

Crude Freight Project

Ecology Stage One Pilot Study

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Introduction

Kerr & Associates has been asked to conduct a pilot ecological descriptive study of 18 transects which border the proposed channel-widening project at the entrance of Whangarei Harbour. The primary aim of the study is to characterise the habitats along each transect so that long term fixed monitoring sites can be selected for which quantitative survey methods can be used to support the project.

The 18 transects chosen were representative of the habitats adjacent to the dredging project and cover the inner entrance and outside delta area of the Harbour and include habitats ranging from intertidal to subtidal bordering the channel itself.

This report presents the data collected in the month of December 2015 via use of a box dredge and drop video camera and diver based photography.

A supplemental map book has been prepared that includes maps of the sites used for this pilot study and a key results of the survey are presented. The map book also includes a collection of historic habitat and sediment maps. This map book should be used in conjunction with this report for interpretation of these results.

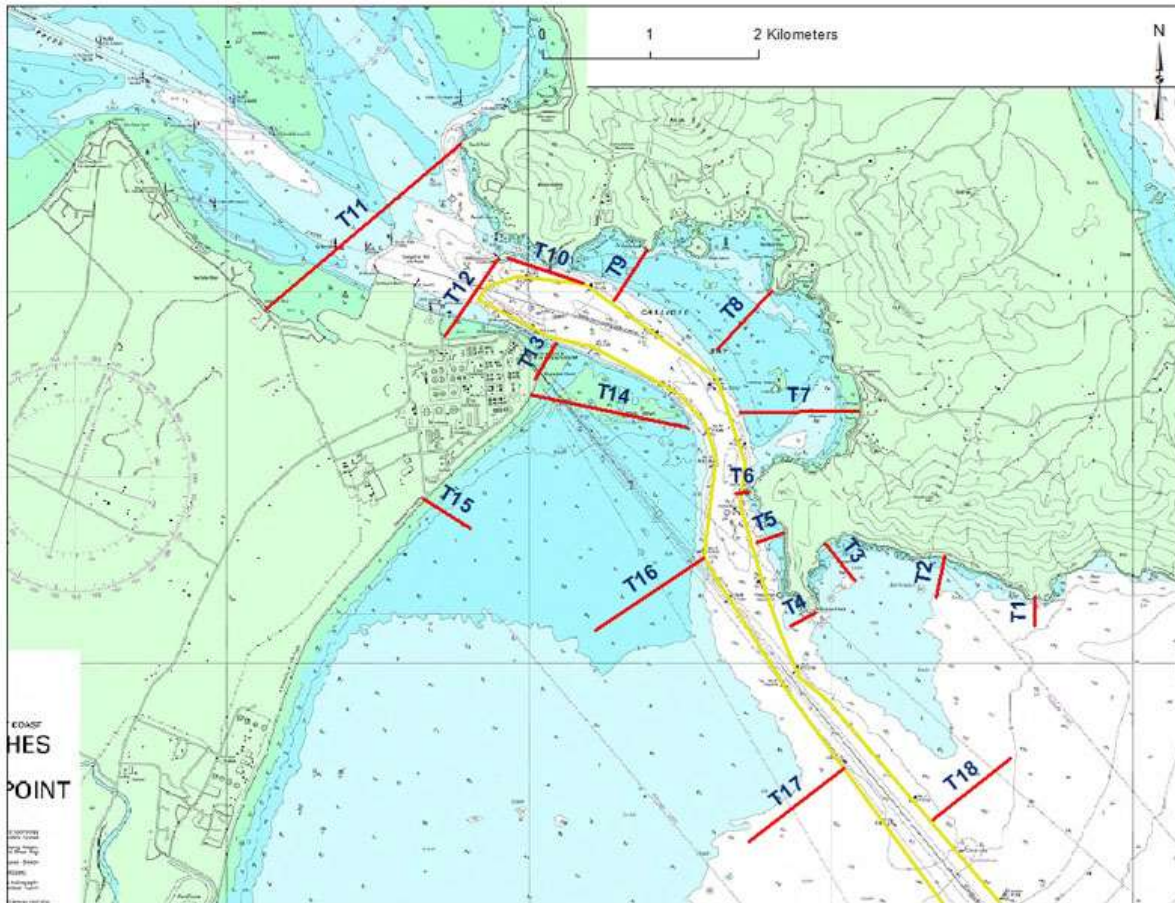


Figure 1. Map of pilot study transects

Methods

Intertidal habitats:

Photos were taken from the water of each intertidal site to aid in selection of sites for the next stage survey.

Subtidal rocky shores

A scuba dive team collected a set of photos and notes along each transect line from the shore out to where the reef turned into a soft bottom substrate. Notes and photos were taken to represent the community changes along the depth profile.

Subtidal soft substrates

A box dredge was deployed at 44 sites divided amongst the 18 transects. The box dredge used has a full volume of 4.5 litres. Notes were kept of the depth, time, dredge volume and residue volume (post sieving). Samples were immediately sieved through either 5mm screens for shelly substrates or a 2 mm screen for predominantly sandy substrates. Following the sieving process the residues were bagged and stored in an iced chilly bin. Back at base, Roger Grace analysed the benthic invertebrate communities present in the dredge samples. Identification of organisms was aimed at categorising their main taxonomic group, but most often were identified to species or genus level. Individual numbers were generally counted. A collection of voucher organisms was fixed and stored for future reference. A photographic record was made of the residue and organisms found in each dredge sample. These photo records are available for further reference.

From the dredge samples notes were taken of the dredge sample volume and the volume of the residual material after the material was washed and sieved. A brief description of the substrate type was recorded. These results are listed below in the results for each transect. The descriptions of substrate were classified into a simple substrate classification for both the dredge samples and the video observations. The classification adopted was: mud, fine sand, shelly fine sand, shelly medium sand, medium sand and shell gravel. The substrate classification of the sample sites are represented in the first two maps of the map book along with a graphic display of the species numbers or diversity of the dredge samples.



Figure 2. Box dredge used for this survey

A simple drop video camera was deployed at 21 sites. These sites were selected to augment the information on substrate type and show any visible epifauna.

Results

Transects 1 and 2

Intertidal zones

The shores of Transects 1 and 2 are typical of the inner coast of Bream Head. They can be described as boulder and semi-sheltered. They are generally sheltered, but in strong southerly or southeast weather conditions are exposed to swell. Transect 1 more so than Transect 2 as it is located on a small point where the coastline turns slightly. Transect 2 is further in towards Smuggler's beach and is located on a straight section of coastline.



Figure 3 The intertidal site for Transect 1

Subtidal rocky reef zone Transect 1

The rocky reef in this location is bouldery with some boulders reaching several meters in size. It contains a shallow mixed weed zone of *Ecklonia radiata* and *Carpophyllum* macroalgae species with a diverse understory of encrusting invertebrates. From 1m to 4m depth there are extensive kina grazed areas where the kelp forest is absent. Coralline turfs dominate the encrusting community in these areas. Below 4m *Ecklonia* forest dominates, thinning with depth, as the understory invertebrate community becomes more diverse and lush. At 12m the reef ends making a transition to a coarse sand soft bottom habitat. Below 6-8m large sponge species start to appear in the understory.



Figure 4. (left) dense *Ecklonia radiata* forest below 4m depth, (right) understory encrusting invertebrate community associated with the *Ecklonia* forest community consisting of encrusting algae, sponges, Ascidians and Bryozoans.



Figure 5 (left) Bouldery reef with extensive kina grazed zone in the 1m to 4m depth profile. (right) Transition area at 12m from bouldery reef to coarse sand soft bottom habitat.

