

Bay of Plenty Biological Survey: Aquaculture Management Areas



For



Environment Bay of Plenty



Marine Consulting and Research

Bay of Plenty Biological Survey: Aquaculture Management Area

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Bay of Plenty Biological Survey: Aquaculture Management Area

Underwater Video, Grab Samples and Dredge Tows of the Bay of Plenty Sub-Tidal Area (10- 100 m depth).

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EXECUTIVE SUMMARY

Sediment samples and dredge tow samples obtained from the seabed in depths ranging from 10 m to 100 m depth within the eastern Bay of Plenty in December 2004 have been analysed for both infaunal and epifaunal organisms. In addition over 200 video camera images have been obtained over the same area to classify the variability of the seabed habitat and environment. These data provide base-line information on the variety of organisms that inhabit the Bay of Plenty seabed and insight into the relative abundance and distribution of these organisms and their association with different physical seabed characteristics in the survey area.

This sub-programme formed part of the larger ASR Ltd study being undertaken for Environment Bay of Plenty with the goals to:

- Be informed about offshore oceanographic and ecological systems when choosing open coast AMA sites, for a sustainable environment, kaimoana and aquaculture industry in the Bay of Plenty
- Do background monitoring to complement the monitoring required under coastal permits for the proposed farm(s)
- Involve local iwi in determining effects on kaimoana, aquaculture planning and training
- Involve graduate university students who will be better trained for the expected future growth of the industry

A total of 3257 individuals (124 species from 14 groups) were identified in the grab and dredge-tow samples. Polychaetes and amphipods are the dominant fauna in the area, however, large variations in species and abundance were found, demonstrating the patchy distribution of benthic organisms. Some associations with respect to sediment type were evident. For example, amphipods dominate shallower (<50 m) mud/silt areas, while polychaetes dominate sandy areas, with high organic content. A wide variety of bivalves are spread throughout region, although some patterns are present, i.e. larger numbers of deposit-feeding bivalves are present in the in the muddy areas compared to the sandy areas.

The video surveys of the Bay of Plenty subtidal area identified 5 main habitat types, which are classified in order of dominance, as:

1. Silt/mud
2. Sand (usually rippled)
3. Coarse sand/gravel (with a shell lag between ripples).
4. Shallow reef (with kelp).
5. Deep reef (with sponge).

In terms of complexity, with the exception of 4 and 5, these habitats can be classified in the reverse order (i.e. 4 is the most complex, followed by 5, 3, 2 and 1).

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1 - BACKGROUND

This project is part of the on-going aquaculture management area (AMA) programme for the Bay of Plenty ('Choosing open coast AMA's to sustain the environment, kaimoana and aquaculture industry'). A field programme has measured physical and chemical properties throughout the area – this report presents the results of the biological aspects of the seabed survey of the 13 transects shown in Figure 1.

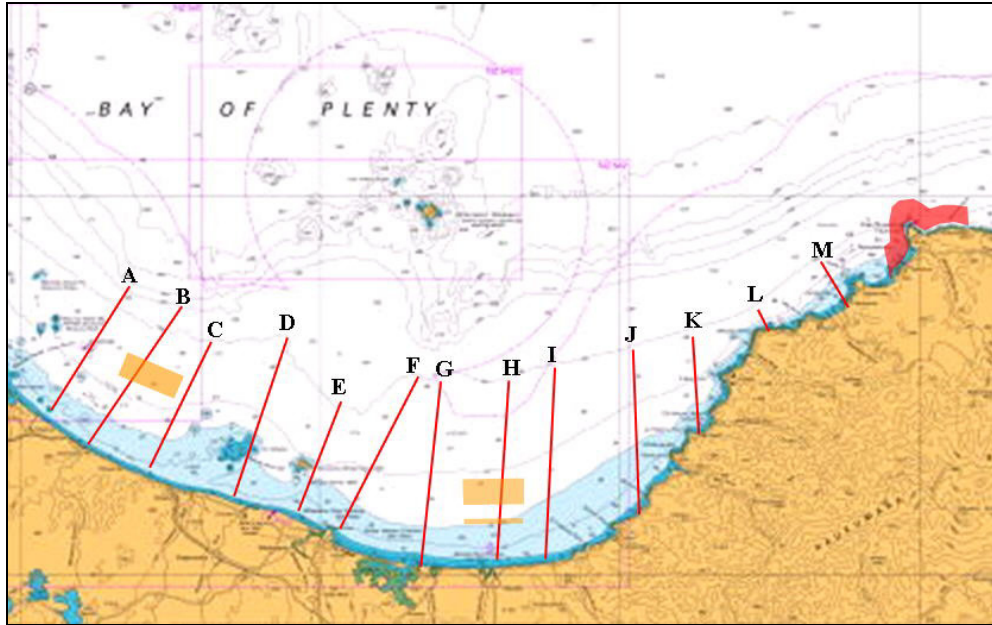


Figure 1. Locality map of the Bay of Plenty seabed survey area showing the positions of transects out to the 100 m contour. The red-shaded area to the east of the map denotes the area covered by a previous drop-camera survey of Cape Runaway, while the orange-shaded areas denote proposed mussel farms.

2 - METHODOLOGY

Three different methods were utilized to gain biological information along the 13 subtidal transects:

- Underwater videoing;
- Infaunal grab-sampling, and;
- Epi-faunal dredge-tows.

The surveys were undertaken during a 5-day cruise (5-11 December 2004) on the Macy Gray, where operations were undertaken throughout each 24 hour day. These methods provide quantitative (grab-sampling), semi-quantitative (dredge-tows) and qualitative (underwater videoing) data on the seabed biology and habitat types in the survey area. It is noted that due to the large area surveyed in comparison to the number and size of surveys, these data have little statistical significance. However, these data provide base-line information on the variety of organisms that inhabit the Bay of Plenty seabed and insight into the relative abundance and distribution of these organisms and their association with different seabed characteristics (physical) in the survey area.

2.1 UNDERWATER VIDEO

A total of 200 video clips were collected with the drop-camera (Fig. 2). Up to 16 samples were taken on each transects between 10 and 60 m¹, and then a sample at every 10 m depth contour between 60 and 80 m. Each video clip was evaluated for habitat type/complexity, biogenic characteristics and any organisms observed were recorded. Habitat complexity was classified as defined in Table 1.

Each video clip was edited into a 10 second segment and linked onto a geo-referenced base map (Fig. 2). Each video clip shows the site number, location (northing and easting), date of survey and depth. Video clips can be viewed via the MapInfo ProViewer package by 'clicking' on the site. The CD provided with this report contains video surveys and the installation software for MapInfo ProViewer.

¹ It was originally proposed to use a video sled from 10-50 m depth, however, due to the abundance of patch reefs encountered in early surveys and since the sled data is cut into short video clips it meant that a change to drop-camera surveying was justified.



Figure 2. Location map of the underwater video survey positions recorded during the Bay of Plenty seabed survey.

Table 1. Complexity scale and predominant habitat types used to classify the bottom topography within subtidal AMAs.

<i>Complexity scale</i>	<i>Habitat type</i>
0	Very fine muds and silts – worm holes – disturbed sediment remains in suspension.
0.25	mainly mud/silt, some worm holes
0.5	mixture mud/silt and fine sands
0.75	very fine sand, may have ripples, small amounts of mud/silt
1	sand
1.25	sand with visible cobbles or rocks
1.5	mainly sand with areas of rock
1.75	rocks and cobbles inundated with sand
2	bare rock and cobble reef
2.25	rock and cobble reef with turf cover, sponges, small plant life
2.5	rocky reef with some boulders and turf cover
2.75	rock and boulder reef with turf cover, sponges and some plant life
3	small boulder reef with turf cover, sponge and plant cover
3.25	mixed boulder reef, turf and plant cover
3.5	mixed boulder reef, dense plant cover
3.75	mixed boulder reef, large rock outcrops, dense plant cover
4	complex boulders, large wall, rocky overhangs, dense plant cover

2.2 GRAB SAMPLES

A total of 118 Grab samples were collected with a Shipek grab-sampler, on each of the 10 m contours from 10 to 100 m offshore on every transect (Fig. 3). The Shipek is a centre-pivot sampler that is designed to sample unconsolidated sediments from soft ooze to hard-packed silts in the near offshore. It brings virtually undisturbed, unwashed samples to the surface. It is specifically designed for sampling benthic organisms living at or immediately below the water/bottom

interface and sediment containing a significant population of non-sessile forms.
Shipek Specifications:

- Metal parts: 316 stainless steel
- Size: 472 x 638 x 442 mm (18.6 x 25.1 x 17.4")
- Weight/ ship wt: 60 kg (134 lb.) / 90 kg (200 lb) ship wt
- Case: 546 x 762 x 1092 mm (21.5 x 30 x 43")
- Volume: 3000 ml
- Sample area: 1/25 (.04) square meter
- Bite depth: 102 mm (4")
- Scoop top area: 198 x 198 mm (7.8 x 7.8")



Figure 3. The Shipek grab-sampler.

Each sample was sieved with a 1 mm mesh sieve and all organisms were preserved in 5% buffered formalin. Organisms were later classified to lowest possible level at Leigh Marine Laboratory and representative organisms were preserved and catalogued for future reference.

