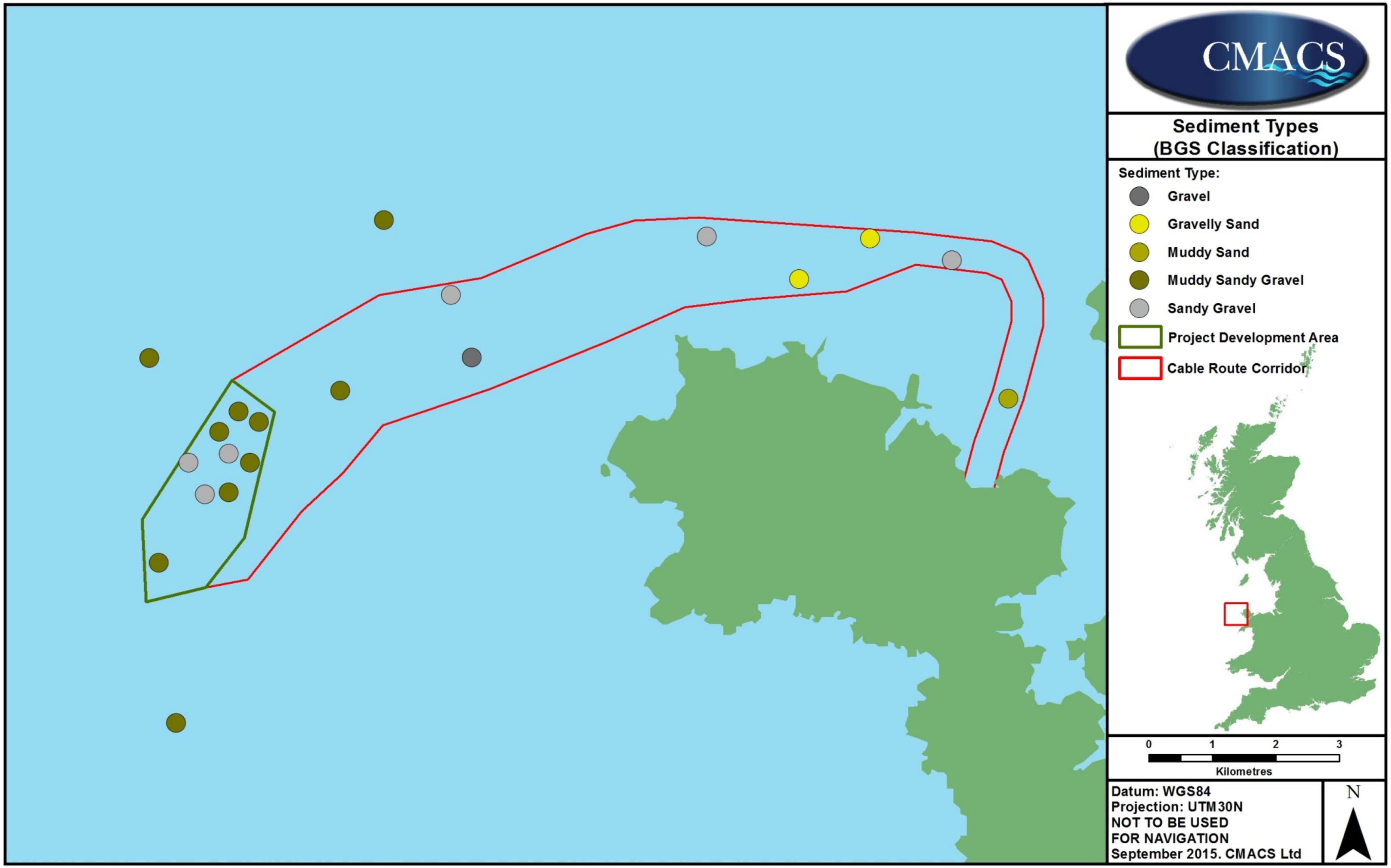


Figure 7. Sediment types according to BGS classifications

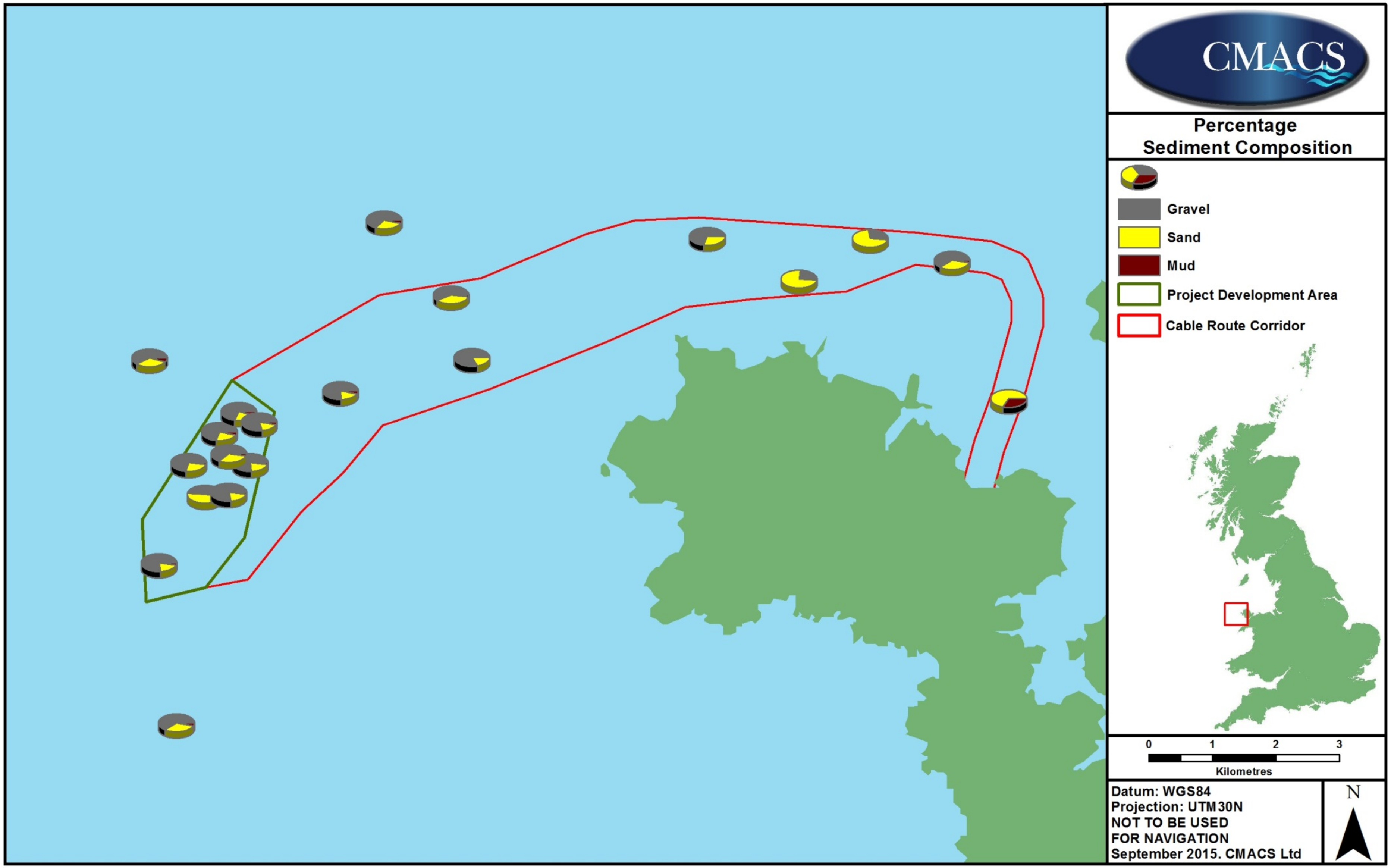


Figure 8. Percentage sediment composition of sand, gravel and mud at each station.

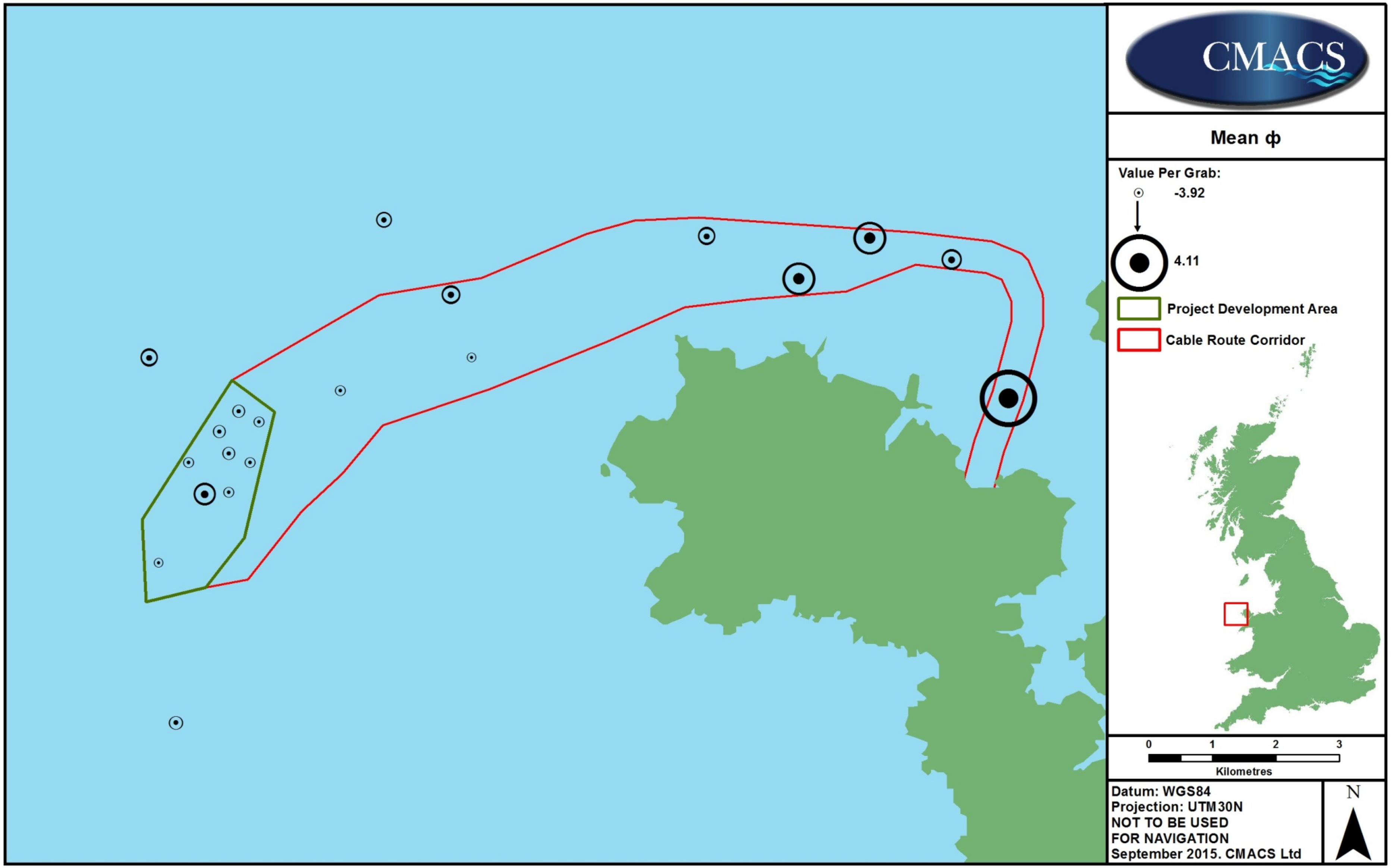


Figure 9. Mean phi of sediments at each station

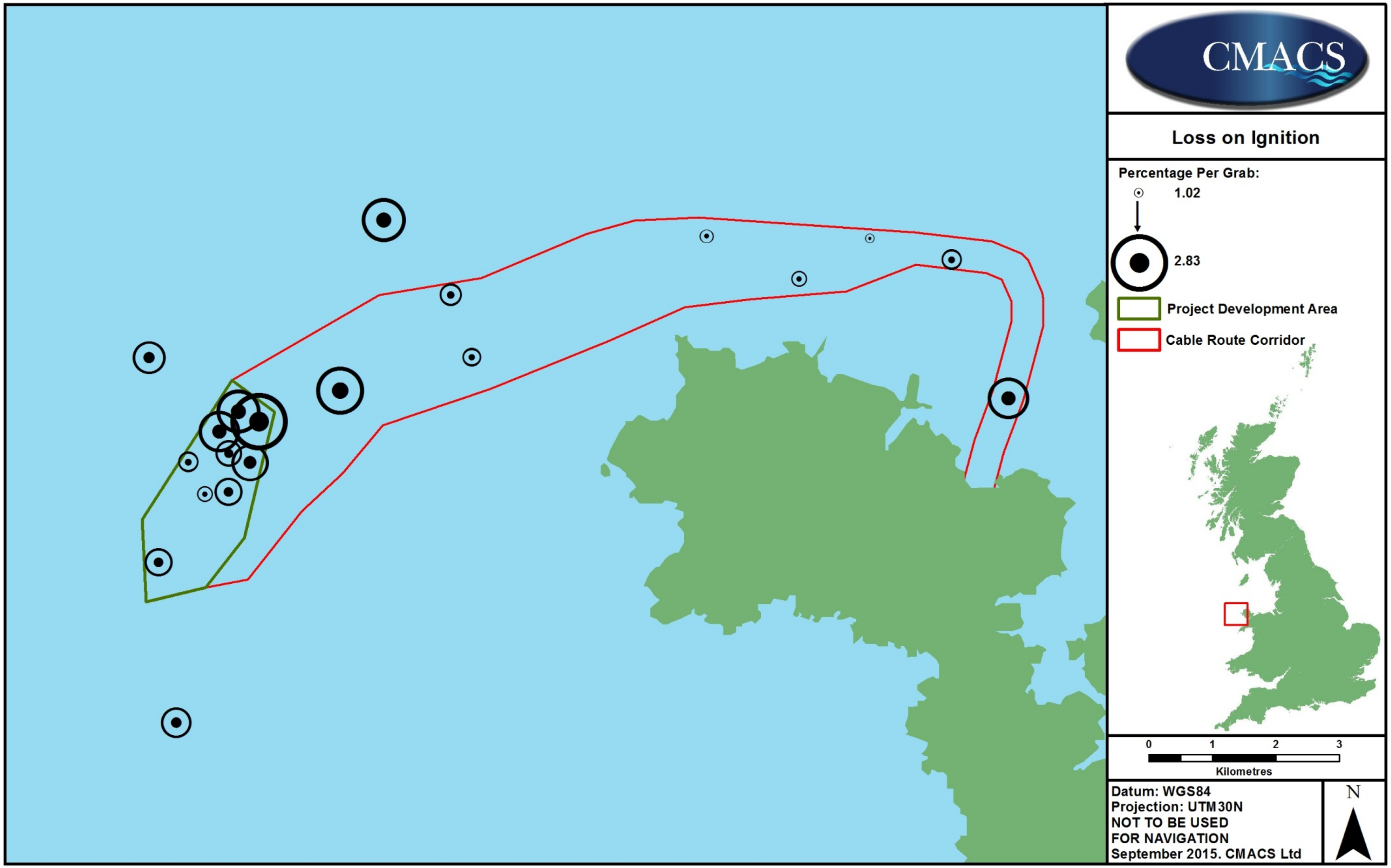


Figure 10. TOM of sediments at each station (analysed using LOI).

3.1.3 Contaminant analysis

The results of the contaminants testing for heavy and trace metals are presented in Table 7. Interim Sediment Quality Guidelines (ISQG[1]), Probable Effect Levels (PEL) and Cefas Guideline Action Levels for the Disposal of Dredged Material (AL)[2] are also provided within Table 7 to enable the results to be reviewed within the context of marine contamination thresholds.

High concentrations of aluminium were recorded from the sediments at all stations. There are no ISQG or PEL values set for this metal.

The level of arsenic recorded was above the ISGQ levels at all but two of the thirteen stations tested with the highest concentration of 9.98 mg/kg recorded from Station 9 within the PDA (see Table 7). However, the results from all of the stations were well below the Probable Effects Level (PEL) of 41.6 mg/kg.

Chromium was elevated slightly above Cefas Action Level 1 (AL1) at five stations (only one of which (Station 13) was within the PDA) but only above the ISQG level at one station (31- located within the CRC off the north coast of Holy Island, Anglesey). Levels of nickel were also recorded slightly above the AL1 at stations 19 and 35 but were well below Action Level 2 (AL2). There are no probable effect levels available for this metal.

Lead was found to be elevated slightly above ISQG at three stations (33, 35 and 19- all from within the CRC) but well below the action levels and PEL.

Mercury was recorded in low concentrations across the area and at station 7 (within the PDA) was recorded above the ISQG and slightly over the AL1 (0.31 compared to the AL1 of 0.30). This level was below the PEL of 0.7 mg/kg.

Cadmium, copper, tin, vanadium, barium and zinc were detected in samples from all stations but all were present at low levels (below quoted ISQG levels or Cefas action levels).

Metal levels in the current survey are compared with those from a survey (Seastar Surveys, 2013) at the Rhiannon wind farm development area (Table 6), which was also off the north coast of Anglesey (though predominantly much further offshore than the Deep Green area). It can be seen that levels of some metals were much higher in the Deep Green area than in the Rhiannon area.

[1] ISGQ (Interim Sediment Quality Guidelines) levels are a national standard to which contaminant levels are compared. Levels of contamination below ISGQ level are expected to have no effect on marine ecosystems, levels above the PEL (probable effect level) are likely to have an effect on the marine ecosystem and contamination levels between the two tiers may need further research to determine any likely effects.

[2] Cefas Guideline Action Levels for the disposal of dredged material are not statutory contaminant concentrations for dredged material but are used as part of a weight of evidence approach to decision-making on the disposal of dredged material to sea. The action levels are therefore not 'pass/fail' criteria but triggers for further assessment. In general, contaminant levels in dredged material below action level 1 are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above action level 2 is generally considered unsuitable for sea disposal. Dredged material with contaminant levels between action levels 1 and 2 requires further consideration and testing before a decision can be made.

Table 6. Comparison of metal levels in sediments in the Deep Green PDA and CRC with those for the Rhiannon Round 3 wind farm development area.

Parameter	Deep Green	Rhiannon OWF
Aluminium	11,300-25,200 mg/kg	1,600-7,100 mg/kg
Arsenic	7.19-10.20 mg/kg	5.3-22.0 mg/kg
Cadmium	<0.10 mg/kg	0.2-0.3 mg/kg
Chromium	22.9-69.1 mg/kg	4.9-12.0 mg/kg
Copper	5.21-11.80 mg/kg	2.4-8.8 mg/kg
Lead	10.2-41.2 mg/kg	5.9-12.0 mg/kg
Mercury	0.02-0.31 mg/kg	<0.05 mg/kg
Nickel	11.9-22.0 mg/kg	4.2-13.0 mg/kg
Vanadium	32.3-55.9 mg/kg	14-31 mg/kg
Tin	0.74-4.46 mg/kg	n/a
Barium	87.4-219.6 mg/kg	13-37 mg/kg
Zinc	28.4-72.7 mg/kg	17-40 mg/kg

Table 7. Heavy and Trace Metal Contaminant Analysis Results (results all expressed as mg/kg)

Metal	LOD	7	8	9	10	11	13	15	16	19	ISQG	PEL	AL 1	AL 2
Aluminium	10 µg.g-1	16500	18900	22500	19400	19700	22300	20800	12400	25200	n/a*	n/a	n/a	n/a
Arsenic	3 µg.g-1	9.52	7.19	9.98	7.38	7.22	7.70	8.22	8.46	8.14	7.24	41.6	20	100
Cadmium	1 µg.g-1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.7	4.2	0.4	5
Chromium	2 µg.g-1	29.8	26.6	39.3	32.5	30.1	47.4	50.4	22.9	44.1	52.3	160	40	400
Copper	1 µg.g-1	6.90	7.17	8.75	8.22	7.66	7.20	6.67	5.45	11.7	18.7	108	40	400
Lead	5 ng.g-1	16.8	17.4	21.3	19.9	19.3	17.8	16.1	13.9	41.2	30.2	112	50	500
Mercury	0.01 ng.g-1	0.31	0.04	0.05	0.04	0.05	0.04	0.03	0.03	0.06	0.13	0.7	0.3	3
Nickel	2 µg.g-1	13.1	11.9	17.1	14.0	13.9	13.3	16.8	10.5	22.0	n/a	n/a	20	200
Vanadium	1 µg.g-1	40.50	37.30	52.00	42.60	41.20	40.40	48.50	32.30	55.90	124	271	130	800
Tin	5 ng.g-1	1.56	1.49	1.98	2.07	1.70	1.50	1.92	1.16	2.43	n/a	n/a	n/a	n/a
Barium	1 µg.g-1	126.60	124.70	160.40	152.50	141.20	130.70	155.50	127.40	219.60	n/a	n/a	n/a	n/a
Zinc	2 µg.g-1	44.5	44.2	57.3	47.8	48.0	48.4	42.6	32.6	72.7	n/a	n/a	n/a	n/a

N.B. Concentrations that were recorded above ISQG or PEL are highlighted with the appropriate colour.

*n/a = no value

Table 7 continued. Heavy and Trace Metal Contaminant Analysis Results (results all expressed as mg/kg)

Metal	LOD	31	33	35	38	ISQG	PEL	AL 1	AL 2
Aluminium	10 µg.g-1	11300	10900	16100	20400	n/a*	n/a	n/a	n/a
Arsenic	3 µg.g-1	8.69	9.62	10.2	8.33	7.24	41.6	20	100
Cadmium	1 µg.g-1	< 0.10	< 0.10	< 0.10	< 0.10	0.7	4.2	0.4	5
Chromium	2 µg.g-1	69.1	25.2	49.2	38.6	52.3	160	40	400
Copper	1 µg.g-1	5.21	11.8	11.0	9.42	18.7	108	40	400
Lead	5 ng.g-1	10.2	37.9	33.3	21.8	30.2	112	50	500
Mercury	0.01 ng.g-1	0.02	0.03	0.04	0.04	0.13	0.7	0.3	3
Nickel	2 µg.g-1	15.9	16.4	20.7	17.6	n/a	n/a	20	200
Vanadium	1 µg.g-1	34.40	37.30	48.40	49.50	124	271	130	800
Tin	5 ng.g-1	0.74	0.94	4.46	1.82	n/a	n/a	n/a	n/a
Barium	1 µg.g-1	87.40	122.60	191.30	161.50	n/a	n/a	n/a	n/a
Zinc	2 µg.g-1	28.4	56.3	56.1	58.2	n/a	n/a	n/a	n/a

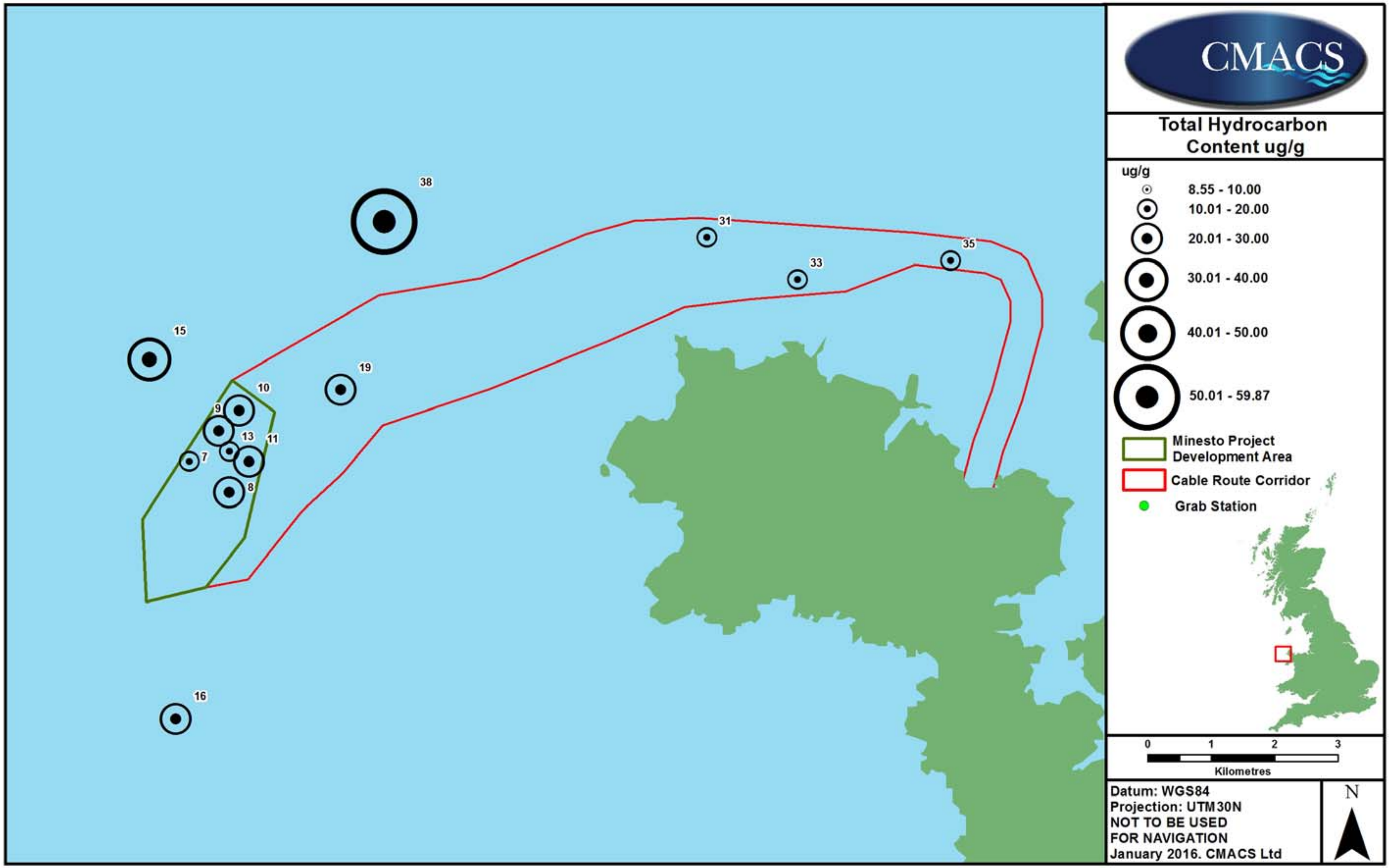


Figure 11. Estimated levels of hydrocarbon at each sample station (where a sample was successfully obtained).