Subtidal rocky reef zone Transect 2

The rocky reef in this location is bouldery with some boulders reaching several meters in size. There is a diverse shallow mixed weed zone of *Ecklonia radiata*, *Carpophyllum* and other brown macro algae species with a diverse understory of encrusting invertebrates extending down to 3-4m. From 1m to 4m depths there are a few small patches of kina grazed areas where the kelp forest is absent. Coralline turfs dominate the encrusting community in these patches. Below 4m the *Ecklonia* forest dominates, thinning with depth, as the understory invertebrate community becomes more diverse and lush. At 11m depth the reef ends making

a transition to a coarse sand and fine gravel soft bottom habitat. Below 6-8m large sponge species start to appear in the understory.

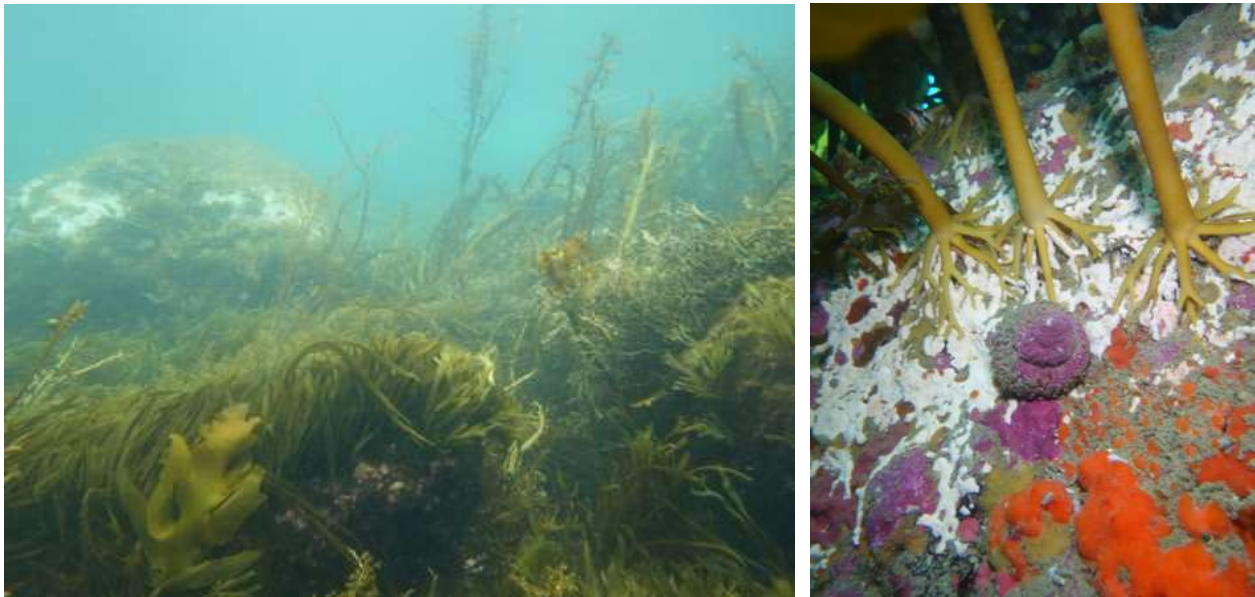


Figure 6 (left) Shallow mixed weed zone extending to 3-4 m depth. (right) The understory of dense *Ecklonia radiata* forest with encrusting sponges and coralline paint algae at 4-8m depth.



Figure 7 (left) Dense canopy of *Ecklonia radiata* kelp forest in the depth zone from 3-8 m, (right) transition of reef edge to coarse sand and gravel soft bottom habitat, several large sponge species are common on rocks at this depth.

Benthic communities transects 1 and 2



Figure 8 Site map of Transects 1 and 2

Notes:

Species identified are listed in Appendix 1

T1 D38

Substrate: shelly medium sand, slightly silty

Residue: mainly shell

T1 D37

Substrate: shelly medium sand, slightly silty

Residue: shell

T2 D35

Substrate: shelly medium sand, slightly silty

Residue: shell

T2 D36

Substrate: shelly medium sand, slightly silty

Residue: shell

Dredge Sampling results	T1 D38	T1 D37	T2 D35	T2 D36
number of individuals counted	81	25	13	22
number of species	15	10	7	13
fraction of dredge filled	6/10	7/10	8/10	7/10
dredge residue volume (liters)	1	0.15	0.5	0.2
depth (m)	21	23	16	17
sieve size (5 mm)	5	5	5	5

Table 1 Dredge sample notes

Transect 3, 4, and 5

Intertidal zones

Transect 3 Smugglers Cove: a fine sand beach habitat, moderate to low exposure

Transect 4 Busby Head: a steep rocky shore with some large boulders. This is quite an exposed site with strong winds and tidal currents whipping around the point. The point is itself is one of the area's most used rock fishing sites and as such is heavily trampled by foot traffic. If this site is selected for intertidal sampling, it would be advisable to locate the transect around the corner some distance towards the harbour entrance to avoid the trampling impact on intertidal communities.

Transect 5 Seaward of Home Point: This is a sheltered site with a boulder shore and very limited subtidal reef.



Figure 9 Transect 3 intertidal habitats, Smuggler's Cove



Figure 10 Transect 4 Busby Head intertidal habitat



Figure 11 Transect 5 intertidal boulder habitat

Subtidal rocky reef habitats

Transect 4: The subtidal reef at Busby Point is a steep slope down to 8m depth where there is a transition to a shelly coarse sand soft bottom habitat. There is a shallow mixed weed zone of *Ecklonia radiata* and mixed *Carpophyllum* species macroalgae going down to about 3m. Beyond that there is a fairly dense *Ecklonia radiata* forest with encrusting sponge and invertebrate community understory extending down to 8m depth.



Figure 12 (left) shallow mixed weed zone 1.5 m deep, (right) understory encrusting invertebrate community associated with *Ecklonia* forest at 8m depth, several sponges species and encrusting algae and other invertebrates.



Figure 13 (left) Dense *Ecklonia radiata* forest at 6m depth, (right) the reef edge at 11m showing the shelly coarse sand soft bottom fringing habitat.

Transect 5: This shoreline is made up of small boulders that extend into the subtidal zone. At 4-6m from the shore a complete transition to a shelly coarse sand soft bottom takes place. In this subtidal zone the small boulders have *Ecklonia radiata* and encrusting invertebrate communities growing on them with sand patches between them.



Figure 14 The subtidal shore habitat is a boulder and coarse shelly sand environment that makes becomes a soft bottom habitat 6m from shore at about 2m depth.

