Marine Ecological Survey, Great Island CCGT, Barrow Nore Suir Estuary, Co. Waterford

Produced by

AQUAFACT International Services Ltd

On behalf of

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AQUAFACT

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1. Introduction

AQUAFACT International Services Ltd. was commissioned by Scottish and Southern Energy (SSE) to undertake a biological assessment of the environmental impact of cooling water discharges and sodium hypochlorite dosing (active since April 7th, 2020) (licence ref. SW2) from Great Island CCGT (Combined Cycle Gas Turbine) on the receiving environment. Figure 1.1 below indicates in location of the discharges within the greater Barrow Nore Suir Estuary area.

Figure 1.1: Location of the discharge points within the study area, Barrow Nore Suir Estuary, Co. Waterford.

2. Floral and Faunal Surveys

2.1. Materials and Methods

2.1.1. Subtidal Survey Procedure

To carry out the subtidal benthic assessment of the area in question, AQUAFACT sampled a total of 7 stations. Temperature and salinity surface and bottom readings were taken in order to determine appropriate locations for the grab stations. Sampling took place on the 30th April and 1st May 2020 from AQUAFACT's 6.8m Lencraft RIB. The weather on both days was overcast with scattered showers. There was a force 4 south-westerly wind blowing on the 30th April and force 3 north westerly wind on 1st May. Low water was at 6pm (1.5m) at Cheekpoint on the 30th April and at 6.43am, (1.5m) on the 1st May. The locations of all subtidal stations sampled can be seen in Figure 2.1. Table 2.1 shows the station coordinates.

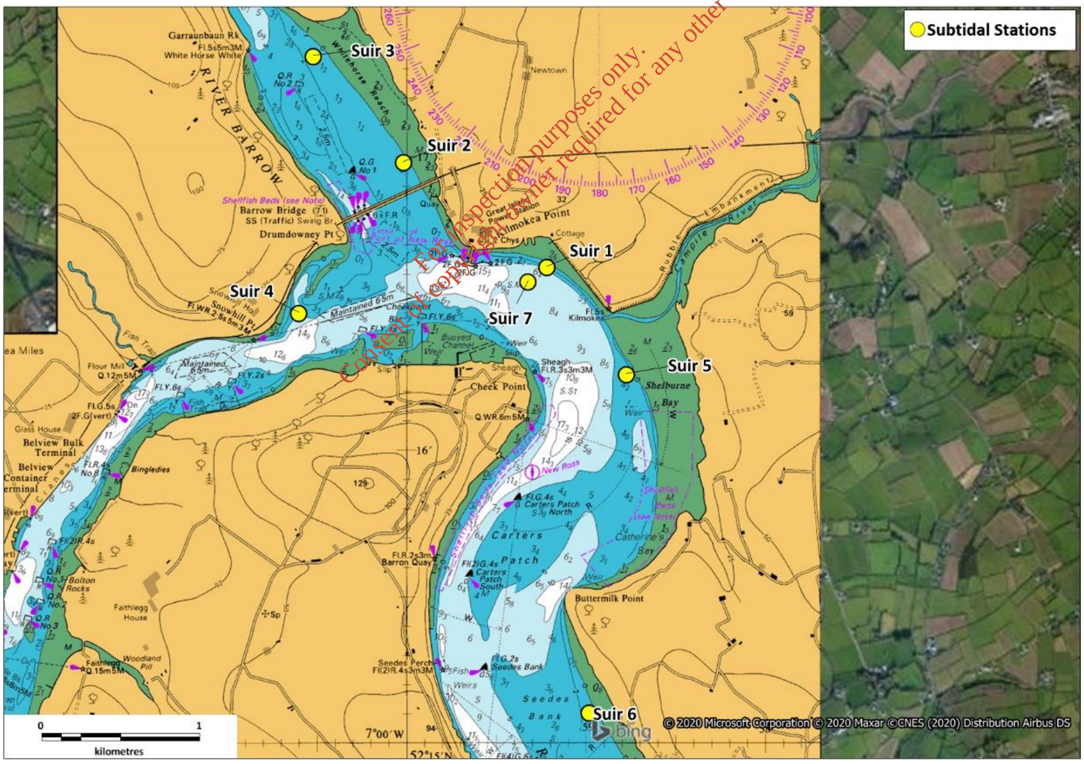

Figure 2.1: Location of all 7 stations sampled on the 30h April and 1st May 2020. Phytoplankton samples were collected at Stations Suir 1 – 6.

Table 2.1: Station coordinates of all 7 subtidal stations sampled on the 30th April and 1ST May 2020.

Station	Latitude	Longitude

Suir 1	52.27749	-6.9879
Suir 2	52.28341	-7.0012
Suir 3	52.28946	-7.0096
Suir 4	52.27485	-7.01096
Suir 5	52.27136	-6.98051
Suir 6	52.25216	-6.98399
Suir 7	52.27665	-6.98968

AQUAFACT has in-house standard operational procedures for benthic sampling and these were followed for this project. Additionally, the NMBAQC report "Guidelines for processing marine macrobenthic invertebrate samples: a processing requirements protocols" (Worsfold and Hall, 2010) was adhered to.

A 0.025m^2 van Veen grab was used to sample each station and 3 replicate grab samples were collected at each site. On arrival at each sampling station, the vessel location was recorded using DGPS (Lat/Long & ING). The grab deployment and recovery rates did not exceed 1 metre/sec and were <0.5 m/sec for the last 5 metres for water depths up to 30m and for the last 10m for depths greater than 30m.

A digital image of each sample (including sample label) was taken and its reference number entered in the sample data sheet. These images can be seen in Appendix 1. The grab sampler was cleaned between stations to prevent cross contamination.

Each grab sample was 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 immediately with Eosin-briebrich scarlet and fixed immediately in with 4% w/v buffered formaldehyde solution (10% w/v buffered formaldehyde solution for very organic mud).

An addition grab sample was collected at each station for sediment analysis (organic carbon and granulometry). Each sediment sample was placed in plastic sampling bags and labelled internally and externally. These samples were frozen (<-18ºC) as soon as possible after acquisition.

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 faunal samples were 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 3.2 shows the classification of sediment particle size ranges into size classes. Sieves, which corresponded to the range of particle sizes (Table 3.2), were used in the analysis. Refer to Appendix 2 for a detailed methodology of this procedure.

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 µm (> 2mm)	Gravel	< -1 Ø

Organic carbon analysis was carried out by the by INAB certified ALS Labs in Loughrea using the Loss on Ignition technique.

2.1.3. Intertidal Survey Procedure

AQUAFACT carried out 8 intertidal transects (T1 to T8) on the 30th April and 1st May 2020. Temperature and salinity surface and bottom readings were taken in order to determine appropriate locations for the transect. Table 2.3 lists the transect stations locations. Figure 2.2 illustrates their locations. The weather on both days was overcast with scattered showers. There was a force 4 south-westerly wind blowing on the 30th April and force 3 north westerly wind on 1st May. Low water was at 6pm (1.5m) at Cheekpoint on the 30th April and at 6.43am, (1.5m) on the 1st May.

Table 2.3: Station coordinates of all intertidal transect stations sampled on the 30th April and 1ST May 2020.

Station	Latitude	Longitude
T1 lower	52.29038	-7.00932
T1 middle	52.29063	-7.00909
T1 upper	52.29111	-7.00889
T2 lower	52.28374	-6.9996
T2 middle	52.28389	-6.99899
T2 upper	52.28399	-6.99856
T3 lower	52.27494	-7.01229
T3 mid	52.27498	-7.0124
T3 upper	52.27498	-7.01255
T4 lower	52.27816	-6.99009
T4 middle	52.27833	-6.99027
T4 upper	52.27841	-6.99036
T5 Lower	52.27539	-6.9832
T5 middle	52.27543	-6.9832
T5 upper	52.27552	-6.98305
T6 lower	52.27197	-6.97893

T6 middle	52.27254	-6.97746
T6 upper	52.27291	-6.97597
T7 lower	52.26557	-6.97692
T7 middle	52.26564	-6.97579
T7 upper	52.26595	-6.97374
T8 Lower	52.25302	-6.98332
T8 middle	52.25314	-6.98289
T8 upper	52.25334	-6.98242

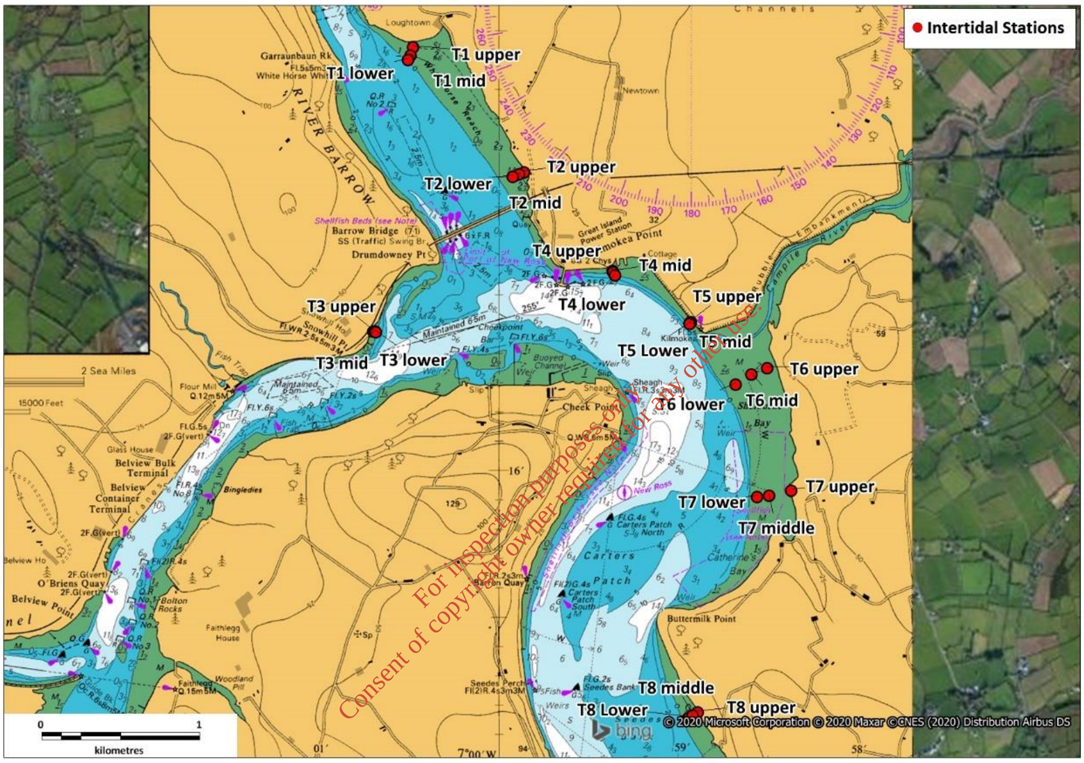

Figure 2.2: Location of the intertidal transects surveyed on the 20th April and 1st May 2020.

Along each transect, a 0.25m^2 quadrat was surveyed at three stations (Upper Shore, Mid Shore and Lower Shore). Salient features were noted as they were encountered along each transect and additional notes, supplemental photographs and level readings made where appropriate. Numerous rocks and stones were overturned and algal canopy cover partially removed at each station (where applicable) to investigate for the presence of any faunal species.

