Survey of Benthic Habitats at the Port of Cork Licensed Dumpsite off Power Head including notes on Fisheries and an Impact Hypothesis

(June 2020)

Commissioned by: Port of Cork Company
Carried out by: Aquatic Services Unit
(December 2020)

1 Introduction & Brief

Aquatic Services Unit were commissioned by Port of Cork to undertake a marine benthic assessment of the subtidal communities within the area of the licensed dredge spoil disposal site located approximately 4½ km south of Power Head and the mouth of Cork Harbour (Figure 1). The object of the assessment was to draw up an impact hypothesis for the disposal of dredge spoil at the site. The 2020 survey is the first benthic survey at the sites since a previous survey carried out in 2004. The survey was carried out in June 2020.

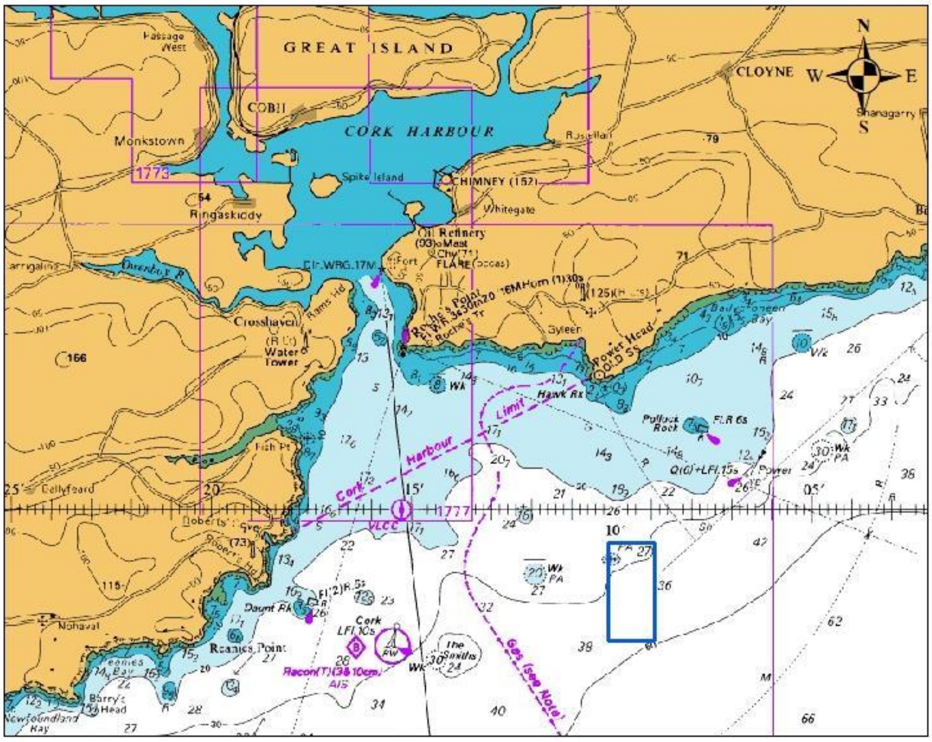

Figure 1 Location of Cork Harbour dredge spoil disposal area

2 Methodology

The survey comprised a sub-tidal benthic grab to assess the benthic infauna community and to measure grainsize, while a drop-down video survey was undertaken in order to characterise the subtidal habitats present.

2.1 Sub-tidal Soft Benthos Survey

2.1.1 Subtidal Grab Sampling

A total of 18 sub-tidal grab samples were collected within and adjacent to the disposal area. All samples were collected on the 25th June 2020 and were sampled using a 0.1m^2 stainless steel Van-Veen Grab. Pre-determined sampling positions were navigated to using the vessel's own GPS system. Once on site, the precise location of each sampling station was fixed and recorded using a Trimble Geo-XM GPS. 8 sites were sampled, with 3 replicate samples collected at 5 locations (Sites 1-5) and a single grab collected at 3 locations (Sites 6-8). Sampling issues at Station 06 resulted in no sample being collected at this site. This reflected the heterogeneous nature of the sediment at this location. A single sample was collected at site P1 from the 2004 survey (labelled P1-Actual). A full list of the stations sampled is presented in Table I and mapped in relation to the dumpsite in the schematic in Figure 3.

Notes on grab Sampling

The initial field programme entailed re-visiting the same areas for grab sampling as those chosen for the previous survey undertaken in 2004. However, information obtained from the video survey, carried out immediately prior to the grab sampling, indicated the unsuitable nature of the seabed in several of these areas, which is a mosaic of bedrock (which cannot be grab sampled), coarse and fine gravel and softer sediment patches. Accordingly, revised sampling programme was used to target those areas suitable for grab sampling. This was drawn up with the aid of the 2020 video survey and side-scan sonar surveys undertaken at the site 1999 and 2013 (Figure 2; RPS, 2014).

Due to a GPS logging issue, no position was recorded for site P1B (Table 1, Figure 3), although the area was within 30m of the target position and in very close proximity to the replicate sampling sites P1A and P1C (Figure 3).

	Latitude	Longitude		Latitude	Longitude
P1A	51° 43.514'N	8° 10.002'W	P4B	51° 43.086'N	8° 09.470'W
P1B	No Record	No Record	P4C	51° 43.152'N	8° 09.426'W
P1C	51° 43.501'N	8° 09.963'W	P5A	51° 43.973'N	8° 09.881'W
P2A	51° 44.379'N	8° 09.920'W	P5B	51° 43.936'N	8° 09.864'W
P2B	51° 44.360'N	8° 09.916'W	P5C	51° 43.945'N	8° 09.855'W
P2C	51° 44.380'N	8° 09.932'W	P6	51° 43.846'N	8° 08.543'W
P3A	51° 43.656'N	8° 09.220'W	P7	51° 43.979'N	8° 08.133'W
P3B	51° 43.663'N	8° 09.276'W	P8	51° 43.904'N	8° 07.699'W
P3C	51° 43.655'N	8° 09.308'W	P1-Actual	51° 43.750'N	8° 09.590'W
P4A	51° 43.074'N	8° 09.422'W			

Table I: Positions of grab sample stations. All positions are provided in Latitude/Longitude.

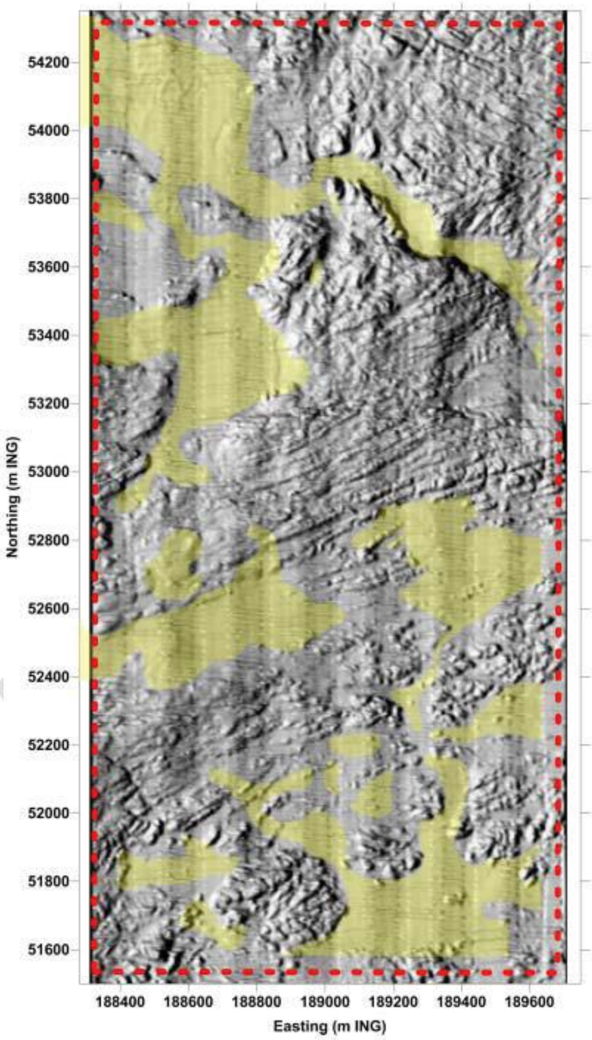

Figure 2: 2013 shaded relief map survey, with the 1999 data overlain. Image taken from Port of Cork Maintenance Dredging Habitats Directive Assessment, Screening Statement (RPS 2014). Yellow shaded area indicates the presence of soft sediments on the seabed. Grey shaded area indicates the presence of coarse sediment or bedrock.

At each grab station:

- 1 x 0.1m^2 Van-Veen grab taken for benthic faunal analysis (Stations P7, P8 & P1-Actual).
- 3 x 0.1m^2 Van Veen grabs taken for benthic faunal analysis (Stations P1, P2, P3, P4 & P5).
- 1 x 0.1m^2 Van-Veen grab from which a small amount of sediment was retained for Particle Size Analysis and Loss on Ignition Analysis (7 stations; P1-P5, P7, P8. No grainsize was collected from P1-Actual). [Note: P1-Actual is a revisit of the station P1 from the original 2004 survey].

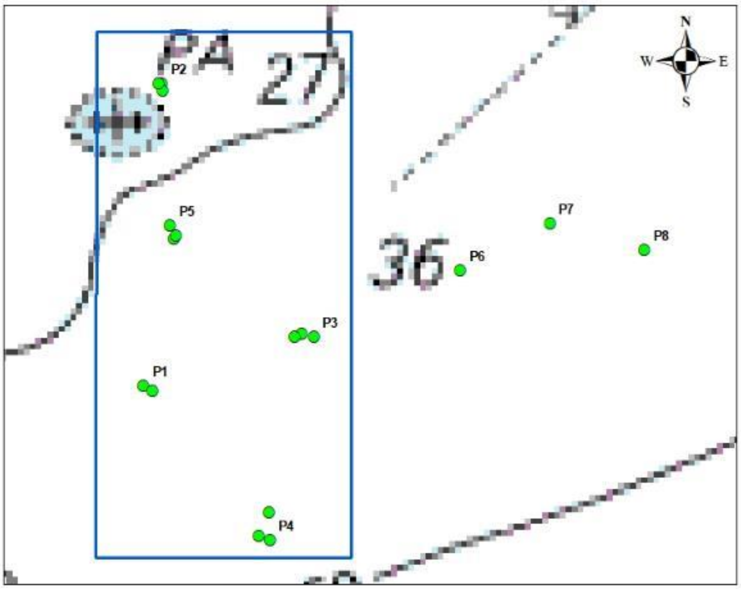

Figure 3: Map showing the positions of grab sampling stations collected during the 2020 survey.

All samples were processed within 24 hours of collection. Samples were sieved through a 1mm mesh sieve and preserved in 4% formalin (buffered with sea water). All fauna were identified to the lowest taxonomic level possible using standard keys to north-west European fauna by specialist taxonomists from Thomson Ecology.

Several biotic indices were calculated from the species / abundance matrix from the grab samples. These indices included Simpson's Dominance Index (where values range from low dominance [0] to high dominance [1]), Shannon-Wiener Diversity Index (Values ranging from low diversity [0] to high diversity [4]) and Pielou's Evenness Index (values ranging from low i.e. dominated by a few species [0] to high evenness i.e. a more even spread of species [1]).

Granulometric Analysis

Granulometric analysis was carried out on oven-dried sediment samples from each station using the protocols described by Holme & McIntyre (1984). The sediment was passed through a series of nested test sieves with the aid of a mechanical shaker. The sieve mesh sizes chosen were 4mm, 2mm, 1mm, 500µm, 250µm, 125µm and 63µm. The sediment passing each sieve was collected and weighed. These results were then grouped into three fractions: % Gravel (>2mm), % Sand (<2.0mm >63µm) and % Silt-Clay (<63µm). Further analysis of the sediment data was undertaken using the Gradistat package (Blott & Pye, 2001).