2.3 DREDGE-TOWS

A total of 12 dredge tows were undertaken during the seabed survey, at depths between 20 and 40 m (Fig. 4). The dredge-tow has a mouth width of 760 mm, with a mouth height of 115 mm and 8 mm mesh. Tow distances varied between 130 and 322 m in length. All organisms were preserved in 5% buffered formalin. Organisms were later classified to lowest possible level at Leigh Marine Laboratory and representative organisms were preserved and catalogued for future reference.

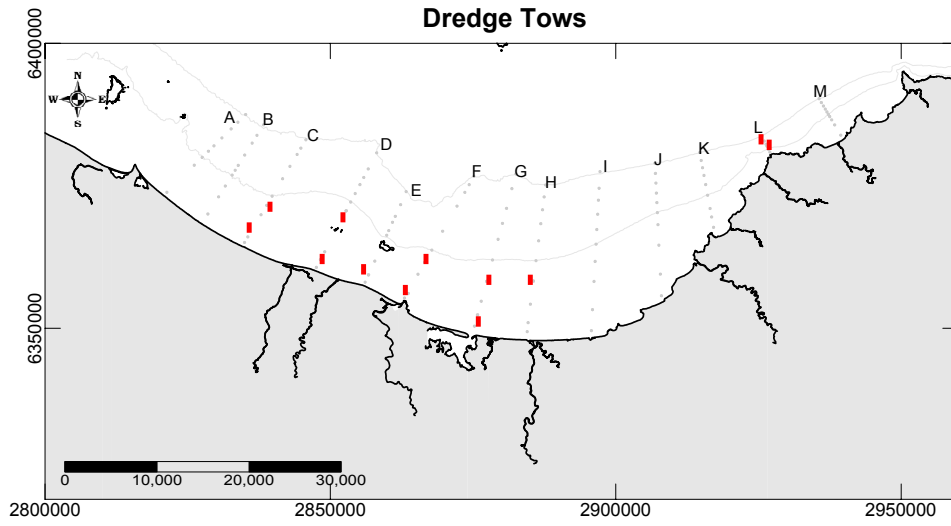


Figure 4. Dredge-tow locations.

3 – RESULTS

3.1 UNDERWATER VIDEO

The drop-camera surveys of 200 locations in the Bay of Plenty (Fig. 2) identified 5 main habitat types. These are defined, in order of dominance, as:

1. Silt/mud
2. Sand (usually rippled)
3. Coarse sand/gravel (with a shell lag between ripples).
4. Shallow reef (with kelp).
5. Deep reef (with sponge).

Table 2 provides the video clip numbers of example sites for each of the 5 habitat types. In terms of complexity, with the exception of 4 and 5 above, these habitats can be classified in the reverse order (i.e. 4 is the most complex, followed by 5, 3, 2 and 1). Thus, silt/mud and sand habitat dominate the subtidal regions of the Bay of Plenty that were surveyed. The distribution of these habitat types is indicated in Figure 5, which shows both the classification habitat complexity and of the grain size distribution. It can be seen that the two types of classification in Figure 5 are in close agreement, with the small differences due to the presence of solid reef habitat (i.e. these cannot be analysed for grain size, but are complex habitat).

Table 2. Video clip example of subtidal habitat types surveyed in the Bay of Plenty.

Habitat Type	Site Example
Silty Sand	H80
Sand	A10
Coarse Sand/Gravel	B27
Shallow Reef	L10
Deep Reef	L33

The main trends in habitat complexity/type are the rippled gravel and shell-lag to depths of 10-40 m in the western part of the survey area, finer sands and silt to the east of Ohope extending into the shallow areas (10 m), with an band of higher habitat complexity west of the central part of the survey area (associated with the offshore islands), and 3 areas of reef between 10 and 30 m deep (Fig. 5). The distinction between the shallow reefs (10-30 m) and the deep reefs is the lack of canopy-forming kelp (mono-specific stands of *Ecklonia radiata*, except at site L13 where a mix of kelps is present). The deep reef in transect L is covered with encrusting red algae and assemblages of sponge (e.g. *Acorina alata* and *Cliona celata*), which are able to flourish in the lower light regime where kelp are unable to survive.

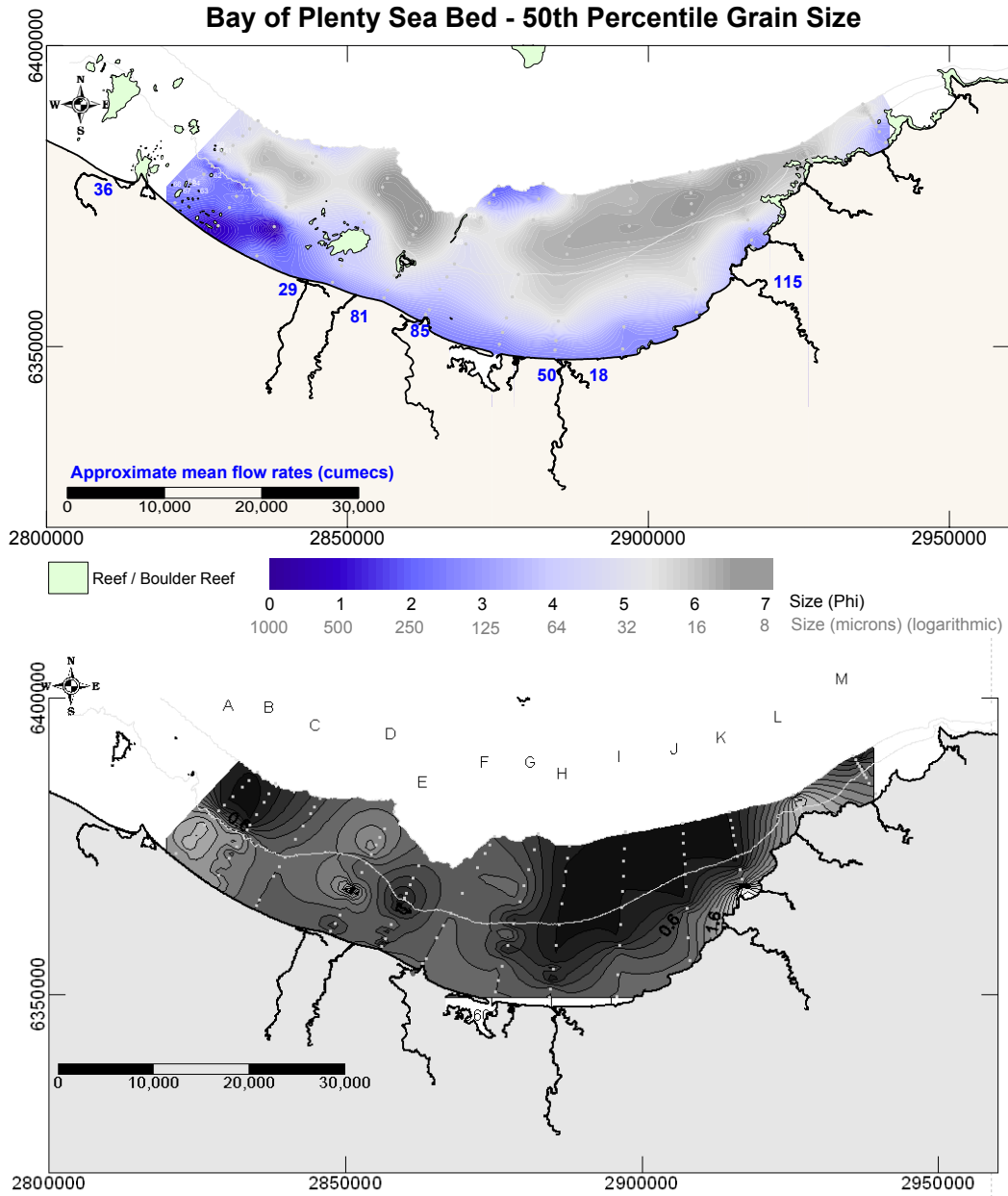


Figure 5. Habitat complexity (bottom) and grain size distribution (top) of seabed habitats in the Bay of Plenty. Reef is indicated by the green shapes on the grain size map.

3.2 GRAB SAMPLES

A total of 2270 individuals, representing 101 different species from 12 different groups were identified from the 118 grab samples. A species list is attached as Appendix 1 – no known rare or endangered species were found in the samples. Representative specimens have been catalogued for future reference. The total number of individuals from each grab sample is presented in Figure 6. There is a lot of variation in the total number of individuals per sample (0-378),

demonstrating the ‘patchiness’ of the inhabitants of the seabed that is well known to occur. Interestingly, the 4 samples with the largest number of individuals (>80), are all located at the 20-30 m sites on transects. However, while crustaceans (amphipods) dominate 2 of these samples, bivalves dominate another and a mix of polychaetes and bivalves make up the high numbers in the last.