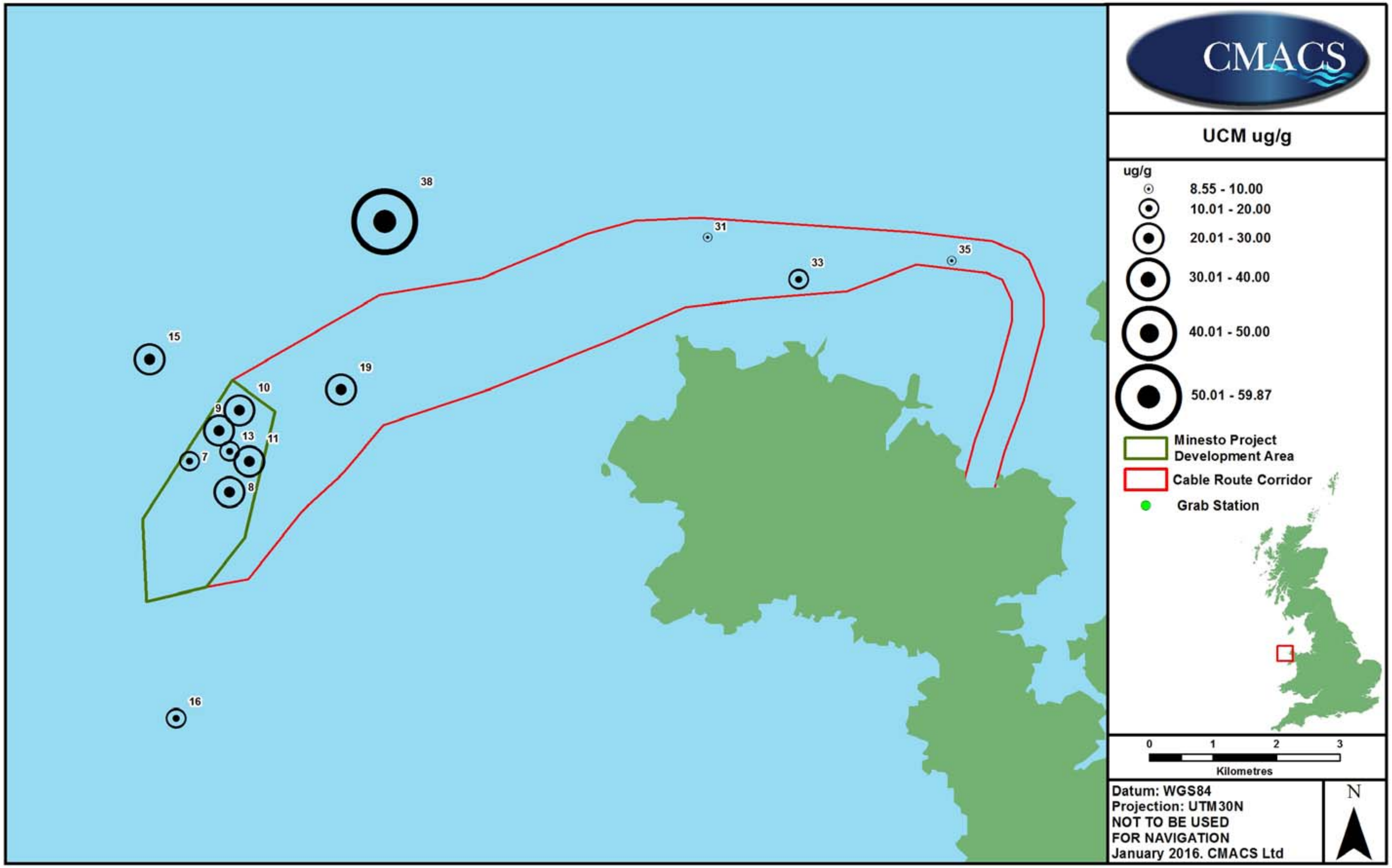


Figure 12. Estimated levels of unresolved complex mixture (UCM) at each of the sample stations

The results of the hydrocarbon analysis are presented in Table 8 with full results displayed in Appendix 7. Results from all stations were between 10.79 and 59.87 µg/g with the highest value being recorded from Station 38 (north (offshore) of the CRC). At this station, the sediment was a muddy sandy gravel similar to that at many of the other stations. In all cases, unresolved complex mixtures comprised the majority of the samples (Table 8; Figure 11 & Figure 12) whilst N9-N40 alkanes comprised a small proportion (Appendix 7). For both total hydrocarbons and UCM, the values were lower along the inner section of the CRC (Stations 31, 33 and 35) than further offshore. These stations had lower mud contents than the other contaminant sampling stations, and overall there seems to be a link with mud content, with the less muddy stations within the PDA also having lower hydrocarbon content.

Table 8. Results from Hydrocarbon analysis of sediments

Station	Total Hydrocarbon Content*	Pristane	Phytane	Ratio (Pris:Phyt)	Carbon preference index	UCM
	µg/g	µg/g	µg/g			µg/g
DG7	13.415	0.013	0.010	1.29	2.459	11.987
DG8	24.299	0.020	0.016	1.27	1.683	22.415
DG9	26.147	0.023	0.014	1.66	1.703	24.063
DG10	29.107	0.024	0.020	1.18	2.400	26.605
DG11	28.924	0.029	0.011	2.63	2.225	26.519
DG13	16.968	0.017	0.009	1.85	2.093	15.194
DG15	34.407	0.065	0.012	5.27	1.852	29.910
DG16	20.246	0.020	0.016	1.30	1.519	18.300
DG19	26.725	0.022	0.014	1.56	1.919	24.554
DG31	12.482	0.004	0.010	0.41	1.053	8.555
DG33	16.176	0.027	0.013	2.02	1.801	14.185
DG35	10.786	0.019	0.011	1.67	1.813	9.399
DG38	59.869	0.035	0.005	6.70	3.159	53.540

Surveys in support of the proposed Rhiannon Offshore Windfarm cable corridor in 2012 (Seastar surveys, 2013) found total petroleum hydrocarbon levels of between 0.2 and 22.6 µg/g in sediments within circa 1-2 km off the northeast of Anglesey. Further offshore in the proposed cable corridor out to around 20 km, values were between 0.2 and 8.8 µg/g. Further offshore for the same project (roughly midway between Anglesey and the Isle of Man), values of <10 µg/g were found in 2012 at four stations, with a further eight stations showing values of 40-510 (average c. 130) µg/g (CMACS, 2013). Thus the values found in the present project are broadly within the large range of values found recently in nearby areas off Anglesey.

There are no guidelines of mandatory levels with which total hydrocarbons can be compared. However, Battelle (2007) provides suggested benchmark levels for aliphatic fractions as shown in Table 9. These levels were considered very stringent and applicable to all aquatic sediments including with very low organic content

(0.1%); suggested benchmark levels for sediments with higher levels of organic content could potentially be much higher.

Table 9. Comparison of values for aliphatic fractions in sediments from grab sample stations with suggested benchmark values (Battelle 2007).

Aliphatic hydrocarbon fraction	Stringent Benchmark level (Battelle 2007) µg/g	Values in Deep green sediments µg/g
$C_9 – C_{12}$	2.72	0.43 - 0.92
$C_{13} – C_{18}$	5.54	0.05 – 0.36
$C_{19} – C_{36}$	9.88	0.55 – 4.25 *

* maximum of 4.25 at station 38 outside of proposed development/cable corridor; all other values less than 2.9

Pristane/phytane ratios can be used as an indication of sources of hydrocarbons, although there are many confounding factors and this needs to be interpreted with caution. According to Moustafa and Morsi (2012), Pristane/phytane ratios substantially below one could be taken as an indicator of petroleum origin and/or highly reducing depositional environments; very high Pr/Ph ratios (more than 3) are associated with terrestrial sediments; and Pr/Ph ratios ranging between 1 and 3 reflect oxidizing depositional environments. It is interesting that the stations with the highest values for total hydrocarbons (DG15 and DG38) have the highest Pr/Ph ratios of 5.27 and 6.7 respectively, whilst the only station with a ratio lower than one (indicating likely petroleum origin) is station 31, in the central part of the cable route corridor, where the total hydrocarbon content was amongst the lowest at c. 12.5 µg/g (Table 8). Thus there is no evidence from this ratio of significant anthropogenic sources for the hydrocarbon contents.

Carbon preference index (which measures the ration of odd to even numbered alkanes) can also give some indication of the potential source of hydrocarbons, although again this needs to be interpreted with caution. According to Deshpande *et al*. (2001) and references therein, hydrocarbon mixtures originating from terrestrial plant materials show a predominance of odd-numbered carbon chains with CPI values >5-7, whilst a CPI value of 1.0 may indicate a petrogenic or algal origin of the hydrocarbons. The values in Table 8 suggest the possibility of terrestrial plant-derived contributions at some stations, notably at station 38 where the total hydrocarbon content was highest (CPI of 3.159).

3.2 Fauna from grabs

Full data from the faunal analysis are provided in Appendix 8. A total of 13,078 individuals[3] from 318 taxa were recorded from the 23 grabs. The vast majority of individuals were identified to genus or species level, with the exception of some juveniles.

The total number of species and individual organisms at each station has been spatially displayed in Figure 13 and Figure 14. Abundance was highest at Station 38 located to the north of the PDA and CRC with 2140 individuals from 75 taxa (1,726 of the individuals were the barnacle *Balanus crenatus*). Stations within the PDA also had a high abundance (see Figures 13 and 14). The lowest numbers were from stations within the CRC and two of these (19 and 27) were grabs which were below the 5L QC volume (but were analysed to provide some qualitative information[4]). It should be noted that stations 1 and 7 within the PDA were also both below QC standards, however; both of these stations had high numbers of countable taxa and individuals (827 individuals from 77 taxa at Station 1 and 415 individuals from 81 taxa at Station 7).

[3] Colonial species were assigned a value of 1.

[4] Samples below QC levels were analysed for qualitative purposes and were not scaled up to levels above QC standards

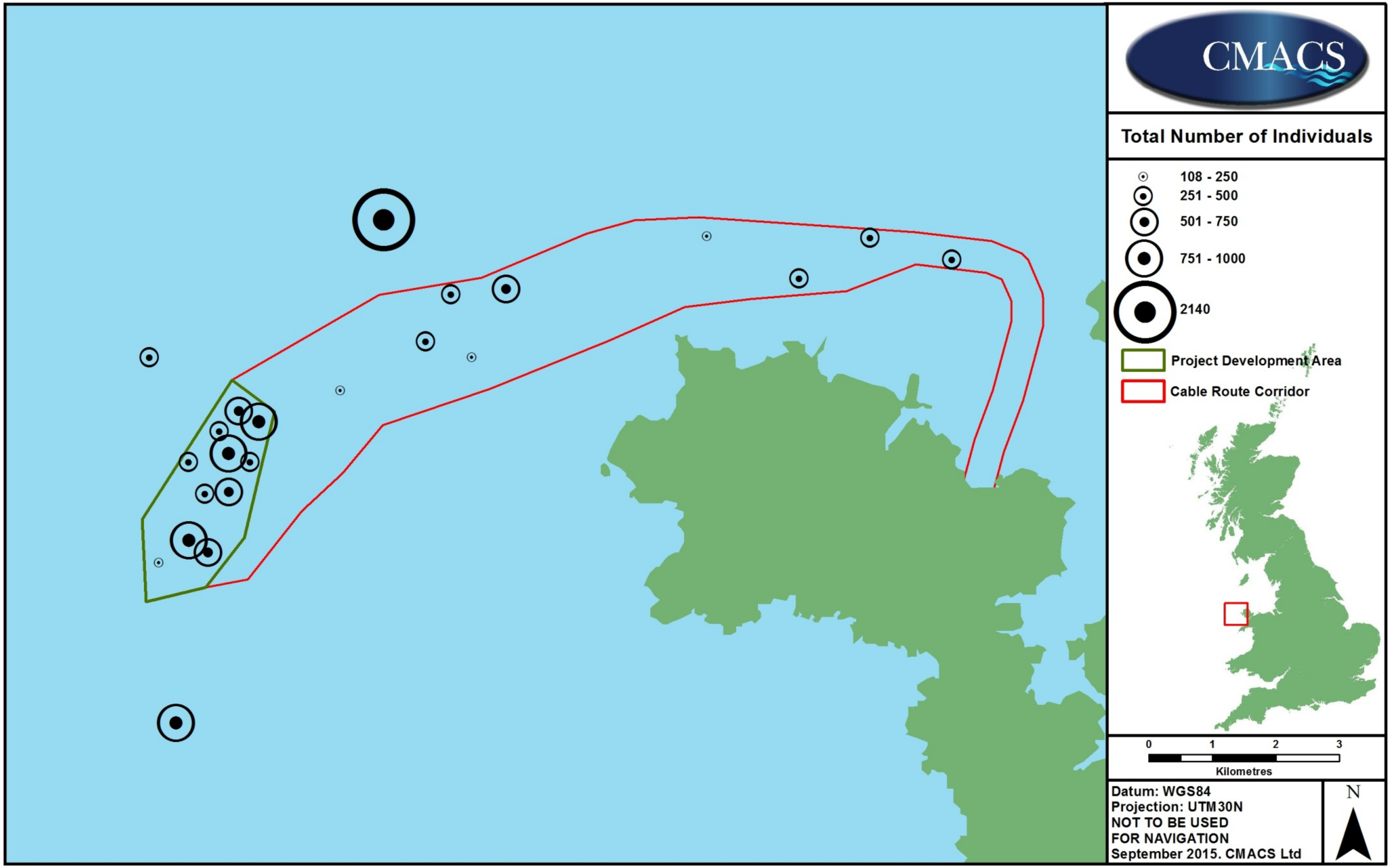


Figure 13. Total number of individuals at each station

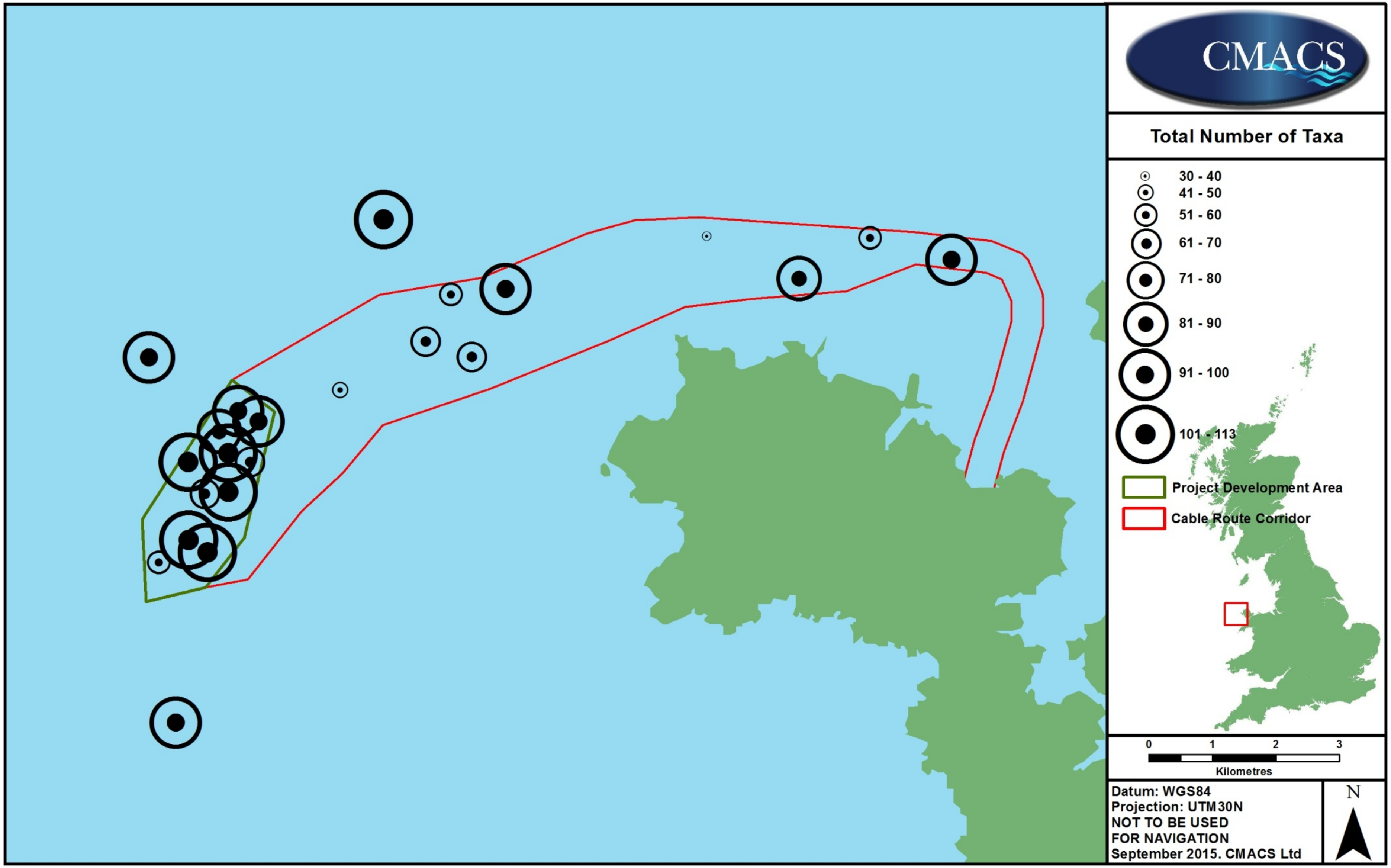


Figure 14. Total number of taxa at each station

3.2.1 Species composition

Faunal communities were generally dominated by annelid worms and molluscs followed by Crustacea (Figure 15). Groups classified into the 'Others' category, e.g. tunicates, were represented by fewer taxa but high numbers of individuals (see Figure 16).

The high abundance of molluscs was attributable to large numbers of two species (*Nucula nitidosa* and *Abra alba*) at two of the stations (32 and 35- both located towards the landfall end of the CRC off the north coast of Anglesey). These two species accounted for approximately 40% of the total individual molluscs.

The high numbers of crustaceans were almost all due to barnacles (total crustaceans with barnacles was 2,997 and without was 292). However, by far the most abundant species recorded during the grab survey were annelid worms. More than 46% of annelids were *Sabellaria* spp. (mostly *S. spinulosa*) but several others were abundant notably *Melinna elisabethae*, *Jasmineira elegans*, *Lumbrineris cf. cingulata*, *Syllis variegata*, *Syllis armillaris*, *Lepidonotus squamatus*. There were 138 annelid taxa altogether, 18 of which contributed over 50 individuals.

High numbers of 'others' were attributable to high numbers of the tunicate *Dendrodoa grossularia* as well as high numbers of nemertea, nematoda, sipunculans, sea spiders especially *Achelia* sp., phoronids, and other tunicate species.

The top fifty taxa recorded (in terms of total number) are presented in Table 10.

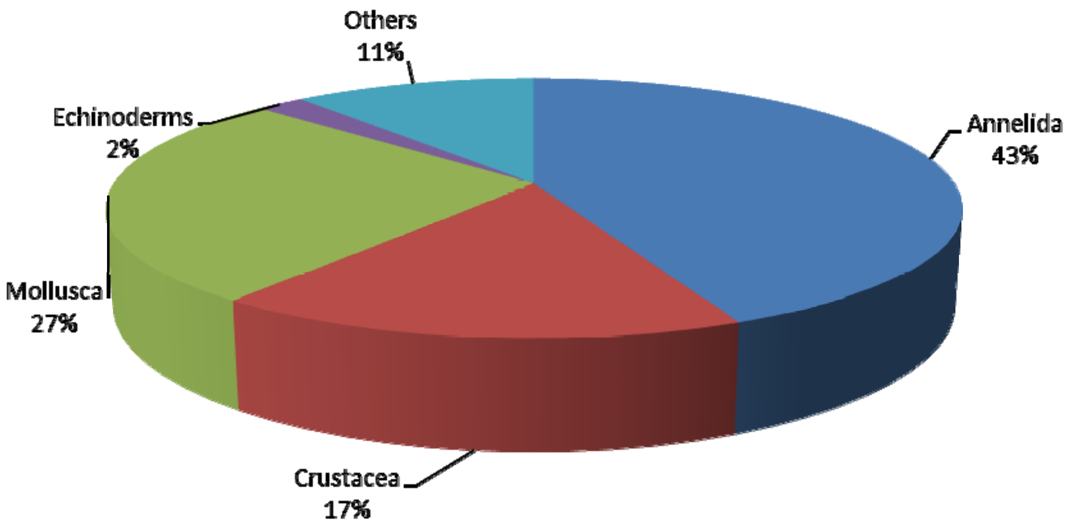


Figure 15. Percentage of taxa by major group (including colonials)

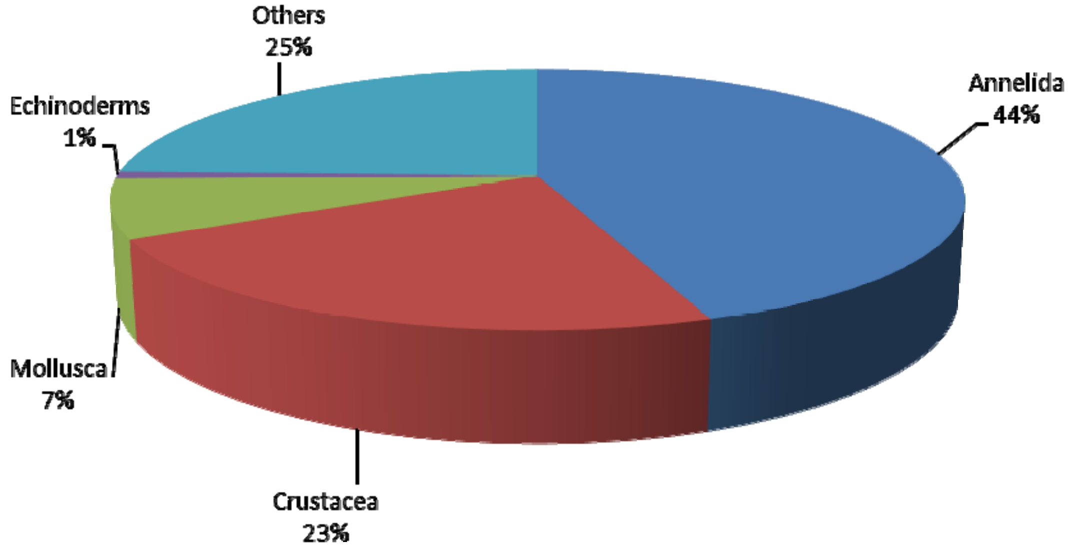


Figure 16. Percentage of individuals by major group (excluding colonials).