Organic Matter Analysis

Organic matter was estimated using the Loss on Ignition (LOI) method. One gram of dried sediment was ashed at 450˚C for 6 hours and organic carbon was calculated as % sediment weight loss.

2.1.2 Subtidal Video Survey

Fieldwork was carried out on the 25th June 2020. Pre-determined sampling positions were navigated to using the vessels own GPS system. Once on site, the precise location of each sampling station was collected using a Trimble Geo-XM GPS. A complete list of stations sampled are presented in Table II and these stations are displayed on a map (Figure 4).

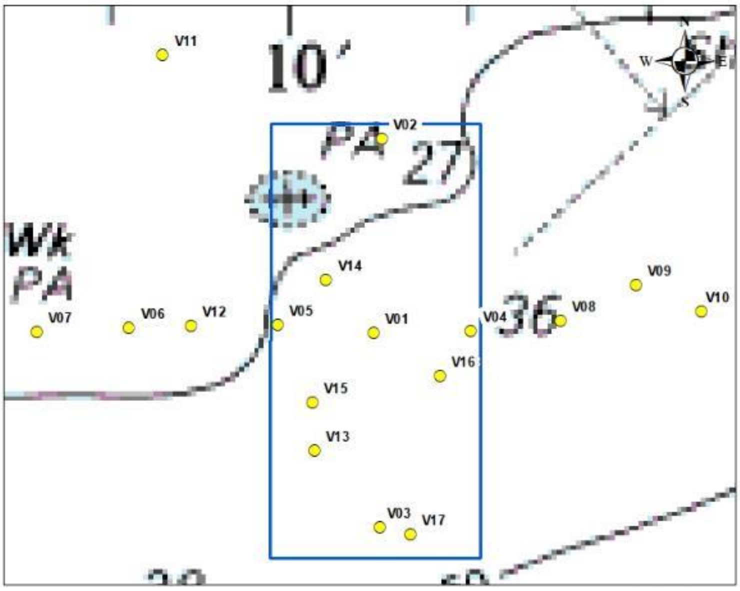

Figure 4: Map showing the positions of video sampling stations collected during the 2020 survey.

Station	Latitude	Longitude	Station	Latitude	Longitude
V01	51˚ 43.790'N	8˚ 09.600'W	V10	51˚ 43.854'**N**	8˚ 07.760'W
V02	51˚ 44.457'N	8˚ 09.553'W	V11	51˚ 44.743'N	8˚ 10.779'W
V03	51˚ 43.111'N	8˚ 09.551'W	V12	51˚ 43.809'N	8˚ 10.653'W
V04	51˚ 43.795'N	8˚ 09.050'W	V13	51˚ 43.389'N	8˚ 09.957'W
V05	51˚ 43.807'N	8˚ 10.153'W	V14	51˚ 43.970'N	8˚ 09.840'W
V06	51˚ 43.803'N	8˚ 10.958'W	V15	51˚ 43.536'N	8˚ 09.934'W
V07	51˚ 43.785'N	8˚ 11.463'W	V16	51˚ 43.644'N	8˚ 09.241'W
V08	51˚ 43.824'N	8˚ 08.563'W	V17	51˚ 43.087'N	8˚ 09.405'W
V09	51˚ 43.948'N	8˚ 08.128'W			

Table II: Positions of video survey stations. All locations given in Latitude/Longitude.

A total of 17 stations were sampled using a Pro-Ray 3 video camera system. The video camera was lowered to above the sediment surface, and video imagery was recorded onto a portable DV recorder in MPEG4 format. The video records were assessed by specialised taxonomists from Thomson Ecology in the UK and ASU.

3 Results

3.1 Particle Size and Loss on Ignition Assessment

Results from the granulometric assessment indicates the presence of sands across large parts of the survey area where soft sediment is present (Table IV, Figures 5 & 6). Results from the video survey indicate the presence of mixed sediment (gravel, cobble & boulder) as well as large areas of exposed bedrock. Loss on Ignition values reflect the nature of the sediment at the site, with highest recorded LOI values at sites where the mud content was the highest (Table IV, Figure 6).

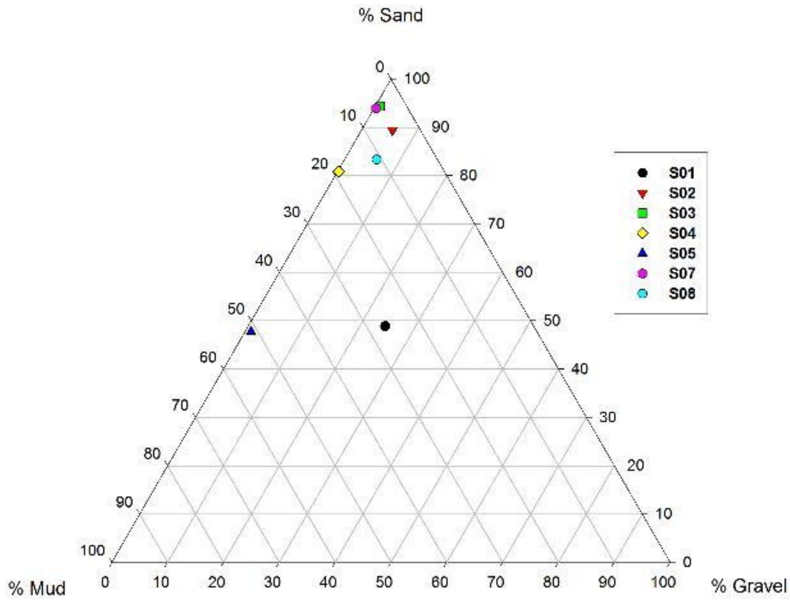

Figure 5: Ternary Plot of granulometric results from the survey area.

	P1	P2	P3	P4
% Gravel	24.6%	5.6%	0.9%	0.2%
% Sand	48.8%	89.4%	94.3%	80.9%
% Mud	26.6%	5.0%	4.8%	18.9%
% LOI	1.82%	0.87%	2.01%	2.79%
Textural Group	Gravelly Muddy Sand	Gravelly Sand	Slightly Gravelly Sand	Slightly Gravelly Muddy Sand
	P5	**P7**	**P8**	**P1-Actual**
% Gravel	1.1%	0.4%	5.8%	No Record
% Sand	47.7%	93.9%	83.3%	No Record
% Mud	51.2%	5.7%	10.9%	No Record
% LOI	3.42%	2.37%	2.72%	No Record
Textural Group	Slightly Gravelly Sandy Mud	Slightly Gravelly Sand	Gravelly Muddy Sand	No Record

Table IV Granulometric and Loss on Ignition results from samples taken within and adjacent to the disposal area.

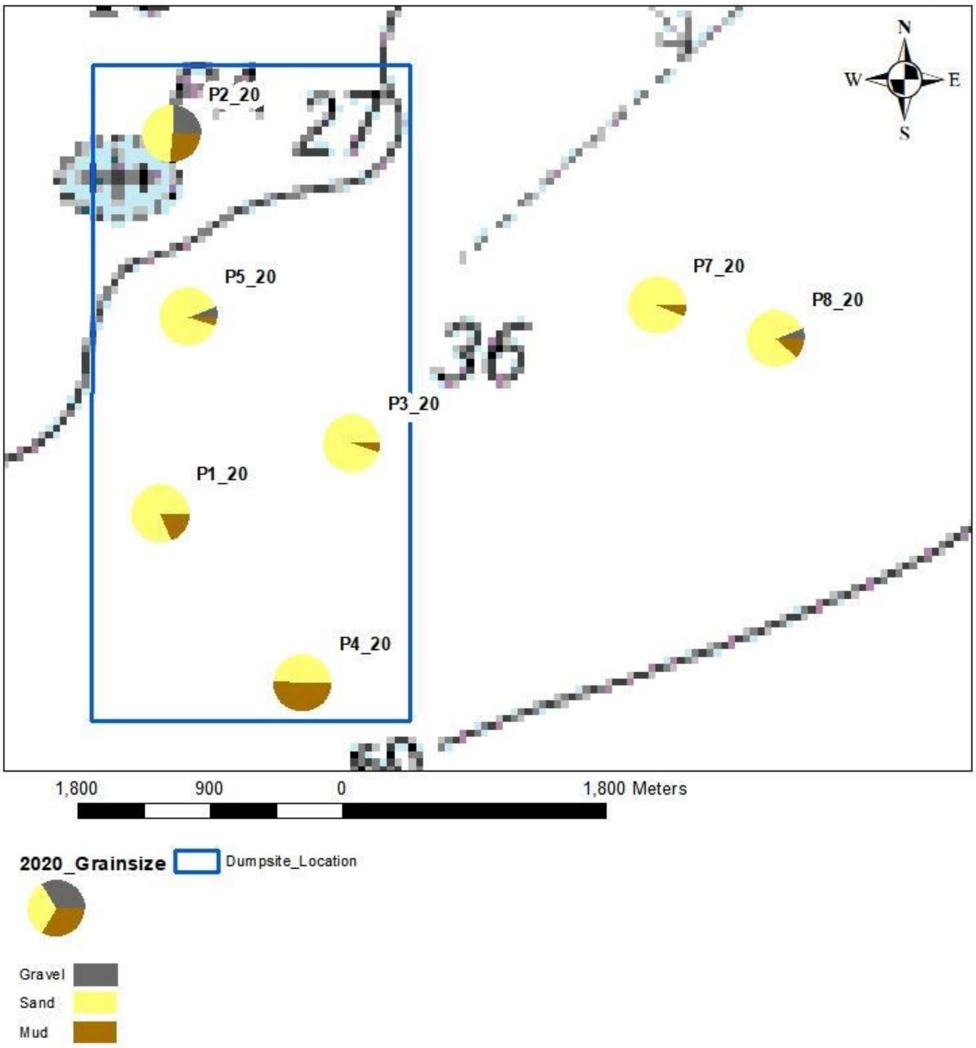

Figure 6: Distribution of PSA within the survey area. (Grey – Gravel; Yellow – Sand; Brown – Mud).

Direct comparisons with results collected from the 2004 survey are difficult as the sampling locations were not exactly the same. Nevertheless, general observations can be made on the distribution of sediment across the survey area. In 2004, more muddy sediment was observed across the central part of the disposal area. Results from the present survey show differences in the sedimentary composition within the dumpsite, with more muddy sediment present along the southern and northern parts of the disposal area and lower mud levels in the central area. Apparent changes in the gravel composition of the sediment can be explained by the targeting of soft sediment areas within the disposal area.

3.2 Infaunal Assessment

A total of 157 countable taxa were recorded in the infaunal grab samples collected from the survey area (Table V). A full list of taxa identified is presented in Appendix I. Analysis of the dataset was undertaken on species level data (where possible). Analysis of the dataset using just family level data was also carried out as this was the analysis level used in interpreting the 2004 benthic faunal data and results obtained were similar to species level analysis. The highest number of species were recorded at P2C and P4C with 36 individual taxa present in these samples. At the same time, replicates at these locations also contained the lowest number of taxa; 6 taxa at P2A and 12 taxa at P4B. The highest number of individuals were recorded at P3B, with 343 individuals. The lowest numbers of individuals were recorded at P2A with only 15 specimens present.

Analysis of the data highlights the presence of one large faunal grouping which is located across the full extent of the survey area. Three faunal communities were identified from the survey area, with a single sample being classified as an outlier. This site, P2A, also returned the lowest species diversity and abundances in the survey. Within-site differences have been noted at Sites P1 and P2, with these sites showing marked differences in replicates from the same location. Previous surveys at this site identified a single soft sediment community, on top of which is a mosaic of small-scale spatial patchiness, resulting in localised differences in taxa and faunal abundances. It is considered that the results from the current survey mirror these findings, with a single community dominating the survey area (Group III) with localised small-scale patchiness present across parts of the site (Groups I & II). These groups will be discussed in terms of their faunal community later in the report under *Habitat Assessment*.

