Preliminary Ecological Assessment of Candidate Disposal Areas 2.2 and 3.2 Crude Shipping Project, Bream Bay, Whangarei

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Cover Photo: Roger Grace: The sand dwelling bryzoan *Otionella sp.*5mm colonies found in our dredge samples

For: Chancery Green on behalf of the New Zealand Refining Company

Report by: V.C. Kerr B.Sc.

R. V. Grace Ph.D.

Kerr and Associates, Whangarei

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1 Introduction

Refining NZ is proposing to carry out dredging work to deepen and re-align the Whangarei Harbour entrance channel. In preparation for this work a series of studies have been commissioned to look at feasibility and environmental considerations. Currently this body of work is summarized in an internal report (Coffey, 2016).

This report describes the results of preliminary biotic and substrate survey work carried out in January 2016 in two additional candidate areas (2.2 & 3.2) in Bream Bay, which are under consideration for disposal of dredge spoils.

The data collection methodology was chosen to parallel previous work, (BioResearchers, 2015) which has looked at biotic and substrate characteristics in the proposed dredging footprint area and candidate dredge spoil disposal sites in the ebb delta of the Whangarei Harbour entrance and further candidature disposal sites in the outer Bream Bay area.

The scope of this report is confined to presenting the data for further analysis of these two candidate disposal sites against the body of information previously assembled from the larger project studies.

2 Methods

2.1 Selection of sample sites

From discussions with Brian Coffey on methodology for this preliminary study it was determined that we would attempt to use 6 sample sites distributed roughly evenly within the pre-determined boundaries of the candidate disposal areas. The map in Figure 1 shows the site locations used in this survey. GPS information on the 12 sample sites is recorded in Appendix 1.

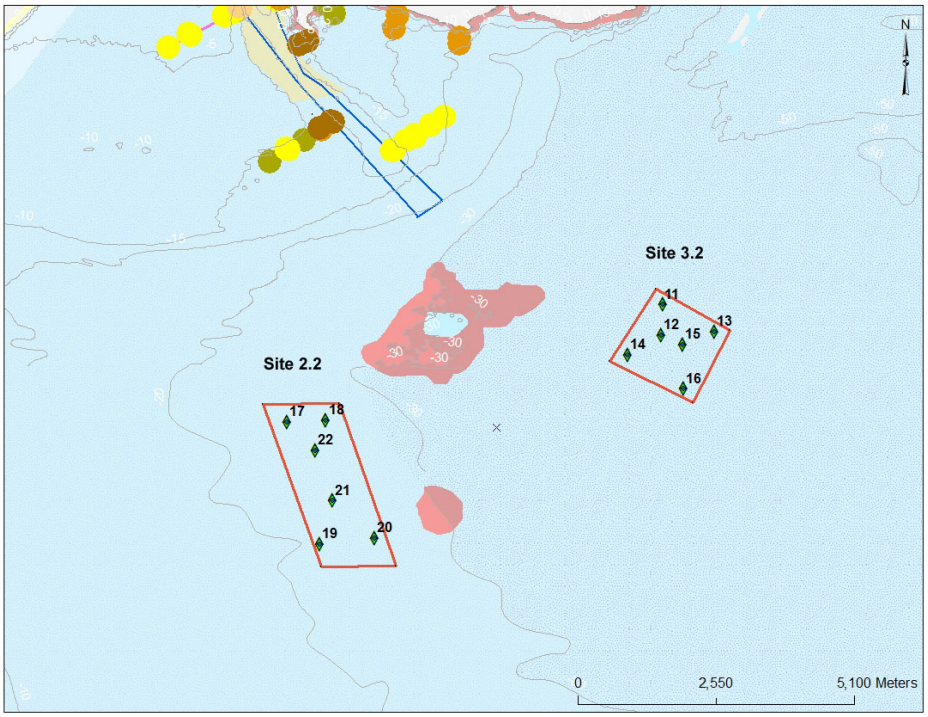

Figure 1 Map of candidate disposal sites and survey sampling sites. Red areas near disposal sites are the outline of rocky reef areas locally know as 3 mile reef. The blue lines and coloured dots at top of map are respectfully the channel dredge footprint (approx.) and stage 1 pilot ecological study sample sites (Kerr and Associates 2016).