The most abundant organisms recorded during the grab survey are all commonly found around British coastlines with similar substrata. The five most abundant species are discussed further below with spatial distribution displayed in Figures 14-18.

Table 10. Top fifty species recorded from all stations

Group	Name	Total
Annelida	*Sabellaria spinulosa*	2,385
Crustacea	*Balanus crenatus*	2,243
Tunicata	*Dendrodoa grossularia*	1,339
Annelida	*Melinna elisabethae*	654
Crustacea	*Verruca stroemia*	374
Nematoda	Nematoda spp.	357
Annelida	*Sabellaria alveolata*	328
Mollusca	*Nucula nucleus*	270
Mollusca	*Sphenia binghami*	259
Annelida	*Jasmineira elegans*	231
Nemertea	Nemertea spp.	208
Annelida	*Lumbrineris* cf. *cingulata*	166
Annelida	*Syllis variegata*	161
Annelida	*Syllis armillaris*	151
Sipuncula	*Nephasoma minutum*	130
Annelida	*Lepidonotus squamatus*	113
Chelicerata	*Achelia echinata*	101

Group	Name	Total
Phoronida	*Phoronis* spp.	95
Annelida	*Dipolydora coeca*	94
Annelida	*Lysidice unicornis*	93
Sipuncula	Sipuncula spp. Juv.	92
Annelida	*Pseudopotamilla reniformis*	89
Echinodermata	*Amphipholis squamata*	89
Tunicata	*Pyura tessellata*	85
Annelida	*Thelepus setosus*	84
Mollusca	*Leptochiton asellus*	81
Annelida	*Sphaerosyllis bulbosa*	74
Mollusca	*Abra alba*	73
Annelida	*Paradoneis lyra*	71
Tunicata	Ascidiacea spp.	61
Crustacea	Balanidae spat	60
Annelida	*Spirobranchus lamarcki*	56
Annelida	*Myrianida* spp.	56
Chelicerata	*Nymphon brevirostre*	56
Annelida	*Pholoe baltica*	53
Annelida	*Mediomastus fragilis*	51
Mollusca	*Heteranomia squamula*	51
Tunicata	*Molgula* spp. Juv.	49
Sipuncula	*Golfingia (Golfingia) elongata*	46
Annelida	*Polycirrus* spp.	45
Mollusca	*Hiatella arctica*	45
Crustacea	*Caprella septentrionalis*	38
Annelida	*Eunereis longissima*	35
Crustacea	*Pisidia longicornis*	34
Crustacea	*Monodaeus couchii*	32
Annelida	*Paraehlersia ferrugina*	31
Annelida	*Syllis garciai*	30
Annelida	*Notoproctus* sp.	30
Cnidaria	Actiniaria spp.	29
Annelida	*Notomastus* spp.	29

Sabellaria spinulosa, also known as the Ross worm, is a polychaete worm that lives in tubes it builds from sand, small gravel and shell fragments. It is found subtidally in exposed areas favouring localities where strong currents or waves churn up sand into the water column and where there are areas of hard substratum so they can become established. Where the worms crowd together the tubes can aggregate to form a pronounced habitat many metres across and up to 60cm high, which then provide a habitat for other marine species such as crustaceans and juvenile fish (Jackson & Hiscock, 2008). These distinct aggregations are termed biogenic reef and are protected Annex I habitat because of the biodiversity they support and their fragility, as they are at risk from human activities such as trawl fishing. *S. spinulosa* worms do not form biogenic reefs over most of their range, being found mostly as individuals or forming thin crusts and/or small aggregations which generally break up in adverse weather storm conditions. This was the most numerous species and was recorded from all grabs. Higher numbers were recorded from the PDA and offshore near-field stations than within the CRC (see Figure 17). Potential Annex I status of this species for the PDA and CRC has been assessed within Section 3.2.6.

Balanus crenatus is primarily a sublittoral species that can sometimes be found under stones or overhangs on the lower shore. *Balanus crenatus* colonizes cobbles, shells, bedrock, molluscs and artificial substrata. *B. crenatus* is one of the most common sublittoral barnacles in Britain. It has six shell plates and grows up to 25 mm in diameter. Figure 18 shows the distribution of this species recorded from the grab survey. The high numbers of this species are mainly attributable to 1,726 individuals being recorded from one station (35 located to the north of the CRC). This species was recorded at lower numbers within the north east of the PDA and along the CRC.

Dendrodoa grossularia, also known as the gooseberry sea squirt, is a reddish-brown sea squirt, up to 2 cm long and 1.5 cm in diameter, occurring either singly or aggregated in dense clusters. It is a widely distributed species being commonly recorded around British and Irish coasts. *D. grossularia* is found on the lower shore and sublittorally to a depth of 600m on a variety of substrata including rock, shell, other ascidians and algae. It is particularly abundant and dominates rocks in two contrasting situations; in surge gullies and caves exposed to severe wave action and in locations entirely sheltered from wave action where tidal streams are moderate to strong (Avant, 2008). *D. grossularia* was recorded in higher numbers in the north of the PDA and in the northern part of the CRC (see Figure 19).

Melinna elisabethae is a polychaete worm recorded from sand or mud from 12m down to 2,900m. A total of 654 individual were recorded from the grab survey with most of these records being from the PDA area (see Figure 20). The highest number at any one station was 173 individuals recorded from the southernmost near-field reference station (16).

Verruca stroemia is a small grey box-like barnacle growing up to 1 cm in diameter and found mainly subtidally between extreme low water and 500 m depth but can also be found on rocky shores attached to the undersides of rocks and in crevices. Figure 21 shows this species to be mainly recorded from the PDA, especially at those stations located on the harder substratum in the east of the PDA. Only small numbers of this species were recorded from the CRC.

The following species of interest were also noted from the grab survey:

Sabellaria alveolata, also known as the honeycomb worm, is an annelid worm which cements coarse sand and/or shell fragments into tubes and can aggregate to form biogenic reefs like *S. spinulosa*. This species was recorded across the survey area (see Figure 22) at low numbers in and around the PDA and along the CRC. At Station 33 on the CRC off the north coast of Holy Island, Anglesey, quite high numbers were present in the grab (154 individuals). Although normally intertidal, this species can occur in shallow subtidal and have regularly been reported from 20m or more off the Irish east coast (e.g. CMACS Ltd. 2006 and Ecoserve 2001).

Modiolus modiolus, the horse mussel, is a large bivalve mollusc which can aggregate to form biogenic reefs (which are designated Annex I habitat and features of UK marine SACs). *M. modiolus* were recorded from four stations. Three of these were located within the CRC: 24 (11 individuals), 33 (7) and 35 (1). The other location with *Modiolus* present was Station 38 to the north of the CRC which yielded one individual. All of the *M. modiolus* recorded from the gab survey were relatively small in size but the density of 11 and 7 individuals recorded per $0.1m^2$ from stations 24 and 33 respectively in the CRC, indicate potential biogenic reef. See Section 3.2.6 for further information.

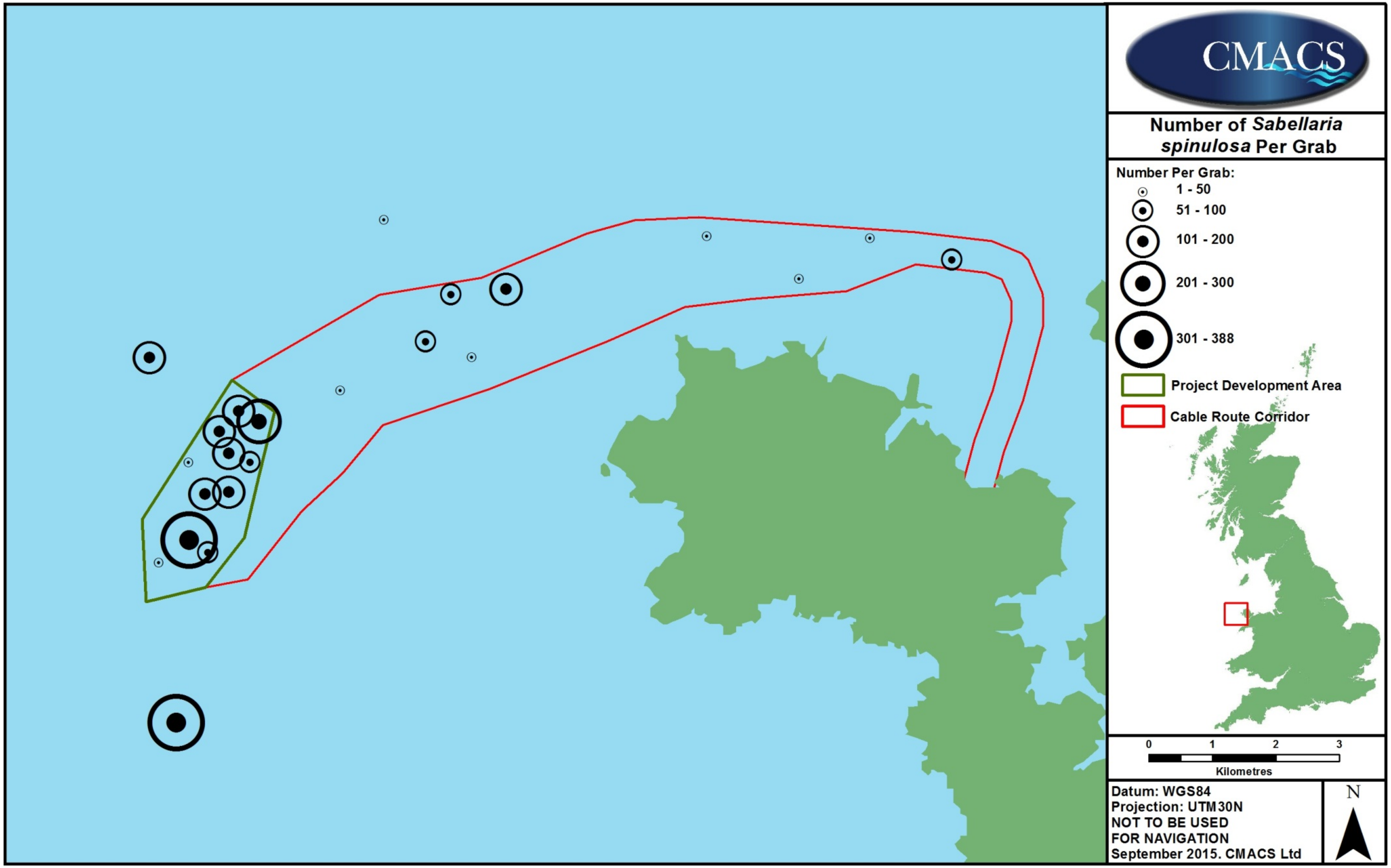


Figure 17. *Sabellaria spinulosa* numbers per grab at each station.

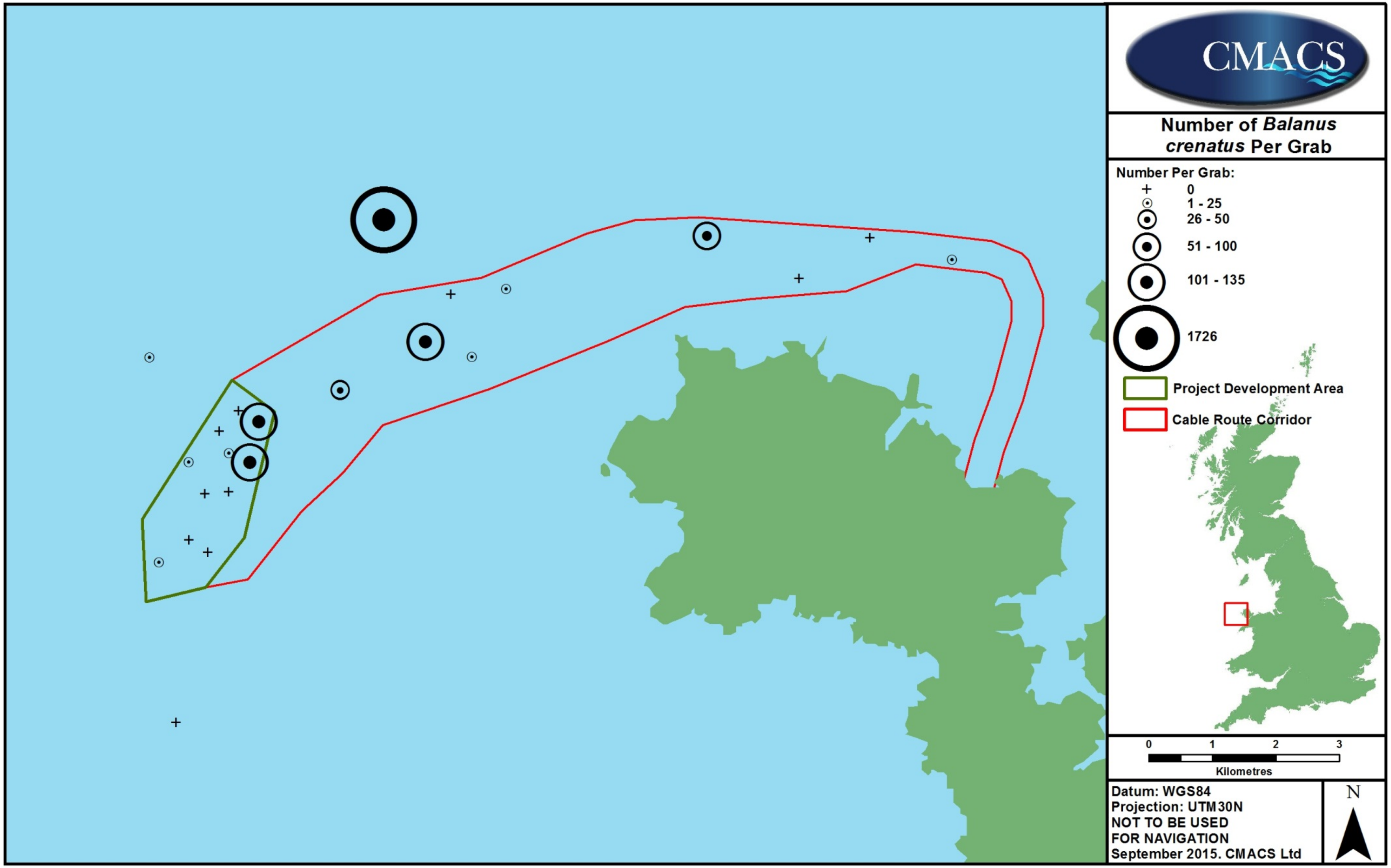


Figure 18. *Balanus crenatus* numbers per grab at each station.

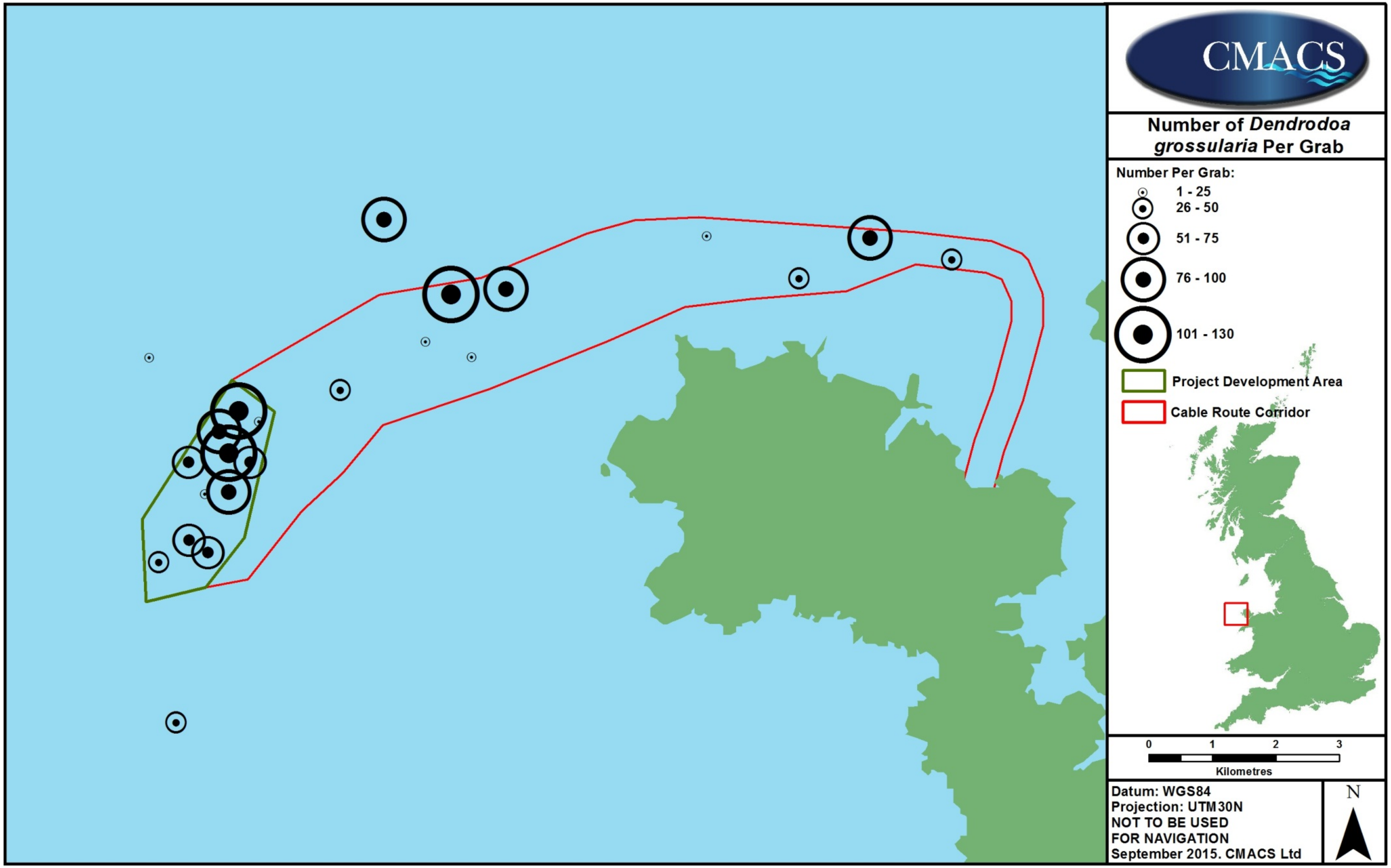


Figure 19. *Dendrodoa grossularia* numbers per grab at each station.

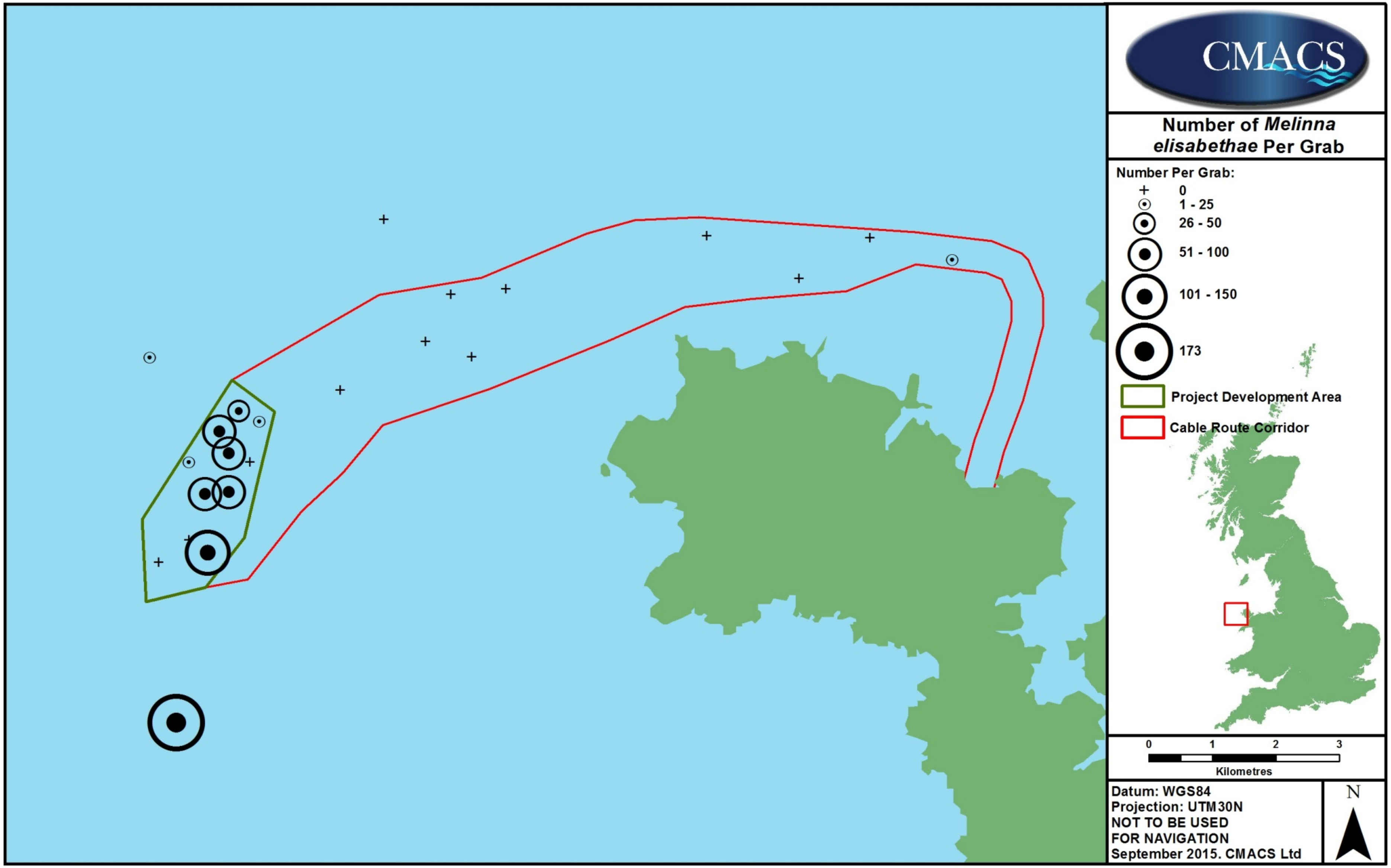


Figure 20. *Melinna elisabethae* numbers per grab at each station.