Benthic communities transects 3, 4, and 5

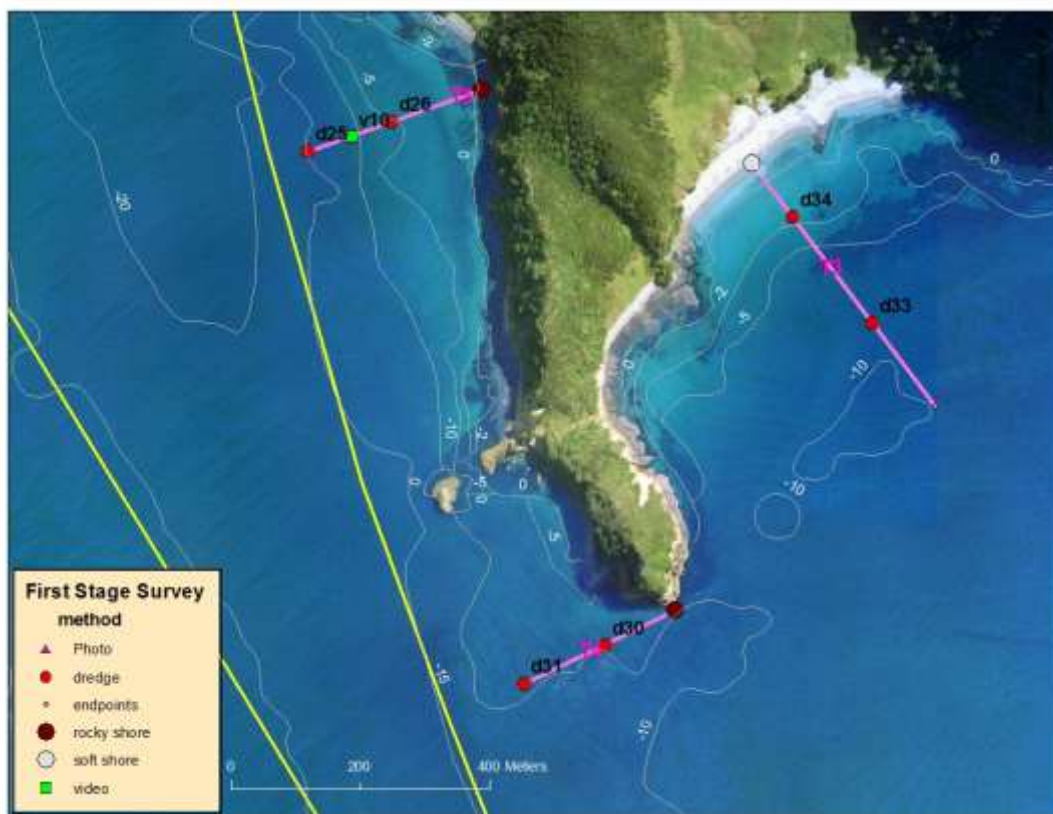


Figure 15 Site map of Transects 3, 4 and 5

Notes:

Species identified in dredge samples are listed in Appendix 1

T3 D34

Substrate: medium sand

Residue: half shell, half worm tubes

T3 D33

Substrate: medium to course sand with a few rocks, slightly silty

Residue: shell

T3 D25

Substrate: muddy fine sand

Residue: half shell, half worm tubes

T3 D26

Substrate: shelly medium to course sand

Residue: shell

T4 D30

Substrate: sandy shelly gravel

Residue: shell

T4 D31

Substrate: shelly course sand

Residue: shell

Dredge Sampling results	T3 D34	T3 D33	T5 D25	T5 D26	T4 D30	T4 D31
number of individuals counted	28	33	120	153	121	63
number of species	13	24	39	21	22	20
fraction of dredge filled	7/10	8/10	8/10	3/10	7/10	5/10
dredge residue volume (liters)	0.2	.150*	0.15	0.2	4	2
depth (m)	6	15	25	8	15	16
sieve size (mm)	2	5	2	5	5	5
* several rocks approx. .6 L						

Table 2 Dredge sample notes

Transect	Site	Depth (m)	Sediment Description	Notes
5	v10	7	medium sand, quite shelly, could be some fine gravels	drift algae, small amount of drift seagrass, small amount of small turfing algae, one Ecklonia radiata growing

Table 3 Video drop notes for Transect 5

Transect 6

Intertidal zone

Home Point is sheltered site but subject to strong currents as its position juts out in to current causing the current to be exaggerated at this point. It is a bouldery shore with a mixture of large and small boulders.



Figure 16 A view of Transect 6 at Home Point looking back from the channel edge. (taken a high tide)

Subtidal rocky reef zone

In the earlier survey carried out on the channel edges this site was videoed during good visibility conditions. That video is available to support this report. We did not do any further survey work here as we have dived and surveyed this area previously. The subtidal habitat is boulder rocky reef from shore to the channel edge at over 20m depth. From the zero point there is approximately 20m of 2-3m depth consisting of a shallow mixed weed zone. Beyond this point the reef slopes gently to a depth of 6-8m and then drops off more steeply down to the channel edge. The reef at depths greater than 3-4m, is covered in *Ecklonia radiata* forest with an understory of encrusting invertebrates. The *Ecklonia* thins out considerably bellow 15m and large sponges become common. In previous survey dives in this location the authors have noted areas of concentrations of a white anemone, *Anthothoe albocincta*.

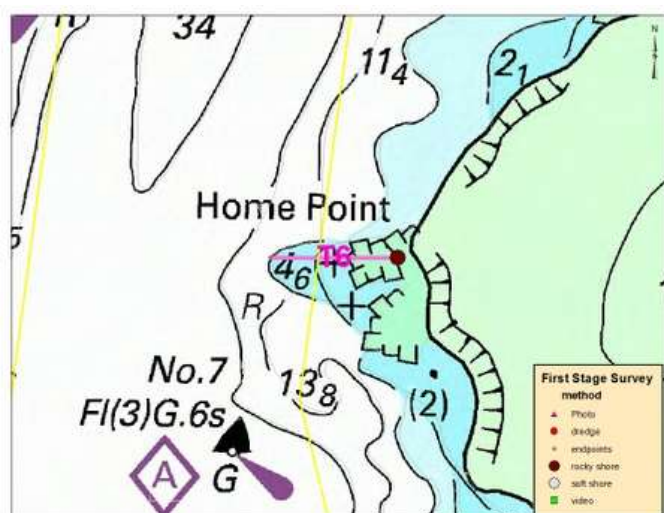


Figure 17 Transect 6 at Home Point.

Transects 7, 8 and 9

Intertidal zones

Transect 7 Urquharts Bay: This is gently sloping beach of gravel and small stones which makes a transition to a muddy sandy soft bottom subtidal environment in at about 2-3m depth. The area is a sheltered shore aside from relatively low wave energy caused by onshore winds blowing across the harbour.

Transects 8 and 9: Both transects are small rocky points that protrude into the shallow Bays of the Taurikura area. They are well-sheltered environments with moderate tidal currents running by the points. The transects are both rock platforms at the top of the intertidal zone and then slope into the sea sharply. Pacific oysters are present in these locations.



Figure 18 The gravel intertidal habitat at Urquharts Bay



Figure 19 (left) Zero point for Transect 8 which is the point between McKenzie and Taurikura Bays , (right) zero point of Transect 9 at Castle Rock.

Subtidal rocky reef zone

Transect 8 McKenzie Bay Point:

This reef is a shallow gently sloping reef that extends only a short distance seaward to a depth of 4m. Beyond the reef edge the bottom is a shelly coarse sand soft bottom. The shallow mixed weed zone is approximately 1.5m deep and consists of turfing algae, *Hormosira banksii*, band giving way to a mixture of *Carpophyllum* algal species. Below that there is a dense forest of predominantly *Carpophyllum flexuosum* with some *Ecklonia radiata* present.



Figure 20 (left) shallow zone showing *Carpophyllum maschalocarpum* and *Hormosira banksii*

Transect 9 Castle Rock Point:

The reef at Castle Rock is medium sloping broken rock reef extending down to 12m depth where a transition to a shelly coarse sand substrate takes place. The shallow mixed weed community is dominated by *Carpophyllum maschalocarpum* that extends to 2-3m depth. There is a tall, dense kelp forest of mixed *Carpophyllum flexuosum* and *Ecklonia radiata* in the 2-6m depth zone. As it deepens the *Ecklonia radiata* thins out and is sparse at the reef edge at 12 m. The encrusting invertebrate community is diverse and lush at depths beyond 6m and at 8-12m depth there is a rich and diverse sponge community.



Figure 21 (left) shallow mixed weed zone with *Carpophyllum maschalocarpum* making a transition to *Ecklonia radiata* at 1-2m depth, (right) *Carpophyllum flexuosum* forest at 5m depth.



Figure 22 (left) finger sponge and rich array of encrusting invertebrate community at 6-12m, (right) the transition of reef to shell coarse sand soft bottom habitat at 12m depth.