Photographs were taken to record the position of transects and any fixed and conspicuous landmarks which would aid returns to these locations in the future, while each of the 3 stations was marked using a digital global positioning system (DGPS). The physical features of the intertidal zone were described and photographed in detail. General physical features which were recorded.

In addition to the transect quadrat survey, a grab survey was carried out at the intertidal station locations where the substrate was too soft or muddy to allow a shore survey on the ground. Instead a 0.025m^2 Van Veen grab was deployed from AQUAFACT's RIB at high water at each of the of the transects' locations (Upper Shore, Mid Shore and Lower Shore) where the substrate was suitable and the grabs were preserved and returned to the lab for identification and analysis. Twenty of the 24 transect locations were grab sampled. Four locations (T3 upper, T3 mid, T3 lower and T8 upper), were too coarse for grab penetration. In the case of T8 upper the station consisted of rock armour. The full methodology for the collection and analysis of grab samples is outlined in Sections 2.1.1 and 2.1.2 above.

2.1.4. Phytoplankton

Six locations (stations Suir 1 – 6 as shown in Figure 2.1 above) in the survey area were sampled for phytoplankton. A 1 litre sample of water was collected at each site and fixed in Lugol's iodine for later examination in the laboratory. A subsample of each sample was examined under a microscope and the DACFOR scale (**D**ominant, **A**bundant, **C**ommon, **F**requent, **O**ccasional, **R**are) was used to estimate the densities of each species.

2.2. Data analysis

2.3. Sediment Data

Organic content of sediment samples was determined for each sample by expressing as a percentage the sediment weight loss following combustion over the initial weight of the sediment. In general, LOI correlates with sediment particle size with fine-grained sediments typically containing higher levels of organic matter than coarse sediments.

For the granulometric analysis of sediment samples, the <63 µm (Silt-Clay) fraction was determined by weight loss following wet sieving. Coarser fractions comprising the sediment samples were determined by mechanical dry sieving through a series of Wentworth sieves; >4mm (Fine Gravel), 2-4mm (Very Fine Gravel), 1-2mm (Very Coarse Sand), 0.5-1mm (Coarse Sand), 0.25-0.5mm (Medium Sand), 125-250µm (Fine Sand), 62.5-125µm (Very Fine Sand). For each station, the weight of each fraction of the sediment retained on the sieve was expressed as a percentage of the total sample. The relative proportion of sediments in each fraction was used to classify sediments at the station *sensu* Folk (1954).

2.4. Faunal Data

Uni- and multi-variate statistical analysis of the faunal data was undertaken using PRIMER v.6 (Plymouth Routines in Ecological Research).

2.4.1. Univariate Indices

Using PRIMER the faunal data was used to produce a range of univariate indices. Univariate indices are designed to condense species data in a sample into a single coefficient that provides quantitative estimates of biological variability (Heip *et al*., 1998; Clarke and Warwick, 2001). Univariate indices can be categorised as primary or derived indices.

Primary biological indices used in the current study include:

number of taxa (S) in the samples and

number of individuals (N) in the samples.

Derived biological indices, which are calculated based on the relative abundance of species in samples, used in the study include:

Margalef's species richness index (d) (Margalef, 1958),

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

where: N is the number of individuals and S is the number of species

Margalef's species richness is a measure of the total number of species present for a given number of individuals.

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

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

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

Pielou's evenness is a measure of how evenly the individuals are distributed among different species.

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

Shannon-Wiener diversity index takes both species abundance and species richness into account quantify diversity (Shannon & Wiener, 1949).

The Shannon-Wiener based Effective Number of Species (ENS) (Hill, 1973; Jost, 2006)

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

where H' is the Shannon-Weiner diversity index.

The Shannon-Wiener index diversity index is converted to ENS to reflect 'true diversities' (Hill, 1973, Jost, 2006) that can then be compared across communities (MacArthur, 1965; Jost, 2006). The 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 the community is twice as diverse as the other.

2.4.2. Multivariate Analysis

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 fourth root transformed and used to prepare a Bray-Curtis similarity matrix in PRIMER. The fourth root transformation allows some of the less abundant species to play a part in the similarity calculation. Various ordination and clustering techniques can then be applied to the similarity matrix to determine the relationship between the samples.

Multidimensional scaling (MDS) is a technique that ordinates samples as points in 2D or 3D space based on similarity in species distribution data. MDS performed on the Bray-Curtis similarity matrix produce ordination maps whereby the placement of samples reflects the similarity of their biological communities, rather than their simple geographical location (Clarke & Warwick, 2001).

An indication of how well the similarity matrix is represented by the ordination is given by stress values calculated by comparing the interpoint distances in the similarity matrix with the corresponding interpoint distances on the ordinations. 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 (2001) 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 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 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 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.
Hierarchical Agglomerative Clustering (HAC) is used to cluster samples based on between-sample similarities into groups in dendrograms. Similarity Profiling (SIMPROF) is used to test if differences between HAC derived similarity-based clusters are significant. Similarity Percentages (SIMPER) analysis can be used to determine the characterising species of each cluster of stations identified either arbitrarily (by eye) from HAC dendrograms or statistically using SIMPROF testing (Clarke and Warwick, 2001; Clarke and Gorley, 2006; Anderson *et al*., 2008).

The species, which are responsible for the grouping of samples in CLUSTER 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.

3. Results

3.1. Subtidal Faunal Results

3.1.1. Fauna

The taxonomic identification of the benthic infauna across all 7 stations sampled in the Suir Estuary yielded a total count of 36 taxa ascribed to 4 phyla. Of the 36 taxa identified, 20 were identified to species level. The remaining 16 could not be identified to species level due to the fact that they were juveniles, damaged or indeterminate. The full faunal abundance species list can be seen in Appendix 3.

Of the 36 taxa recorded, 18 were annelids (segmented worms), 10 were arthropods (crabs, shrimps, insects *etc*.), 7 were molluscs (mussels, cockles, snails etc.) and 1 was a nematode (round worm).

3.1.1.1. Univariate Analysis

In order to carry out the univariate analyses all replicate data were combined to give a total for each station prior to statistical analysis. Univariate statistical analyses were carried out on the station-by-station faunal data. The following parameters were calculated and can be seen in Table 3.4; species numbers, number of individuals, richness, evenness, Shannon-Weiner diversity, and Effective Species Number (ENS). Species numbers ranged from 10 (Suir 5 and Suir 7) to 22 (Suir 4). Number of individuals ranged from 31 (Suir 5) to 900 (Suir 4). Richness ranged from 2.25 (Suir 2) to 3.43 (Suir 3). Evenness ranged from 0.46 (Suir 4) to 0.9 (Suir 3). Shannon-Weiner diversity ranged from 1.41 (Suir 4) to 2.31 (Suir 3). Effective number of species ranged from 4.09 (Suir 4) to 10.12 (Suir 3) indicating that station Suir 3 is almost 2.5 times more diverse than Suir 4. ENS also indicates that the diversity is broadly similar throughout the stations surveyed. Figure 3.1 shows these community indices in graphical form.

Table 3.1: Univariate measures of community structure.

Station	No. Taxa	No. Individuals	Richness	Evenness	Shannon-Weiner Diversity	Effective Species Number
	S	N	d	J'	H'(loge)	EXP(H')
Suir 1	18	263	3.05	0.70	2.01	7.48
Suir 2	11	85	2.25	0.85	2.05	7.74
Suir 3	13	33	3.43	0.90	2.31	10.12
Suir 4	22	900	3.09	0.46	1.41	4.09
Suir 5	10	31	2.62	0.84	1.93	6.87
Suir 6	14	83	2.94	0.72	1.91	6.73
Suir 7	10	27	2.73	0.85	1.96	7.11

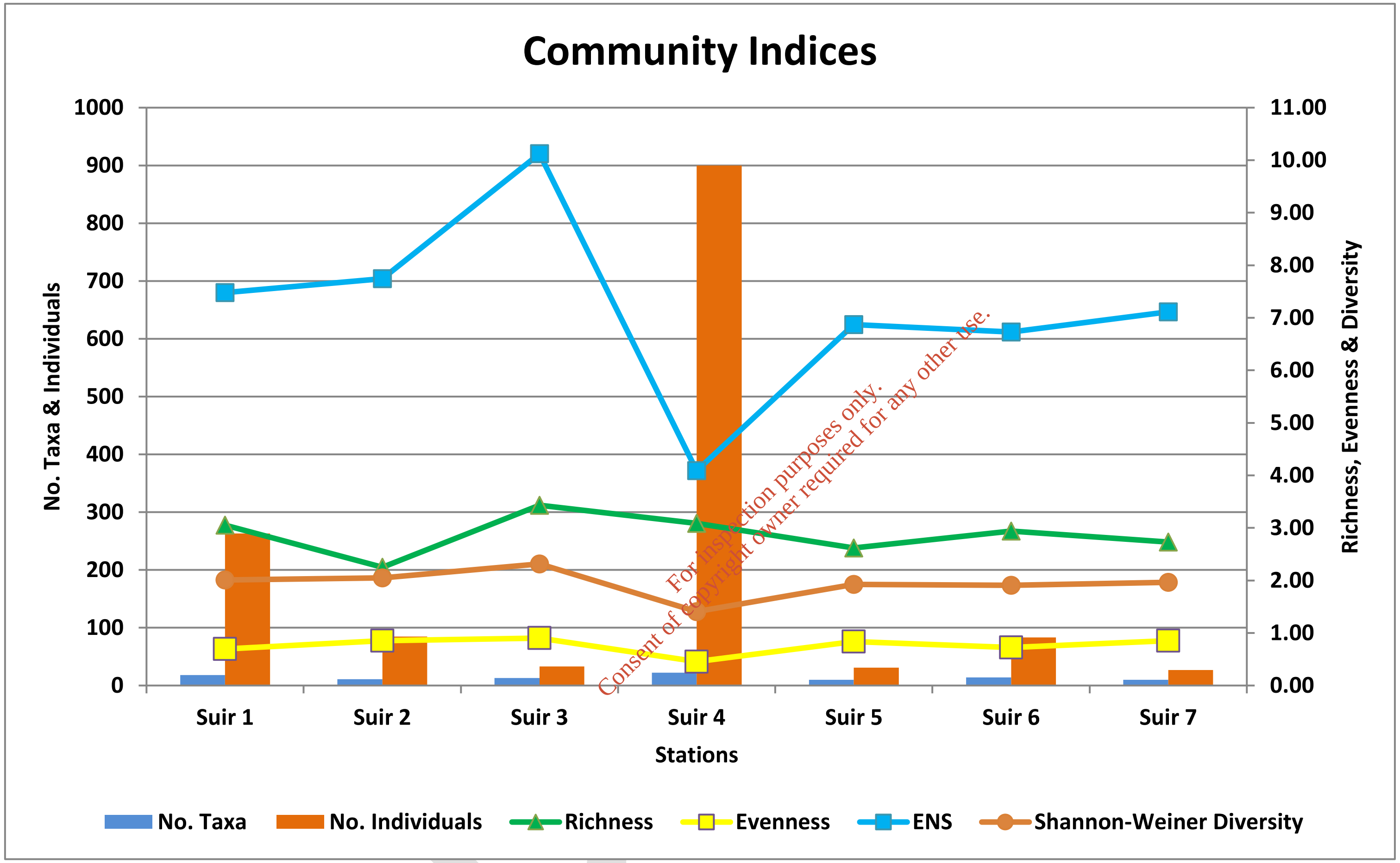

Figure 3.1: Subtidal community diversity indices. Diversity is expressed in Effective Number of Species (ENS) and Shannon-Weiner Diversity.