	P1A	**P1B**	**P1C**	**P2A**	**P2B**	**P2C**	**P3A**	**P3B**	**P3C**
No. of Species	15	26	21	6	26	36	22	36	14
No. of Individuals	50	130	58	15	74	89	50	343	55
Shannon-Wiener	2.08	2.50	2.53	1.52	2.56	3.22	2.80	1.37	2.04
Pielou's Evenness	0.768	0.766	0.831	0.850	0.785	0.897	0.906	0.383	0.771
Simpson's Dominance	0.198	0.132	0.120	0.280	0.140	0.058	0.079	0.569	0.183
	P4A	**P4B**	**P4C**	**P5A**	**P5B**	**P5C**	**P7**	**P8**	**P1-Actual**
No. of Species	35	12	36	26	30	27	29	25	33
No. of Individuals	99	55	116	83	149	268	124	78	225
Shannon-Wiener	2.99	1.91	2.98	2.76	2.89	1.50	2.52	2.68	2.33
Pielou's Evenness	0.842	0.767	0.831	0.846	0.849	0.454	0.748	0.834	0.668
Simpson's Dominance	0.087	0.225	0.086	0.101	0.081	0.489	0.149	0.099	0.169

Table V Diversity indices derived from the infaunal grab data from the Cork disposal site.

GROUP 1: (Average Similarity: 48.23)

Lumbrineris aniara	*Pisidia longicornis*	*Pollycirrinae* sp.
Verruca stroemia	*Owenia* sp.	*Scalibregma inflatum*
Polynoidae sp.	*Onchidorididae* sp	*Mediomastus fragilis*
Thoracica sp.	*Othomaera othonis*	
Hydroides norvegica	*Balanus crenatus*	

GROUP 2: (Average Similarity: 32.10)

Glycera lapidum	*Polygordius* sp.	*Polynoidae* sp.
Echinocyamus pusillus	*Polycirrinae* sp.	*Sphaerosyllis bulbosa*
Nemertea sp.	*Lumbrineris aniara*	*Edwardsia claparedii*

GROUP 3: (Average Similarity: 45.99)

Lumbrineris aniara	*Glycera alba*	*Nephtys* sp.
Edwardsia claparedii	*Phaxas pellucidus*	*Kurtiella bidentata*
Scalibregma inflatum	*Nucula* sp.	*Diastylis laevis*
Spiophanes bombyx	*Stheneleis* sp.	Nemertea sp.
Owenia sp	*Magelona alleni*	*Glycinde nordmanni*
Amphiura filiformis	*Cylichna cylindracea*	*Dosinia* sp.
Phoronis sp.	*Veneridae* sp.	*Acanthocardia* sp.

Table VI: Results from multivariate analysis of the fauna identified in each faunal group identified in the survey area.

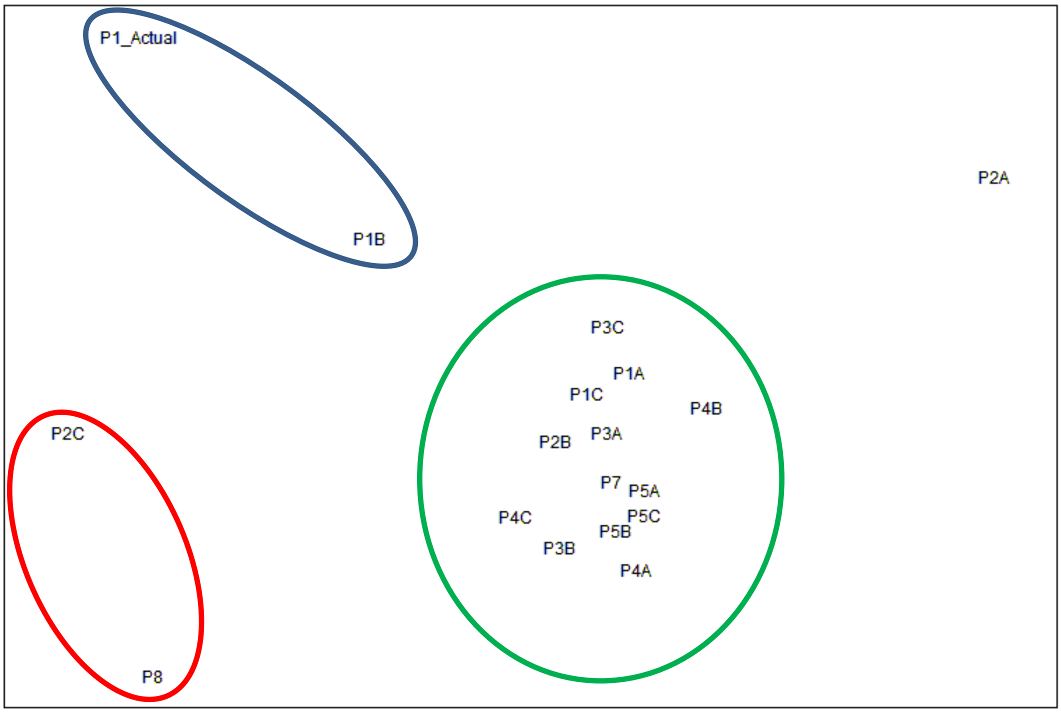

Figure 7: MDS from benthic data at the Cork Harbour Dumpsite. Three discrete faunal groupings were identified in the area. Group I (Blue), Group II (Red) and Group III (Green). [Stress = 0.12].

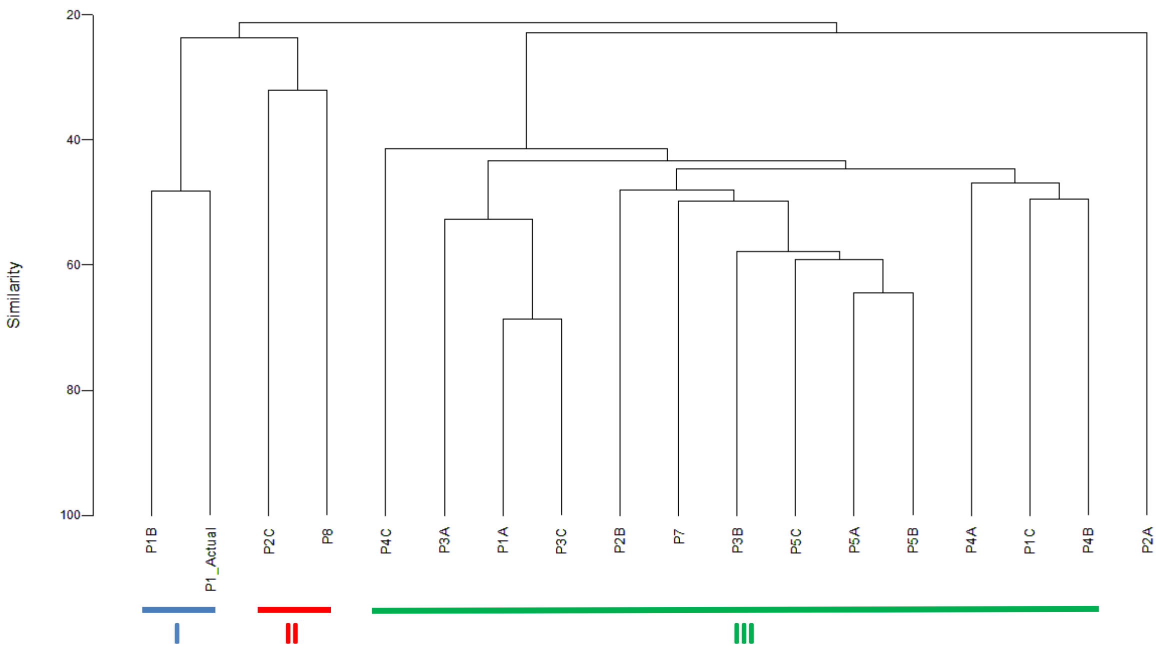

Figure 8: Cluster analysis of the faunal data from the Cork Harbour Dumpsite. Three discrete faunal groupings were identified in the area. Group I (Blue), Group II (Red) and Group III (Green).

3.3 Video Assessment

Video data was assessed by qualified marine biologists from Thomson Ecology and Aquatic Services Unit. Fauna were identified where possible and habitats were assigned using the JNCC Habitat Classification system of Conor *et al.* (2004).

V01

This site consists of boulders and cobbles with a layer of sediment on the surface. Visible fauna present include hydrozoa, bryozoans, orange sponge and the echinoderms *Echinus esculentus* [Common Sea Urchin] and undetermined starfish. In addition, the Cuckoo Wrasse (*Labrus mixtus*) was also recorded at the site. This site has been classified as Echinoderms and crustose communities (CR.MCR.EcCr).

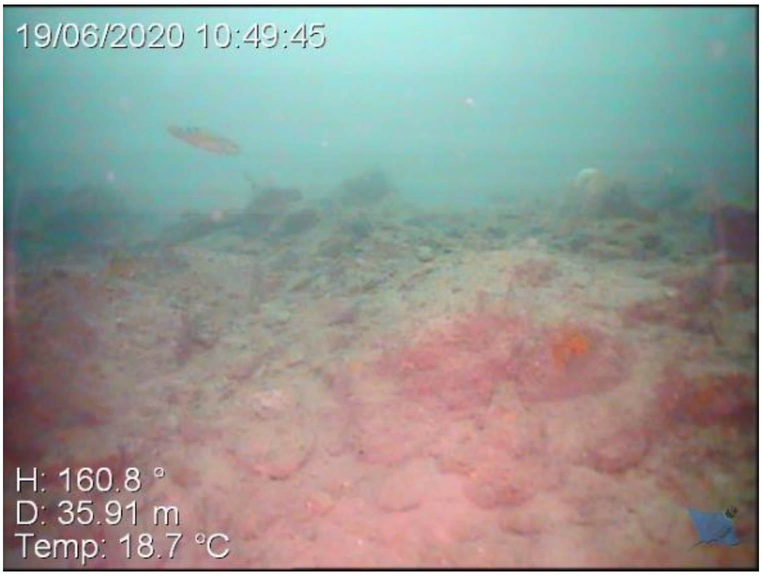

Plate 01: Boulders and cobbles with Hydrozoa, bryozoans and sponges. The echinoderm *E. esculentus* and the Cuckoo Wrasse (*L. mixtus*) are visible.

V02

This site consists of a mosaic of muddy sand with cobbles and boulders and exposed bedrock. Bryozoans and *Serpulidae* worms were visible on the cobble and exposed boulders in the muddy sands. On exposed bedrock, the Common Starfish (*Asterias rubens*) and Common Sea Urchin (*E. esculentus*) were present. Hydrozoa, Bryozoans and *Serpulidae* worms were also present across the site. The site has been classified as a mosaic of Sublittoral mixed sediment (SS.SMx) and Echinoderms and crustose communities (CR.MCR.EcCr).