2.2 Benthic Sampling

A box dredge was deployed at 12 sites, 6 in each of the candidate disposal sites. The box dredge used has a full volume of 4.5 litres. Dimensions of the box are (175mm x130mm x200mm). The jaw opening is (175mm x 165mm). There is a heavy chain of approx. 2m length positioned ahead of the box to improve the bite angle. The box and chain loaded with sediment weighs 22 kgs. When the dredge is deployed the rope is straightened, then allowed to settle with extra rope deployed to lessen the angle. Then the dredge is gently pulled along the seabed until the operator feels it ‘bite’. After about 1 minute of pulling following the bite the pressure on the rope is relaxed and the process repeated several times to assure a good bite and full dredge of sample is achieved. With this method there is no way to calculate the surface area that is sampled or exact depth of the bite, however when operated carefully the bite is clearly felt indicating that the dredge is sinking down into the substrate to at least ½ of its mouth gap or further.

Notes were kept of the depth, time, dredge volume and residue volume (post sieving). Samples were sieved over a 1 mm screen in the field. Following sieving the residues were bagged and stored in an iced chilly bin. Back at base, Roger Grace sorted and analysed the benthic invertebrates from the substrate material. Identification of organisms to most practical taxonomic level was aimed at categorising their main taxonomic group, but most often were identified to species or genus level. Individual numbers of each organism were counted and recorded. A collection of voucher organisms was fixed and stored for future reference.

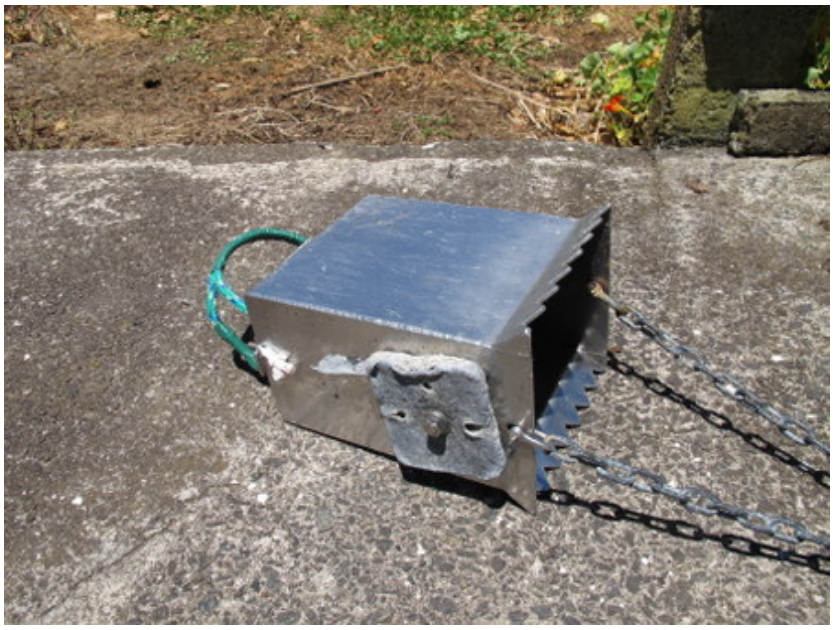

Figure 2. Box dredge used for this survey.

2.3 Grain size analysis

At 12 survey sites a subsample (approx. 300ml volume) of the substrate was removed from the box dredge contents as it came on to the boat. The sample was placed in a zip lock plastic bag and kept chilled until going to the Waikato University lab for ‘general purpose environmental analysis’. At the lab the samples were hand sieved at 2mm. Sample portions below 2mm were run through a Malvern Lasersizer.

2.4 Drop video photography

A drop video camera set up with an additional light source was deployed at each of the 12 sample sites (see Figure 2). Time and depth were recorded. The camera is set up to view the bottom of the seabed from approximately .5m off the seabed. The setup holds the camera at this height and at an angle to the seabed (approx. 70 degrees). The system is rope based using the combination of a float at the top and lead weight at the bottom. This arrangement allows the camera to pan from left to right to varying degrees, which effectively increases the viewing area to over $1m^2$ in most situations. For this survey the system was bounced a minimum of 5 times which involved lifting the system off the seabed and allowing the system to drift over the bottom for approximately 2-10m of horizontal distance. This 'drift' distance was not accurate but estimated by the rope angles and drift rate observed topside in the boat. In this way a greater area of seabed around the immediate sample location is viewed, but the exact location of the bounces from the original drop is an estimate. The direction of drift is noted when the drops are made.

Figure 2 Drop video apparatus.

Video footage for each site was examined and notes were taken consisting of a qualitative description of the substrate surface and epifauna seen. Presence of 'sand ripples' and an estimate of the 'wave length' of the sand ripples were recorded. Time of drop and depth from the boat's sounder were also recorded.

3 Results

3.1 Grain Size analysis

The lab analysis result for each of the 12 samples is provided in two documents accompanying this report.