Benthic Communities Transects 7, 8 and 9



Figure 23 Transect 7

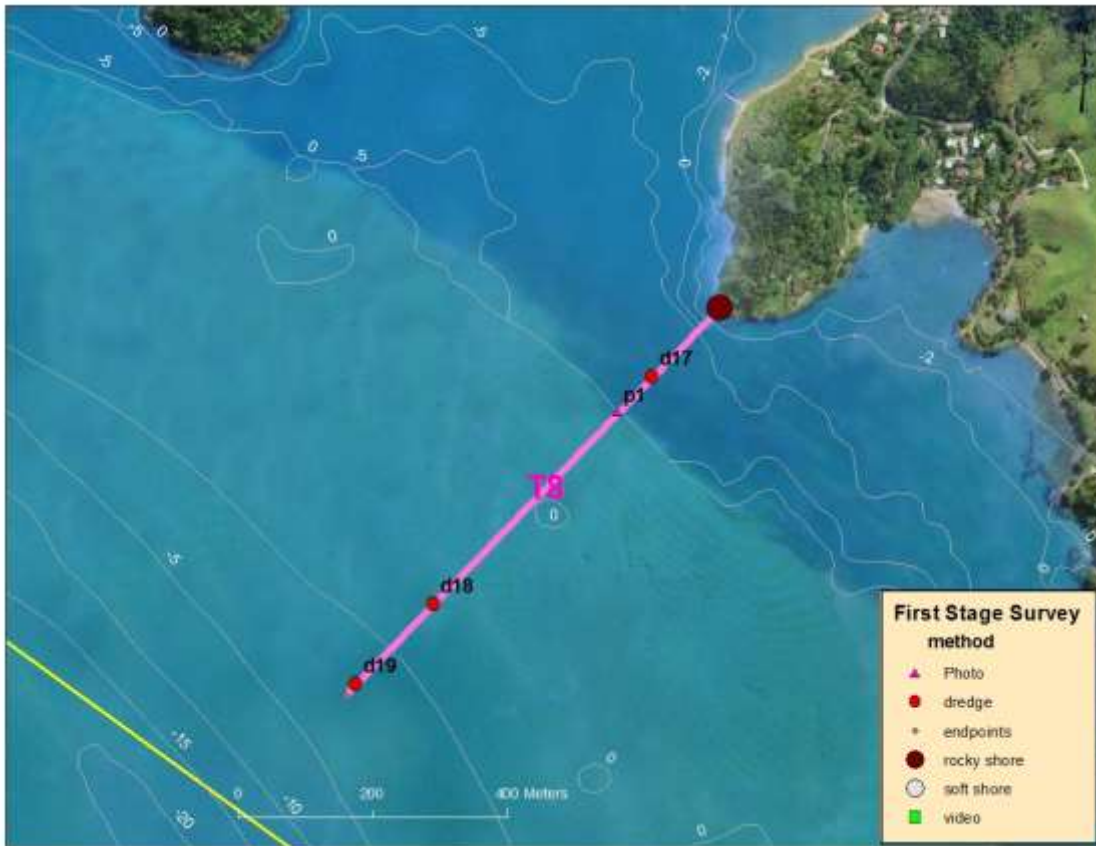


Figure 24 Transect 8

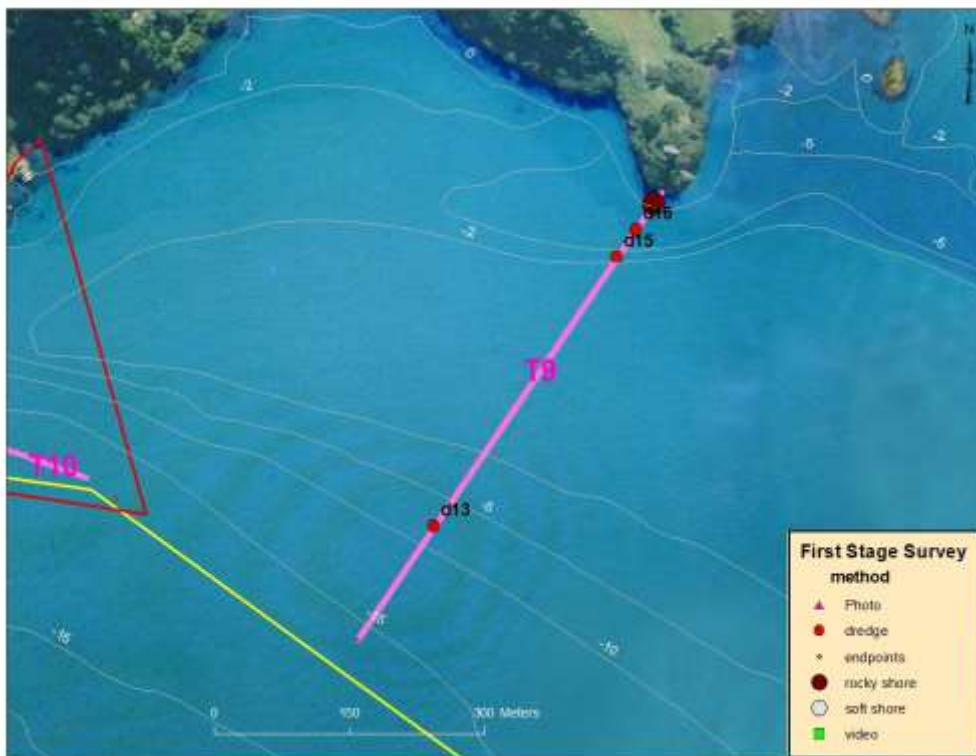


Figure 25 Transect 9

Notes:

Benthic community species identified in dredge samples are listed in Appendix 1

T9 D16

Substrate: muddy shelly sand

Residue: shell

T9 D15

Substrate: muddy shelly sand

Residue: shell

T9 D13

Substrate: slightly shelly medium sand

Residue: shell

T8 D17

Substrate: muddy shelly sand

Residue: shell

T8 D18

Substrate: slightly muddy shelly sand

Residue: shell

T8 D19

Substrate: slightly muddy shelly sand

Residue: shell

T7 D19 Urquharts Bay

Substrate: shelly medium sand

Residue: shell

T7 D24

Substrate: shelly medium sand

Residue: shell

T7 D21

Substrate: muddy fine sand

Residue: shell, tube worms and coralline turf in equal proportions

T7 D23

Substrate: sandy mud

Residue: shell 1/3 and worm tubes 2/3

T7 D20

Substrate: sandy mud

Residue: seagrass

Dredge Sampling results	T9 D16	T9 D15	T9 D13	T8 D17	T8 D18	T8 D19	T7 D19	T7 D24	T7 D21	T7 D23	T7 D20
number of individuals counted	27	15	10	227	2	10	37	4	22	21	23
number of species	13	10	8	13	2	6	16	4	13	15	10
fraction of dredge filled	7/10	9/10	7/10	9/10	8/10	6/10	8/10	9/10	9/10	8/10	10/10
dredge residue volume (liters)	2.5	0.9		0.1	0.6	0.2	0.3	0.5	0.6	0.3	0.3
depth (m)	11	3	11	7	1.8	4.3	5	1.5	7	10	10
sieve size (mm)	5	5	5	5	5	5	5	5	2	2	2

Table 3 Dredge sample notes

Transect 10

Intertidal zones

The intertidal zone of this site is well studied and described. For many years this site has been used for Auckland University field trips because it affords a perfect example of intertidal zonation with its perfect even slope, showing the layering of lichen zones, gastropods grazing zones and barnacle layers.



Figure 26 The zero point of transect 10 on the southeast corner of Motukaroro Island in the marine reserve.

Subtidal rocky reef zone

Transect 10 has a hardly noticeable shallow mixed weed zone with just a few examples of *Carpophyllum maschalocarpum* mixed with *Ecklonia radiata*. At 1.5-2m depth there is a change to a dense *Ecklonia radiata* forest that extends down to the reef edge at about 8-10m. At the reef edge there is a change to a shelly coarse sand soft bottom habitat. The encrusting invertebrate community on this reef is especially lush and diverse below 4m depth and includes a wide diversity of sponge species. There are moderate tidal currents affecting these habitats.