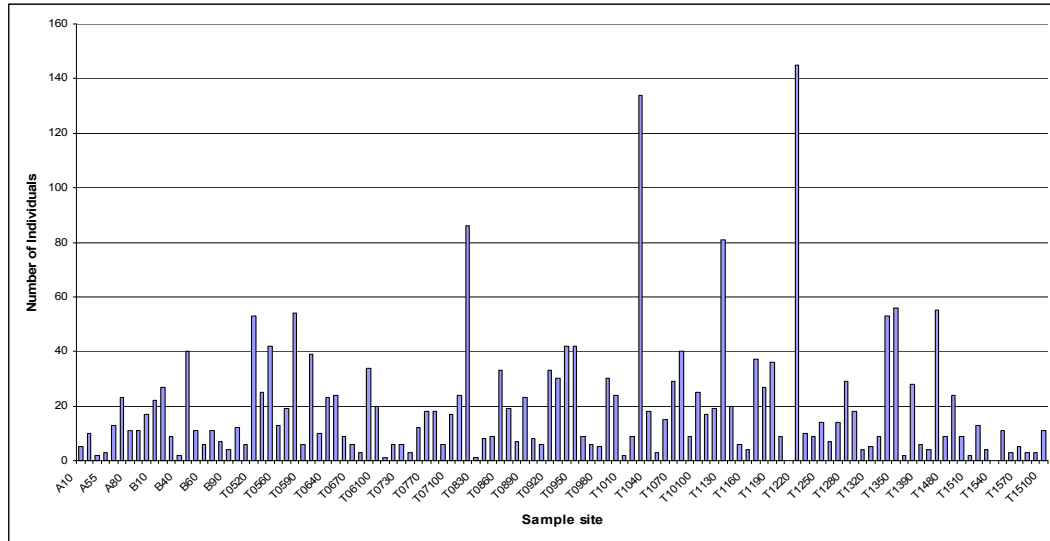


Figure 6. Individuals per grab sample (0.04 m² of the seabed, 3 L of material) identified in the Bay of Plenty survey.

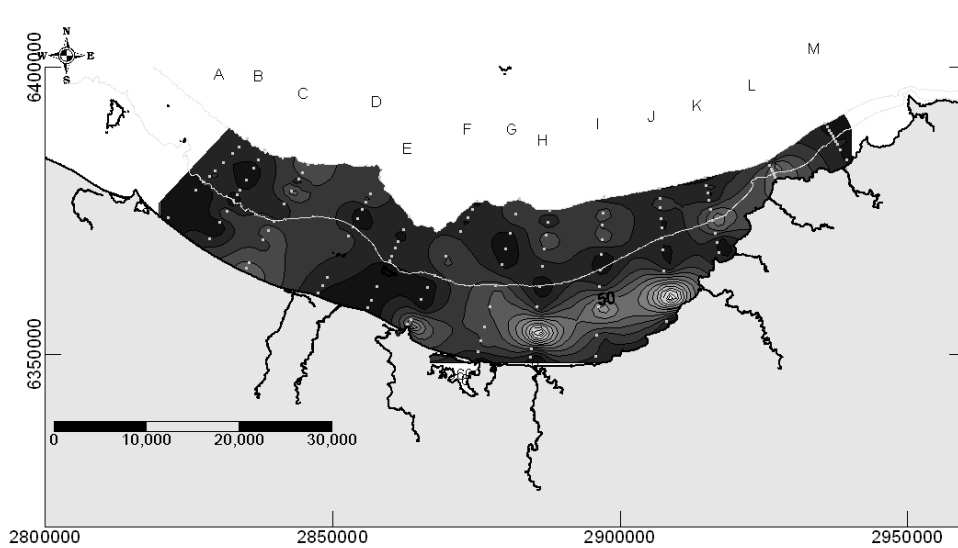


Figure 7. Individuals per grab plotted as a contour map; lighter shades of grey represent higher numbers of individuals.

The numbers of individuals per sample are also spatially presented in Figure 7, where samples with higher numbers of individuals are represented by lighter

shades of grey. Previous biological surveys have shown a strong correlation between the habitat complexity and the number of individuals per sample, with more complex habitats being inhabited with higher numbers of individuals (e.g. Mead and McComb (2002) found a good correlation between drop-camera video habitat complexity classification (496 sites) and individual and species numbers from 96 x 1 m² quadrats (n = 5 per reference site; $r^2 = 0.76$ and 0.71 for individuals and species, respectively). While it is noted that the purpose of this survey was not to provide statistical data, this comparison can be made visually by comparing Figures 5 and 7, and it can be seen that there is little similarity between the spatial distribution of the shading, i.e., there is no correlation between habitat complexity and the number of individuals found ($r^2 = 0.007$). This is due to the large area surveyed in comparison to the number and size of surveys, a single sample at each location (i.e. no replication) and the no surveys of the reef habitat.

Figures 9 and 10 present species rank sum graph of all the individuals found in all of the samples and the groups which they belong to, respectively. Polychaetes and crustacea (mainly isopods) are the dominant species in the subtidal soft sediments between 10 and 100 m depth, with bivalves also being present in large numbers. All of these 3 groups were found at the whole range of depths throughout the survey area, although there are some trends in their distribution. Amphipods were found in higher numbers in the shallower (<50 m) mud/silt areas, while polychaetes dominate sandy areas with high organic content, which are concentrated in the north western parts of the survey area (Fig. 8). A wide variety of bivalves was found to be spread throughout region. Echinoderms (brittle stars and sea cucumbers) and foramiferans were also fairly common in the samples (Fig. 10), with the former being widely distributed and the latter being restricted to deeper survey sites. An XL spreadsheet of the raw sample data is supplied on the video CD.

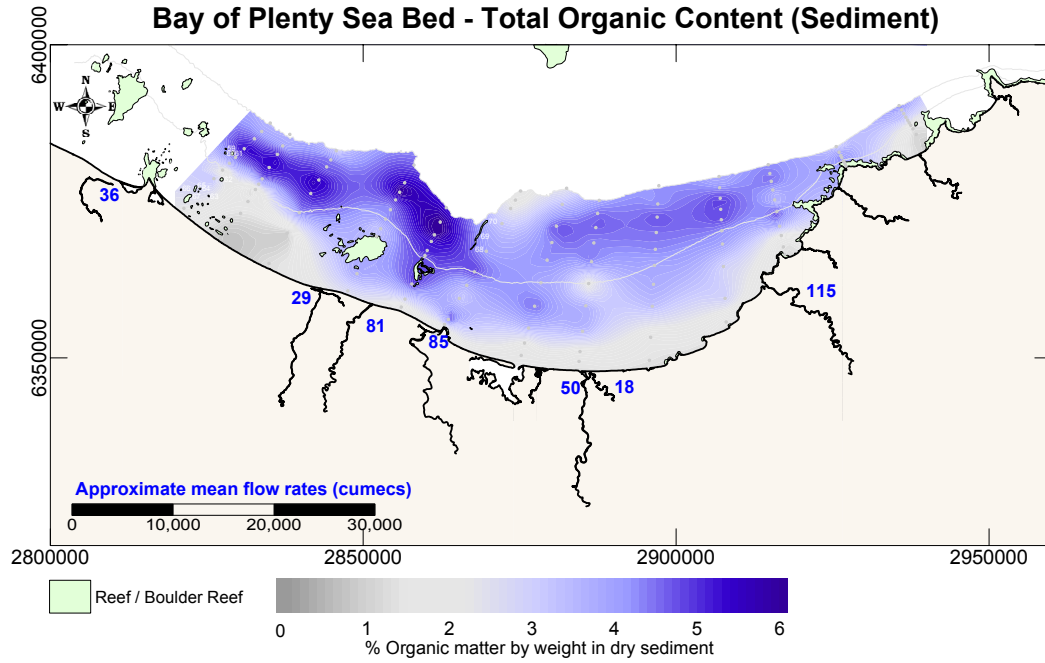


Figure 8. Organic content of the sediment in the grab-samples.