Data files supplied:

Particle size Jan 2016.pdf (includes graphic display and summary tables)

Particle size Jan 2016.xlsx (spreadsheet of % composition of each size class)

The percentage by weight of particle sizes is shown in Tables 1 and 2 and in graphic format in Figures 3 and 4 below.

Sample Name	gravel	very course sand	course sand	medium sand	fine sand	very fine sand	silt	clay
	>2mm	2-1.18mm	1.18-.6mm	.6-.3mm	.3-.150mm	.150-.063mm	.063-.0039mm	<.0039
11	0.00	2.12	3.04	17.22	39.74	18.11	15.13	4.66
12	0.00	0.30	6.35	28.99	37.49	13.05	10.96	2.85
13	3.03	16.68	32.51	37.65	9.97	0.14	0.00	0.00
14	5.69	9.34	30.48	43.60	8.49	0.32	2.08	0.00
15	7.60	21.01	33.08	31.14	7.07	0.10	0.00	0.00
16	9.78	10.03	26.61	40.49	12.51	0.10	0.48	0.00
Average	4.35	9.91	22.01	33.18	19.21	5.30	4.77	1.25

Table 1 Candidate disposal site 3.2 particle size percentages.

Sample Name	gravel	very course sand	course sand	medium sand	fine sand	very fine sand	silt	clay
	>2mm	2-1.18mm	1.18-.6mm	.6-.3mm	.3-.150mm	.150-.063mm	.063-.0039mm	<.0039
17	0.00	0.00	0.00	3.02	50.81	41.23	4.40	0.54
18	0.00	2.39	1.20	4.31	51.18	36.00	4.40	0.52
19	4.44	11.37	30.61	40.61	11.84	0.99	0.16	0.00
20	2.78	19.60	32.99	34.23	9.96	0.43	0.00	0.00
21	1.75	5.43	16.40	34.84	30.06	11.10	0.41	0.00
22	13.34	6.98	7.64	16.25	36.10	17.39	2.16	0.14
Average	3.72	7.63	14.81	22.21	31.66	17.85	1.92	0.20

Table 2 Candidate disposal site 2.2 particle size percentages.

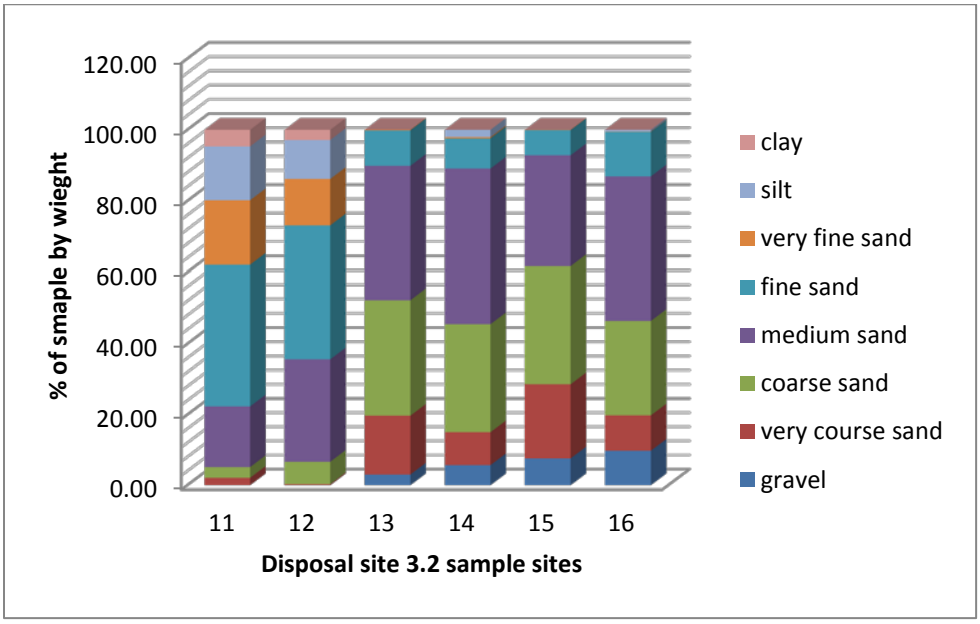

Figure 3 Candidate disposal site 3.2 particle size percentages.

