AECOM

Shannon Technology and Energy Park (STEP) Power Plant

Appendix A7A.1: Intertidal and Subtidal Survey Reports

Shannon LNG Limited

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Shannon Technology and Energy Park (STEP)

Intertidal and Subtidal Surveys

Produced by

AQUAFACT International Services Ltd

On behalf of

Shannon LNG Ltd

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1. Intertidal Survey

1.1. Survey Design

AQUAFACT carried out 2 intertidal transects (T1 and T7) on the 8th April 2020 and a further 2 (T3 and T8) on the 9th April 2020. Transects T3, T7 and T8 had surveyed in 2012 and in 2005/2006 T1, T3, T7 and T8 were surveyed along with another 4 transects (see Figure 1). The weather on both days was dry and sunny, with no cloud cover and there was a force 3 south-westerly wind blowing on the 8th and a force 3 south-easterly wind on the 9th. Low water was at 11:49pm (-0.1m) at Tarbert Island on the 8th and at 12.25pm, (-0.1m) on the 9th.

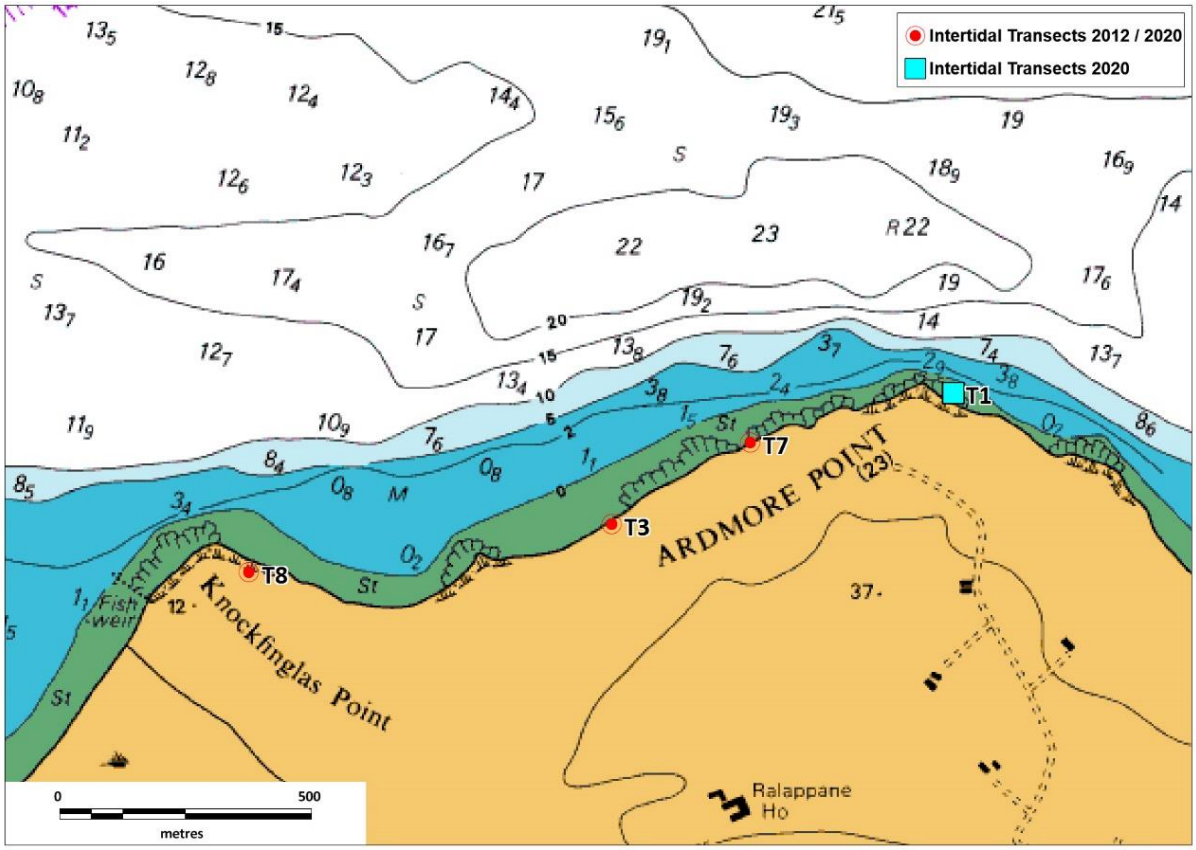

Figure 1- Location of the intertidal transects surveyed on the 8th and 9th April 2020

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 global positioning system.

The physical features of the intertidal zone were described and photographed in detail. General physical features which were recorded included:

- surface relief (even–uneven)
- firmness (firm–soft)
- stability (stable–mobile)
- sorting (well–poor)
- black layer (1 = not visible., 2 = >20cm, 3 = 5–20cm, 4 = 1–5cm, 5 = <1cm)

Station-specific physical features which were recorded included:

- mounds/casts
- burrows/holes
- tubes
- algal mat
- waves/dunes (>10cm high)
- ripples (<10cm high)
- drainage channels/creeks
- standing water
- subsurface coarse layer
- subsurface clay/mud
- surface silt/flocculent

1.2. Results

1.2.1. Transect 1

This transect was located 140m southeast of Ardmore Point. (Starting Point: 52.583921°N, 9.428811°W). The start and end points and the quadrat locations can be seen in **Figure 2-Start** and end points and Quadrat locations along Transect 1

. The total length of the transect from upper to lower shore was 56.8m. The view along the transect from the upper to lower shore and from lower to upper shore can be seen in Figure 3. This transect was backed by forestry plantation. At the top of this transect, a hill topped with grass, bramble, fern and gorse sloped directly onto the cobble shore (see Figure 4). The cobble shore continued to the lower shore before giving way to a substrate of cobbles and muddy sand at the extreme lower shore. The geology of the region is predominately a mix of Namurian shales, flags and sandstones.

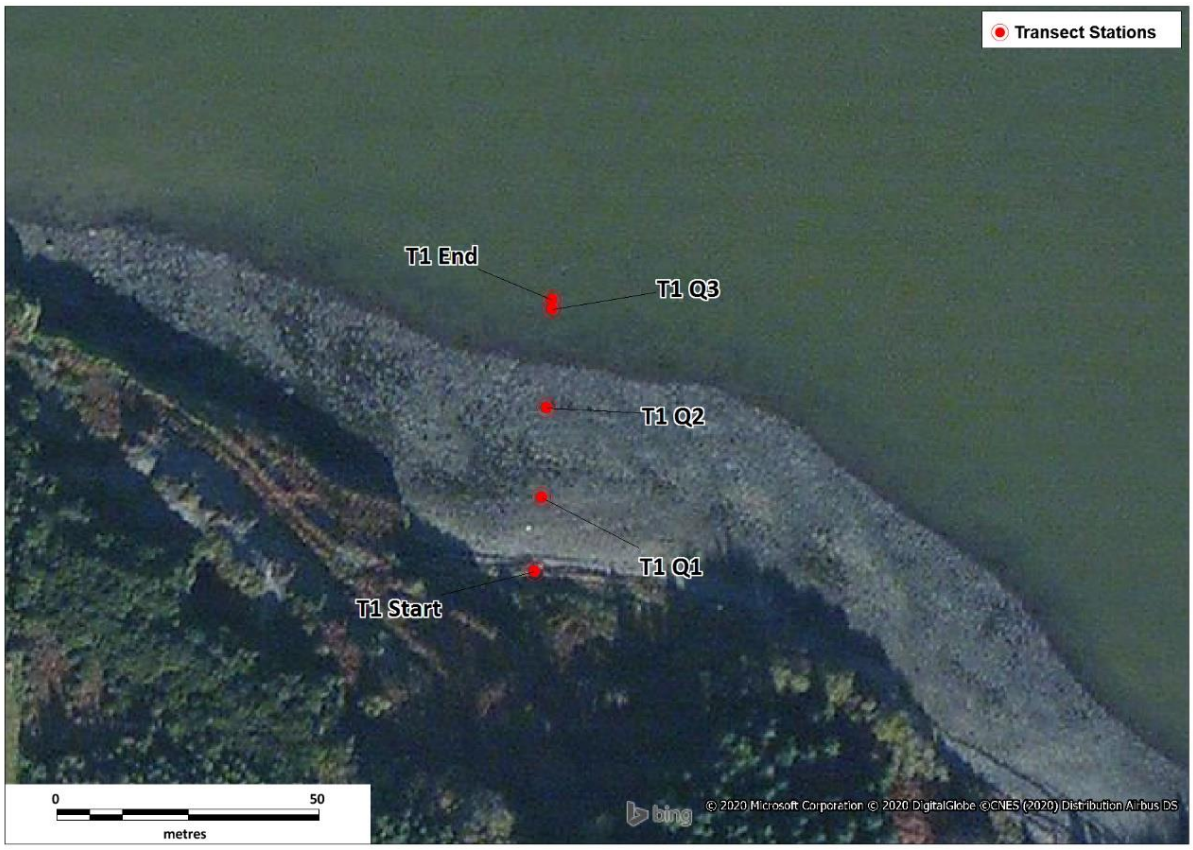

Figure 2-Start and end points and Quadrat locations along Transect 1

Figure 3-Intertidal Transect 1. View from upper and lower shores.

Figure 4-Strandline above Transect 1

Upper Shore

The upper shore consisted of a boulder-cobble mix with very sparse coverage of channel wrack (*Pelvetia canaliculata*). The *Pelvetia* algal zone extended from 8.7m to 13.6m along the transect and the sparse spiral wrack (*Fucus spiralis*) algal band extended from 11.4m to 28.1m along the transect. Within the upper shore quadrat, there was 10% coverage of *P. canaliculata.*

Figure 5 shows the quadrat surveyed in the upper shore. Talitrid amphipods (2 individuals/0.025m²) and rough periwinkle, *Littorina saxatilis,* (7 individuals/0.025m²) were also recorded.

This biotope corresponds with JNCC biotope 'LS.LCS.Sh.BarSh Barren littoral shingle'(EUNIS A2.111).

Figure 5-Transect 1. Upper Shore Quadrat.

Mid Shore

The mid shore consisted of boulders and shale cobbles with sparse algal cover. The sparse *Fucus vesiculosus* algal band extended from 28.2m to 45.3m along the transect. Within the mid shore quadrat, *Fucus vesiculosus* accounted for approximately 7% cover.

Littorina saxatilis (14 individuals/0.025m²), common periwinkle, *Littorina littorea,* (8 individuals/0.025m²), grey topshell, *Steromphala cineraria,* (approx. 5 individuals/0.025m²), flat topshell, *Steromphala umbilicalis*[1] (approx. 2 individuals/0.025m²) and common limpet, *Patella vulgata, (*2 individuals/0.025m²) were recorded.

Figure 6 shows the mid shore quadrat. This biotope corresponds with JNCC biotope 'LS.LCS.Sh.BarSh Barren littoral shingle' (EUNIS A2.111).

