record: 326, 1153, 1257, 1265, 1280

Survey and Monitoring Report No. 1

Description of the macrobenthos from five soft bottom sites in the western outer Marlborough Sounds

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SURVEY AND MONITORING NELSON

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1.0 INTRODUCTION

This report presents a biological description of five subtidal soft bottom sites in the western outer Marlborough Sounds (Fig. 1). Each study site was located in an area proposed as a marine farm (see applicants report).

The study sites were located on the north-east, north, and western aspects of D'Urville Island and in a bay adjacent to the mainland between Croisilles Harbour and French Pass (Fig. 1). All five sites were located in relatively exposed situations, particularly from the northerly quarter.

Each proposed marine farm site was situated over soft sediment substrata in depths ranging from 22 to 26 meters (Table 1). The minimum distance from the farm edge and land ranged between 200 to 600 meters (Table 1). The proposed method of farming is subsurface lines and structures with surface navigational markers. Structures involved in the proposed marine farms are outlined in a report by the applicants. The species applied for are indigenous species of algae.

The Marlborough Sounds lie at the northern end of the South Island. The Sounds are bordered by Cook Strait to the north and east and Tasman Bay to the west. Formed by the submergence of river valleys, the Sounds consist of approximately 1500km of coastline made up of bays, passages, peninsulas, headlands, cliffs, estuaries and beaches, often with an adjacent steep terrestrial topography. The Sounds are a resource of major ecological importance. In a nationwide report by the Department of Conservation the Sounds was identified as being of national conservation value. The Sounds was also identified as having areas of international biological importance (Davidson et al ., 1990; Davidson et al., in press). These values will also probably be an important consideration in the soon to be produced Marlborough District Council Coastal Plan.

Multiple use (marine farming, fishing, boating, housing, waste water disposal, port development, forestry, agriculture) have the potential to degrade the environment of the Sounds. Marine farming for example, can have considerable impact on the environment through habitat

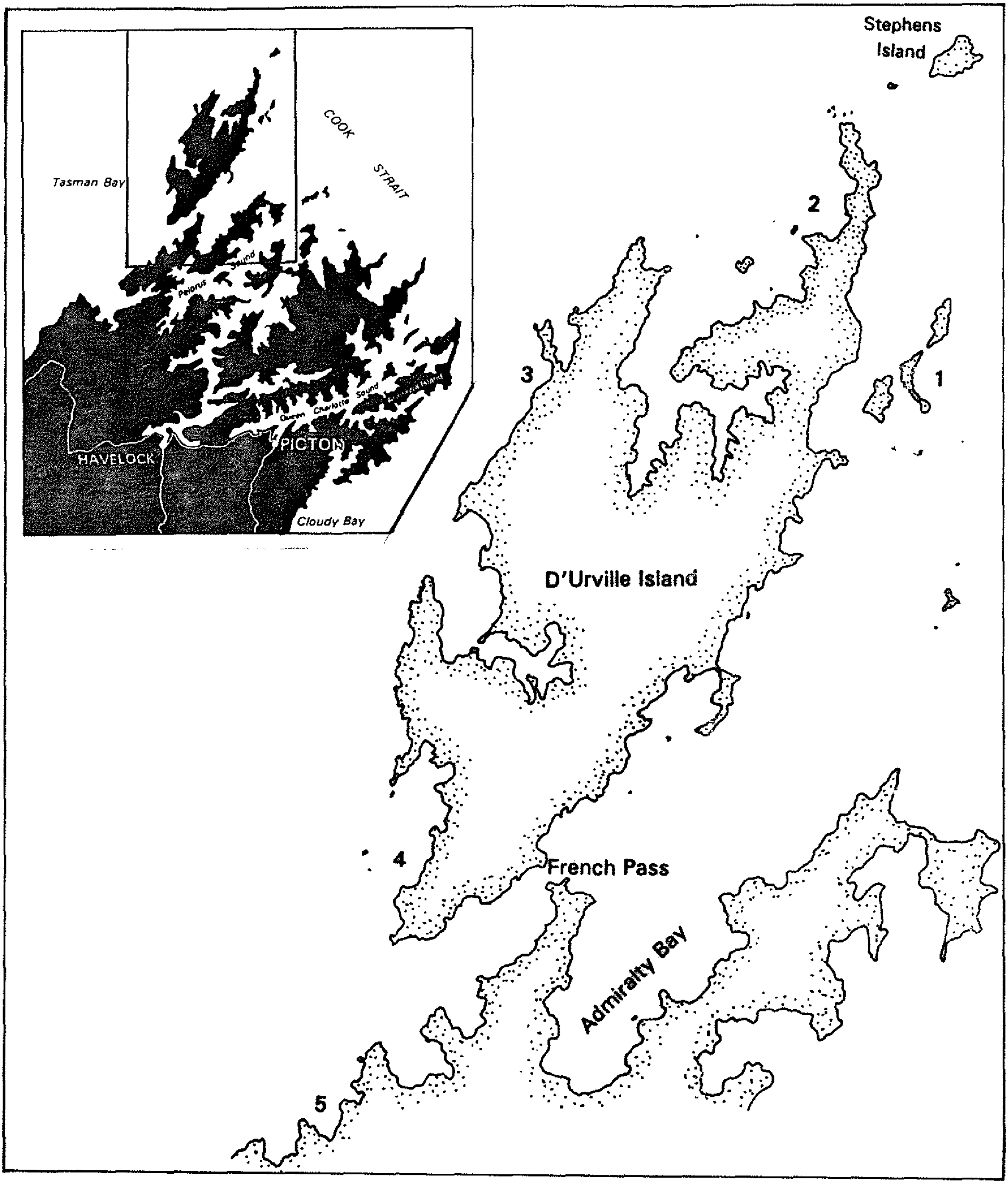


Figure 1 Location of study sites.

Table 1: List of study sites and grid reference of core samples.

Site	Site number	Farm area	Depth (m)	Distance from shore	Grid reference	
Puangiangi Island	1	49 ha	25 m	600m	NZMS 260	6048160N 2594000E
Rakiura Rocks (west)	2	49 ha	24 m	500m	NZMS 260	6054000N 2589390E
Punaatawake Bay	3	49 ha	26 m	350m	NZMS 260	6023325N 2572450E
Cone Island (north)	4	49 ha	22 m	500m	NZMS 260	6032000N 2575280E
Papawai Bay	5	49 ha	21 m	200m	NZMS 260	6023325N 2572450E

modification or lowering water quality. It is therefore important that all new marine farm proposals adequately identify natural values within and adjacent to a proposed marine farm.