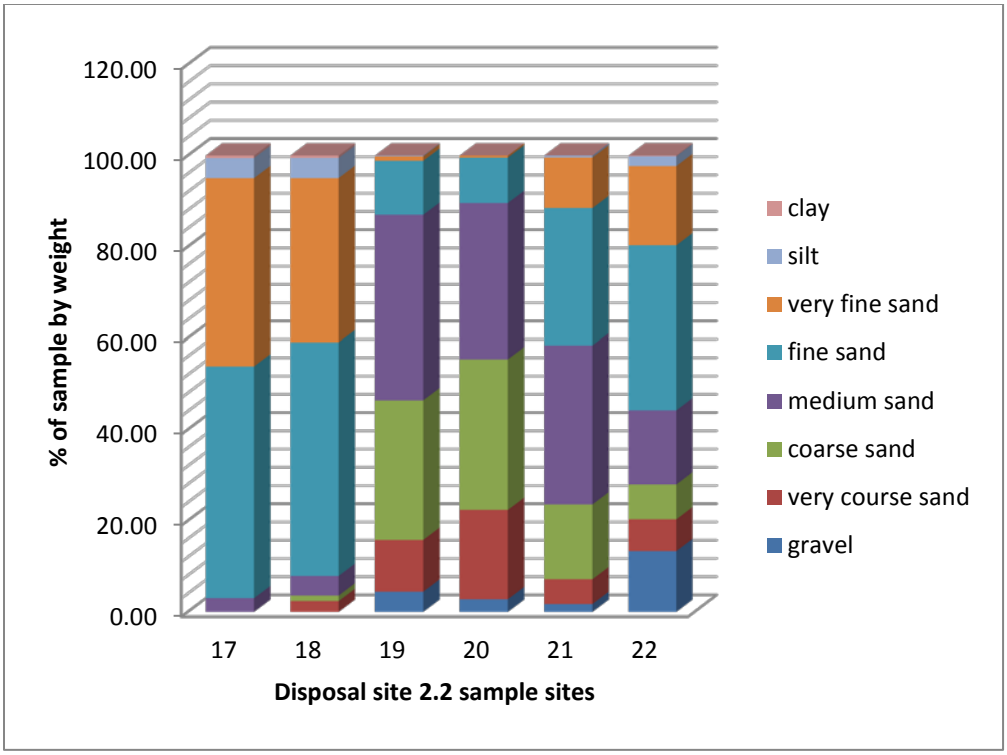

Figure 4 Candidate disposal site 2.2 particle size percentages.

In both disposal sites there are two sample locations, samples 11 & 12 in disposal area 3.2 and samples 17 & 18 in disposal site 2.2, which have greater proportions of clay, silt and fine sands. They also have very low proportions of coarse sands and little or no gravels or shell hash. These four sites were noticeably muddy as they came up in the dredge, sample location 11 being the most muddy in appearance. It is significant to note, (please refer to the location map in Figure 1) that in both disposal sites these more 'muddy' sites are situated at the northern end of the disposal sites.

The other four samples for each disposal site have a degree of variation but in general are composed of a mix of coarse and fine sands with quite small quantities of silt or clay. The particle size class represented as gravel largely consists of shell fragments.

3.2 Benthic Invertebrate Communities

The results of the benthic invertebrate community analysis are presented here in Tables 3-5 and Figures 5-8. The raw data in spreadsheet format has been supplied to accompany this report and support further analysis and comparative work in the overall project.

The file name of the raw species data counts is:

Benthic invertebrate data sites 2.2 and 3.2.xlsx

The data presented here in table and graph form includes the field notes on the dredge operation. The counts are summarized by sample sites and for each candidate disposal site as a whole. Counts are presented as individual organism counts, which provide information on abundance and by taxonomic groups. They can be examined from a substrate or diversity perspective.

There are some clear overall patterns visible in the graphs. The more northerly sites in each disposal area had generally higher diversity and abundance. This pattern parallels the grain size and substrate description. Where there was less gravel and shell hash and more silt and fine and very fine sand there were more individuals and species in the taxonomic groups of Polychaetes, Crustacea and Mollusca. This trend and difference between north and south parts of the disposal sites was evident in both sites but to a greater degree in the candidate disposal site 3.2 which had higher silt and diversity and abundance in its northern sample sites than did candidate disposal site 2.2.