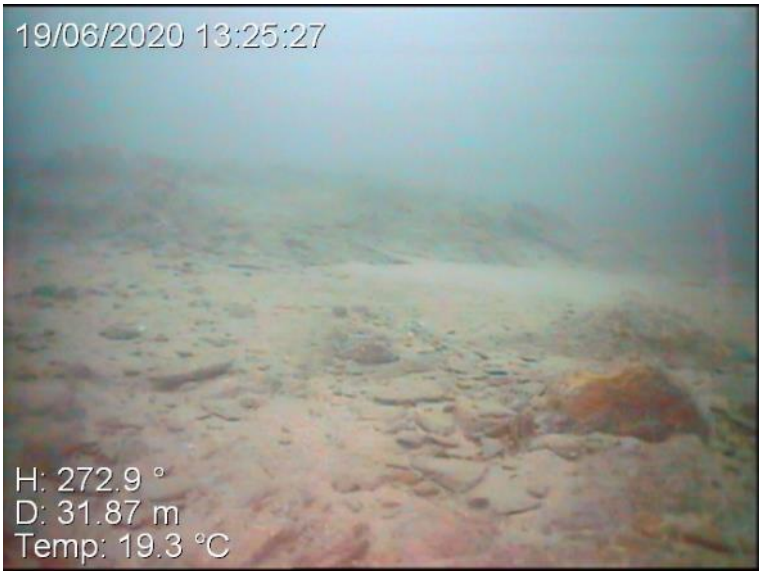

Plate 02: Muddy sand with cobbles present at Drop V02.

Plate 03: Boulder with Hydrozoa, bryozoans and *E. esculentus* at Drop V02.

V03

This site consists of muddy sand with surface patterns that indicate the presence of burrowing fauna. The site has been classified as a matrix of Sublittoral cohesive mud and sandy mud communities (SS.SMu.CSaMu).

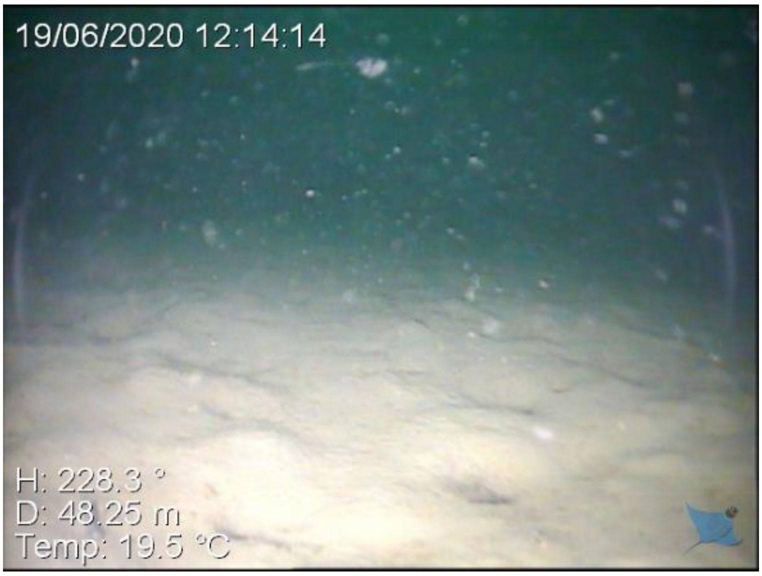

Plate 04: Infaunal burrows on sandy muds at Drop V03.

V04

This site consists of bedrock with muddy sand present. The video shows a high degree of turbidity which reduces visibility at the site, but large areas of the seabed were seen. Visible fauna present at the site include Hydrozoa, *Serpulidae* spp., bryozoans, the Devonshire Cup Coral (*Caryophillia smithii*) and the echinoderms *A. rubens* and *Marthasterias glacialis* (Spiny Starfish). The site has been classified as Echinoderms and crustose communities (CR.MCR.EcCr).

Plate 05: Spiny Starfish (*Marthasterias glacialis*) and Common Starfish, *A. rubens* and on bedrock at Drop V04.

Plate 06: A thin veneer of sediment present on bedrock at Drop V04.

V05

The site consists of muddy sands with cobble, with sparse epifauna present within this sand/cobble matrix. Areas of exposed bedrock which are common within the sediment matrix contain epifauna similar to those found in previous video drops, dominated by orange and blue sponge, hydrozoa, bryozoans, *Serpulidae* spp. and barnacles (*Thoracica*). Other fauna present on the bedrock include the echinoderms *Luidia ciliaris* [Seven-Armed Starfish], *A. rubens* and *E. esculentus*. Anthropogenic metal debris (a metal block) was present in the area. The site has been classified as 'Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' (CR.MCR.EcCr.FaAlCr) leading to 'Sublittoral Mixed Sediment' (SS.SMx).

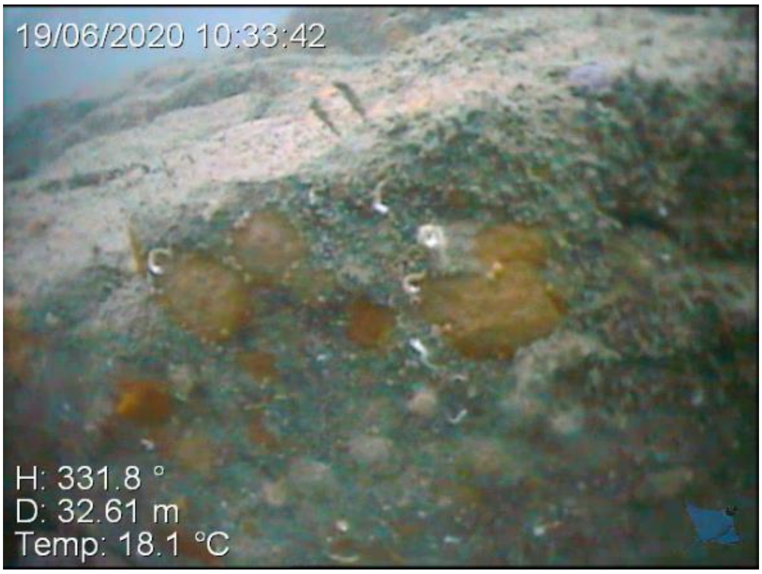

Plate 07: *Serpulidae* worms and patches of orange sponge present on bedrock and cobble from Drop V05

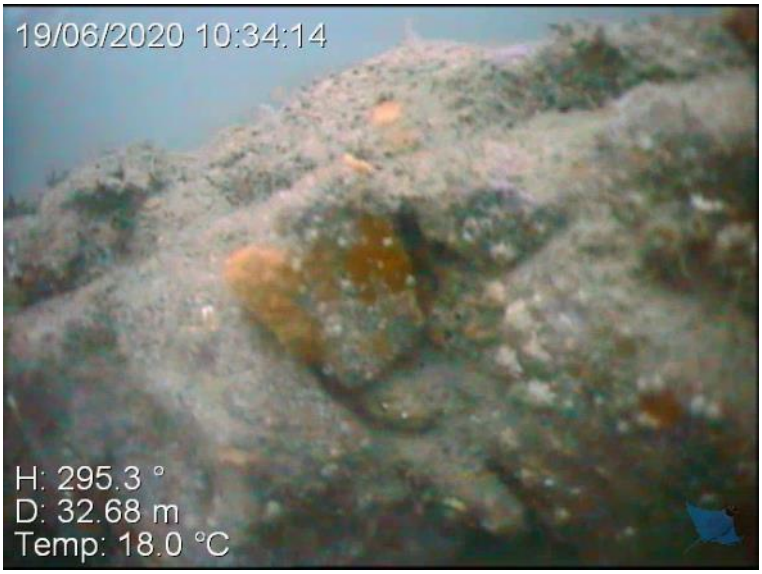

Plate 08: Barnacles (*Thoracica*) and orange sponge at Drop V05.

Plate 09: Muddy sand, with cobbles and boulders present at Drop V05. There was anthropogenic debris present at the site (large metal block).

Plate 10: The seven-armed starfish, *Luidia ciliaris*, on sublittoral mixed sediment at Drop V05.

V06

This area consists of bedrock with a surface layer of mud and/or sand. The cup coral (*C. smithii*), as well as the starfish *A. rubens* and *Henricia* sp. (either *H. sanguinolenta* or *H. oculata*) are present on the bedrock, as well as hydroids, *Alcyonium digitatum* [Dead-Man's Fingers], sponges and *Serpulidae* spp. Between the bedrock ridges are areas of sandy gravels with sparse visible fauna in these areas. The site has been classified as 'Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' (CR.MCR.EcCr.FaAlCr).

Plate 11: Bedrock with epifauna at Drop V06 with *A. digitatum* present.

Plate 12: *Henricia* sp. and *A. rubens* present at Drop V06.

Plate 13: Starfish (orange boxes) and epifauna present on bedrock and cobble, which is typical for the area at Drop V06.

V07

This site consists of mixed sediment with cobbles and boulders with occasional patches of visible bedrock. A number of epibenthic species were identified across the site including *A. digitatum*, Hydrozoans, *A. rubens*, *E. esculentus*. In addition, sponges and Bryozoa were present across the site as well as the tube building polychaetes, *Serpulidae* spp. There was no evidence of sediment build up at this site. Occasional pelagic fish (*Ctenolabrus repestrus* [Goldsinny Wrasse] and *L. mixtus* [Cuckoo Wrasse]) were also identified at the site. The site has been classified as 'Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' (CR.MCR.EcCr.FaAlCr).

Plate 14: A colony of Deadmans fingers (*Alcyonium digitatum*) on rock with Goldsinny Wrasse (*Ctenolabrus rupestrus*) in the background at Drop V07

Plate 15: The soft-coral, *A. digitatum*, Hydrozoa, bryozoans, sponges and starfish (*A. rubens*) on bedrock at Drop V07.

Plate 16: Cuckoo Wrasse (*L. mixtus*) swimming above bedrock with *A. digitatum* at Drop V07

V08

The site consists of soft sediment (muddy sands) with sparse visible fauna, but surface patterns indicate burrowing fauna is present. The visible fauna present on the bedrock includes Hydrozoa, *Serpullidae* spp., bryozoans and the echinoderms *E. esculentus* and *A. rubens*. The site has been classified as a matrix of Sublittoral cohesive mud and sandy mud communities (SS.SMu.CSaMu) adjacent to Echinoderms and crustose communities (CR.MCR.EcCr).

Plate 17: Muddy sand with infaunal burrows visible on the sediment surface at Drop V08. The faunal/algal turf is visible in the background.

Plate 18: Hydrozoa and *Serpulidae* worms on cobble and boulder at Drop V08.

V09

This site consisted of rippled muddy sands with occasional brittlestar (*Ophiura* sp.) and dragonet (*Callionymus lyra*) present at the site. The site has been classified as Sublittoral sands and muddy sands (SS.SSa).

Plate 19: Rippled muddy sands with the Dragonet (*Callionymus lyra*) on the sediment surface at Drop V09.

V10

This site consists of rippled muddy sands and is similar to that identified at V09. No fauna was visible during the survey, but surface patterns indicate that burrowing fauna is present at the site. The site has been classified as Sublittoral sands and muddy sands (SS.SSa).

Plate 20: Rippled muddy sands at Drop V10.

V11

This site consists of rippled gravelly muddy sands. There was no obvious epifauna present on the seabed at the site, fish were identified at the site with dogfish (possibly *Scyliorhinus canicula* [Lesser-spotted dogfish]) identified swimming above the seabed. The site has been classified as 'Sublittoral Mixed Sediment' (SS.SMx).