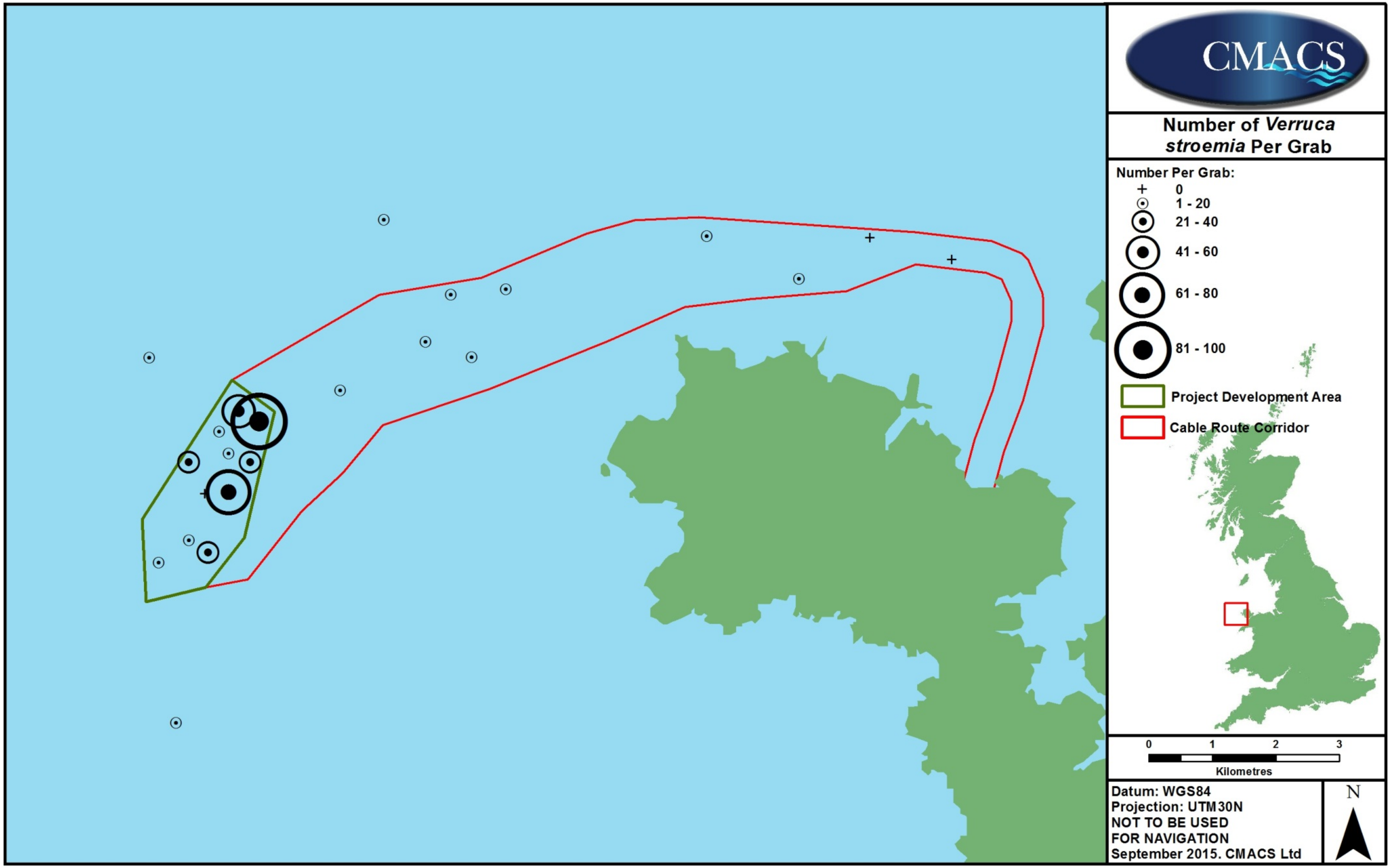


Figure 21. *Verruca stroemia* numbers per grab at each station.

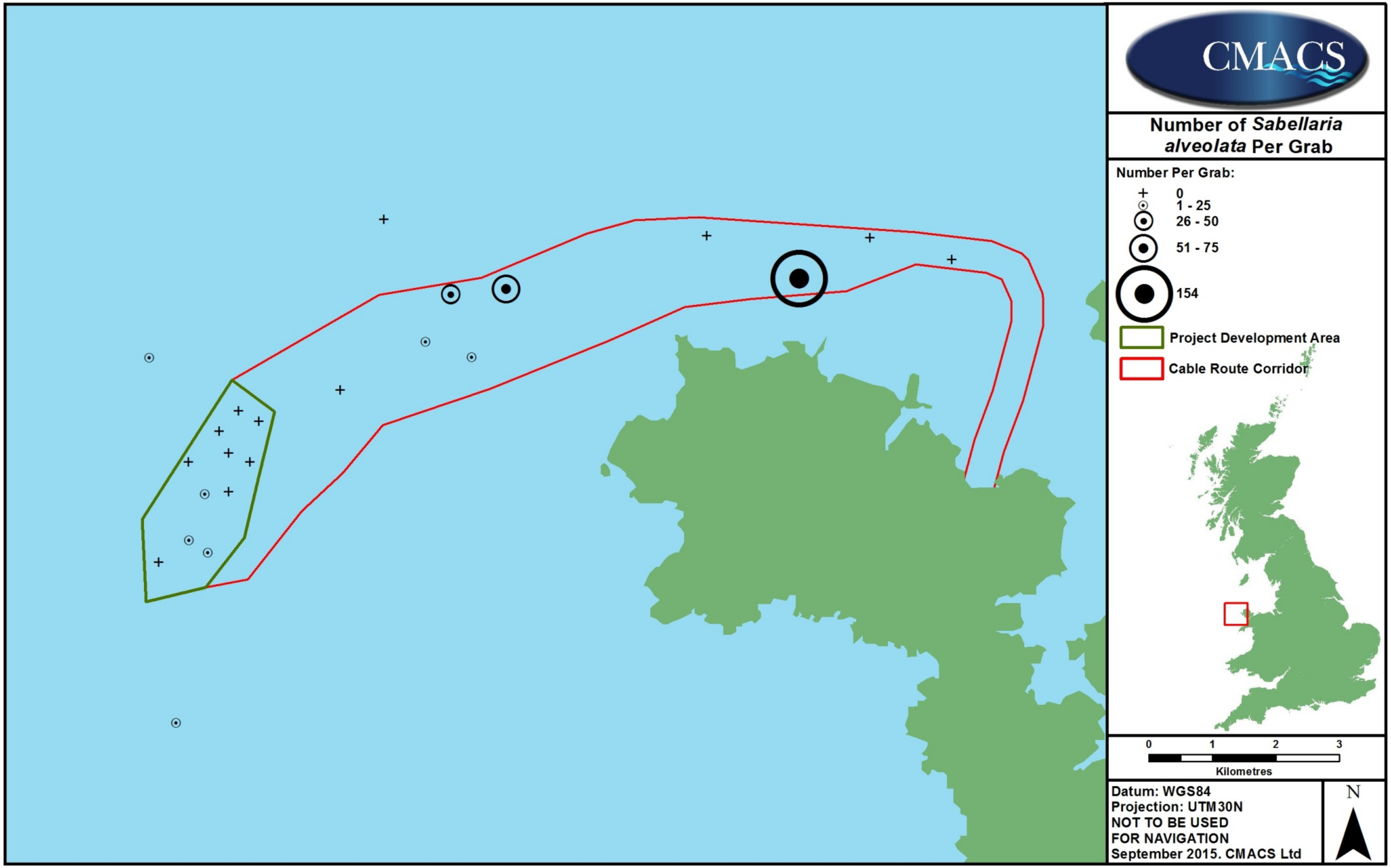


Figure 22. *Sabellaria alveolata* numbers per grab at each station.

3.2.2 Statistical analysis

The number of taxa, individuals and diversity indices for each faunal grab station are provided in Table 11. Overall, samples were generally very diverse; twelve of the twenty three samples had a Shannon-Wiener index of greater than 3.0 (Simpson's over 0.9) and seven of the remaining samples were over 2.5 (Simpson's over 0.75). The least diverse stations were 31 and 38, the latter of which had a Shannon-Wiener of just over 1.0 (Simpson's of 0.35). Stations 1 and 7 within the PDA and stations 19, 20, 22 and 27 within the CRC were all below the QC levels for testing. Station 7 was the most diverse station from the entire grab survey and station 27 was also one of the most diverse with a Shannon-Wiener of 3.38 (see Figure 23 for Shannon-Wiener diversity index spatial distribution and Figure 24 for Simpsons Index).

Pielou's evenness index was over 0.6 in most samples and was over 0.7 at many, which indicates, along with the diversity indices, that not only were there large numbers of taxa in each sample but that numbers of individuals were not dominated by any one taxa. Rarefaction values were also generally high with most samples estimating 30 to 47 taxa per 100 random individuals, which again suggests numbers of individuals were fairly even between taxa (see Figure 25 for spatial distribution).

Sample stations were divided into eight groups using the dendrogram and associated SIMPROF test (Figure 26). Similarities between groups and, indeed, sample stations was generally low with the first split at around 30% (group A from the rest of the samples) and the last split at 60-70% (group F and the differences in samples within it). The sample groupings did not show any geographical trend with many groups containing samples from across the survey area.

The SIMPER analysis indicated that the faunal community at almost all of the samples stations was characterised by a relatively high abundance of the tube-building polychaete *Sabellaria spinulosa* and the highly aggregative ascidian *Dendrodoa grossularia* with cumulative similarity between stations of between 40% and 60% as a result of these two species.

The exception was in group A where samples were mainly characterised by the barnacle *Balanus crenatus* but also with *Sabellaria spinulosa*, burrowing anemones (Edwardsiidae), nematodes and the errant polychaete *Eulalia mustela* contributing to the similarity between samples. Groups B and C were characterised by *Sabellaria alveolata* and nematode worms (in addition to *S. spinulosa* and *D. grossularia*), while group D was characterised by the barnacle *Verruca stroemia*, the sea spider *Achelia echinata* and the bivalve *Sphenia binghami*.

Group E was similar to group C in the most abundant taxa with *S. spinulosa, D. grossularia*, nematode and nemertean worms as well as *Syllis variegata* in common between the two groups but were separated by differences in abundance of S. *spinulosa*, *Mellina elisabethae* and *Balanus crenatus*. Group F was characterised by the terebellid polychaete *Mellina elisabethae* and *Verruca stroemia* the latter of which was also a characteristic species of Group G but the two groups were separated on the basis of differing abundance of *Balanus crenatus*, *M. elisabethae* and *Dendrodoa grossularia*. Group G was characterised by *Nucula nucleus,* sipunculids and *Polycirrus* (a polychaete genus in the family Terebellidae).

The MDS plot (Figure 27) also reveals a low similarity between sample stations and with a stress level of 0.14 that the two-dimensional ordination is not a good representation of the distribution and samples are more dissimilar than they appear in the plot, especially the small cluster placed centre-right in the plot. The MDS was re-plotted with sediment type (Figure 28), which did not reveal any particular trend with samples apparently placed at random with regard to sediment type.

Table 11. Number of taxa, individuals and diversity indices for each faunal sample. Ordered from most diverse to least (according to Shannon-Wiener index). Highlighted stations indicate samples which were taken for faunal analysis despite being below QC standards e.g. stone in jaws or below requisite 5 litres.

Sample	Total taxa	Total individuals	Margalef	Pielou's	Rarefaction	Shannon-Wiener	Simpson's
7	111	415	18.25	0.82	46.66	3.86	0.96
15	95	479	15.23	0.76	41.13	3.44	0.90
13	113	758	16.89	0.72	35.94	3.40	0.93
27	67	204	12.41	0.80	41.62	3.38	0.93
6	110	629	16.91	0.71	36.42	3.33	0.91
8	102	655	15.58	0.72	35.60	3.31	0.92
24	93	717	13.99	0.73	33.46	3.29	0.93
10	95	607	14.67	0.72	35.27	3.26	0.91
35	94	470	15.12	0.72	35.40	3.25	0.92
4	60	186	11.29	0.79	41.09	3.24	0.91
12	99	783	14.71	0.67	33.18	3.09	0.89
33	84	438	13.65	0.69	35.40	3.05	0.86
9	83	461	13.37	0.68	32.85	3.00	0.88
20	67	393	11.05	0.70	32.66	2.95	0.87
16	100	930	14.48	0.59	28.63	2.71	0.82
1	101	827	14.89	0.58	30.77	2.70	0.77
11	66	442	10.67	0.64	27.15	2.68	0.85
19	50	212	9.15	0.68	30.62	2.66	0.85
2	64	479	10.21	0.62	26.81	2.58	0.81
22	55	333	9.30	0.59	24.13	2.37	0.81
34	59	412	9.63	0.53	22.52	2.15	0.73
31	31	108	6.41	0.58	29.48	1.99	0.64
38	101	2140	13.04	0.26	14.44	1.19	0.35

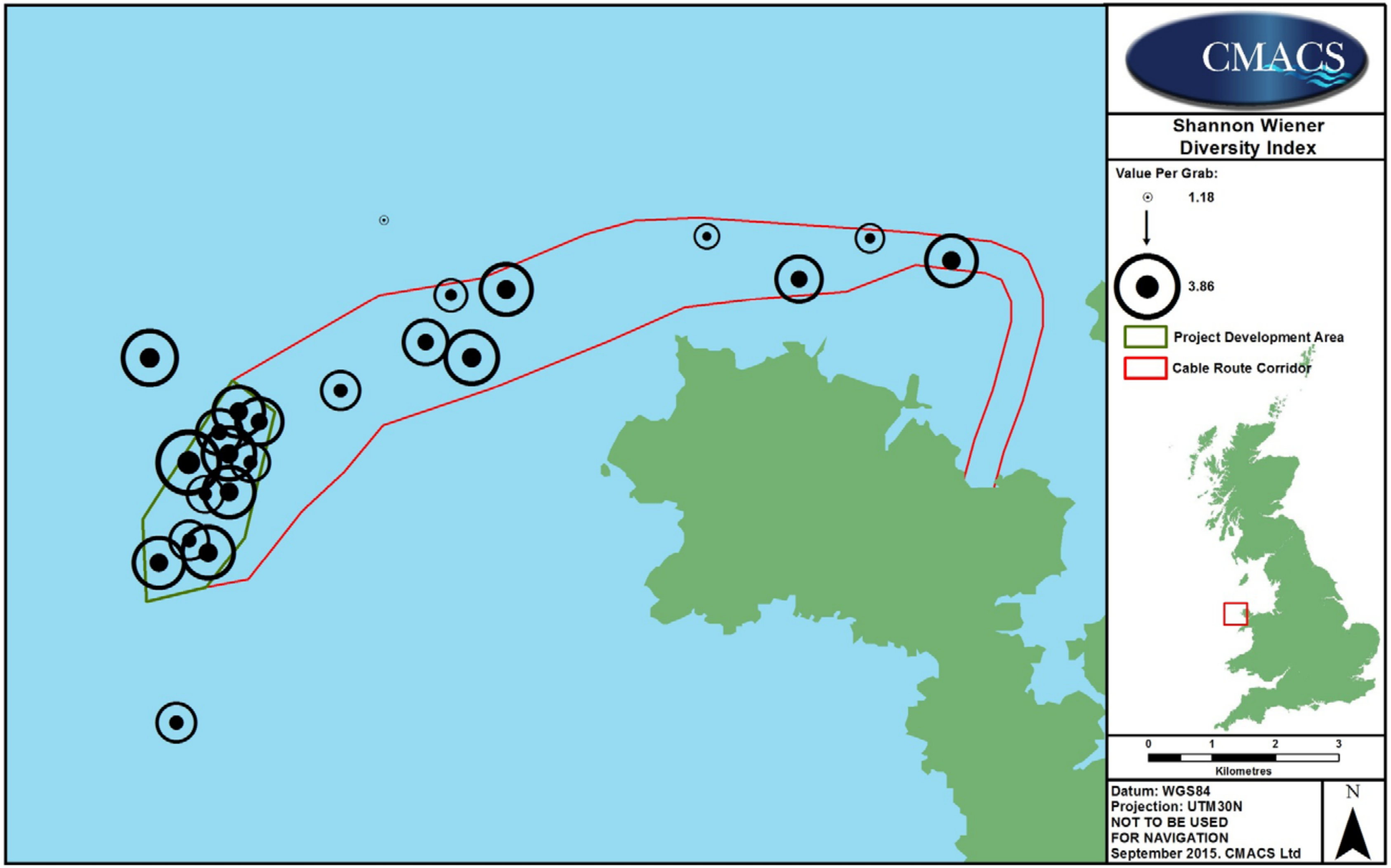


Figure 23. Shannon Wiener diversity indices at each grab station

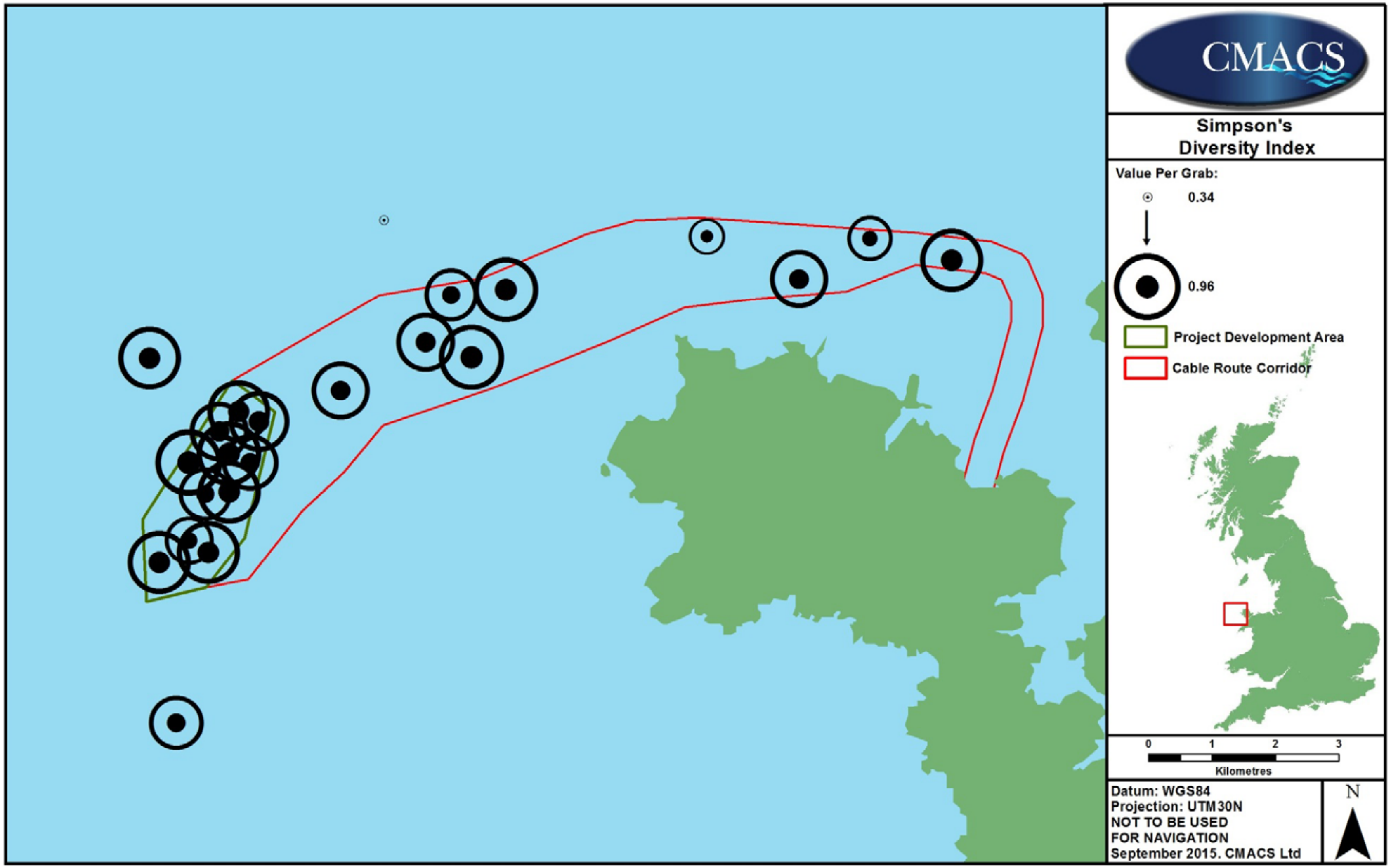


Figure 24. Simpson's diversity index at each grab station

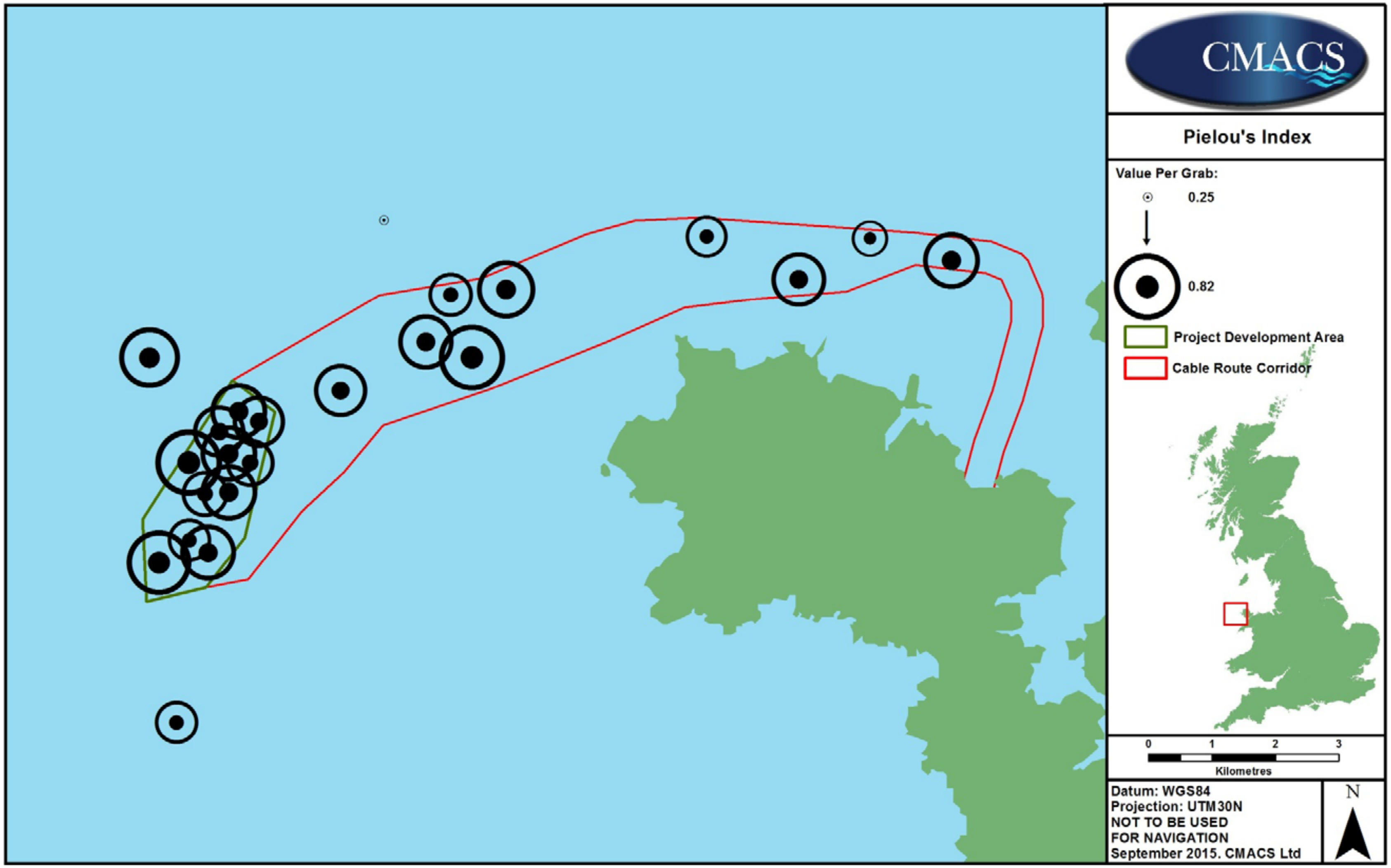


Figure 25. Pielou's diversity index at each grab station.