Dredge Sampling Results	**Site 3.2**	**Site 3.2**	**Site 3.2**	**Site 3.2**	**Site 3.2**	**Site 3.2**	**Site 2.2**	**Site 2.2**	**Site 2.2**	**Site 2.2**	**Site 2.2**	**Site 2.2**
Sample wpt	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
number of individuals counted	168	100	18	69	24	47	65	95	92	47	66	73
number of species	32	28	14	20	10	18	27	30	24	24	27	32
fraction of dredge filled	8/10	9/10	7/10	7/10	7/10	7/10	8/10	7/10	6/10	7/10	7/10	8/10
dredge residue volume (litres)	0.08	0.07	0.55	0.52	0.51	0.55	0.07	0.06	0.18	0.65	0.15	1.25
depth (m)	45.5	45.9	46.5	43.1	45.4	43.1	26.7	27.7	23.3	26.9	25.8	26.9
sieve size (mm)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 3 Dredge sampling information. (Note depths are not tide corrected)

Totals calculated by disposal site	Count	Average per sample site
total number of individuals counted on Area 3.2	426	71
total number of individuals counted on Area 2.2	438	73
total number of species counted on Area 3.2	122	20
total number of species counted on Area 2.2	164	27

Table 4 Benthic invertebrate communities' total and average counts for each disposal site.

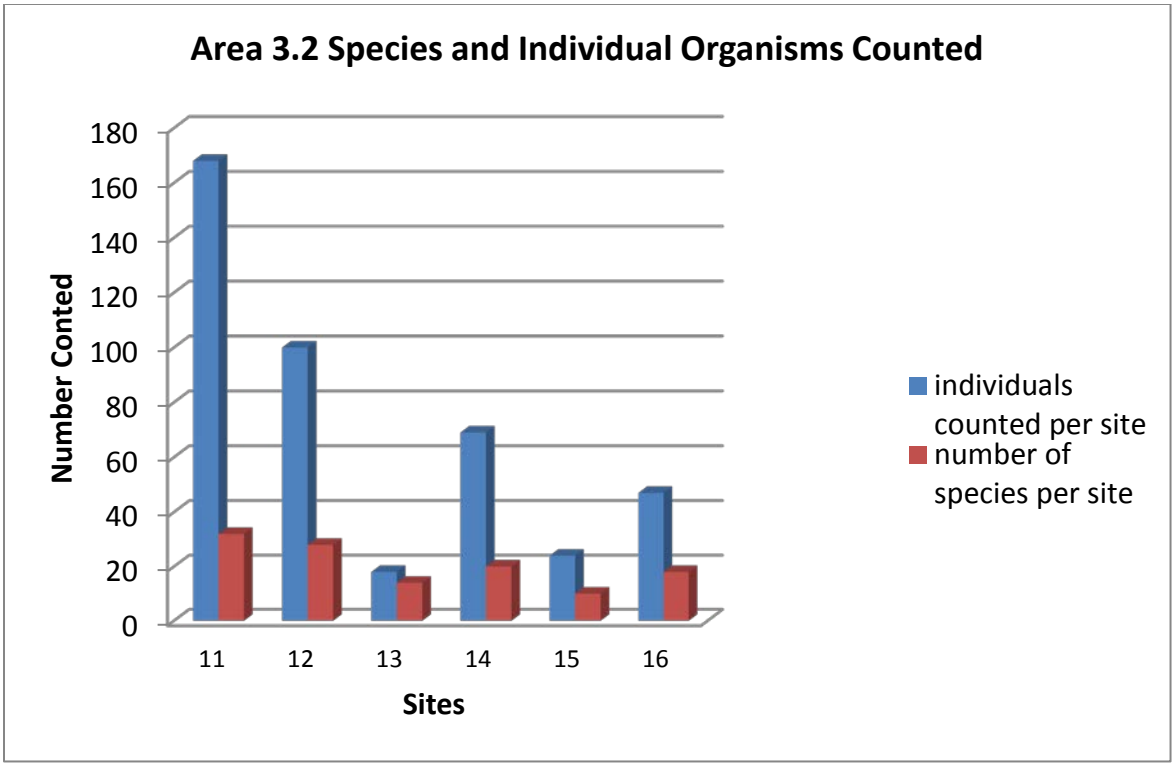

Figure 5 Disposal area 3.2 Species and individual organisms counted per sample site.