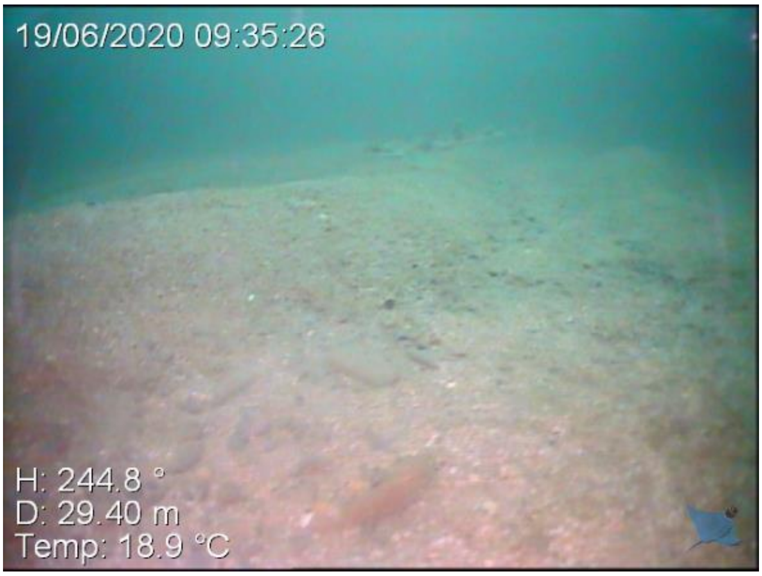

Plate 21: Lesser spotted dogfish (*Scyliorhinus canicula*) in the background swimming over rippled sands at Drop 11

V12

This area consists of bedrock with a thin surface layer of mud and/or sand, with occasional cobble present. Visible fauna along the bedrock include hydrozoa, bryozoans, *A. digitatum*, sponges and *Serpulidae* spp., as well as the echinoderms *E. esculentus*, *Henricia* sp. and *A. rubens*. The site has been classified as 'Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' (CR.MCR.EcCr.FaAlCr).

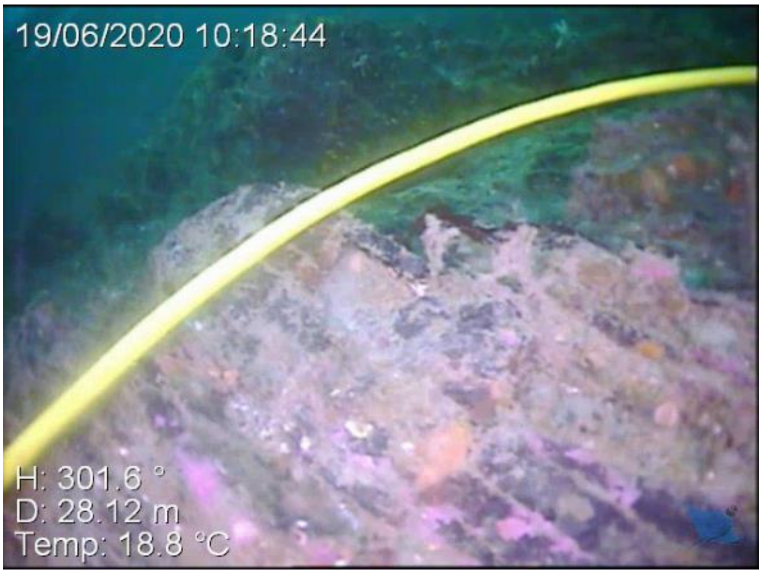

Plate 22: Encrusting algae on bedrock at Drop V12 (the yellow arc is the video cable).

Plate 23: Epifauna including arborescent brown sponge and *E. esculentus* on bedrock at Drop V12.

V13

This site consisted of exposed bedrock and mixed sediment with incidental patches of boulders in rippled gravelly sands. In areas of exposed bedrock hydrozoa, bryozoans, sponges and *Serpulidae* worms were evident, in addition to the echinoderms *E. esculentus* and *A. rubens*. The site has been classified as a mosaic of Sublittoral Mixed Sediment (SS.SMx) and Echinoderms and crustose communities (CR.MCR.EcCr).

Plate 24: Echinoderms *E. esculentus* and *A. rubens* on bedrock with sand surrounding the bedrock at Drop V13.

Plate 25: Coarse sands and mixed sediment sat Drop V13.

V14

This site consisted of gravelly muddy sands with occasional cobble and boulder present. This site has been classified as Sublittoral Mixed Sediment (SS.SMx).

Plate 26: Sublittoral mixed sediment at Drop V14.

V15

This site is dominated by gravelly sands, with no visible fauna present on the sediment surface. The site has been classified as Sublittoral Mixed Sediment (SS.SMx).

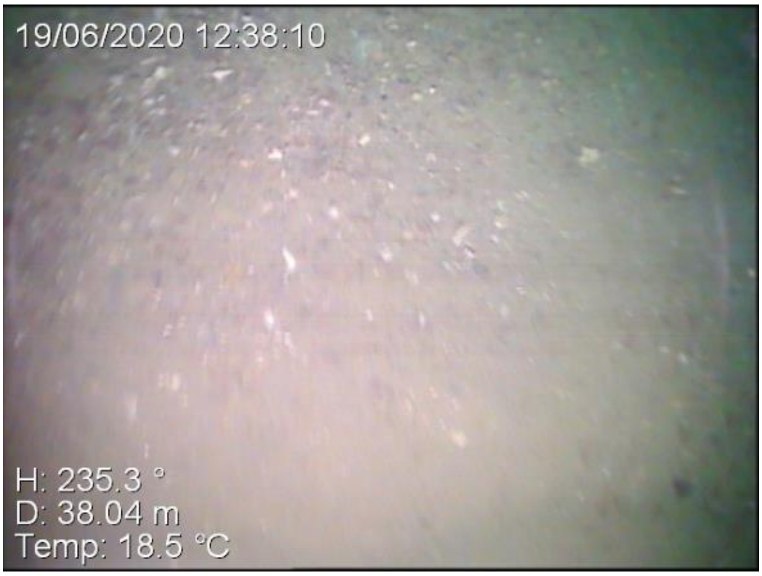

Plate 27: Sublittoral mixed sediment at Drop V15.

V16

This site is dominated by muddy sands across the site. No fauna was visible on the sediment surface but there was evidence of burrowing fauna present at the site. A dragonet (*C. lyra*) was seen on the sediment surface at this site. The site has been classified as Sublittoral cohesive mud and sandy mud communities (SS.SMu.CSaMu).

Plate 28: The dragonet on sandy muds from Drop V16.

V17

This site is dominated by muddy sands across the site. No fauna was visible on the sediment surface but there was evidence of burrowing fauna present at the site. The site has been classified as Sublittoral cohesive mud and sandy mud communities (SS.SMu.CSaMu).

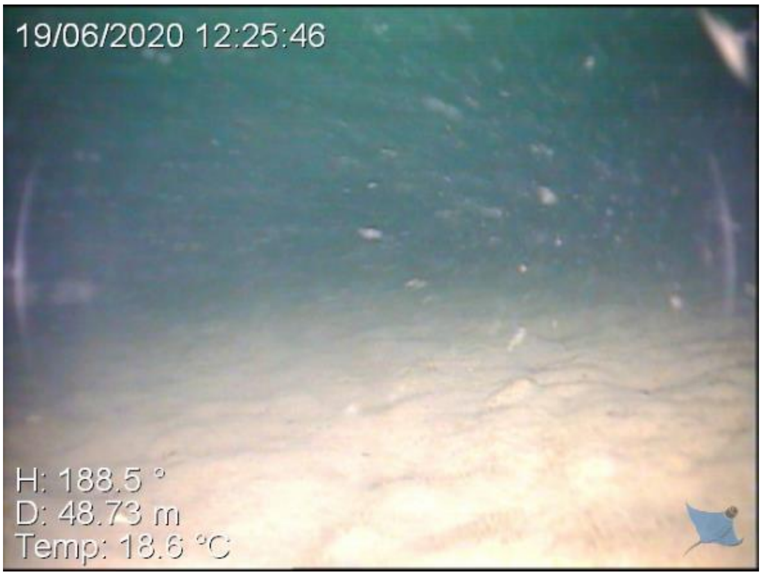

Plate 29: Muddy sands with infaunal burrows present on the sediment surface from Drop V17.

Habitat Assessment

The seabed within, and adjacent to the disposal area consists of a mosaic of hard and soft substrates with associated benthic communities. Assessment of the soft benthos communities is based on analysis of the grab results, with hard benthos communities assessed using the video drop imagery. The benthic habitats identified during the present survey were assigned biotopes bases on the JNCC classification system of Connor *et al* (2004), which allows for an easier interpretation of the data and allows for comparisons to be made with previous surveys from the area. Results from the habitat assessment are presented in Figure 9.

Analysis of the soft benthos data identified the presence of one main community type (Group III), with smaller imbedded groupings (Groups I & II). There is a large degree of overlap in the fauna present at all sites, with differences between groups based on relative abundances rather than species differences *per se.* A single replicate at Site 2 was identified as an outlier probably because it returned the lowest species diversity and abundances during the present survey. These small-scale differences highlight the spatial patchiness present across the survey area. Though definitive identification of the predominant biotope is difficult, the fauna present at the sites within the largest group are commonly found in the *Mysella (Kurtiella) bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment biotope (SS.SMx.CMx.MysThyMx). This biotope is commonly found in exposed or sheltered muddy sands and gravels, which is typical of the soft-sediment benthos in the area. Groups I and II contain fauna which are commonly found in the polychaete rich deep-Venus community in offshore mixed sediments (SS.SMx.OMxPoVen), but Group I also contains fauna common in the *Mysella (Kurtiella) bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment biotope. This deep-Venus community occurs in slightly muddy, mixed sediments, containing a diverse community.

Results from the video survey highlight the diverse habitat structure of the seabed in the area. The seabed contains areas of bedrock, colonised by typical epifauna of the 'Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' (CR.MCR.EcCr.FaAlCr) community. This area extends to areas beyond the dumpsite where bedrock is present, primarily to the west of the disposal area. Between these areas of bedrock, mixed sediments dominate the seabed, with gravelly sands and muddy sands common in the area. Sandy muds, with occasional cobble and boulder are also present. Low lying areas of cobble and boulder, which frequently occur adjacent to the soft sediment areas, are classified as Echinoderms and crustose communities (CR.MCR.EcCr). From the video assessment, this habitat dominates the hard benthos within the disposal area.

Comparisons with previous surveys

Results from both previous surveys of the disposal area returned a wide range of benthic faunal families (40 in 1993; 60 in 2004), as well as good Shannon-Wiener Diversity index values (1.75 – 2.78 in 1993; 0.71 – 3.00 in 2004). It should be noted that a single site in 2004 returned a value of 0.71 due to the numerical dominance of a single species, *Capitella capitata*, a species which is considered an indicator of disturbance and was considered a remnant of a previous disposal event. Notwithstanding the result at this single site, the general condition of the benthos in the disposal area was considered to be good *"with no obvious adverse impacts from the disposal activities*" (RPS_KMM, 2004).

The number of families identified in the present survey was higher compared to the previous two surveys (98 families from 157 countable taxa), while the Shannon-Wiener Diversity indices are in line with results obtained from both previous surveys (1.37 – 3.22). Similar to the survey in 2004, the current survey identified a single distinct soft-sediment community type with a mosaic of small-scale spatial differences, interspersed with hard benthos communities.

Although there was an increase in the number of families during the present survey, broadscale similarities exist between the communities identified in the 2004 and 2020 surveys. The dominant families present in 2004 consisted of the polychaetes *Capitellidae*, *Lumbrineridae* and *Scalibregmatidae*. No *Capitellidae* were identified in the 2020 survey, but *Lumbrineridae* and *Scalibregmatidae* were the most abundant families present. In addition, broad similarities were noted between the hard benthos communities identified in 2004 and in 2020. The dominant fauna present in both surveys on the hard substrates (rock and boulders) were bryozoans, hydrozoa and sponges as well as the common sea urchin *E. esculentu*s and the common starfish *A. rubens*, which were present across all hard benthos sites.

