Appendix 8-2:
Benthic Survey Report

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Environmental Impact Assessment Report
Appendix 8-2: Benthic Survey Report

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Oriel Wind Farm
Benthic Studies

Produced by

AQUAFACT International Services Ltd

On behalf of

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AQUAFACT

Table of Contents

List of Figures

List of Tables

List of Appendices

1. Introduction

Parkwind commissioned AQUAFACT to carry out a marine benthic survey of the Oriel wind farm site and proposed cable route in order to characterise the baseline environment in terms of its sediment composition and faunal communities.

An infaunal grab sampling survey and underwater drop down video survey was carried out at the station location illustrated in Figure 1.1 below.

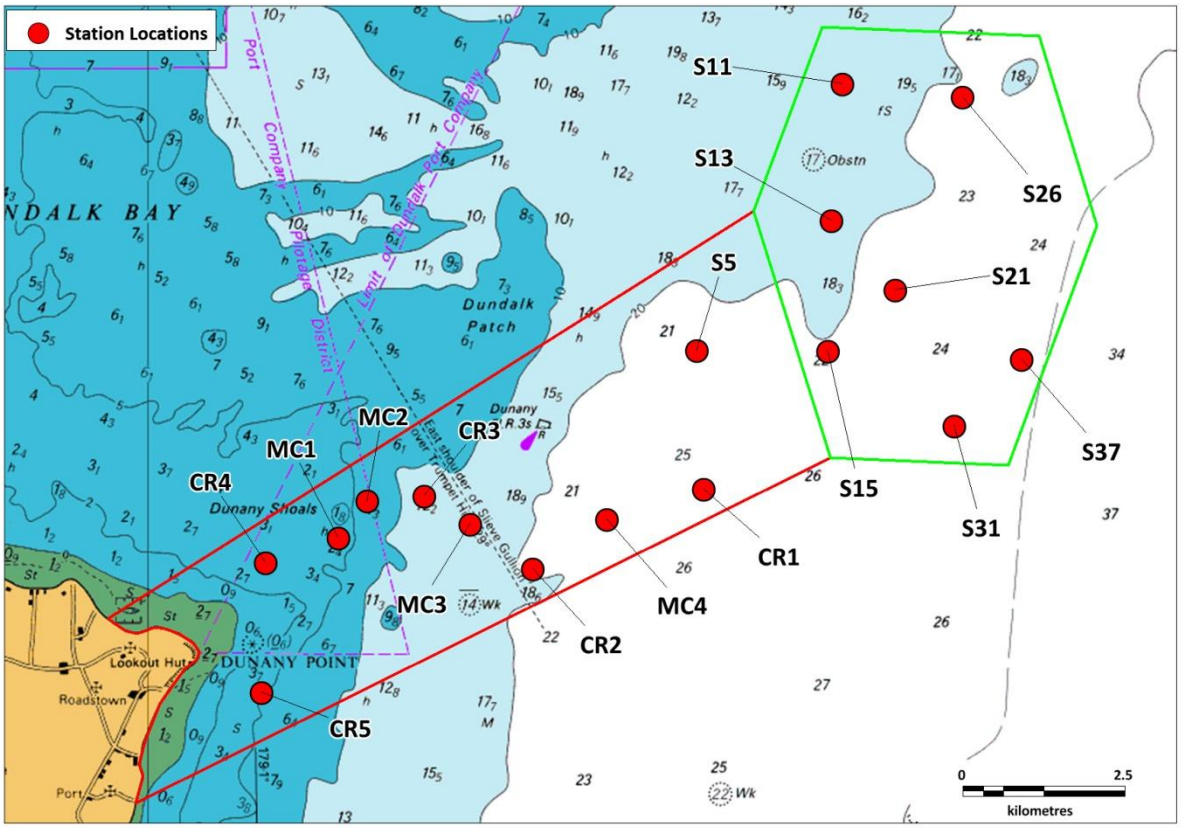


Figure 1.1: Location of the stations surveyed at Oriel Wind Farm (green outline) and cable route area (red outline).

2. Benthic Grab Survey

2.1. Materials & Methods

2.1.1. Sampling Procedure

To carry out the subtidal benthic assessment of the Oriel Wind farm and cable route, AQUAFACT grab sampled a total of 10 stations and surveyed a further 9 locations with drop down video camera. Sampling took place on the 21st October and 3rd December 2019 from Fastnet Shipping's vessel *Petrel.* Sea state was calm with a slight (5kt) northwesterly breeze in the October survey. Sea state was choppy with an 11kt southwesterly breeze. Figure 2.1 shows the location of the grab stations and video stations surveyed and Table 2.1 shows the station coordinates and depths.

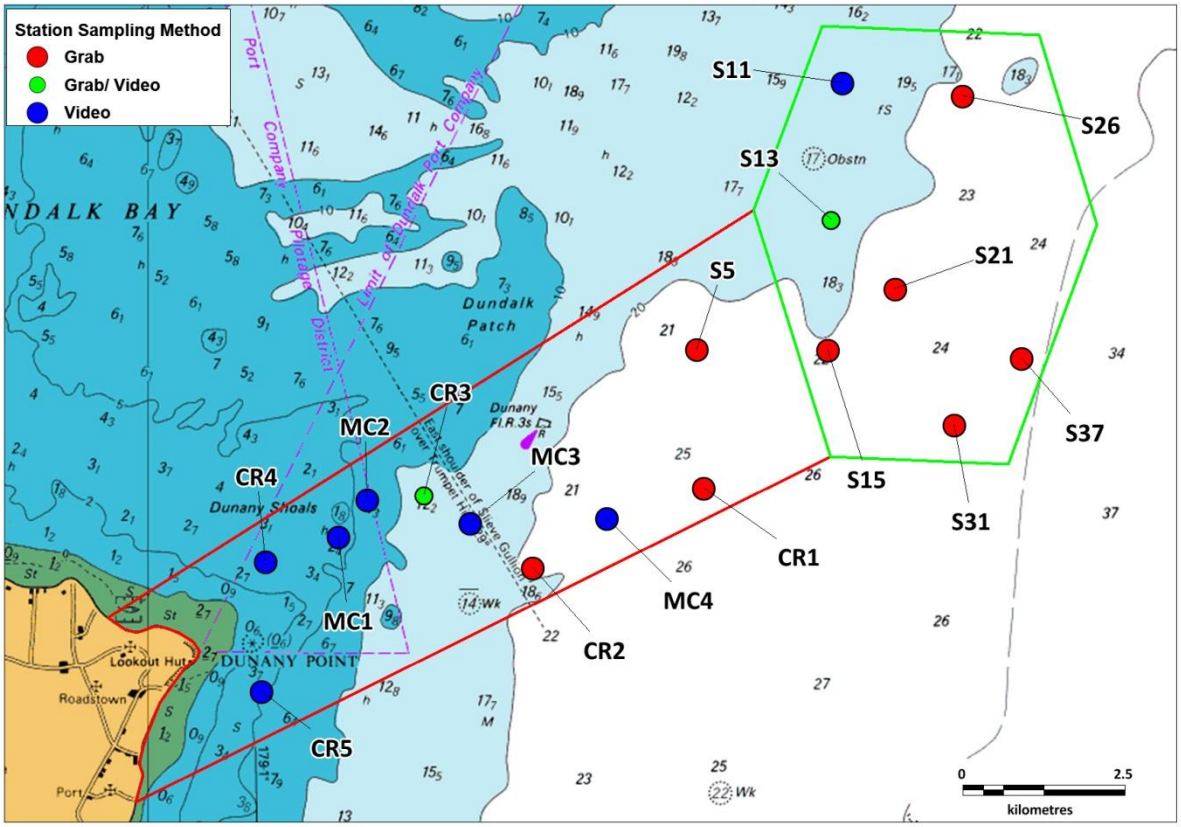


Figure 2.1: Location of the grab stations and video transect locations surveyed on the 12th October and 3rd December 2019.

Table 2.1: Station coordinates and depths at the grab stations and video transect locations.

Station	Latitude	Longitude	Depth (m)	Survey method
CR1	53.8836°	-6.1203°	27	Video
CR2	53.8725°	-6.1605°	21	Video
CR3	53.88269°	-6.18616°	15	Grab & Video
CR3	53.8824°	-6.1864°	15	Video
CR4	53.8734°	-6.2235°	5	Video
CR5	53.85533°	-6.2244°	6	Video
S5	53.9030°	-6.1218°	25	Grab
S11	53.9400°	-6.0875°	19	Video
S13	53.9210°	-6.0901°	18	Grab & Video
S15	53.9029°	-6.0910°	27	Grab
S21	53.9113°	-6.0751°	27	Grab
S26	53.9382°	-6.05929°	19	Grab & Video
S31	53.8925°	-6.0613°	31	Grab
S37	53.9017°	-6.0454°	34	Grab
MC1	53.8769°	-6.2063°	7	Video
MC2	53.8820°	-6.1995°	8	Video
MC3	53.8788°	-6.1753°	18	Video
MC4	53.8795°	-6.1431°	25	Video

AQUAFACT has in-house standard operational procedures for benthic sampling and these were followed for this project. Additionally, the recently published MESH report on "Recommended Standard methods and procedures" was adhered to.

A 0.1m^2 Day grab was used to sample the grab sites. On arrival at each sampling station, the vessel location was recorded using DGPS (latitude/longitude). Additional information such as date, time, site name, sample code and depth were recorded in a data sheet.

A single grab sample was taken at each of the ten stations for faunal analysis and a second sample was collected for sediment grain size and organic carbon analysis. The grab deployment and recovery rates did not exceed 1 metre/sec. This was to ensure minimal interference with the sediment surface as the grab descended. Upon retrieval of the grab a description of the sediment type was noted in the sample data sheet. Notes were also made on colour, texture, smell and presence of animals.

A digital image of each sample (including sample label) was taken and these images can be seen in Appendix 1. The grab sampler was cleaned between stations to prevent cross contamination.

The samples collected for faunal analysis were carefully and gently sieved on a 1mm mesh sieve as a sediment water suspension for the retention of fauna. Great care was taken during the sieving process in order to minimise damage to taxa such as spionids, scale worms, phyllodocids and amphipods. The sample residue was carefully flushed into a pre-labelled (internally and externally) container from below. Each label contained the sample code and date. The samples were stained with Eosin-briebrich scarlet and fixed in 4% w/v buffered formaldehyde solution upon returning to the laboratory. These samples were ultimately preserved in 70% alcohol prior to processing.

2.1.2. Sample Processing

All faunal samples were placed in an illuminated shallow white tray and sorted first by eye to remove large specimens and then sorted under a stereo microscope (x 10 magnification). Following the removal of larger specimens, the samples were placed into Petri dishes, approximately one half teaspoon at a time and sorted using a binocular microscope at x25 magnification.

The fauna was sorted into four main groups: Polychaeta, Mollusca, Crustacea and others. The 'others' group consisted of echinoderms, nematodes, nemerteans, cnidarians and other lesser phyla. The fauna were maintained in stabilised 70% industrial methylated spirit (IMS) following retrieval and identified to species level where practical using a binocular microscope, a compound microscope and all relevant taxonomic keys. After identification and enumeration, specimens were separated and stored to species level.

The sediment granulometric analysis was carried out by AQUAFACT using the traditional granulometric approach. Traditional analysis involved the dry sieving of approximately 100g of sediment using a series of Wentworth graded sieves. The process involved the separation of the sediment fractions by passing them through a series of sieves. Each sieve retained a fraction of the sediment, which were later weighed and a percentage of the total was calculated. Table 2.2 shows the classification of sediment particle size ranges into size classes. Sieves, which corresponded to the range of particle sizes (Table 2.2), were used in the analysis. Appendix 2 provides the detailed granulometric methodology.

Table 2.2: The classification of sediment particle size ranges into size classes (adapted from Buchanan, 1984).

Range of Particle Size	Classification	Phi Unit
<63µm	Silt/Clay	>4 Ø
63-125 µm	Very Fine Sand	4 Ø, 3.5 Ø
125-250 µm	Fine Sand	3 Ø, 2.5 Ø
250-500 µm	Medium Sand	2 Ø, 1.5 Ø
500-1000 µm	Coarse Sand	1 Ø, 1.5 Ø
1000-2000 µm (1 – 2mm)	Very Coarse Sand	0 Ø, -0.5 Ø
2000 – 4000 µm (2 – 4mm)	Very Fine Gravel	-1 Ø, -1.5 Ø
4000 -8000 µm (4 – 8mm)	Fine Gravel	-2 Ø, -2.5 Ø
8 -64 mm	Medium, Coarse & Very Coarse Gravel	-3 Ø to -5.5 Ø
64 – 256 mm	Cobble	-6 Ø to -7.5 Ø
>256 mm	Boulder	< -8 Ø

The additional sediment samples collected from the faunal stations had their organic carbon analysis performed by ALS Laboratories in Loughrea using the Loss on Ignition method. Appendix 2 provides the methodology.