Figure 27 (left) Dense *Ecklonia radiata* forest typical of depths between 1m and 6m, (right) example of the rich and diverse encrusting invertebrate community below 4m depths.



Figure 28 (left) At depths below 8m the Ecklonia forest thins out to nothing and the habitat is dominated by large sponge species and a diverse array of other encrusting invertebrate life. (right) Another example from below 8m where sponges dominate the community and large dense patch of sea anemones are found.

Transect	Site	Depth (m)	Sediment Description	Notes
10	v8	11	medium sand, quite shelly, could be some fine gravels	drift algae, small amount of small turfing algae
10	v9	11	medium sand, coarse shell, some gravels	drift algae, small amount of small turfing algae, <i>Dosinia</i> shells present. Two small <i>Ecklonia radiata</i> growing
10	vD10	9	medium sand, quite shelly, could be some fine gravels	drift algae, small amount of small turfing algae, <i>Dosinia</i> shells present
10	vD11	11	medium sand, quite shelly, could be some gravel patches, few small rocks present	drift algae, small amount of small turfing algae, few rocks present with red algae and two species of encrusting sponges

Table 4 Video drop notes from Transect 10

Transects 11 and 12

Intertidal zones

Transects 11 and 12 are both in high current areas as their shorelines protrude out into the harbour current and are both close to deep holes formed from the tidal constriction created by the island and Darch Point. They are both bouldery shores with many of the boulders being large. Both sites have Pacific oysters growing on the intertidal rocks.



Figure 26 The zero point of Transect 11 at Darch Point (taken at high tide).



Figure 27 The zero point of Transect 12 on the southwest corner of Motukaroro Island in the marine reserve.

Subtidal rocky reef zone

Transect 11 Darch Point:

The fringing subtidal reef at Darch Point extends down to approximately 11m in depth. There is a shallow mixed weed zone extending to about 2m in depth with a mix of *Carpophyllum* species and an upper band of *Hormosira banksii*. Below this level there is a mixed algal forest of *Carpophyllum flexuosum* and *Ecklonia radiata*. Down to about 6m the kelp forest is quite dense and some of the *Carpophyllum flexuosum* reach 2m in height. The kelp forest and understory encrusting invertebrate community is noticeably more silty here than at the other sites further out towards the harbour entrance. From 6m to 11m the kelp forest thins out and sponge community is more diverse and dominates the encrusting life. Silt deposition is also significant in the deeper sponge dominated zone. At 11m the reef makes a transition to a coarse sand soft bottom habitat.



Figure 28 (left) Mixed dense canopy of *Ecklonia radiata* and *Carpophyllum flexuosum* typical of the zone between 2m and 6m, (right) understory encrusting community showing a number of varieties of encrusting sponges and coralline algae.



Figure 29 (left) Dense *Ecklonia radiata* forest at 6-8m, (right) reef edge at 11m showing coarse sand soft bottom substrate and encrusting invertebrate community and red algae species.

Transects 11 and 12

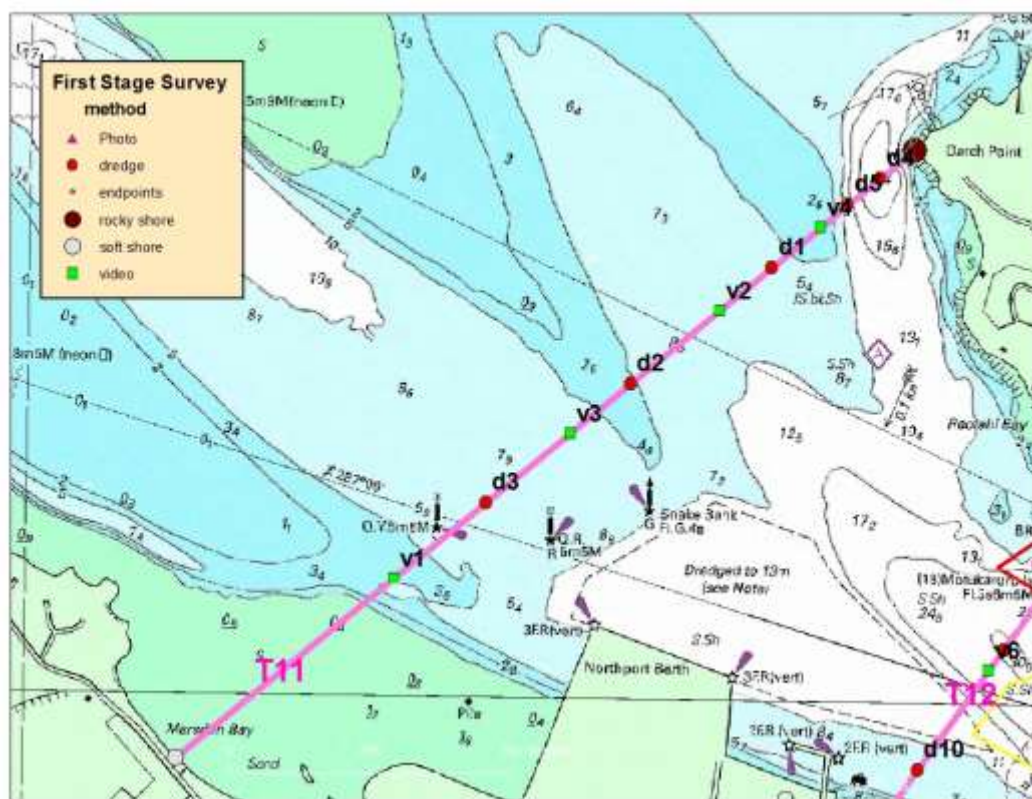


Figure 30 Transect 11



Figure 31 Transect 12

Notes:

Benthic community species identified are listed in Appendix 1

T11 D3

Substrate: muddy shelly sand

Residue: shell

T11 D2

Substrate: shelly sand

Residue: shell

T11 D1

Substrate: shelly coarse sand

Residue: shell

T11 D5

Substrate: shelly medium sand

Residue: shell

T11 D4

Substrate: shelly medium sand

Residue: shell

T12 D7

Substrate: Fine sand

Residue: shell

T12 D10

Substrate: fine sand

Residue: shell

T12 Dv7

Substrate: fine sand

Residue: shell

Dredge Sampling results	T11 D3	T11 D2	T11 D 1	T11 D5	T11 D4	T12 D7	T12 D10 Nil Live	T12 Dv7
number of individuals counted	15	29	5	5	22	52	0	14
number of species	11	10	4	2	11	15	0	6
fraction of dredge filled	9/10	6/10	8/10	6/10	7/10	7/10	7/10	7/10
dredge residue volume (liters)	1	1.5	1	0.5	1.2	2	0.1	0.3
depth (m)	11	7	8	18	28	34	11	1.6
sieve size (mm)	5	5	5	5	5	5	5	2

Table 5 Dredge sample notes

Transect	Site	Depth (m)	Sediment Description	Notes
11	v1	3.5	fine sand small ripples, some shells present on surface but looks predominantly sandy	drift algae,

11	v2	8	medium sand, quite shelly, could be some gravels	drift algae, some small turfing algae present. Two small <i>Ecklonia radiata</i> growing
11	v3	5.5	fine sand small ripples, some shells present on surface but looks predominantly sandy	very little on surface except odd shell
11	v4	2.5	fine sand small ripples, some shells present on surface but looks predominantly sandy	very little on surface except odd shell
12	v6	27	coarse sand or gravel with dense shell hash on surface	turfing algae