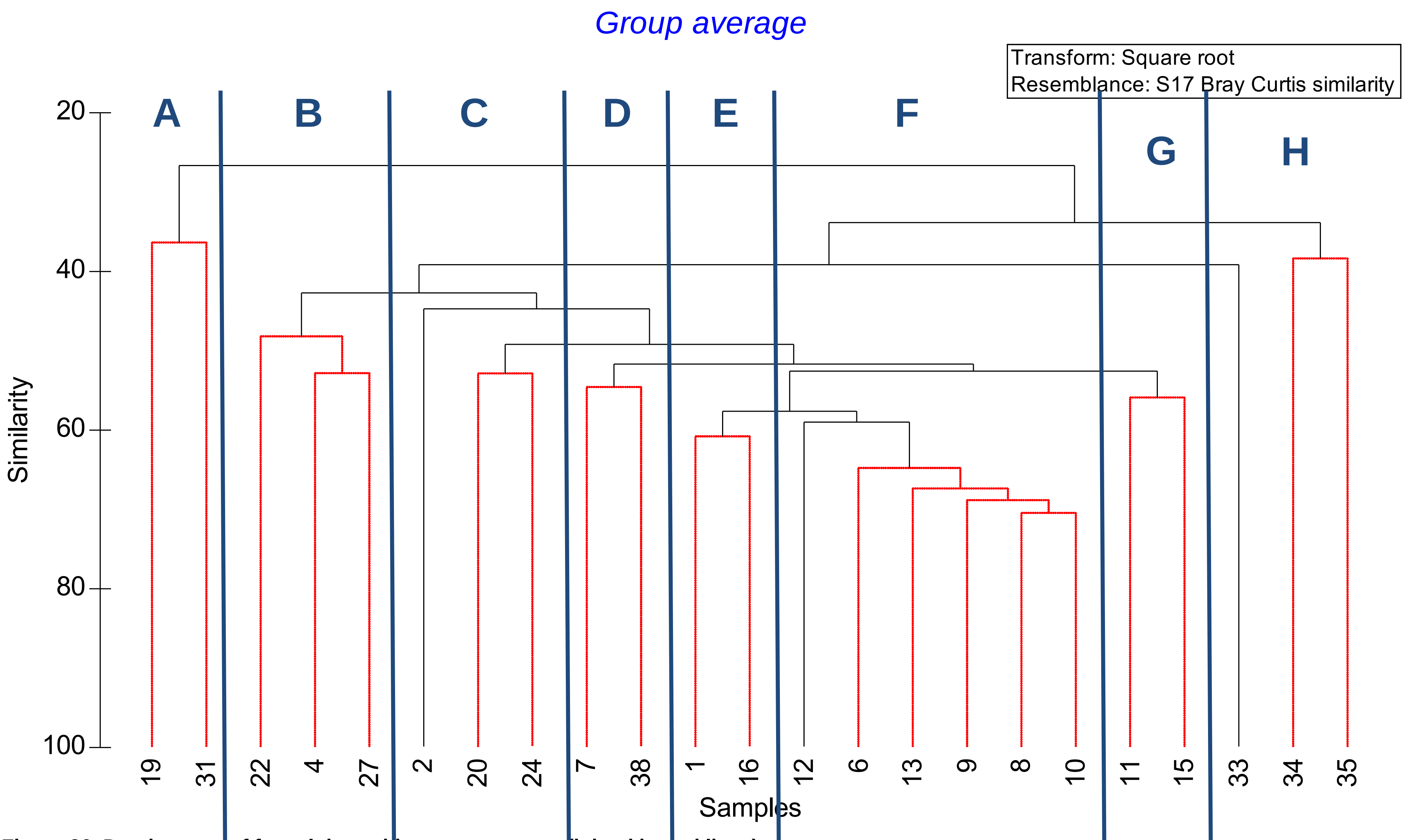


Figure 26. Dendrogram of faunal data with SIMPROF groups (joined by red lines).

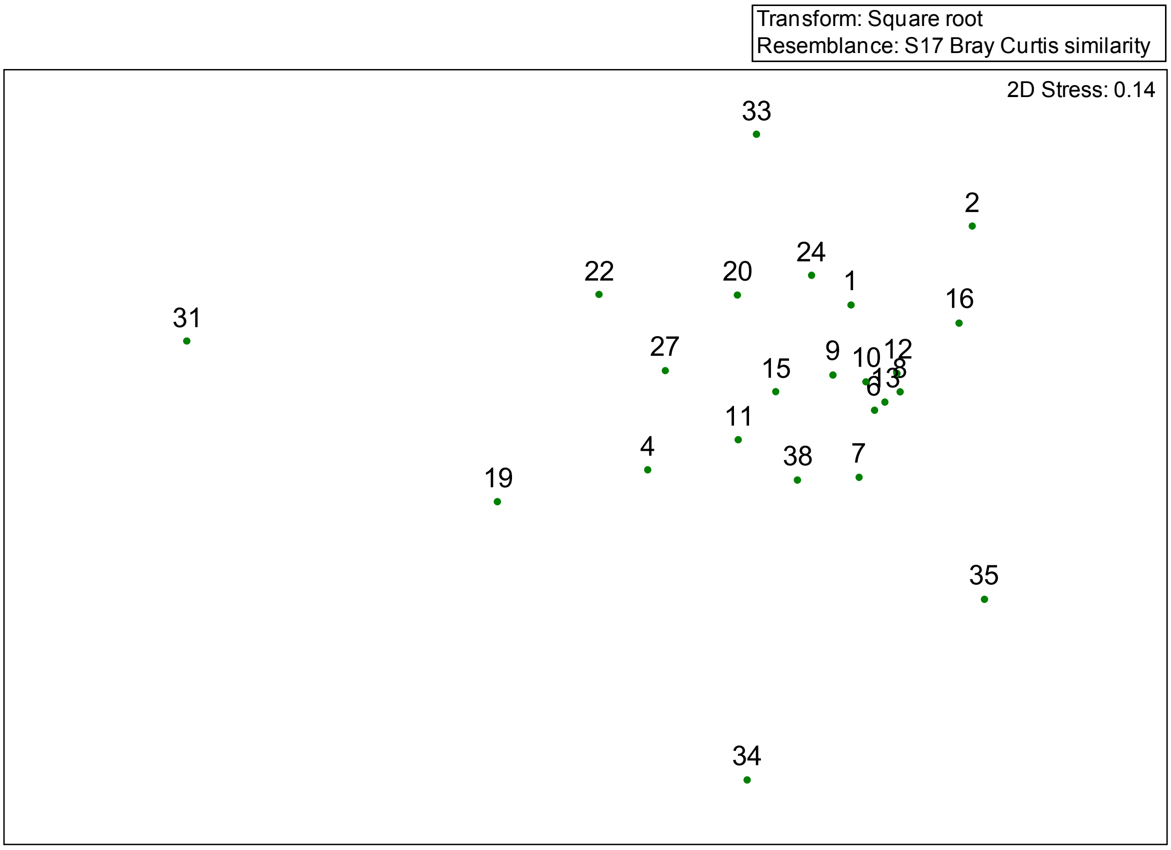


Figure 27. MDS plot of faunal data.

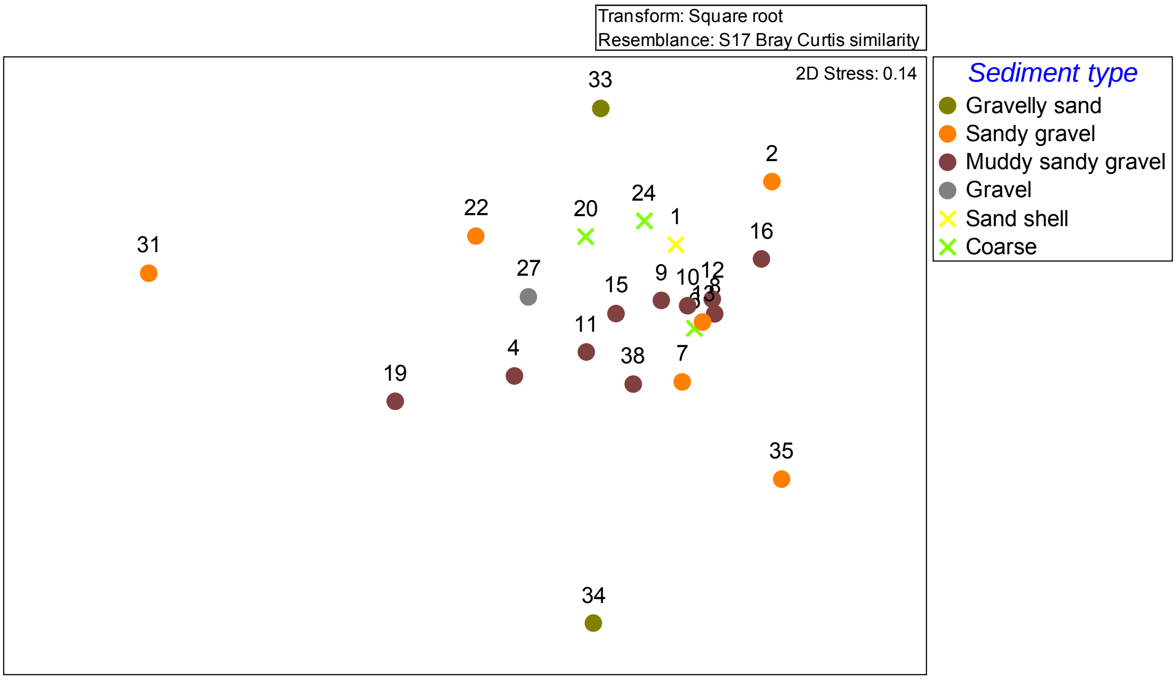


Figure 28. MDS plot of faunal data with sediment type. Cross symbols represent stations where no PSA sample was obtained and therefore sediment type has been described from drop down camera images.

3.2.3 Subtidal community structure

The groupings from the statistical analysis and the raw data from each station were analysed against the marine sublittoral biotope classifications for Britain and Ireland rich species (Connor *et al.,* 2004) and are summarised in Table 13. One grab sample at each station makes it difficult to fully describe the biotope communities accurately especially when not all stations were able to yield a sample for fauna or sometimes sediment analysis; however it is considered enough to characterise the overall seabed habitat along with the information from the drop down camera survey of the stations as discussed in Section 3.2.4 below.

The coarse sand and gravel sediments recorded from the PDA yielded a rich variety of species dominated by the tubeworm *S. spinulosa*, and a diverse mixture of annelid worms, crustaceans, tunicates, molluscs and nematode worms. Station 1 in particular had over 3,000 individual *S. spinulosa* worms per square metre. Depths at the PDA stations were between 71-88 metres and the sediments either sandy gravel or muddy sandy gravel. These stations are considered to be offshore circalittoral mixed sediments (SS.SMX.OMx) and a match (albeit not a very good one due to a low number of venerid bivalves and not all typical defining species being present) for the biotope **SS.SMX.OMx.PoVen**- Polychaete-rich deep Venus community in offshore mixed sediments. This deep Venus community (also described as the Boreal Offshore Gravel Association) is prevalent throughout the deeper parts of the Irish Sea. At the PDA this biotope is interspersed with the biotope **SS.SBR.PoR.SspiMx**- *Sabellaria spinulosa* on stable circalittoral mixed sediment at stations 1, 2, 8 and 12 where *S. spinulosa* counts were >1,316 individuals per m^2 (as defined for this biotope in Connor *et al.* (2004). Station 24 (depth 44m) on the CRC was also a match for this *S. spinulosa* biotope as was the near-field reference stations 16 (depth 67m) with 3,500 individual worms per m^2 and station 15 (depth 64m) 1,380 individuals per m^2. This biotope supports a diverse range of fauna and is usually recorded down to depths of 30m where the *S. spinulosa* tubes typically form loose agglomerations of tubes over a low lying matrix of sand, gravel and mud on the seabed. The stations where this biotope was recorded here are all deeper (between 44m-88m) than this but were nonetheless considered a close enough match based upon sediment type and species.

Station 38 located to the north of the CRC on muddy sandy gravel had extremely high numbers of barnacles *B. crenatus (*17,260 per square metre) as well as supporting high numbers of tunicates annelid and nematode worms and tunicates, molluscs and crustacea. The infaunal community recorded here is likely to be a variant of the deep Venus polychaete rich community (offshore circalittoral mixed sediments) as found at the PDA but the high number of barnacles indicates coarser material on the seabed such as cobble and pebble overlaying this biotope (this is discussed further in Section 3.2.4 below).

Along the CRC, stations 33, 34 and 35 along the north coast of Anglesey is considered a match for the biotope **SS.SCS.CCS.MedLumVen**- *Mediomastus fragilis, Lumbrineris* spp. This biotope also forms part of the 'Deep Venus' biotope complex/Boreal offshore gravel association (Connor *et al*., 2004). Species were similar to those identified from the polychaete-rich community (SS.SMX.OMX.PoVen) as identified at the PDA, but increased bivalve species and greater numbers of defining species for the MedLumVen biotope made it a better match. Stations 19, 20 and 21 within the CRC are all considered to be offshore mixed sediments more like the polychaete-rich deep Venus community as found at the PDA.

3.2.4 Camera survey fauna

Results from the drop down camera survey image analysis are provided in Appendix 9. All underwater photographs and any video footage from all stations are provided on DVD. The main habitats and species identified from the camera survey are discussed below.

3.2.5 Habitat classification/biotopes

The large majority of images showed a seabed of very coarse sediment, predominantly pebble and gravel but with varying proportions of cobble, boulder, sand and shells of dead bivalves. In the PDA, the seabed consisted mainly of pebble and gravel with sand and/or cobble at a few stations and a relatively small area supporting aggregations of *S. spinulosa*. At the western end of the CRC, the seabed consisted of coarser particles than in the PDA and there were also small areas of exposed bedrock. Bedrock became more prevalent further to the east in the PDA and was interspersed with areas of pebble and gravel as well biogenic reef. In the more eastern parts of the CRC, there were finer sediments including areas of predominantly sand but also an area of pebble and gravel supporting encrusting growths of *S. spinulosa* and another area of exposed bedrock.

Epifauna was variable but generally sparse (with a few exceptions) and was principally made up of scour tolerant taxa including various anemones, hydroids, erect bryozoa and epifaunal polychaetes.

Thirteen broad biotope classifications were assigned (see

Table 12 for summary and Figure 29 for a map) which are described in full below, with selection of representative images of the different biotopes which. Notes on image analysis are provided in Appendix 9.

Note that at Station 32 two different biotopes were assigned to different photographs, and that at some locations more than one biotope was considered to be present.

With regard to those sample stations where there is both faunal and camera data, a comparison of assigned biotopes is provided in

Table 12. Broadly, the assigned biotopes were similar between the two survey types with offshore mixed sediment classified from the camera survey refined to specific biotopes with the aid of infaunal data. Likewise, there was some agreement between the two surveys on *Sabellaria* biotopes although there were some stations that differed owing to *Sabellaria* being abundant but not obvious in the images. There were also some differences where epifauna-dominated biotopes had been assigned from the camera data but an infauna-dominated one had been assigned from the grab data. This was to be expected and in these cases, it is likely there is some spatial heterogeneity of the seabed. Where very coarse particles predominate, the epifauna-derived biotope will be prevalent and where there are patches of finer sediments (which the grab will select for in order to collect suitable samples), the infauna-derived biotope will be prevalent.

Table 12. Biotopes assigned at each sample station from camera survey (see also Figure 29)

Biotope	Stations	Depth range (metres)
CR.HCR.FaT	17, 18	56 to 71
CR.HCR.FaT.BalTub	23, 25, 38	35 to 38
CR.HCR.XFa	3	72
CR.LCR.BrAs.AntAsH	36	8
CR.MCR.Csab.Sspi	1, 24, 27	40 to 80
CR.MCR.Csab.Sspi/SS.SBT.PoR.SspiMx	16	66
CR.MCR.EcCr.UrtScr	19, 20, 21, 32	26 to 65
CR.MCR.EcCr.UrtScr/CR.HCR.FaT.BalTub	26, 28, 29	35 to 52
SS.SCS.ICS.SSh	30, 31	28 to 32
SS.SMX.CMx.FluHyd	6, 9, 10	77 to 87
SS.SMX.IMx	33, 34, 35, 37	6 to 22
SS.SMX.OMx	2, 4, 5, 7, 8, 11, 12, 13, 14, 39, 41	48 to 87
SS.SMX.OMx/CR.MCR.Csab	22	50
SS.SSA.IfiSa.ScupHyd	32	26

CR.HCR.FaT 'Very tide-swept faunal communities' Stations 17, 18.

Stations 17 and 18 were assigned this broad classification according to substratum type of bedrock, but could not be taken any further owing to the low diversity and abundance of the fauna.

Station 18 CR.HCR.FaT	**Notes**
	Bedrock with dahlia anemone *Urticina* sp., barnacles (probably a species of *Balanus*) and a low faunal turf probably of erect bryozoa and hydroids. Mobile fauna is restricted to a single painted topshell *Calliostoma zizyphinum*.

At three stations this biotope was further refined to CR.HCR.FaT.BalTub '*Balanus crenatus* and *Tubularia indivisa* on extremely tide-swept circalittoral rock' based on the abundance of barnacles but this can be considered as a 'best fit' as the epifauna at these stations was not as diverse as the biotope description suggests. Habitat at these stations was a mixture of boulder, cobble, pebble and gravel.

Stations 23, 25, 38.

Station 23 CR.HCR.FaT.BalTub	**Notes**

	Boulder, cobble, pebble and gravel with abundant barnacles. Dahlia anemone are present as is a small area of hydroid. Mobile fauna includes small gastropods (possibly *Nucella lapillus*) and a hermit crab (a member of the Paguridae family of indeterminate species).

CR.HCR.Xfa ‘Mixed faunal turf communities’ Station 3.

Only Station 3 was included in this classification, which was assigned owing to the dense coverage of the hard substratum with sessile epifauna, mainly hydroids and bryozoans the majority of which could not be identified further.

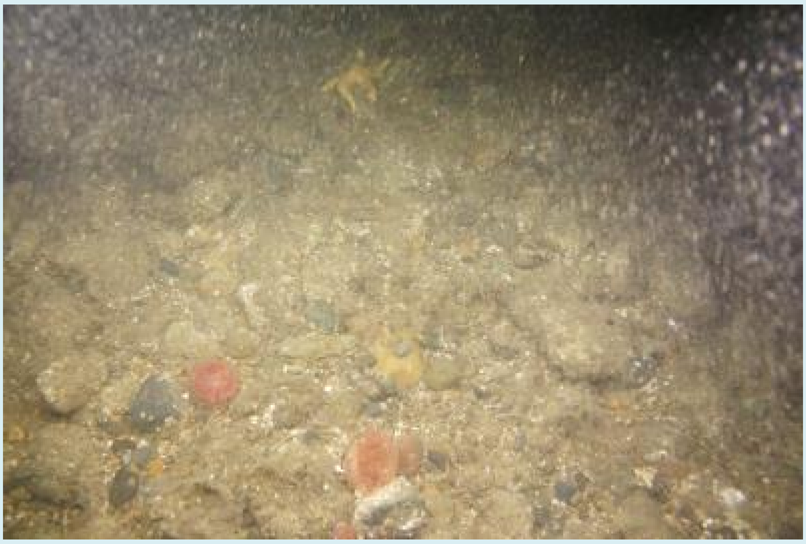
Station 3 CR.HCR.Xfa	**Notes**
	Cobble with some pebble, gravel and shell fragments. The larger particles are covered with a turf of erect fauna which may include the hydroid *Hydrallmania falcata* and the sponge *Hemimycale columella*.

CR.MCR.EcCr.UrtScr '*Urticina felina* and sand-tolerant fauna on sand-scoured or covered circalittoral rock' Stations 19, 20, 21, part of 32.

This biotope was assigned to a number of stations mainly with habitat of cobble and pebble but with bedrock at one station. Epifauna was generally sparse and was characterised by scour-tolerant taxa such as dahlia anemone, keelworms (Serpulidae) and barnacles.

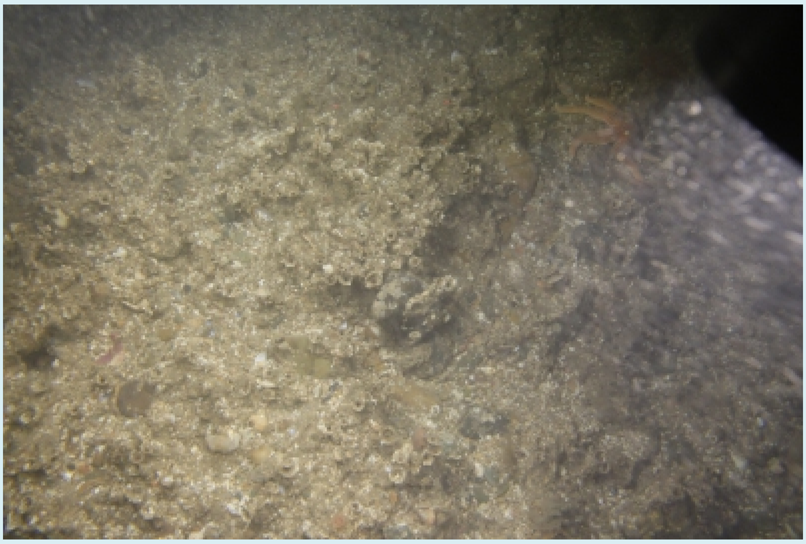
At a few stations, there was a slightly richer epifauna with characteristics of CR.MCR.EcCr.UrtScr but also some that matched CR.HCR.FaT.BalTub. To account for this, the stations in question were classified as a combination of the two biotopes.

Stations 26, 28, 29

Station 21 CR.MCR.EcCr.UrtScr	**Notes**
	Cobble, pebble and gravel with some shell fragments. A sparse covering of barnacles and faunal turf indicates regular disturbance of seabed particles. There are several dahlia anemones and a single common starfish *Asterias rubens*.
Station 28 CR.MCR.EcCr.UrtScr/ CR.HCR.FaT.BalTub	**Notes**
	Boulder and cobble with some pebble and shell. The larger particles are covered in a moderately rich epifauna of barnacles, ascidians (possibly *Dendrodoa grossularia* or *Distomus variolosus*) and the erect bryozoan *Alcyonidium diaphanum* as well as dahlia anemone *Urticina* sp. Mobile epifauna includes the sea urchin *Echinus esculentus*, the painted topshell *Calliostoma zizyphinum*, hermit crab and a small starfish.

<u>CR.MCR.CSab.Sspi</u> ‘*Sabellaria spinulosa* encrusted circalittoral rock’ stations 1, 24, 27.

There were five stations where honeycomb/ross worm was deemed to be in sufficient abundance that a *Sabellaria spinulosa* biotope could be assigned. Images generally showed a few aggregations of *Sabellaria* sp., mostly on coarse particles such as cobble and pebble but with some sand and possibly bedrock. Only Stations 22, 24 (see below) and 27 were deemed to have a sufficient abundance and elevation of *Sabellaria* aggregations to be considered as reef which is discussed further in the next section. At Station 16, the seabed was made up of finer sediment than at the other stations with *Sabellaria* and this shared as many features of the subtidal sediment biotope (SS.SBR.PoR.SSpiMx) as the circalittoral rock and has been classified as a combination of the two.

Station 24 CR.MCR.CSab.Sspi	**Notes**
	Cobble and boulder (possibly bedrock) with elevated aggregations of *Sabellaria* sp.. A common starfish *Asterias rubens* and an indeterminate anemone species are also present.