2.1.3. Data Analysis

Statistical evaluation of the faunal data was undertaken using PRIMER v.6 (Plymouth Routines in Ecological Research). Univariate statistics in the form of diversity indices are calculated. Numbers of species and numbers of individuals per sample will be calculated and the following diversity indices will be utilised:

1) Margalef's species richness index (D) (Margalef, 1958),

$$D = \frac{S - 1}{\log_2 N}$$

where: N is the number of individuals

S is the number of species

2) Pielou's Evenness index (J) (Pielou, 1977)

$$J = \frac{H'(observed)}{H'_{max}}$$

where: H'_{max} is the maximum possible diversity, which could be achieved if all species were equally abundant (= $\log_2 S$)

3) Shannon-Wiener diversity index (H') (Pielou, 1977)

$$H' = -\sum_{i=1}^{S} p_i (\log_2 p_i)$$

where: p_I is the proportion of the total count accounted for by the i^{th} taxa

4) Effective number of species (ENS) (Hill, 1973; Jost, 2006)

$$H = \exp(H')$$

Where H' is the Shannon-Weiner diversity index.

Species richness is a measure of the total number of species present for a given number of individuals. Evenness is a measure of how evenly the individuals are distributed among different species. The Shannon-Wiener index incorporates both species richness and the evenness component of diversity (Shannon & Weaver, 1949). The diversity index is then converted to effective numbers of species to reflect 'true diversities' (Hill, 1973, Jost, 2006) that can then be compared across communities (MacArthur, 1965; Jost, 2006). The effective number of species (ENS) is equivalent to the number of equally abundant species that would be needed in each sample to give the same value of a diversity index, *i.e.* Shannon-Weiner Diversity index. The ENS behaves as one would intuitively expect when diversity is doubled or halved, while other standard indices of diversity do not (Jost, 2006). If the ENS of one community is twice that of another then it can be said that that community is twice as diverse as the other.

The PRIMER programme (Clarke & Warwick, 2001) was used to carry out multivariate analyses on the station-by-station faunal data. All species/abundance data from the grab surveys was square root transformed and used to prepare a Bray-Curtis similarity matrix in PRIMER ®. The square root transformation was used in order to allow the intermediate abundant species to play a part in the similarity calculation. All species/abundance data from the samples was used to prepare a Bray-Curtis similarity matrix. The similarity matrix was then be used in classification/cluster analysis. The aim of this analysis was to find "natural groupings' of samples, *i.e.* samples within a group that are more similar to each other, than they are similar to samples in different groups (Clarke & Warwick, *loc. cit.*). The PRIMER programme CLUSTER carried out this analysis by successively fusing the samples into groups and the groups into larger clusters, beginning with the highest mutual similarities then gradually reducing the similarity level at which groups are formed. The result was represented graphically in a dendrogram, the x-axis representing the full set of samples and the y-

axis representing similarity levels at which two samples/groups are said to have fused. SIMPROF (Similarity Profile) permutation tests were incorporated into the CLUSTER analysis to identify statistically significant evidence of genuine clusters in samples which are *a priori* unstructured.

The Bray-Curtis similarity matrix was also be subjected to a non-metric multi-dimensional scaling (MDS) algorithm (Kruskal & Wish, 1978), using the PRIMER programme MDS. This programme produced an ordination, which is a map of the samples in two- or three-dimensions, whereby the placement of samples reflects the similarity of their biological communities, rather than their simple geographical location (Clarke & Warwick, 2001). With regard to stress values, they give an indication of how well the multi-dimensional similarity matrix is represented by the two-dimensional plot. They are calculated by comparing the interpoint distances in the similarity matrix with the corresponding interpoint distances on the 2-d plot. Perfect or near perfect matches are rare in field data, especially in the absence of a single overriding forcing factor such as an organic enrichment gradient. Stress values increase, not only with the reducing dimensionality (lack of clear forcing structure), but also with increasing quantity of data (it is a sum of the squares type regression coefficient). Clarke & Warwick (*loc. cit*.) have provided a classification of the reliability of MDS plots based on stress values, having compiled simulation studies of stress value behaviour and archived empirical data. This classification generally holds well for 2-d ordinations of the type used in this study. Their classification is given below:

- Stress value < 0.05: Excellent representation of the data with no prospect of misinterpretation.
- Stress value < 0.10: Good representation, no real prospect of misinterpretation of overall structure, but very fine detail may be misleading in compact subgroups.
- Stress value < 0.20: This provides a useful 2-d picture, but detail may be misinterpreted particularly nearing 0.20.
- Stress value 0.20 to 0.30: This should be viewed with scepticism, particularly in the upper part of the range, and discarded for a small to moderate number of points such as < 50.
- Stress values > 0.30: The data points are close to being randomly distributed in the 2-d ordination and not representative of the underlying similarity matrix.

Each stress value must be interpreted both in terms of its absolute value and the number of data points. In the case of this study, the moderate number of data points indicates that the stress value can be interpreted more or less directly. While the above classification is arbitrary, it does provide a

framework that has proved effective in this type of analysis.

The species, which are responsible for the grouping of samples in cluster and ordination analyses, were identified using the PRIMER programme SIMPER (Clarke & Warwick, 1994). This programme determined the percentage contribution of each species to the dissimilarity/similarity within and between each sample group.

In order to assess the benthic ecological quality of the community, the AZTI Marine Biotic Index (AMBI) was calculated. AMBI offers a 'pollution or disturbance classification' which represents the benthic community health (*sensu* Grall & Glémarec, 1997). Individuals are put into one of five ecological sensitivity groups (Group I - very sensitive to disturbance/pollution; Group II - indifferent to disturbance/pollution; Group III - tolerant to disturbance/pollution; Group IV - second-order opportunists and Group V - first order opportunists) and the AMBI score is calculated as a weighted average of the sensitivity scores of each replicate sample. Assemblages with high proportions of sensitive taxa are indicative of areas with low levels of disturbance and stations dominated by opportunistic taxa reflect impacted areas.

2.1.4. Underwater drop down video survey.

The drop down video stations can be seen in Figure 2.1 above. Nine stations are shown and they have been selected to cover the areas where hard ground would prevent grab sampling for benthic faunal survey.

Offshore still and video seabed photographic data were acquired using a high resolution underwater camera. A drop down camera (manufactured by LH-Camera) was be used for this survey. This is an upgraded version of their standard unit. Its specification include a high resolution, 560 line colour PAL camera with 0.1 lux sensitivity. Footage will be digitized and captured using a Getac B300 rugged notebook and backed up to writeable DVD media. A video overlay unit allows position (dGPS) to be inserted and recorded continually on screen, streamlining the incorporation of footage into GIS for ground truthing and mapping purposes. The underwater camera is combined with a dedicated still camera that captures in real time

A minimum of ten (10) clear images were obtained from each survey location. The video

photography data was reviewed in conjunction with the still photographs. The locations of habitats and/or associated flora and faunal communities were noted.

The physical characteristics of the seabed was recorded, estimated or classified (as appropriate), including: minimum & maximum depth, underwater visibility. Should suitable geophysical data be available, this will be interpreted in conjunction with the video data.

2.2. Results

2.2.1. Fauna

The taxonomic identification of the benthic infauna across all 10 grab stations sampled at Oriel Wind Farm and cable route yielded a total count of 148 taxa ascribed to 9 phyla. The 148 taxa consisted of 1,464 individuals. Of the 148 taxa recorded, 115 were identified to species level. The remaining 33 could not be identified to species level as they were juveniles (14 taxa), partial/damaged (13 taxa) or indeterminate (6 taxa). Appendix 3 shows the faunal abundances from the sampled sites.

Of the 148 taxa present, 3 were cnidarians (hydroids, anemones etc.), 1 was a nematode (roundworm), 4 were nemerteans (ribbon worms), 3 were sipunculids (acorn worm), 64 were annelids (segmented worms), 24 were crustaceans (crabs, prawns, amphipods), 37 were molluscs (mussels, cockles, snails), 1 was a phoronid (horseshoe worm), 11 were echinoderms (brittlestars, starfish.

2.2.1.1. Univariate Analysis

Univariate statistical analyses were carried out on station-by-station faunal data. In addition all colonial, epifaunal, parasitic and fish species were removed prior to analysis. The following parameters were calculated and can be seen in Table 2.3: taxon numbers, number of individuals, richness, evenness, Shannon-Weiner diversity and Effective species numbers (Hill numbers based on the Shannon-Weiner diversity). Taxon numbers ranged from 9 (CR3) to 46 (S26). Number of individuals ranged from 23 (CR3) to 349 (S31). Richness ranged from 3.63 (CR1) to 8.91 (S26). Evenness ranged from 0.53 (S31) to 0.97 (CR2). Shannon-Weiner diversity ranged from 1.97 (CR3) to 3.1 (S26). Effective species numbers (exponential of Shannon-Weiner diversity) ranged from 7.18 (CR3) to 22.24 (S26) indicating the station S26 is effectively over three times as diverse as station CR3. Figure 2.2 shows these community indices in graphical form.

Table 2.3: Univariate measures of community structure.

Station	No. Taxa	No. Individuals	Richness	Evenness	Shannon-Weiner Diversity	Effective Species No.
	S	N	d	J'	H'(loge)	exp(H')
CR1	14	36	3.63	0.88	2.33	10.28
CR2	20	34	5.39	0.97	2.89	18.06
CR3	9	23	2.55	0.90	1.97	7.18
S5	25	155	4.76	0.66	2.13	8.37
S13	33	121	6.67	0.82	2.88	17.79
S15	40	310	6.80	0.77	2.84	17.16
S21	45	217	8.18	0.81	3.09	21.88
S26	46	156	8.91	0.81	3.10	22.24
S31	45	349	7.51	0.53	2.02	7.56
S37	25	63	5.79	0.89	2.88	17.76

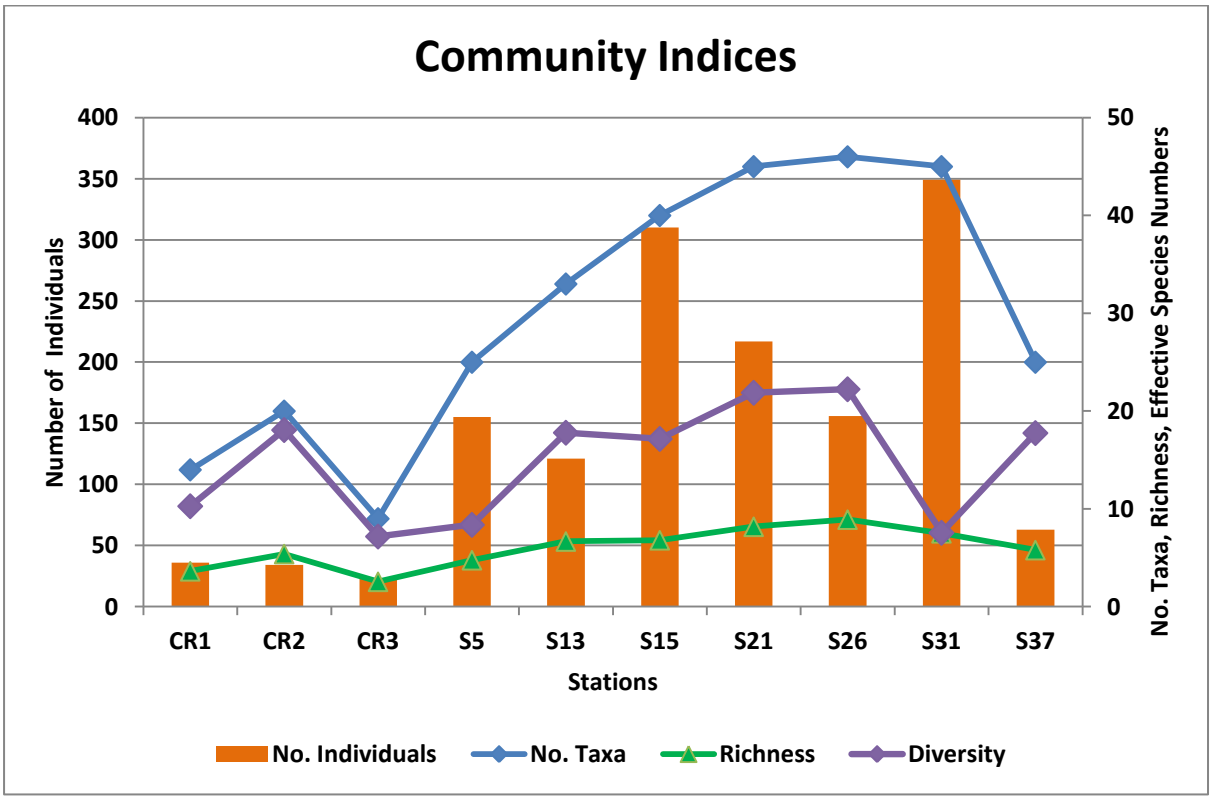


Figure 2.2: Community indices. Diversity is expressed in effective species numbers.

2.2.1.2. Multivariate Analysis

The same data set used above for the univariate analyses was also used for the multivariate

analyses. The dendrogram and the MDS plot can be seen in Figures 2.3 and 2.4 respectively. The stress level of 0.09 on the MDS plot indicates an excellent representation of the data with no prospect of misinterpretation. SIMPROF analysis revealed 4 statistically significant groupings between the 10 stations (the stations connected by red lines cannot be significantly differentiated).