Figure 6-Transect 1. Mid Shore Quadrat.

[1] *Steromphala cineraria* and *S. umbilicalis* were previously known as *Gibbula cineraria* and *G. umbilicalis.*

Lower Shore

The lower shore substrate consisted of fine sand and shale cobbles. Algal band within the lower shore included serrated wrack, *Fucus serratus,* (43.7m to subtidal) and *Chondrus crispus* (50.3m into subtidal). The quadrat contained *Fucus serratus* (approx. 80% coverage) with encrusting spirorbids, encrusting red algae (10% coverage), *Chondrus crispus* (<10% coverage), *Dilsea carnosa* (<1% coverage), *Delesseria sanguinea* (<1% coverage), *Ceramium* spp. (<1% coverage), *Apoglossum ruscifolium* (<1% coverage), *Palmaria palmata* (<1% coverage), *Polysiphonia* spp. (<1% coverage) and other filamentous red algae (<1% coverage).

Fauna observed included *Littorina littorea* (2 individuals/0.025m²), *Lanice conchilega* (1 individual/0.025m²) and *Ostrea edulis* (1 individual/0.025m²).

Figure 7 shows the quadrat surveyed on the lower shore. This biotope corresponds with JNCC biotope 'LR.MLR.BF.Fser.R *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock' (EUNIS A1.2141).

Figure 7-Transect 1. Lower Shore Quadrat.

1.2.2. Transect 3

This transect was located approximately 650m southwest of Ardmore Point and approximately 800m east of Knockfinglas Point. (Starting Point: 52.58227°N, 9.43939°W). The start and end points and the quadrat locations can be seen in Figure 8-Start and end points and Quadrat locations along Transect 3.. The total length of the transect from upper to lower shore was 53.4m. The view along the transect from the upper to lower shore and from lower to upper shore can be seen in Figure 9.

This transect was backed by a mixed soil cliff (*ca* 3-4m high). This cliff was backed by improved agricultural land. The strandline (seeFigure 10) consisted of a gravel track (c. 2-3m wide) with outcropping boulders, which consisted of washed up *Ascophyllum nodosum* and *Fucus vesiculosus.* The boulders were covered with lichens (*Verrucaria, Caloplaca thallinicola, Tephromela atra* and *Ramalina cuspidata*).

The biotope located in the supralittoral level corresponds with the 'LR.FLR.Lic.YG Yellow and grey lichens on supralittoral rock' according to the Marine Habitat Classification for Britain and Ireland (Connor *et al.,* 2004). The gravel and boulder mix merges into a boulder field towards the mid and lower shore.

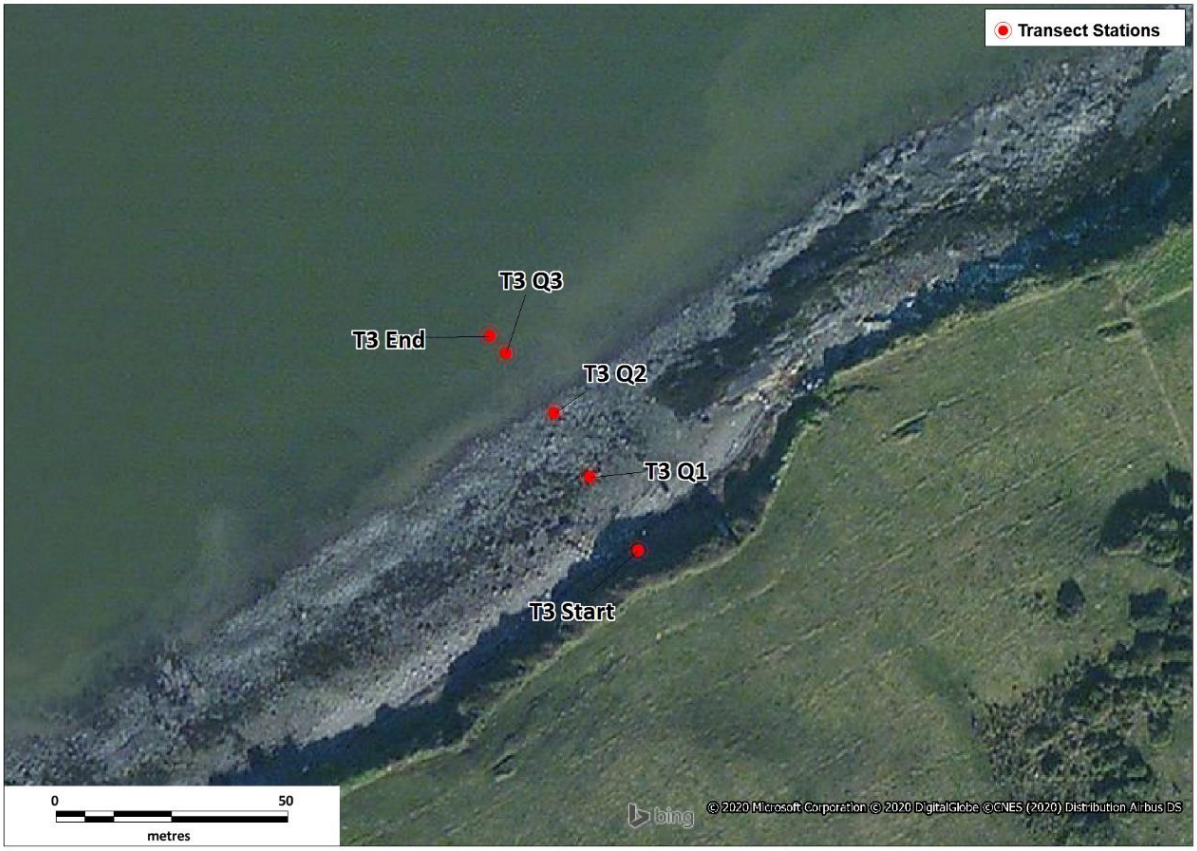

Figure 8-Start and end points and Quadrat locations along Transect 3.

Figure 9-Intertidal Transect 3. View upper and lower shore.

Figure 10-Strandline above Transect 3

Upper Shore

The upper shore consisted of a gravel-boulder mix. The *Pelvetia canaliculata* algal band extended from 10.9m to 15.6m down the transect; the *Fucus spiralis* algal band from 13.2m to 17.8m; the *Ascophyllum nodosum* algal band from 16.4 to 28.4m. The *Fucus vesiculosus* algal band from 17.4m to 47.5m.

The quadrat (Figure 11-Upper Shore **Quadrat, Transect 3**) contained 30% coverage of *Ascophyllum nodosum,* 30% *Fucus vesiculosus, Patella vulgata* (16 individuals), *Carcinus maenas* (1), Talitrid amphipods (>100 individuals), *Melaraphe neritoides* (5), *Littorina littorea* (1) and *Littorina obtusata* (2).

The upper shore at this location displays elements of both the 'LS.LCS.Sh.BarSh Barren littoral shingle' biotope (EUNIS code A2.111) and the 'LR.LLR.FVS.AscVS *Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid eulittoral rock' (EUNIS code A1.324).

Figure 11-Upper Shore Quadrat, Transect 3

Mid Shore

The mid shore consisted of a boulder field with patches of *Fucus vesiculosus*. *Polysiphonia* spp. recorded at 20m.

Figure 12 shows the quadrat surveyed in the mid shore. It contained no macroalgae, *Patella vulgata* (11 individuals), *Littorina littorea* (7), *Steromphala cineraria* (2), *Semibalanus balanoides* (5% cover) and *Austrominius modestus* (<1%).

This biotope corresponds to the 'LR.HLR.MusB.Sem.LitX *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles' (EUNIS code A1.1133).

Figure 12-Mid Shore Quadrat, Transect 3.

Lower Shore

The lower shore consisted of a boulder field with patches of *Fucus serratus* and *Chondrus crispus*. The *Fucus spiralis* algal band extended from 41.3m to 52m; the *Chondrus crispus* algal band from 51.1m into the subtidal; *Laminaria digitata* extended from 53.4m into the subtidal.

Within the 0.25m^2 quadrat the following flora and fauna were found – *Chondrus crispus* (55% coverage), *Fucus serratus* (25%), *Steromphala cineraria* (1 individual) and *Littorina littorea* (6).

Figure 13shows the lower shore quadrat. These biotopes correspond to the LR.MLR.BF.Fser.R *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock' (EUNIS code A1.2141).

Figure 13-Lower Shore Quadrat, Transect 3.

1.2.3. Transect 7

This transect was located approximately 335m southwest of Ardmore Point (Starting Point: 52.58375°N, 9.43536°W). The start and end points and the quadrat locations can be seen in Figure 14.

The view along the transect from the upper to lower shore and from lower to upper shore can be seen in Figure 15-Intertidal Transect **7. View from upper and lower shore.**. This transect was backed by improved agricultural land. At the top of this transect a 3m high vertical cliff topped with grass, ivy and gorse dropped directly onto bedrock (seeFigure 16).

The flat bedrock was covered with lichens (*Caloplaca* spp., *Tephromela atra* and *Ramalina* spp.). The biotope located in the supralittoral level corresponds with the JNCC 'LR.FLR.Lic.YG Yellow and grey lichens on supralittoral rock' (EUNIS code B3.111) The bedrock continued to the end of the mid shore before giving way to a substrate of stones, cobbles and pebbles with some muddy sand at the extreme lower shore.