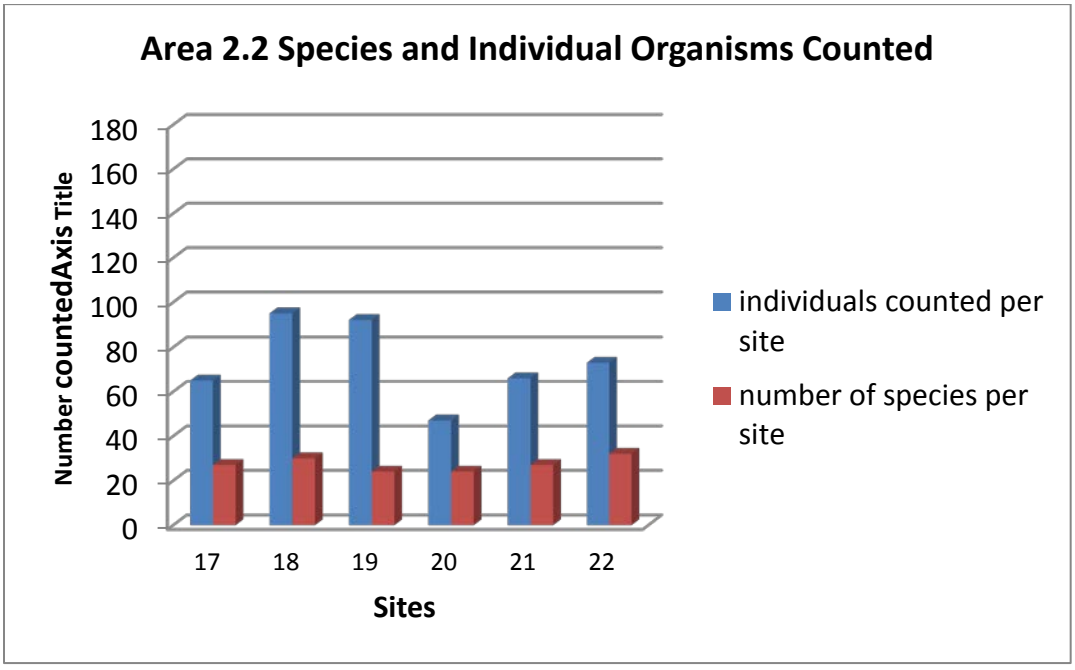

Figure 6 Disposal area 2.2 Species and individual organisms counted per sample site.

Taxanomic group	total	% of individuals
Cnidaria	1	0.23%
Porifera	2	0.47%
Mollusca, Scaphopoda	3	0.70%
Mollusca, Polyplacophora	2	0.47%
Insecta	1	0.23%
Foraminifera	7	1.64%
Protochordates	1	0.23%
Nemertea	8	1.88%
Echinodermata	66	15.49%
Bryozoa	54	12.68%
Mollusca, Bivalvia	34	7.98%
Mollusca, Gastropoda	24	5.63%
Crustacea	78	18.31%
Polychaetes	145	34.04%

Table 4 Disposal site 3.2 Total counts for 6 sample sites of individual organism for each taxonomic group and percentages.

Taxanomic group	total	% of individuals
Cnidaria	0	0.00%
Porifera	0	0.00%
Mollusca, Scaphopoda	0	0.00%
Mollusca, Polyplacophora	2	0.46%
Insecta	0	0.00%
Foraminifera	1	0.23%
Protochordates	8	1.83%
Nemertea	5	1.14%
Echinodermata	2	0.46%
Bryozoa	23	5.25%
Mollusca, Bivalvia	72	16.44%
Mollusca, Gastropoda	114	26.03%
Crustacea	101	23.06%
Polychaetes	110	25.11%

Table 5 Disposal site 2.2 Total counts for 6 sample sites of individual organism for each taxonomic group and percentages.