- Group a: Station CR3
- Group b: Stations CR1, CR2 and S37
- Group c: Stations S5, S15 and S31
- Group d: Stations S13, S21 and S26

Group a contained station CR3 and separated from all other groups at a similarity level of 5.34%. This group contained 9 taxa comprising 23 individuals. Of the 9 taxa, 5 were present twice or less. Four species accounted for just almost 74% of the faunal abundance of this group; the bivalves *Nucula* sp. (juv.) (6 individuals, 26.09% abundance), *Fabulina fabula* (5 individuals, 21.74%) and *Nucula nitidosa* (3 individuals, 13.04% abundance) and the polychaete *Nephtys cirrosa* (3 individuals, 13.04% abundance. SIMPER analysis could not be carried out on this group as it only contained one station. *Nucula* sp. (juv), *Nucula nitidosa* and *Fabulina fabula* are very sensitive to organic enrichment and present under unpolluted conditions. *Nephtys cirrosa* are indifferent to enrichment, typically present in low densities with non-significant variations over time. The number of taxa and individuals, species richness and diversity were lowest in this group. This group (station CR3) broadly conforms to the JNCC biotope SS.SSa.IMuSa.FfabMag *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand and the EUNIS biotope A5.242. This Shallow *Venus* community [the 'Boreal offshore sand association' of Jones 1950] is present in shallow (5 m to 40 m) nearshore sands.

Group b contained stations CR1, CR2 and S37 and had a within group similarity of 52.98% and separated from group c at a 26.24% similarity level. This group contained 35 taxa comprising 133 individuals. Of the 35 taxa, 19 were present twice or less. Five species accounted for almost 52% of the faunal abundance of this group; the polychaetes *Prionospio* sp. (19 individuals, 14.29% abundance), *Magelona minuta* (18 individuals, 13.53% abundance), *Nephtys incisa* (13 individuals, 9.77% abundance) and *Levinsenia gracilis* (10 individuals, 7.52% abundance) and the bivalve molluscs *Abra nitida* (9 individuals, 6.77% abundance). SIMPER analysis revealed *Prionospio* sp., *Magelona minuta, Nephtys incisa, Levinsenia gracilis, Abra nitida, Eudorella truncatula* and *Goneplax rhomboides* as the characterizing species of this group. SIMPER results are presented in Appendix 4.

Magelona minuta, Eudorella trucatula and *Goneplax rhomboides* are very sensitive to organic enrichment and present under unpolluted conditions. *Nephtys incisa* is indifferent to enrichment, typically present in low densities with non-significant variations over time. *Abra nitida* and *Levinsenia gracilis* are tolerant to excess organic enrichment, they occur under normal conditions but their populations are stimulated by organic enrichment. *Prionospio* sp. is a second order opportunistic species which are adapted to slight to pronounced unbalanced conditions. The number of taxa and individuals were below average. Diversity was medium to high within this group. The stations within this group broadly conform to the biotope SS.SMu.OMu.LevHet *Levinsenia gracilis* and *Heteromastus filiformis* in offshore circalittoral mud and sandy mud and the EUNIS biotope A5.375.

Group c contained the stations S5, S15 and S31 and had a within group similarity of 42.39%. This group contained 74 taxa comprising 814 individuals. Of the 74 taxa, 37 were present twice or less. Four species accounted for almost 59% of the faunal abundance of this group; the gastropod *Turritella communis* (327 individuals, 40.17%), the bivalve *Abra nitida* (43 individuals, 5.28% abundance), the brittlestar *Amphiura filiformis* (66 individuals, 8.11% abundance) and the amphipod *Abludomelita obtusata* (41 individuals, 5.04% abundance). SIMPER analysis revealed *Diplocirrus glaucus, Abludomelita obtusata, Nephtys* sp. (juv), *Cylichna cylindracea, Chamelea striatula, Abra nitida* and *Turritella communis* as the characterizing species of this group. SIMPER results are presented in Appendix 4. *Diplocirrus glaucus* and *Chamelea striatula* are very sensitive to organic enrichment and present under unpolluted conditions. *Nephtys* sp. (juv), *Turritella communis*, *Cylichna cylindracea* and *Amphiura filiformis* are indifferent to enrichment, typically present in low densities with non-significant variations over time. *Abludomelita obtusata* and *Abra nitida* are tolerant to excess organic enrichment, they occur under normal conditions but their populations are stimulated by organic enrichment. The number of taxa and individuals were high in this group. Diversity ranged from low to high. The stations within this group broadly conform to the JNCC biotope SS.SMu.CSaMu.AfilKurAnit *Amphiura filiformis, Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud and the EUNIS biotope A5.351. This *Amphiura* community [the 'Boreal offshore muddy sand association' of Jones 1950] is present in offshore sandy muds at shallow to moderate depths (15 m to 100 m) and typically including the brittle-star *Amphiura filiformis*, the urchin *Echinocardium cordatum* and the tower shell *Turritella communis*.

Group d contained the stations S13, S21 and S26 and had a within group similarity of 26.04% and separated from Groups b and c at a 16.66% similarity level. This group contained 97 taxa comprising

4,949 individuals. Of the 97 taxa, 50 were present twice or less. Seven species accounted for just under 49% of the faunal abundance of this group; the polychaetes *Scoloplos armiger* (53 individuals, 10.73% abundance), *Lumbrineris cingulata* aggregate (35 individuals, 7.09% abundance), *Diplocirrus glaucus* (27 individuals, 5.47% abundance), the brittlestar *Ophiura* sp. (juv) (42 individuals, 8.5% abundance), the bivalve *Thracia phaseolina* (37 individuals, 7.49% abundance), Nemertea (indet)(24 individuals, 4.86% abundance) and Nematoda (22 individuals, 4.45% abundance). SIMPER analysis revealed *Ampelisca typica, Euspira nitida, Lumbrineris cingulata* aggregate, Nemertea (indet) and Veneridae (juv) are the characterising species of this group. SIMPER results are presented in Appendix 4. *Ampelisca typica* and Veneridae (juv) are very sensitive to organic enrichment and present under unpolluted conditions. *Euspira nitida* and *Lumbrineris cingulata* aggregate are indifferent to enrichment, typically present in low densities with non-significant variations over time. Nemertea are tolerant to excess organic enrichment, they occur under normal conditions but their populations are stimulated by organic enrichment. Numbers of taxa and individuals in this group were medium to high. The diversity was highest in this group with stations S26 highest, followed by station S21. Effective species numbers indicate that these two stations are more than 3 times more diverse than the least diverse station (CR3). Although the stations within this grouping only had a within group similarity level of 26.04%, they can be broadly said to exhibit elements of the JNCC biotope SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel and the EUNIS biotope A5.142.

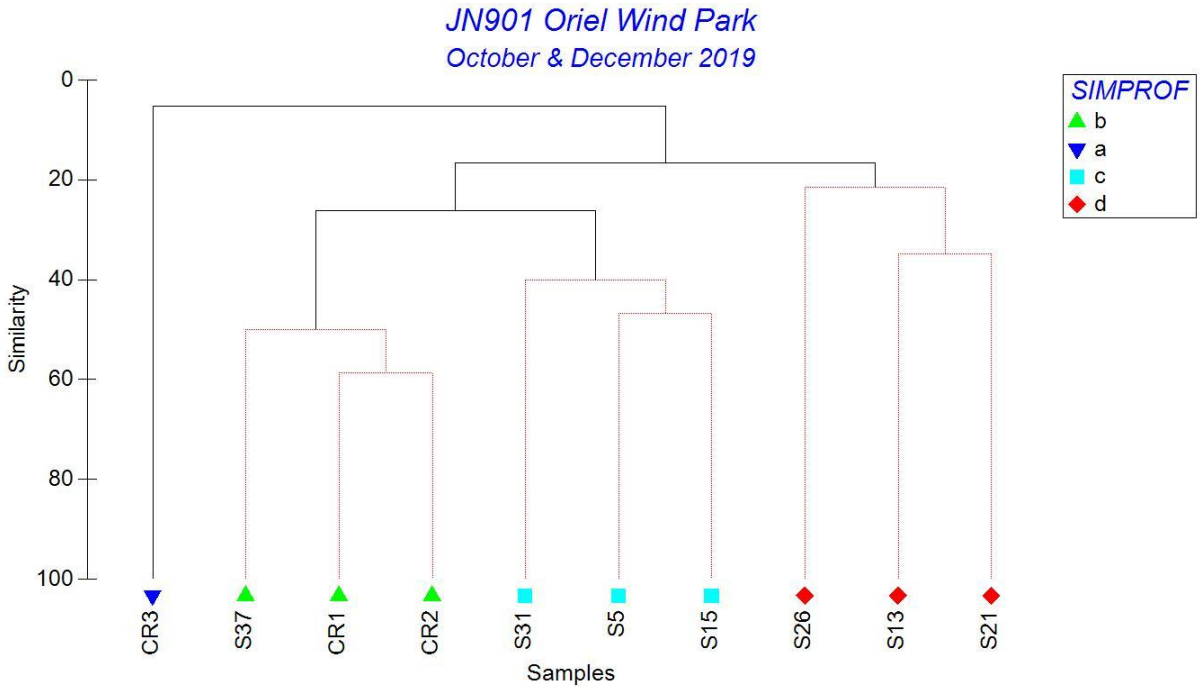


Figure 2.3: Dendrogram produced from Cluster analysis.

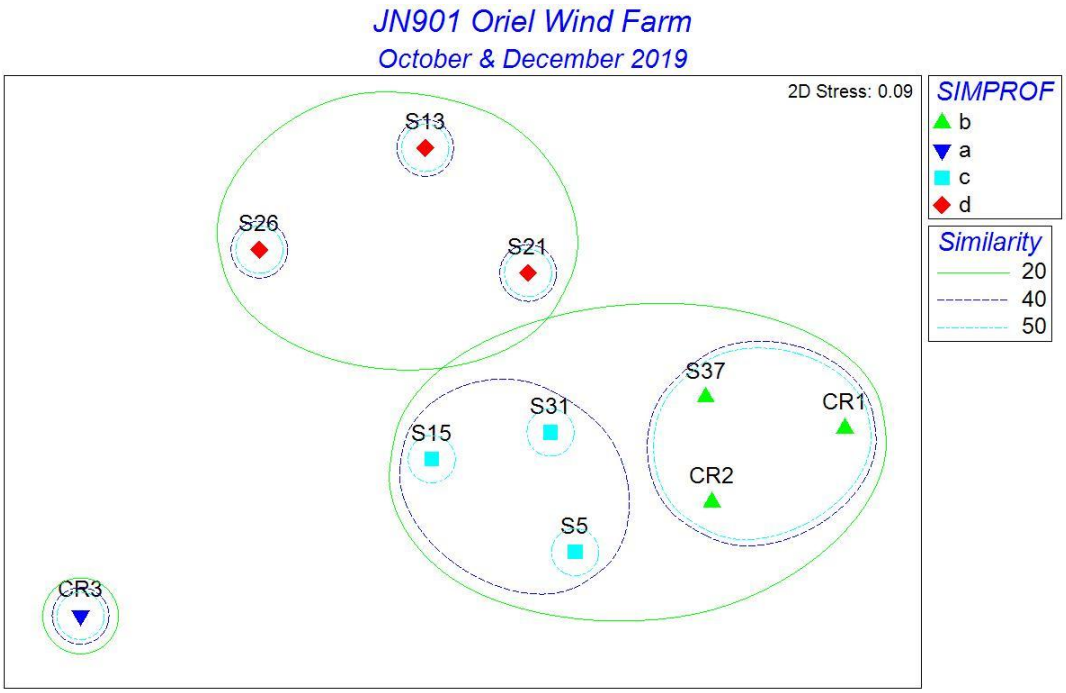


Figure 2.4: MDS plot.

2.2.1.3. AMBI analysis

Table 2.4 shows the AMBI results from the analysis of faunal samples. Stations CR3 was classified as undisturbed. All other stations were classified as slightly disturbed. Figure 2.6 presents histograms of the AMBI results indicating the relative abundance of species based on sensitivities.