The aim of this study was therefore to provide environmental information on the proposed sites and to identify features of biological value which could be threatened by the establishment of the proposed marine farms.

2.0 METHODS

During 7th April 1994, 20 benthic soft sediment samples were collected from five sites centrally located within five proposed marine farm areas (four samples per site)(Table 1). Within each site, core samples were collected from four corners of a 100x100m quadrat using SCUBA and a 130mm diameter by 130mm deep core sampler. Cores were washed in socks of 0.5mm mesh and the residue preserved in 70% isopropyl alcohol for later sorting. All macroinvertebrates were extracted using a white tray and binocular microscope. Animals were identified to the lowest taxonomic level practical and were then counted.

At each site, three replicate sediment cores were collected using clear perspex tubes (62mm diameter) to a depth of 130mm. Cores were brought to the surface and photographed intact inside the tubes and then extracted onto a white tray and cut in half before more photographs were collected. Photographs provided a visual record of the sediment composition and degree of deoxygenation of the profiles. Light grey being indicative of oxygenated conditions, while a black silty appearance often with a strong sulphur smell indicating oxygen depletion. Oxygen depletion is found in sediments which are enriched with organic material.

At each site an underwater video of a representative area inside the study area were collected.

Qualitative information collected by divers from adjacent subtidal rocky shores during 1989-90 were summarized and included in the report. These data were collected by divers recording substratum, depth and associated communities and their relative abundance.

3.0 RESULTS AND DISCUSSION

3.1 Underwater Video Interpretation

Underwater video footage of a representative area where samples were collected on each proposed marine farm suggested that for all sites apart from Puangiangi Island (Rangitoto Islands) the benthos was dominated by a relatively featureless fine sand or sand substratum. In these sites few epibenthic (surface dwelling) species were observed from the video. In contrast, at site 1, a horse mussel (*Atrina zelandica*) bed was apparent. Horse mussels were encrusted by a variety of sponges, hydroids, ascidians, and bryozoans. Juvenile blue cod (*Parapercis colias*) were common in the horse mussel bed suggesting this area may be a juvenile cod area. Such relationships between horse mussel beds and juvenile fish have been suggested by Hay (1990). Hay (1990) reported that horse mussel beds enhance species diversity of surface dwelling species by providing opportunity for species normally attached to rocky substrata to obtain an appropriate surface for attachment. Horse mussels have been known to provide attachment for large macroalgae species such as *Macrocystis pyrifera*. Large foliose red algae such as *Shizoseris, Hymenena, Epymenia, Laingia, Stenogramme* and *Asparagopsis* also form large clumps on mussels at 15-20m depth (Hay, 1990). In areas where there are strong currents small depressions up to 30-30cm deep and about 1-2m wide can form. Fragments of seaweed, shells and other debris accumulate within such depressions around mussels and this debris attracts additional marine life (Hay, 1990). The effect of dredging on dredging on horse mussel communities is devastating (Hay, 1990). Horse mussels are sessile, fragile creatures which once dredged are usually damaged beyond repair.

The extent, density and depth range of horse mussels and a list of species associated with the mussels at this site was not collected in the present study.

3.2 Sediments

The sediment at sites 1, 2, 4 and 5 were dominated by substrata less that 0.5mm in size while at site 3 most of the sediment was larger than 0.5mm in size. These findings basically agreed with those described by Lewis and Mitchell (1980). Sediments from sites 1, 2, 4, and 5 were described as silty sands (Figs 3, 4, 6, 7), while site 3 (Fig. 5) had a coarser sand proportion (ie most sand was greater than 0.5mm diameter). This was probably due the proximity of this site to a large gravel dominated area north of D'Urville Island. This gravel dominated area is probably maintained by the strong tidal currents which flow around the north of D'Urville Island.

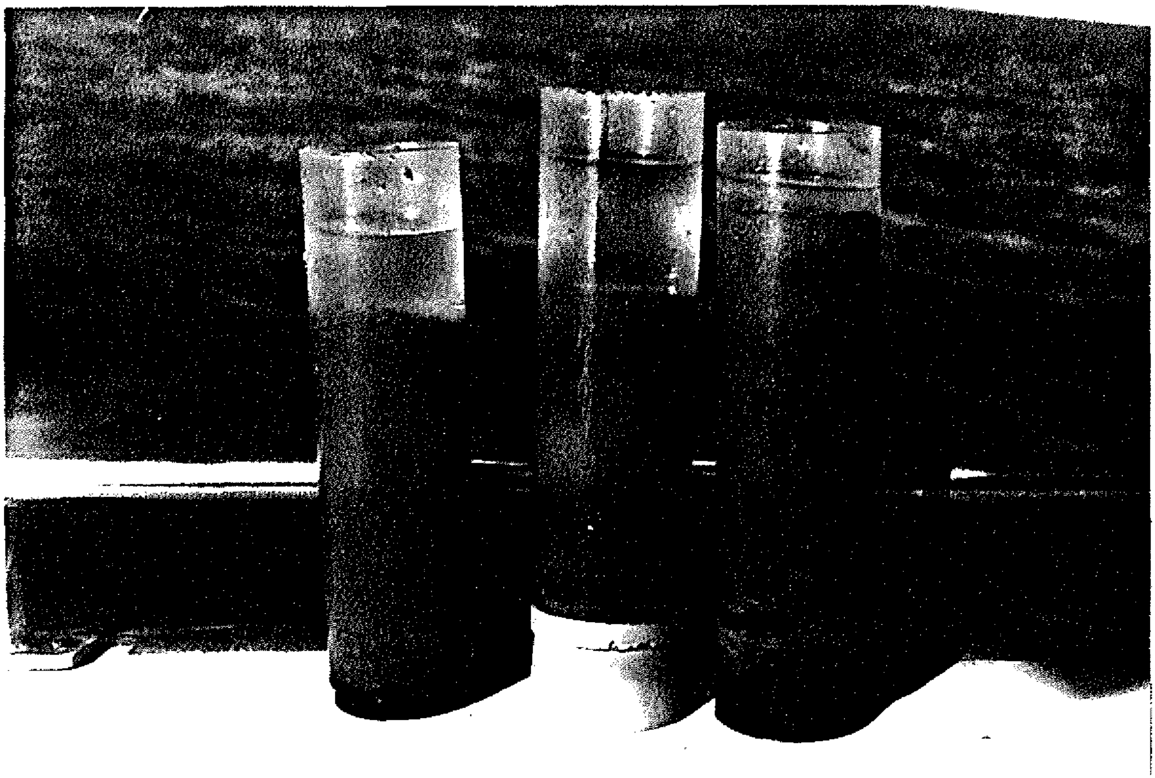
Cores showed that sediments to a depth of 130mm were aerobic with no indication of an anaerobic layer (Figures 3-7). It would be expected that any anaerobic layer at site 3 would be considerably deeper than at the other four sites due to the coarser nature of the sediment at this site.