3.1.1.2. Multivariate Analysis

The same data set used above for the univariate analyses was also used for the multivariate analyses. However, epifaunal species (*i.e.* barnacles) were removed from the data set. The dendrogram and the MDS plot can be seen in Figures 3.2 and 3.3, respectively. SIMPROF analysis revealed the 7 stations could not be significantly differentiated from each other. The stress level on the MDS plot indicates an excellent representation of the data with no prospect of misinterpretation of the overall structure.

All seven stations were grouped together and had an average within group similarity of 50.77%. The 32 taxa used in the multivariate analysis consisted of 854 individuals. Of the 32 taxa, 12 were present twice or less. Six species accounted for almost 71% of the total abundance: Nematoda (129 individuals, 15.11% abundance), the polychaetes *Tharyx killariensis* (117 individuals, 13.7% abundance), *Polydora cornuta* (98 individuals, 11.48% abundance) and *Streblospio shrubsolii* (89 individuals, 10.42% abundance), and the oligochaetes *Tubificoides benedii* (98 individuals, 11.48% abundance) and *Baltidrilus costatus* (73 individuals, 8.55% abundance). SIMPER analysis revealed that *Tubificoides benedii*, *Streblospio shrubsolii* and the gastropod *Peringia ulvae* are the characterising species of this grouping. *S. shrubsolii, P. ulvae* and Nematoda are tolerant of disturbance, occurring under normal conditions, but their populations are stimulated by organic enrichment. *Tharyx killariensis* and *Polydora cornuta* are second order opportunistic species that are present in slight to pronounced unbalanced conditions. *Tubificoides benedii* and *Baltidrilus costatus* are first order opportunistic species which proliferate in reduced sediments with high organic content. This group can be seen as belonging to the JNCC biotope SS.SMu.SMuVS.PolCvol *Polydora ciliata* and *Corophium volutator* in variable salinity infralittoral firm mud or clay (EUNIS code A5.321). SS.SMu.SMuVS.PolCvol is a sublittoral biotope occurring in sheltered, very sheltered and extremely sheltered areas with weak tidal streams (Connor *et al.,* 2004). The biotope occurs in variable salinity and exclusively in clay and very firm mud and is characterized by a turf of the polychaete *Polydora* along with the amphipod *Corophium volutator.* This biotope is not sensitive to local increases in temperature and the resilience and resistance of the biotope is considered high (De-Bastos, ESR *et al.*, 2016).

Additionally, these stations can be classified as belonging to one of the four common benthic community habitat types occurring in the River Barrow and River Nore SAC (Figure 3.7) (NPWS,

2011) namely the habitat 'Muddy estuarine community complex'. This community is present intertidally and subtidally from Cheek Point and Great Island northward to New Ross. The substrate of this community complex is predominantly of fine material. The distinguishing species for this group are the bivalve *Scrobicularia plana* and *Limecola balthica,* the amphipod *Corophium volutator,* the polychaete *Streblospio shrubsolii* and the oligochaetes *Tubificoides pseudogaster* and *Tubificoides benedii.* These species are indicative of variable salinity community (NPWS, 2011).

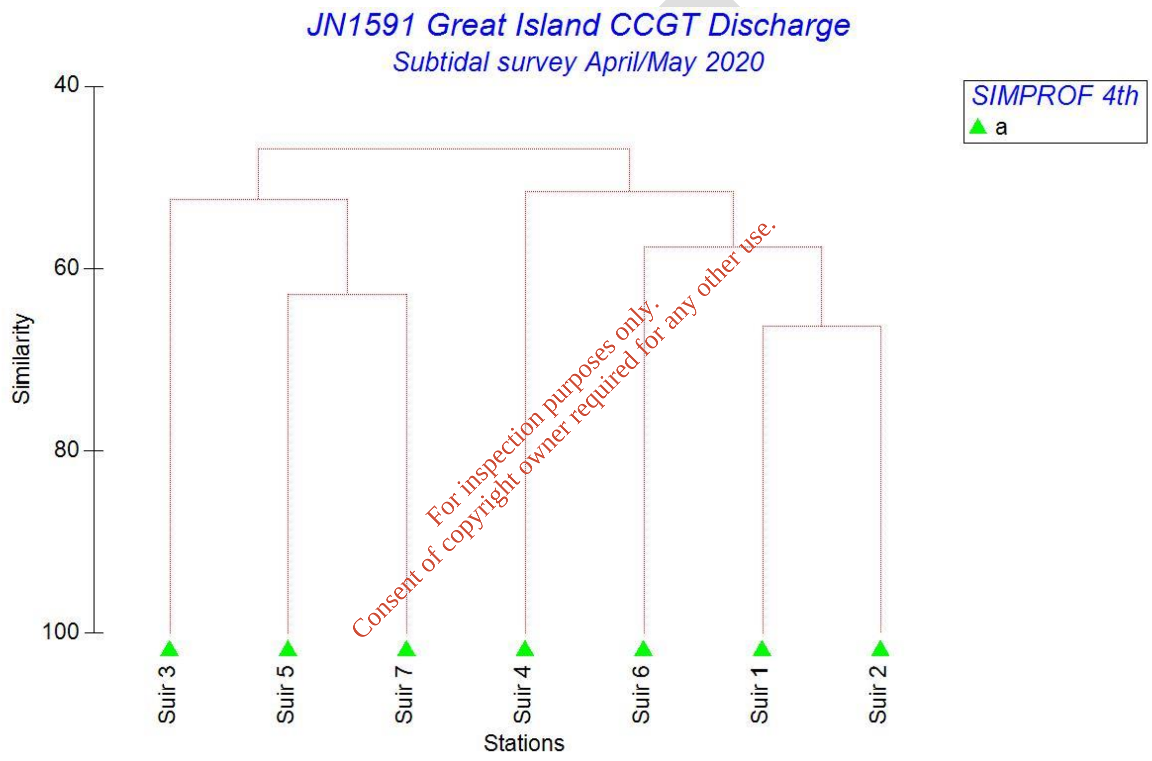

Figure 3.2: Dendrogram produced from Cluster analysis.

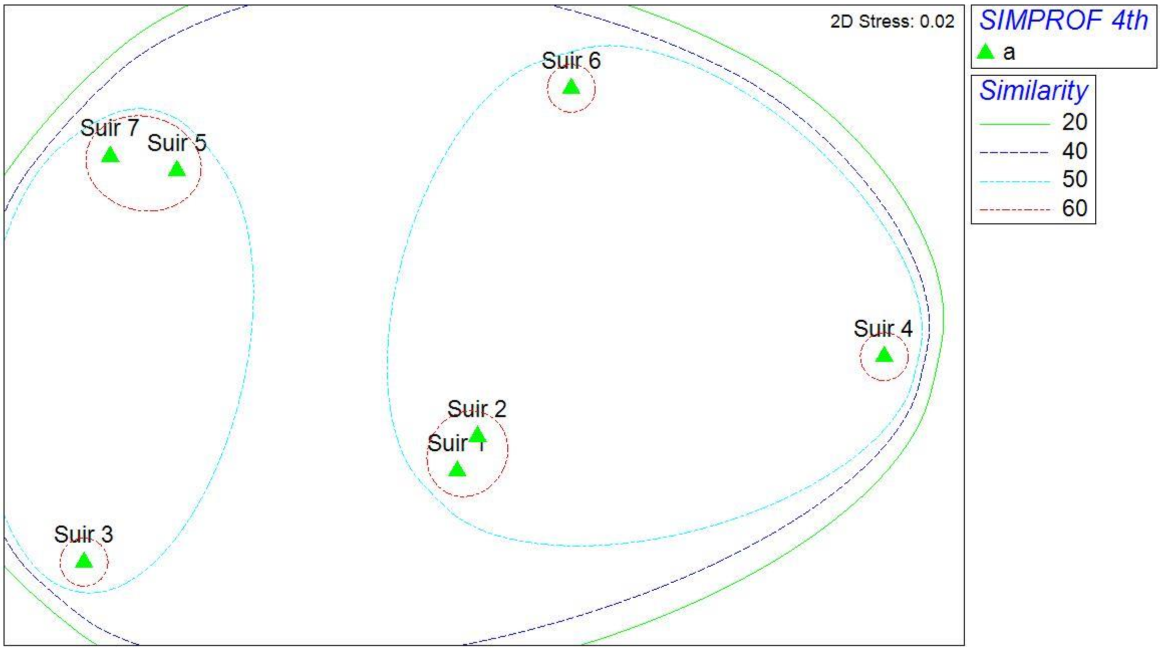

Figure 3.3: MDS plot.

3.2. Intertidal Faunal Results

3.2.1. Fauna

The taxonomic identification of the benthic infauna across all 20 of the 24 intertidal transect grab stations sampled in the Suir Estuary yielded a total count of 35 taxa ascribed to 4 phyla. Of the 35 taxa identified, 21 were identified to species level. The remaining 14 could not be identified to species level as they were juveniles, damaged or indeterminate. The full faunal abundance species list can be seen in Appendix 1.

Of the 35 taxa recorded, 19 were annelids (segmented worms), 7 were arthropods (crabs, shrimps, insects etc.), 8 were molluscs (mussels, cockles, snails etc.) and 1 was a nematode (round worm).

3.2.1.1. Univariate Analysis

Univariate statistical analyses were carried out on the station-by-station faunal data as described above. The following parameters were calculated and can be seen in Table 3.4; species numbers, number of individuals, richness, evenness, Shannon-Weiner diversity, and Effective Species Number (ENS). Species numbers ranged from 3 (T5 lower) to 23 (T8 mid). Number of individuals ranged from 4 (T5 lower) to 1710 (T8 mid). Richness ranged from 0.85 (T5 upper) to 2.96 (T8 mid). Evenness ranged from 0.27 (T4 mid) to 0.95 (T5 lower). Shannon-Weiner diversity ranged from 0.56 (T4 mid) to 2.11 (T1 lower). Effective number of species ranged from 1.75 (T4 mid) to 8.23 (T1 lower) indicating that station T1 lower is over 4.7 times more diverse than T4 mid. Figure 3.4 shows these community indices in graphical form.

Table 3.2: Univariate measures of community structure.