Table 2.4: AMBI Results

Stations	I (%)	II (%)	III (%)	IV (%)	V (%)	Not assigned (%)	AMBI	BI from Mean AMBI	Disturbance Classification
CR1	22.22	22.22	19.44	36.11	0	0.00	2.54	2	Slightly disturbed
CR2	29.41	26.47	26.47	17.65	0	0.00	1.99	2	Slightly disturbed
CR3	69.57	17.39	13.04	0.00	0	0.00	0.65	1	Undisturbed
S5	18.07	65.16	16.77	0.00	0	0.00	1.48	2	Slightly disturbed
S13	50.41	15.70	32.23	1.65	0	0.00	1.28	2	Slightly disturbed
S15	17.10	61.29	21.61	0.00	0	0.00	1.57	2	Slightly disturbed
S21	35.02	26.27	36.41	2.30	0	0.00	1.59	2	Slightly disturbed
S26	16.77	64.52	18.07	0.65	0	0.60	1.54	2	Slightly disturbed
S31	8.93	68.88	22.19	0.00	0	0.60	1.70	2	Slightly disturbed
S37	41.27	20.64	28.57	9.52	0	0.00	1.60	2	Slightly disturbed

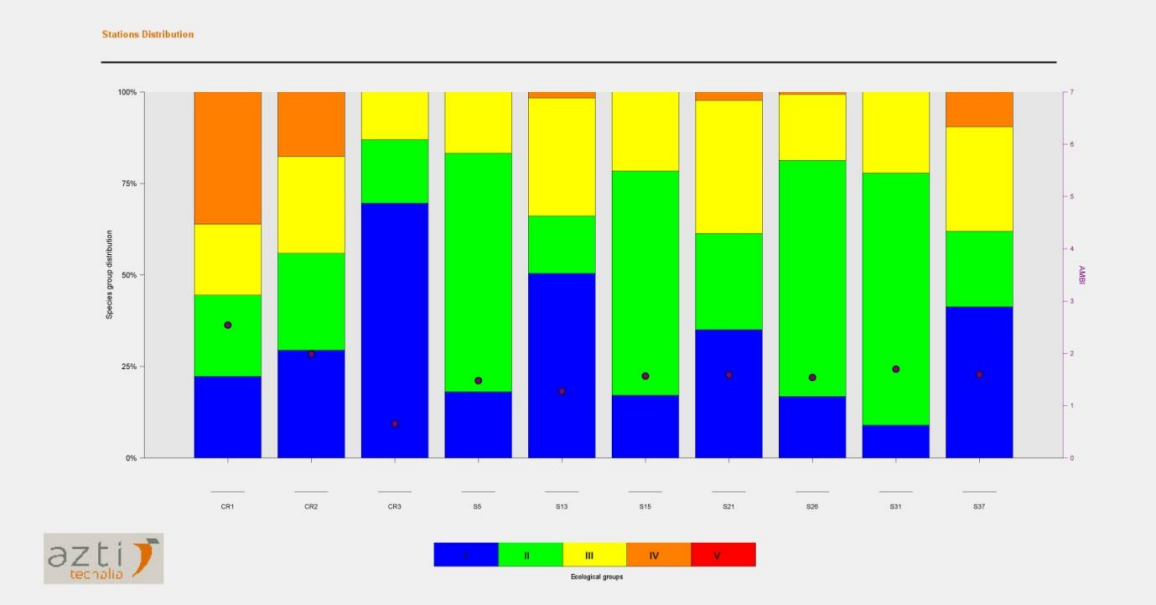


Figure 2.5: AMBI results histogram

2.2.2. Underwater drop down video analysis

Station MC1

Date/ Time: 03/12/2019, 11.22

Video Coordinates: 53.87686°N 6.2063°W

Water Depth: 7m

Station Description: Boulder, cobble and gravel seafloor with canopy of red and brown algae attached to the boulders. The sea urchin, *Echinus esculentus* and the starfish *Asterias rubens* as well as calcareous tube worms and sponges were noted. Figure 2.6 displays the still images of the video transect. The biotope at this station can be broadly classified as IR.MIR.KR Kelp with red seaweeds (moderate infralittoral rock).

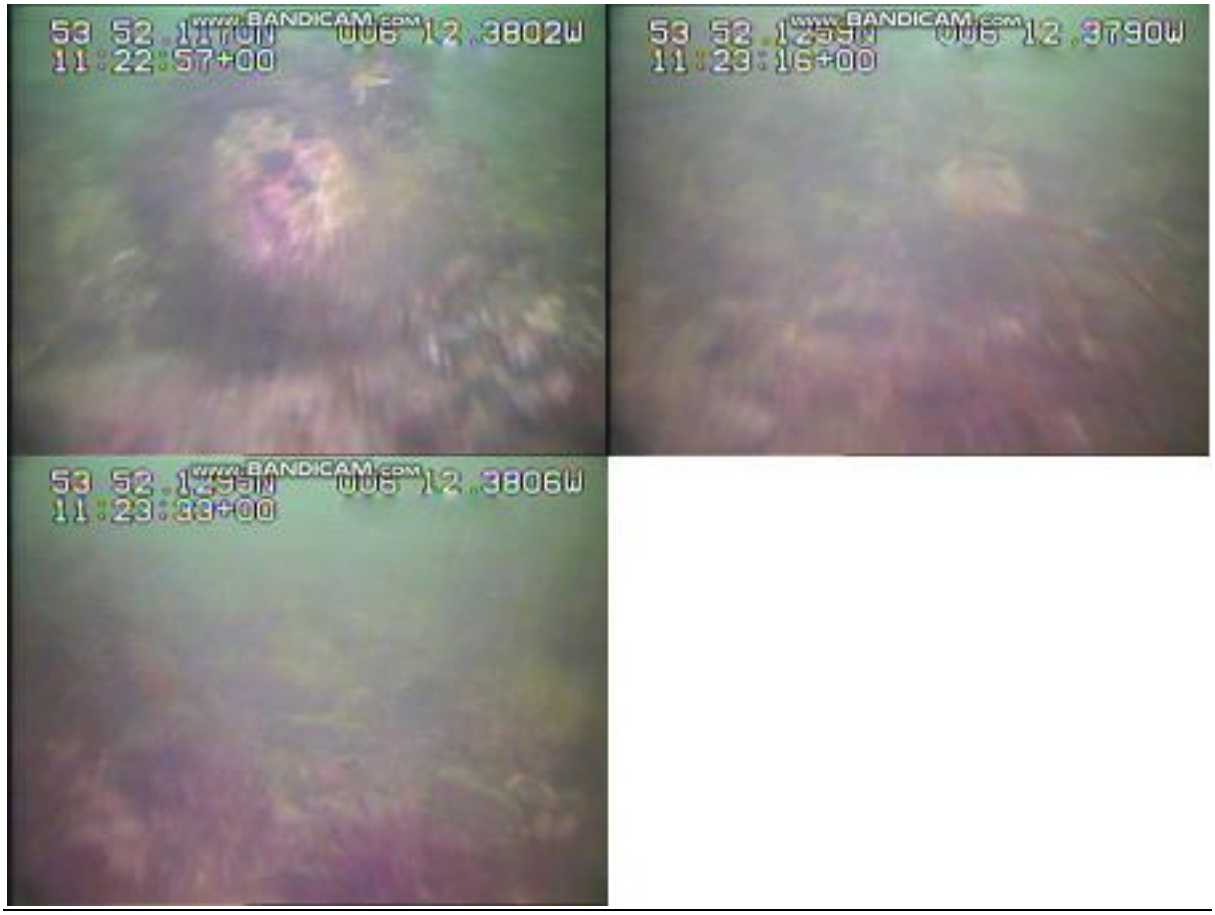


Figure 2.6: Still images from drop down video transect at Station MC1.

Station MC2

Date/ Time: 03/12/2019, 11.50

Video Coordinates: 53.8820°N 6.1995°W

Water Depth: 8m

Station Description: Boulder, cobble and gravel seafloor with canopy of red and brown algae attached to the boulders. The sea urchin, *Echinus esculentus*, the starfish *Asterias rubens,* calcareous tubeworms and sponges were noted as was a shoal of small fish. Figure 2.7 displays the still images of the video transect. The biotope at this station can be broadly classified as IR.MIR.KR Kelp with red seaweeds (moderate infralittoral rock).

Figure 2.7: Still images from drop down video transect at Station MC2.

Station MC3

Date/ Time: 03/12/2019, 11.59

Video Coordinates: 53.8778°N 6.1753°W

Water Depth: 18m

Station Description: Sea floor consists of fine sand formed into small waves. Numerous starfish (*Asterias rubens*) were recorded as were a number of small fish (Gurnard and Cod). Figure 2.8 displays the still images of the video transect.

Figure 2.8: Still images from drop down video transect at Station MC3.

Station MC4

Date/ Time: 03/12/2019, 12.10

Video Coordinates: 53.8795°N 6.1431°W

Water Depth: **25**m

Station Description: Sea floor consists of fine sand formed into small waves. Numerous starfish (*Asterias rubens*) were recorded and a sea pen, *Virgularia mirabilis,* was imaged protruding from the sand. The biotope at this station can be broadly classified as SS.SMu.CSaMu Circalittoral sandy mud. Figure 2.9 displays the still images of the video transect.

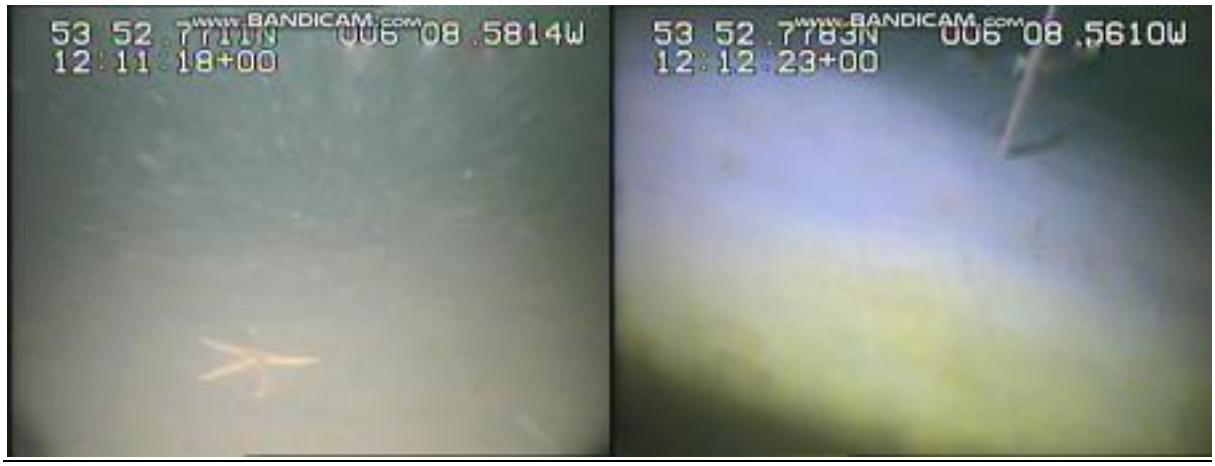


Figure 2.9: Still images from drop down video transect at Station MC4.

Station CR4

Date/ Time: 03/12/2019, 11.10

Video Coordinates: 53.8734°N 6.2235°W

Water Depth: 5m

Station Description: A seafloor of fine sand formed into small waves with a light scattering of shell across the surface. No macrofauna or megafauna were observed along this transect. Figure 2.10 displays the still images of the video transect.

Figure 2.10: Still images from drop down video transect at Station CR4.

Station CR3

Date/ Time: 03/12/2019, 11.10

Video Coordinates: 53.8824°N 6.1864°W

Water Depth: 15m

Station Description: Boulder, cobble and gravel seafloor with light sediment cover. Hydroids (*Halecium halecium*), tunicates (*Ascidiella aspersa*), anemones (*Metridium senile*), calcareous tubeworms and sponges were noted attached to suitable substrates. A number of starfish (*Asterias rubens*) were also observed. The biotope observed here has elements of the JNCC SS.SCS.CCS.SpiB *Spirobranchus triqueter* with barnacles and bryozoans crusts on unstable circalittoral cobbles and pebbles (EUNIS A5.141) and SS.SMx.CMx.FluHyd *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (EUNIS A5.444). The bottom composition transitioned from coarse stone and cobble to fine sand at 53.8829°N, 6.1860°W, where the infaunal grab station CR3 was located. Figure 2.11 displays the still images of the video transect.

Figure 2.11: Still images from drop down video transect at Station CR3

Station CR5

Date/ Time: 03/12/2019, 11.35

Video Coordinates: 53.8533°N 6.2244°W

Water Depth: 6m

Station Description: Seafloor consisting of boulder, cobble and gravel with a canopy of red and brown algae and crustose reds attached to the boulders. The sea urchin, *Echinus esculentus,* and the starfish, *Asterias rubens,* were noted. The biotope at this station can be broadly classified as IR.MIR.KR Kelp with red seaweeds (moderate infralittoral rock). Figure 2.12 displays the still images of the video transect.