3.3 Biota from Core Samples

A total of 49 benthic infaunal invertebrates and one species of vertebrate were recorded from five sites and 20 core samples analysed. Counts of all species from individual cores are displayed in Table 2.

The mean number of taxa per site (species richness) ranged from 4.5 to 14.5 species (2-16 for individual samples)(Table 2). The mean density of individuals ranged from 527 to 11625 per m^{-2} (151 to 13863 per m^{-2} per sample)(Figure 2). This represented considerable variation between sites (Figure 2). Lowest densities of invertebrates and the lowest number of taxa were recorded from site 3. Highest invertebrate diversity was recorded from site 2, while highest number of taxa were recorded from site 1 (Figure 2).

The macrofauna was dominated by Polychaeta (16 species), Crustacea (15 species), Mollusca (13 species), Echinodermata (3 species), and Brachyura (2 species). This species composition was representative of the types of assemblages recorded for other parts of the Marlborough Sounds (Dell, 1951; Estcourt, 1967; McKnight and Grange, 1991; Roberts and Asher, 1993). Species common from enriched anaerobic subtidal sediments (such as capitellid and nematode worms)(Pearson and Rossenburg, 1978) were virtually absent from the present samples suggesting little enrichment. This was result was to be expected due to the composition of



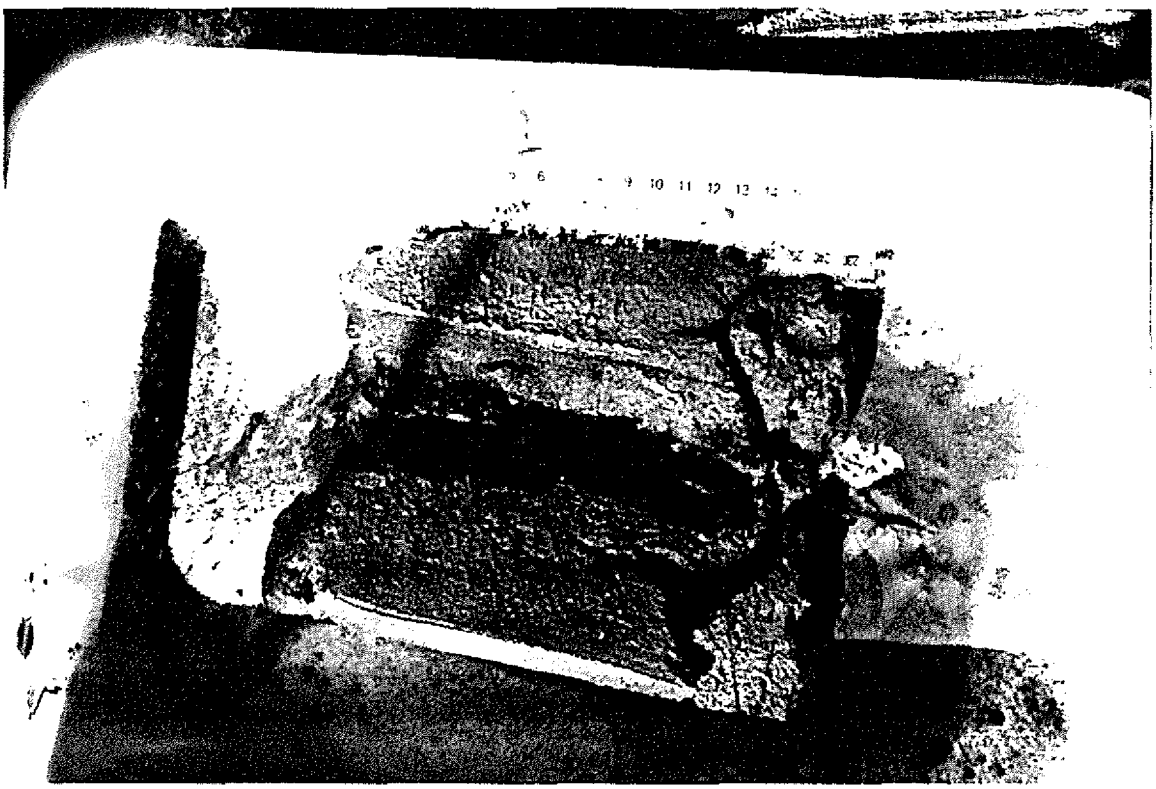


Figure 3 Representative core samples from Puangiangi Island.