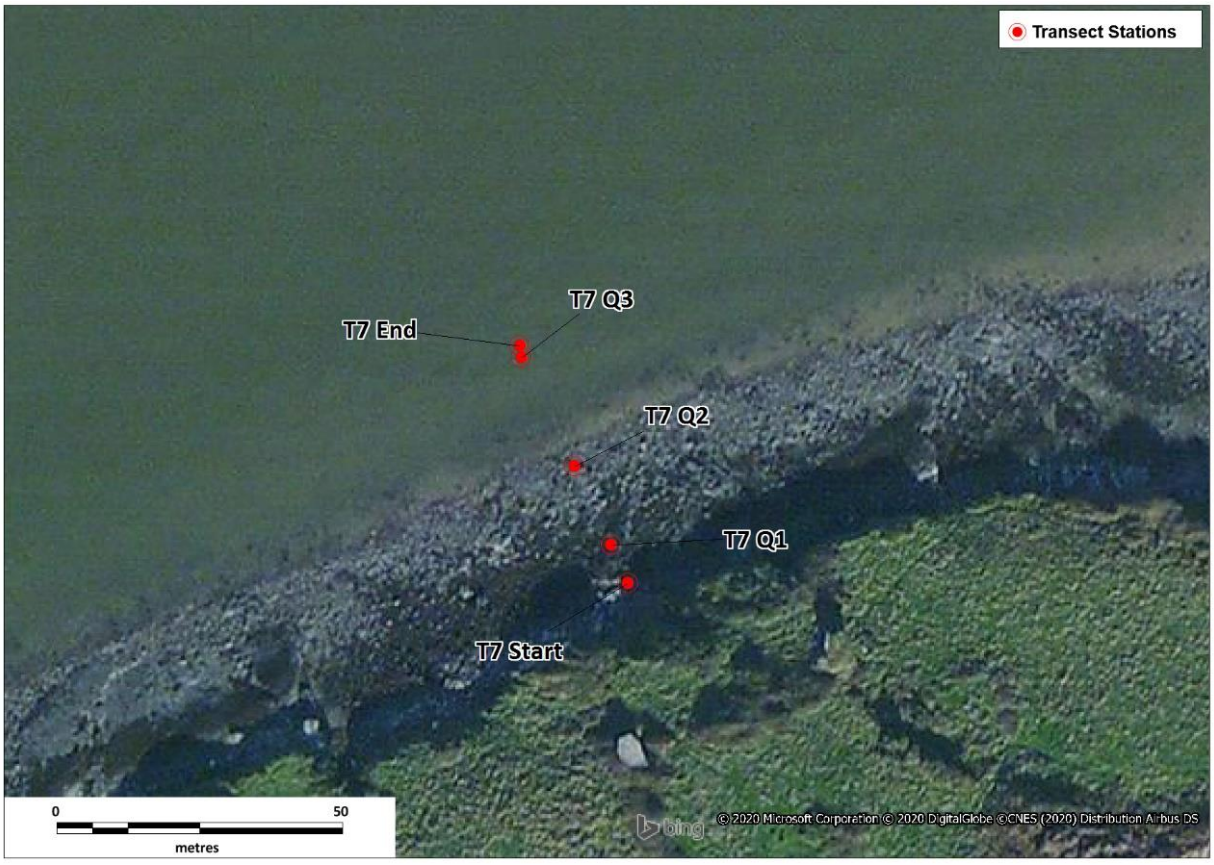

Figure 14-Start and end points and Quadrat locations along Transect 7.

Figure 15-Intertidal Transect 7. View from upper and lower shore.

Figure 16-Strandline above Transect 7.

Upper Shore

The upper shore consisted of broken bedrock with *Pelvetia canaliculata* present in a band extending from 1.2m to 5.8m covering between 80 – 100% of the bedrock substrate in the upper eulittoral. The *Fucus spiralis* algal band extended from 4m to 6.9m; the *Ascophyllum nodosum* algal band from 4.8m to 9.6m and the *Fucus vesiculosus* algal band extended from 9.2m into the midshore to 31.1m.

Figure 17-Upper Shore **Quadrat, Transect.** shows the quadrat from the upper shore. Flora and fauna from the quadrat included *Ascophyllum nodosum* (100% coverage), *Vertebrata lanosa* (10%), *Patella vulgata* (17 individuals), *Littorina obtusata* (2), Talitrid amphipods (3), *Ligia oceanica* (1) and *Semibalanus balanoides* (<1%).

The biotopes found in the upper eulittoral correspond to the JNCC biotopes 'LR.LLR.FVS.PelVS *Pelvetia canaliculata* on sheltered, variable salinity littoral fringe rock' (EUNIS code A1.311) above 'LR.LLR.F.Fspi *Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock' (EUNIS code A1.3122) which was above 'LR.LLR.FVS.AscVS *Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid eulittoral rock' (EUNIS code A1.3141).

Figure 17-Upper Shore Quadrat, Transect.

Mid Shore

The flat broken bedrock with small boulders continued down into the mid shore region. Patches of *Fucus vesiculosus* were present (*ca* 20% cover).

Figure 18 shows the quadrat from the mid shore. Flora and fauna within the quadrat included *Fucus vesiculosus* (10% coverage), *Littorina littorea* (9 individuals), *Littorina saxatilis* (2), *Littorina obtusata* (1), *Steromphala cineraria* (1), *Patella vulgata* (3), *Semibalanus balanoides* (<1%) and *Austrominius modestus* (<1%).

This biotope corresponds to the JNCC biotope 'LR.LLR.FVS.FvesVS *Fucus vesiculosus* on variable salinity mid eulittoral boulders and stable mixed substrata' (EUNIS code A1.323).

Figure 18-Mid Shore Quadrat, Transect 7.

Lower Shore

The substrate in the lower shore was composed of small boulders on bedrock with silt deposits. The *Fucus serratus* algal band began at 30.9m and extended into the lower shore to 39m. Other macroalgae in the lower shore included *Laminaria digitata* (at 40.1m), *Delesseria sanguinea* and *Ceramium* spp. (at 42m) and encrusting red algae (at 41.2m). **Figure 19**shows the quadrat from the lower shore. The flora and fauna recorded within the quadrat include *Laminaria digitata* (4 holdfasts, 20% coverage), *Chondrus crispus* (10%) *Delesseria sanguinea* (<5%), *Ceramium* spp. (<5%), *Phycodrys rubens* (<5%) and Gracilariacea (<5%), encrusting polychaetes *Spirorbis* spp. (5%) and saddle oyster *Anomia ephippium* (5 individuals).

These biotopes correspond to the JNCC biotope 'IR.MIR.KR.Ldig.Ldig *Laminaria digitata* on moderately exposed sublittoral fringe bedrock' (EUNIS code A3.2111).

Figure 19-Lower Shore Quadrat, Transect 7.

1.2.4. Transect 8

This transect was located east of the tip of Knockfinglas Point (Starting Point: 52.58114°N, 9.44946°W). The start and end points and the quadrat locations can be seen inFigure 20.

The view along the transect from the upper to lower shore and from lower to upper shore can be seen inFigure 21.

The strandline/splash zone consisted of a gravel shore merging onto a mixed sediment cliff (approximately 4m high), the top of which was banking onto a grass field which contained bramble, gorse and ivy (seeFigure 22). Some of the rocks and cobbles in the strandline were sparsely covered with lichens (*Tephromela atra*).

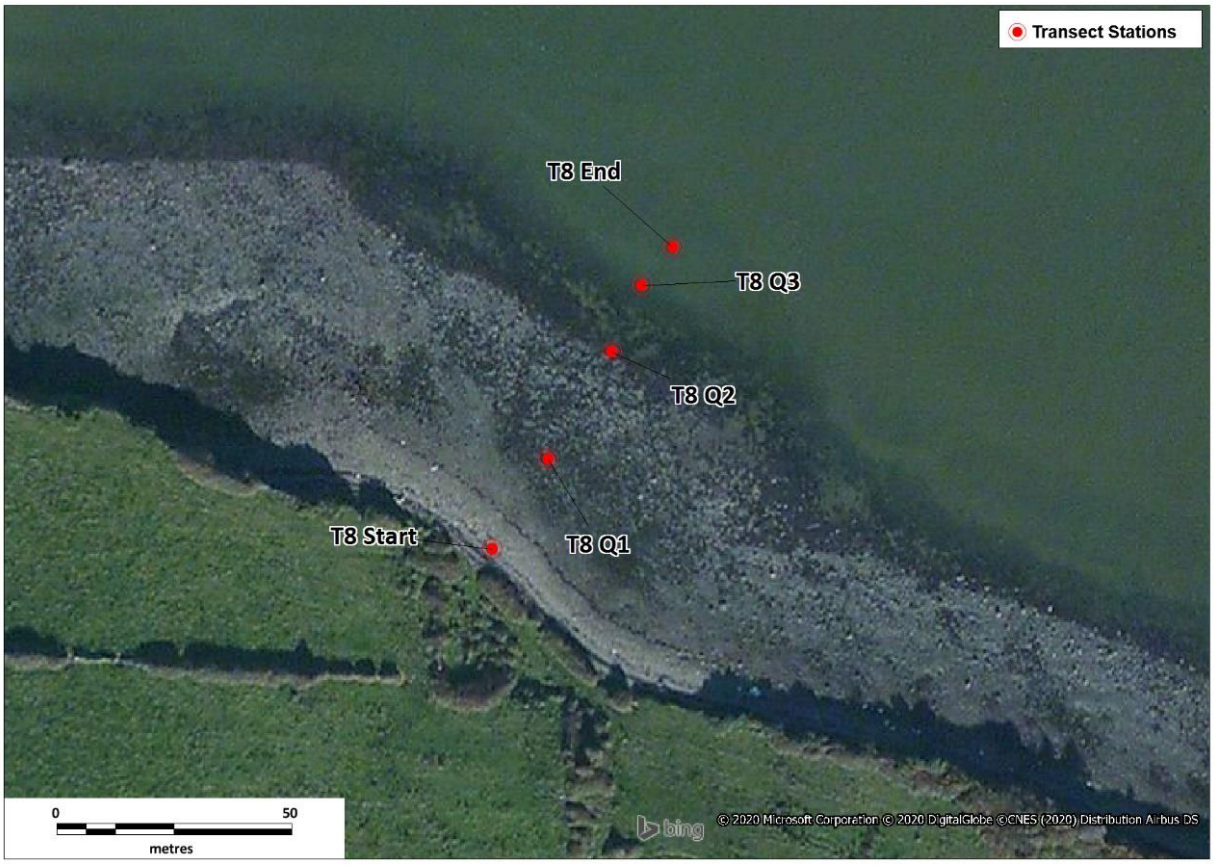

Figure 20-Start and end points and Quadrat locations along Transect 8.

Figure 21-Intertidal Transect 8. View from upper and lower shores.

Figure 22-Strandline above Transect 8.

Upper Shore

The upper shore consisted of cobbles, dominated by a band of *Pelvetia canaliculata* (from 9.6m to 18.4m) above a band of *Fucus spiralis* (14.4m to 19.9m). The *Ascophyllum nodosum* algal band extended from 19.5m into the mid-shore to 33.2m. Barnacles (*Austrominius modestus* and *Semibalanus* balanoides) were noted on the cobbles.

Figure 23 shows the quadrat from the upper shore. Flora and fauna within the quadrat include *Ascophyllum nodosum* (40% coverage), *Vertebrata lanosa* (5%), *Fucus spiralis* (5%), *Patella vulgata* (3), *Littorina littorea* (6), *Littorina saxatilis* (15), *Littorina obtusata* (2), Talitrid amphipods (>100 individuals), *Austrominius modestus* (5%) and *Semibalanus balanoides* (5%).

The biotopes in the upper shore resembled the 'LR.LLR.F.Pel *Pelvetia canaliculata* on sheltered littoral fringe rock' (EUNIS code A1.311), 'LR.LLR.F.Fspi *Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock biotopes' (EUNIS code A1.3122) and 'LR.LLR.FVS.AscVS *Ascophyllum nodosum* and *Fucus vesiculosus* on variable salinity mid eulittoral rock' (EUNIS code A1.3141).

Figure 23-Upper Shore Quadrat, Transect 8.