Station	No. Taxa	No. Individuals	Richness	Evenness	Shannon-Weiner Diversity	Effective Species Number
	S	N	d	J'	H'(loge)	EXP(H')
T1 lower	12	60	2.69	0.85	2.11	8.23
T1 mid	16	553	2.38	0.52	1.44	4.22
T1 upper	14	663	2.00	0.41	1.09	2.97
T2 lower	8	59	1.72	0.57	1.19	3.28
T2 mid	12	340	1.89	0.61	1.52	4.55
T2 upper	10	123	1.87	0.66	1.52	4.58
T4 lower	13	644	1.86	0.35	0.90	2.47
T4 mid	8	141	1.41	0.27	0.56	1.75
T4 upper	9	42	2.14	0.91	1.99	7.31
T5 Lower	3	4	1.44	0.95	1.04	2.83
T5 mid	13	291	2.12	0.52	1.34	3.83
T5 upper	4	34	0.85	0.75	1.04	2.82
T6 lower	11	361	1.70	0.67	1.60	4.95
T6 mid	14	180	2.50	0.74	1.95	7.01
T6 upper	13	251	2.17	0.70	1.80	6.04
T7 lower	10	87	2.02	0.70	1.62	5.05
T7 mid	12	153	2.19	0.65	1.61	4.98
T7 upper	16	327	2.59	0.73	2.03	7.65
T8 mid	23	1710	2.96	0.53	1.65	5.21
T8 upper	11	69	2.36	0.56	1.35	3.85

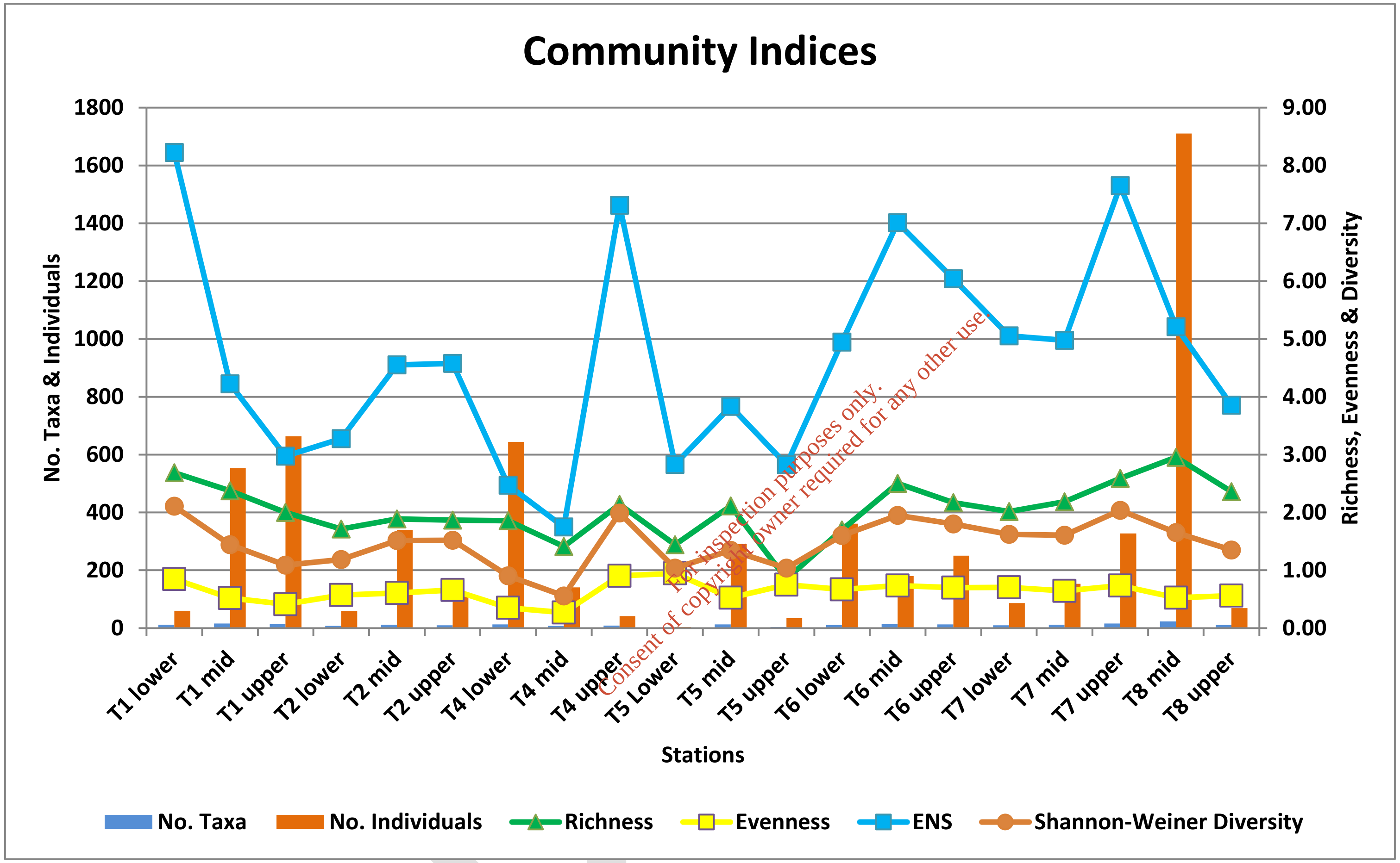

Figure 3.4:Intertidal community diversity indices. Diversity is expressed in Effective Number of Species (ENS) and Shannon-Weiner Diversity.

3.2.1.2. 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 3.5 and 3.6 respectively. SIMPROF analysis revealed 6 statistically significant groupings between the 20 stations (the samples connected by red lines cannot be significantly differentiated). The stress level on the MDS plot indicates that this gives us a useful picture, but very fine detail may be misleading in compact subgroups.

A clear divide (13.48% similarity) can be seen between **Groups a** and all other groups. A similarly clear divide (38.09% similarity) can be seen between **Group b** and the remaining groups (**Groups c, d, e,** and **f**).

Group a consisted of station T5 lower. This group separated from all other groups at a 13.48% similarity level. T5 lower contained 3 taxa comprising 4 individuals. All of the taxa were present twice or less. SIMPER analysis could not be carried out on this group as it only contained one station. The gastropod *Peringia ulvae* was present twice and the bivalve *Abra* sp. (juvenile) and Nematoda were each recorded once. *Peringia ulvae, Abra* sp. and Nematoda are tolerant of disturbance, occurring under normal conditions, but their populations are stimulated by organic enrichment. The numbers of taxa and individuals were lowest at this station.

Group b consisted of T5 mid. This group separated from Groups c, d, e, and f at 38.09% similarity level. T5 mid contained 13 taxa comprising 291 individuals. Of the 13 taxa, 4 were present twice or less. Three taxa accounted for over 83% of the faunal abundance: Nematoda (188 individuals, 65.6% abundance), the oligochaete *Tubificoides benedii* (35 individuals, 12.03% abundance) and the polychaete *Streblospio shrubsolii* (20 individuals, 6.87% abundance). SIMPER analysis could not be carried out on this group as it only contained one station. Nematoda and *Streblospio shrubsolii* are tolerant of disturbance, occurring under normal conditions, but their populations are stimulated by organic enrichment. *Tubificoides benedii* is a first order opportunistic species which proliferates in reduced sediments with high organic content.

Group c contained stations T1 lower, T2 lower, T4 mid, T5 upper and T7 lower. This group had a within group similarity of 54.22% and was most similar to Group f, at a level of 41.2%. This group contained 18 taxa comprising 423 individuals. Of the 18 taxa, 7 were present twice or less. Five species accounted for just over 86% of the faunal abundance: the oligochaete *Tubificoides benedii* (210 individuals, 49.65% abundance), the polychaete *Streblospio shrubsolii* (44 individuals, 10.4% abundance), the gastropod *Peringia ulvae* (42 individuals, 9.93% abundance), Nematoda (36 individuals, 8.51% abundance) and the amphipod *Corophium volutator* (33 individuals, 7.8% abundance). SIMPER analysis revealed that *Peringia ulvae, Tubificoides benedii* and Nematoda are the characterising species of this group. SIMPER analysis for this group is presented in Table 3.3. *P. ulvae* and Nematoda are tolerant of disturbance, occurring under normal conditions, but their populations are stimulated by organic enrichment. *Tubificoides benedii* is a first order opportunistic species which proliferates in reduced sediments with high organic content.

Group d consisted of T8 lower. This group separated from Groups e and f at 48.12% similarity level and was most similar to Group f (41.82% similarity). T8 lower contained 11 taxa comprising 69 individuals. Of the 11 taxa, 6 were present twice or less. Three taxa accounted for almost 78% of the faunal abundance: *Peringia ulvae* (46 individuals, 66.67% abundance), the oligochaete *Tubificoides* sp. (damaged) (5 individuals, 7.25% abundance) and bivalve the Semelidae (juvenile) (4 individuals, 5.8% abundance). SIMPER analysis could not be carried out on this group as it only contained one station. Nematoda and *Streblospio shrubsolii* are tolerant of disturbance, occurring under normal conditions, but their populations are stimulated by organic enrichment. *Tubificoides benedii* is a first order opportunistic species which proliferates in reduced sediments with high organic content.

Group e consisted of station T8 mid. This group separated from Group f at 45.26% similarity level and was most similar to Group f (45.26% similarity). T8 mid contained 23 taxa comprising 1,710 individuals. Of the 23 taxa, 7 were present twice or less. Three taxa accounted for just over 79% of the faunal abundance: *Tubificoides benedii* (801 individuals, 46.84% abundance), *Peringia ulvae* (364 individuals, 21.64% abundance) and *Corophium volutator* (196 individuals, 11.29% abundance). SIMPER analysis could not be carried out on this group as it only contained one station. *Tubificoides benedii* is a first order opportunistic species which proliferates in reduced sediments with high organic content. *Peringia ulvae* and *Corophium volutator* are tolerant of disturbance, occurring under normal conditions, but their populations are stimulated by organic enrichment.

Group f contained stations T1 mid, T1 upper, T2 mid, T2 upper, T4 lower, T6 lower, T6 mid, T6 upper, T7 mid and T7 upper. This group had a within group similarity of 60.49% and was most similar to Group e, at a level of 45.26%. This group contained 26 taxa comprising 3,595 individuals. Of the 26 taxa, 4 were present twice or less. Four species accounted for just over 83% of the faunal abundance: *Tubificoides benedii* (1,706 individuals, 83.14% abundance), *Peringia ulvae* (869 individuals, 24.73% abundance), *Streblospio shrubsolii* (214 individuals, 5.95% abundance) and Nematoda (180 individuals, 5.01% abundance). SIMPER analysis revealed that *Peringia ulvae, Tubificoides benedii, Streblospio shrubsolii* and the bivalve *Scrobicularia plana* are the characterising species of this group. SIMPER analysis for this group is presented in Table 3.3. *P. ulvae, S. shrubsolii* and *Scrobicularia plana* are tolerant of disturbance, occurring under normal conditions, but their populations are stimulated by organic enrichment. *Tubificoides benedii* is a first order opportunistic species which proliferates in reduced sediments with high organic content.

Analysis of the fauna from the intertidal grab stations indicates that these stations can be classified as belonging to one of the four common benthic community habitat types occurring in the River Barrow and River Nore SAC (Figure 3.7) (NPWS, 2011) namely the habitat 'Muddy estuarine community complex'. This community is present intertidally and subtidally from Cheek Point and Great Island northward to New Ross. The substrate of this community complex is predominantly of fine material. The distinguishing species for this group are the bivalve *Scrobicularia plana* and *Limecola balthica,* the amphipod *Corophium volutator,* the polychaete *Streblospio shrubsolii* and the oligochaetes *Tubificoides pseudogaster* and *Tubificoides benedii.* These species are indicative of variable salinity community (NPWS, 2011).