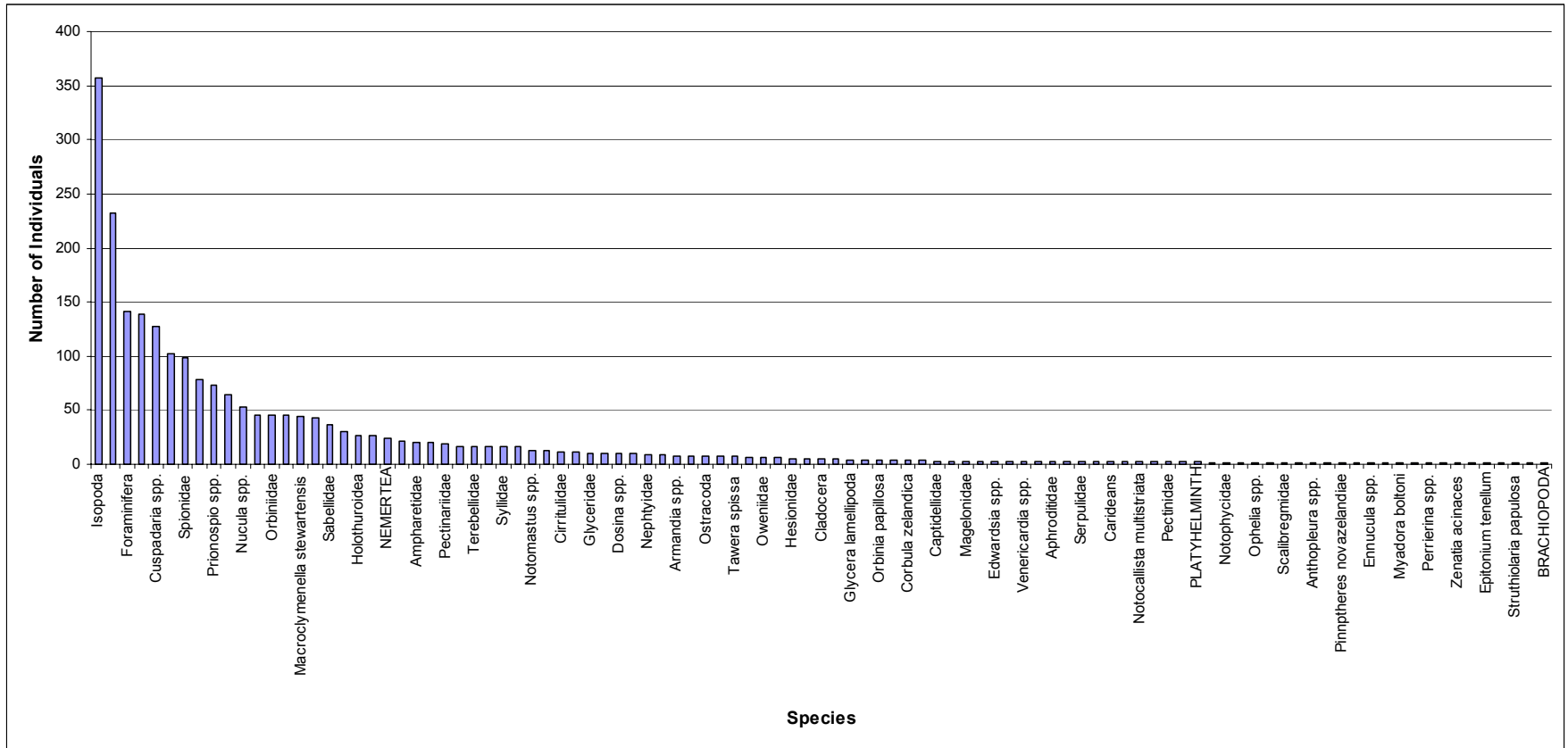


Figure 9. Species rank sum graph of grab-sample data.

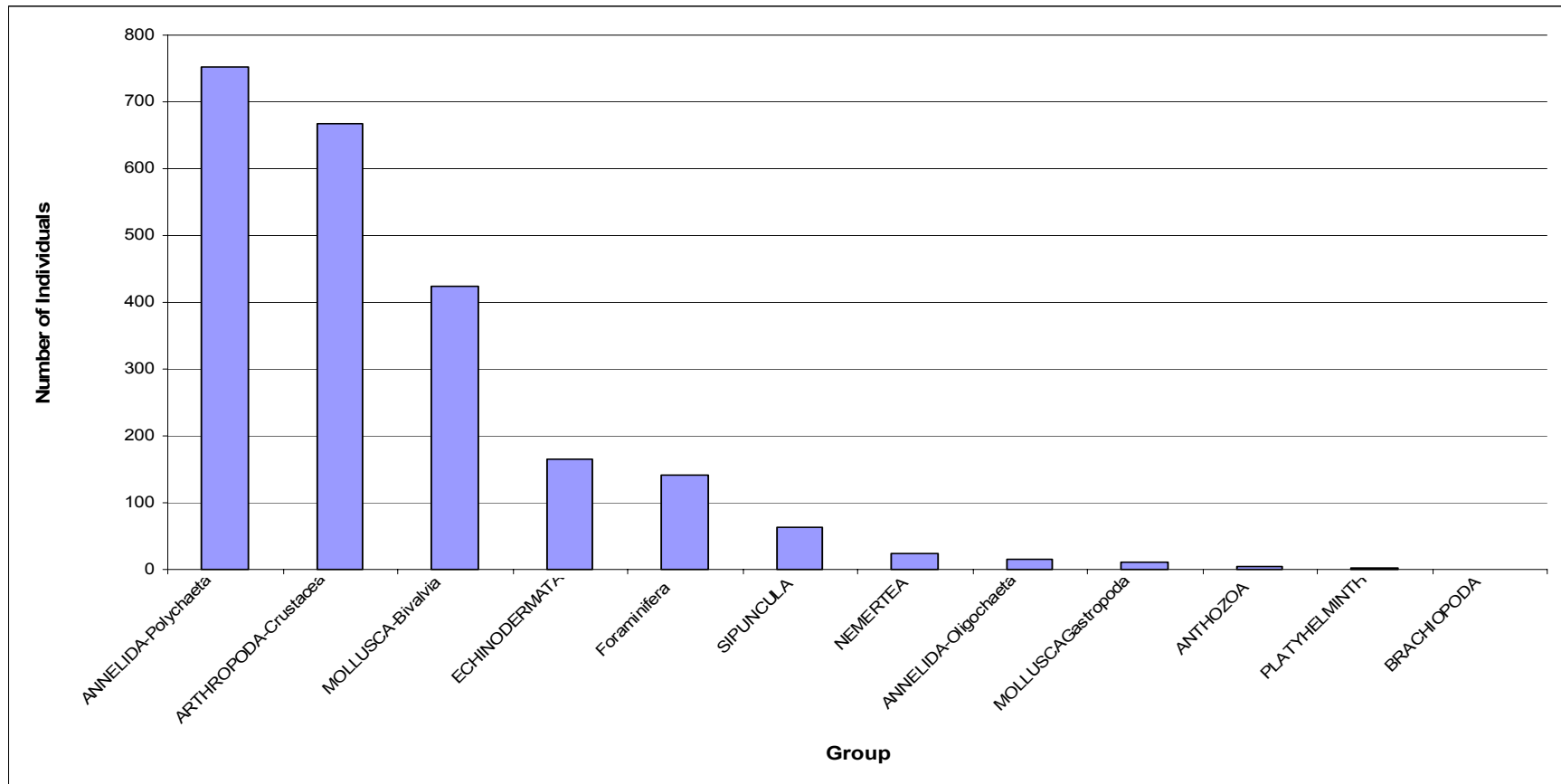


Figure 10. Group rank sum graph of grab-sample data.

3.3 DREDGE-TOWS

Of the 12 dredge-tows undertaken, 3 tows were empty, which is assumed to be due to malfunction of the dredge rather than an absence of organisms in the area. A total of 988 individual organisms were found in the 9 remaining dredge-tows, with 378 individuals found in a single tow (site D60, a 302 m tow – Fig. 11). A range of organisms were found (67 species from 9 groups – Figs. 12 and 13), with individuals from 23 additional species and 2 additional groups identified that were not previously found in the grab samples. A species list is attached as Appendix 1 – no known rare or endangered species were found in the dredge-tow samples (the single unidentified fish was too damaged for identification).

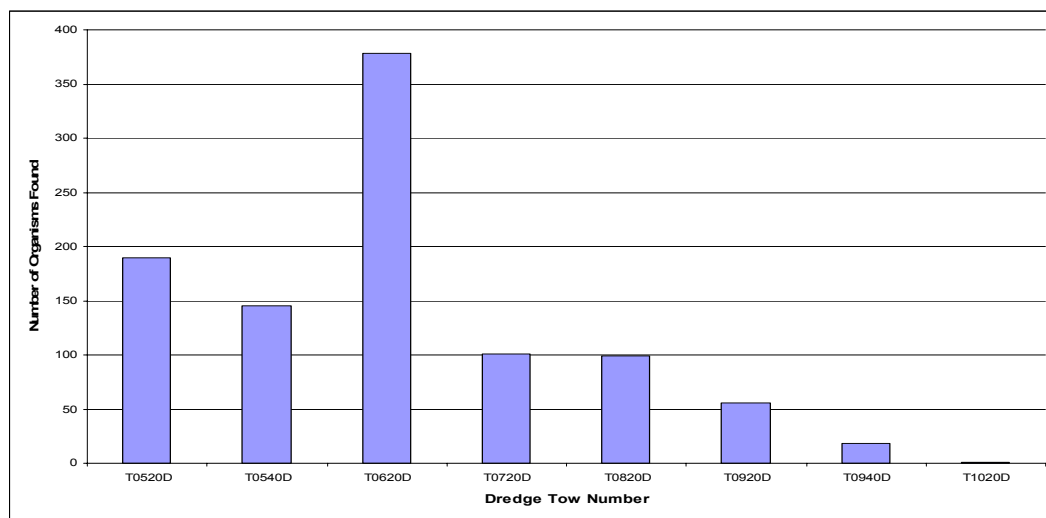


Figure 11. Individuals per dredge-tow identified in the Bay of Plenty survey (to distances ranged from 130 to 322 m).

Polychaetes and crustaceans dominate the species found in the dredge-tow samples, with hermit crabs making up a large fraction of the crustaceans, which were mainly isopods and hermit crabs. There is a clear relative increase in the number of bivalves and gastropods found in comparison to those found in the grab-samples (Figs. 13 and 10). This demonstrates how the dredge-tow concentrates hard-bodied organisms that are at or near the surface. The gastropods in the dredge-tows are all carnivorous whelks, with *Austrofucus glans* being the most common. The range of filter-feeding bivalves identified included low numbers of pipi's, scallops and *Tawera spissa*, while few deposit feeding bivalves were found in the dredge-tow samples.