Mid Shore

The mid shore consisted of boulders, cobbles and gravel. A *Fucus vesiculosus* algal band extended from 19.2m to 60.2m. Figure 24shows the mid shore transect.

Flora and fauna within the quadrat include *Fucus vesiculosus* (5% coverage), *Littorina littorea* (6 individuals), *Littorina saxatilis* (15), *Patella vulgata* (3), *Steromphala cineraria* (1), Talitrid amphipods (20), *Austrominius modestus* (<1%) and *Semibalanus balanoides* (<1%).

This biotope corresponds to the JNCC biotope 'LR.LLR.FVS.FvesVS *Fucus vesiculosus* on variable salinity mid eulittoral boulders and stable mixed substrata' (EUNIS code A1.323).

Figure 24-Mid Shore Quadrat, Transect 8.

Lower Shore

The lower shore substrate consisted of fine sand and cobbles. The *Fucus serratus* algal band extended from 42.6m to 67.7m and a band of *Chondrus crispus* extended from 65.8m into the subtidal.

Figure 25 shows the quadrat surveyed on the lower shore. The flora and fauna recorded in the quadrat included *Fucus serratus* (75% coverage), with encrusting spirorbids on the algae, *Littorina saxatilis* (3 individuals), there was also a small patch of reef building polychaete *Sabellaria* present (15%). Elsewhere on the sandy lower shore there were numerous sand mason tubes (*Lanice conchilega,* approx. 160/m^2).

This biotope corresponds to the JNCC biotopes 'LR.MLR.BF.Fser.R *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock' (EUNIS code A1.2141) and 'SS.SCS.ICS.SLan Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (EUNIS A5.137).

Figure 25-Lower Shore Quadrat, Transect 8.

2. Subtidal Survey

2.1. Survey Design

To carry out the subtidal benthic assessment of the area, AQUAFACT sampled a total of 10 stations. Sampling took place on the 17th April 2020 from AQUAFACT's 6.8m Lencraft RIB. The weather on the day was dry and mild with a force 3 easterly wind. All stations sampled can be seen in Figure 26and their locations were selected in order to be representative of the previous survey sites. Station coordinates are presented in Table 1.

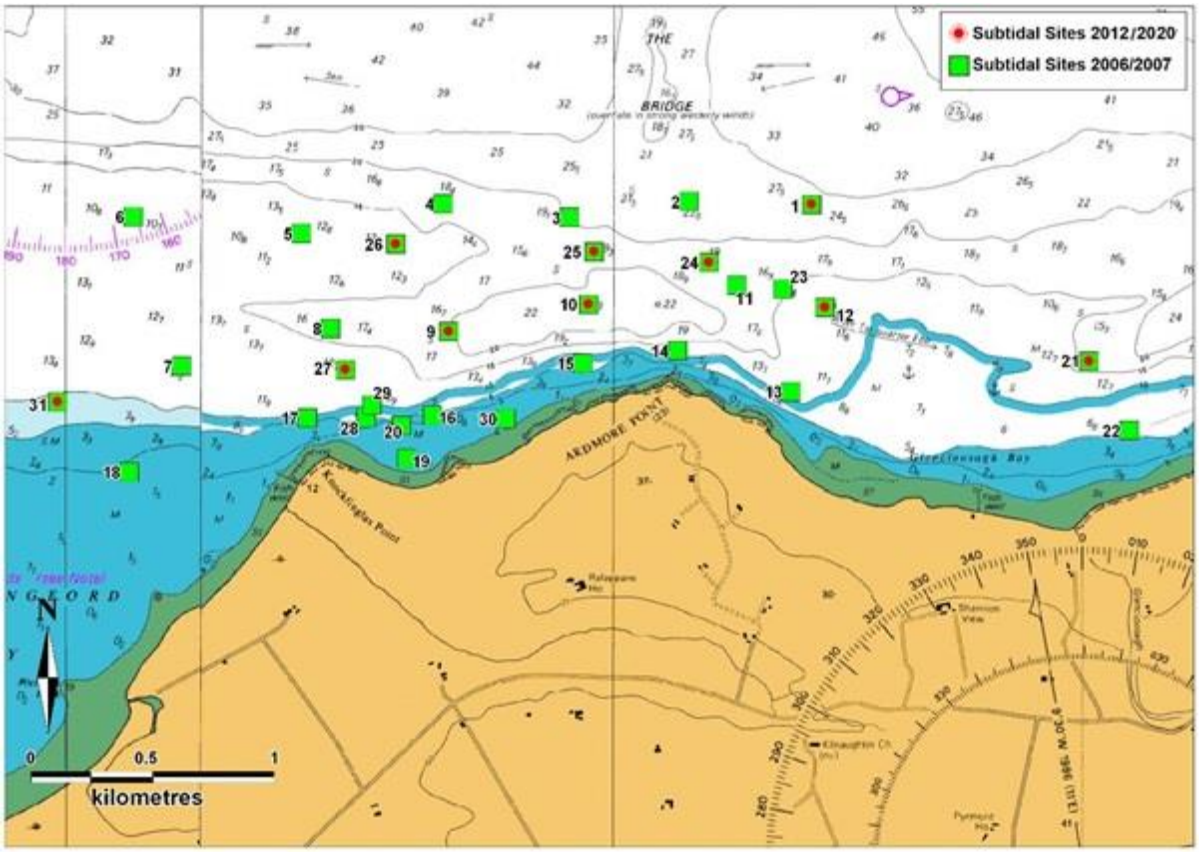

Figure 26-Location of all 10 stations sampled on the 17th April 2020 (and October 2012) and the 31 stations sampled in 2006/2007.

Table 1-Coordinates.

Station	Longitude	Latitude	Longitude	Easting	Northing
S1	-9.42206	52.59132	-9.42206	103676.3	149798.2
S9	-9.44401	52.58662	-9.44401	102178.6	149304.8
S10	-9.43554	52.58762	-9.43554	102754.8	149404.6
S12	-9.42125	52.58752	-9.42125	103722.9	149374.3
S21	-9.40523	52.58555	-9.40523	104804.4	149134.3
S24	-9.42828	52.58917	-9.42828	103250.1	149567.5

Station	Longitude	Latitude	Longitude	Easting	Northing
S25	-9.43522	52.58955	-9.43522	102781.1	149619.4
S26	-9.44723	52.58982	-9.44723	101967.3	149665.4
S27	-9.45025	52.5852	-9.45025	101752.5	149155.8
S31	-9.4677	52.58398	-9.4677	100567.1	149044.3

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 0.025m^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. 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 (<-18^{o}C) as soon as possible after acquisition.

2.1.1. 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 (x10 magnification). Following the removal of larger specimens, the samples were placed into Petri dishes, approximately one half teaspoon at a time and sorted using a binocular microscope at x25 magnification.

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 shows the classification of sediment particle size ranges into size classes.

Organic carbon analysis was carried out using the Loss on Ignition technique.

Table 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

2.1.2. Data Analysis

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), 125-250mm (Fine Sand), 62.5-125mm (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).

Additionally, a drop-down video survey of the seabed was carried out using a drop-down camera (manufactured by LH-Camera). This is an upgraded version of their standard unit. Its specification includes a high resolution, 560-line colour PAL camera with 0.1 lux sensitivity. A video overlay unit allowed position (GPS) to be inserted and recorded continually on screen, streamlining the incorporation of footage into GIS for ground truthing and mapping purposes. The video photography data will be reviewed, and the locations of habitats and/or associated flora and faunal communities will be noted.

Faunal Data

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

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:

1. Number of taxa (S) in the samples and
2. 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:

3. 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.

4. 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 (= $\log_2 S$)

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

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

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

where: p_l 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).

6. 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 that community is twice as diverse as the other.

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 square root transformed and used to prepare a Bray-Curtis similarity matrix in PRIMER. The square root transformation allows the intermediate 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.

AZTI Marine Biotic Index

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).

In the AMBI tool, species are allocated to one of five ecological groups depending on their sensitivity to pollution:

- 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).

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.

Results

Fauna

The taxonomic identification of the benthic infauna across all 10 stations sampled in the Shannon Estuary yielded a total count of 82 taxa ascribed to 9 phyla. Of the 82 taxa, 2 could not be enumerated due to their colonial nature and the remaining 80 taxa consisted of 1,740 individuals. Of the 82 taxa identified, 58 were identified to species level. The remaining 24 could not be identified to species level due to the fact that they were juveniles, damaged or indeterminate.

Of the 82 taxa recorded, 34 were annelids (segmented worms), 20 were arthropods (crabs, shrimps, sea spiders), 18 were molluscs (mussels, cockles, snails *etc*.), 2 were bryozoans (moss animals), 2 were sipunculids (peanut worms), 2 were echinoderms (brittlestars, sea cucumbers), 1 was a tunicate (sea squirts), 1 was a nemertean (ribbon worm) and 1 was a nematode (round worm).

Univariate Analysis

The univariate analyses were carried out using the same methodology as was used in the previous 2012 study (AQUAFACT, 2012), for ease of comparison.

All replicate data was combined to give a total for each station prior to statistical analysis. The following taxa were removed prior to statistical analyses: nematodes, nemerteans, all epifaunal species and all taxa not identified to species level. 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-Community** indices: species numbers, number of individuals, richness, evenness, Shannon-Weiner diversity, and Effective Species Number (ENS).

Species numbers ranged from 3 (LS1) to 31 (LS31). Number of individuals ranged from 3 (LS1) to 466 (LS10). Richness ranged from 1.82 (LS1) to 5.72 (LS31). Evenness ranged from 0.22 (LS21) to 1.0 (LS1). Shannon-Weiner diversity ranged from 0.61 (LS21) to 2.35 (S31). Effective species number ranged

from 1.85 (LS21) to 10.53 (LS31) indicating that station LS31 is over 6.6 times more diverse than station LS21. Figure 27shows these community indices in graphical form.