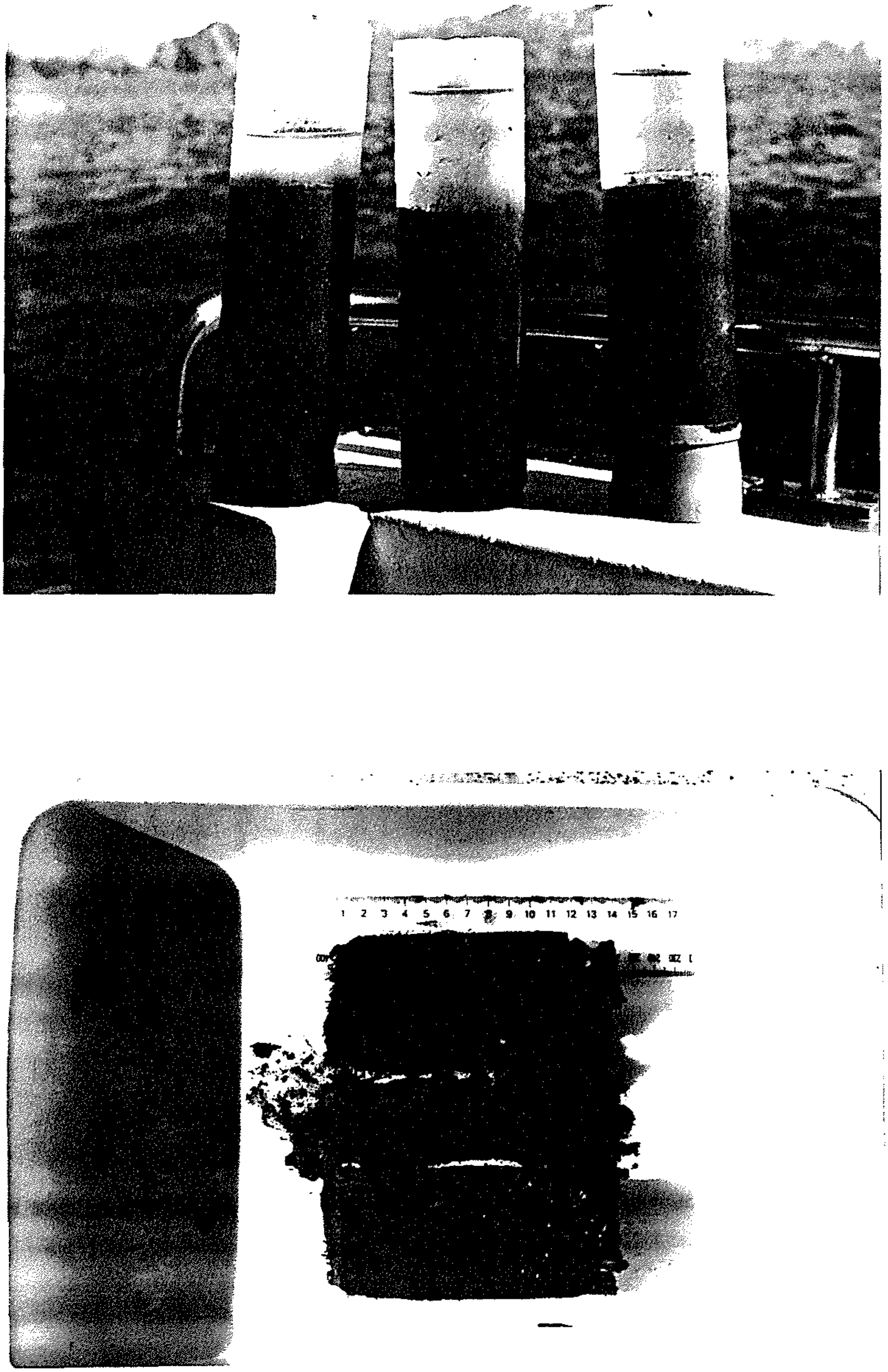
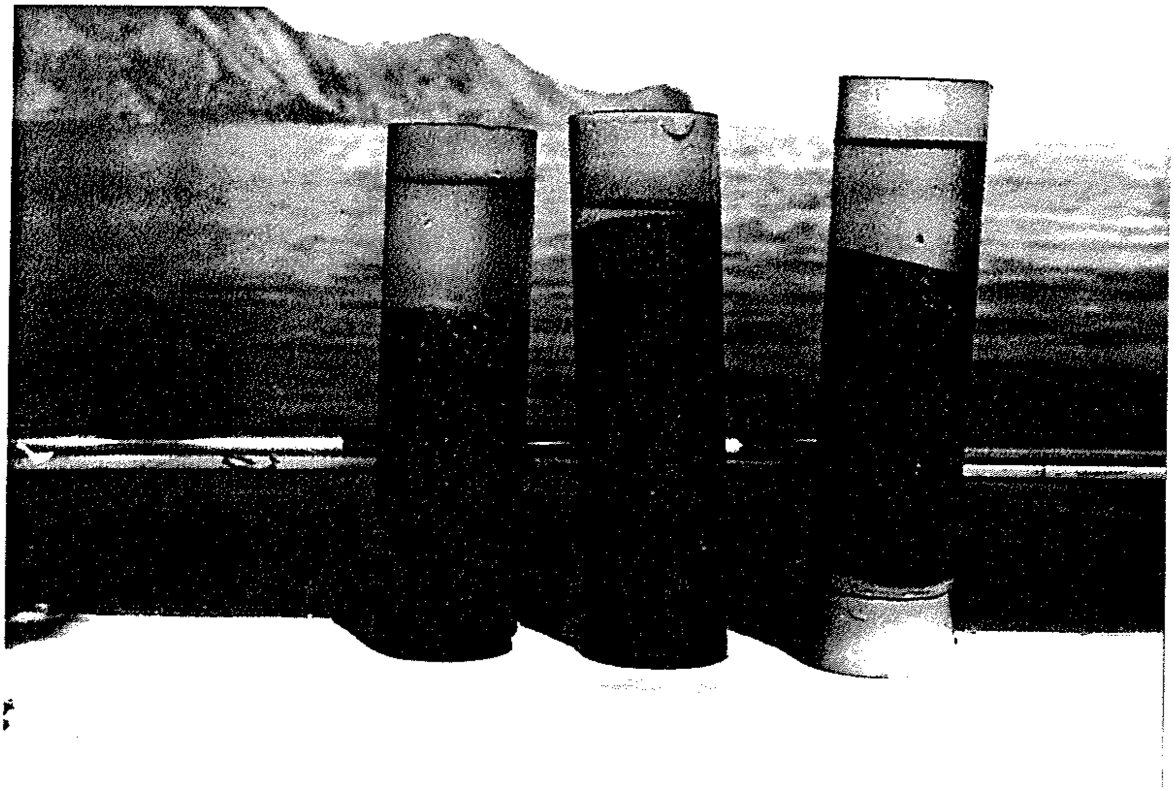


Figure 4 Representative core samples from Rakiura Rocks area.