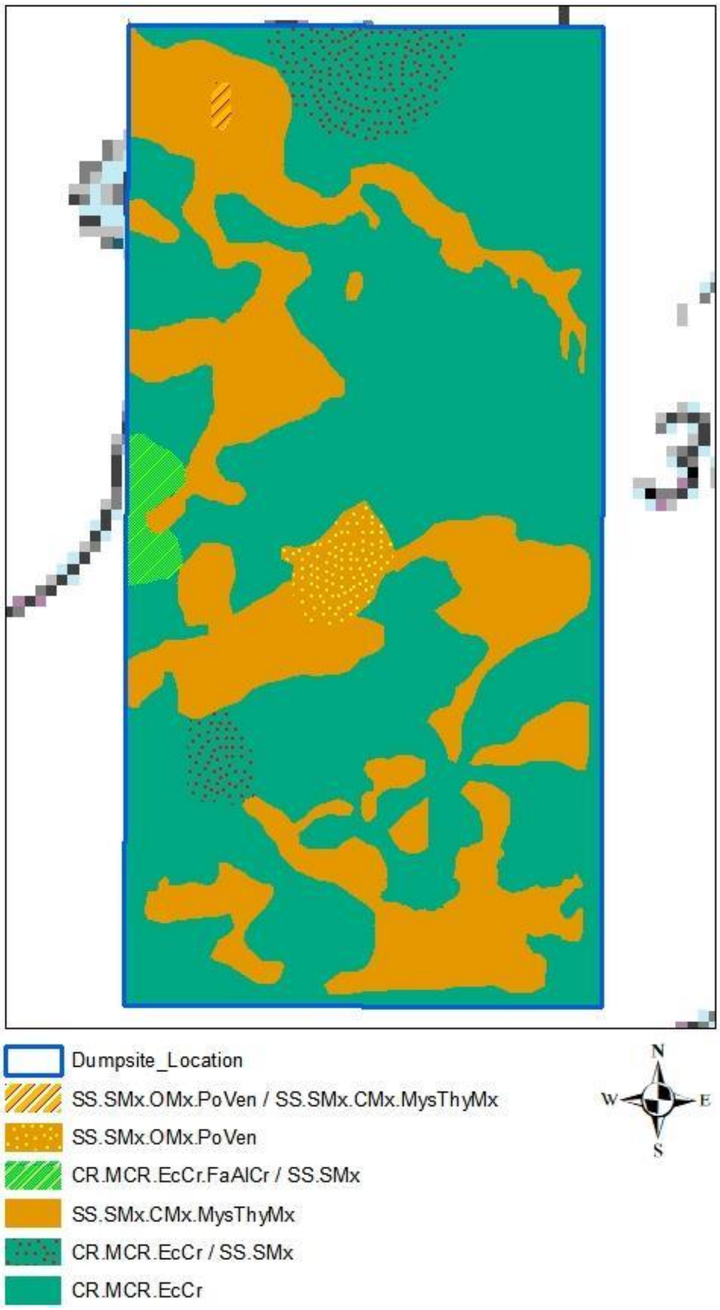

Figure 9: Generalised habitat map for the biotope communities identified within the disposal area. Extent of the biotopes is extrapolated from side-scan sonar and multibeam surveys undertaken previously at the disposal site (see Figure 1).

4 Discussion

From 1978 to 1996 the current area formed the eastern half of the full dumpsite, which was reduced to its current size in 1996, and has been in operation within those bounds since. The dumpsite has received considerable amounts of dredge spoil since 1996. Table VII list the amounts of spoil disposed at the site from 1978 to 2019, highlighting the active nature of the dumpsite on a continuous basis since it opened. It has received 1.4 million m^3 since the last benthic survey in 2004, and just over 500,000 m^3 between 2017 and 2019. It is notable that in the year prior to the 2004 survey the site received 373,942 m^3 of spoil whereas in 2019 it only received 85,872m^3.

Year	Volume Disposed
1978 – 1999	6,730,000m^3
2000	149,854m^3
2003	373,942m^3
2005	133,979m^3
2008	253,848m^3
2011	272,075m^3
2014	241,976m^3
2017	267,268m^3
2018	148,513m^3
2019	72,661m^3

Table VII Total quantities dumped at the Cork Harbour disposal area

Geological surveys undertaken at the location of the dumpsite (INFOMAR, 2020), indicate that the site is dominated by rock, with pockets of fine material present in the area (Fig. 10). This is confirmed in the video survey undertaken in 2004 and the present survey of 2020, which show that large parts of the disposal area contain exposed bedrock and cobble, interspersed with areas of sands and muddy sands. The area to the west of the disposal area is dominated by bedrock and gravels, with finer sediments present to the east of the disposal area. Previous geophysical surveys undertaken at the current disposal site indicate the resilience of the site, in terms of the dispersal nature of the site and the robust nature of the benthos present at the site. Multibeam and side-scan sonar surveys have taken place across the dumpsite in 1999, 2008 and 2013. These surveys have highlighted the mosaic nature of the seabed substrate across the disposal area, with areas of exposed bedrock interspersed with surface sediments across the site (See Figure 2). Results of the 1999 survey, compared to the 2008 and 2013 surveys indicate very little change in the nature of the seabed and its mosaic of hard substrates interspersed with expanses of sediment, highlighting the dispersive nature of the site, despite the high levels of spoil disposal at the site over these years. These factors indicate that the is exposed to strong currents which assist with the dispersal of fine sediments from the area during and following dredge spoil disposal operations. It should also be noted, that biological communities at dispersive active sites, such as the Cork dumpsite, tend to have a higher resilience to disposal events (Bolam & Rees 2003; Bolam *et al.,* 2011).

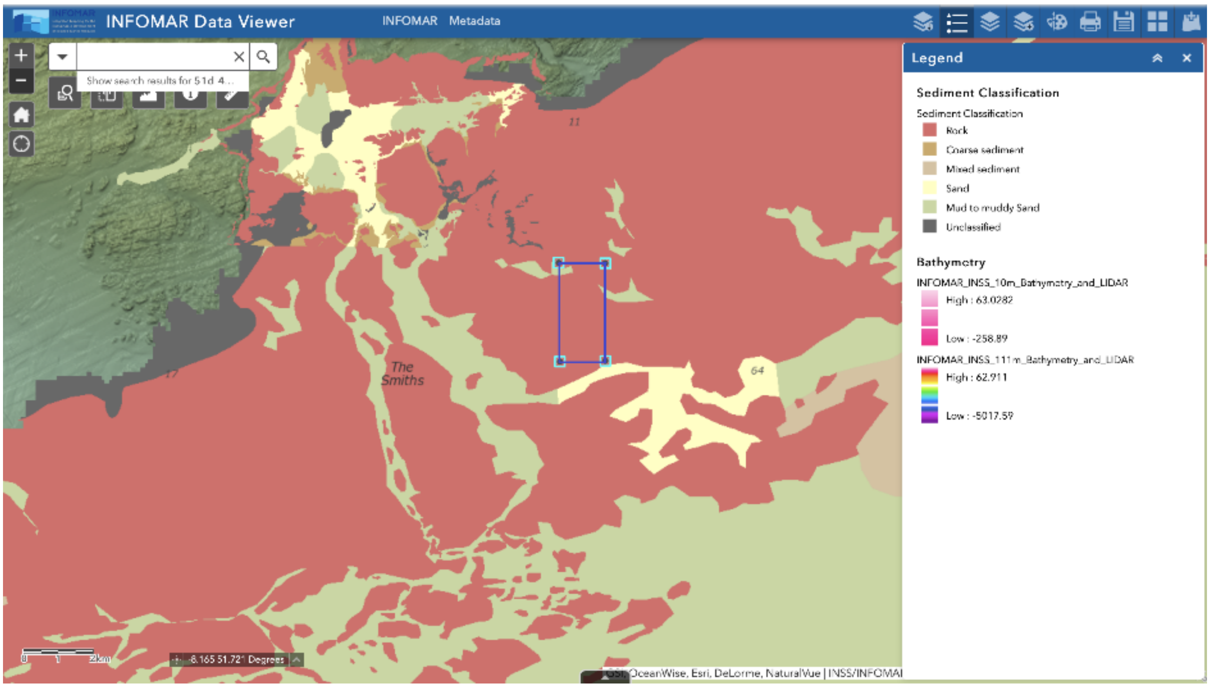

Figure 10: Sediment characterisation across the seabed of the dumpsite disposal area (Blue Rectangle). Data reproduced from INFOMAR (2020).

The ecological impacts associated with dredge spoil disposal are considered site specific (Ware *et al.*, 2010), with factors such as hydrodynamic regime of the receiving environment, dispersive nature of the site, habitat type of the receiving environment and nature & volume of the sediment to be disposed all playing an important role. It should be noted that impacts on benthic communities from disposal operations result in alterations to macrobenthic community structure and do not necessarily result in areas of seabed devoid of life (Ware *et al*, 2010). Large areas of the current disposal area consist of hard and mixed seabed, dominated by epilithic fauna such as sponges, bryozoans, cup-corals, hydrozoans and cnidaria. This fauna is susceptible to smothering due to its sessile nature. The deposition of large volumes of soft sediment on top of hard benthos would result in the covering of the benthos in a layer of soft sediment which could potentially impact the epilithic fauna present. A review of this habitat type (Stamp & Tyler, 2016) classified it as having a high resistance to light smothering (No significant effects to the character of the habitat and no effect on population viability of the key specie, but effects may occur on feeding, respiration and reproduction rates), and medium resistance to heavy smothering (Some mortality of species without a change to habitat). Due to the nature of the fauna present, resilience is considered high in both instances, meaning recovery is expected within 2 years (Stamp & Tyler, 2016).

At soft sediment sites, recovery is expected to follow a typical pattern. If the sediment to be disposed is similar in nature to the receiving environment, then the impacts will be less, with recovery proceeding more rapidly than would be the case if the sediment was different compared to that in the receiving environment. This feature of recovery has been noted in several studies reported in the literature (Smith & Rule, 2001; Ware *et al*., 2010; Bolam *et al.,* 2006). After spoil deposition, macroinvertebrate species diversity, abundance and biomass will be reduced. If the sediment deposited on the site is similar in nature to the native sediment, and the layer of deposition is thin (<15cm) then vertical migration through the sediment of existing fauna may occur (Wilbur *et al.,* 2007;

Fredette & French, 2004, Maurer *et al.,* 1981 (a), Maurer *et al.,* 1981 (b), Maurer *et al.,* 1982). This will be complimented by lateral migration of mobile fauna from adjacent areas and through larval settlement from the plankton.

Where the dredge spoil contains different sediment than the native sediment, recovery occurs in a number of stages depending on a range of factors. In high dynamic areas, such as those identified in the Cork dump site, the silt fraction initially settles with the sand fraction. Vertical migration through predominantly mud sediments would be reduced and recolonisation of these sediments would be through lateral migration of mobile species and larval settlement from the plankton. Initial colonisation will be by small, fast-growing, opportunistic species, especially small polychaete and oligochaete worms. Due to the dynamic nature of the site, the finer material will disperse away from the site in under a year leaving coarser, mixed sediment behind which will gradually revert, through the process of recolonisation, to a community more closely resembling that which occurred before disposal, i.e. typical of the dominant substrate and the prevailing hydrodynamic regime.

A video and grab survey of the survey area was undertaken in 2004 for a previous licence application (RPS 2004). This survey was undertaken within 12 months following the disposal of nearly 380,000m^3 of dredge spoil the previous year. Results from the survey identified that the infaunal benthic community at the dumpsite belonged to a single distinct community, on which is a mosaic of small-scale patchy habitats across the survey area. In addition, although there was evidence of disposal at the site in terms of some minor silt build up on some areas of hard benthos at the time, analysis of the infauna indicated little evidence of organic enrichment or prolonged disturbance.