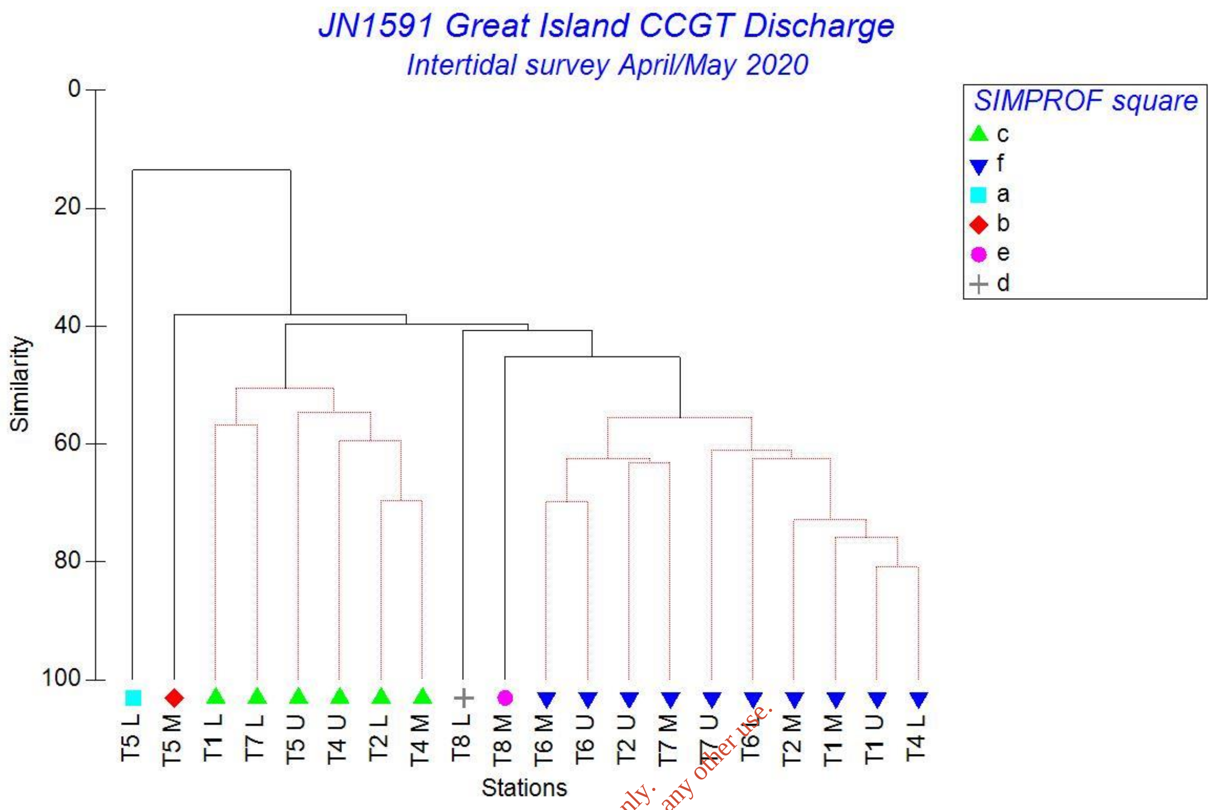

Figure 3.5: Dendrogram produced from Cluster analysis.

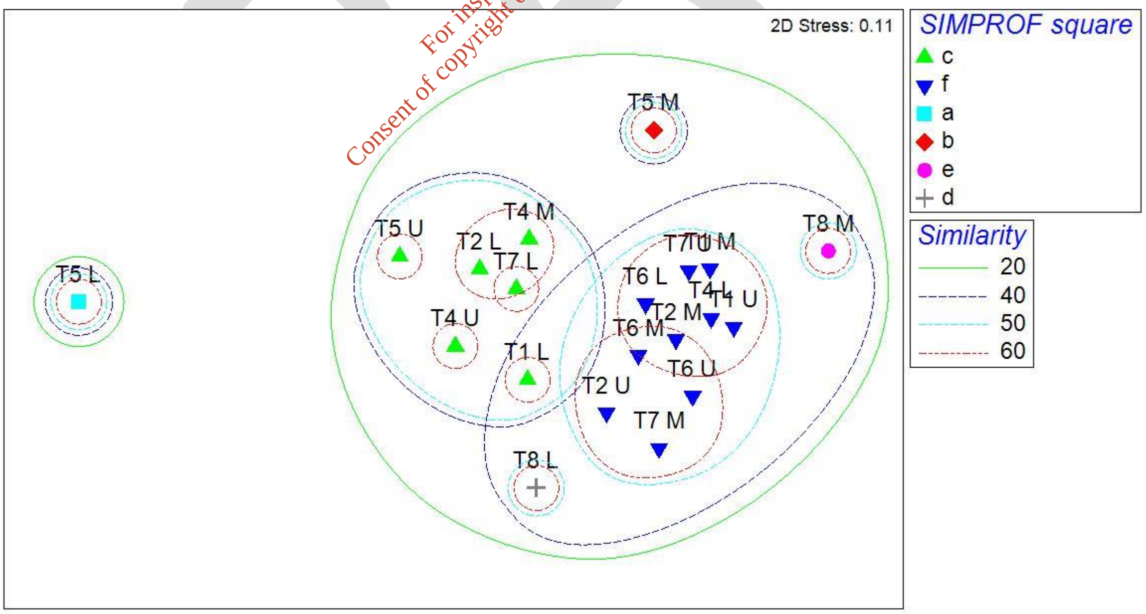

Figure 3.6: MDS plot.

Table 3.3: SIMPER analysis of the intertidal grab samples.

Group a					
Less than 2 samples in group					
Group b					
Less than 2 samples in group					
Group c					
Average similarity: 54.22					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Tubificoides benedii	5.16	18.58	3.07	34.26	34.26
Peringia ulvae	2.6	12.01	7.88	22.14	56.41
Nematoda	2.35	10.31	3.27	19.01	75.42
Streblospio shrubsolii	2.02	4.52	1.2	8.34	83.76
Scrobicularia plana	1.15	2.29	0.68	4.22	87.97
Cirratulidae (partial/damaged)	0.91	2.24	0.75	4.14	92.11
Group d					
Less than 2 samples in group					
Group e					
Less than 2 samples in group					
Group f					
Average similarity: 60.49					
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Peringia ulvae	9.28	17.65	3.97	29.18	29.18
Tubificoides benedii	11.29	14.43	2.2	23.86	53.04
Streblospio shrubsolii	4.16	6	2.27	9.93	62.97
Scrobicularia plana	3.14	5.02	2.82	8.3	71.26
Cyathura carinata	2.74	4.26	1.93	7.05	78.31
Nematoda	3.28	3.1	1.01	5.12	83.43
Semelidae (juv)	2.25	2.65	1.08	4.38	87.81
Limecola balthica	1.23	1.4	1.18	2.31	90.12

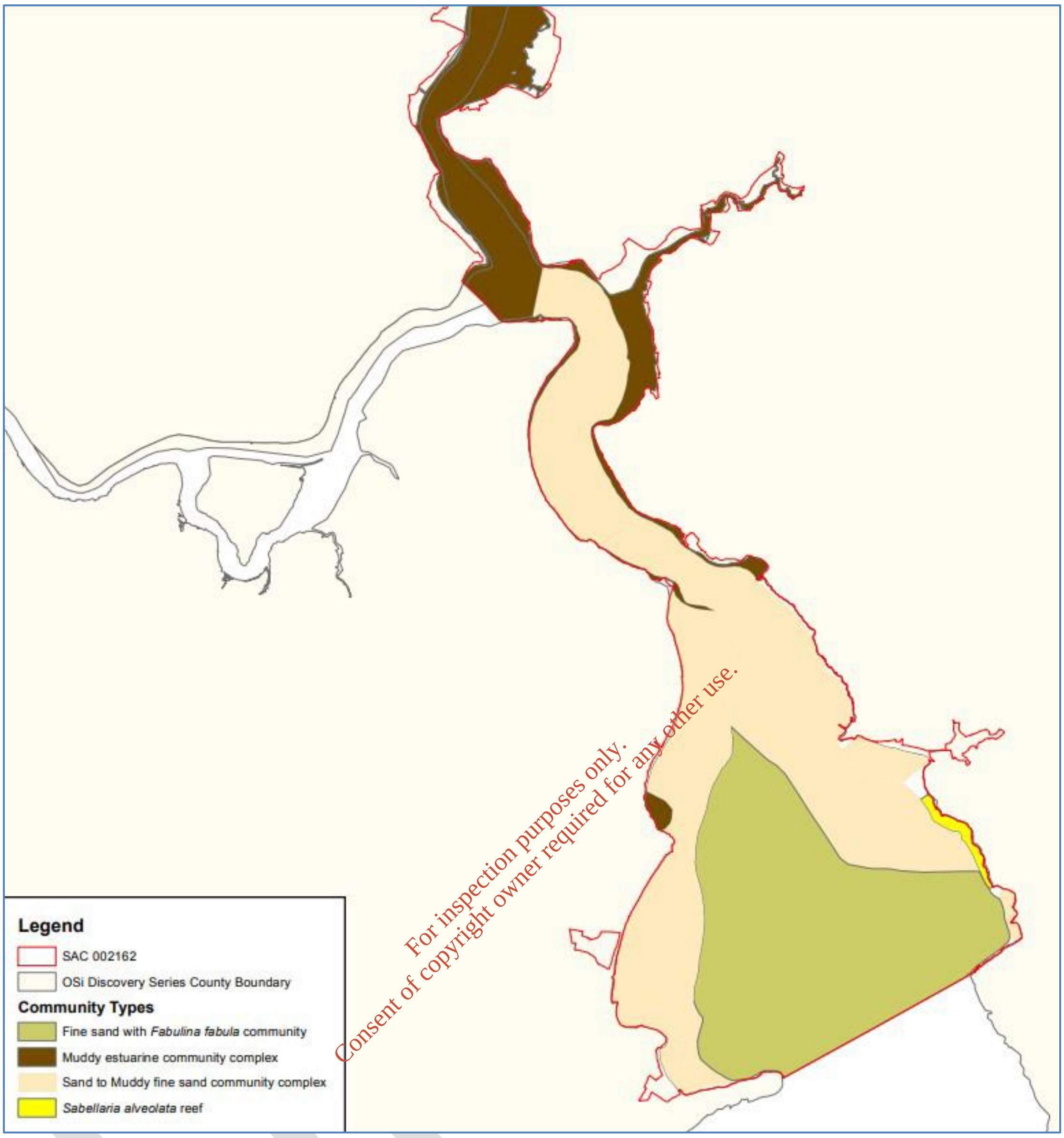

Figure 3.7: River Barrow and River Nore conservation objectives marine community types (NPWS, 2011).

3.3. Sediment

Table 3.7 shows the sediment characteristics of the subtidal and intertidal stations surveyed including the granulometry and the percentage organic carbon.