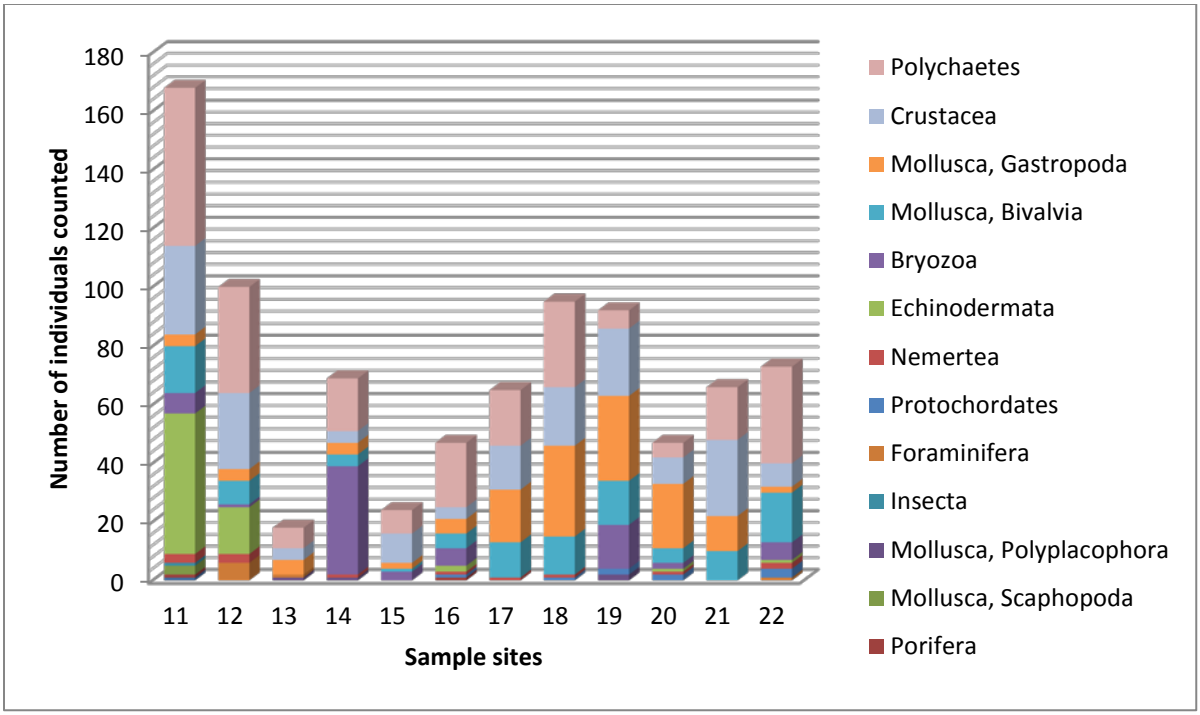

Figure 7 Number of individual organisms counted for each taxonomic group and sample site.

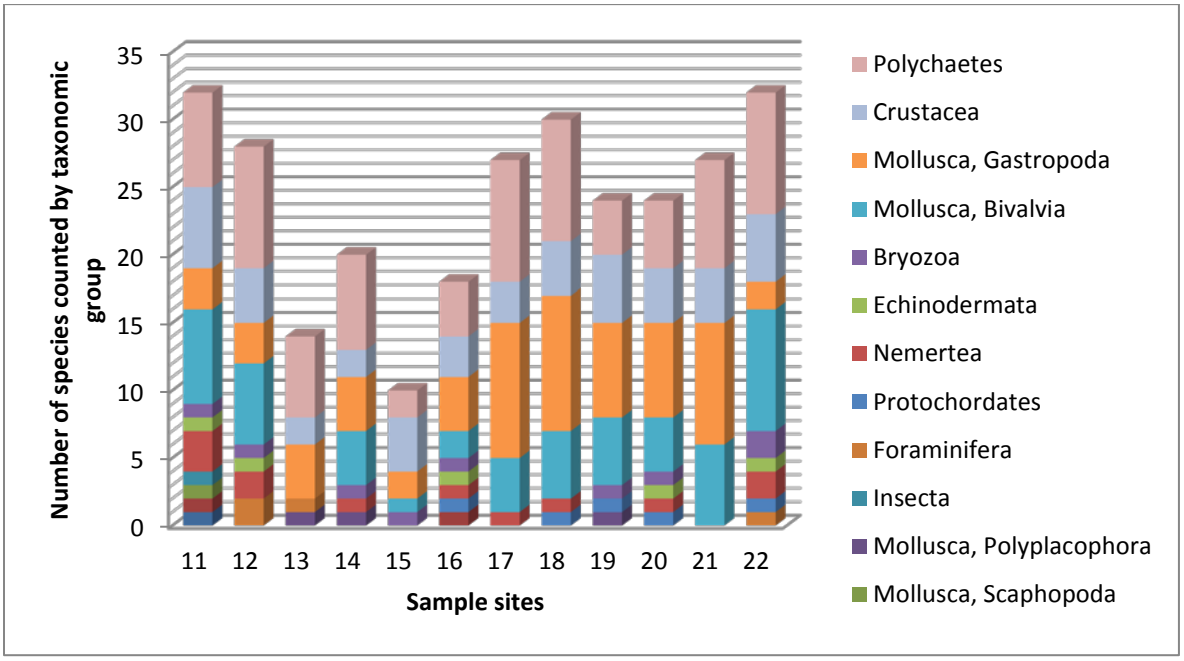

Figure 8 Number of species counted for each taxonomic group and sample site.

3.3 Drop Video Photography

Observations made from the video recorded for each site are summarized in Table 6 below.

The general observation was that these areas have a very sparse epifaunal community. The main species seen was scallop *Pecten novazealandiae,* however in all areas the density was less than one per square metre. There was one possible carrier shell *Xenophora zealandica* observed. Small amounts of drift algae were in most places and two unidentified small sponges were seen at low densities, usually one or two per sample site. Sand ripple presence and size was recorded. Ripple 'wave length', the distance from peak to peak of the ripples is noted in the Table 6. When the drop video apparatus hit the bottom at some of the sites a small plume of silt was visible on the camera. Presence or absence of this silt observation is noted in the table below.