An earlier benthic survey of the disposal area undertaken in 1993 (Neiland, reported in RPS-KMM 2004) concluded that '*The faunal composition of the sites sampled at the dredge spoil dumpsite compared favourably with sites outside the dumpsite. There was no indication of any build-up of depositional material. In conclusion, it can be said that the present dumping operations at the site are not having a deleterious effect on the benthos.*'

A dispersal model undertaken by RPS simulated the disposal of 385,000m^3 of sediment over a 15-day period (RPS, 2015). The results of the model show the proposed sea disposal of this volume of dredge material would result in the deposition of material mainly within the dumpsite, and that the highest levels deposited immediately outside the dumpsite would be 5cm with no measurable levels of deposition beyond 4km from the disposal area. A more recent modelling exercise undertaken by RPS for the current disposal application (RPS, 2020) corroborates those results and refined them indicating that at the end of each disposal season, deposition would mainly occur within the boundaries of the disposal site with deposition thicknesses falling to below 10mm farther than 1-2km beyond the site with the main dispersal axis in a SE and to a lesser extent NW direction.

In view of the dispersive nature of the site and the findings of previous studies which recorded similar habitats despite regular spoil disposal, it is considered that the impacts associated with the deposition of dredge spoil, following a similar pattern to previous disposal events, will be temporary and negative in nature, principally affecting the direct footprint of the disposal site, and that substantial recovery can be expected to occur within 12 to 24 months of the cessation of disposal, depending on the quantities being disposed of in any given year.

Fisheries

The 2020 video survey noted the presence of several fish species including lesser spotted dogfish, grey gurnard, dragonet and several species of wrasse at the dumpsite. Pollack, a common gadoid species in the Celtic Sea over hard ground, is also likely to be present within the dumpsite. Other, smaller bottom dwelling species such as gobies or flat fish such as lemon sole may also be present over mixed sediments on the bottom but would not be noticeable in a video. Pelagic species in the area are likely to included sprat, herring and mackerel. Details of commercial fishing in the area of the dump isn't known but in the wider Celtic Sea area pollack, cod, haddock and whiting are taken by gill nets (pollack) and bottom otter trawls (cod, whiting and haddock), and while in theory all these species could be caught in the dumpsite, most of the heavier fishing activity for these species tends to be in deeper water than the dumpsite (pollack and haddock), i.e. farther off shore or toward the south west of the Celtic Sea area off Wexford (cod and whiting) – Anon. (2019). Hake is also an important white fish in the Celtic Sea, but landings are from deeper and more offshore waters than the dumpsite. All white fish landings other than hake are low in recent years, especially cod, which is below sustainable levels (Anon., 2019). Historically, herring is the most intensively fished pelagic species in inshore waters off Cork Harbour. A detailed survey of spawning grounds around the Irish coast (O'Sullivan *et al.,* 2013) identified 7 spawning beds and 4 spawning grounds in the Daunt spawning area, which is located south and west of Cork Harbour. The 7 identified beds, which in total only make up a very small proportion of the Daunt spawning area, are distributed between the southwestern entrance to Cork Harbour and west as far as the Old Head of Kinsale. The nearest spawning bed to the dumpsite is named Daunt 5 in the report and is the smallest of the beds in Daunt spawning area. It is located just over 5km west of the western edge of the dumpsite. The Daunt spawning area is estimated at 307km^2 and does not include the dumpsite which is east of its eastern boundary. The report defines a *spawning bed* as: a discrete spatial unit of sea bed over which herring eggs are deposited, or over which actively spawning herring have been identified, a *spawning ground* is defined as one or more spawning beds located in a larger spatial unit, enclosing all contiguous potential spawning habitat or substrate type and a *spawning area* is defined as: a number of spawning grounds in a larger geographical region. The location of the spawning beds was based mainly on interviews with very experienced fishermen, often several, covering the same area, so that locations could be cross-checked.

De-Groot (1996) indicated that anthropogenic activities could have a serious adverse impact on herring spawning areas if fines from dredging (in that instance marine aggregate extraction) were deposited on the spawn, which the fish lay directly on the bottom. Similarly, dredge spoil deposited onto a spawning bed, either during spawning or before larvae had hatched and dispersed from the bed would also be expected to be detrimental. In order to assess the near and farther field deposition rates due to dredge spoil disposal at the site, RPS undertook a dispersal modelling study of the site which simulated the disposal of 385,000m^3 of spoil continuously over a 15 day period at the rate of 1 load every 205 minutes (see RPS 2015, Chapter 12, Coastal Processes). That modelling exercise determined that beyond 4km from the centre of the site, the quantity of fines that would be deposited would not be measurable. These results have been corroborated by a more recent modelling exercise (RPS, 2020) which noted that deposition levels dropped below 10mm beyond 1-2km from the dumpsite with the longest axis of dispersal in a mainly SW direction. These analyses, suggest that the nearest spawning bed, Daunt 5, at just over 5km east of the dumpsite, would experience negligible if any deposition such that if herring did spawn at the site during a disposal event, the likelihood would be that it would lead to little or no reduction in hatching success of the deposited spawn. The 2013 spawning bed survey (O'Sullivan *et al.*, 2013) also included data on the dispersal of early and late stage herring larvae which were modelled as dispersing over a very wide geographical area along the Cork coast, covering hundreds of square kilometres. It would therefore be inevitable that the water column over the dumpsite would contain herring larvae in its zooplankton in the weeks and months after spawning, i.e. from October through November in particular. In such a scenario, were dumping actively taking place at the time, the possibility of some of the larvae present being killed within the footprint of the dumpsite could not be ruled out because of the very high concentrations of suspended solids that they would be exposed to at this vulnerable life stage. It is important to note, however, that the effect would be temporally and spatially limited i.e. confined to the main dredge plume within the dumpsite and close to the dredger during a dumping event. This assumption is supported by the findings of the dispersion modelling exercise undertaken for the current application (RPS, 2020). That report found that the average total suspended sediment concentration beyond the immediate vicinity of the licensed disposal site did not generally exceed 4.2mg/l and this sediment plume quickly dispersed to less than 0.5mg/l approximately 2km from the disposal site boundary. Overall, given that the disposal site is over 5km from the nearest and smallest of the 7 identified spawning beds within the Daunt spawning area and that the dispersed larvae would cover hundreds of square kilometres, it is considered extremely unlikely that disposal of dredge soil at the licensed dumpsite would have any measurable negative impact on herring recruitment in that spawning area and certainly not on commercial catches in the Celtic Sea region. Herring catches go through waves, presumably depending on the levels of recruitment in the preceding years. Currently both spawning stock biomass (SSB) and commercial catches in the region are at their lowest recorded since 1958 (Figure 11).

The benthic invertebrate study predicted that there would be a drop in both benthic diversity and biomass as a result of the dredging spoil disposal within and immediately adjoining the dumpsite and that it would require up to 2 years for recovery. It is likely therefore that fish foraging at the dumpsite would also experience a reduction in the density and biomass of prey items, during this period. While this would not exclude fish from the site, the carrying capacity of the affected area in terms of fish biomass could be expected to be lower than in adjoining areas of similar habitat type. The extensive seabed survey work undertaken in the wider region including the dumpsite, which is reported in O'Sullivan *et al.*, 2013, clearly shows that the dumpsite substrate mix is typical of hundreds of square kilometres off the Cork Coast, such that a temporary reduction of fish food at the dumpsite is likely to have a negligible adverse on fish biomass in the wider area.

Conclusion

Based on surveys by ASU in 2004 and 2020 it is evident that the licensed Port of Cork disposal is a dynamic and resilient site exhibiting a wide diversity of sessile and mobile epifauna and fish, and a diverse infauna community. A comparison of the 2004 and current 2020 surveys would indicate that the 2020 diversity was higher than that of the 2004 survey. This is not unexpected given that in the year prior to the 2004 survey 373,942m^3 of spoil were dumped at the site, whereas in the year prior to the current survey that figure was just 72,661m^3 i.e. just under 20% of the earlier quantity. This confirms that the site does respond to the quantity of material being disposed and does recover following disposal events.

In term of fisheries impacts, these are expected to be negligible because of the very confined spread of the spoil and associated turbidity in the context of the vast aerial extent of the commercial fishing activity in the Celtic Sea. In relation to herring spawning, the current state of the spawning stock within the Celtic Sea, at it's lowest for over 60 years, combined with the distance of over 5km of the nearest and smallest spawning bed of the Daunt Spawning Area would suggest that the dumping operation will have negligible or no adverse impact on herring recruitment and any effect will certainly not be measurable at the scale of the commercial catch. This is because the 2020 RPS dispersion model indicated that deposition of fines from the operation would be less than 10mm at just 1-2km from the dumpsites and a previous RPS model (RPS, 2015) predicted that beyond 4km deposition of fines would not me measurable. Taken in the round these details would suggest that the port could safely disposed of spoil at the licensed dumpsite at any time of year without endangering the Celtic Sea herring stock.

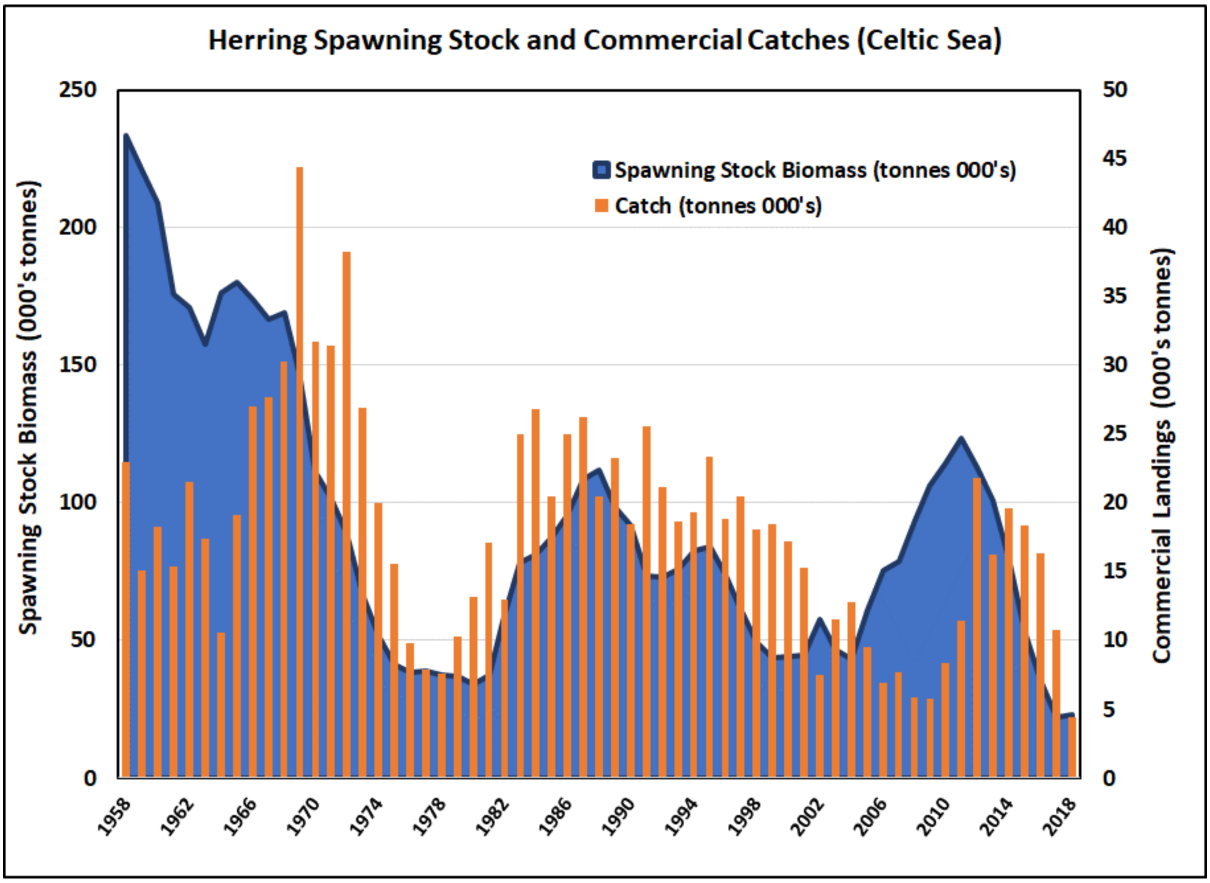

Figure 11: Celtic Sea herring spawning stock biomass (SSB) and commercial catches in the Celtic Sea (ICES divisions 7.a South of 52°30'N, 7.g–h, and 7.j–k). 1958-2018. Data from Irish Stock Book (Anon., 2019)