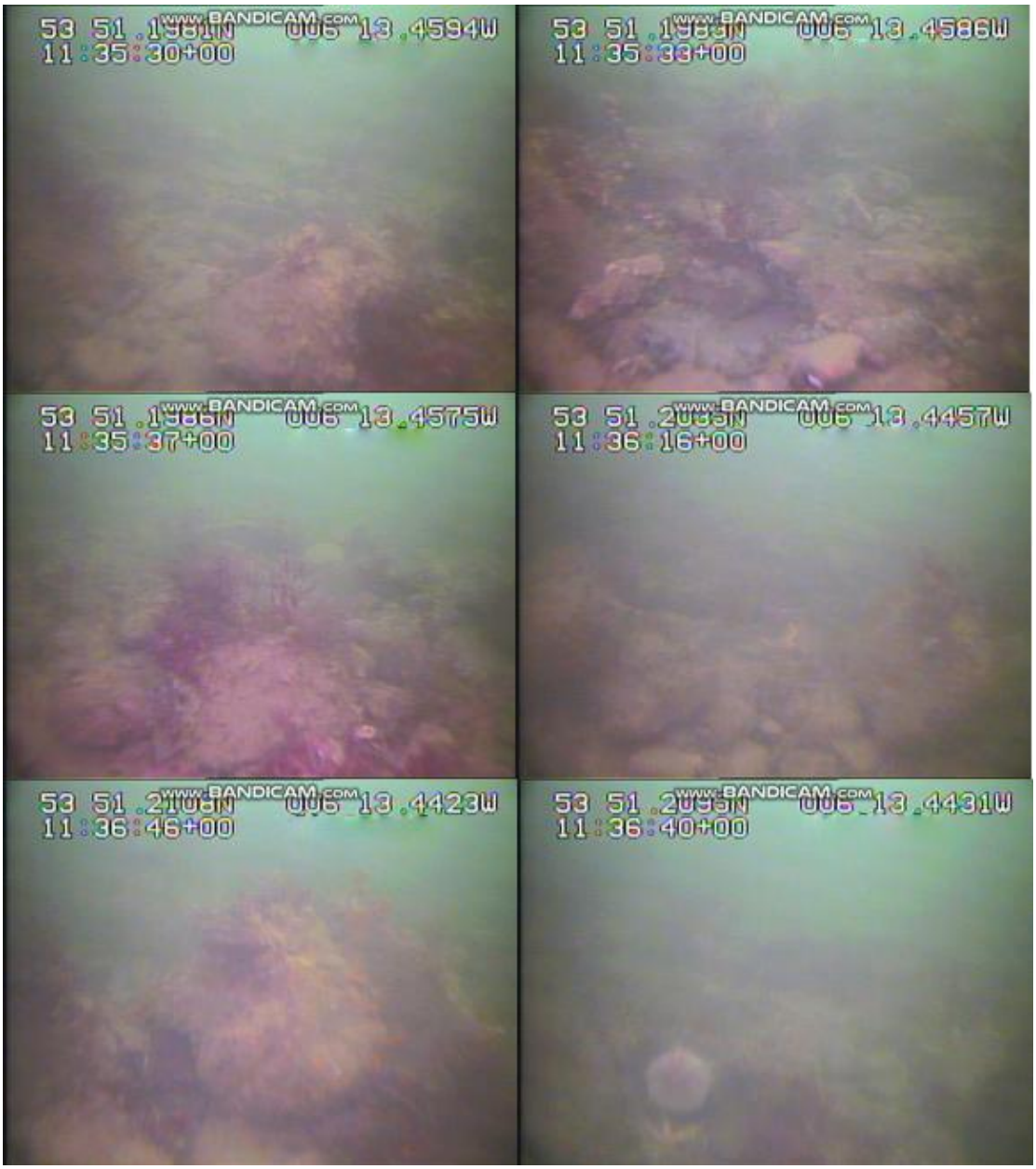


Figure 2.12: Still images from drop down video transect at Station CR5.

Station 26

Date/ Time: 03/12/2019, 09.32

Video Coordinates: 53.9391°N 6.0581°W

Water Depth: 20m

Station Description: A seafloor of fine muddy sand with a scattering of shell and gravel over its surface. No macrofauna or megafauna were observed along this transect. Figure 2.13 displays the still images of the video transect.

Figure 2.13: Still images from drop down video transect at Station 26.

Station 11

Date/ Time: 03/12/2019, 09:20

Video Coordinates: 53.9400°N 6.0875°W

Water Depth: 19m

Station Description: Seafloor with gravel, cobble and boulders with sparse flora or faunal attached. Brittle stars (*Ophiothrix fragilis*) were common. Boulders with cover of crustose corallines. A large starfish (*Luidia ciliaris*) and sea urchin (*Echinus esculentus*) were also imaged. Figure 2.14 displays still images of the video transect. The biotope at this station can be broadly classified as SS.SMx.CMx.Oph.Mx *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment (EUNIS classification A5.445).

Figure 2.14: Still images from drop down video transect at Station 11.

Station 13

Date/ Time: 03/12/2019, 10.07

Video Coordinates: 53.9210°N 6.0100°W

Water Depth: 18m

Station Description: A seafloor of fine sand formed into small waves with a light scattering of shell over its surface. No macrofauna or megafauna were observed along this transect. Figure 2.15

displays the still images of the video transect.

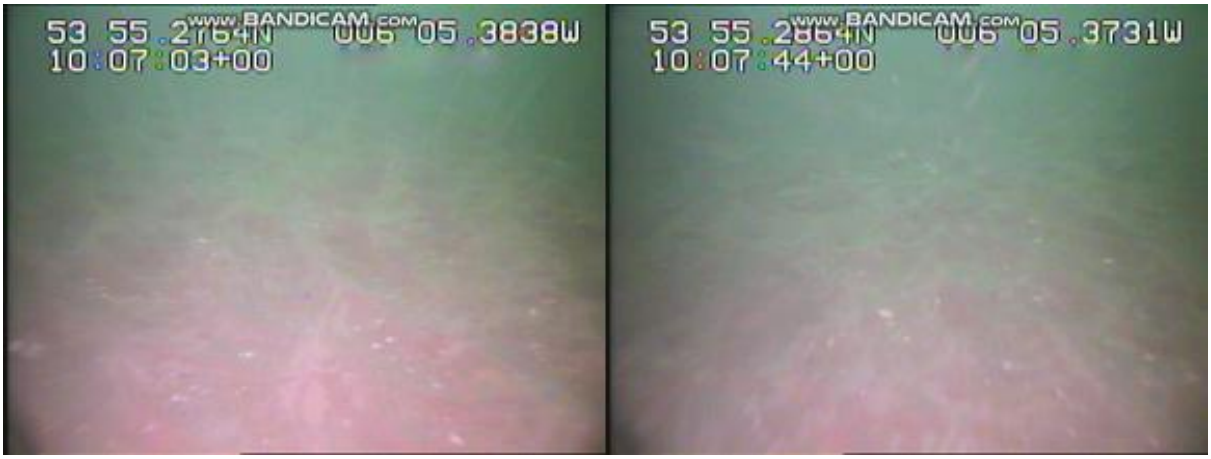


Figure 2.15: Still images from drop down video transect at Station 13.

2.2.3. Sediment

Table 2.6 shows the sediment characteristics of the faunal stations in Oriel Wind Farm and cable route. A digital image of each sediment sample can be seen in Appendix 1.

The sediment sampled at Oriel Wind Farm and along the cable route was classified as muddy sand, sand, slightly gravelly sand, slightly gravelly muddy sand and sandy gravel according to Folk (1954). No medium gravel-boulders were recorded. Highest levels of fine gravel, very fine gravel, very coarse sand and coarse sand were observed at S26 (21.3%, 26.5%, 21.6% and 24.6% respectively). Highest levels of medium sand were found at S13 (55.9%). Highest levels of fine sand were found at S15 (74.3%). Highest levels of very fine sand were found at CR1 and CR2 (50.4%) and highest levels of silt-clay at CR1 (28.7%). Figure 2.16 illustrates the sediment type according to Folk (1954) including the sediment type observed along the video transects. Figure 2.17 shows the breakdown of sediment composition at each grab station.

Table 2.6 also displays the organic matter values recorded at each station. Organic matter values ranged from 1.02 (CR3) to 6.01 (S26).

Table 2.5: Sediment characteristics of the faunal stations at Oriel Wind Farm and cable route. LOI refers to the % organic carbon loss on ignition.

Station	>8mm	Fine Gravel (>4mm)	Very Fine Gravel (2-4mm)	Very Coarse Sand (1-2mm)	Coarse Sand (0.5-1mm)	Medium Sand (0.25-0.5mm)	Fine Sand (125-250mm)	Very Fine Sand (62.5-125mm)	Silt-Clay (<63mm)	Folk (1954)	LOI
CR1	0	0	0	0.3	0.9	3	16.8	50.4	28.7	Muddy sand	3.84
CR2	0	0.8	2.2	1.5	0.5	1.4	16.3	50.4	26.9	Slightly gravelly muddy sand	3.99
CR3	0	0	0	0.2	0.4	1.5	54	43.6	0.3	Sand	1.02
S5	0	0	0.3	1.2	5.6	7.6	29.3	37.6	18.3	Muddy sand	3.31
S13	0	0.1	0.5	1.1	8.7	55.9	33.5	0.2	0	Sand	1.05
S15	0	1.7	0.3	0.3	0.5	6.7	74.3	11.9	4.1	Slightly gravelly sand	3.76
S21	0	0.3	1.1	1.7	8.4	0.2	87	0.6	0.7	Slightly gravelly sand	1.64
S26	0	21.3	26.5	21.6	24.6	3.3	1.6	0.6	0.5	Sandy gravel	6.01
S31	0	0.9	0.6	2.2	7.9	14.5	32.4	29	12.4	Slightly gravelly muddy sand	1.25
S37	0	0	0	0.2	0.1	0.8	37.6	40.9	20.3	Muddy sand	2.92

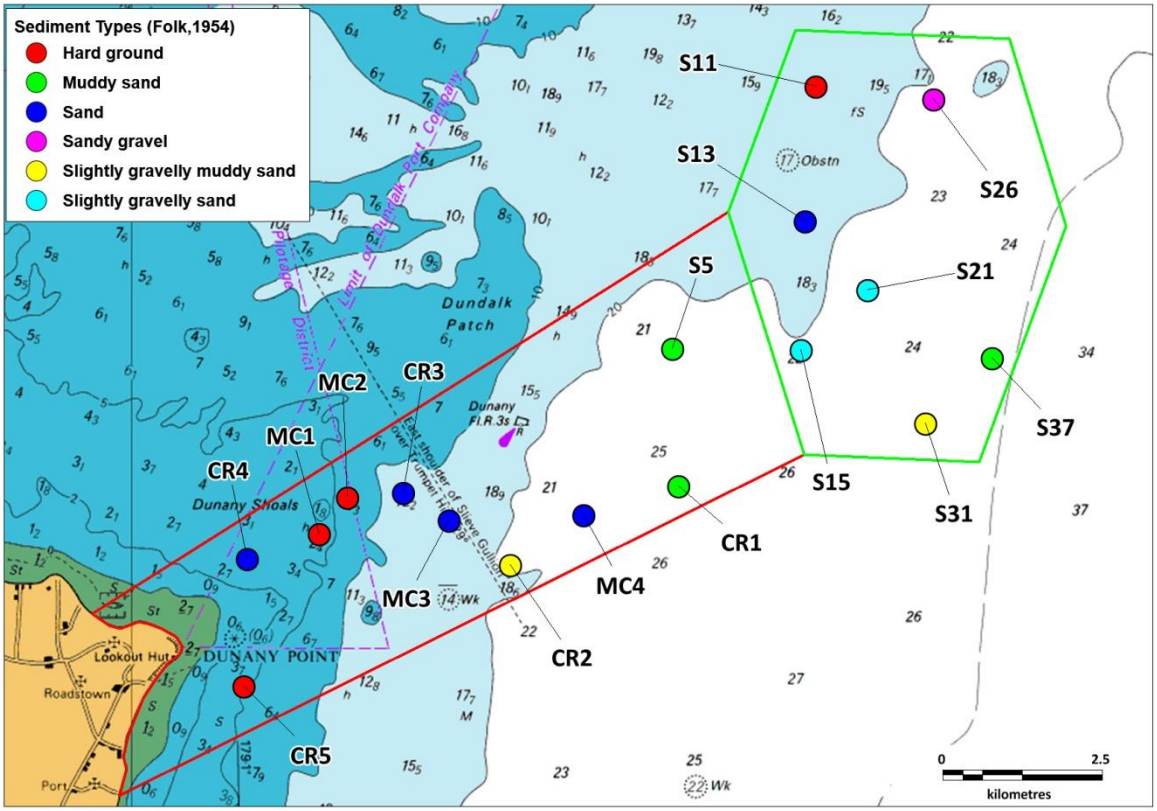


Figure 2.16: Sediment type according to Folk (1954) at Oriel Wind Farm and along the cable route.

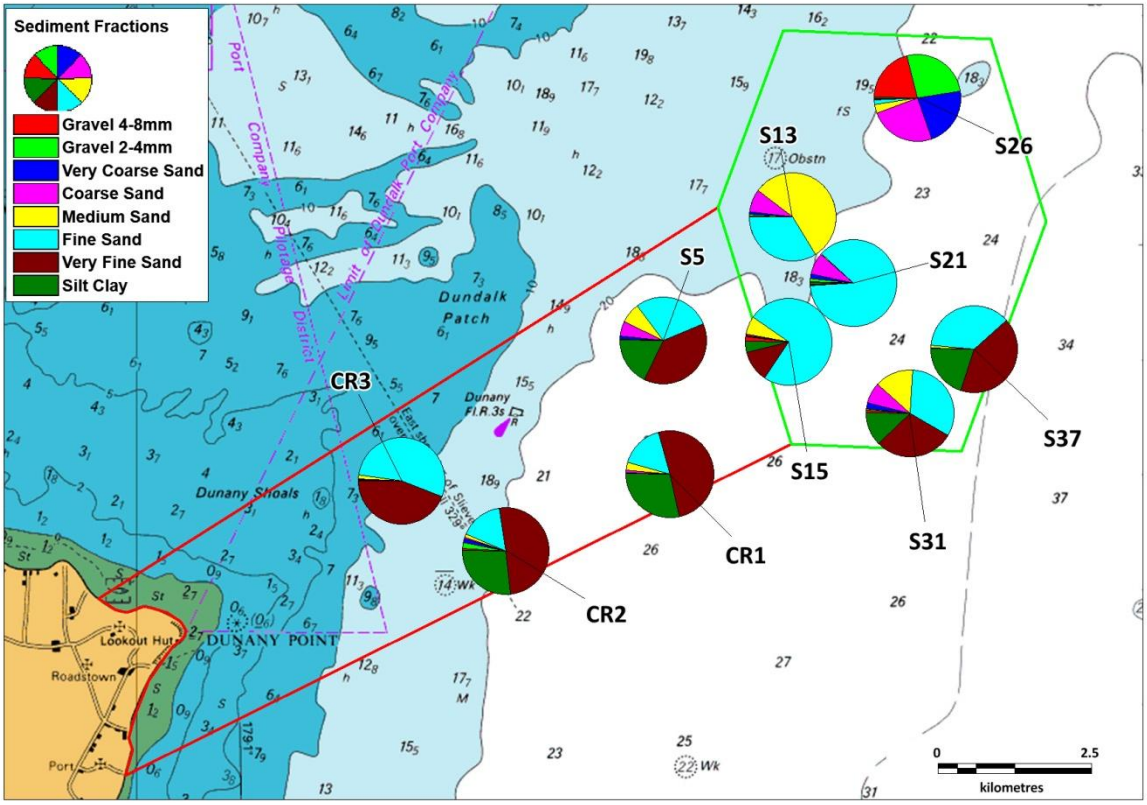


Figure 2.17: A breakdown of sediment type at each grabs station at Oriel Wind Farm and along the cable route.