No fish species were observed in the drop video footage.

Wpt	Site	Depth (m)	Substrate qualitative description	Sand ripple 'wave length'	Epifauna species observed	Silt observed
11	3.2	45	fine sand with some shell	small ripples 100m and flat areas	1 small yellow sponge and one small white sponge	yes, quite silty
12	3.2	45	fine sand some shell	small ripples 100m and flat areas	one small yellow sponge and light drift seaweed	yes
13	3.2	46	coarse medium sand	300mm	1 possible carrier shell *Xenophora zealandica*, light drift seaweed and 1 small red algae	yes small amount
14	3.2	42	fine and coarse sand with some shell	200-300mm	6 scallops <1m^2 density and two small yellow sponges	no
15	3.2	46	fine and coarse sand with some shell	200mm	1 scallop <1m2 density and two small yellow sponges	yes small amount
16	3.2	43	medium sand with some fines and shell hash	200mm	3 small yellow sponges	yes small amount
17	2.2	27	fine sand with some coarse sand and some shell	mainly flat with some small ripples 100m	1 scallop seen <1m2 density	yes
18	2.2	28	fine sand with some coarse sand and shell	100-200m	2 scallops seen <1/m2 density	yes

19	2.2	23	shelly coarse sand	300mm	light drift algae, 5 scallops < $1m^2$ density	yes
20	2.2	27	shelly coarse sand	100-300mm	light drift algae 3 scallops per bounce , <$1m^2$ density	yes
21	2.2	26	sand with some coarse sand and shell	flat areas and small ripples 100-150mm	light drift algae 1 scallop <$1m^2$ density	very small amount
22	2.2	27	coarse and fine sand with shell	500-600mm	4 scallops seen < $1m^2$ density	yes

Table 6 Notes and observations from drop video survey.

4 Discussion

4.1 Limitations of this study

This study was intended as a rapid characterization of the benthic environment of these sites and was based on a relatively small sampling effort. In terms of benthic invertebrate community, the sorting and identification of species, and counts of abundance were done to the lowest practical taxonomic level but were not exhaustive for the Polychaetes and some of the Crustacea species. For this reason if in future studies 0.5mm sieves were used instead of 1mm sieves, it could be expected that the overall diversity and abundance would be higher within these 2 main taxonomic groups.

The box dredge apparatus and method of use does not create a sample of exact known depth or length of dredge, as it bites as deeply as its mouth opening, the substrate and speed of tow allows. While it is possible to deploy the dredge consistently in terms of technique it can't be guaranteed exactly what profile is being sampled. As such the box dredge is useful to characterize a benthic invertebrate community but is not ideally suited to generate data for accurate quantitative comparisons.

The drop video technique we used is only useful for a simple characterization of the substrate surface and epifauna community. Other methods such as ROV transects, a benthic sled camera system or a benthic dredge would give a more detailed semi quantitative survey of the epifauna community present at these sites.

5 References

Coffey, B.T., 2015. Refining New Zealand Crude Shipping Project: Complimentary Literature Review to Inform Survey Work and Reporting Requirements to Assess the Environmental Effects of Proposed Dredging and Spoil disposal Activities in the Approaches to Whangarei Harbour. Prepared for Chancery Green. Brian T. Coffey and Associates Limited.

Kerr, V. C. and Grace, R. V., 2016. Crude Shipping Project Ecology Stage One Pilot Study. Prepared by Vince Kerr and Roger Grace of Kerr & Associates. A report prepared for Chancery Green on behalf of the New Zealand Refining Company by Kerr and Associates, October 2016.

West S.A, Bell, J.E., 2015. Preliminary Environmental Assessment of Potential Dredge Spoil Disposal Areas Bream Bay (Draft). Prepared for Chancery Green by Bioresearches.

6 Appendix 1 GPS data for survey sample sites

wpt	Latitude	Longitude	Disposal site
11	174.5896598	-35.90645966	3.2
12	174.5893959	-35.91147379	3.2
13	174.5981801	-35.91090829	3.2
14	174.5837786	-35.91475372	3.2
15	174.5929021	-35.9130572	3.2
16	174.5930529	-35.92044646	3.2
17	174.5271335	-35.92592026	2.2
18	174.5336176	-35.92562283	2.2
19	174.5325468	-35.94620517	2.2
20	174.5417077	-35.94525338	2.2
21	174.5346288	-35.9390073	2.2
22	174.5318925	-35.93067918	2.2