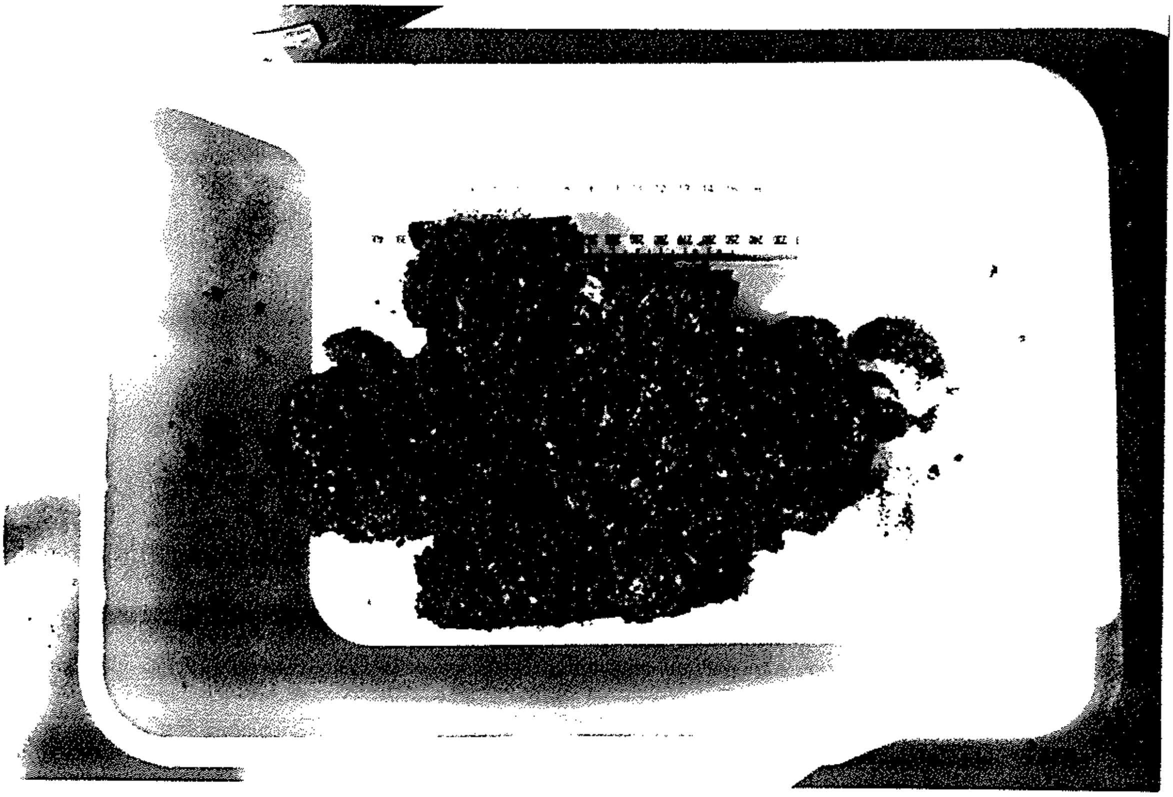
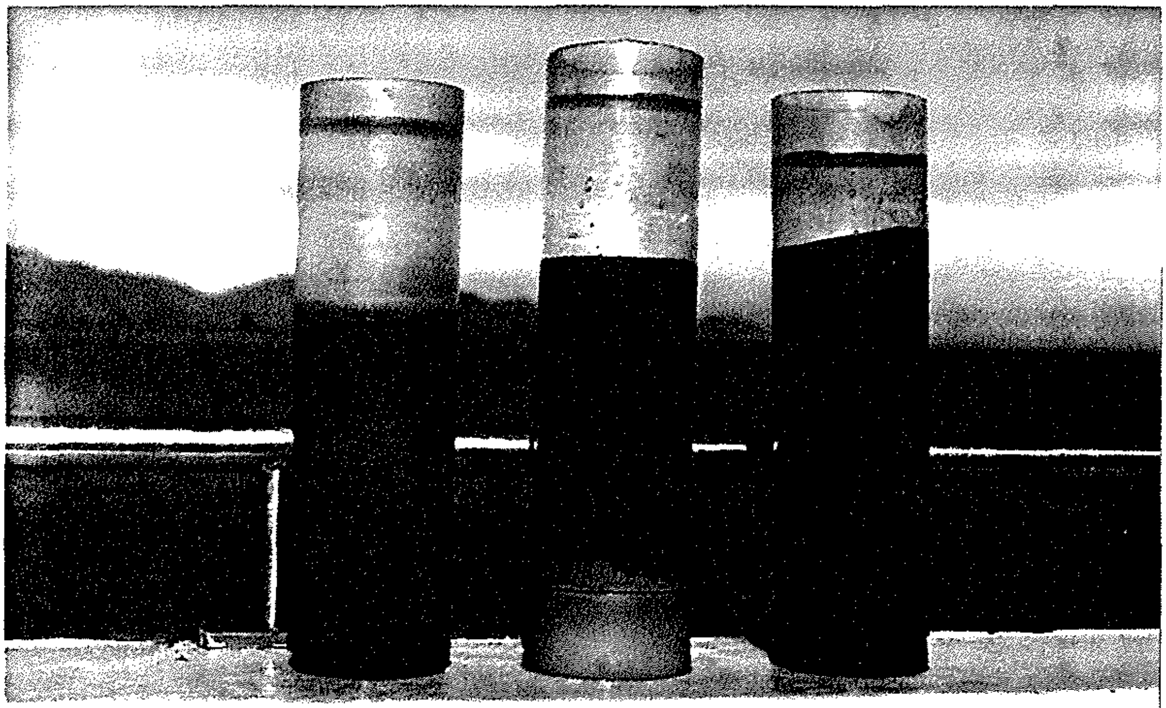


Figure 5 Representative core samples from Punaatawake Bay.