Table 3-Community indices

Station	No. Taxa	No. Individuals	Richness	Evenness	Shannon-Weiner Diversity	Effective Species Number
	S	N	d	J'	H'(loge)	EXP(H')
LS1	3	3	1.82	1.00	1.10	3.00
LS9	21	272	3.57	0.39	1.19	3.28
LS10	16	466	2.44	0.17	0.46	1.58
LS12	9	16	2.89	0.91	1.99	7.34
LS21	17	273	2.85	0.22	0.61	1.85
LS24	8	15	2.58	0.77	1.60	4.95
LS25	6	14	1.89	0.91	1.63	5.11
LS26	10	26	2.76	0.77	1.76	5.83
LS27	11	67	2.38	0.59	1.41	4.09
LS31	31	190	5.72	0.69	2.35	10.53

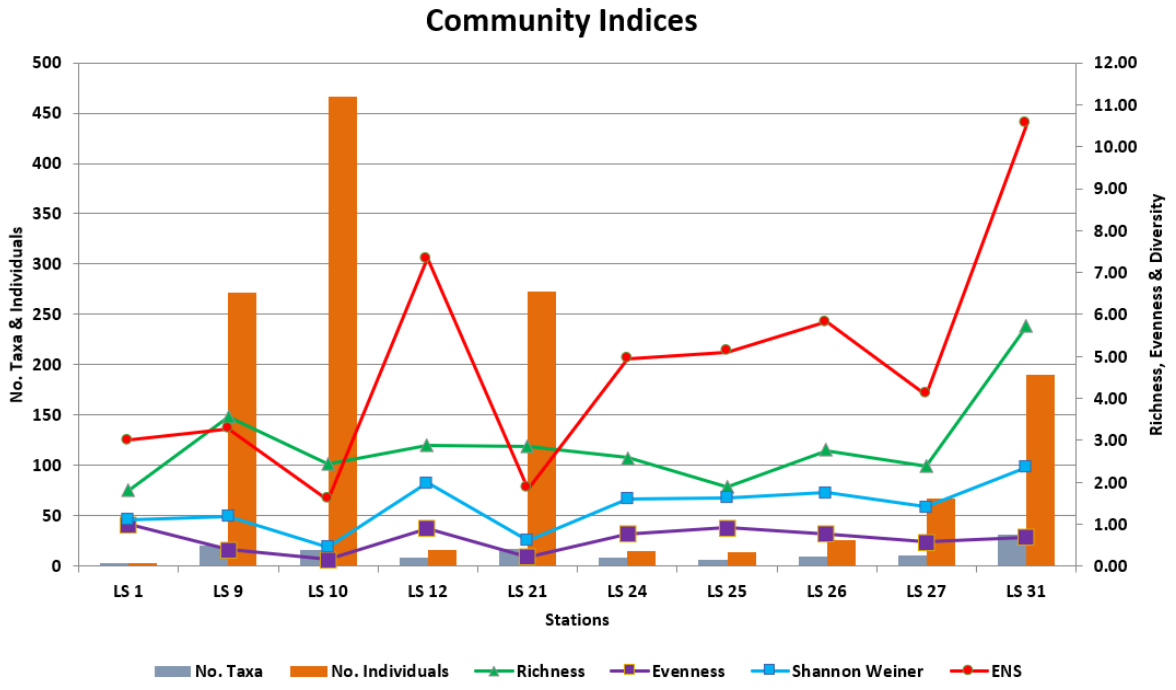

Figure 27-Community diversity indices. Diversity is expressed in Shannon-Weiner Diversity and Effective Species Number (ENS).

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 Figure 28and Figure 29respectively. SIMPROF analysis revealed 3 statistically significant groupings between the 10 stations (the samples connected by red lines cannot be significantly differentiated). The stress level on the MDS plot indicates a good representation of the data with no real prospect of misinterpretation of overall structure.

A clear divide (9.24% similarity) can be seen between **Group a** and **Groups b** and **c**.

Group a consisted of Station LS1. This group separated from all other groups at a 9.24% similarity level. Station S1 contained 3 species comprising 3 individuals. The polychaetes *Scoloplos armiger*, the gastropod *Peringia ulvae* and the hermit crab *Pagurus bernhardus* were all recorded only once. This station had the highest evenness value given the identical numbers of species and individuals recorded. This station was also species poor when sampled in 2012 and 2006. No epifaunal species were recorded at this station.

Group b consisted of Stations LS9, LS10, LS21, LS26 and LS31. Group b had a within group similarity of 41.82% and was most similar to Group c, but only at a level of 17.82%. This group contained 51 taxa comprising 1,294 individuals. Of the 51 taxa, 27 were present twice or less. Four species accounted for almost 87% of the faunal abundance: the bivalve *Nucula nucleus* (951 individuals, 73.49% abundance), the polychaetes *Paradoneis lyra* (105 individuals, 8.11% abundance) and *Pholoe inornata* (37 individuals, 2.86% abundance) and the amphipod *Metaphoxus simplex* (31 individuals, 2.4% abundance). SIMPER analysis revealed that *Nucula nucleus* and *Pholoe inornata* are the characterising species of this group. *Nucula nucleus* is very sensitive to organic enrichment and present under unpolluted conditions *P. inornata* are indifferent to disturbance, typically present in low densities with non-significant variations over time.

Individually, Station LS9 contained 21 species comprising 272 individuals. Thirteen of the 21 species were present twice or less. The bivalve *Nucula nucleus* accounted for 76% of the faunal abundance at this station and *Paradoneis lyra* accounted for 3.6% of it. Two epifaunal bryozoan species were present at this station as well as a large number of the tunicate *Dendrodoa grossularia* (114 individuals). Diversity was below average at this station. The number of species and individuals and richness were above average. Evenness was below average due to the high numbers of *Nucula nucleus* at this station. When sampled in 2012 and 2006 this station was dominated by *Nucula* spp. (*Nucula sulcata* and *Nucula nucleus*). This station can be ascribed to the habitat 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex'. This is one of ten benthic community habitat types occurring in the Lower River Shannon cSAC (NPWS, 2012) and has previously been recorded in this vicinity as illustrated in Figure 30**.**

Station LS10 contained 16 species comprising 466 individuals. Eleven of the 16 species recorded were present twice or less. The bivalve mollusc *Nucula nucleus* accounted for approximately 92% of the faunal abundance at this station. The epifaunal tunicate *Dendrodoa grossularia* (14 individuals) was recorded at this station. Richness was below average, and diversity and evenness were lowest at this station given the superabundance of one species. This station had above average species numbers and the highest species abundance. When sampled in 2012 and 2006 this station was also dominated by *Nucula* spp. (*Nucula sulcata* and *Nucula nucleus*). This station can also be ascribed to the habitat 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex'.

Station S21 contained 17 species comprising 273 individuals. Thirteen of the 17 species recorded were present twice or less. The bivalve *Nucula nucleus* accounted for 89.4% of the faunal abundance at this station. No epifaunal species were present at this station. Evenness and diversity were below average; richness was average and species numbers and abundance were above average. In 2006 and 2012,

Nucula spp. were also the dominant at this station. This station can also be ascribed to the habitat 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex*'.*

S26 contained 10 species comprising 26 individuals. Nine of the 10 species recorded were present twice or less. One species accounted for 50% of the faunal abundance at this station: the bivalve mollusc *Nucula nucleus.* No epifaunal species were present at this station. Moderate levels of richness and diversity were found at this station. Species abundance was low at this station. Surveys in 2006 and 2012 produced similar findings with the station dominated by *Nucula* spp. but species and abundance poor. This station can also be ascribed to the habitat 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex*'.*

Station S27 contained 11 species comprising 67 individuals. Eight of the 11 species recorded were present twice or less. Two species accounted for just under 63% of the faunal abundance at this station: the bivalve mollusc *Nucula nucleus* (34.3%) and the polychaete *Paradoneis lyra* (28.35%). Three epifaunal species were present at this station including two colonial bryozoans and high numbers of the tunicate *Dendrodoa grossularia* (194 individuals). This station had average richness, evenness and diversity. In 2012 this was the second most diverse of the stations sampled with *P. lyra, Nucula* and *Metaphoxus simplex* (then known as *Metaphoxus pectinatus*) the most dominant. In 2007, this station was the most diverse sampled and *Nucula* and *M. simplex* were also the dominant. This station can also be ascribed to the habitat 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex*'.*

Station S31 contained 31 species comprising 190 individuals. Eighteen of the 31 species recorded were present twice or less. Three species accounted for just under 62% of the faunal abundance at this station: the polychaete *Paradoneis lyra* (37.9%), the bivalve mollusc *Nucula nucleus* (12.1%), and the amphipod *Metaphoxus simplex* (11.58%). Two epifaunal species were present at this station including a colonial bryozoan and the tunicate *Dendrodoa grossularia* (20 individuals). This station was the most diverse and had the highest richness and diversity values of all stations sampled. Its effective species number (ENS 10.53) indicated that it was 6.6 times more diverse than the least diverse station (LS10). This station was also the most diverse in 2012, when it was dominated by *Nucula, P. lyra* and *Harpinia antennaria. Nucula* and *Harpinia* were also the dominants back in 2007 but overall diversity was lower. This station can also be ascribed to the habitat 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex*'.*

Group c consisted of Stations LS12, LS24 and LS25. Group c had a within group similarity of 34.83% and was most similar to Group c, but only at a level of 17.82%. This group contained 16 taxa comprising 45 individuals. Of the 16 taxa, 11 were present twice or less. Four species accounted for almost 67% of the faunal abundance: the polychaetes *Scoloplos armiger* (10 individuals, 22.22% abundance), the polychaetes *Travisia forbesii* (10 individuals, 22.22% abundance), *Nephtys cirrosa* (5 individuals, 11.11% abundance) and *Paradoneis lyra* (5 individuals, 11.11% abundance). SIMPER analysis revealed that *Nephtys cirrosa* and *Scoloplos armiger* are the characterising species of this group. *N. cirrosa* are indifferent to disturbance, typically present in low densities with non-significant variations over time. *S. armiger* are tolerant of disturbance, they occur under normal conditions, but their populations are stimulated by organic enrichment.

Individually, the station assemblages were as follows:

Station S12 contained 9 species comprising 16 individuals. Seven of the 9 species recorded were present twice or less. Three species accounted for 62.5% of the faunal abundance at this station: the polychaetes *Scoloplos armiger* (25%) and *Paradoneis lyra* (25%) and the bivalve *Nucula nucleus* (12.5%). No epifaunal species were present at this station. This was the second most diverse station sampled. Richness was average and evenness was above average at this station. In 2006 and 2012 *Nucula* was the dominant taxon at this station. This station exhibits elements of two of the ten

common benthic community habitat types occurring in the Lower River Shannon cSAC (Figure 30below) namely the habitats 'Subtidal sand to mixed sediment with *Nephtys* spp. community complex' and 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex' .

Stations LS24 contained 8 species comprising 15 individuals. Seven of the eight species recorded were present twice or less. The polychaete *Travisia forbesii* accounted for 53.33% of the faunal abundance at this station with the remaining species all accounting for 6.66% each. No epifaunal species were recorded form this station. Diversity was above average while richness, species numbers and species abundance were below average. In 2012 this station was dominated by the polychaetes *Spio goniocephala* and was similarly species poor. This station was just as impoverished when sampled in 2007. This station can also be said to exhibit elements of the habitats 'Subtidal sand to mixed sediment with *Nephtys* spp. community complex' and 'Subtidal sand to mixed sediment with *Nucula nucleus* community complex'.

Stations S25 contained 6 species comprising 14 individuals. Four of the 6 species recorded were present twice or less. The polychaete *Scoloplos armiger* accounted for 35.7% of the faunal abundance at this station and *Nephtys cirrosa* accounted for 21.4% of it. No epifaunal species were recorded from this station. Diversity was above average while richness, species numbers and species abundance were below average. This station similarly impoverished when sampled in 2012 and 2007. This station can also be ascribed to the habitat 'Subtidal sand to mixed sediment with *Nephtys* spp. community complex'.