2.2.4. 2006 Benthic Survey

Table 2.6 below lists the community habitats identified in the stations surveyed in 2006 and re-surveyed during present investigation. Sediment types are categorised according to Folk (1954). A full breakdown of the particle size analysis and % organic carbon from the 2019 survey is presented in section 2.2.3. Stations surveyed along the current proposed cable route were not previously surveyed as alternative cable routes were investigated.

Table 2.6: Comparison of benthic community results from 2006 and 2019 surveys.

Station	2006 Survey			2019 Survey		
	Community	Sediment type (Folk, 1954)	Organic carbon (%)	Community	Sediment type (Folk, 1954)	Organic carbon (%)
S5	*Amphiura* community	Muddy sand	3.8	SS.SMu.CSaMu.AfilKurAnit (*Amphiura* community)	Muddy sand	3.31
S11	Hard Ground	Not sampled	N.A.	SS.SMx.CMx.Oph.Mx Hard Ground (video survey)	Boulders and cobbles	N.A.
S13	Hydroids, *Edwardsia*, *Thracia* sp., *Lumbrineris* sp.	Sand	1.92	SS.SCS.CCS.MedLumVen (including *Lumbrineris, Thracia, Edwardsia*)	Sand	1.05
S15	*Abra* community	Sandy mud	3.91	SS.SMu.CSaMu.AfilKurAnit (*Amphiura* community)	Slightly gravelly sand	3.76
S21	Hydroids, *Edwardsia*, *Thracia*, *Lumbrineris*	Not sampled	1.66	SS.SCS.CCS.MedLumVen (including *Lumbrineris, Thracia, Edwardsia*)	Slightly gravelly sand	1.64
S26	Hydroids, *Edwardsia*, *Thracia*, *Lumbrineris*	Sand	1.85	SS.SCS.CCS.MedLumVen (including *Lumbrineris*)	Sandy gravel	6.01
S31	*Abra* community	Muddy sand	5.96	SS.SMu.CSaMu.AfilKurAnit (*Amphiura* community)	Slightly gravelly muddy sand	1.25
S37	*Amphiura* community	Gravelly muddy sand	3.9	SS.SMu.OMu.LevHet (broad *Amphiura* community)	Muddy sand	2.92

Stations that have changed their community composition in the intervening years since the 2006 survey include S15 and S31. Stations S15 and S31 have changed from an *Abra* community to an

Amphiura community. This is expected considering the change in sediment type recorded – from sandy mud to slightly gravelly sand in the case of S15 and from muddy sand to slightly gravelly sand in the case of S31. The reduction in the silt-clay content and increase in coarse material has an impact on the species composition favouring an *Amphiura* community and reducing the suitability for an *Abra* dominated community.

3. Discussion

Detailed faunal analysis of grab samples within the Oriel Wind Farm site and proposed cable route showed a statistical divide of 4 groups between the stations surveyed. Group a (station CR3) can be classified as SS.SSa.IMuSa.FabMag *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand. This community, the Shallow *Venus* community [the 'Boreal offshore sand association' of Jones 1950] has been previously recorded in this area by Mackie (1990). Group b (stations CR1, CR2 and S37) can be classified as SS.SMu.OMu.LevHet *Levinsenia gracilis* and *Heteromastus filiformis* in offshore circalittoral mud and sandy mud, and its sensitivity to disturbance is considered by MarLIN (The Marine Life Information Network – www.marlin.ac.uk) in conjunction with a broad array of *Amphiura* dominated biotopes. Group c (stations S5, S15 and S31) can be classified as SS.SMu.CSaMu.AfilKurAnit *Amphiura filiformis, Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud. This community, the *Amphiura* community [the 'Boreal offshore muddy sand association' of Jones 1950] is present in offshore sandy muds and has been previously recorded in this area by Mackie (1990) as well as the previous Oriel Benthic survey (2006). Group d (stations S13, S21 and S26) did not form a statistically meaningful group but can be broadly considered as belong to a community similar to SS.SCS.CCS.MedLumVen *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel.

MarLIN classifies the sensitivity of the SS.SSa.IMuSa.FabMag community to smothering and siltation rate change to be low with a high recoverability. The broad *Amphiura* communities are classified as not sensitive to smothering and siltation. SS.SCS.CCS.MedLumVen community is also classified as having low sensitivity and high recoverability to smothering and siltation.

Species richness and diversity were highest in the stations with the higher gravel content and lowest in CR3 which had the highest fine sand and very fine sand content. AMBI results from the analysis of

the faunal classified stations CR3 as undisturbed. All of the remaining grab stations were classified as slightly disturbed.

The underwater drop down video survey was carried out in areas it was suspected that hard ground would hinder a grab survey. These included seven stations within the cable route area and four stations within Oriel Wind Farm boundaries. Five video station transects revealed hard ground: MC1, MC2, CR3, CR5 and S11. Stations MC1, MC2 and CR5 can be broadly classified as IR.MIR.KR Kelp with red seaweeds (moderate energy infralittoral rock). This biotope is classified by MarLIN as not sensitive to smothering and siltation with a high recoverability. Station CR3 transect is classified as having elements of SS.SCS.CCS.SpiB *Spirobranchus triqueter* with barnacles and bryozoans crusts on unstable circalittoral cobbles and pebbles (EUNIS A5.141) and SS.SMx.CMx.FluHyd *Flustra foliacea a*nd *Hydrallmania falcata* on tide-swept circalittoral mixed sediment and transitions into the SS.SSa.IMuSa.FfabMag *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand where the grab station for CR3 was taken. These are classified by MarLIN as having a no sensitivity and high recoverability to smothering and siltation. S11 transect is classified as SS.SMx.CMx.Oph.Mx *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment. MarLIN classifies this biotope as having a medium sensitivity and recoverability to smothering and siltation indicating a low resilience to impact.

The last benthic survey of the Oriel Wind Farm site was conducted in 2006. At that time, 44 grab stations both inside and outside of the wind farm boundaries were surveyed. In addition, two potential cable routes which followed different routes to the current proposed route were surveyed. The findings of the benthic survey indicated that “While all the wind farm faunal groups identified differed with respect to their dominant species, they all contained characteristics of assemblages documented from the Irish Sea. Two communities from Jones (1950) “Boreal Offshore Muddy Sand Association’, the *Amphiura* community and the *Abra* community. The *Amphiura* community occurs in offshore muddy sands at shallow to moderate depths (5-30m). Typical species include the brittlestar *Amphiura filiformis*, the urchin *Echinocardium cordatum* and the tower shell *Turritella communis.* This group is common in the Irish Sea between Ireland and the Isle of Man. The *Abra* community occurs in small pockets in shallow (5-30m) nearshore muddy sands/muds with rich organic contents. Typical species include the bivalve mollusc *Abra alba* and the polychaete *Lagis koreni.* Elements of Jones (1950) “Boreal Offshore Sand Association’ were also observed. This community occurs in shallow (5-40m) nearshore sands. Dominants of this community range from the bivalve molluscs *Chamelea gallina* and *Fabulina fabula* to the polychaetes *Magelona mirabilis and*

Nephtys cirrosa. This community is widely distributed around the Irish Sea coastline. Mackie (1990) also described these communities from this area." (AQUAFACT, 2007).

Since the 2006 survey, two stations have change in their sediment composition and benthic community types – stations S15 and S31. Both of these stations have experienced an increase in coarse sediment and a reduction in silt-clay content. As a result, these stations have switched from an *Abra* community to an *Amphiura* community. In the 2006 survey, 9 stations were identified as having an *Abra* community (S15, S16, S17, S30, S31, S32, S38, S39 and S43). These stations were located in the south east of the wind farm site. It is unknown whether the stations other than S15 and S31 have also experienced changes in granulometry and community type but both *Abra* and *Amphiura* communities are common throughout the Irish Sea.

4. Conclusions

The communities and biotopes identified in the infaunal and video surveys are widely distributed around the Irish Sea coastline and have been identified previously from the area. Diversity and abundance of fauna was higher in the wind farm area than in the area surrounding the proposed cable route. The Marine Life Information Network (MarLIN) initiative in the UK considers the characterising species of the majority of the biotopes identified in the present study as having a low to no sensitivity to smothering. Recovery will either be immediate or within a few weeks to six months. Sensitivity to substratum loss is moderate (the habitat or species is very adversely affected by an external factor arising from human activities or natural events, but is expected to take more than 1 year or up to 10 years to recover). The SS.SMx.CMx.Oph.Mx community at S11 identified as having a medium sensitivity to smothering and siltation indicating a likely return to pre-impact conditions within 2-10 years.

The species recorded in the study area are commonly found along the east coast of Ireland. None of the species recorded in the proposed wind farm area or proposed cable routes are uncommon, rare or protected.

5. References

AQUAFACT. 2007. Oriel Wind Farm Ltd. Offshore Wind Farm. Environmental Impact Statement. Main EIS. 636 pp.

Clarke, K.R. & R.M. Warwick. 2001. Changes in marine communities: An approach to statistical analysis and interpretation. 2nd Edition. *Primer-E Ltd.*

Folk, R.L. 1954. The distinction between grain size and mineral composition in sedimentary rock nomenclature. *Journal of Geology* **62 (4):** 344-359.

Hill, M. 1973. Diversity and evenness: a unifying notation and its consequences. *Ecology* **54**: 427–432.

Jones, N. S. 1950. Marine bottom communities. *Biological Reviews* **25(3):** 283-313.

Jost, L. 2006. Entropy and diversity. *Oikos* **113**: 363–375.

MacArthur, R.H. 1965. Patterns of species diversity. *Biological Reviews* **40**: 510–533.

Mackie, A.S.Y. 1990. Offshore benthic communities of the Irish Sea. In: *The IrishSea: an environmental review. Part 1: Nature Conservation.* Liverpool University Press. pp. 169-218.

Margalef, D.R. 1958. Information theory in ecology. *General Systems* **3:** 36-71.

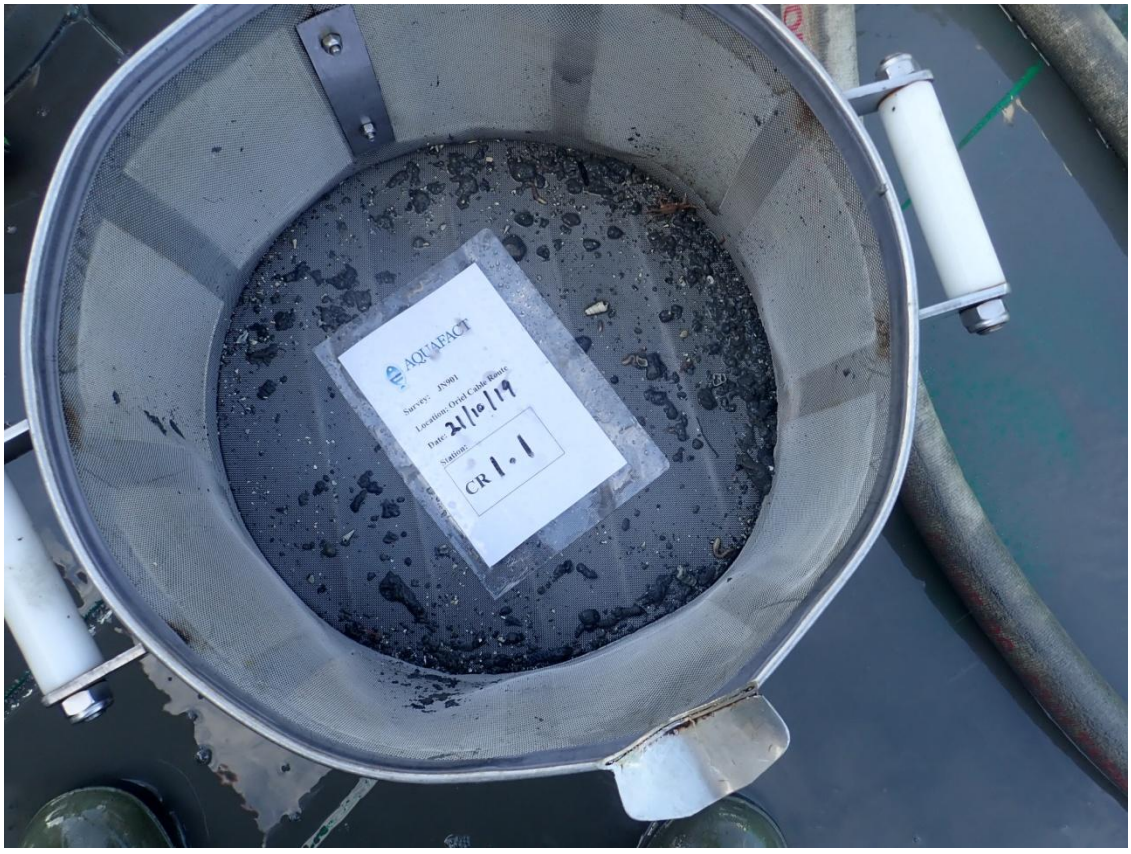
NPWS, 2012. Lower River Shannon SAC (site code: 2165). Conservation objectives supporting document – marine habitats and species. 33pp.