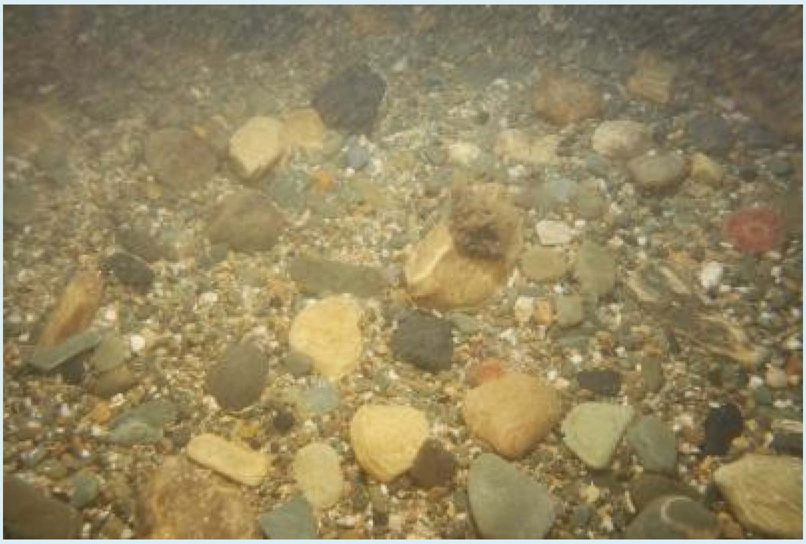
CR.LCR.BrAs.AntAsH '*Antedon* spp., solitary ascidians and fine hydroids on sheltered circalittoral rock' Station 36.

This biotope was assigned to a single station that was in a sheltered location on the cable route, as evidenced by the prevalence of a layer of fine sediment over bedrock. The epifauna was quite limited, and the characterising brachiopods were not seen (although these are typically very small and difficult to see in camera images) but there were numerous feather stars *Antedon bifida* and lightbulb sea squirt *Clavelina lepadiformis* which gave a best match for this biotope.

Station 36 CR.LCR.BrAs.AntAsH	**Notes**
	Silty bedrock or very large boulders. Identifiable epifauna was mainly feather stars and solitary ascidians but also with the erect bryozoan *Alcyonidium diaphanum*. There also appeared to be a short faunal turf and occasional fronds of a red alga

SS.SCS.ICS.SSh 'Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)' Stations 30, 31.

The seabed at two stations was characterised by clean pebble and gravel, with an apparent lack of fine sediment, indicating that the sediment was mobile. At one station, there were cobbles the largest of which supported growths of mussels, which were probably *Musculus discors* and dahlia anemone were also present. The mussels were not at sufficient density to base a biotope classification on and the general lack of epifauna led to SS.SCS.ICS.SSh being assigned to this station.

Station 30 SS.SCS.ICS.SSh	**Notes**
	Cobble, pebble and gravel. Small aggregations of mussels, probably *Musculus discors*, on larger particles and one dahlia anemone.

SS.SMX.IMx 'Infralittoral mixed sediment' Stations 33, 34, 35, 37.

At two stations on the cable route, there were a variety of coarse sediment, predominantly gravel but with some cobble. Epifauna was sparse but more conspicuous than at station 30 (see above) which in combination with the likely presence of fine sediment and the relatively shallow depth of the station, it was designated as SS.SMX.IMx. The habitat at these stations are likely to be infauna-dominated and the biotope will be redefined upon interpretation of the grab faunal data.

Station 34 SS.SMX.IMx	**Notes**
	Gravel and pebble with hermit crabs, hydroids and serpulid worms.
Station 35 SS.SMX.IMx	**Notes**
	Cobble and pebble with some boulder and gravel. Epifauna includes various hydroids and anemones with gastropods and the brittlestar *Ophiura albida*

<u>SS.SMX.CMx.FluHyd</u> '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' Stations 6, 9, 10.

There were three stations in the PDA, where the seabed was heavily encrusted with a faunal turf and all of them supported hornwrack *Flustra foliacea* though generally at low abundance. Other sessile fauna included sea anemones (*Sagartia* sp. and *Urticina* sp.), serpulid worms, the hydroid *Nemertesia antennina* and a sabellid worm at station 9.

Station 10 SS.SMX.CMx.FluHyd	**Notes**
	Pebble and gravel with coarse sand. Sessile epifauna includes *Flustra foliacea*, the hydroid *Nemertesia antennina*, sea squirts of indeterminate species and anemones possibly *Sagartia* sp. Mobile fauna visible in the image was restricted to bloody henry starfish *Henricia* sp.

SS.SSA.IFiSa.ScupHyd ‘*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles.’

There was one station towards the eastern end of the CRC where five images were obtained one of which showed bedrock and anemones (see CR.MCR.EcCr.UrtScr above) but the remainder showed a seabed of showed a seabed of sand, gravel and dead bivalve shells. This supported a varied epifauna but hydroids dominated and the seabed in these images was classified as SS.SSA.IFiSa.ScupHyd.

Station 32 SS.SSA.IFiSa.ScupHyd	**Notes**
	Coarse sand and horse mussel shell. The horse mussel shell supports growths of hydroids including *Hydrallmania falcata*. Other sessile fauna includes serpulid worms and small anemones of an indeterminate species.

SS.SMX.OMx 'Offshore circalittoral mixed sediment' Stations 2, 4, 5, 7, 8, 11, 12, 13, 14, 39, 41.

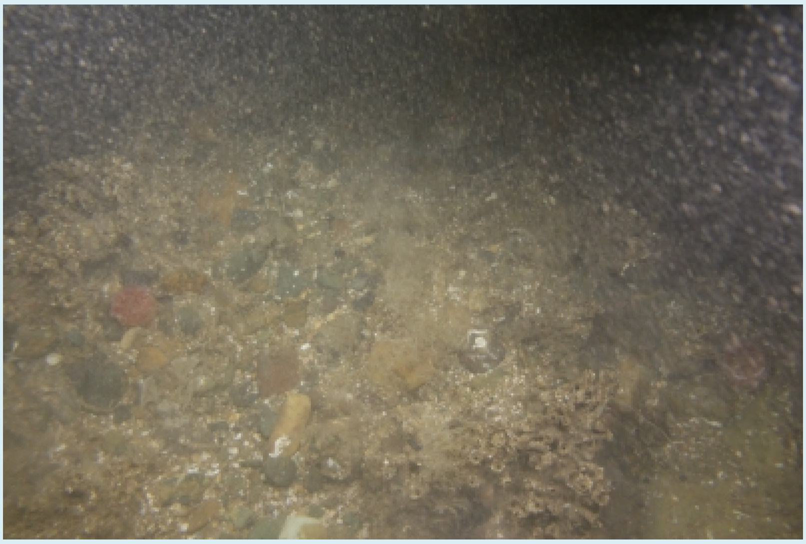
At most stations in the PDA the seabed was of coarse particles, mainly pebble and gravel but with variable proportions of cobble and sand. There were variable quantities of epifauna between stations but it is likely that these stations are infauna dominated and therefore the classification was limited to SS.SMX.OMx.

Station 7 SS.SMX.OMx	**Notes**
	Pebble and gravel and some sand with *Modiolus* shell. Some of the larger particles support a faunal turf, a small patch of sponge and a hydroid that may be *Sertularia* sp.
Station 13 SS.SMX.OMx	**Notes**
	Pebble, gravel, shell fragments and broken *Sabellaria* tubes. Larger particles support faunal turf and serpulid worms. Mobile epifauna included a sea urchin *Psammechinus miliaris* and a crab of indeterminate species.

Station 41 SS.SMX.OMx	**Notes**
	Cobble, pebble and gravel with small aggregations of *Sabellaria* sp. This station was investigated for *Modiolus modiolus* reef which is further discussed in Section 3.2.6.

<u>SS.SMX.Omx/CR.MCR.Csab</u> Offshore circalittoral mixed sediment' and 'Circalittoral *Sabellaria* reefs'. Station 22.

At this station in the CRC, the seabed had many characteristics of the offshore mixed sediments seen elsewhere (particularly in the PDA) but also had some seabed coverage of *Sabellaria* aggregations, though not sufficient to assign the station purely to a *Sabellaria* biotope. As a result, this station was assigned as a combination of the two biotopes.

Station 22 SS.SMX.Omx/CR.MCR.Csab	**Notes**
	Gravel, pebble, cobble and probably boulder. Obvious epifauna consists of two relatively large aggregations of *Sabellaria* sp., anemones *Urticina* sp. and hydroids including *Hydrallmania falcata*.

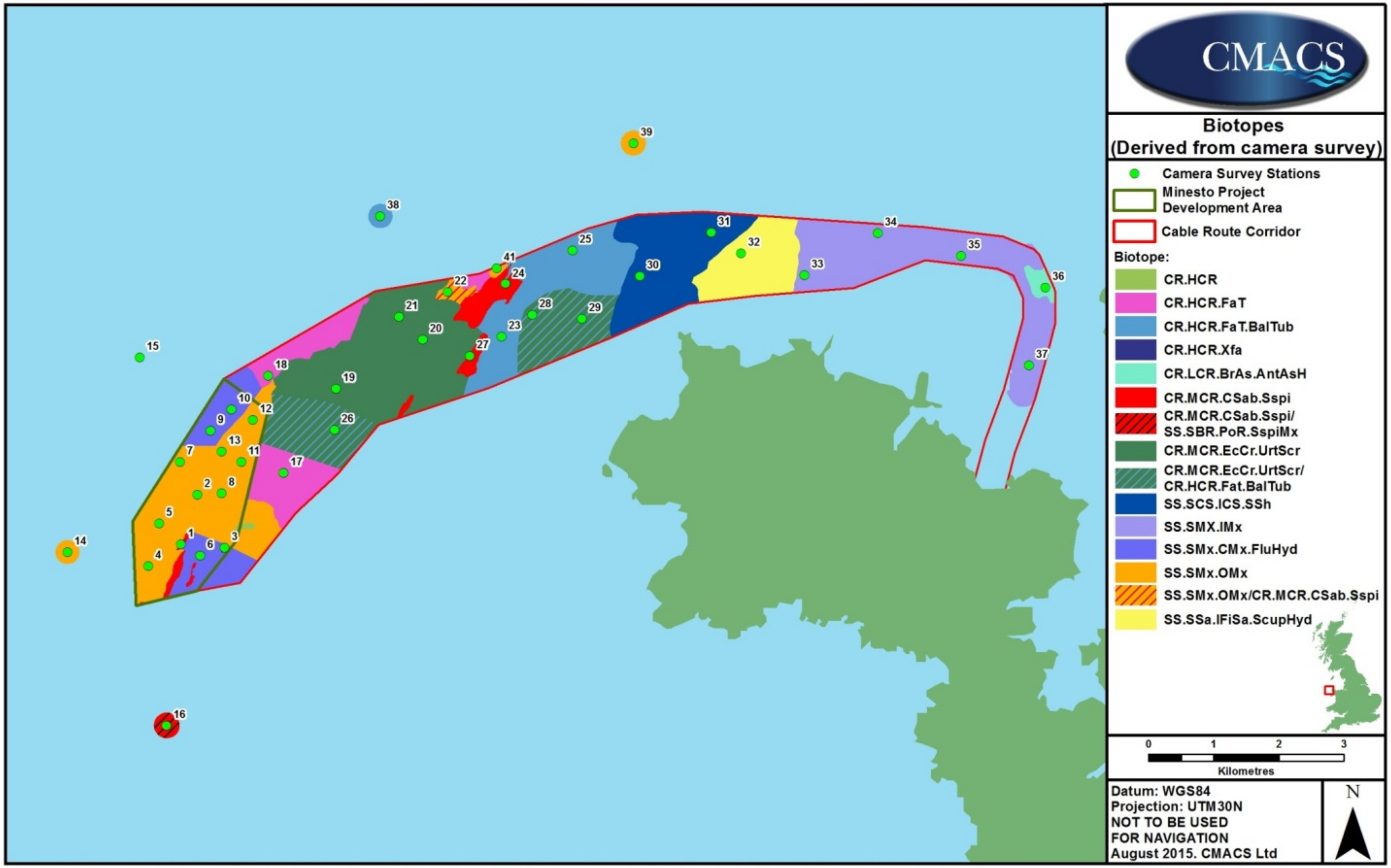


Figure 29. Indicative biotope map based on side scan sonar mosaic and drop down camera images.

Table 13. Comparison of biotopes in each of the Simprof groups (see Figure 24), with camera-derived biotopes also. Note: this table differs from Table 12 as it only considers stations where a grab was successfully obtained.

Simprof group	Sample station	Biotopes*	Biotopes‡
A	19, 31	SS.SMX.OMx.PoVen	CR.MCR.EcCr.UrtScr, SS.SCS.ICS.SSh
B	4, 22, 27	SS.SMX.OMx.PoVen	SS.SMX.OMx, CR.MCR.CSab.Sspi
C	2, 20, 24	SS.SBR.PoR.SspiMx, SS.SMX.OMX.PoVen	SS.SMX.OMx, CR.MCR.CSab.Sspi, CR.MCR.EcCr.UrtScr
D	7, 38	SS.SMX.OMx.PoVen	SS.SMX.OMx, CR.HCR.FaT.BalTub
E	1, 16	SS.SBR.PoR.SspiMx	CR.MCR.Csab.Sspi/SS.SBT.PoR.SspiMx
F	6, 8, 9, 10, 12, 13	SS.SBR.PoR.SspiMx	SS.SMX.CMx.FluHyd, SS.SMX.OMx
G	11, 15	SS.SMX.OMx.PoVen, SS.SBR.PoR.SspiMx	SS.SMX.OMx
H	33, 34, 35	SS.SCS.CCS.MedLumVen	SS.SMX.IMx

*based on grab sample data

‡based on drop down camera images

3.2.6 Habitats of conservation importance

Benthic images were screened for potential Annex I habitats which, where possible, were classified into a quality category according to present guidelines. Any other habitats of conservation importance were also noted. A map of habitat types extrapolated from benthic data, with reference to bathymetric and side scan sonar data is presented in Figure 30. Extensive bedrock platforms were obvious around stations 29, 32 and 36 (see Figure 2) though the outcrops at the western end of the CRC were bedrock only around station 17. Elsewhere on this part of the CRC (e.g. around stations 19-21), the seabed was predominantly of cobble and this was classified as stony reef. The majority of the PDA and large swathes of the CRC had a seabed of coarse sediment (e.g. gravel and pebble) with insufficient elevation to be considered stony reef but this habitat is further discussed below as a habitat of principal importance.

Sabellaria spinulosa was a common species in the grab samples and was found throughout the survey area but reef structures identified from benthic imagery were less widespread. Based on drop down camera images and reflectivity on the side scan sonar data, areas of differing reef quality were mapped and were mainly in the centre of the CRC. Each Annex I habitat is discussed further below.

Sabellaria spinulosa biogenic reef

There were five stations (see Table 14) with aggregations of *Sabellaria* sp. which were assessed against "reefiness" according to the guidelines of Gubbay (2007; defined in Table 15) and their approximate extent is mapped in Figure 30.

Table 14. Stations assessed for *S. spinulosa* reef

Station	Elevation	Area[5]	Patchiness	Reef quality
1	<2cm	19,000m^2	10%	Not a reef
16	<2cm	Unknown	10-20%	Not a reef
22	5-10cm	140,000m^2	10%	Low-medium
24	2-5cm	398,000m^2	20%	Low
27	2-5cm	123,000m^2	10%	Low

[5] These are estimates based on extrapolation of area from the sidescan mosaic.

Table 15. Assessment of reefiness according to Gubbay (2007)

Measure of 'reefiness'	Not a reef	Low	Medium	High
Elevation (average tube height, cm)	<2	2-5	5-10	>10
Area (m^2)	<25	25-10,000	10,000-1,000,000	>1,000,000
Patchiness (% cover)	<10	10-20	20-30	>30

Elevation and patchiness were estimated from still and video images, whilst the extent was estimated from sidescan images. At most stations where obvious aggregations of *Sabellaria* sp. were present, they were sparse and often restricted to encrusting the larger stones. The aggregations were generally not consolidating sediment and were typically of low elevation, and therefore were either considered to be "not a reef" (due primarily to lack of elevation), or of low 'reefiness' according to the guidance. At Station 22, due to the combination of elevation appearing to be predominantly between 5 and 10cm, and the considerable area involved (estimated 140,000m^2) the habitat is considered to represent low-medium reefiness, although even here the patchiness is estimated at around 10% which is at the lower limit of what is considered as reef.

Stony reef

There were nine stations (see Table 16) where the proportion of large particles was high enough that they might be considered as stony reef. These were assigned a reefiness score using the guidelines outlined in Table 17 (Irving, 2009).

Table 16. Stations assessed for stony reef

Station	Composition	Elevation	Extent	Biota	Patchiness	Reefiness
3	10-40%	<64mm	>25m^2	>80% epifauna	20%	Medium
19	<10%	<64mm	>25m^2	<80% epifauna	10%	Low
20	<10%	<64mm	>25m^2	<80% epifauna	30%	Low
21	<10%	<64mm	>25m^2	<80% epifauna	25%	Low
23	80%	64mm-5m	>25m^2	Likely epifauna dominated	>75%	Medium
25	50%	64mm-5m	>25m^2	Likely epifauna dominated	50%	Medium
28	80%	<64mm	>25m^2	Likely epifauna dominated	>75%	Medium
29	70%	64mm-	>25m^2	Likely epifauna	>75%	Medium

Station	Composition	Elevation	Extent	Biota	Patchiness	Reefiness
		5m		dominated		
35	20%	<64mm	>25m^2	<80% epifauna	20%	Low

Table 17. Guidelines for assessing stony reef according to Irving (2009)

		'Reefiness'		
Characteristic	**Not a 'stony reef'**	**Low**	**Medium**	**High**
Composition Boulders/cobbles (>64mm)	<10%	10-40% (Matrix supported)	40-95%	>95% (Clast supported)
Elevation	Flat or undulating seabed	<64mm	64mm-5m	>5m
Extent	<25m^2		>25m^2	
Biota	Dominated by infauna			>80% epifauna
Patchiness	10%	10-50%	50-75%	>75%

None of the stations were classified as having high reefiness but there were five that were of medium and four of low reefiness. This was mainly of the basis of the physical characteristics as biota were limited in many cases.

Bedrock reef

There are no current guidelines specifically for determining the quality or reefiness of bedrock reef but there were four stations (17, 18, 32, 36) that could be assessed as this habitat. Arguably the elements of extent, patchiness and elevation could be used, whilst composition and biota are not relevant to assessing reefiness of bedrock. Although patchiness is unclear, the bedrock at the four stations identified as such was clearly between 64mm and 5m and extent was clearly over 25m^2, hence suggesting a medium reefiness according to these criteria. The substrate at Station 32 was certainly patchy to some degree, since both sedimentary and bedrock biotopes were identified at this station. The associated fauna at all four stations was neither rich nor diverse, typically consisting of scattered dahlia anemones with sparse hydroids, sponges and barnacles.

Possible horse mussel reef

The images of the seabed in the region of Station 41, where possible horse mussel reef was identified from sidescan sonar records, were reviewed but there was no indication of *Modiolus* reef (no grab data could be obtained from this Station). No live *Modiolus* were seen, and only one or two empty shells. A few *Sabellaria* tubes were seen, although these were sparse and therefore did not present *Sabellaria* reef. This station was classified as SS.SMX.OMx.

The faunal grab from Station 24 (on the CRC) yielded 11 individual *M. modiolus* (all small specimens) corresponding to 110 per m^2 and Station 33 yielded 70 per m^2 (both levels are high enough to be potential *Modiolus modiolus* reef e.g. Tyler-Walters (2007) and Dr. T.J.Holt pers comm). Station 24 was dominated by the *S. spinulosa* community and there was no evidence from the camera survey of any *M. modiolus* aggregations at either of these stations. It is therefore likely that these were individuals growing on the coarse sediments interspersed with the *S. spinulosa* aggregations.

Tide-swept channels

The ‘Tide-swept channels’ habitat was identified by Xodus in the Scope of Works as being near, but not present, in the PDA. This habitat is a habitat of principal importance in Wales (previously UKBAP). Results from the drop down camera are in agreement with this; while the seabed was subject to strong tidal currents, it did not support the diverse array of epifauna that is typical of tide-swept channels such as that found between The Skerries and mainland Anglesey located a few miles to the north-east of the PDA and CRC.

Sublittoral sands and gravels

This habitat (including muddy sands) is a Marine Conservation Zone (MCZ) feature of interest and is also a habitat of principal importance in Wales (previously UK BAP). Most of the sediments of the PDA and CRC were described as this habitat.

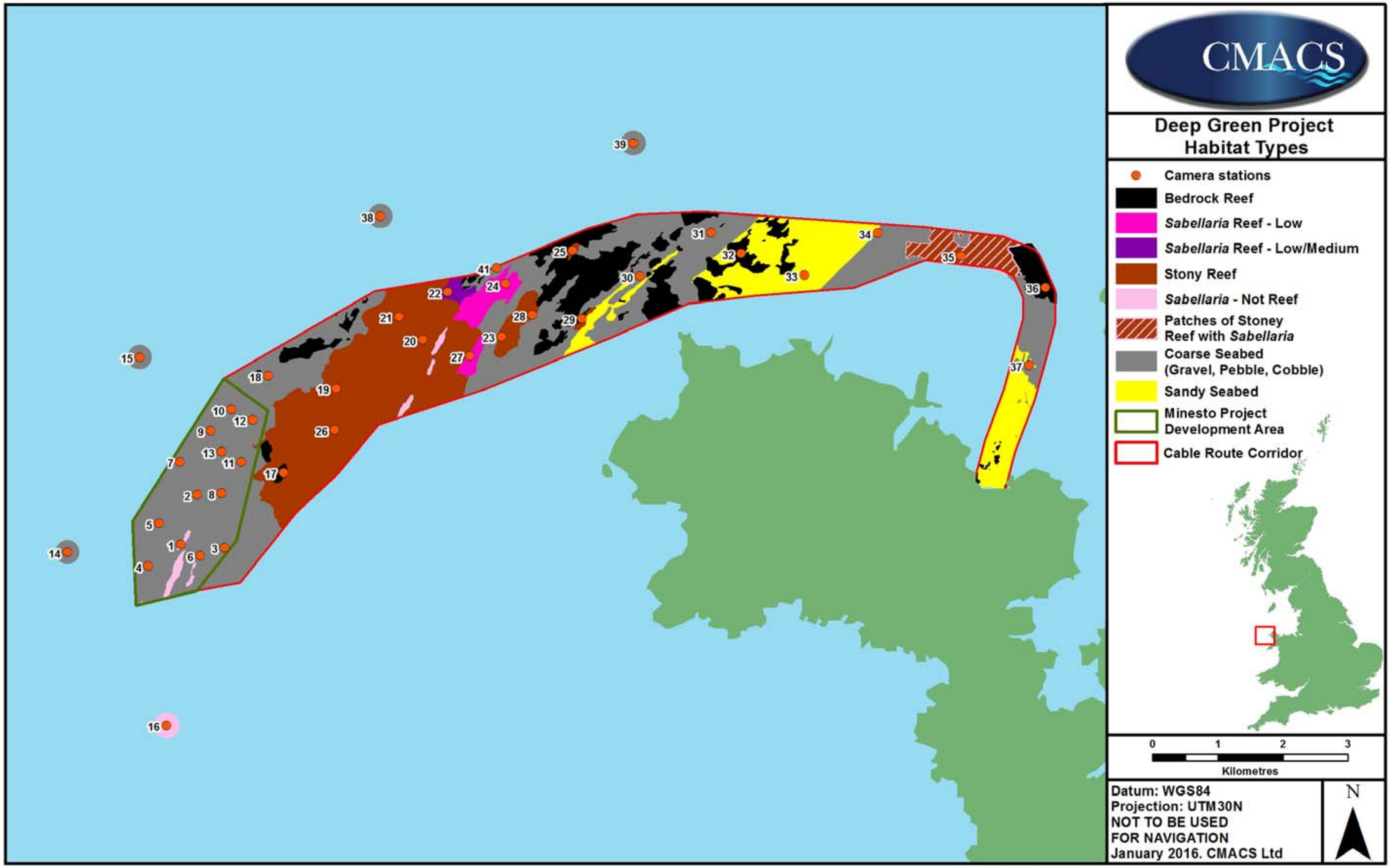


Figure 30. Habitat types and reef quality in the PDA, CRC and on reference stations.