The sediment sampled within the study area was classified as slightly gravelly muddy sand, slightly gravelly sandy mud, gravelly muddy sand, muddy sand and sandy mud according to

Folk (1954). No medium gravel-boulders were recorded. Highest levels of fine gravel were observed at Suir 4 (29.4%). Highest levels of very fine gravel were observed at T6 (8.2%). Highest levels of very coarse sand, coarse sand and medium sand were found at T7 (3.5%, 7.1% and 11.2%, respectively). Highest levels of fine sand were found at Suir 3 (38.3%). Highest levels of very fine sand were found at Suir 6 (69.6%) and highest levels of silt-clay were found at T2 (56.5%). Figure 3.5 shows the breakdown of sediment composition at each subtidal station and Figure 3.6 shows the breakdown of sediment composition at each intertidal station. Figure 3.7 illustrates the sediment type according to Folk (1954). Organic matter values ranged from 3.52% (Suir 6) to 8.41% (T7).

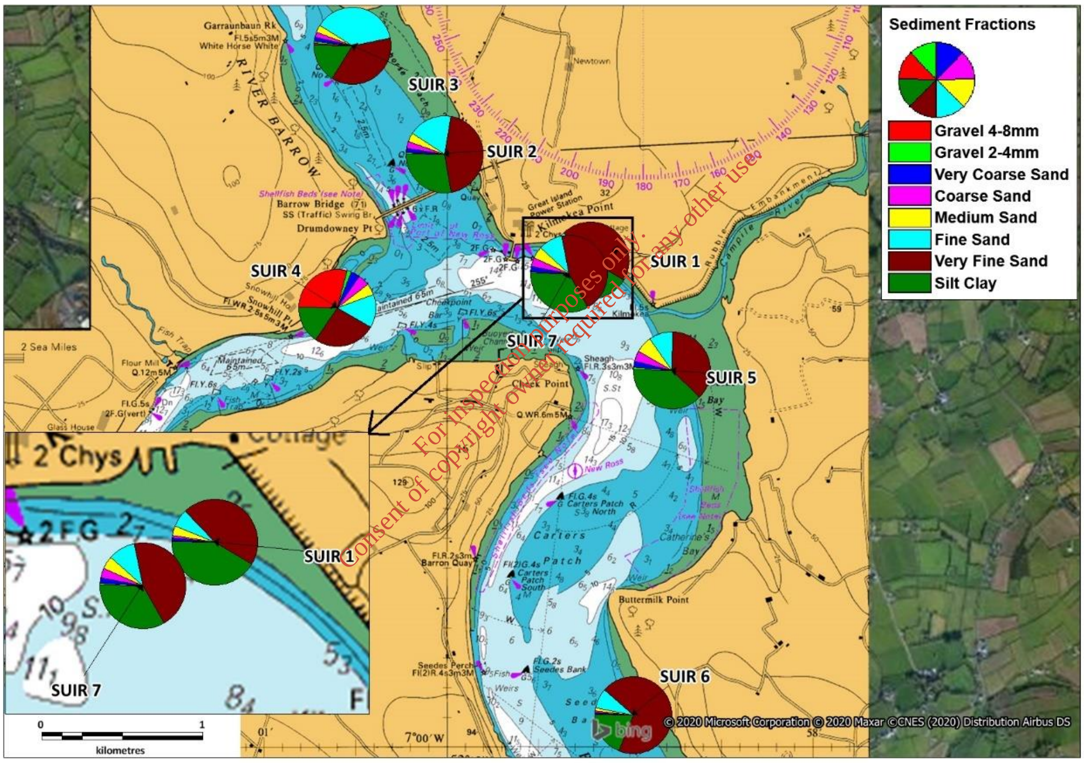

Figure 3.8: A breakdown of sediment type at each subtidal station.

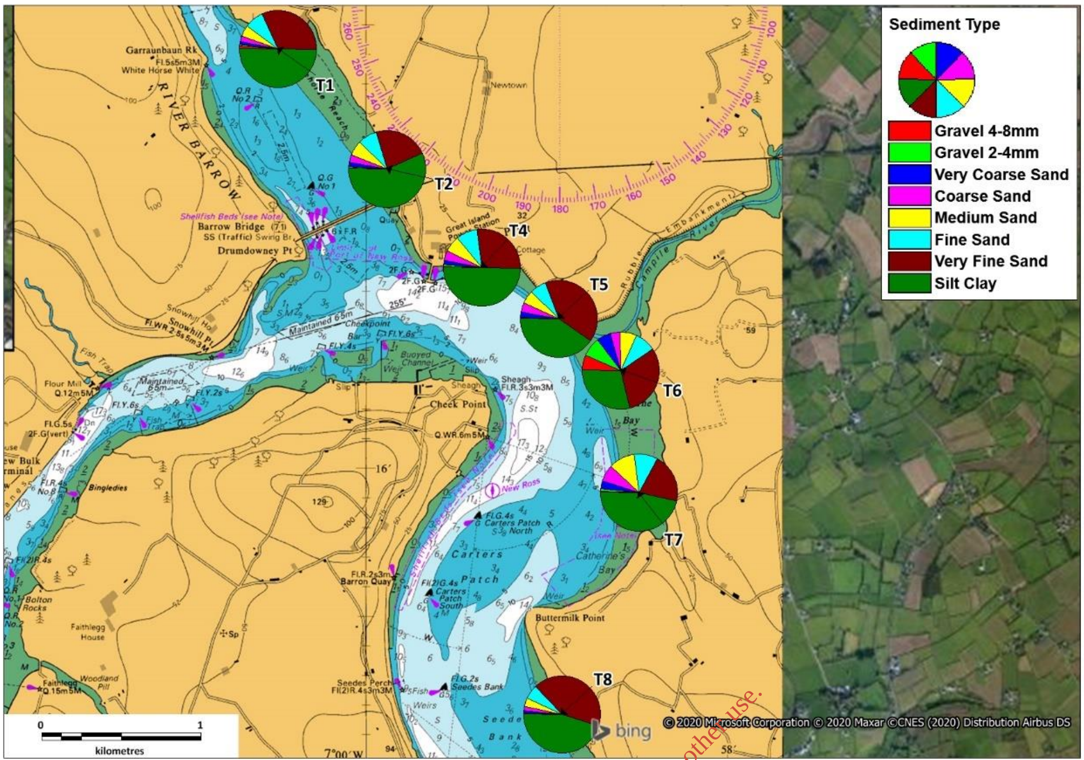

Figure 3.9: A breakdown of sediment type at each intertidal station.

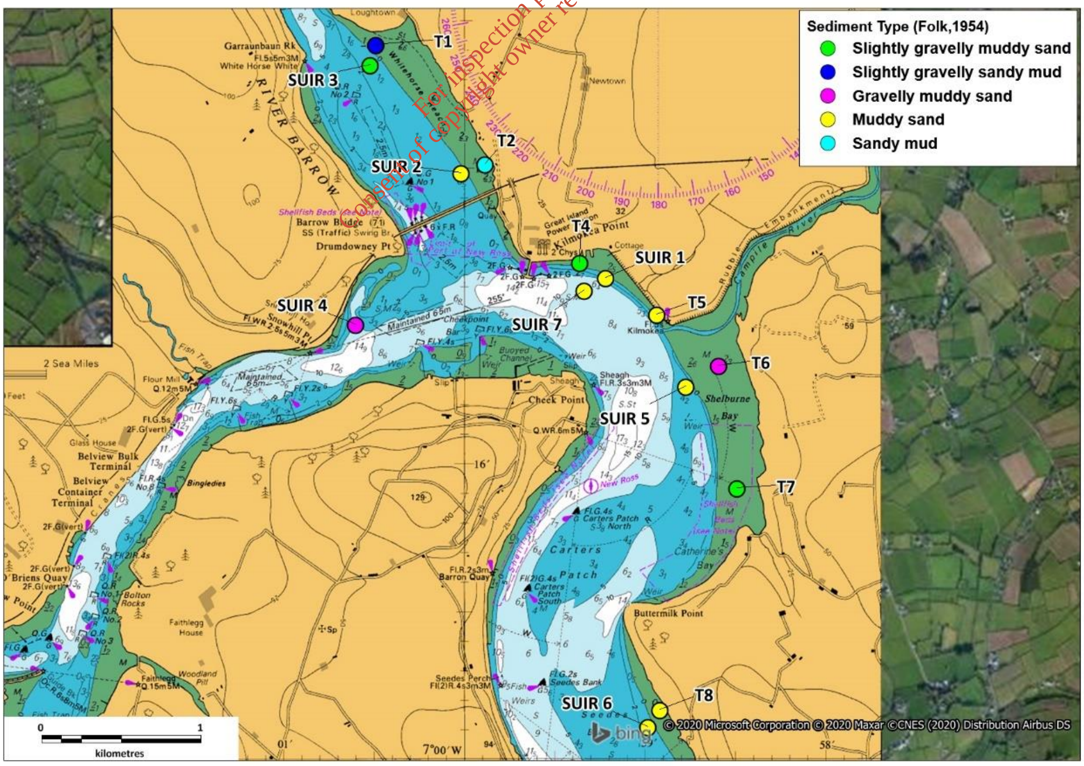

Figure 3.10: Sediment type at each of the subtidal and intertidal stations according to Folk (1954)

Table 3.4: Sediment characteristics of the benthic faunal stations sampled. LOI refers to the % organic carbon loss on ignition.

Station	>8mm	Fine Gravel (4-8mm)	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
Suir 1	0	0	0.3	1.1	0.9	3.8	6.6	45.8	41.5	Muddy Sand	5.31
Suir 2	0	0.1	0.5	1.8	2.8	3.9	18.9	44.3	27.9	Muddy Sand	6.12
Suir 3	0	0.8	0.8	1.8	2.3	3.1	38.3	36.4	16.4	Slightly Gravelly Sandy Mud	6.58
Suir 4	0	29.4	1.8	4	4.7	4.9	13.6	25.8	15.8	Gravelly Muddy Sand	6.93
Suir 5	0	0.1	0.8	2.7	4.6	7.2	10.2	36.8	37.7	Muddy Sand	6.73
Suir 6	0	0	0.2	0.6	0.7	1.4	8.5	69.6	19.1	Muddy Sand	3.52
Suir 7	0	0	0.6	2.3	3.7	5	10.4	44.7	33.2	Muddy Sand	7.23
T1	0	1.1	0.5	1.3	2.4	4.8	8.3	32.2	49.5	Slightly Gravelly Sandy Mud	6.62
T2	0	0.4	0.5	1.8	3.1	6.6	8.2	23	56.5	Sandy Mud	6.38
T4	0	0.2	0.9	1.9	4.1	6.8	9.4	27.3	49.4	Slightly Gravelly Muddy Sand	5.52
T5	0	0	0.4	2.1	4.3	5.5	7	40.5	40.1	Muddy Sand	5.89
T6	0	6.5	8.2	6	4.3	6.9	9	30.2	28.8	Gravelly Muddy Sand	5.74
T7	0	0.2	1.1	3.5	7.1	11.2	9.9	20.7	46.2	Slightly Gravelly Muddy Sand	8.41
T8	0	0	0.3	1.1	1.6	3.8	6.1	42	45.1	Muddy Sand	4.72

3.4. Intertidal Transect Results

Due to the muddy substrate, it was not possible to survey the majority of the intertidal transects using the traditional quadrat method. Instead, grab samples were taken at high tide from AQUAFACT's RIB and the samples analysed as outlined above. Figure 2.2 illustrates the intertidal transect locations. A brief description of the transects follows.