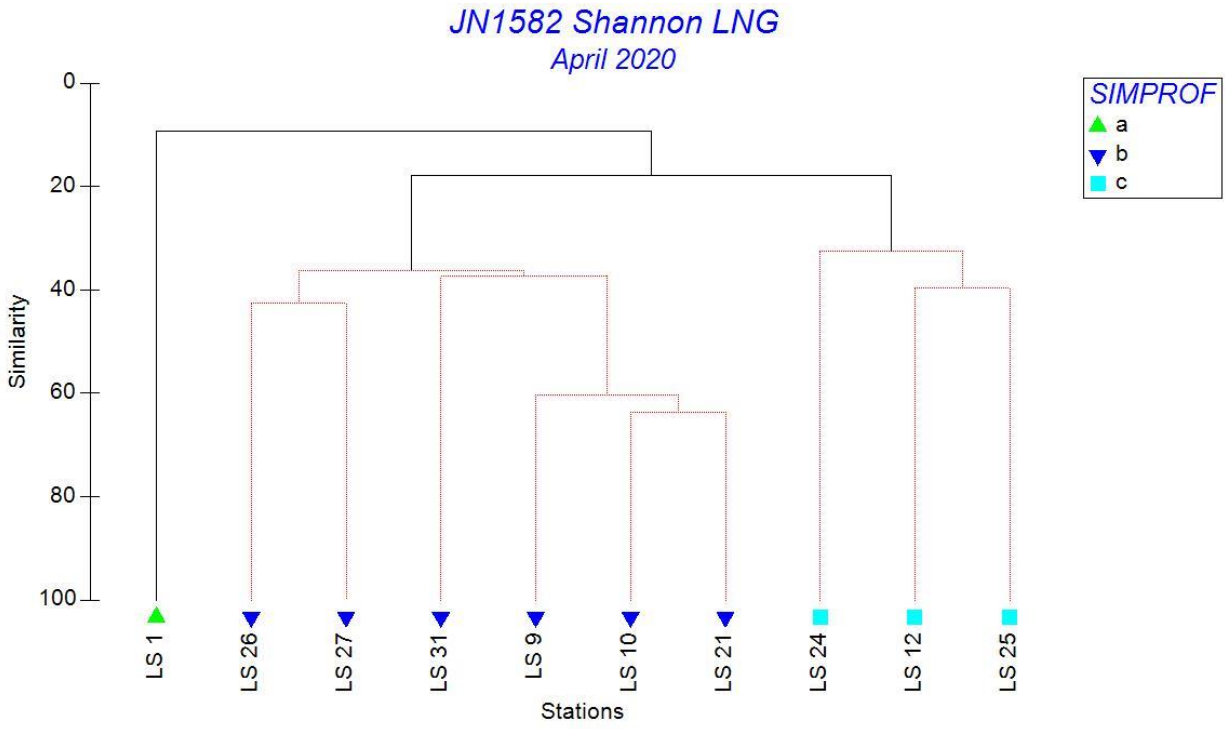

Figure 28-Dendrogram produced from Cluster analysis.

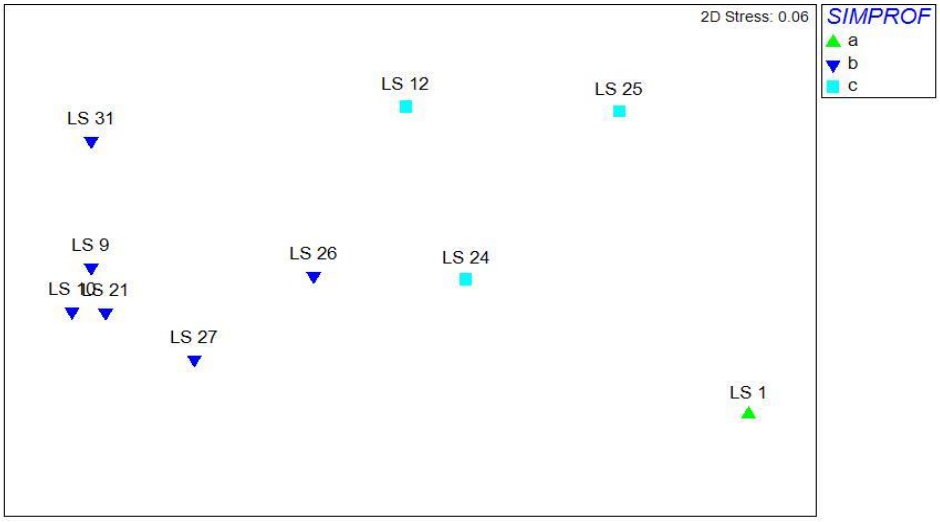

Figure 29-MDS plot.

Table 4-SIMPER Results

Group a					
Less than 2 samples in group					
Group b					
Average similarity: 41.82%					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Nucula nucleus	10.84	18.22	1.85	43.57	43.57
Pholoe inornata	2.39	5.48	4.81	13.1	56.67
Paradoneis lyra	3.12	3.3	0.97	7.9	64.56
Euclymene oerstedii	1.68	2.97	1.19	7.09	71.66
Sabellaria spinulosa	1.12	2.33	1.25	5.57	77.22
Scoloplos armiger	0.87	1.37	0.72	3.27	80.49
Achelia echinata	0.9	1.15	0.75	2.76	83.25
Metaphoxus simplex	1.56	1.08	0.71	2.59	85.84
Dipolydora flava	0.91	0.98	0.76	2.35	88.19
Golfingia (Golfingia) vulgaris vulgaris	0.83	0.88	0.78	2.09	90.28
Group c					
Average similarity: 34.83%					
Species	**Av.Abund**	**Av.Sim**	**Sim/SD**	**Contrib%**	**Cum.%**
Scoloplos armiger	1.75	13.31	2.36	38.23	38.23
Nephtys cirrosa	1.24	10.02	14.95	28.76	66.99
Travisia forbesii	1.41	5.06	0.58	14.53	81.52
Paradoneis lyra	1	3.3	0.58	9.47	90.99

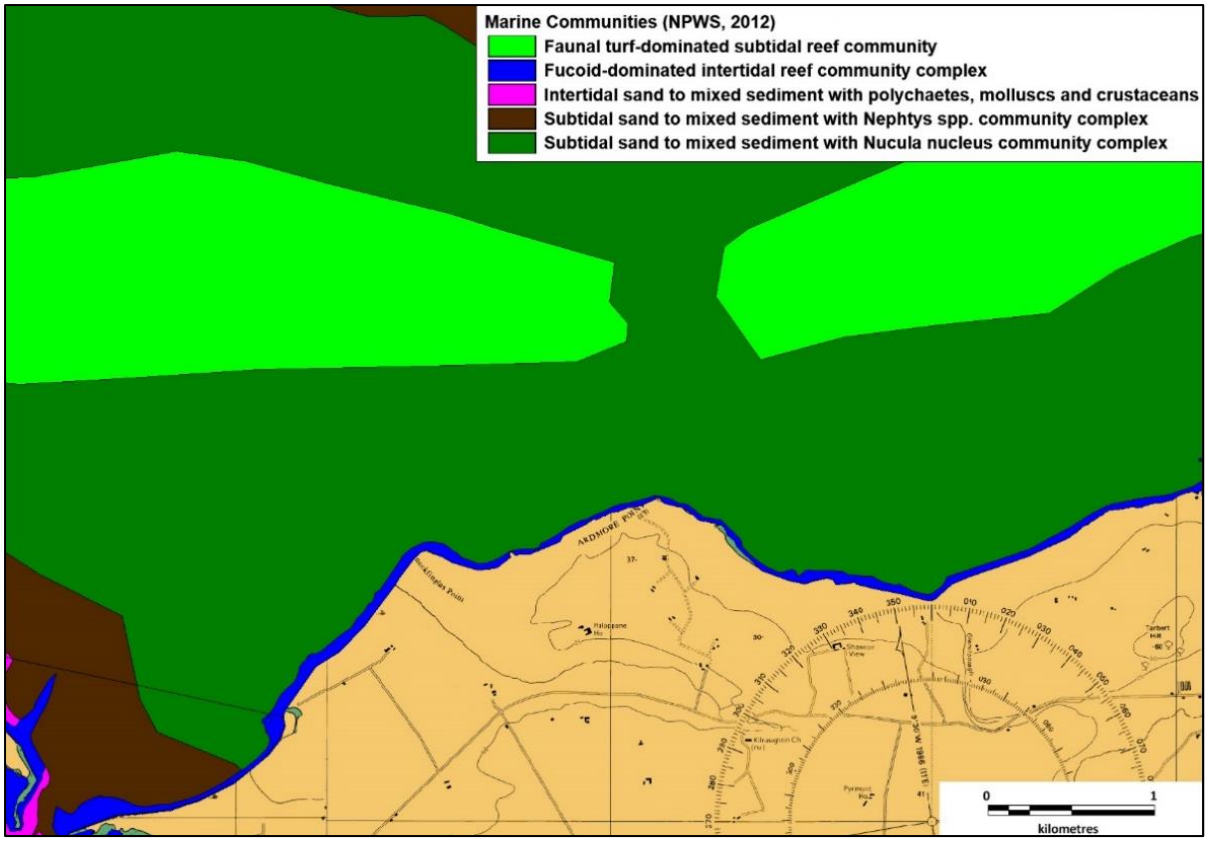

Figure 30-Marine biotopes in survey area of Shannon Estuary (NPWS, 2012).

AMBI Results

Table 5 shows the mean AMBI results from the analysis of the replicate samples and these results are presented in a histogram in Figure 31-Histogram of AMBI results. Four stations were described as slightly disturbed (Stns LS1, LS12, LS25 and LS31), while 6 were classified as undisturbed (Stns LS9, LS10, LS21, LS24, LS26 and LS27). The slightly disturbed stations had a fairly even split between the abundance of species indifferent to disturbance/pollution and those tolerant of polluted/disturbed sediments. The undisturbed stations had a higher abundance of sensitive species that cannot survive in polluted/disturbed sediments.

Table 5-AMBI results.