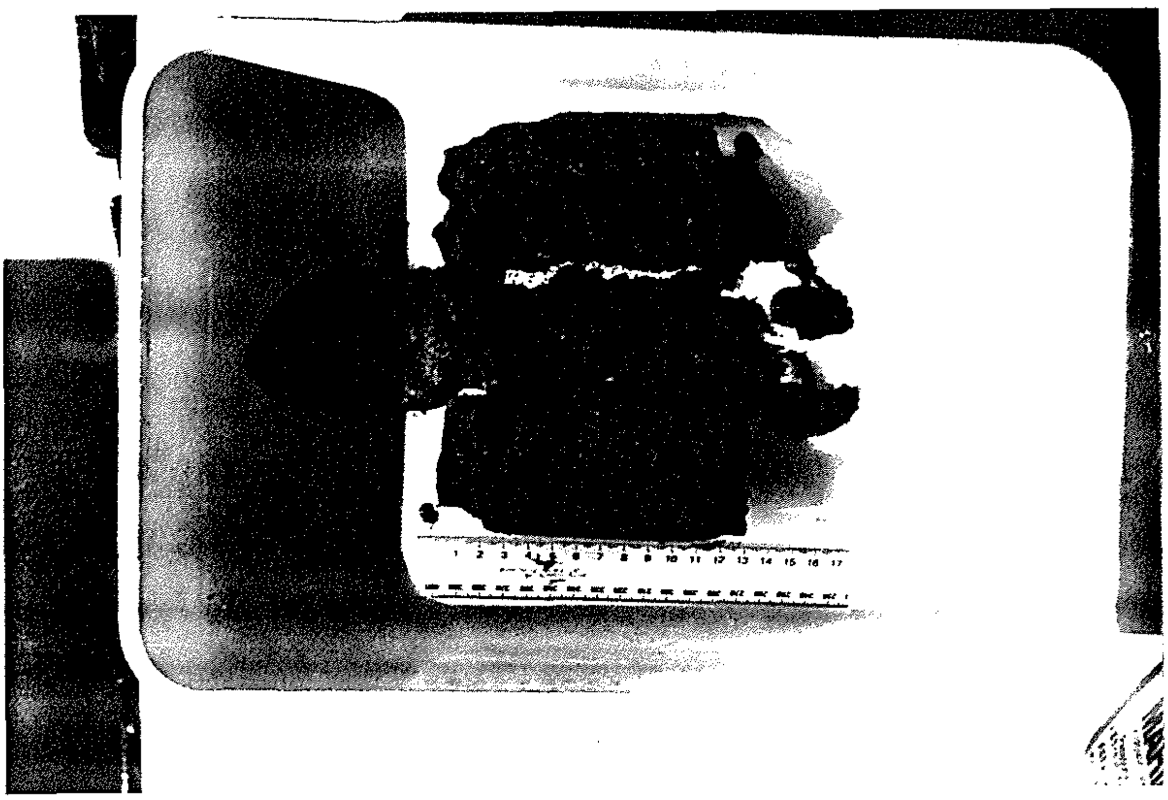


Figure 6 Representative core samples from coast north of Cone Island.

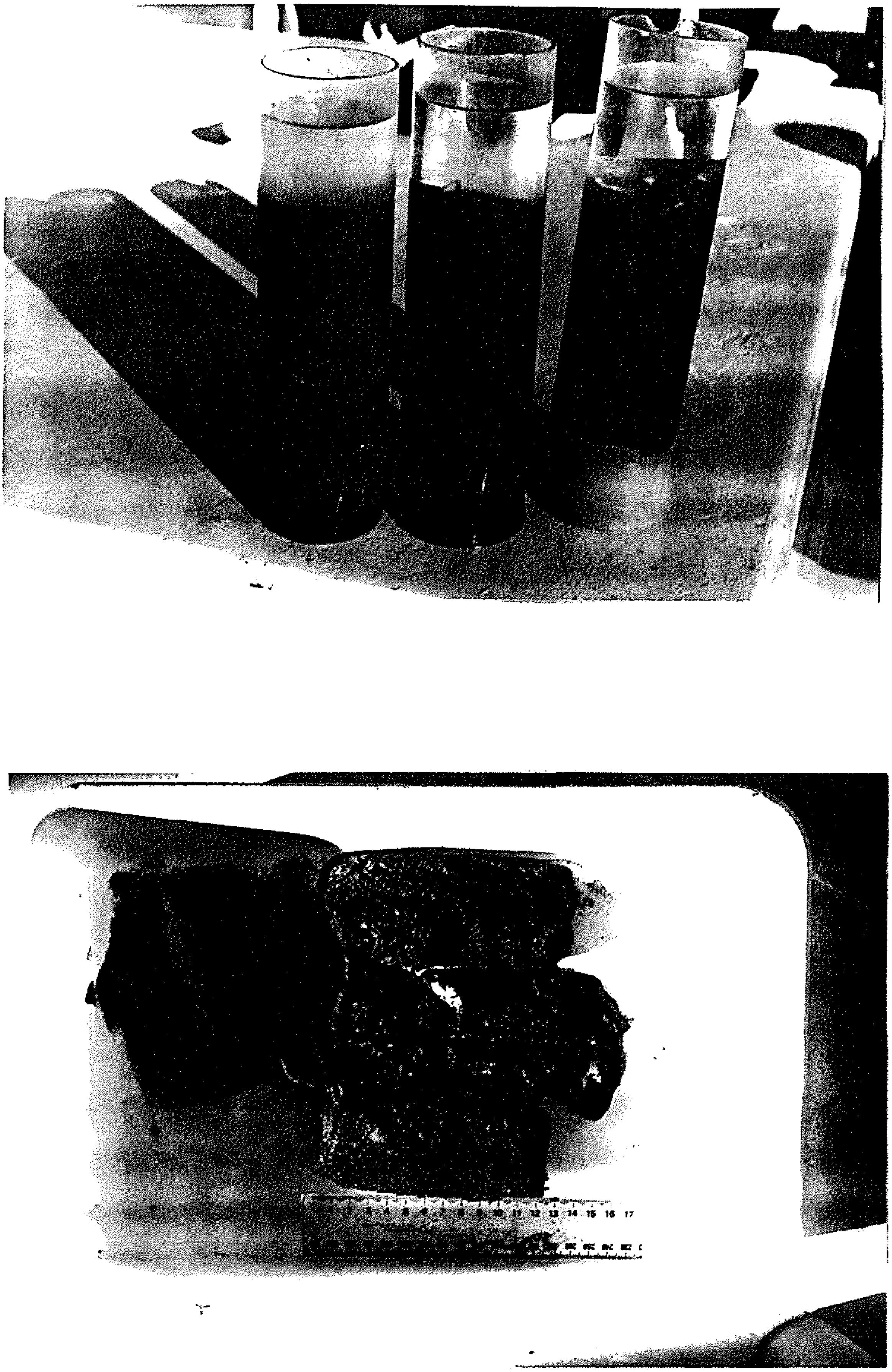


Figure 7 Representative core samples from Papawai Bay.

sediments and the low level of human nutrient input in this area.