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6 Appendices

Appendix 1: Abundance Matrix - Grabs

	P1A	P1B	P1C	P2A	P2B	P2C	P3A	P3B	P3C	P4A	P4B	P4C	P5A	P5B	P5C	P7	P8	P1Actual
Edwardsia claparedii	8	10	8	2	9	1	8	1	16	11	8	5	6	29	11	40	1	-
Cerianthus lloydii	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
PLATYHELMINTHES	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
NEMERTEA	-	-	-	-	1	2	-	-	-	5	-	3	-	1	3	1	14	-
NEMATODA	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
SIPUNCULA	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Thysanocardia procera	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-	-
Phascolion strombus strombus	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-
Pholoe baltica	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	1	-	-
Polynoidae	-	4	-	-	-	2	-	-	-	-	-	2	-	1	-	-	1	6
Harmothoe glabra	-	1	1	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-
Malmgrenia	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-
Pisione remota	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-
Sthenelais	1	-	-	-	1	-	-	5	-	-	-	2	1	3	5	5	-	-
Sthenelais limicola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Glycera	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Glycera alba	4	3	1	2	1	-	-	2	-	4	3	7	1	-	4	2	-	-
Glycera lapidum	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	3	-
Glycera unicornis	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-
Glycinde nordmanni	1	1	-	-	-	1	1	1	1	-	-	2	-	-	-	-	-	-
Goniada maculata	-	-	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	-
Oxydromus flexuosus	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-
Podarkeopsis	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	-	-	-

	P1A	P1B	P1C	P2A	P2B	P2C	P3A	P3B	P3C	P4A	P4B	P4C	P5A	P5B	P5C	P7	P8	P1Actual
Psamathe fusca	-	-	-	-	-	4	-	-	-	1	-	-	-	-	-	-	-	-
Sphaerosyllis bulbosa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-
Syllis	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Syllis armillaris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Eteone cf. longa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Eulalia mustela	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Eumida	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Phyllodoce	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Phyllodoce rosea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Nephtyidae	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Aglaophamus agilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Nephtys	-	-	-	-	-	-	1	1	-	1	-	-	1	3	5	1	-	-
Nephtys hombergii	-	-	-	-	-	-	-	2	-	1	-	-	-	3	-	-	-	-
Nephtys incisa	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Protodorvillea kefersteini	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
***Lumbrineris aniara* agg.**	19	26	15	-	10	6	5	8	14	23	23	16	5	4	13	19	1	10
Aponuphis bilineata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-
Mediomastus fragilis	-	5	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	1
Notomastus	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-
Ophelina acuminata	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-
Scoloplos armiger	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Cirrophorus branchiatus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Paradoneis lyra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Scalibregma inflatum	6	1	1	-	2	-	1	258	7	4	2	4	7	2	186	3	2	1
Apistobranchus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
***Dipolydora* sp.B**	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Laonice	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Prionospio* cf. *multibranchiata	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-

	P1A	P1B	P1C	P2A	P2B	P2C	P3A	P3B	P3C	P4A	P4B	P4C	P5A	P5B	P5C	P7	P8	P1Actual
Spio	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Spiophanes bombyx	1	1	3	7	1	-	3	2	1	3	3	1	4	7	6	10	-	-
Spiophanes kroyeri	-	2	-	-	-	-	-	-	-	1	-	2	-	1	-	2	-	-
Macrochaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Aphelochaeta	1	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	-
Caulleriella alata	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Chaetozone christiei	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaetozone gibber	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Kirkegaardia	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Tharyx killariensis	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
Diplocirrus glaucus	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
Flabelligera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ampharete	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Amphicteis	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Lagis koreni	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-
Terebellidae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Polycirrinae	-	2	1	-	1	3	-	2	-	-	-	-	-	-	-	1	1	1
Polycirrus	-	-	-	-	-	2	-	2	-	1	-	-	-	-	-	2	-	-
Nicolea venustula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Pista mediterranea	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-
Sabellidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Serpulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Hydroides norvegica	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Owenia	2	1	3	-	-	-	3	6	6	7	-	2	2	18	4	-	2	3
Sabellaria spinulosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65
Spiochaetopterus	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-	-	-	-
Magelona alleni	-	-	-	-	-	-	1	-	-	2	1	1	2	1	2	-	-	-
Magelona minuta	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-

	P1A	P1B	P1C	P2A	P2B	P2C	P3A	P3B	P3C	P4A	P4B	P4C	P5A	P5B	P5C	P7	P8	P1Actual
Polygordius	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-
Anoplodactylus petiolatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
THORACICA	-	33	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Balanus crenatus	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Verruca stroemia	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44
Bodotria arenosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Iphinoe serrata	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Diastylis laevis	-	-	-	-	1	-	-	-	-	-	-	2	2	5	3	1	-	-
Deflexilodes subnudus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Perioculodes longimanus	1	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Synchelidium maculatum	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eusirus longipes	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Nototropis vedlomensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Ampelisca brevicornis	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
Ampelisca spinipes	-	1	-	-	1	4	-	-	-	1	-	-	-	-	-	-	-	-
Ampelisca tenuicornis	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Ampelisca typica	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Harpinia pectinata	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Urothoe elegans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Cheirocratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Animoceradocus semiserratus	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Othomaera othonis	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Aoridae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ericthonius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Ericthonius punctatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Pariambus typicus	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-
Cymodoce truncata	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
ANOMURA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	P1A	P1B	P1C	P2A	P2B	P2C	P3A	P3B	P3C	P4A	P4B	P4C	P5A	P5B	P5C	P7	P8	P1Actual
Philocheras trispinosus	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Callianassa subterranea	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Galathea intermedia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Pisidia longicornis	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	4
Anapagurus	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Anapagurus hyndmanni	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Goneplax rhomboides	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Ebalia	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Cylichna cylindracea	-	-	-	-	-	-	1	2	1	-	-	-	5	1	2	1	-	-
Philinidae	-	-	-	-	-	-	3	5	-	-	-	1	1	6	-	-	-	-
Scaphander lignarius	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
DORIDOIDEI	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Onchidorididae	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Hyala vitrea	-	-	-	-	-	-	-	1	-	-	-	9	-	-	1	-	-	-
Euspira nitida	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Mangeliidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bela nebula	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Raphitoma linearis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
BIVALVIA	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-
Phaxas pellucidus	-	2	7	-	3	-	2	3	-	4	-	1	1	11	2	-	-	-
Acanthocardia	1	-	-	-	1	-	-	3	-	-	-	-	-	5	-	2	-	-
Gari fervensis	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Abra	-	-	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	1
Abra alba	-	-	1	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-
Moerella donacina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
Kurtiella bidentata	-	-	3	-	-	2	-	1	-	-	6	-	21	4	-	1	-	-
Lucinoma borealis	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1	-	-
Thyasiridae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-

	P1A	P1B	P1C	P2A	P2B	P2C	P3A	P3B	P3C	P4A	P4B	P4C	P5A	P5B	P5C	P7	P8	P1Actual
Thyasira flexuosa	-	-	-	-	-	-	-	2	-	-	-	2	1	3	-	-	-	-
Corbula gibba	-	-	-	-	-	-	-	-	-	1	-	2	-	-	1	-	1	-
Nucula	-	-	1	-	1	-	-	8	-	1	1	-	2	7	3	-	-	-
Nucula nitidosa	-	-	-	-	-	-	-	2	-	2	1	-	3	-	-	1	1	-
Anomiidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heteranomia squamula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Veneridae	1	-	5	-	23	-	3	5	-	-	-	-	-	7	-	-	-	-
Chamelea striatula	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Dosinia	2	-	-	-	1	1	-	1	2	-	-	-	1	-	-	-	-	-
Dosinia lupinus	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	2	-	-
THRACIOIDEA	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Phoronis	-	-	1	-	2	-	2	4	-	4	-	24	7	11	7	3	-	-
Luidia sarsii	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ECHINOIDEA	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Echinocyamus pusillus	1	-	-	-	-	2	2	-	1	-	-	-	-	-	-	2	11	-
DENDROCHIROTIDA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-
Amphiuridae	-	-	1	-	-	-	7	-	-	2	-	-	-	1	-	-	-	-
Amphiura filiformis	1	-	-	-	4	1	1	4	1	-	5	-	4	9	1	11	-	-
Ophiothrix fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Ophiuridae	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2
Ophiocten affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
ASCIDIACEA	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	46

Appendix 2: Abundance Matrix – Video Data

		V_01	V_02	V_03	V_04	V_05	V_05 Sediment	V_06	V_07	V_08	V_09	V_10	V_11	V_12	V_13	V-14	V-15	V-16	V-17
NO VISIBLE FAUNA	Present	-	-	Y	-	-	Y	-	-	-	Y	Y	Y	-	-	Y	Y	Y	Y
HYDROZOA	SACFOR	2	1	-	2	3	-	3	2	1	-	-	-	2	P	-	-	-	-
Alcyonium digitatum	SACFOR	-	-	-	-	-	-	2	3	-	-	-	-	2	-	-	-	-	-
Caryophyllia smithii	Count	-	-	-	5	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Serpulidae	SACFOR	-	3	-	1	1	-	1	1	2	-	-	-	1	P	-	-	-	-
THORACICA	SACFOR	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
ASTEROIDEA	Count	1	1	-	-	-	-	5	1	-	-	-	-	-	-	-	-	-	-
Asterias rubens	Count	-	3	-	4	2	-	3	3	1	-	-	-	30	2	-	-	-	-
Marthasterias glacialis	Count	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Luidia ciliaris	Count	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Henricia	Count	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-
Echinus esculentus	Count	1	10	-	-	31	-	3	3	1	-	-	-	13	2	-	-	-	-
HOLOTHUROIDEA	Count	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ACTINOPTERYGII - PELAGIC	Count	2	5	-	2	-	-	1	3	-	-	-	-	-	-	-	-	-	-
Ctenolabrus rupestris	Count	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Labrus mixtus	Count	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Callionymus lyra	Count	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-
Scyliorhinus canicula	Count	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
CORALLINALES	SACFOR	-	-	-	2	1	-	-	1	-	-	-	-	1	-	-	-	-	-
FAUNAL/ALGAL TURF	SACFOR	2	2	-	1	1	-	2	2	6	-	-	-	2	1	-	-	-	-
BRYOZOA - ENCRUSTING	SACFOR	2	4	-	1	3	-	3	3	1	-	-	-	3	P	-	-	-	-
BRYOZOA - FOLIACEOUS	SACFOR	-	2	-	-	-	-	-	2	1	-	-	-	1	-	-	-	-	-
PORIFERA - ARBORESCENT, BROWN	SACFOR	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
PORIFERA - ARBORESCENT, ORANGE	SACFOR	1	-	-	-	1	-	-	-	-	-	-	-	-	P	-	-	-	-
PORIFERA - ENCRUSTING, YELLOW	SACFOR	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PORIFERA - ENCRUSTING, BLUE	SACFOR	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-