Table 6 Video drop notes for Transects 11 & 12

Transects 13 and 14

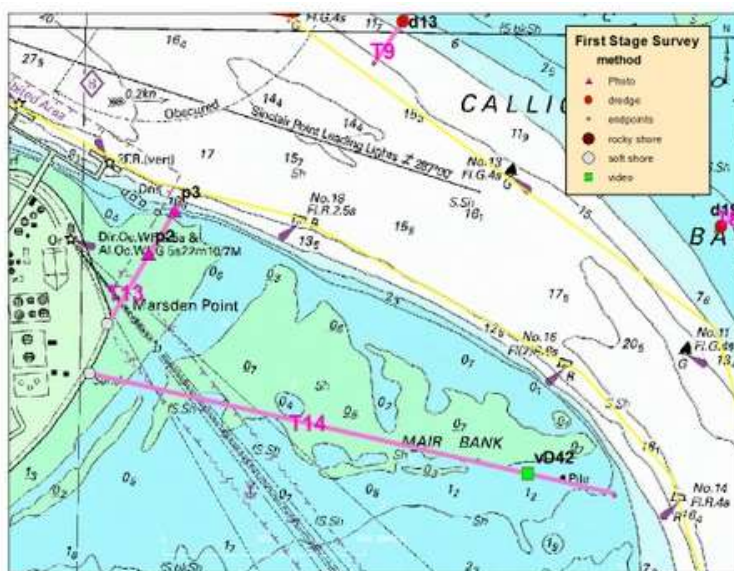


Figure 32 Map of Marsden and Mair Banks transects, showing photo points and video drop locations.

Intertidal zones

The transects at Mair and Marsden Bank are similar habitats. They both have zero points on a slope fine sandy beach and then traverse the largely intertidal pipi beds. The substrates on the beds consist of shelly sands. Some areas are densely armoured with adult pipi shells, other areas less so. Marsden Bank is quite flat and uniform, whereas Mair Bank has a more undulating contour with some raised ridges where the armoured nature of the surface is very dense and elevated to near the top of the intertidal depth range. Towards the end of the Mair Bank transect there is a significant area of shallow subtidal habitat marked on the map above with a drop video station. This area is not armoured and is fine sand with some shell. In this subtidal area tidal currents are quite strong and the sand tends to be more mobile, increasingly so as you approach the channel edge which drops off quite steeply.

Descriptive photos of the transects are included here to help with selection of sampling locations. Substrates, hydrology and biological descriptions have been recently reviewed in a NIWA study.¹



Figure 32 (left) Marsden Bank looking from Transect 13 shore zero point (fine sandy beach) to end of transect at channel edge, (right) view from end of Transect 13 at channel edge looking back towards zero point on shore.

¹ Williams, J.R., Hume, T.M., 2014. Investigation into the decline of pipi at Mair Bank, Whangarei Harbour. Prepared for Northland Regional Council. June 2014 NIWA Client Report No: AKL2014-022



Figure 33 (left) Example of substrate at outer section of Marsden Bank Transect 13 showing the lesser shell content and armouring, (right) example of heavy armouring and dense shell surface layer in the middle area of Marsden Bank.



Figure 34 Mair Bank: A view of Transect 14 looking from the sloping fine sand beach to out along the transect towards the channel edge. This photo was taken at low tide. Note the raised areas (white) which are elevated areas of heavily armoured substrate.

Subtidal section of Mair Bank, Transect 14

Transect	Site	Depth (m)	Sediment Description	Notes
14	vD42	1.5	fine sand with pipi shell	pipi shell quite dense no sign of live pipi

Table 7 Video drop notes for subtidal section of Transect 14.

Transect 15 Ruakaka Beach

Transect 15 at the northern end of Ruakaka Beach runs out from a clean fine sandy beach. Two video drops were made on the outer part of this transect to characterise the substrate and habitat. The substrate on both drops was uniform clean fine sand with very few shells or shell fragments noticeable. At both sites the common sand dollar, *Fellaster zealandiae* was abundant with an estimated density of 10 organisms per meter squared. This area is very popular for paddle crab potting, but no crabs were seen in the video drops. There were approximately a dozen recreational crab pots set in the area of the transect. The intertidal area of this beach is a popular location for harvesting tuatua, however in recent times the beds have been very scattered and small in size. It is very possible that the large numbers of people attempting to harvest tuatua in this area combined with the closure of pipi harvesting at Marsden and Mair Banks is resulting in the tuatua beds disappearing from this locality.



Figure 32 (left) Map showing video drop locations on Transect 15 Ruakaka Beach, (right) view of Transect 15 zero point on beach from video drop point 39.



Figure 33 Video drop site 39 on Transect 15 off Ruakaka Beach showing the high density of *Fellaster zelandiae* and fine sand substrate.

Transect	Site	Depth (m)	Sediment Description	Notes
15	vD39	3	fine sand	<i>Fellaster zelandiae</i> uniformly present at about 10/m ² , tube worm holes present
15	vD40	4	fine sand	<i>Fellaster zelandiae</i> uniformly present at about 10/m ² , tube worm holes present

Table 8 Video drop notes from Transect 15.