Stations	I(%)	II(%)	III(%)	IV(%)	V(%)	Not assigned (%)	Mean AMBI	BI from Mean AMBI	Disturbance Classification
LS1	0.0	33.3	66.7	0.0	0.0	0.0	2.5	2	Slightly disturbed
LS9	86.4	6.5	4.3	2.8	0.0	0.3	0.351	1	Undisturbed
LS10	94.8	3.5	1.4	0.2	0.0	0.2	0.105	0	Undisturbed
LS12	18.8	25.0	56.3	0.0	0.0	0.0	2.063	2	Slightly disturbed
LS21	93.1	4.0	2.9	0.0	0.0	0.0	0.146	0	Undisturbed
LS24	70.6	17.6	11.8	0.0	0.0	0.0	0.618	1	Undisturbed
LS25	33.3	16.7	38.9	11.1	0.0	0.0	1.917	2	Slightly disturbed
LS26	76.7	13.3	10.0	0.0	0.0	0.0	0.500	1	Undisturbed
LS27	89.8	1.9	7.9	0.4	0.0	2.2	0.282	1	Undisturbed
LS31	48.9	4.1	45.7	0.9	0.5	0.0	1.500	2	Slightly disturbed

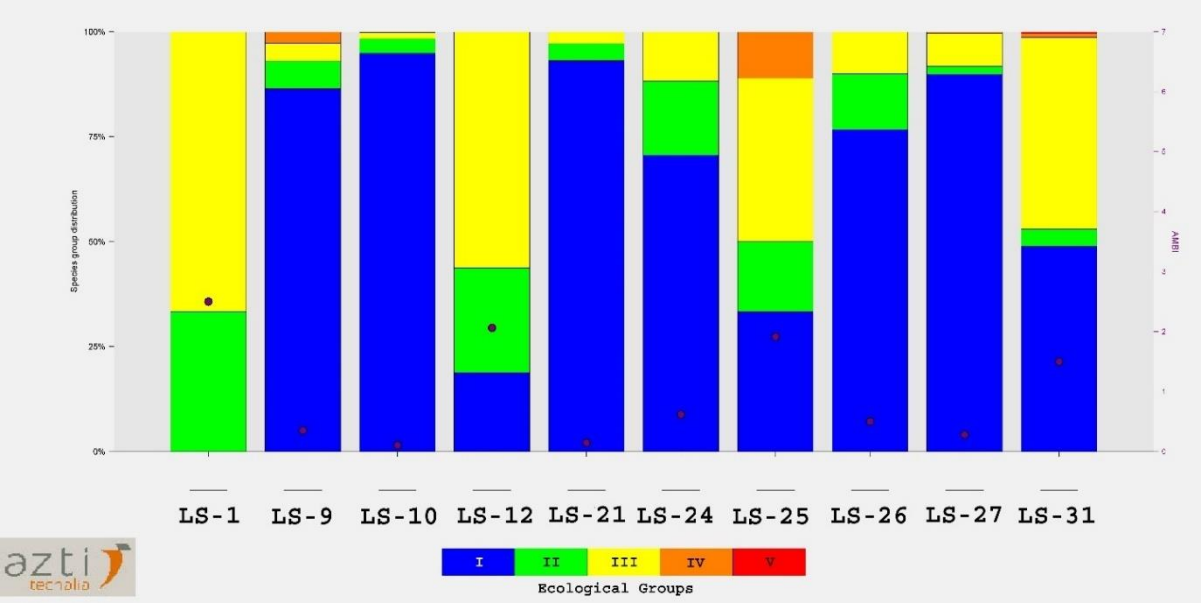

Figure 31-Histogram of AMBI results.

Sediment

Table 6 shows the sediment characteristics of the subtidal stations surveyed including the granulometry and the percentage organic carbon.

The sediment sampled within the study area was classified as sand, sandy gravel, gravelly muddy sand and slightly gravelly muddy sand according to Folk (1954). No medium gravel-boulders were recorded. Highest levels of fine gravel and very fine gravel were observed at LS10 (43.2% and 19.8% respectively). Highest levels of very coarse sand were found at LS27 (8.8%). Highest levels of coarse sand and medium sand were found at LS1 (7.1% and 65.9% respectively). Highest levels of fine sand were found at LS24 (65.7%). Highest levels of and very fine sand and silt-clay were found at LS31 (33.9% and 28.3% respectively).

Figure 32-A breakdown of sediment type at each subtidal station.shows the breakdown of sediment composition at each station and Figure 33illustrates the sediment type according to Folk (1954). Organic matter values ranged from 1.66% (LS1) to 4.22% (LS10).

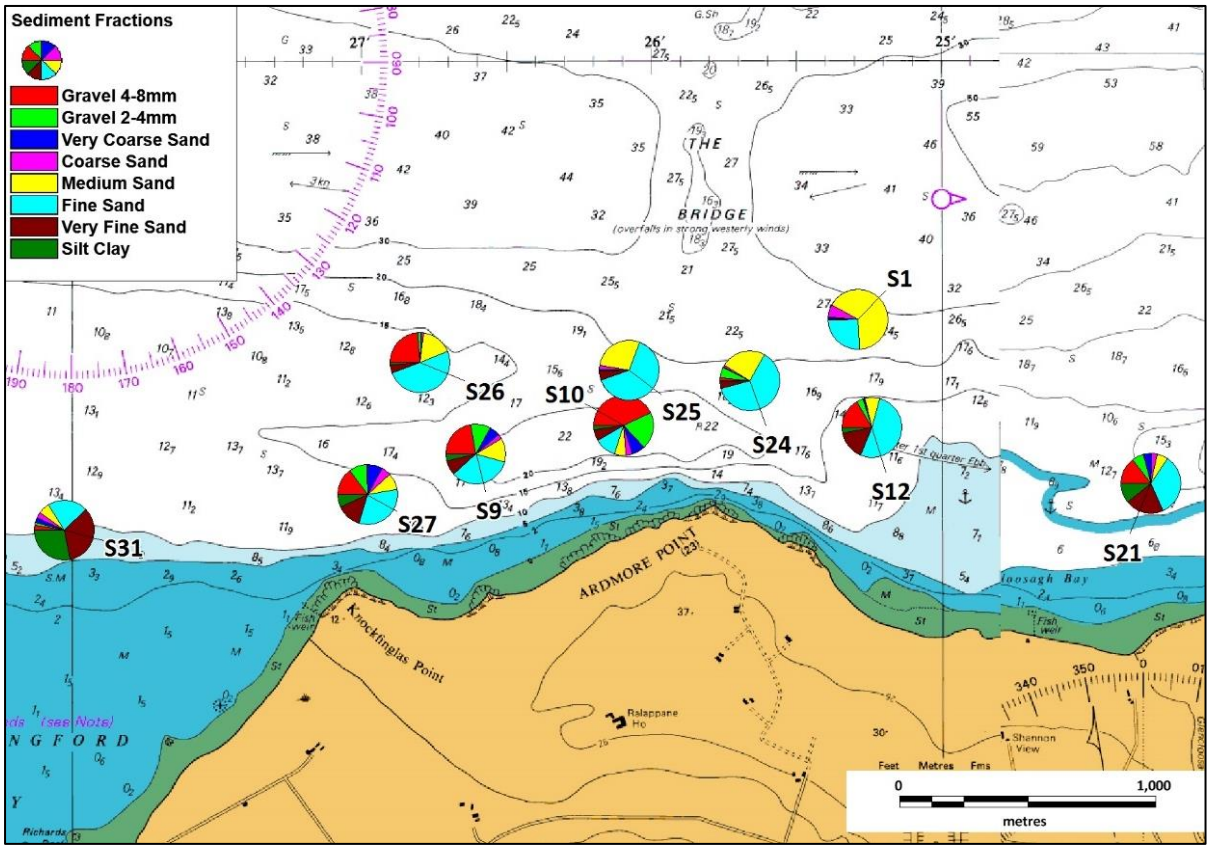

Figure 32-A breakdown of sediment type at each subtidal station.

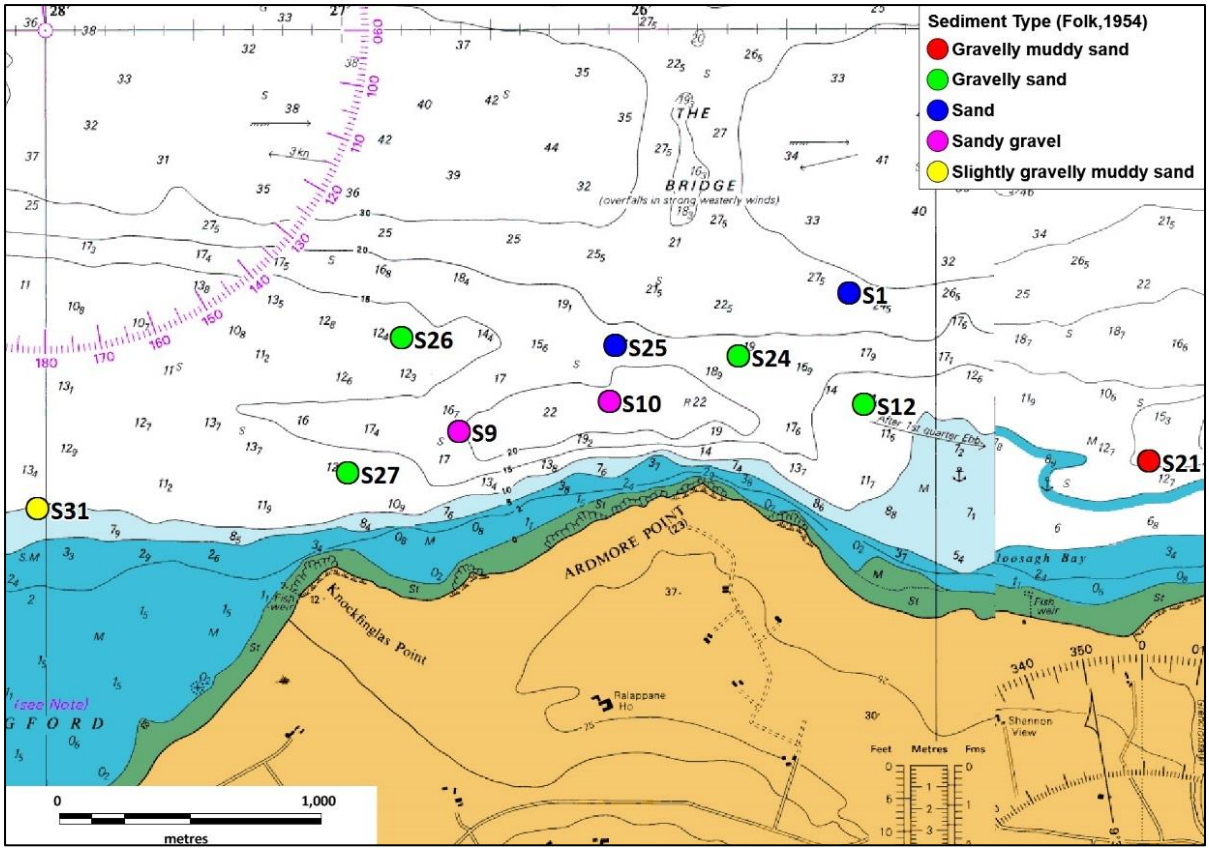

Figure 33-Sediment type (Folk, 1954) at subtidal station surveyed in April 2020.