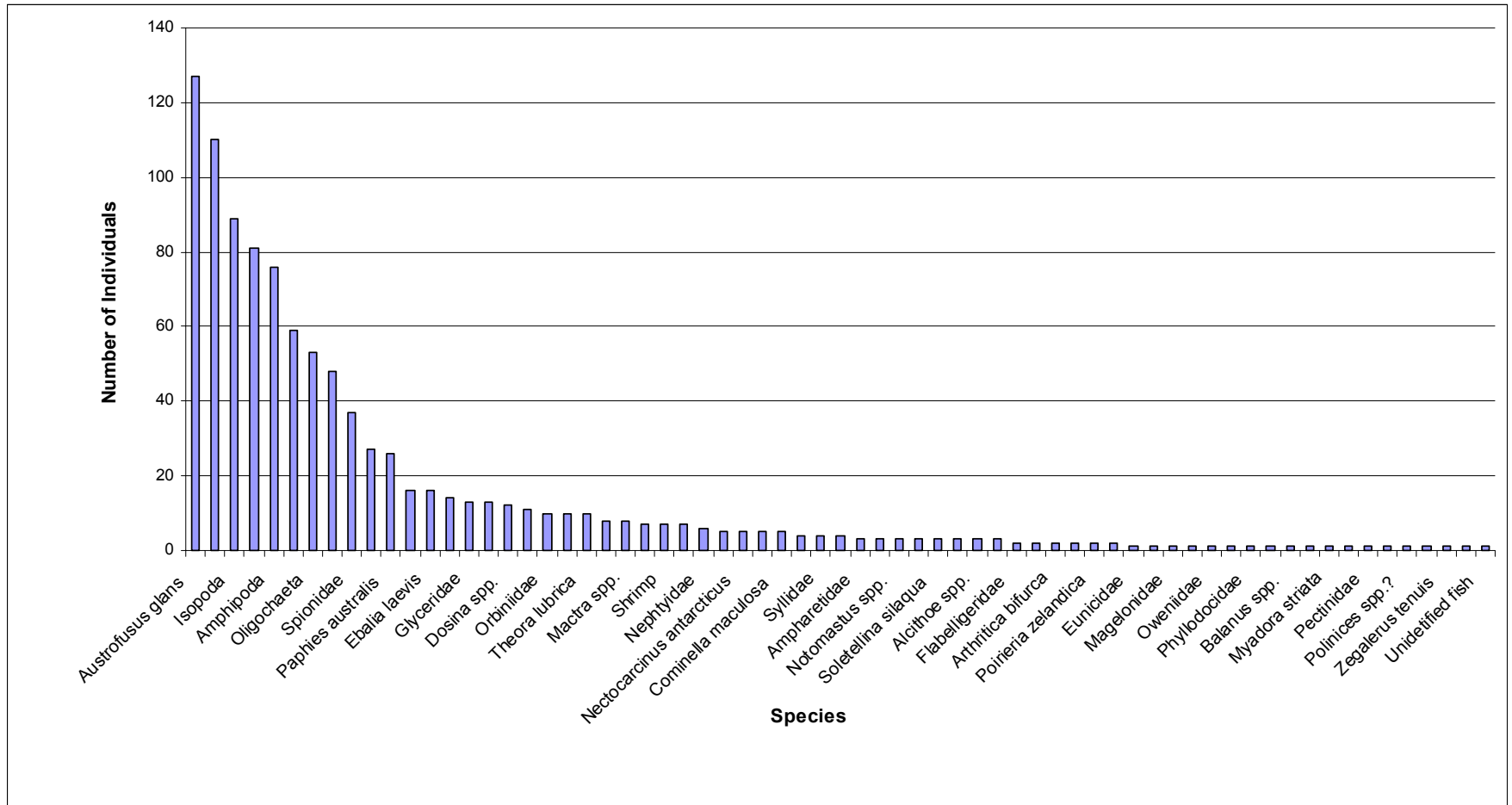


Figure 13. Species rank sum graph of dredge-tow data.

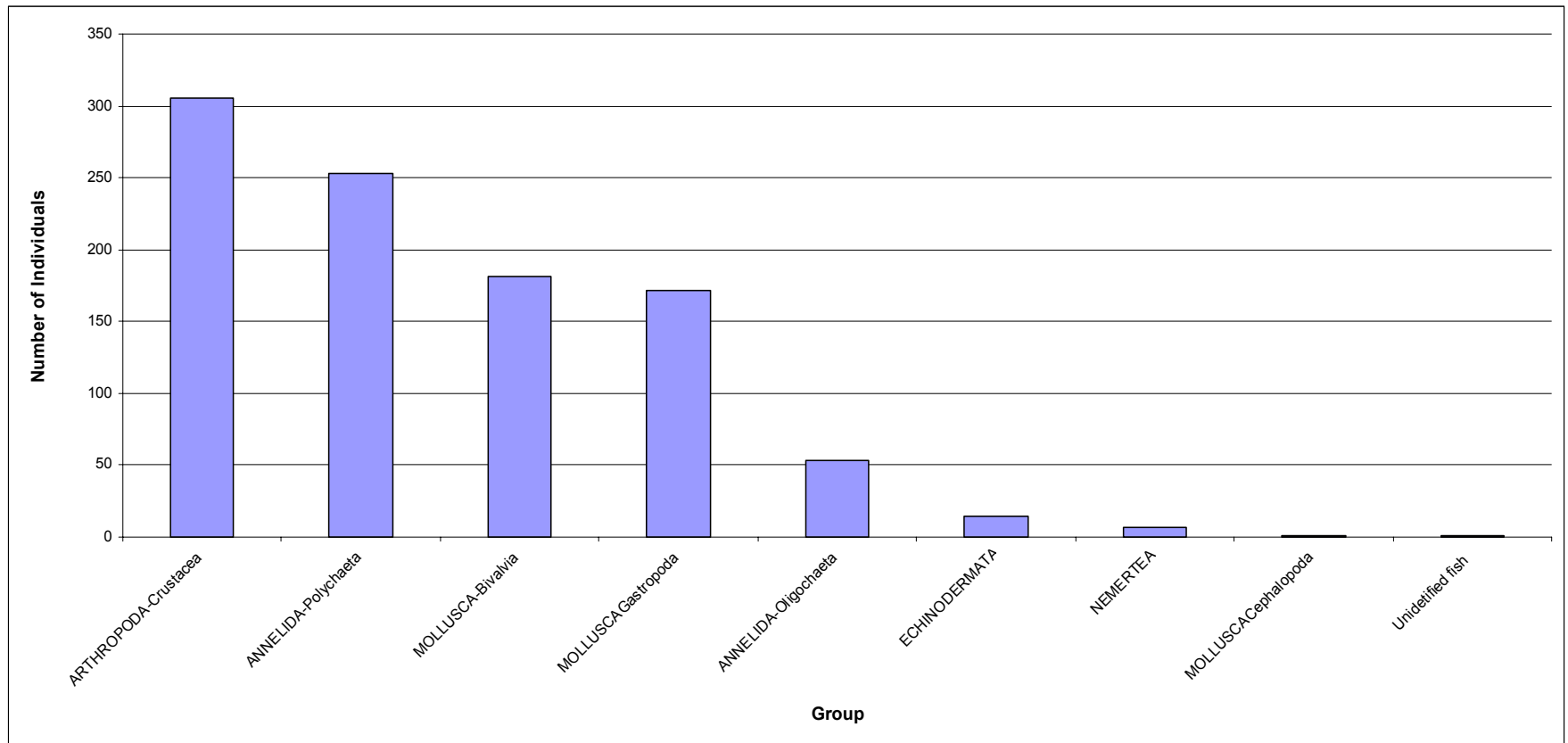


Figure 14. Group rank sum graph of dredge-tow data.

4 - EXISTING LITERATURE RELEVANT TO SUBTIDAL BIOLOGICAL SURVEY OF THE BAY OF PLENTY

Very little literature is available on the subtidal areas >10 m deep of the present survey, especially with respect to the soft-sediments. Previous searches for existing literature pertaining to the Cape Runaway area, which was video-surveyed in 2003 (Mead *et al.*, 2003a), identified 5 main sources of information,

1. Benthic community classification of the soft sediment infauna (McKnight, 1969)
2. Fish surveys and habitat descriptions of 4 sites (2 eastern and 2 western) at 0-24 m depths around Cape Runaway (Cole *et al.*, 2003)
3. An ecological survey at Te Kaha for a potential marine reserve (Hogan, 1992)
4. Classification of New Zealand Coastal Units: Comment on East Coast Hawke's Bay Conservancy (Internal Correspondence from Clinton Duffy, 26 October 1998)
5. Comprehensive dive notes from Whanarua Bay (Eastern Bay of Plenty) (C. Duffy, unpub.).

However, with the exception of McKnight (1969) the majority of these documents are focussed on reef habitat and/or depths of <10 m. Documents 2, 3 and 4 (Cole *et al.*, 2003; Hogan, 1992; Duffy, 1998) are Department of Conservation documents, which are available to the public - details such as species lists, etc., are not repeated here, rather a description of the relevant information contained in these reports is supplied. Further general information on fish species that occur in the area was gained through conversation with fishing charter operators in the area, on the Tumonz fishing information guide (Vision Software, 2001), and from Francis (1996). The summaries of documents 2-5 are attached as Appendix 2. Here we concentrate McKnight (1969), one of the few papers which consider the subtidal soft-sediment assemblages around New Zealand's exposed coastlines, and compare the findings of the present study.

McKnight (1969) describes the results of an analysis of nearly 600 benthic samples of the soft sediments around the New Zealand coast. Seventeen infaunal benthic community types were identified from these data. Only 10 of the samples are between Transects A and M, with 6 of these shallower than 100 m and relevant to the present survey. The habitat descriptions (mainly sediment types) for these sites are in general agreement with the findings of the drop-camera and grab-sample surveys, i.e. mud or muddy-sand, except in the shallower areas. The shallowest sample of McKnight (1969) is in 22 m depth just east of Ohope and was found to have a sandy substrate, while the remaining 5 samples are all at greater depths (26 – 99 m) and were found to have mud or mud/sand substrates. The community type in the muddy areas was classified as *Nemocardium* community specifically the *Nemocardium pulchellum* – *Pleuromeris zelandica* community, which is dominated by deposit-feeding bivalves and worms. In contrast, the sandy infaunal community is identified as a *Venus* community, specifically the *Scalpomactra scalpellum* – *Maorimactra ordinaria* community, which is characterised by suspension-feeding bivalves, probably due to the low organic content of the substrate in comparison to the muddy sands of other areas.