Benthic community transects 16, 17 and 18

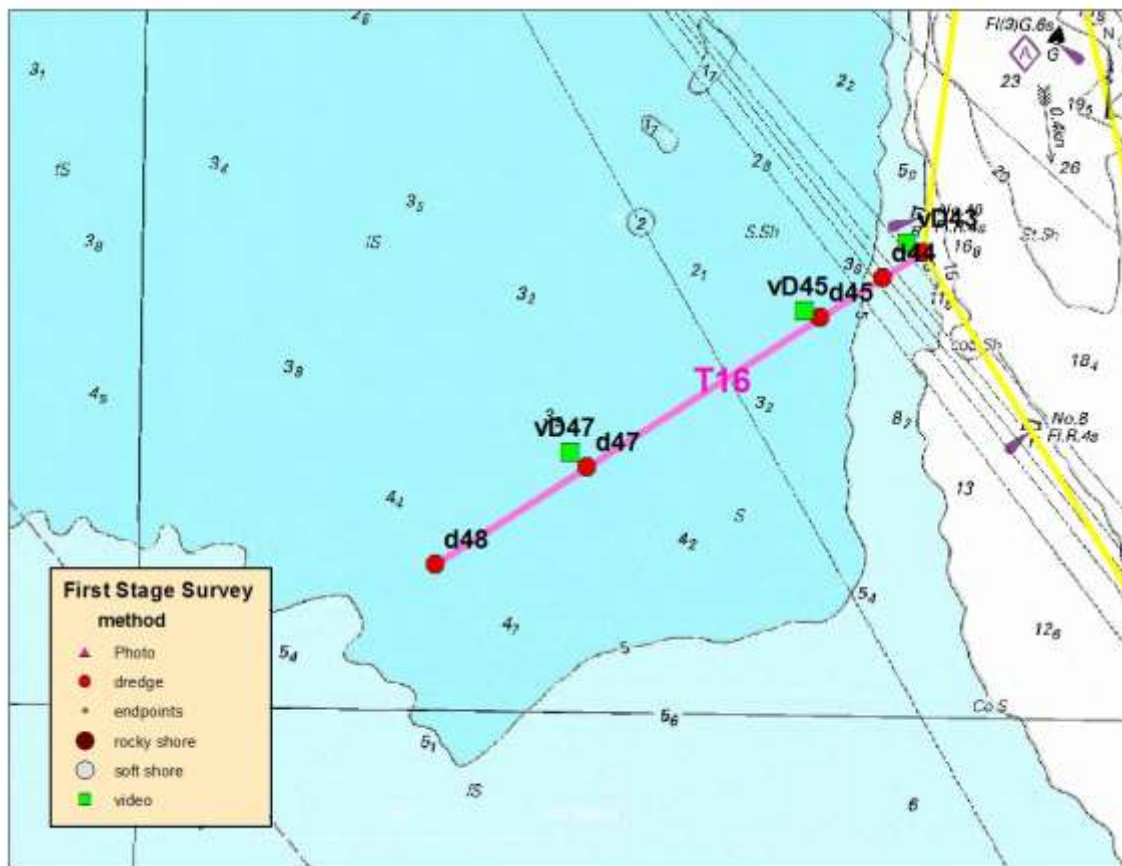


Figure 34 Transect 16

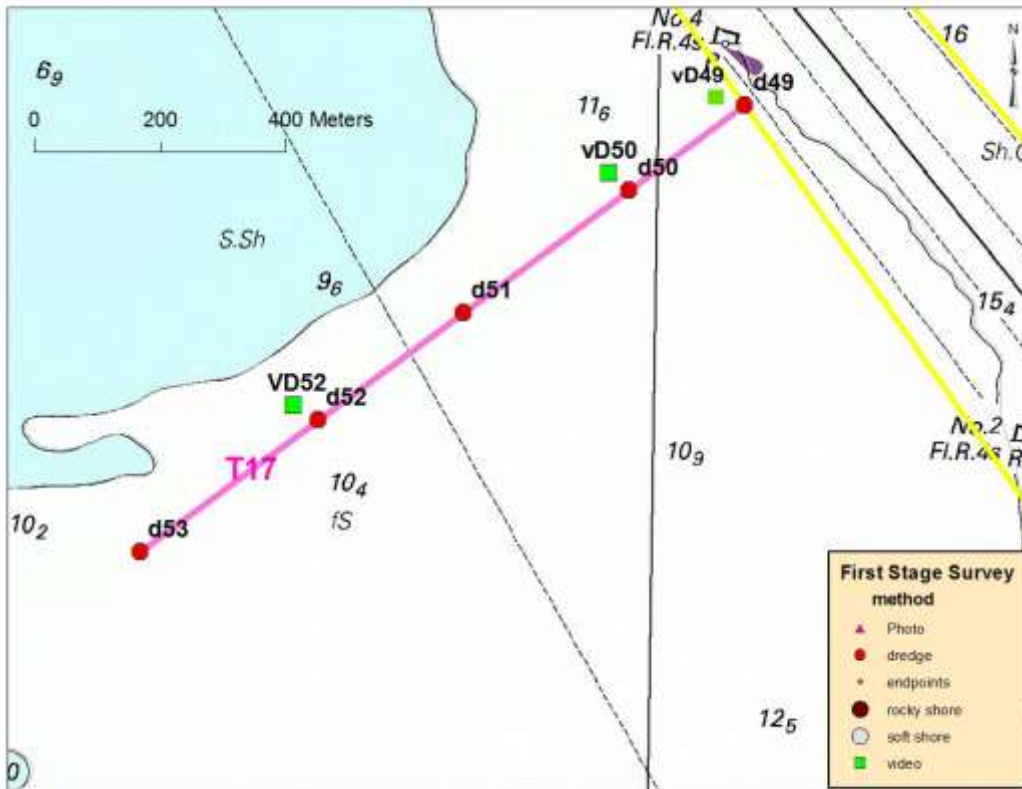


Figure 35 Transect 17

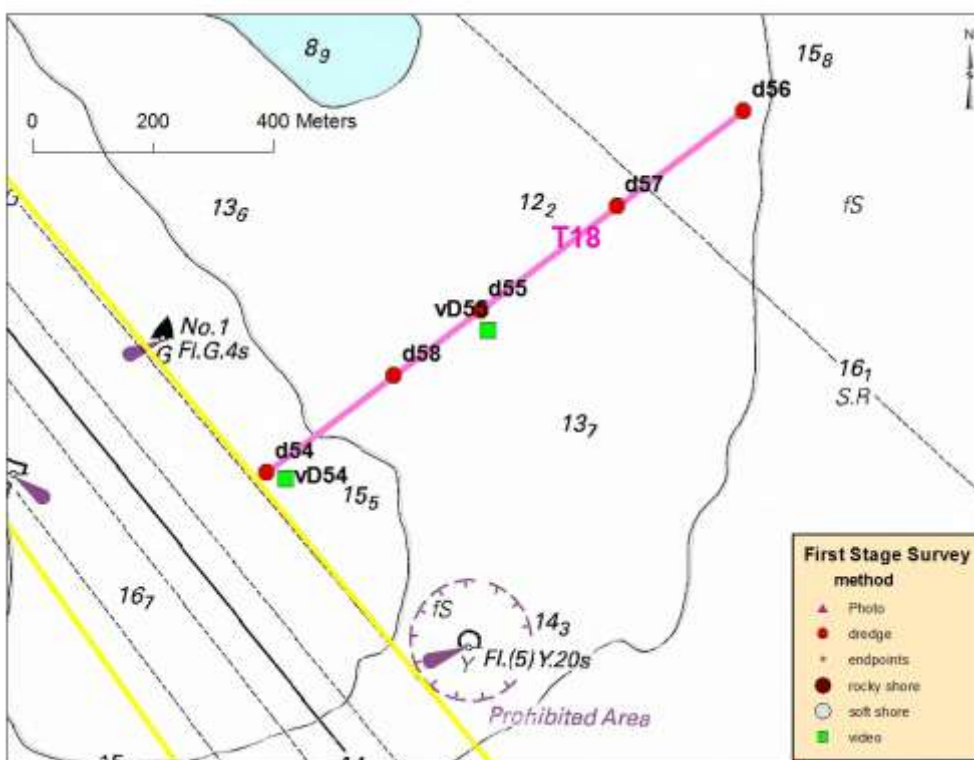


Figure 36 Transect 18

Notes:

Benthic community species identified in dredge samples are listed in Appendix 1

T18 D54

Substrate: fine sand

Residue: shell

T18 D58

Substrate: fine sand slightly shelly

Residue: shell

T18 D55

Substrate: fine sand

Residue: shell

T18 D57

Substrate: fine sand very slightly silty

Residue: shell 2/3, worm tubes 1/3

T18 D56

Substrate: fine sand slightly silty

Residue: shell 1/2, worm tubes 1/2

T7 D53

Substrate: medium sand

Residue: shell 6/10, worm tubes 4/10

T17 D52

Substrate: fine sand slightly silty

Residue: shell 3/5 worm tubes 2/5

T17 D51

Substrate: medium sand

Residue: shell

T17 D50

Substrate: shelly medium sand

Residue: shell

T17 D49

Substrate: shelly gravel

Residue: shell

T16 D48

Substrate: fine sand

Residue: shell

T16 D47

Substrate: fine sand slightly muddy

Residue: shell

T16 D45

Substrate: fine sand

Residue: shell 1/2, worm tubes 1/2

T16 D44

Substrate: fine sand

Residue: shell

T16 D43

Substrate: shelly fine sand

Residue: shell

Dredge Sampling results	T18 D54	T18 D58	T18 D55	T18 D57	T18 D56	T17 D53	T17 D52	T17 D51	T17 D50	T17 D49	T16 D48	T16 D47	T16 D45	T16 D44	T16 D43
number of individuals counted	25	15	13	32	35	43	89	39	63	84	13	10	25	9	13
number of species	14	10	10	14	17	15	16	14	13	22	7	6	14	5	5
fraction of dredge filled	8/10	6/10	6/10	6/10	7/10	8/10	7/10	8/10	9/10	6/10	8/10	9/10	9/10	8/10	7/10
dredge residue volume (liters)	0.04	0.05	0.03	0.03	0.05	0.03	0.05	0.01	1.50	1.30	0.05	0.05	0.02	0.04	1.50
depth (m)	22	21	19	20	22	16	16	15	18	21	9	9	8	12	22

Table 9 Dredge sample notes

Transect	Site	Depth (m)	Sediment Description	Notes
16	vD43	11	fine sand small ripples, some shells present on surface but looks predominantly sandy	drift algae,
16	vD45	4	fine sand small ripples	very little on surface almost no shell visible
16	vD47	3.5	fine sand small ripples	very little on surface, a few shells visible, small amount of drift algae
17	vD49	14	medium sand, quite shelly	drift algae, small amount of small turfing algae
17	vD50	11	medium sand, quite shelly	drift algae,
17	vD52	10	fine sand	drift algae, small amount of small turfing algae
18	vD54	17	fine sand, few shell fragments on surface	drift algae,
18	vD55	13	fine sand, few shell fragments on surface	drift algae,

Table 10 Video drop notes for Transects 16, 17 and 18.