Table 6-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
LS1	0	0.1	0.2	0.6	7.1	65.9	25.3	0.5	0.2	Sand	1.66
LS9	0	22.4	11	5.5	2.9	12.5	33.6	8.1	4	Sandy Gravel	3.38
LS10	0	43.2	19.8	7.1	3.3	6.2	11.8	6.1	2.5	Sandy Gravel	4.22
LS12	0	16.6	3.6	0.7	0.5	8	51.6	15.8	3.1	Gravelly Sand	1.94
LS21	0	14.5	6.6	4.6	3.1	6	33.6	20.7	11	Gravelly Muddy Sand	3.78
LS24	0	1.7	6	0.2	1.3	26	65.7	4	0.6	Gravelly Sand	1.96
LS25	0	0.3	0	0.2	1.9	28.5	63.7	4.6	0.8	Sand	1.75
LS26	0	24	1.7	0.5	0.9	16.9	50.1	4.5	1.3	Gravelly Sand	1.87
LS27	0	14.8	9.7	8.8	5.1	9	31.9	13.4	7.2	Gravelly Sand	3.84
LS31	0	2.4	1.5	2.7	3.3	6.3	21.7	33.9	28.3	Slightly Gravelly Muddy Sand	4.21

Figure 34indicates the locations of the drop-down video transects surveyed and the sediment type observed on the video footage.

Figure 35illustrates still images from the drop-down video survey indicating the substrate types encountered throughout the survey area.

Stations DV1 and DV4 consisted of cobble substrate; stations DV2, DV6, DV7, DV8, DV9, DV10 and DV12 were sandy substrates with the sand frequently in ripples; stations DV3 and DV5 had boulders that were encrusted with the tunicate *Dendrodoa grossularia* and bryozoans; station DV11 consisted of a sand and shell substrate.

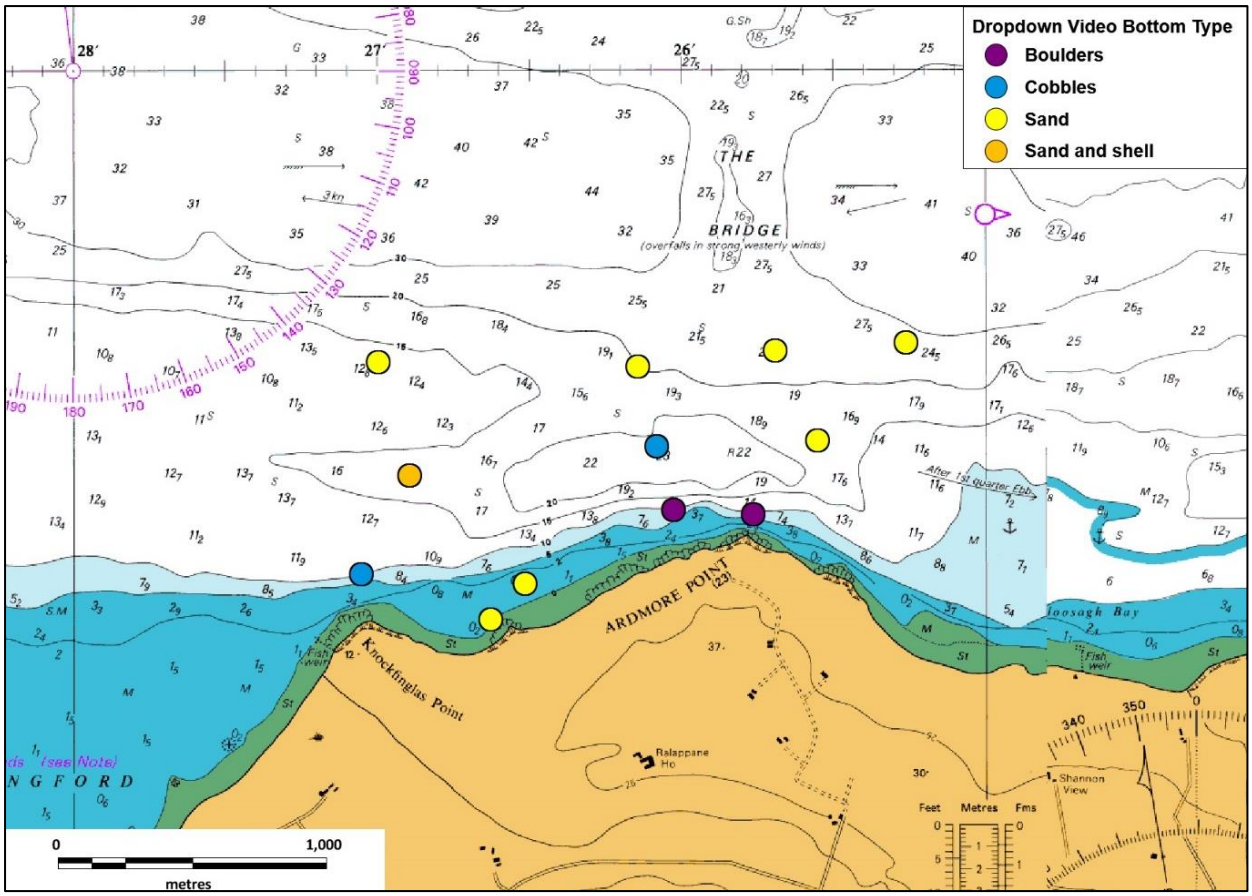

Figure 34-Location of drop-down video transects, and sediment type observed.

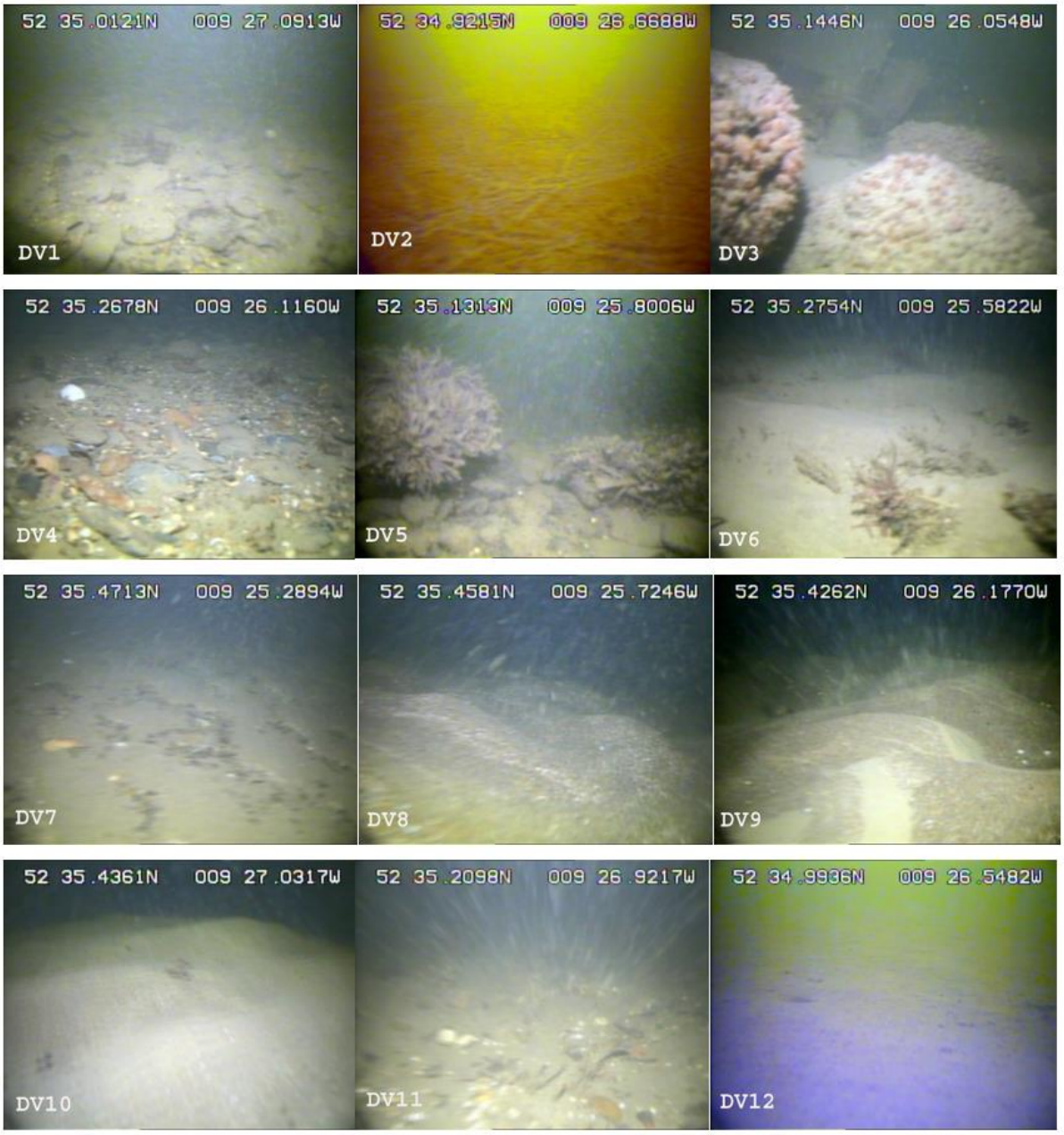

Figure 35-Drop-Down video images of substrate type in the survey area.

3. Discussion

The intertidal habitats encountered are typical of cobbly rocky shores in Ireland being dominated by *Pelvetia canaliculata*, Fucus sp. and *Ascophyllum nodosum*. No rare, protected or unusual species were observed, and no changes were observed compared to previous survey undertaken in 2012.

The subtidal fauna was dominated by species typical of fine sandy habitats *e.g.* the polychaetes *Nephtys cirrosa*, *Paradoneis lyra*, *Travisia forbesii*, *Pholoe inornata* and *Scoloplos armiger*, the bivalve *Nucula* spp. and the amphipods *Metaphoxus simplex* and *Harpinia antennaria*.

In areas with boulders or cobbles there were abundant populations of the tunicate *Dendrodoa grossularia*. No rare, protected or unusual species were observed. Graphs comparing the 2020 and 2012 univariate results are included in the EIAR Marine Ecology Chapter Appendices. One-way ANOVA

shows a significant difference between the Shannon-Weiner Diversity and the Effective Number of Species between the 2020 and 2012 results. Whether this is a seasonal variation due to the difference in time of surveys (October in 2012 and April in 2020) is unknown. Despite the significant decreases in these indices from 2012 to 2020, the dominant taxa present are similar in both surveys and indicate similar community types between surveys. All species observed are typical of this area of the Lower River Shannon Estuary cSAC.

AMBI analysis indicated that all sites were either undisturbed or slightly disturbed due to the high proportion of sensitive species at each station. Slight variations in the substrate type were observed between this survey and the previous one. Given the strong current speeds and mobile sediments in the area, this is not unusual.