When the results of the current survey are compared to the classifications of McKnight, there is a general agreement, but there are several noticeable features. The first is that bivalves are not the dominant fauna of the subtidal areas (as was found in McKnight's (1969) investigation), rather polychaetes and iso/amphipods dominate. Similar results have been found with recent deep subtidal surveys the North Island's West Coast (e.g. Haggitt *et al.*, 2004; McComb and Mead, 2003; Mead and McComb, 2002) and North-eastern coast (Mead *et al.*, 2003b). This is likely due to the method of data collection, as well as preservation (with soft-bodied organisms being under-represented).

McKnight's (1969) investigation utilised benthic samples in the New Zealand Oceanographic Institute that were collected by a range of methods including grabs of various types, dredges and trawls, and focussed on species that were present in 20% or more of the samples. Organisms were then listed by percentage occurrence and the species with the highest occurrence lent the name to the particular benthic community. Mixing the various types of sampling methodologies to classify benthic communities may have led to differences of interpretation with respect to dominant organisms - as can be seen when the percentages of species found with grab samples is compared to those from the dredge-tows, they are significantly different, especially for hard and soft bodied species (Figs 9, 10, 12 and 13).

The differences in the results between the dredge-tows and the grab samples are highlighted when the deposit-feeding nutshells, *Nucula* spp., are considered. The presence of *Nucula* spp. follows sediment types well in the grab samples, with few individuals being found to the west of the survey area and larger numbers in the muddy regions (*Nucula* spp., feature in the deposit-feeding dominated *Nemocardium pulchellum* – *Pleuromeris zelandica* community, with more than 50% occurrence). A total of 131 *Nucula* spp. were identified in the grab samples, the 5th most common species. However, no *Nucula* spp. were found in any of the dredge-tows, most likely because these species are small (mesh size was 8 mm) and very fragile, and so were not collected by the dredge.

Park (1991) also noted that most studies of the Bay of Plenty subtidal region are restricted to the nearshore area. *Stuthiolaria papulosa* were reported as very common and the most abundant species in surveys around Matakana Island (Bioresearches Ltd, 1977, 1978 – cited Park, 1991). However, only a single specimen was found in both grab and dredge-tow samples in the present study.

Cole and Healy's (1997) studies of the Tauranga dredge spoil site (some 16 m depth) focussed on the bivalve species. Although there many similar species as those identified in the present study were found (a total of 31 species), the relative abundances vary greatly from those found in the present study (e.g. very high numbers of *Tawera spissa* were sampled). This is likely due to the intensity and methodology of sampling, as well as the influence of the nearby Tauranga Harbour entrance.

The most extensive offshore subtidal (28-46 m depth) surveys were undertaken for the proposed Eastern Seafarm Ltd mussel farm (Hopkins and Robertson,

2001). Similar species and abundances were found as those in the present study, with infaunal deposit-feeders dominating. Hopkins and Robertson (2001) also commented on the differences between their findings and the assemblages reported by McKnight's (1969) investigation, which they attributed mainly to differences in sampling techniques.

Classification of the deeper subtidal communities around New Zealand is an area that is still very limited in information. In the future, as more information is collected in surveys such as the present one and for large-scale offshore ventures (e.g. mussel farming, the oil industry, sand-mining), a better and better picture of the benthic communities and their associations with particular substrates/habitats and regions will be gained. It should be possible to relate the higher resolution studies (e.g. a 500 sample study between 10 and 50 m depth, utilising video, grab-samples and dredge-tows, is currently being undertaken in an 8 x 10 km area in northern Taranaki) to the lower resolution studies such as the present study and McKnight's (1969) nation wide classification.

5 - SUMMARY

- I. The data collected in the Bay of Plenty subtidal survey provide baseline/first order ecological information on the variety of organisms that inhabit the Bay of Plenty seabed and insight into the relative abundance and distribution of these organisms and their association with different seabed characteristics in the survey area.
- II. Video surveys of the Bay of Plenty subtidal area (200 sites from 10-100 m depth) identified 5 main habitat types, which are classified in order of dominance, as:
 6. Silt/mud
 7. Sand (usually rippled)
 8. Coarse sand/gravel (with a shell lag between ripples).
 9. Shallow reef (with kelp).
 10. Deep reef (with sponge).In terms of complexity, with the exception of 4 and 5, these habitats can be classified in the reverse order (i.e. 4 is the most complex, followed by 5, 3, 2 and 1).
- III. A total of 3257 individuals (124 species from 14 groups) were identified from 118 grab-samples and 12 dredge-tows - representative individuals have been catalogued for future reference.
- III. Large variations in species and abundance were found in the grab sample data, demonstrating the patchy distribution of benthic organisms. However some associations with respect to sediment type are discernable. The grab-samples show that polychaetes and amphipods are the dominant fauna in the area. Amphipods dominate shallower (<50 m) mud/silt areas, while polychaetes dominate sandy areas, with high organic content. A wide variety of bivalves are spread throughout region, although some patterns are present, i.e. the larger numbers of deposit-feeding bivalves are present in the in the muddy areas compared to the sandy areas.
- IV. Similar to the grab-sample data, large variations in species and abundance were found in the dredge-tow data. Polychaetes and crustaceans dominate the species found in the dredge-tow samples, with hermit crabs making up a large fraction of the crustaceans (unlike the grab-samples), which were mainly isopods and hermit crabs. In comparison to the grab-sample data, there is a marked relative increase in the number of bivalves and gastropods, which demonstrates how the dredge-tow concentrates hard-bodied organisms that are at or near the surface. The gastropods found in the dredge-tows were all carnivorous whelks, with a range of filter-feeding bivalves identified, but few deposit feeding bivalves.
- V. There is very little literature available on the subtidal areas >10 m depth relevant to the present survey area, especially with respect to the soft-sediments. When existing classification of benthic communities is

compared to the data collected in this survey there is a general agreement, but the paucity of samples and combinations of different sampling methodologies make it difficult to draw any solid conclusions. Future research could fill in 'gaps' in data and other high resolution benthic studies will help develop more comprehensive classification systems from New Zealand's benthic fauna.

6 - REFERENCES

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APPENDIX 1 – SPECIES LISTS FOR ORGANISMS IDENTIFIED IN GRAB-SAMPLES AND DREDGE-TOWS

Grab-Sample Species List:

Isopoda	357
Amphipoda	232
Foraminifera	141
Ophiuroidea (brittle star)	139
<i>Cuspadaria spp.</i>	128
Maldanidae	102
Spionidae	99
<i>Nucula hartvigana</i>	78
<i>Prionospio spp.</i>	73
SIPUNCULA	64
<i>Nucula spp.</i>	53
<i>Aglaophamus macroura</i>	45
Orbiniidae	45
<i>Arthritica bifurca</i>	45
<i>Macroclymenella stewartensis</i>	44
Lumbrineridae	43
Sabellidae	37
Flabelligeridae	30
Holothuroidea	27
Mysid shrimp	26
NEMERTEA	24
<i>Saccella bellula</i>	22
Ampharetidae	20
Siglionidae	20
Pectinariidae	19
Neriedae	17
Terebellidae	17
<i>Pagurus spp.(hermit)</i>	17
Syllidae	16
Oligochaeta	16
<i>Notomastus spp.</i>	13
<i>Poroleda lanceolata</i>	12
Cirritulidae	11
Cumacea	11
Glyceridae	10
<i>Cuna spp.</i>	10
<i>Dosina spp.</i>	10
<i>Paphies spp.</i>	10
Nephtyidae	9
<i>Pseudopolydora spp.</i>	9
<i>Armandia spp.</i>	8
<i>Theora lubrica</i>	8
Ostracoda	7
<i>Soletellina silaqua</i>	7
<i>Tawera spissa</i>	7
Eunicidae	6
Oweniidae	6
<i>Venericardia purpurata</i>	6
Hesionidae	5
<i>Exogonid spp.</i>	5
Cladocera	5
Shrimp	5

<i>Glycera lamellipoda</i>	4
<i>Magelona dakini</i>	4
<i>Orbinia papillosa</i>	4
Polynoidae	4
<i>Corbula zelandica</i>	4
<i>Venerupis largillierti</i>	4
Captidellidae	3
Cossuridae	3
Magelonidae	3
<i>Travisia spp.</i>	3
<i>Edwardsia spp.</i>	3
<i>Ebalia laevis</i>	3
<i>Venericardia spp.</i>	3
<i>Austrofusus glans</i>	3
Aphroditidae	2
<i>Glycera spp.</i>	2
Serpulidae	2
Sternaspidae	2
Carideans	2
<i>Myadora striata</i>	2
<i>Notocallista multistriata</i>	2
<i>Thracia australica</i>	2
Pectinidae	2
<i>Acteon (maxacteon) milleri</i>	2
PLATYHELMINTH	2
Chrysopetalidae	1
Notophycidae	1
Onuphidae	1
<i>Ophelia spp.</i>	1
Phyllodocidae	1
Scalibregmidae	1
<i>Scolecopides spp.</i>	1
<i>Anthopleura spp.</i>	1
<i>Hemigrapsus spp.</i>	1
<i>Pinnotheres novazelandiae</i>	1
<i>Batharca cybaea</i>	1
<i>Ennucula spp.</i>	1
<i>Glycyms modesta</i>	1
<i>Myadora boltoni</i>	1
<i>Paphies australis</i>	1
<i>Perrierina spp.</i>	1
<i>Protothaca crassicosta</i>	1
<i>Zenatia acinaces</i>	1
<i>Crepidula monoxyla</i>	1
<i>Epitonium tenellum</i>	1
<i>Notoacmea helmsii</i>	1
<i>Struthiolaria papulosa</i>	1
Architectonicidae	1
BRACHIOPODA	1