3.4.1. Transect 1

Starting point 52.29111°N, 7.00889°W, End point 52.29038°N, 7.00932°W, length 85m.
The upper shore of this transect was backed by agricultural land and trees with a grass bank. A view of the transect from the lower to the upper shore taken from the water is presented in Figure 3.11 below. Knotted wrack, *Ascophyllum nodosum*, covered the scattered boulders in the upper shore which transitioned onto the mudflats. The mudflats can be classified as 'Muddy estuarine community complex' as outlined above in section 3.2.1.

Figure 3.11: View of Transect 1 from lower to upper shore.

3.4.2. Transect 2

Starting point 52.298399°N, 6.99856°W, End point 52.28389°N, 6.9996°W, length 77m.

The upper shore of this transect was backed a small shale cliff and dwellings. A view of the transect from the lower to the upper shore taken from the water is presented in Figure 3.12 below. Knotted wrack, *Ascophyllum nodosum*, covered the shale in the upper shore which transitioned onto the mudflats. The mudflats can be classified as 'Muddy estuarine community complex' as outlined above in section 3.2.1

Figure 3.12: View of Transect 2 from lower to upper shore.

3.4.3. Transect 3

Starting point 52.27498°N, 7.01255°W, End point 52.27494°N, 7.01229°W, length 18.5m.

The upper shore of this transect was backed sycamore and oak woodland with boulders. A view of the transect from the lower to the upper shore taken from the lower shore is presented in Figure 3.13 below. The upper shore (Figure 3.14) consists of shale cobble with scattered green algae, *Enteromorpha* spp. as can be seen in the upper shore quadrat (Figure 3.15). There is a band of *Ascophyllum nodosum* stretching 20m from the upper shore to the mid shore over mud covered shale. The mid shore quadrat (Figure 3.16) indicates that the *Ascophyllum* coverage is dense (100% coverage). *A. nodosum* also has epiphytic *Vertebrata lanosa* as is typical for this species. Under the *Ascophyllum* cover, the amphipod *Gammarus* sp. is common. The shore slopes gently into the subtidal. The lower shore quadrat (Figure 3.16) indicates that the algal cover is approximately 50% *Ascophyllum nodosum* and 50% bladder wrack, *Fucus vesiculosus*, with some scattered *Enteromorpha*. The biotope along transect 3 can be classifies as similar to JNCC biotope 'LR.LLR.FVS.AscVS *Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid eulittoral rock' (EUNIS code A1.324)

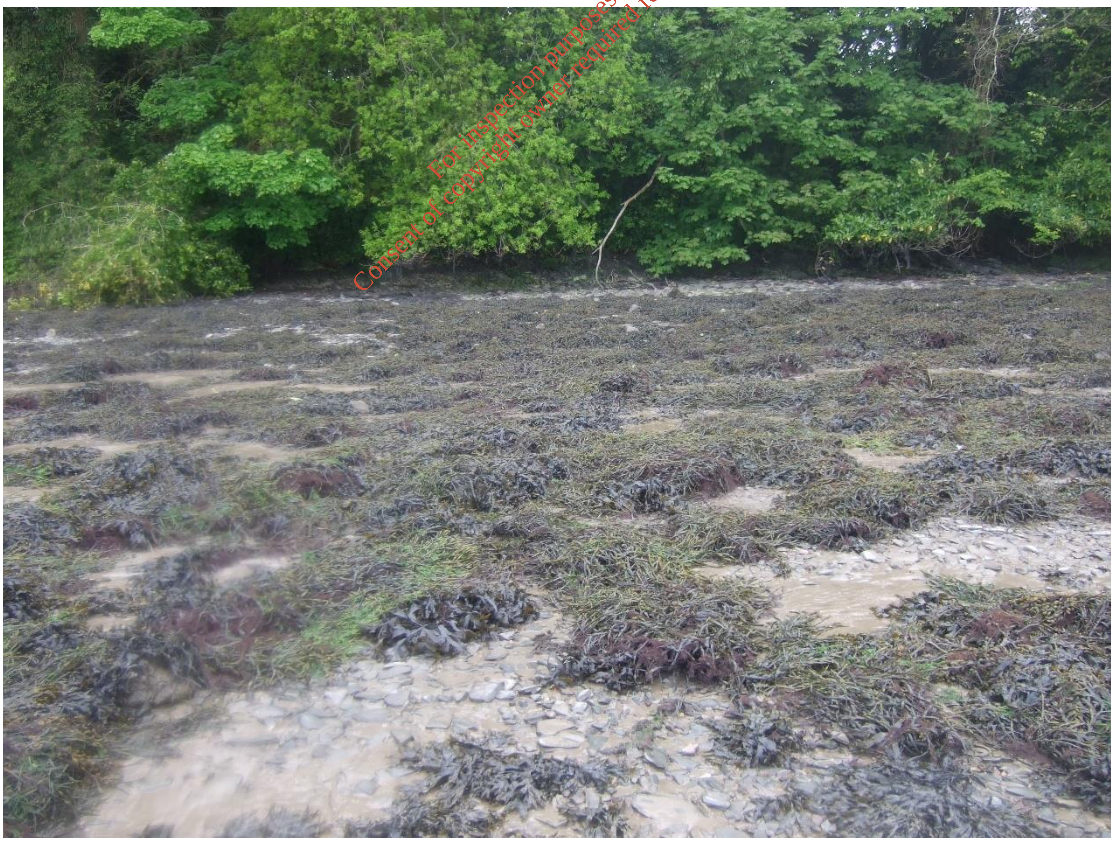

Figure 3.13: View of Transect 3 from lower to upper shore.

Figure 3.14: Upper Shore Transect 3.

Figure 3.15: Upper shore quadrat. Transect 3.

Figure 3.16: Mid Shore Quadrat, Transect 3.

Figure 3.17: Lower Shore Quadrat, Transect 3.

3.4.4. Transect 4

Starting point 52.27857°N, 6.99055°W, End point 52.27816°N, 6.99009°W, length 56m.

This transect was located immediately west of the main discharge point. A view of the transect from the lower to the upper shore taken from the water is presented in Figure 3.18 below. The upper shore of this transect was backed by sloped rock armour with the Great Island CCGT complex behind. An upper shore quadrat (Figure 3.19) indicates that the *Ascophyllum nodosum* coverage is approximately 100% with epiphytic *Vertebrata lanosa* also present. Other species in the upper shore include channel wrack, *Pelvetia canaliculata,* spiral wrack, *Fucus spiralis,* and bladder wrack, *Fucus vesiculosus.* Below this the rock armour abruptly transitions into mud flats. The mudflats can be classified as 'Muddy estuarine community complex' as outlined above in section 3.2.1

Figure 3.18: View of Transect 1 from lower to upper shore Transect 4.

Figure 3.19: Upper Shore Quadrat, Transect 4.

3.4.5. Transect 5

Starting point 52.27552°N, 6.98305°W, End point 52.27539°N, 6.9832°W, length 18m.
This transect was located downstream and near the main discharge point. A view of the transect from the lower to the upper shore taken from the water is presented in Figure 3.20 below. The upper shore of this transect was backed by sloped rock armour with scattered *Ascophyllum nodosum* and a grass covered wall, topped with sea pinks, *Armeria maritima*. Below this the rock armour abruptly transitions into mud flats. The mudflats can be classified as 'Muddy estuarine community complex' as outlined above in section 3.2.1

Figure 3.20: View of Transect 5 from lower to upper shore.

3.4.6. Transect 6

Starting point 52.27291°N, 6.97597°W, End point 52.27197°N, 6.97893°W, length 227m. This transect was located close to the mouth of the Campile River. It is backed by agricultural land and gorse over a rock cliff (approximately 2-3m high). A view of the transect from the lower to the upper shore taken from the water is presented in Figure 3.21 below. Knotted wrack, *Ascophyllum nodosum*, covered the upper shore which transitioned onto the mudflats. The mudflats can be classified as 'Muddy estuarine community complex' as outlined above in section 3.2.1

Figure 3.21: View of Transect 6 from lower to upper shore.

3.4.7. Transect 7

Starting point 52.26595°N, 6.97374°W, End point 52.26557°N, 6.97692°W, length 220m. This transect was located in Catherine's Bay south of the mouth of the Campile River. It is backed by agricultural land. A view of the transect from the lower to the upper shore taken from the water is presented in Figure 3.22 below. The upper shore consists of shell gravel with scattered *Ascophyllum nodosum* which transitioned onto the mudflats. The mudflats can be classified as 'Muddy estuarine community complex' as outlined above in section 3.2.1

Figure 3.22: View of Transect 7 from lower to upper shore.

3.4.8. Transect 8

Starting point 52.25334°N, 6.98242°W, End point 52.25302°N, 6.98332°W, length 71m.
This transect was located south of the Buttermilk point. A view of the transect from the lower to the upper shore taken from the water is presented in Figure 3.23 below. It is backed a tree line of pine and gorse with large boulders and a band of sea pinks, *Armeria maritima*. The upper shore (Figure 7.24) consists of shale with scattered *Ascophyllum nodosum* and bladder wrack, *Fucus vesiculosus,* which transitioned onto the mudflats. The mudflats can be classified as 'Muddy estuarine community complex' as outlined above in section 3.2.1

Figure 3.23: View of Transect 8 from lower to upper shore.

Figure 3.24:Upper shore Transect 8.

3.5. *Phytoplankton*

Examination of the 6 phytoplankton returned 21 species of diatoms all of which are common coastal species that typically occur in late Spring. The species recorded and their densities are presented below in Table 3.5.

The species grouping that were present at the 6 sampling locations is similar throughout with no Station standing apart from any other Station.

Station number	1	2	3	4	5	6
Guinardia delicatula	d	a	a	a	a	a
Cerataulina pelagica	o	a	a	a	a	a
Ditylum brightwellii	a	f	f	f	f	f
Coscinodiscus radiatus	r			r	r	
Eucampia zodiacus		r	r		r	r
Odontella sinensis	r				o	r
Rhizosolenia setigera	f			o	o	
Gyrodinium spirale	r	r	r	r	r	r
Rhizosolenia setigera						
Rhizosolenia imbricata	r					
Chaetoceros curviseum						
Chaetoceros didymum						
Eutrepiella sp.	r	r	r			r
Asterionellopsis glacialis	r					
Ceratium lineatum				r		
Leptocylindrus glacialis				r		
Heterocapsa triquetra		o		o	r	r
Skeletonema costatum	r	o		r	r	r
Pseudonitzschia sp.					o	
Guinardia striata					r	
Polykrikos sp.					r	

Table 3.5 Phytoplankton species recorded at 6 water sampling stations in Waterford Harbour.