The most widespread species throughout the 20 samples were sabellid and spionid polychaetes (14 samples), bivalve (*Scalpomactra scalpellum*)(13 samples) and Amphipoda sp#1 (13 samples)(Table 2). The latter and spionid polychaetes were the only species recorded from all sites (Table 2).

3.4 Comparison of Benthic Communities

Previous macrobenthic research from soft sediments in the Marlborough Sounds has been published by Dell (1951), who reported on three dredge hauls from the outer Queen Charlotte Sound, Roberts and Asher (1993) who investigated an area of Port Ligar (Pelorus Sound) and Estcourt (1967) and McKnight (1969, 1974) who both investigated the fauna from Queen Charlotte Sound, Pelorus Sound and the adjacent part of Cook Strait. Mcknight and Grange (1991) analysed samples collected over most of the Sounds and aimed at an understanding of the distributions of species and marine biological communities throughout the Marlborough Sounds.

Inspection of species compositions in the present study suggest that sites 1, 2, 4 and 5 (called group 1 in this report) have similar species assemblages. In addition, densities of invertebrates from group 1 were similar apart from site 2 which had very high densities of a sabellid polychaete (Table 2)(Figure 2). Site 3 (group 2) had a low number of taxa and low numbers of individuals (Figure 2). Group 1 had three endemics, including the bivalve *Scalpomactra scalpellum*, and maldanid and sabellid polychaetes, while group 2 was characterised by its endemic syllid polychaete, urchin *Pseudechinus novaezelandiae* and lancelet *Epigonichthysis hectori* (Table 2).

McKnight and Grange (1991) compared benthic communities from throughout the Marlborough Sounds and identified four major groups which they related to physical attributes such as substratum and depth. The group most closely related to group 1 in the present study was classified as characteristic of outer Sounds sandy muds with shell fragments found in depths between 20 to 28m by McKnight and Grange (1991). Species identified by McKnight and

Grange (1991) as dominant and subdominant species were all present in site 1 in the present study and to a lesser extent in the other three sites (Table 2). Site 3 in the present study did not fit into any group in the McKnight and Grange (1991) classification, however, their study did not include the outer western Marlborough Sounds.

3.5 Rocky Subtidal Information

A list of invertebrates and macroalgae recorded from shallow subtidal shores adjacent to proposed marine farms are displayed in Tables 2-6 in the Appendix of this report.

At site 1 (Table 2 in Appendix) the shore graded from bedrock (0-33m depth) to outcropping rock surrounded by sand. The rock terminated at 35m depth leaving a soft bottom dominated by sands which continued offshore. The rock substrata had a high percentage cover of brown macroalgae dominated by *Ecklonia radiata* and a component of *Marginerieila*.

At site 2 (Table 3 in Appendix) a bedrock fringe graded into large boulders to 10m depth. At 14 m depth the substratum was dominated by small boulders, cobbles and pebbles. *E. radiata* and *C. flexuosum* formed a high percentage cover over hard substrata down to 10m depth.

A site 3 (Table 4 in Appendix) the shore was dominated by large boulders colonised by a high percentage cover of *E. radiata, C. flexuosum* and *Landsbergia*. A high percentage cover of encrusting organisms dominated by bryozoan and sponge communities were observed on rock faces and overhangs.

At site 4 (Table 5 in Appendix) the rocky shore terminated at 10m depth. Below this depth the substratum was dominated by rippled sands. Little macroalgal species were recorded from this area.

At site 5 (Table 6 in Appendix) bedrock substrata graded into large boulders at 14m depth and then to small boulders at 26m depth and to cobbles and fine sand and broken shell at 30m depth.

Table 2: Counts of benthic macroinvertebrates from core samples collected from outer western M. Sounds (7/4/94).

		Site 1				Site 2				Site 3				Site 4				Site 5			
Scientific name	Common name	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
NEMATODA	round worms												1								
NEMERTINA					1																
SIPUNCULA	peanut worms				2															1	
MOLLUSCA																					
GASTROPODA																					
Austrofucus glans	whelk	1																			
Sigapatella novaezelandiae				1																	
BIVALVIA																					
Ennucula strangeri	nut shell	1			1																
Gari lineolata	sunset shell	1						3						1		1					
Nemocardium pulchellum		1		1								1	1								
Notocallista multistriata		1	1	2	3																
Soltellina silique			1											1		1					
Scalpomactra scalpellum		1	1			2	2	1	3					5	4	2		5	7	6	5
Tellina edgari	wedge shell	1	1	4	2																
Tellina huttoni	wedge shell	1																			
POLYCHAETA	bristle worms																				
Capitellidae		1	1	1	1																
Cirratulidae			1				1					1							2	1	
Eunicidae				2																	
Glyceridae				1	1	1												1			
Lumbrineridae		1		1											1	1					
Magelona papillicornis																				2	7
Maldanidae	bamboo worms			1	13	3	1								2	1				2	
Nephtyidae						2	4	6	3						1	3		3	2	1	2
Opheliidae																	1				
Orbiniidae				1										1							
Pectinaria						1															
Phyllodocidae	paddle worms				1	1	2													1	
Sabellidae sp#1			2	4	1	80	105	160	123					18	14	16		3	10	5	8
Sabellidae sp#2		1																			
Spionidae		4	6	9	3	1					2		1		2	3	6	4	5	5	4
Syllidae											2	5	2							1	
Unidentified polychaete										1											
CRUSTACEA																					
Cumacea sp#1						1								1					1		
Cumacea sp#2						5		2	2												
Cumacea sp#3									1												
Amphipoda	hopper	1	3	2	8	9	16	8	15	1		3	4	2	1	1			2		
Amplpoda sp#1	hopper			2		1	5	1	6		1			2	1	2	3	1	3	2	
Amphipoda sp #2	hopper					8								6	3	2	9	1	6	3	3
Phoxocephalid sp#1	hopper		2	1	7	5	1												1	4	
Phoxocephalid sp#2	hopper		2			8		1	8									1			
Caprellidae	hopper						3														
Ostrocoda sp#1							1		1												
Ostracoda sp#2														4							
Mysidae	shrimp		2		1											2			3		
Tanaidacea sp#1			1		2			2													
Tanaidacea sp#2														3	2						
Isopoda																1					
ECHINODERMATA	stars																				
Echinocardium cordatum	sea mouse														1	1					
Ophiuroidea	sand star		1																		
Pseudechinus novaezelandiae	urchin												1								
BRACHYURA																					
Pagrus sp#1	hermit crab															2			1		
Pagrus sp#2	hermit crab				1																
OTHER																					
Epigonichthys hectori	lancelet											1									
TOTAL INDIVIDUALS		16	25	33	48	128	143	184	162	2	5	11	10	45	34	39	27	19	43	34	27
NUMBER OF TAXA		13	14	15	16	15	12	9	9	2	3	6	7	11	13	15	5	8	12	13	6