4. DISCUSSION AND CONCLUSIONS

Sediments

Results from the camera and grab survey showed the main seabed habitats to be coarse sands and gravel with pebble, cobble, boulders and some outcrops of bedrock at the western end of the CRC. Sediments at the PDA were mainly coarse sands and gravels with occasional pebble and cobble. Muddy sand was recorded from the inshore CRC area. Because of the coarse sediments the majority of stations were sampled using the camera as they were considered unsuitable for grab sampling e.g. exposed bedrock and areas of cobble. Some of the infaunal grab samples were retained for analysis despite only small amounts of material being obtained. The rationale for this was the high number of stations failing to yield any samples from the grab survey and the fact that some qualitative information on the infaunal species could be obtained which would assist the characterisation of the seabed habitats.

The contaminant analysis revealed elevated levels of certain trace and heavy metals within the seabed sediments. The sediments of the Irish Sea potentially act as a sink for contaminants. Elevated metal concentrations in these sediments originate from inputs as a result of processes such as natural mineralization (weathering), mining, industrial and other anthropogenic sources, with estuaries along the coasts of Anglesey, North Wales and North West England acting as a source. The concentration of metals within marine sediments in the coastal zone and around the estuaries of the region are generally higher than offshore as a result of this riverine input. Cadmium, mercury, lead and zinc all have relatively high residues occurring in the eastern Irish Sea sediments (Defra, 2000).

High concentrations of aluminium (relative to the other trace and heavy metals tested for) were recorded at all stations. This metal is present in marine sediments resulting from erosion of land masses and may also be discharged from anthropogenic sources such as mining or industry and are often found in high levels around the UK coastline (Langston *et al.,* 2003), especially in or near large estuaries (Cole *et al.,* 1999).

Although well below the Probable Effects Level (PEL), arsenic levels were recorded above the ISQG levels at all but two of the thirteen stations tested for heavy and trace metal contaminants. Arsenic is historically recorded at elevated levels in the eastern Irish Sea (e.g. Camacho-Ibar *et al.,* 1992). Studies have found that such elevated arsenic levels are not attributable to anthropogenic sources of pollution such as historic offshore dumping activities (sewage sludge can contain arsenic) or direct introduction to the riverine system (Leah *et al.,* 1992). Instead the main sources are thought to be of natural origin as a result of weathering of glaciated regions such as North Wales and the Lake District (e.g. Thornton *et al.,* 1975). Nickel was also found to be above the Cefas Action level 1 at two stations. Nickel source in the marine environment can be attributed to riverine input.

Other trace elements present in very high concentrations in the sediments of the eastern Irish Sea are zinc and lead as a result of historic sphalerite and galena mining in the past (Elderfield *et al.,* 1971). Of these two metals, only lead was found to be elevated slightly above guideline levels at three stations (all located within the CRC) but well below the level of probable effect.

Mercury was found in low concentrations across the area but raised above the ISQG and Action Level 1 at one station within the PDA. Mercury source in the marine environment is attributable to historic industry and mining sources e.g. Camacho-Ibar (1992) found the level of mercury within sediments at the mouth of the Mersey Estuary to be almost six times higher than natural background levels as a result of the past discharges into the river from the chloro-alkali chemical industry. However, reduced inputs of mercury in recent times have resulted in some long-term reduction in sediment concentrations throughout the Liverpool Bay area (Leah *et al.*, 1993).

Although some of the trace and heavy metal contaminants were recorded as being above the ISQG levels, none were above the level of probable effect (PEL level). It is therefore determined that the areas sampled within and around the PDA and CRC areas do not harbour any sinks for metal contaminants and that all metal contaminant levels recorded were as expected for the sediments of the eastern Irish Sea.

Contaminants such as hydrocarbons reach the sediments of the marine environment via sewage discharges, surface run-off, industrial discharges, oil spillages, offshore oil and gas production activity and deposition from the atmosphere. The Irish Sea as a whole is thought to contain relatively large amounts of hydrocarbons attributable in particular to oil and gas extraction activity, shipping and proximity to pyrogenic sources (Defra, 2000). Levels of hydrocarbons in the sediment were found to be low across of the PDA and CRC areas and comparable to those from surveys in support of developments in this part of the Irish Sea.

Fauna

The analysis of the fauna from the grab and camera surveys found the stations to be extremely rich and generally very diverse in species, as is often typical of offshore sands and gravels (JNCC, 2015). All fauna identified has previously been recorded from the Irish Sea and analysis indicated that the faunal community at almost all of the stations was characterised by a relatively high abundance of the tube-building polychaete *Sabellaria spinulosa* and the highly aggregative ascidian *Dendrodoa grossularia*. The habitat was classified as being a best fit (rather than an excellent match) for the 'Deep Venus' complex (also known as the Boreal offshore gravel complex) on coarse gravelly sediments with patches of *Sabellaria spinulosa* biotope, as identified at the PDA and CRC. These are both very rich communities which can also be quite variable over time.

The 'Deep Venus' (which includes the MedLumVen habitat) biotope is prevalent throughout the offshore areas of the Irish Sea (Connor *et al*, 2004). Classification to this biotope was more of a best fit rather than an excellent match as although samples were very speciose not all defining species for these biotopes were present and low numbers of venerid bivalves were indeed recorded. Venerid bivalves are often under sampled in benthic grab surveys and as such may be inconspicuous in many infaunal data sets (Connor *et al.*, 2004). This is likely to be the case here. Additionally, Connor *et al*, (2004) also states that there are likely a number of sub-biotopes for this biotope complex which are yet to be defined (Connor *et al.*, 2004).

Potential Annex I reef habitat was identified as being present across the PDA and CRC areas. This reef habitat included biogenic reef (*Sabellaria spinulosa*), stony reef and exposed bedrock reef.

Although high numbers of *S. spinulosa* were recorded from across the PDA and CRC, the camera survey revealed that the aggregations were sparse and restricted to encrusting pebble and cobble and were generally not consolidating and therefore not considered to be reef. At one station on the CRC, the *S. spinulosa* aggregations had a greater elevation covering a larger area and were assessed as being of low-medium reefiness, although the patchiness was estimated at around 10%, which is at the lower limit of what is considered as reef. Epifauna recorded from this station were anemones including Urticina sp., hydroids including *H. falcata* and the keel worm, *P. triqueter.*

Low or medium quality stony reef was recorded from the camera survey at nine locations (one in the east of the PDA, the rest from within the CRC) these sites were considered as being likely epifaunal dominated but assessment of reef classification was interpreted mainly from the physical characteristics of the habitat rather than the epifauna which was mainly sparse. Epifaunal species included encrusting barnacles, tunicates, anemones and bryozoans.

At a further four stations (all located within the CRC), areas of bedrock were tentatively described as being of medium 'reefiness' (there are no current guidelines for determining bedrock reef quality). The associated epifauna for all four of these stations was neither rich nor diverse, typically consisting of scattered dahlia anemones with sparse hydroids, sponges and barnacles.

Although known to be present off the North Wales coastline (e.g. within the Pen Llyn a'r Sarnau SAC) no potential horse mussel (*M. modiolus*) reef (an Annex I reef habitat) was recorded in the survey. Elevated numbers of horse mussels recorded at two sites were not aggregated into reef formations. The 'tide-swept channel' habitat, a habitat of principal importance in Wales (previously UKBAP) was also considered but concluded not to have been recorded in the survey.

Most of the sediments at the PDA and CRC were described as being sublittoral sand and gravels (including muddy sands). This is a habitat of principal importance in Wales (formerly UKBAP) and is also a Marine Conservation Zone (MCZ) feature. Sand and gravel habitats are widespread in UK waters (JNCC, 2015). In deeper areas, these habitats can support some of the richest marine life communities with a variety of annelids, bivalves, anemones. Offshore gravel and sand habitats are also important habitats for commercially fished species such as scallops and flatfish and are also important nursery grounds for other commercially fished species and species of conservation interest e.g. elasmobranchs (JNCC, 2015).

No other rare or designated species or habitats were recorded.

5. REFERENCES

Avant P. (2008). *Dendrodoa grossularia*. Baked bean ascidian. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 01/10/2015]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3128>

Bibby HydroMap.(2015). Geophysical survey of the DeepGreen Project Development Area and associated Cable Route Corridor. Project report to Xodus Group.

Blott SJ and Pye K (2001). Gradistat: a grain size distribution and statistics package for the analysis of unconsolidated sediments. DOI: 10.1002/esp.261.

Buchanan JB (1984). Sediment Analysis In: Holme, N.A & McIntyre, A. Methods for the study of Marine Benthos. Blackwell Scientific Publications, London. pp 41-65.

Camacho-Ibar VF Wrench JJ and Head PC (1992). Contrasting Behaviour of Arsenic and Mercury in Liverpool Bay Sediments. Estuarine and Coastal Shelf Science. Vol 34, pp 23-36.

CMACS Ltd (2006). Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey Report. Surveys 9th - 10th November 2005. A report to NE Divers by CMACS Ltd June 2006.

Cole S Codling ID Parr W & Zabel T. (1999) Guidelines for managing water quality impacts within UK European marine sites. Prepared for the UK Marine SAC Project. Natura 2000

Connor DW Allen JH Golding N Howell KL Lieberknecht LM Northern KO and Reker JB (2004). The Marine Habitat Classification for Britain and Ireland. Version 04.05 JNCC, Peterborough. ISBN 1 861 07561 8 (internet version).

Defra. (2000). Quality Status report of the marine and Coastal Areas of the Irish Sea and Bristol Channel. Department for Environment, Food & Rural Affairs Report. www.defra.gov.uk/environment/marine/quality/05.htm.

Ecoserve (2001). A marine ecological study of the Arklow Bank for a proposed off-shore wind park development. Chapter 1. Baseline survey. April 2001.data

Elderfield H Thornton L and Webb JS (1971). Heavy metals and oyster culture in Wales. Marine Pollution Bulletin. Vol 2, pp 44-47.

Folk (1954). The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *Journal of Geology*, 62, 344-359.

Gubbay S (2007). Defining and managing *Sabellaria spinulosa* reefs: report of an inter-agency workshop. 1-2 May 2007. Joint Nature Conservation Committee, Peterborough. 405: 26pp.

Irving R (2009). The identification of the main characteristics of stony reef habitats under the Habitats Directive. JNCC Report No. 432.

Jackson A & Hiscock K. (2008). *Sabellaria spinulosa*. Ross worm. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 05/10/2015]. Available from: <http://www.marlin.ac.uk/speciesfullreview.php?speciesID=4278>

JNCC (2001). Marine Monitoring Handbook. March 2001. Joint Nature Conservation Committee. 20pp.

JNCC. (2015). Subtidal sand and gravel as Marine Conservation Zone Features of Interest. http://jncc.defra.gov.uk/page-6031-theme=default. Accessed September 2015.

Langston WJ Chesman BS Burt GR Hawkins SJ Readman J & Worsfold P (2003). Site characterisation of the South West European Marine Sites; Plymouth Sound and Estuaries cSAC, SPA. Report for Environment Agency and English Nature. 216pp.

Leah RT Evans SJ & Johnson MS. (1992). Arsenic in plaice (*Pleuronectes platessa*) and whiting (*Merlangius merlangus*) from the North east Irish Sea. Marine Pollution Bulletin. 24.pp 544-9.

Leah RT Collings SE Johnson MS & Evans SJ. (1993). Mercury in plaice (*Pleuronectes platessa*) from the Sludge Disposal Ground of Liverpool Bay. Marine Pollution Bulletin. 26(8). pp 436-9.

Limpenny DS Foster-Smith R Edwards TM Hendrick VJ Diesing M Eggleton JD Meadows WJ Crutchfield Z Pfeifer S & Reach IS. (2010) Best methods for identifying and evaluating *Sabellaria spinulosa* and cobble reef. ALSF Ref no MAL0008. Prepared for Natural England. 149pp.

Long D (2006). BGS detailed explanation of seabed sediment modified folk classification. a MESH project report, downloadable at: http://www.searchmesh.net/PDF/GMHM3_Detailed_explanation_of_seabed_sediment_classification.pdf

Moustafa YM & Morsi RE (2012). 9. Biomarkers. *In:* Biomarkers, Chromatography and Its Applications, Dr. Sasikumar Dhanarasu (Ed.), ISBN: 978-953-51-0357-8, InTech, Available from: http://www.intechopen.com/books/chromatography-and-its-applications/biomarkers, accessed 22 Dec 2015.

Deshpande AD, Dockum BW, & Tesolin-Gee AM (2001). Chapter III Petroleum Hydrocarbons in Sediments and Ribbed-Mussels. *In* Packer DB, editor.(2001). Assessment and characterization of salt marshes in the Arthur Kill (New York and New Jersey) replanted after a severe oil spill. NOAA Tech Memo NMFS NE 167; 218 p. Available from http://nefsc.noaa.gov/publications/tm/tm167/chapters/tm167p3.htm, accessed 22 Dec 2015

Picton BE & Howson CM eds (2000). The species directory of the marine fauna and flora of the British Isles and surrounding seas. Ulster Museum and The Marine Conservation Society, Belfast and Ross-on-Wye. CD-Rom Edition.

Thornton I Watling H and Darracott A (1975). Geochemical studies in several rivers and estuaries used for oyster rearing. Science of the total environment. Vol 4, pp 325-345.

Tyler-Walters, H., 2007. *Modiolus modiolus* Horse mussel. In Tyler-Walters H. and Hiscock K. (eds) *Marine Life Information Network: Biology and Sensitivity Key Information Reviews*, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/species/detail/1532

Appendix 1 Survey Position Fixes

Sample station	X_WGS84	Y_WGS84	X_UTM30N	Y_UTM30N	Notes
1	-4.794403	53.294022	380402.2	5906480.6	Possible *Sabellaria*
2	-4.790912	53.300907	380654.0	5907240.6	Possible *Sabellaria*
3	-4.784285	53.293723	381075.6	5906430.4	
4	-4.80175	53.290885	379903.7	5906143.9	Bedrock camera station only
5	-4.799557	53.296818	380066.5	5906800.3	
6	-4.789824	53.292527	380703.2	5906306.6	
7	-4.795046	53.305406	380391.1	5907748.0	Rough ground
8	-4.785324	53.301185	381027.2	5907262.2	
9	-4.788158	53.309826	380862.3	5908228.0	
10	-4.783455	53.312815	381184.0	5908552.7	
11	-4.780885	53.305622	381335.2	5907748.3	Rough ground
12	-4.778552	53.311457	381506.8	5908393.5	
13	-4.785603	53.306936	381024.5	5907902.3	
14	-4.82048	53.292538	378660.1	5906359.5	Reference station (near field)
15	-4.804991	53.319706	379768.7	5909355.3	Reference station (near field)
16	-4.796617	53.268956	380184.5	5903696.2	Reference station (near field)
17	-4.771135	53.304246	381981.1	5907579.1	Bedrock camera station only
18	-4.775261	53.317586	381743.0	5909069.8	Bedrock camera station only
19	-4.759563	53.316073	382784.5	5908875.6	
20	-4.739844	53.323082	384117.0	5909623.1	Possible *Sabellaria*
21	-4.745435	53.326206	383753.1	5909979.7	
22	-4.734344	53.329751	384501.2	5910356.0	Possible *Sabellaria*
23	-4.721662	53.323822	385329.9	5909676.0	
24	-4.721003	53.331114	385393.3	5910486.0	Possible *Sabellaria*

Sample station	X_WGS84	Y_WGS84	X_UTM30N	Y_UTM30N	Notes
25	-4.705757	53.335922	386421.2	5910996.5	Bedrock camera station only
26	-4.759635	53.31036	382764.0	5908240.3	
27	-4.728884	53.321008	384841.3	5909374.7	Possible *Sabellaria*
28	-4.714642	53.326888	385805.5	5910005.8	
29	-4.703179	53.326528	386568.0	5909947.5	
31	-4.673871	53.338877	388551.9	5911275.0	
32	-4.666905	53.336037	389008.3	5910948.2	Bedrock camera station only
33	-4.652111	53.333258	389986.2	5910616.2	
30	-4.685847	53.332822	387738.7	5910620.3	Possible bedrock maybe camera station only
34	-4.63548	53.339294	391108.9	5911262.2	
35	-4.616078	53.336406	392393.3	5910911.6	
36	-4.596539	53.332317	393684.1	5910427.4	
37	-4.599913	53.321505	393432.5	5909229.7	
38	-4.750299	53.340012	383466.8	5911523.3	Cable route reference station
39	-4.692353	53.350938	387353.3	5912645.6	Cable route reference station
40	-4.713192	53.309428	385855.5	5908061.4	Cable route reference station
41	-4.630739	53.322965	391383.1	5909438.6	Cable route reference station

Appendix 2 Field notes from Camera survey

Station Number	Date	Time (BST)	Depth (m)	Fix on bottom	Image Number	Description & notes
36	24/6/15	16:15	12.6	48 to 50	18 to 23	Boulders covered in silt and epifauna. *Asterias rubens*, hydroids and one anemone.
35	24/6/15	16:42	22.1	52 to 56	24 to 31	Coarse seabed, pebble, gravel, some cobble. Possible encrusting *Sabellaria*, hydroids
34	24/6/15	17:06	25.0	57 to 61	32 to 37	Shelly gravel with hermit crab (one image) and hydroid, possibly *Rhizocaulus*.
33	24/6/15	17:16	26.2	62 to 66	38 to 43	Gravel and *Modiolus* shell. Hermit crab, some hydroid.
32	24/6/15	17:36	28.0	67	44	Only one image which was a veneer of sediment over bedrock, numerous *Urticina* sp.
37	24/6/15	18:08	10.8	68 to 72	45 to 50	Sand and silt
32	25/6/15	08:55	28.6	73 to 76	51 to 54	Gravel and shell, pebbles with abundant hydroids
31	25/6/15	09:20	30.8	77 to 81	55 to 59	Clean gravel and pebble. Two *Urticina* sp. in image 59.
30	25/6/15	09:35	34.5	82 to 86	60 to 64	Clean pebble and cobble, some encrusting growths and *Urticina* sp.
25	25/6/15	09:50	37.1	87 to 89	65 to 67	Cobbles and boulder over bedrock. Numerous *Urticina* sp., *Henricia* and *Crossaster*, hydroids.
29	25/6/15	15:50	N/A	N/A	68	Coarse seabed. Currents very strong and pulled camera over. Small-spotted catshark in video.
29	27/6/15	06:35	39.2	108	69	Boulder or cobbles with abundant epifauna including hydroids, *Urticina* and keelworm

Station Number	Date	Time (BST)	Depth (m)	Fix on bottom	Image Number	Description & notes
28	27/6/15	06:49	40.7	109	70	Boulder and cobble with epifauna
24	27/6/15	07:00	43.8	110	71	Pebbles with *Sabellaria* and an *Asterias rubens*
41	27/6/15	07:29	51.9	111	72	Pebbles with some *Sabellaria* tubes
23	27/6/15	07:48	42.5	112	73	Cobble, boulder with epifauna including *Urticina*
27	27/6/15	07:58	47.4	113	74	Pebble and gravel, some *Sabellaria*, prawn seen in video
22	27/6/15	08:09	53.8	114	75	Pebble and gravel, some *Sabellaria*
20	27/6/15	08:20	54.9	115	76	Pebble, gravel, shell and cobble
21	27/6/15	08:30	63.6	116	77	Pebble and cobble, *Urticina*, *Asterias* and hydroids
19	27/6/15	08:42	69.7	118	78	Cobble and pebble, one *Urticina*
26	27/6/15	08:55	55.0	119	79	Cobble and pebble
17	27/6/15	09:22	56.0	120	80	Bedrock with *Flustra* and sponges
11	27/6/15	09:30	82.6	122	81 & 82	Pebbles and cobbles, visibility not great owing to strong tide
8	27/6/15	09:38	83.6	123	83	Camera on its side? Some *Flustra* seen
2	27/6/15	09:49	N/A	N/A	-	No visibility, camera probably landed on its side
38	27/6/15	10:48	79.3	125	84	Gravel and pebble, one *Urticina*

Station Number	Date	Time (BST)	Depth (m)	Fix on bottom	Image Number	Description & notes
39	27/6/15	11:37	39.8	126	85	Gravel and pebble, hydroids, barnacles and hermit crabs
18	29/6/15	14:44	74.0	173	86	Visibility not great, bedrock with barnacles and *Urticina* and painted topshell
12	29/6/15	14:54	71.0	175	87	Stills camera froze only got an image just as the camera lifted off the seabed. Seabed of pebbles with barnacles and hydroids
10	29/6/15	15:05	84.6	177	88	Pebble and cobble, *Flustra* and *Asterias*, hydroids
9	29/6/15	15:17	88.4	178	89	Pebbles and gravel with some shell, hydroids. Dogfish on video
13	29/6/15	15:26	85.7	180	90	Pebble and sand with hydroids
7	29/6/15	15:41	86.8	181	91	Pebble and shell with hydroids and gravel
2	29/6/15	15:51	88.0	182	92 & 93	Pebble, gravel and shell. Hydroids and some encrusting *Sabellaria*
8	29/6/15	16:03	79.8	183	94	Cobble and pebble with *Asterias*
3	29/6/15	16:16	75.3	184	95	Cobble and boulder with hydroid
6	29/6/15	16:29	79.5	185	96	Pebble and gravel with *Urticina* and hydroid and *Flustra*
1	29/6/15	16:36	81.2	186	97 & 98	Sand and shell possibly with boulder or cobble
5	29/6/15	16:45	80.4	187	-	No still image – fault with camera, video okay. Pebble, gravel and cobble, quite clean some serpulids
4	29/6/15	16:57	81.5	188	99	Pebble and gravel
16	29/6/15	17:16	67.0	189	100	Sand, shell and gravel with hydroids. Broken *Sabellaria* tubes make up much of sediment, some pebble

Station Number	Date	Time (BST)	Depth (m)	Fix on bottom	Image Number	Description & notes
14	29/6/15	17:36	51.6	190	101	Gravel, pebble and shell
15	29/6/15	17:50	63.9	191	102	Very poor visibility but looks like pebble and gravel with a starfish.