4. Discussion

With respect to the main findings of this survey, concerning firstly the intertidal communities, only the low water site at Transect 5 which is close to the main warm water + sodium hypocholite dosing outfall is statistically different to the remainder of the locations sampled having a reduced number of taxa and individuals. This indicates that the mixed water plume disperses quickly and over a spatially small area close to the out fall. This finding is in line with the results of another warm water outfall + sodium hypochlorite dosing study that AQUAFACT carried out at Moneypoint in the Shannon and also for a hydrodynamic modelling study for a different thermal plume in the Shannon where the plume was found to quickly disperse within short distance of the outfall location.

The results of the subtidal benthic survey indicate that the faunal data recorded are all quite similar statistically between all stations and that there is no location that stands out from any other. This is not surprising as the warm water floats on the colder marine/riverine water and therefore there can be no temperature transfer to the benthic habitat/fauna. This means that the benthic habitat is essentially isolated from any thermal impacts and sodium hypochorlite concerntrations that could arise from the outfall.

Analysis of the fauna from the intertidal and subtidal grab stations indicates that these stations can be classified as belonging to one of the four common benthic community habitat types occurring in the River Barrow and River Nore SAC namely the habitat 'Muddy estuarine community complex'. This community is present intertidally and subtidally from Cheek Point and Great Island northward to New Ross. The substrate of this community complex is predominantly of fine material. The distinguishing species for this group are the bivalve *Scrobicularia plana* and *Limecola balthica,* the amphipod *Corophium volutator,* the polychaete *Streblospio shrubsolii* and the oligochaetes *Tubificoides pseudogaster* and *Tubificoides benedii.* These species are indicative of variable salinity community (NPWS, 2011) and they are all common species in muddy sediments that experience regular fluctuations in salinity.

The results of the analyses of the phytoplankton samples show that the phytoplankton community in the area is comprised of the same suite of taxa throughout and that none of the sampled sites were different in species composition. This finding shows that in terms of water composition, the survey area is homogenous throughout reflecting the high levels of water flow through the area. This factor shows that the thermal plume and sodium hypochortie dosing has no discernible impact on the phytoplankton community.

In conclusion, these results show that, except for the area in the immediate vicinity of the outfall, neither the warm water discharge nor the sodium hypochlorite dosing waters are having a significant effect on the intertidal and subtidal invertebrate communities nor on the phytoplankton community in the estuary.

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Appendix I

Species Lists

JN1591 Waterford Subtidal								
Station	**AphiaID**	**Suir 1**	**Suir 2**	**Suir 3**	**Suir 4**	**Suir 5**	**Suir 6**	**Suir 7**
NEMATODA	799							
Nematoda	799	102	5	1	1		10	10
ANNELIDA	882							
POLYCHAETA	883							
PHYLLODOCIDA	892							
Phyllodocidae	931							
Phyllodocidae (partial/damaged)	931	1						
Eteone longa aggregate	130616						1	
Nereididae	22496							
Hediste diversicolor	152302							
Nephtyidae	956							
Nephtys sp. (damaged)	129370			1	1			2
Nephtys hombergii	130359	11			2	5		
SPIONIDA	889							
Spionidae	913							
Polydora sp. (damaged)	129619	1						
Polydora cornuta	131143				98			
Pygospio elegans	131170	1	6	4		1		
Streblospio shrubsolii	131193	52	8	4	16	2	6	1
CAPITELLIDA	890							
Capitellidae	921							
Mediomastus fragilis	129892				1			
TEREBELLIDA	900							
Cirratulidae	919							
Cirratulidae (partial/damaged)	919	10	7		26	2	3	3
Tharyx killariensis	152269	11	28		77		1	
Ampharetidae	981							
Ampharetidae (partial/damaged)	981				1			
Alkmaria romijni	129769			1				2

JN1591 Waterford Subtidal								
Station	**AphiaID**	**Suir 1**	**Suir 2**	**Suir 3**	**Suir 4**	**Suir 5**	**Suir 6**	**Suir 7**
SABELLIDA	901							
Serpulidae	988							
Spirobranchus sp. (damaged)	129582				1			
OLIGOCHAETA	2036							
HAPLOTAXIDA	2118							
Naididae	2039							
Baltidrilus costatus	743898				67		6	
Tubificoides sp. (damaged)	137393	6		3	2		1	
Tubificoides pseudogaster aggregate	137582			1				
Tubificoides benedii	137571	19	14	3	10	12	38	2
CRUSTACEA	1066							
SESSILIA	106033							
Archaeobalanidae	106056							
Austrominius modestus	712167						1	
Balanidae	106057							
Balanidae (juv)	106057				2			
Balanus crenatus	106215				563			
Barnacle Cyprid larvae	564954	2						
MALACOSTRACA	1071							
AMPHIPODA	1135							
Gammaridae	101383							
Gammarus sp. (damaged)	101537				8			
Melitidae	101397							
Melitidae (damaged)	101397	1						
Corophiidae	101376							
Corophiidae (juv)	101376	1						
Corophium volutator	102101	25	1		1	2	3	1
ISOPODA	1131							
Anthuridae	118244							

JN1591 Waterford Subtidal								
Station	**AphiaID**	**Suir 1**	**Suir 2**	**Suir 3**	**Suir 4**	**Suir 5**	**Suir 6**	**Suir 7**
Cyathura carinata	118474		1	1	2			
INSECTA	1307							
Insecta	1307							
Elmidae larvae							1	
MOLLUSCA	51							
GASTROPODA	101							
LITTORINIMORPHA	382213							
Hydrobiidae	120							
Peringia ulvae	151628	9	6	3	1	1	4	1
BIVALVIA	105							
MYTILIDA	210							
Mytilidae	211							
Mytilidae (juv)	211				17		7	
CARDIIDA	869602							
Tellinidae	235							
Limecola balthica	880017	2		8		3		4
Semelidae	1781							
Semelidae (juv)	1781	5	4	2	2	2	1	
Abra alba	141433					1		1
Scrobicularia plana	141424	4	5	1				
MYIDA	245							
Myidae	247							
Mya arenaria	140430				1			
BRYOZOA	146142							
GYMNOLAEMATA	1795							
CHEILOSTOMATIDA	110722							
Membraniporidae	110762							
Conopeum seurati	111352				+			

JN1591 Waterford Intertidal																					
Station	**AphiaID**	**T1 Lwr**	**T1 Mid**	**T1 Upr**	**T2 Lwr**	**T2 Mid**	**T2 Upr**	**T4 Lwr**	**T4 Mid**	**T4 Upr**	**T5 Lwr**	**T5 Mid**	**T5 Upr**	**T6 Lwr**	**T6 Mid**	**T6 Upr**	**T7 Lwr**	**T7 Mid**	**T7 Upr**	**T8 Mid**	**T8 Lwr**
NEMATODA	799																				
Nematoda	799	5	65	8	6	4	1	26	2	4	1	188	14	9	11		5		56	127	1
ANNELIDA	882																				
POLYCHAETA	883																				
PHYLLODOCIDA	892																				
Phyllodocidae	931																				
Phyllodocidae (partial/damaged)	931																			1	
Eteone longa aggregate	130616	2		2														1			
Nereididae	22496																				
Hediste diversicolor	152302		2	3		5		1							1	3			3		
Nephtyidae	956																				
Nephtys hombergii	130359								1	1										2	2
SPIONIDA	889																				
Spionidae	913																				
Spionidae (damaged)	913																		1		
Spionidae (juv)	913																			2	
Polydora cornuta	131143														2	4		7	1	1	1
Pygospio elegans	131170	16						1						1	14	6		4		5	
Streblospio shrubsolii	131193	8	21	6	3	17	4	2	1			20	1	33	17	49	31	6	59	26	3
CAPITELLIDA	890																				
Arenicolidae	922																				
Arenicola marina	129868																			1	
TEREBELLIDA	900																				
Cirratulidae	919																				
Cirratulidae (partial/damaged)	919		1		1		1	2	3	3		4		9			1	2		22	
Tharyx killariensis	152269	1																21	2	97	
Ampharetidae	981																				

JN1591 Waterford Intertidal																					
Station	**AphiaID**	**T1 Lwr**	**T1 Mid**	**T1 Upr**	**T2 Lwr**	**T2 Mid**	**T2 Upr**	**T4 Lwr**	**T4 Mid**	**T4 Upr**	**T5 Lwr**	**T5 Mid**	**T5 Upr**	**T6 Lwr**	**T6 Mid**	**T6 Upr**	**T7 Lwr**	**T7 Mid**	**T7 Upr**	**T8 Mid**	**T8 Lwr**
Alkmaria romijni	129769			3		2	1									7		2			
SABELLIDA	901																				
Sabellidae	985																				
Manayunkia aestuarina	130926		4	3								5								3	
OLIGOCHAETA	2036																				
HAPLOTAXIDA	2118																				
Naididae	2039																				
Baltidrilus costatus	743898		25	15		3		1				11				2			3	2	
Tubificoides sp. (damaged)	137393	2	2			3						14		2	1	9	1			7	5
Tubificoides pseudogaster agg.	137582		3	2	1							5			1						
Tubificoides benedii	137571	10	314	461	39	153	21	475	124	8		35	16	114	27	28	13	15	98	801	3
Tubificoides brownae	137572						2										1				
CRUSTACEA	1066																				
SESSILIA	106033																				
Balanidae	106057																				
Balanidae (juv)	106057											3									
MALACOSTRACA	1071																				
AMPHIPODA	1135																				
Melitidae	101397																				
Melitidae (damaged)	101397																		2		
Melita palmata	102843																		3		
Corophiidae	101376																				
Corophiidae (juv)	101376											2								2	
Corophium volutator	102101	1	4							5		2		82	7	1	27		4	193	
ISOPODA	1131																				
Anthuridae	118244																				
Cyathura carinata	118474	1	2	8		14	18	3						1	8	24		3	9		
INSECTA	1307																				

JN1591 Waterford Intertidal																					
Station	**AphiaID**	**T1 Lwr**	**T1 Mid**	**T1 Upr**	**T2 Lwr**	**T2 Mid**	**T2 Upr**	**T4 Lwr**	**T4 Mid**	**T4 Upr**	**T5 Lwr**	**T5 Mid**	**T5 Upr**	**T6 Lwr**	**T6 Mid**	**T6 Upr**	**T7 Lwr**	**T7 Mid**	**T7 Upr**	**T8 Mid**	**T8 Lwr**
Elmidae larvae			1																	1	
MOLLUSCA	51																				
GASTROPODA	101																				
LITTORINIMORPHA	382213																				
Hydrobiidae	120																				
Peringia ulvae	151628	7	95	121	7	108	61	111	8	11	2	1	3	104	73	106	6	84	26	364	46
BIVALVIA	105																				
MYTILIDA	210																				
Mytilidae	211																				
Mytilidae (juv)	211																			3	2
CARDIIDA	869602																				
Cardiidae	229																				
Cerastoderma sp. (juv)	137735																			6	1
Tellinidae	235																				
Limecola balthica	880017		4	2	1	1		1	1	2					1	1	1	3	10	9	1
Semelidae	1781																				
Semelidae (juv)	1781	1	8	18		8	2	9						1	13				13	31	4
Abra sp. (juv)	138474										1										
Abra alba	141433				1			5		2											
Scrobicularia plana	141424	6	2	11		22	12	7	1	6		1		5	4	11	1	5	37	4	