Dredge-Tow Species List:

<i>Austrofuscus glans</i>	127
<i>Pagurus spp.(hermit)</i>	110
Isopoda	89
<i>Corbula zelandica</i>	81
Amphipoda	76
<i>Prionospio spp.</i>	59
Oligochaeta	53
<i>Aglaophamus macroura</i>	48
Spionidae	37
<i>Pratulium pulchellum</i>	27
<i>Paphies australis</i>	26
Pectinariidae	16
<i>Ebalia laevis</i>	16
<i>Amalda australis</i>	14
Glyceridae	13
Sabellidae	13
<i>Dosina spp.</i>	12
Acmaeidae	11
Orbiniidae	10
Siglionidae	10
<i>Theora lubrica</i>	10
Holothuroidea	8
<i>Mactra spp.</i>	8
Neriedae	7
Shrimp	7
NEMERTEA	7
Nephtyidae	6
<i>Exogonid spp.</i>	5
<i>Nectocarcinus antarcticus</i>	5
Ophiuroidea (brittle star)	5
<i>Cominella maculosa</i>	5
<i>Pseudopolydora spp.</i>	4
Syllidae	4
<i>Tawera spissa</i>	4
Ampharetidae	3
Aphroditidae	3
<i>Notomastus spp.</i>	3
<i>Pecten novaezelandiae</i>	3
<i>Soletellina silaqua</i>	3
Patellacea	3
<i>Alcithoe spp.</i>	3
<i>Xenophora neozelanica</i>	3
Flabelligeridae	2
Opheliidae	2
<i>Arthritica bifurca</i>	2
<i>Myadora antipodum</i>	2
<i>Poirieria zelandica</i>	2
ASTEROIDEA	2
Eunicidae	1
Lumbrineridae	1
Magelonidae	1
Maldanidae	1

Oweniidae	1
<i>Owenia fusiformis</i>	1
Phyllodocidae	1
Terebellidae	1
<i>Balanus spp.</i>	1
Cumacea	1
<i>Myadora striata</i>	1
<i>Poroleda lanceolata</i>	1
Pectinidae	1
<i>Crepidula monoxyla</i>	1
<i>Polinices spp.?</i>	1
<i>Struthiolaria vermis vermis</i>	1
<i>Zegalerus tenuis</i>	1
Cephalopoda	1
Unidentified fish	1

**APPENDIX 2 – LITERATURE REVIEW FROM MEAD ET AL. (2003A), THE
CAPE RUNAWAY MARINE SURVEY.**

1. McKnight, 1969 – This paper describes the results of an analysis of nearly 600 benthic samples of the soft sediments around the New Zealand coast. Seventeen infaunal benthic community types were identified from these data. Only two of the samples are relevant to Cape Runaway, one on either side of the Cape, although not within the study area as shown in Figure 1. The habitat descriptions (mainly sediment types) for these two sites is in general agreement with the findings of the drop-camera survey, i.e. silty sand on the western side and coarse sand on the east. The community type in the silty sands to the west of Cape Runaway is identified as a *Nemocardium* community specifically the *Nemocardium pulchellum* – *Pleuromeris zelandica* community, which is dominated by deposit-feeding bivalves and worms. In contrast, the eastern infaunal community is identified as a *Venus* community, specifically the *Tawera spissa* – *Venericardia purpurata* community, which is characterised by suspension-feeding bivalves, probably due to the low organic content of the substrate in comparison to the silty sands of the western side.

2. Cole et al., 2003 – This report summarises the findings of a FRST-funded project regarding the fish fauna and habitats of Cape Runaway. Depth and habitat stratified fish counts (3 strata in 8 m intervals down to 24 m, plus a reef edge stratum) were taken at 4 sites; 2 on the western side and 2 on the eastern side of the Cape proper. In addition to fish counts, habitat was also quantified in two randomly chosen sections of the fish count transects. Habitat was quantified by recording the substratum type (bedrock, boulders, cobbles, gravel, sand), topographic complexity, cover of seaweed species and their canopy heights – species and methodology is presented in Table 1 of this report. Canonical discriminant analysis (CDA) was used to classify fish and habitat variables, which is a useful technique for displaying differences among groups of samples. No data regarding other fauna and flora, such as encrusting invertebrates, and non-canopy seaweeds. Limitations due to the small number of sites sampled and inter-annual variability are noted.

39 fish species are listed from Cape Runaway, and the habitat data are compared to other localities in the Bay of Plenty. This comparison demonstrated that the habitat at Cape Runaway is most similar to that at Te Kaha, some 30 km to the west, where a comprehensive ecological survey was undertaken by Hogan (1992). General diver observations at Cape Runaway include less current, more swell, and greater visibility on the east (less affected by Whangaparaoa River) and higher sediment loads on the west (as found with the drop-camera survey). It was also noted that the west side lacked the seaweed *Lessonia variegata*, a seaweed that usually occurs in areas of strong wave action.

The report concludes that Cape Runaway has high species richness for a mainland locality, with a wide variety of fish species in an accessible setting. Because of the differences between the west and east sides of the Cape (no doubt a combination of different physical parameters such as sediment load, substrate type, depth range, exposure to large swell, etc.) it is suggested that a marine reserve that included both sides of the Cape would result in representation of the maximum amount of habitat variability. This is consistent with the findings of the drop-camera survey. Eastern sites are considered better for recreational diving (which is supported by local knowledge) and there are representative

examples of the classic north-eastern New Zealand sub-tidal habitat types such as mixed shallow water seaweeds, urchin barrens and kelp forests occurring down a predictable depth gradient – this is also supported by the drop-camera survey. Fish species likely to benefit from a marine reserve at Cape Runaway are listed as snapper (*Pagrus auratus*), blue moki (*Latridopsis ciliaris*) and red moki (*Cheilodactylus spectabilis*), as well as the spiny lobster (*Jasus edwardsii*).

3. Duffy, 1998 – This Department of Conservation internal correspondence gives a general description of the geography/topography, oceanography and biota (divided into open coast inter-tidal, estuarine, pelagic and coastal benthic communities) between Opape to Matakaoa Point. Although only 3 pages in length, this document presents a comprehensive list of species (both pelagic and benthic) associated with particular habitat types in this region.

This document notes the fast depth increase and proximity of the continental shelf off of the Cape Runaway area and the input of 3 large rivers that discharge large amounts of silt to the southwest of Cape Runaway. A large variety of pelagic fish species are listed, which in conjunction with those identified by Cole *et al.* (2003) and the fishing guide and local knowledge, shows the large variety of fish species inhabiting or visiting the Cape Runaway area. Big eye, two spot demoiselle, black angelfish, green wrasse, red pig fish and golden snapper are identified as being species that are characteristic of the north-eastern New Zealand biogeographic region. It is also noted that blue moki spawn off Cape Runaway.

The general description of sub-tidal habitats is consistent with those identified from the drop-camera survey, with shallow mixed seaweed, kina barrens, Ecklonia forests and deep reef zones. Characteristic and common species are described for each specific habitat.

4. Hogan, 1992 – The document reports the results of a preliminary inter-tidal and sub-tidal marine habitat study for a proposed marine reserve at Maraetai Bay, Te Kaha, some 30 km west of Cape Runaway. Although preliminary, the marine survey methodology was fairly comprehensive and incorporated diver transects, spot dives, manta tows and depth soundings to collect a mainly qualitative dataset. Detailed descriptions of the habitat down shore-normal transects are presented that list a wide range of species present. In addition, 4 pages of algal and invertebrate species and 1 page of fish species are listed.

Similar habitat types as those identified in the drop-camera survey are present at Maraetai Bay, with the kina barrens present as a band between the shallow mixed weed zone and the Ecklonia forest zone. Silty sand was found to be present offshore from depths greater than 10-15 m, similar to that found on the western side of Cape Runaway.

5. General notes on fish species at Cape Runaway adapted from Tumonz digital map of NZ (Vision Software, 2001) and discussion with local anglers

During summer, warm oceanic waters move inshore to Cape Runaway, visibly obvious as water of a deeper shade of blue ('blue water'). With these waters come the gamefish. Fishing the waters around the Cape has been described as nothing short of spectacular at times.

The water around the Cape itself is fairly shallow and good rock ledges are few and far between. Of the gamefish available in New Zealand waters, virtually all species have been hooked within a short distance of the Cape. Snapper fishing around the Cape can be excellent at times. Hapuku and moki are popular targets over winter and large numbers of kingfish appear in spring. Good runs of kahawai are common at the Whangaparaoa River mouth over summer. At Tahuru (Eastern border of area, off of Site 342) there are a lot of underwater reef systems that are frequented by snapper.