Pielou, E.C. 1977. Mathematical ecology. Wiley-Water science Publication, John Wiley and Sons. pp.385.

Shannon, C.E. & W. Weaver. 1949. The mathematical theory of communication. University of Illinois Press, Urbana.

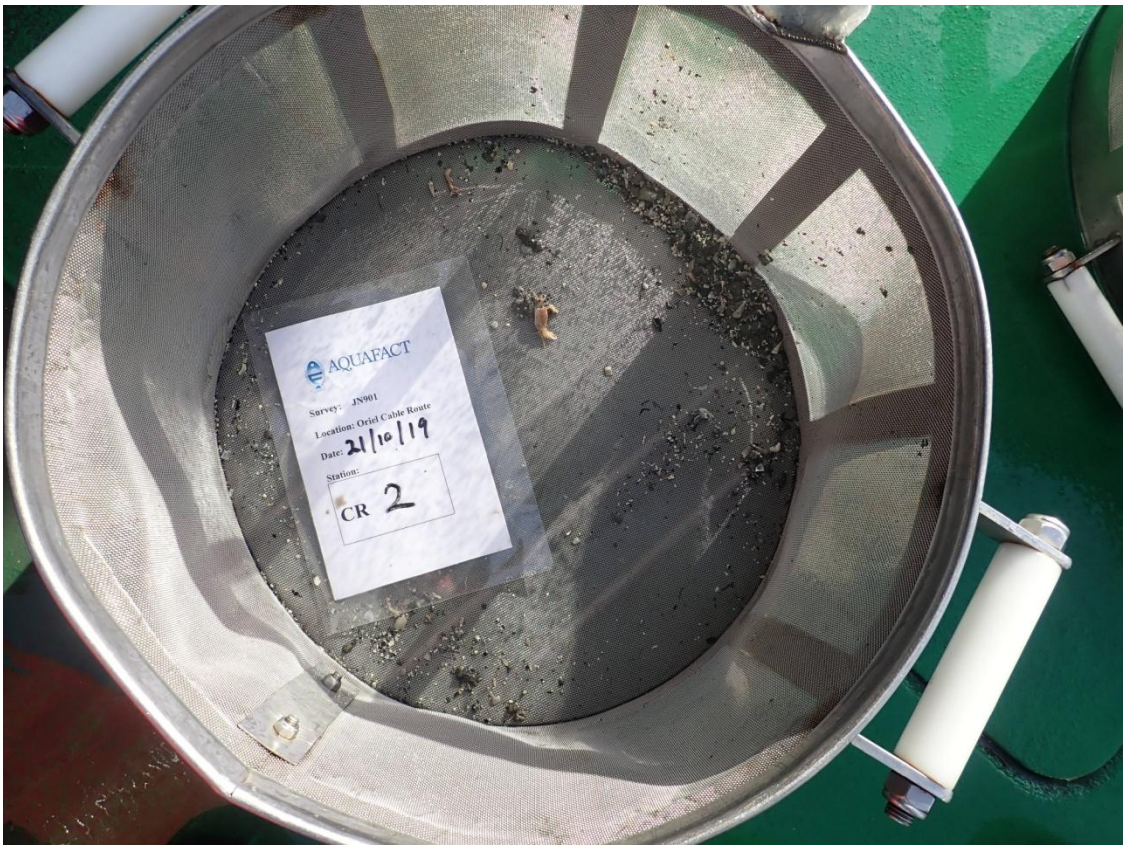
APPENDIX 1 PHOTOGRAPHIC LOG

CR1- Grab

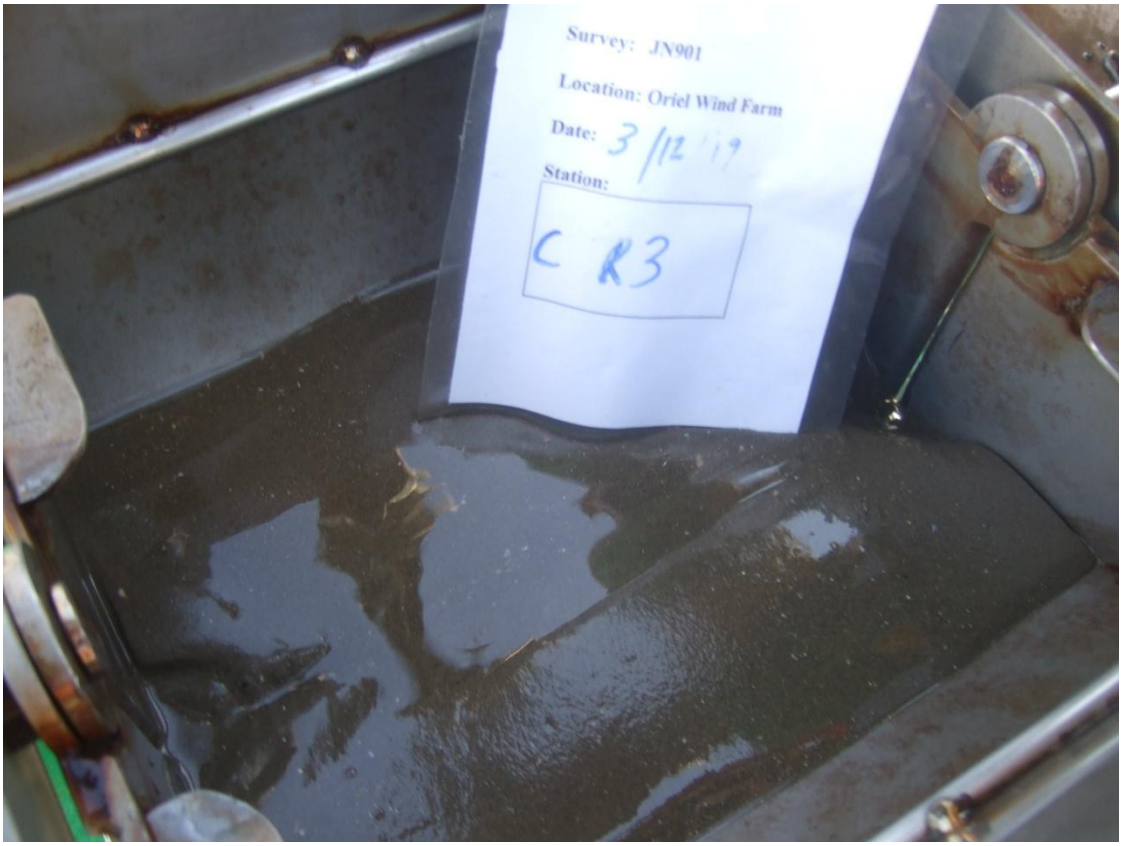


CR1 – Sieve

CR2 – Grab



CR2 – Sieve



CR3 – Grab

CR3 – Sieve

Stn 5 – Grab

Stn 5 – Sieve

Stn 11 – Grab

Stn 13 – Sieve

Stn 15 – Grab

Stn 15 – Sieve

Stn 21 – Grab

Stn 21 – Sieve

Stn 26 – Grab

Stn 31 – Grab

Stn 31 – Sieve

Stn 37 – Grab


AQUAFACT
Survey: JN901
Location: Oriel Wind Farm
Date: 21/10/19
Station:
Stn 37.1

Stn 37 – Sieve

APPENDIX 2 SEDIMENT ANALYSIS

AQUAFACT carry out the granulometric analysis using the traditional granulometric technique. We have all of the necessary equipment required *e.g.* Wentworth graded sieves, Easysize computer software, hydrogen peroxide, sodium hexametaphosphate, drying oven, beakers, mixers, electronic scales. We have carried out sediment analysis for all subtidal sampling programmes that we have been involved in.

AQUAFACT employ the following methodology for the granulometric analysis:

1. Approximately 100g of dried sediment (previously washed in distilled water and dried) is weighed out and placed in a labelled 1L glass beaker to which 100ml of a 6 percent hydrogen peroxide solution is then added. This is allowed to stand overnight in a fume hood.
2. The beaker is placed on a hot plate and heated gently. Small quantities of hydrogen peroxide are added to the beaker until there is no further reaction. This peroxide treatment removes any organic material from the sediment which can interfere with grain size determination.
3. The beaker is then emptied of sediment and rinsed into a 63µm sieve. This is then washed with distilled water to remove any residual hydrogen peroxide. The sample retained on the sieve is then carefully washed back into the glass beaker up to a volume of approximately 250ml of distilled water.
4. 10ml of sodium hexametaphosphate solution is added to the beaker and this solution is stirred for ten minutes and then allowed to stand overnight. This treatment helps to dissociate the clay particles from one another.
5. The beaker with the sediment and sodium hexametaphosphate solution is washed and rinsed into a 63µm sieve. The retained sampled is carefully washed from the sieve into a labelled aluminium tray and placed in an oven for drying at 100ºC for 24 hours.
6. The dried sediment should then be passed through a Wentworth series of analytical sieves (>8,000 to 63µm; single phi units). The weight of material retained in each sieve is weighed and recorded. The material passing through the 63µm sieve is also weighed and the value added to the value measured in Point 5 above.
7. The total silt/clay fraction is determined by subtracting all weighed fractions from the initial starting weight of sediment as the less than 63µm fraction was lost during the various washing stages.
8. The reporting of sediment samples will be as percentages within the following range of particle sizes:

- PSA % <63
- PSA % 63<125
- PSA % 125<250
- PSA % 250<500
- PSA % 500<1000
- PSA % 1000<2000
- PSA % 2000<4000
- PSA % 4000<8000
- PSA % ≥8000

The grain size data will be used to determine Folk (1954) classification, which is standard in all AQUAFACT's reports.

The organic matter (Loss on Ignition) is carried out by ALS Labs in Loughrea using the following methodology:

1. The collected sediments are transferred to aluminium trays, homogenised by hand and dried in an oven at 100º C for 24 hours.
2. A sample of dried sediment is placed in a mortar and pestle and ground down to a fine powder.
3. 1g of this ground sediment is weighed into a pre-weighed crucible and placed in a muffle furnace at 450ºC for a period of 6 hours.
4. The sediment samples are then allowed to cool in a dessicator for 1 hour before being weighed again.
5. The organic content of the sample is determined by expressing as a percentage the weight of the sediment after ignition over the initial weight of the sediment.

APPENDIX 3 SPECIES INVENTORY

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
CNIDARIA	1267										
ANTHOZOA	1292										
Cerianthidae	100684										
Cerianthus lloydii	283798					1					
ACTINIARIA	1360										
Actiniaria (indet)	1360				6		6			5	
Edwardsiidae	100665										
Edwardsia claparedii	100880					2		5			
NEMATODA	799										
Nematoda	799				1			14	8	3	3
NEMERTEA	152391										
Nemertea (indet)	152391					3	1	19	2	3	1
Nemertea sp. B	152391					1					
Tubulanidae	122321										
Tubulanus polymorphus	122637	1	2					2		2	
Lineidae	122314										
Cerebratulus sp. (damaged)	122348						3	1			
SIPUNCULA	1268										
Golfingiidae	2032										
Golfingia sp. (juv)	1648				1						
Thysanocardia procera	136063									2	
Phascolionidae	1647										
Phascolion (Phascolion) strombus strombus	410749						1				
ANNELIDA	882										
POLYCHAETA	883										
PHYLLODOCIDA	892										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Aphroditidae	938										
Aphrodita aculeata	129840								3		
Polynoidae	939										
Harmothoe sp. (damaged)	129491								1	2	
Pholoidae	941										
Pholoe inornata	130601	2			1						1
Pholoe baltica (sensu Petersen)	130599		1				23	1	13	10	
Sigalionidae	943										
Sthenelais limicola	131077							2			
Phyllodocidae	931										
Eteone longa aggregate	130616					2	1		2		
Eumida bahusiensis	130641								1		
Pseudomystides limbata	130683								1		
Phyllodoce mucosa	334512							1			
Phyllodoce rosea	334514								1		
Glyceridae	952										
Glycera sp. (damaged)	129296								2		
Glycera lapidum aggregate	130123					1			7		
Glycera tridactyla	130130			1					1		
Glycera unicornis	130131									1	
Goniadidae	953										
Goniada maculata	130140									1	
Goniadella gracilis	130145								6		
Sphaerodoridae	957										
Ephesiella abyssorum	131081								1		
Hesionidae	946										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Hesionidae (damaged)	946									1	
Oxydromus flexuosus	710680						1				
Podarkeopsis helgolandicus	130197									1	2
Pilargidae	15009										
Litocorsa stremma	130697							1		6	1
Syllidae	948										
Syllis cornuta	157583								1		
Syllis mauretanica	766393								1		
Streptosyllis websteri	131402							2			
Exogone naidina	327985						3				
Nephtyidae	956										
Nephtys sp. (juv)	129370		1		6		1	1		1	1
Nephtys cirrosa	130357			3		3		1			
Nephtys hombergii	130359				2		6	2			
Nephtys incisa	130362	3	2		1					1	8
Nephtys kersivalensis	130363								1		
EUNICIDA	895										
Lumbrineridae	967										
Lumbrineris cingulata aggregate	130240					8		20	7	6	
Lumbrineris latreilli	130248								7		
Abyssoninoe hibernica	146469										1
Dorvilleidae	971										
Protodorvillea kefersteini	130041								3		
ORBINIIDA	884										
Orbiniidae	902										
Scoloplos armiger	130537					22	1	31			