Appendix 1 Benthic invertebrate communities

Transects 1 through 9

Latin Name	T9 D 16	T9 D 15	T9 D 13	T8 D 17	T8 D 18	T8 D 19	T7 D 19	T7 D 22	T7 D 21	T7 D 23	T7 D 20	T1 D 38	T1 D 37	T2 D 35	T2 D 36	T3 D 34	T3 D 33	T5 D 25	T5 D 26	T4 D 30	T4 D 31
C=common S=several P=present																					
Angiosperms																					
<i>Zostera muelleri</i>											1.5 L										
Algae																					
<i>Corallina officinalis</i>				200m ls					100m ls								C		150m ls		
Coralline "paint"																	P				
"Rhodoliths"																				6	3
small red algae														1			P				
Porifera																					
Yellow encrusting sponge	1																				
Cnidaria																					
<i>Edwardsia sp.</i>										1											
Platyctenophore?							1														
Nemertea																					
Nemertine	1																				
Nemertine, pink,																1					
Nemertine, white,																1					
Nemertine, black																1					
Polychaetes																					
<i>Aglaophamus macroura</i>										1							1	P			
<i>Ampharete sp.</i>										1								P			
<i>Armandia maculata</i>																		P	1		
<i>Axiiothella sp.</i>		1	1			3	1					3	4			4					
<i>Euchone sp.</i>									C						1	9		P			
Eunicidae																	1				
<i>Hydroides norvegicus</i>												3	2		C						C
Indetermined polychaetes										C				5			1	man y	1		
<i>Lanice conchilega</i>												1									
<i>Lumbrinereis sp.</i>												1									
Maldanidae															2			P			
Nereidae																			1		1
<i>Orbinia papillosa</i>		1																			
<i>Owenia fusiformis</i>		1	2			3	6		1	1								P			
<i>Pectinaria australis</i>										1											
Phyllodoctidae																2					
Polynoidae							2											P			
Sabellidae							1														
<i>Sigalion sp.</i>											1		1								
Syllidae																	3	P	2	1	
Terebellidae																	1				
Mollusca, Bivalvia																					
<i>Corbula zelandica</i>	7			200	1									2					2	13	
<i>Dosinia maoriana</i>							2											1			

Dosinia subrosea																3					
Gari convexa							1														
Gari stangeri	5			1			7											2			
Glycymeris modestus				1																	1
Hiatula nitida																1					
Hunkydora novozelandica				1									1								
Leptomys retiaris																		1			
Limatula maoria	2																				
Linucula hartvigiana								1										1	3		
Modiolus areolatus																	1				
Myadora striata			1				1						1	1							
Myadora subrostrata										1											
Notocallista multistriata																		2			
Nucula nitidula				1														12			
Pecten novaezelandiae																		2			
Pleuromeris zelandica									2									1			
Pratulum pulchellum									2								S				
Scalpomactra scalpellum												1		1							
Tawera spissa	3						3				4 2	1		1			1	1	1	22	3 1
Tucetona largillierii																					1
Venericardia purpurata			1				1				1			2				1		5	1
Zemysia zelandica			1				7											2			
Mollusca, Gastropoda																			1		
Amalda novaezelandiae																		3			
Austromitra rubiginosa																			1		
Bulla quoyii								1		4									1		
Cominella adspersa	1	1		1		1		1					1				4	8		2	
Cominella quoyana	2	4		11		1		6	3	2	1		2				2	3	4	1	
Maoricolpus roseus																			120	2	
Neoguraleus sinclairi																		1			
Pellicaria vermis				7				1													
Phenatoma zelandica									2												
Philine sp.																		2			
Sigapatella tenuis			1			1	1					4		5			1	1		1	2
Mollusca, Polyplacophora																					
Acanthochiton zelandicus																				1	1
Anthochiton stangeri														3			2		3	6	C
Notoplax sp.																		5		2	1
small pink chiton							1				4	1					2			5	7
Terenochiton inquinatus											1								4	4	
Crustacea																					
Amphipoda	1	1															2	34	1	S	
Austrohelice crassa										4											
Balanus decorus																					1
Balanus trigonus											1						C			40	C
Caprellidae																		1			
Charybdis japonica								1													
Elamena producta				1																	
Ebalia laevis									1									1			
Halicarcinus spp.							1		4		5						5	16			
Haustoriidae																2					
Hemiplax hirtipes										4											
Hermit crabs	1	1		1	1		1		3	1		1	1	3				4	4	5	5
Indet. Isopod																		2			

Mollusca, Gastropoda																									
Amalda australis															1										
Antisolarium egeum												13	3	4	40	2							4	1	
Bulla quoyii																				1					
Chelidonura sp.															1										
Coelotrochus viridis					1																				
Cominella adspersa		3											2												
Cominella quoyana																									
Cylichna zealandica									2					1		1	1								
Euterebra tristis														2											1
Philine sp.												1			1										
Sigapatella tenuis	1					1					1				2	2		9	7						
Mollusca, Polyplacophora																									
Acanthochiton zelandicus																			1						
Anthochiton stangeri		3																10	8						
Notoplax sp.		1																		2					
small pink chiton	1	1																11	18						
small white chiton		6					1																		
Terenochiton inquinatus																									
Crustacea																									
Amphipoda																6					2		1	2	
Balanus trigonus	1																		C				4		
Cirolana sp.									3	3	2				1										
Cyclasterope sp.																2									
Elamena producta	1																								
Elminius modestus		5																						2	
Haustoriidae									1					1	3		2								
Hermit crabs	3	6		3	6	30			1		1	2	5				4	7	4				4		10
Indet. Isopod																							1		
Isocladus armatus									1											1					
Jassidae										1															
Liocarcinus corrugatus					1	1													4						1
Notomithrax minor		1																		2					
Ovalipes punctatus											2											1	1		
Pontophilus australis	1																						1		
Sphaeroma sp.									6	3		1			4	9									
Pycnogonida																									
Echinodermata																									
Amphipholis squamata						1																			
Amphiura sp.									1		1					2					1				
Apatopygus recens			2																						
Astropecten polyacanthus	1																								
Fellaster zelandiae									2			1									1	2			
Patiriella regularis						2																	1		
Trochodota sp.										1		1			1		1								
Brachiopoda																									
Bryozoa																									

Encrusting bryozoa					C	C																		
<i>Otionella</i> sp																								
Orange globular bryozoan																		C						
Ascidians																								
Sandy simple ascidian												3												
Protochordates																								
<i>Balanoglossus australiensis</i>								3		1	1						1				1			
<i>Heteropleuron hectori</i>																	2	5		1				
Pisces																								
<i>Tewara cranwellae</i>																	1				2	1		
<i>Trachelochismus</i> sp.		1																						
Insect																								
<i>Philanisus</i> sp.									1			1												
Sspecies Number	11	10	4	2	11	15	0	6	14	10	10	14	17	15	16	14	13	22	7	6	14	5	5	
Individuals Counted	15	29	5	5	22	52	0	14	25	15	13	32	35	43	89	39	63	84	13	10	25	9	13	
	T11 D3	T11 D2	T11 D1	T11 D5	T11 D4	T12 D7	T12 D10	T12 Dv7	T18 D54	T18 D58	T18 D55	T18 D57	T18 D56	T17 D53	T17 D52	T17 D51	T12 D50	T17 D49	T16 D48	T16 D47	T16 D45	T16 D44	T16 D43	