There are a series of deep water ledges 3 km east of the survey area boundary. A large variety of species can be found here, including snapper, trevally, kingfish and bronze whalers. Over summer, very large blue maomao turn up here at high densities. Other summer 'visitors' to the Cape include dolphins, orcas, flying fish and occasionally humpback whales.

6. Duffy, unpublished – These dive notes have been transcribed to the Appendix and describe observations of two dives undertaken some 20 km to the west of Cape Runaway. A comprehensive list of species (algal, invertebrate and fish) is provided, along with an indication of the relative abundance of most (1=present, 2=common, 3=abundant). Again, similar habitat types as those identified from the drop-camera survey are described in the dive notes, namely shallow mixed seaweed, kina barrens and Ecklonia forest. Deep Ecklonia forests similar to those videoed off of Cape Runaway are described, with low densities of plants with long stipes. Note, some spelling mistakes are present due to errors during transcription from hand-written notes.

Dive 379	13 September 1998
Site:	Inner Whanarua Bay BOP
Time in: 11.02am	Duration: 49 mins
Maximum depth:	40ft Vis 30ft
Buddy: Steve Sawyer	

Comments:

Nice dive around middle western side of the bay. Shingle beach, cobbles from low water to 20-25 ft, poorly sorted sand (with large shore-parallel ripples), numerous outcropping reefs to around 34 ft. Lots of *Chamaesipho columna*, *Cellana radians* *Lepsiella* in intertidal. Fringe of *Xiphophora*, *Carpophyllum masc.*, *C. plumosum*, *Ecklonia*, occasional *Lessonia* and *Landsburgia*. Dense *Osmundaria colensoi*, *Zonaria* to 20 ft. *Pterocladia lucida* on tops of rocks. *Carpophyllum augustifolium* fringe on exposed pinnacles. *Ecklonia* and *Carpophyllum flexuosum* 20 ft – 40 ft. Thick coralline crusts on the land substrates.

Grazing inverts. *Turbo*³, *Cookia*³, *Cellana stellifera*³, *Eudoxochiton*², *Pseudechinus huttoni*² (around 30 ft), *Evechinus*³, *Trochus viridis*³, *Pagurus traversi*³, *Pagurus novaezelandia*².

Encrusting inverts: *Ancorina alata*², *Stelletta cenulosa*, *Polymastia granulosa*², *Waltonia inconspicue*³, *Cliona celata*³, *Flabellum rumbrum*³, *Culicia rubeola*², (above 20 ft), *Asterocarpus coerulea*², *Cuemidocarpa bicaruate*³, white solitary ascidian², large warty solitary ascidian invariably encrusted with coralline crusts (?*Pyura* sp.), several species of compound ascidian common.

Other inverts: green and yellow deposit feeding polychaete (?Acrocirrus sp.); ophionereis fasciata3 (beneath cobbles, on reef), Pectinura maculata (beneath cobbles), Ophiopteris antipodim2, Thais orbita2, Haustrium haustorium, Stichopus mollis3, Plagusia chabrus3, Jasus , Astrostole Scabra,edwardsi3, Haliotis iris3, H. australis2, Maurea tigris2, Penion sulcatus2, Cominella adspersa2, Cominella virgata2, Cryptoconchus porosus, Eurytolambus australis1, Shrimps seen at Three Kings (Rhynchocinetes sp. Hingeback shrimp), Phylctenactis tuberculosa2,

Fish: spotty3, N. Fucicola2, Forsterygion lapillum2, Forsterygion varium3, F. malcolmi2, Karalipis Stewarti1, Notoclinops, segmentitus2, Obliquichthys maryannae, Parablennius laticlevis2, Scopaeana papillosus2, Optiurus elogetus3, Pempheris3, Hypoplectrodes hunti2, Cheilodactylus spectabilis3 Aplodactylus arctidens2, Chironemus memoratus1, Scorpius liveolatus2 (schools of new recruits), Paraperis colias1, Chlomis dispilus1, Upeneichthys Lieatus2, Parika scaber1, Dellichthys morelandi2, Ruanohe whero3, Thalasseleotris sp1.

Note: Patches of short Corallina officinalis on cobbles near shore. "Urchin Barrens"

Tigris2, Penion sulcatus2, Cominella adspersa2, Cominella virgata2, Cryptoconchus porosus1, Eurytolambus australis1, Shimps seen at Three Kings, Phylctenactis tuberculosa2.

Fish: Spotty3, N.Fucicola2, Forsterygion lapillum2, Fersterygion varium3, F. melcolmi2, Karalepis Stewerti1, Notoclinops segmentatus2, Obliquichthys maryzwe1, Parablennius laticlavus2, Scopoeana papillocus2, Optiurus elongatus2, Pempheris3, Hypoplectrodes hunti2, Cheilodactylus spectabilis3, Aplodactylus archidems2, Chironemus mermoratus1, Scorpius liveolatus2, (schools of new recruits), Paraperis colias1, Chromis dispilus1, Upeneichthys linatus2, Parika scaber1, Dellichthys morelandi2, Ruaneho whero3, Thalasseleotris sp1.

Note: Patches of short Corallina officinalis on cobbles near shore. "Urchin Barrens", common, large, dominated by herb. gastropsods and Evechinus. Patches of Amphiroa Sp. Below 20 ft. Many recently settled Optiurus present. Large patches of iridescent red (?Champia Sp.), most abundant around 20 ft. Most of the Jasus were very small, Haven't seen this many tiny crays since Cook Strait/Port Underwood.

Dive 380	13 September 1998
Site:	Headland 4 km east by road from Kereu River
Location:	Bay of Plenty
Time in: 2.30pm	Duration: 52 mins
Maximum depth:	62ft Vis 30ft -15 ft at 60 ft.
Buddy: Steve Sawyer	

Comments: Intertidal zonation littorina > chamaesipho brunnea > c. columa zone.

Mixed fringe: Xiphophora > C. Angustifolium and C. maschalocarpum. Also Lessonia variegata to 20 ft, occasional Xiphophora seen to this depth. Dense Zonaria and Osmunderia?Champia sp. common. Carpophyllum flexuosum and Ecklonia dominant spp. From 20-40 ft. Occasional C. maschalocarpum to 30 ft. Occasional Halopteris Sp. Osmunderia Zonaria. Interesting divaricating encrusting red collected at 26 ft. 40-60 ft low density Ecklonia forest. Tall stripes, ~ 1 m, Little growing beneath it. Thick coralline crusts cover all land substrates at all depths. Sponges sparse.

Grazing Inverts: Evechinus3 (urchin barrens common between 20-30 ft), Turbo smaragadus2, T. granosus2, Trochus viridus3, Cookia sulcata3, (all sizes present), Cantharidus purpureus2, Haliotis iris3, Cellana stellifera3, Endoxachiton2.

Other molluscs: Penion sulcatus2, Penion dilatatus, Buccinum multilinum2, Scutus breviculus2, Maurea tigris2, Chromodoris amoena 1, Cryptoconchus porous1.

Other inverts: Astrostole, red collected at 26 ft. 40-60 ft low density Ecklonia forest. Tall stipes, ~1 m. Little growing beneath it. Thick coralline crusts cover all hard substrates at all depths. Sponges sparse.

Grazing inverts: Evechinus3, (urchin barrens common between 20-30 ft), Turbo smaragadus2, T. granosus2, Trochus viridus3, Cookia sulcata3. (all sizes present), Cantharidus purpureus2, Haliotis iris3, Cellana stellifera3, Endoxochiton2.

Other molluscs: Penion sulcatus2, Penion dilatatus, Buccinum multilinum2, Scutus breviculus2, Maurea tigris2, Chromodoris amonea 1, Cryptoconchus porosus1.

Other inverts: Astrostole scabra2, Plagusia chebleus3, Jasus edwardsi2, Cnemidocarpa bicornuata3, Asterocarpa coeruleus3, (most abundant above 40 ft but present at all depths), Stichopus mollis3, Ophiopteris antipodum, Ancorina alata2, Polymastia fusca 1, Tethya spp2. Below 50 ft Hippelozoan novaezelandiae was common. Calicia rubeole2, Flabellum rubrum3, Maurea tigris2, sheets of compound ascidians in fissures and beneath overhangs.

Most fish life in upper 20 ft: Spotty³, banded wrasse², Parika scaber¹, Scorpoena papillosari², butterfish², porae², Parma alborcapularis², Forsterygion lapillum², Forsterygion varium³, Notoclinops segmentatus², Parapercis colias¹, Optiurus elongatus³, Peupheris³, (latter spp. at all depths).

Other fish: sweep², blue mao mao¹, Hypoplectrodes huntii², Cheiladactylus spectrabilis³, (all depths, most common about 50 ft), Apolodactylus cretilus², Forsterygion malcolmi², Obliqueichthys maryannae², (small groups and individuals), Forsterygion flevonigrum¹, Ruanoho whereo³, Lotella rhecinus¹, 2 large conger, Dellichthys², goat fish², Chromis dispilis².

Outcropping reef extends a long way offshore. Cobbles and gravel lined surge channels – 20 ft deep. Patches of coarse sand accumulated in places. Large areas of poorly sorted, silty sand at 60 ft. Ripples along almost shore-normal, Ecklonia forest felt empty – little movement, little cover except for outcropping rocks. Only fish seen down there were spotty, banded wrasse, Ophiurus, Pempheris, Sweep, red moki, banded perch, yellow-black trip, F. malcolmi, R. whereo, school of Chromis.

Notable absences: Crassostrea gigas, scarlet wrasse.