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Paraonidae	903										
Levinsenia gracilis	130578	3	2							3	5
Paradoneis lyra	130585							1	1	1	
SPIONIDA	889										
Spionidae	913										
Spionidae (damaged)	913		1								
Aonides oxycephala	131106					2			4		
Laonice cirrata	131128								1		
Prionospio sp. (damaged)	129620	10	3					1			6
Prionospio fallax	131157	3	3					1			
Prionospio multibranchiata	131160										1
Scolelepis sp. (damaged)	129623	1									1
Spio symphyta	596189			1							
Magelonidae	914										
Magelona alleni	130266									4	
Magelona filiformis	130268							2			1
Magelona minuta	130270	5	3		1					3	10
Magelona johnstoni	130269			1							
CAPITELLIDA	890										
Capitellidae	921										
Mediomastus fragilis	129892					2			2	1	
Notomastus latericeus	129898									1	1
OPHELIIDA	891										
Opheliidae	924										
Ophelia borealis	130491					3					
Scalibregmatidae	925										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Scalibregma inflatum	130980								3	16	
TEREBELLIDA	900										
Cirratulidae	919										
Chaetozone setosa	129955							2			
Flabelligeridae	976										
Diplocirrus glaucus	130100		1		1		2	27		3	2
Acrocirridae	920										
Macrochaeta clavicornis	129745								1		
Pectinariidae	980										
Lagis koreni	152367								1		
Ampharetidae	981										
Melinna palmata	129808		1								
Ampharete lindstroemi aggregate	129781							1			
Trichobranchidae	983										
Terebellides stroemii	131573					1					
Terebellidae	982										
Terebellidae (damaged)	982								1		
Polycirrus sp. (damaged)	129710							1			
SABELLIDA	901										
Oweniidae	975										
Galathowenia oculata	146950						5	1		2	
Owenia borealis	329882					1		14			
ARTHROPODA	1065										
CRUSTACEA	1066										
AMPHIPODA	1135										
Oedicerotidae	101400										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Monoculodes carinatus	102882								1		
Perioculodes longimanus	102915					1					
Phoxocephalidae	101403										
Harpinia antennaria	102960							3			
Harpinia crenulata	102963										2
Lysianassidae	101395										
Acidostoma obesum	102497					3					
Ampeliscidae	101364										
Ampelisca sp. (damaged)	101445									1	
Ampelisca typica	101933					5		4	4		
Pontoporeiidae	101406										
Bathyporeia elegans	103058					1					
Melitidae	101397										
Abludomelita obtusata	102788				10		17			14	
Photidae	148558										
Photis longicaudata	102383				15			1			
Aoridae	101368										
Autonoe longipes	102021								2		
Leptocheirus hirsutimanus	102036					1					
Caprellidae	101361										
Pariambus typicus	101857							1			
ISOPODA	1131										
Arcturidae	118280										
Astacilla dilatata	295579						3				
CUMACEA	1137										
Bodotriidae	110378										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Iphinoe serrata	110460						1			1	1
Leuconidae	110382										
Eudorella truncatula	110535	1	1								1
Diastylidae	110380										
Diastylis sp. (damaged)	110398									1	
Diastylis laevis	110481						2		1		
DECAPODA	1130										
Decapoda larvae	1130									1	
Caridea	106674										
Processidae	106791										
Processa nouveli holthuisi	108344		1								
Nephropidae	106741										
Nephrops norvegicus	107254									1	
Laomediidae	106802										
Jaxea nocturna	107737									2	
PAGUROIDEA	106687										
Porcellanidae	106734										
Pisidia longicornis	107188									1	
BRACHYURA	106673										
Goneplacidae	106757										
Goneplax rhomboides	107292	2	1		3					2	2
MOLLUSCA	51										
GASTROPODA	101										
Turritellidae	127										
Turritella communis	141872				74		50	1		203	
LITTORINIMORPHA	382213										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Rissoidae	123										
Alvania sp. (damaged)	138439									1	
Iravadiidae	122										
Hyala vitrea	140129									5	
Naticidae	145										
Euspira nitida	151894					1	1	1	1		
Eulimidae	135										
Eulima glabra	139805						7				
Nassariidae	151										
Tritia sp. (juv)	246140									1	
Mangeliidae	153853										
Sorgenfreispira brachystoma	847930						3				4
Pyramidellidae	162										
Odostomia sp. (juv)	138413				2					3	
Acteonidae	155										
Acteon tornatilis	138691					2		5			
CEPHALASPIDEA	154										
Cylichnidae	159										
Cylichna cylindracea	139476		1		1		7	3		1	
Philinidae	161										
Philine quadripartita	574582					1					
Diaphanidae	1750										
Diaphana minuta	139557								2		
SCAPHOPODA	104										
DENTALIIDA	200										
Dentallidae	202										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Antalis entalis	150534						2				
BIVALVIA	105										
NUCULIDA	382247										
Nuculidae	204										
Nucula sp. (juv)	138262			6			8				
Nucula nitidosa	140589			3	2	1	4			1	
Nucula nucleus	140590							4		2	
MYTILIDA	210										
Mytilidae	211										
Mytilidae (juv)	211			2							
Musculus subpictus	506128							1			
Lucinidae	218										
Lucinoma borealis	140283							1			
Thyasiridae	219										
Thyasira sp. (juv)	138552							1			
Thyasira flexuosa	141662		2		3		1		2	2	1
IMPARIDENTIA	869600										
Lasaeidae	222										
Kurtiella bidentata	345281				2		30		3		
Mactridae	230										
Spisula subtruncata	140302		1								
Tellinidae	235										
Fabulina fabula	146907			5					1		
Moerella donacina	147021								1		
Psammobiidae	237										
Gari fervensis	140870					5					

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Semelidae	1781										
Abra sp. (juv)	138474	1									
Abra alba	141433										
Abra nitida	141435	2	3		10	4	8	2		25	4
VENERIDA	217										
Veneridae	243										
Veneridae (juv)	243		2			14	2	2	1		2
Chamelea striatula	141908			1	1		14	2		1	
Clausinella fasciata	141909								3		
Dosinia sp. (juv)	138636				1		4	6	1		
Dosinia lupinus	141912					1	1				
MYIDA	245										
Corbulidae	248										
Corbula gibba	139410					2					
Hiatellidae	251										
Hiatella arctica	140103				2		1				
ANOMALODESMATA	254										
Thraciidae	256										
Thracia sp. (juv)	138549						1				
Thracia phaseolina	152378					21		16			
PHORONIDA	1789										
Phoronidae	148378										
Phoronis sp.	128545	1	2		6		17		1	1	
ECHINODERMATA	1806										
ASTEROIDEA	123080										
Asteroidea (juv)	123080					1	1				

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
FORCIPULATIDA	123086										
Asteriidae	123121										
Asterias rubens	123776								1		
OPHIUROIDEA	123084										
OPHIURIDA	123117										
Amphiuridae	123206										
Amphiuridae (juv)	123206	1				1	5	5			1
Amphiura filiformis	125080				2		64	3			
Ophiuridae	123200										
Ophiura sp. (juv)	123574								42		
ECHINOIDEA	123082										
CLYPEASTEROIDA	123100										
Echinocyamidae	510679										
Echinocyamus pusillus	124273					3					
SPATANGOIDA	123106										
Loveniidae	123175										
Echinocardium cordatum	124392						1				
Echinocardium flavescens	124394					1					
HOLOTHUROIDEA	123083										
DENDROCHIROTIDA	123111										
Phyllophoridae	123188										
Thyone fusus	124670							1	5		
Cucumariidae	123187										
Oncus planci	124647				1						
APODIDA	123108										
Synaptidae	123182										

JN 901 Oriel Nov Dec 2019											
Station	**AphiaID**	**CR1**	**CR2**	**CR3**	**STN 5**	**STN 13**	**STN 15**	**STN 21**	**STN 26**	**STN 31**	**STN 37**
Leptosynapta sp. (damaged)	123449						1		1		
CHORDATA	1821										
TUNICATA	146420										
ASCIDIACEA	1839										
Ascidiidae	103443										
Ascidiella aspersa	103718							1			
PISCES	11676										
PERCIFORMES	11014										
Ammodytidae	125516										
Ammodytes tobianus	126752					1					

APPENDIX 4 SIMPER ANALYSIS

Table 1: SIMPER analysis of Group b fauna.

Group b Average similarity: 52.98					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Prionospio sp. (damaged)	1.55	6.17	6.4	11.66	11.66
Magelona minuta	1.53	6.07	6.84	11.47	23.12
Nephtys incisa	1.4	5.44	7.02	10.27	33.39
Levinsenia gracilis	1.33	5.44	7.02	10.27	43.65
Abra nitida	1.31	5.42	9.6	10.23	53.88
Goneplax rhomboides	1.13	4.69	6.4	8.86	62.74
Eudorella truncatula	1	4.42	6.95	8.34	71.08
Prionospio fallax	0.88	2.24	0.58	4.23	75.31
Tubulanus polymorphus	0.73	1.7	0.58	3.21	78.52
Phoronis sp.	0.73	1.7	0.58	3.21	81.73
Veneridae (juv)	0.79	1.52	0.58	2.88	84.61
Pholoe inornata	0.73	1.44	0.58	2.71	87.32
Scolelepis sp. (damaged)	0.67	1.44	0.58	2.71	90.03

Table 2: SIMPER analysis of Group c fauna.

Group c Average similarity: 42.39					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Turritella communis	3.12	5.69	6.08	13.42	13.42
Abludomelita obtusata	1.91	3.76	11.52	8.87	22.29
Abra nitida	1.9	3.54	6.74	8.36	30.65
Actiniaria (indet)	1.54	3.14	6.8	7.4	38.05
Phoronis sp.	1.53	2.48	2.74	5.86	43.91
Nucula nitidosa	1.2	2.2	4.86	5.2	49.12
Thyasira flexuosa	1.17	2.2	5.03	5.2	54.31
Diplocirrus glaucus	1.17	2.17	26.64	5.13	59.44
Nephtys sp. (juv)	1.19	2.06	7.59	4.87	64.31
Cylichna cylindracea	1.21	2.06	7.59	4.87	69.18
Chamelea striatula	1.31	2.06	7.59	4.87	74.05
Pholoe baltica (sensu Petersen)	1.32	1.04	0.58	2.45	76.49
Nephtys hombergii	0.92	0.89	0.58	2.09	78.58
Kurtiella bidentata	1.18	0.89	0.58	2.09	80.67
Amphiura filiformis	1.34	0.89	0.58	2.09	82.76
Goneplax rhomboides	0.84	0.88	0.58	2.06	84.83
Odostomia sp. (juv)	0.84	0.88	0.58	2.06	86.89
Dosinia sp. (juv)	0.8	0.74	0.58	1.76	88.65
Hiatella arctica	0.73	0.74	0.58	1.76	90.4

Table 2: SIMPER analysis of Group d fauna.

Group d Average similarity: 26.04					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Lumbrineris cingulata aggregate	1.81	3.2	10.63	12.29	12.29
Ampelisca typica	1.44	2.75	11.64	10.56	22.85
Nemertea (indet)	1.53	2.4	8.35	9.21	32.06
Veneridae (juv)	1.37	2.07	6.45	7.96	40.02
Euspira nitida	1	1.94	11.64	7.47	47.48
Scoloplos armiger	1.51	1.45	0.58	5.59	53.07
Thracia phaseolina	1.38	1.34	0.58	5.16	58.23
Nematoda	1.21	0.98	0.58	3.78	62
Eteone longa agg.	0.79	0.82	0.58	3.14	65.15
Aonides oxycephala	0.87	0.82	0.58	3.14	68.29
Mediomastus fragilis	0.79	0.82	0.58	3.14	71.44
Edwardsia claparedii	0.89	0.8	0.58	3.07	74.5
Acteon tornatilis	0.89	0.8	0.58	3.07	77.57
Abra nitida	0.87	0.8	0.58	3.07	80.64
Glycera lapidum agg.	0.88	0.69	0.58	2.64	83.28
Nephtys cirrosa	0.77	0.67	0.58	2.58	85.86
Owenia borealis	0.98	0.67	0.58	2.58	88.44
Amphiuridae (juv)	0.83	0.67	0.58	2.58	91.02