Appendix 3. Field notes from Grab survey

Sample number	Date	Time (UTC)	Depth (m)	Fix	Sample volume (litres)	Sediment description
35b	25/6/15	11:21	19.3	18091	5	Sand, gravel, pebble, larger particles, some epifauna. Attempt a (fix 18090) failed to obtain a suitable sample.
35d	25/6/15	11:34	19.7	18093	5	Sand, gravel, pebble, larger particles, some epifauna. Attempt c (fix 18092) failed to obtain a suitable sample.
34a	25/6/15	11:49	22.6	18094	6	Sand and gravel
34d	25/6/15	11:57	22.6	18097	2	Sand, gravel, pebble, *Sabellaria* aggregation. Kept for PSA but not contaminants. Attempts b & c (fixes 18095 and 18096) failed to obtain a suitable sample.
33a	25/6/15	12:11	24.8	18098	7	Shelly sand and gravel, some pebble, *Sabellaria* aggregations encrusting pebble
33b	25/6/15	12:13	24.2	18099	5	Shelly sand and gravel with some pebble
31b	25/6/15	12:32	30.5	18102	6	Coarse sand, pebble and gravel, large polychaete, hermit crab, anemone. Attempt a (fix 18101) failed to obtain a suitable sample.
31d	25/6/15	12:39	30.6	18104	7	Pebble and gravel with some coarse sand and shell. Attempt c (fix 18103) failed to obtain a suitable sample.
30	25/6/15	12:59	34.9	18105-7		Three attempts, all unsuccessful (no sample at all)
37	27/6/15	11:31	8.4	18127-34	≤2	3 attempts with Day grab, 5 attempts with Hamon grab. Small samples of fine sand and pebble. No sample taken.
41	29/6/15					3 attempts, no sample, a few grains of sand in grab (re-attempted on 1st July)
24	29/6/15					As above

Sample number	Date	Time (UTC)	Depth (m)	Fix	Sample volume (litres)	Sediment description
27b	29/6/15	07:25	47.6	18141	≈3	Small sample but taken for fauna. Attempt a (fix 18140) failed to obtain a suitable sample.
27c	29/6/15	07:34	44.9	18142	≈2	Small sample but taken for PSA only
20a	29/6/15	07:49	54.9	18143	≈3	Cobble, pebbles, some finer sediment, anemones, crab, hydroids.
20d	29/6/15	08:00	54.8	18146	≈2	1 large cobble and some pebbles. No sample kept. *Sabellaria* on the cobble. Attempts b & c (fixes 18144 and 18145) failed to obtain a suitable sample.
21	29/6/15	08:10	62.0	18147-49	≤1	Pebble and gravel. Some shell fragments and soft clay (?), barnacles. No sample obtained.
22c	29/6/15	08:39	53.2	18152	2-3	Pebble, gravel, shells, some sand and clay. *Sabellaria* tubes. Small sample but kept for fauna. Attempts a & b (fixes 18150 and 18151) failed to obtain a suitable sample.
22d	29/6/15	08:43	52.2	18153	2-3	As above. Kept for PSA but not enough fine sediment for contaminants
38b	29/6/15	09:03	79.5	18156	8	Pebbles, gravel, clay and shell fragments. Some barnacles and hydroids. Fix 18154 was a failure grab failed to fire. Attempt a (fix 18155) failed to obtain a suitable sample.
38c	29/6/15	09:07	80.9	18157	8	Pebbles, gravel, clay and shell fragments. Some barnacles and hydroids.
19a	29/6/15	09:27	66.7	18158	3	Pebble and gravel, taken for fauna.
19e	29/6/15	09:54	68.8	18162	5	Pebble and gravel with clay and shell fragments. Attempts b to d (fixes 18159 to 18161) failed to obtain a suitable sample. Attempt c had a good sample but a large cobble was in the jaw of the grab
11b	29/6/15	10:14	84.3	18164	5	Clay, pebble, gravel, shell. Attempt a (fix 18163) obtained 3 litres of sediment - discarded.

Sample number	Date	Time (UTC)	Depth (m)	Fix	Sample volume (litres)	Sediment description
11c	29/6/15	10:19	80.9	165	5	Clay, pebble, grave and shell
24c	29/6/15	10:56	44.3	166	5	Clay, pebble, gravel and shell. Taken for fauna. Attempts a & b (fixes 18167 and 18168) obtained a suitable sample but stones were caught in the jaws.
39	29/6/15	11:32	39.7	18169-72	≤1	Pebble, gravel, some sand and shell, encrusting *Sabellaria*, hydroids, *Psammechinus miliaris*
12b	1/7/15	12:09	76.7	19490	6	Some clay, mostly pebble, hydroids
12d	1/7/15	12:21	77.8	19492	5	Some clay and pebble, large cobble caught in jaws. Kept a PSA sample but not contaminants.
10a	1/7/15	12:35	86.7	19494	8	Clay and pebble and hydroids
10b	1/7/15	12:42	86.3	19495	8	Clay and pebble and hydroids
9b	1/7/15	12:58	88.7	19497	6	Clay, shell fragments, pebble and gravel, hydroid. 9a good sample but stones in jaws.
9c	1/7/15	13:05	88.4	19498	5	Clay, shell fragments, pebble and gravel, hydroid.
13b	1/7/15	13:23	88.3	19500	6	Clay, shell, pebble and gravel, *Sabellaria* tubes, hydroids 13a: good sample but stone in jaws
13c	1/7/15	13:29	87.4	19501	6	Clay, pebble and gravel, some shell and sand. Spider crab and large polychaete.
7a	1/7/15	13:37	86.8	19502	6	Attempt a: Stone in jaws. Mud, pebble and gravel, abundant hydroids, *Pisidia*, kept for fauna but note stone in jaws. Attempt b: 1 litre of sediment, gravel, pebble and shell fragments
7c	1/7/15	13:50	86.3	19504	6	Attempt c: cobble, pebble, gravel and clay

Sample number	Date	Time (UTC)	Depth (m)	Fix	Sample volume (litres)	Sediment description
						Attempt d: 1 litre of sediment, station abandoned
2a	1/7/15	14:04	88.3	19506	5	First attempt large cobble in jaws (see photo). Sample kept for PSA. Second attempt less than 1 litre of sediment.
2c	1/7/15	14:15	88.7	19509	6	Kept for fauna. Clay, pebble and gravel. Crabs and hydroid.
8a	1/7/15	14:24	81.3	19510	8	Clay, pebble, hydroids. 2nd attempt sample ≤1 litre.
8c	1/7/15	14:34	80.4	19512	6	Cobble, pebble and clay
6a	1/7/15	14:44	78.4	19513	8	Clay, sand, pebble.
6b	1/7/15	14:48		19514	≤1	Pebbles. Attempt c (fix 19515) also failed. Faunal sample only at this station
1a	1/7/15	15:00	80.9	19517	4	First sample kept for fauna. Cobble and pebble with *Sabellaria*. Second sample *Sabellaria* 1 litre of sediment. Third attempt <1 litre of sediment
5a	1/7/15	15:17	79.5	19520	3	Cobble, pebble, gravel and clay. Fail
5b	1/7/15	15:22	79.8	19521	1	Cobble, pebble and gravel. Fail. Attempt c (fix 19522) <1 litre sediment.
4b	1/7/15	15:41	81.6	19524	5	Pebble, gravel, some clay, gravel
4c	1/7/15	15:47	81.3	19525	8	Cobble, pebble and clay
16a	1/7/15	16:00	64.3	19526	7	Cobble, pebble, gravel, sand and clay
16b	1/7/15	16:05	66.8	19527	8	Cobble, pebble, gravel, sand and clay
14a	1/7/15	16:20	49.3	19528	≈2	Pebble, gravel and shell, some sand. Hydroids. Attempt b (at 16:23, fix 19529) similar. Stones in jaws and samples rejected.

Sample number	Date	Time (UTC)	Depth (m)	Fix	Sample volume (litres)	Sediment description
14c	1/7/15	16:23	49.0	19530	≤1	Pebble, gravel and shell, some sand. Stones in jaws and sample rejected.
15a	1/7/15	16:42	60.6	19531	8	Almost solid lump of clay with some pebble and gravel
15b	1/7/15	16:46	60.2	19532	8	Almost solid lump of clay with some pebble and gravel. *Asterias rubens* and *Pisa* sp. in sample.
41d	1/7/15	17:13	49.0	19533	≤1	Pebble and gravel some shell. Brittlestar. Attempt e (at 17:19, fix 19534) ≈2 litres of sediment; pebble, gravel and shell.
41f	1/7/15	17:22	49.1	19535	≈2	Pebble, gravel and shell
24d	1/7/15	17:28	42.3	19536	≤1	Pebble and gravel.

Appendix 4. Sediment and faunal grab success and failures

Station	Fauna	PSA	Contaminants	Notes
1	-	x	x	could not get a suitable second grab
2		-	x	cobble in jaws of psa, not enough for contaminants
3	x	x	x	not sampled
4				
5	x	x	x	station abandoned
6		x	x	could not get a suitable second grab
7	-			stone in jaws
8				
9				
10				
11				
12		-	x	stone in psa jaw not enough for conts
13				
14	x	x	x	station abandoned
15				
16				
17	x	x	x	not sampled
18	x	x	x	not sampled
19	-			
20	-	x	x	no sample suitable for psa/conts analysis
21	x	x	x	station abandoned
22	-	-	x	not enough for cont
23	x	x	x	not sampled
24		x	x	no sample suitable for psa/conts analysis
25	x	x	x	not sampled
26	x	x	x	not sampled
27	-	-	x	not enough for contaminants
28	x	x	x	not sampled
29	x	x	x	not sampled
30	x	x	x	station abandoned
31				
32	x	x	x	not sampled
33				
34		-	x	not enough for contaminants
35				

32	x	x	x	not sampled
37	x	x	x	station abandoned
38				
39	x	x	x	station abandoned
40	x	x	x	not sampled
41	x	x	x	station abandoned
42	x	-	x	due to sediments being from hand held van veen grab

Key

x	No suitable sample obtained
-	Sample below QC standards taken
	Sample conforming to QC standards taken
x	Station identified as bedrock on video so no grab deployed

Appendix 5. Particle size analysis data

	Mesh size, mm													Mesh size, µm												
Station	90.0	63.0	45.0	31.5	22.4	16.0	11.2	8.0	5.6	4.0	2.8	2.0	1.4	1.0	707	500	355	250	177	125	88	63	<63	Gravel	Sand	Mud	Sediment type
DG2	0.0	0.0	0.0	18.8	11.3	2.1	1.8	0.9	1.1	2.0	4.3	6.4	9.3	13.7	11.3	5.5	4.9	2.2	0.8	0.5	0.4	0.4	2.4	48.7	48.9	2.4	Sandy Gravel
DG4	0.0	50.1	0.0	7.0	6.0	0.5	3.0	2.8	2.7	1.6	1.6	1.3	1.1	2.5	3.5	3.6	5.5	2.7	0.6	0.3	0.4	0.4	2.9	76.5	20.6	2.9	Muddy Sandy Gravel
DG7	0.0	0.0	24.0	28.1	2.4	1.1	1.5	1.9	3.9	3.5	2.7	2.1	3.1	5.1	6.2	4.5	4.5	1.8	0.6	0.3	0.3	0.3	2.4	71.1	26.5	2.4	Sandy Gravel
DG8	19.6	16.6	24.2	4.8	2.6	2.2	1.9	1.6	1.0	0.8	1.1	1.1	0.9	2.4	4.0	4.7	5.0	1.2	0.7	0.4	0.4	0.3	2.4	77.6	20.0	2.4	Muddy Sandy Gravel
DG9	0.0	0.0	30.6	10.1	11.1	1.9	1.7	0.9	1.4	3.4	5.4	4.0	3.3	5.7	4.8	3.4	3.6	1.6	0.6	0.4	0.5	0.5	4.9	70.7	24.4	4.9	Muddy Sandy Gravel
DG10	0.0	0.0	23.2	25.4	5.5	7.6	2.5	1.1	0.8	0.6	1.2	1.4	1.9	3.9	6.8	5.0	3.8	1.4	0.7	0.6	0.6	0.6	5.5	69.2	25.3	5.5	Muddy Sandy Gravel
DG11	0.0	0.0	27.1	27.4	4.8	0.8	5.2	1.9	2.4	2.1	2.3	2.5	3.8	4.1	4.2	3.2	3.1	1.1	0.6	0.3	0.4	0.3	2.4	76.5	21.1	2.4	Muddy Sandy Gravel
DG12	0.0	0.0	38.7	12.3	5.2	6.6	3.2	3.7	2.6	2.0	2.1	2.4	3.1	3.7	2.9	2.1	2.2	1.2	0.8	0.6	0.6	0.5	3.7	78.7	17.6	3.7	Muddy Sandy Gravel
DG13	0.0	0.0	17.5	19.7	13.7	3.5	2.6	1.5	1.1	0.9	1.0	1.3	2.5	8.5	10.9	5.2	3.7	1.2	0.6	0.4	0.5	0.4	3.2	63.0	33.9	3.2	Sandy Gravel
DG15	0.0	0.0	16.4	18.6	8.4	3.7	2.0	1.3	2.4	2.3	2.5	2.0	2.4	5.2	6.3	5.4	7.1	4.5	1.6	0.6	0.8	0.7	6.0	59.5	34.5	5.9	Muddy Sandy Gravel
DG16	0.0	0.0	46.7	0.0	1.8	2.1	1.7	1.8	1.8	1.4	1.9	2.3	1.8	4.4	9.8	8.7	5.8	2.4	0.6	0.3	0.4	0.4	4.1	61.3	34.6	4.1	Muddy Sandy Gravel
DG19	0.0	0.0	37.5	11.3	3.4	5.7	3.4	2.1	2.3	2.7	3.5	3.9	3.4	4.4	3.7	1.8	1.4	1.1	1.3	0.9	0.9	0.6	4.6	75.9	19.5	4.6	Muddy Sandy Gravel
DG22	0.0	0.0	0.0	26.5	14.5	3.3	3.6	2.5	2.0	1.6	1.7	2.4	4.0	5.5	6.8	8.0	8.6	4.3	1.3	0.4	0.4	0.4	2.2	58.1	39.8	2.2	Sandy Gravel
DG27	0.0	0.0	32.1	6.5	19.8	6.0	2.3	5.8	3.2	1.9	2.0	2.0	3.5	4.0	3.5	2.2	2.2	1.6	0.5	0.1	0.1	0.1	0.4	81.8	17.8	0.4	Gravel
DG31	0.0	0.0	0.0	13.5	15.2	3.7	4.4	7.6	8.4	6.7	6.3	4.2	4.6	6.9	7.4	4.3	2.8	1.5	1.0	0.3	0.2	0.1	1.0	69.9	29.1	1.0	Sandy Gravel
DG33	0.0	0.0	0.0	0.0	0.7	1.0	1.2	2.6	4.6	5.3	5.2	2.6	7.5	13.9	15.8	11.2	12.7	9.2	3.5	0.8	0.5	0.1	1.6	23.2	75.1	1.6	Gravelly Sand
DG34	0.0	0.0	0.0	0.0	0.0	1.4	2.0	2.4	6.1	7.2	5.2	3.2	5.6	8.6	10.2	8.0	11.0	15.5	8.9	1.4	0.7	0.3	2.1	27.6	70.3	2.1	Gravelly Sand
DG35	0.0	0.0	21.2	14.7	0.0	1.4	4.2	2.6	3.8	4.2	4.6	3.9	4.5	5.6	5.0	3.8	4.9	4.3	4.3	2.4	1.5	0.6	2.6	60.5	37.0	2.6	Sandy Gravel
DG38	0.0	0.0	18.0	10.0	11.4	6.5	4.3	1.8	2.7	2.4	3.5	3.9	6.8	8.6	5.2	2.3	2.3	2.2	1.7	0.8	0.7	0.5	4.4	64.6	31.0	4.4	Muddy Sandy Gravel
DG42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	9.9	23.7	25.6	8.3	32.6	0.0	67.4	32.3	Muddy Sand

All table values are percentages of the sample in each fraction.

Appendix 6. Total organic content (from loss on ignition)

Sample	Crucible No	Weight Empty	Wt with Air Dry Soil	Wt Oven Dry	Wt After Ignition	% Moisture	% LOI
DG2	10	10.6959	17.2985	17.2688	17.1859	0.449823	1.261239
DG4	11	10.606	14.3632	14.3367	14.2719	0.705312	1.736939
DG7	12	10.618	15.0816	15.0163	14.9517	1.462945	1.468749
DG8	13	10.4475	13.9518	13.9303	13.8704	0.613532	1.719881
DG9	14	10.3411	13.7929	13.7434	13.6681	1.434034	2.213209
DG10	15	10.5832	14.0186	13.9891	13.9116	0.858706	2.275463
DG11	16	10.7615	15.2766	15.2249	15.1327	1.145047	2.06569
DG12	17	10.5361	13.8132	13.7867	13.695	0.808642	2.821018
DG13	18	10.4941	14.4813	14.4599	14.3927	0.536717	1.694488
DG15	19	10.8672	14.5002	14.4692	14.4007	0.853289	1.901721
DG16	20	10.5855	14.2708	14.2465	14.1796	0.659376	1.82737
DG19	21	10.3038	13.9123	13.8735	13.7852	1.075239	2.473597
DG22	22	10.5813	14.8328	14.8146	14.7501	0.428084	1.523634
DG27	23	10.7654	14.7251	14.6667	14.6128	1.474859	1.381591
DG31	24	9.4252	13.9933	13.9752	13.9198	0.396226	1.217582
DG33	25	10.7359	15.009	14.9923	14.9382	0.390817	1.271027
DG34	26	10.509	14.9301	14.9102	14.865	0.450114	1.026993
DG35	27	10.7491	15.2864	15.2603	15.195	0.575232	1.447508
DG38	28	10.3761	13.855	13.8273	13.7481	0.796229	2.294854
DG 42	9	10.183	13.054	13.0326	12.9682	0.745385	2.259966

Appendix 7. Hydrocarbon Contaminant analysis results

SAMPLE NUMBER	DG7	DG8	DG9	DG10	DG11	DG13	DG15	DG16	DG19	DG31	DG33	DG35	DG38
Compound	Amount (µg/g)												
nC9	0.00000	0.01963	0.00000	0.01729	0.01979	0.01917	0.04558	0.033704	0.062219	0.007759	0.046648	0.039518	0.008581
nC10	0.47010	0.32677	0.51742	0.55968	0.48214	0.57219	0.41697	0.385403	0.550431	0.746336	0.557298	0.514175	0.349608
nC11	0.10349	0.07217	0.11005	0.12763	0.10377	0.11765	0.09177	0.076529	0.112385	0.125182	0.109398	0.097055	0.068467
nC12	0.02849	0.01514	0.03323	0.02158	0.01905	0.02540	0.02427	0.016411	0.027416	0.014933	0.020028	0.012956	0.490499
nC13	0.00356	0.00486	0.00404	0.00494	0.00410	0.00394	0.00337	0.005727	0.007282	0.006631	0.003156	0.002498	0.002129
ISA Heptamethylnonane													
nC14	0.02057	0.02990	0.03059	0.03647	0.03662	0.02462	0.04553	0.031088	0.031769	0.009228	0.032814	0.017582	0.034193
nC15	0.01838	0.03124	0.00297	0.03371	0.03122	0.02386	0.00609	0.025635	0.030968	0.016526	0.028003	0.018295	0.01081
ISB D34													
nC16	0.01649	0.02160	0.02400	0.03110	0.02738	0.01842	0.03696	0.021436	0.021861	0.005668	0.024849	0.014461	0.019383
nC17	0.02378	0.06699	0.03868	0.05760	0.04858	0.03113	0.06838	0.03665	0.05913	0.022938	0.040881	0.025409	0.037125
Pristane	0.01258	0.02025	0.02338	0.02377	0.02925	0.01681	0.06468	0.020196	0.021817	0.004262	0.027238	0.019212	0.034547
nC18	0.03004	0.04478	0.05598	0.06482	0.05508	0.00314	0.23540	0.040802	0.002963	0.010255	0.005286	0.030101	0.261771
Phytane	0.00972	0.01590	0.01411	0.02021	0.01111	0.00911	0.01227	0.015545	0.013989	0.010377	0.013496	0.011495	0.005162
nC19	0.00805	0.00734	0.00819	0.01453	0.01228	0.00408	0.02243	0.006835	0.007292	0.005269	0.010645	0.006408	0.048473
ISC Squalane													
nC20	0.01944	0.02719	0.03175	0.03257	0.03184	0.02367	0.04824	0.031602	0.029143	0.018182	0.031575	0.015942	0.029322
nC21	0.01701	0.02620	0.02816	0.03192	0.03530	0.02005	0.05502	0.029514	0.02622	0.036781	0.030189	0.017088	0.024866
nC22	0.04460	0.08879	0.09358	0.08759	0.09897	0.06649	0.91486	0.076482	0.113361	0.084351	0.084124	0.041256	2.388225
nC23	0.01180	0.02416	0.02981	0.02614	0.03113	0.02072	0.16545	0.017818	0.030236	0.004061	0.028099	0.013965	0.345601
nC24	0.00253	0.00682	0.00704	0.00914	0.00786	0.00616	0.02796	0.004226	0.006293	0.00508	0.006441	0.005397	0.015326
nC25	0.02225	0.02775	0.03147	0.03868	0.04027	0.02308	0.04660	0.078486	0.027157	0.243772	0.03221	0.016025	0.016722
nC26	0.01031	0.05777	0.06055	0.05607	0.02946	0.01959	0.03326	0.114377	0.022336	0.469331	0.054458	0.012013	0.168677
ISD D42 Eicosane													
nC27	0.06034	0.08998	0.09480	0.12426	0.12078	0.07533	0.13946	0.131837	0.094501	0.481809	0.094138	0.048411	0.160879
nC28	0.04812	0.06803	0.05871	0.07049	0.09219	0.04440	0.07478	0.098292	0.047973	0.432853	0.057325	0.043529	0.057814

SAMPLE NUMBER	DG7	DG8	DG9	DG10	DG11	DG13	DG15	DG16	DG19	DG31	DG33	DG35	DG38
Compound	Amount (µg/g)												
nC29	0.12171	0.21561	0.24295	0.27493	0.29049	0.18168	0.65486	0.199453	0.242426	0.377688	0.201601	0.096598	0.004747
nC30	0.04861	0.13140	0.14606	0.11432	0.12719	0.10224	0.34108	0.111115	0.162041	0.269358	0.11593	0.044762	0
nC31	0.09436	0.15350	0.12914	0.24138	0.20306	0.11987	0.19801	0.118389	0.146332	0.177438	0.127509	0.063755	0.399722
nC32	0.01931	0.04453	0.03624	0.04791	0.05840	0.02928	0.04760	0.044691	0.038609	0.120945	0.040224	0.026903	0.023134
nC33	0.04594	0.07201	0.06605	0.09769	0.10856	0.05793	0.10119	0.061045	0.069587	0.088848	0.068421	0.035347	0.252327
nC34	0.02724	0.05760	0.05620	0.06553	0.06902	0.04357	0.24762	0.036175	0.06115	0.010938	0.041677	0.02915	0.013654
nC35	0.01631	0.01711	0.02836	0.02646	0.03680	0.01515	0.07314	0.020089	0.019565	0.041455	0.016536	0.016794	0.085285
nC36	0.01506	0.02680	0.02872	0.03708	0.03333	0.01881	0.02156	0.01967	0.023924	0.0274	0.013277	0.014663	0.218617
nC37	0.02733	0.01251	0.00439	0.03725	0.00874	0.00151	0.20348	0.005568	0.018951	0.009726	0.005724	0.009048	0.052515
nC38	0.00800	0.00000	0.01540	0.01974	0.01648	0.01334	0.01035	0.014187	0.016752	0.016055	0.007835	0.008596	0.624306
nC39	0.01189	0.03516	0.01467	0.02413	0.06075	0.01287	0.01959	0.00759	0.01254	0.014146	0.0073	0.008484	0.036991
nC40	0.00991	0.02420	0.01713	0.02582	0.02371	0.00865	0.00000	0.008816	0.011893	0.01121	0.00626	0.00978	0.039613
Total area nC9-nC40 (inc UCM and IS)	0.01341	0.02430	0.02615	0.02911	0.02892	0.01697	0.03441	0.02025	0.02672	0.012482	0.016176	0.010786	0.059869
Total Resolved µg/g	0.00227	0.00300	0.00303	0.00358	0.00347	0.00268	0.00604	0.002954	0.00305	0.004967	0.002889	0.002258	0.0086
UCM µg/g	0.01115	0.02129	0.02312	0.02552	0.02546	0.01429	0.02836	0.01729	0.02367	0.00751	0.01329	0.00853	0.05127

Appendix 8 Faunal Data from grab survey

'3279 Xodus Group (Deep Green Benthic Technical Report) v1 App 8' is provided under separate cover.

Appendix 9 Drop down camera Analysis

‘3279 Xodus Group (Deep Green Benthic Technical Report) v1 App 9’ is provided under separate cover.