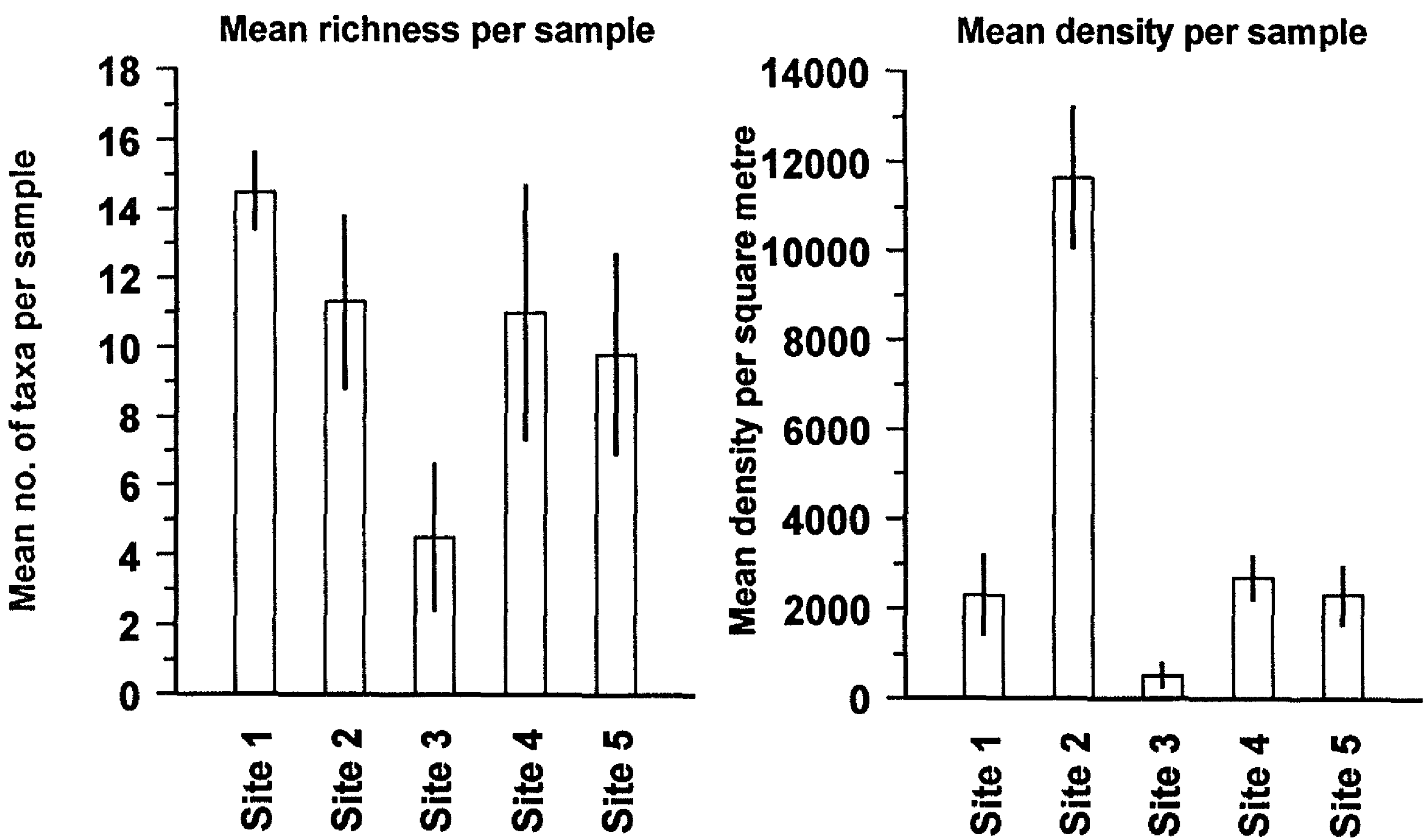


Figure 2 Mean richness (left) and mean densities (per square metre) for each site. Error bar represents 2SD.

4.0 DISCUSSION OF POTENTIAL IMPACTS OF MARINE FARMS

4.1 Benthic Communities

Little is known about the impact of subsurface algae farms on benthic rocky or soft bottom communities in New Zealand. On sites 2, 3, 4 and 5 there is little opportunity (hard substratum) directly beneath the proposed farms for algae spores from a farm to settle as sediments were dominated by sands with a relatively small proportion of fragmented shell. At site 1 the presence of horse mussels (*A. zelandica*) provides opportunity for algal settlement onto a hard surface medium.

At all sites the adjacent shores were dominated by rock. As the proposed marine farms propose to farm naturally settled indigenous algae, it is likely that these areas will be the major source of spores. The influence of algae settlement from the proposed farms back into adjacent hard shores is unknown and will likely depend on the species involved, degree of exposure and depth. Changes resulting from an algae marine farm on the benthic community should be monitored through regular core samples, quadrats and benthic community analysis (see chapter 5).

Studies on the impacts of dredging on marine environments has suggested that benthic communities can be destroyed or modified into a different community (de Groot 1984; Poiner and Kennedy, 1984; Jones, 1992). The establishment of marine farms effectively precludes this activity from the area directly beneath the farm. This advantage to the benthic community is outweighed under many types of marine farms as the benthos is modified by material falling from the farm. In the case of an algae farm, the impact on the benthos may be minimal and therefore the advantage of dredge cessation could be realized. This could be an advantage to communities which are sensitive to dredging as the farm may provide some level of protection.

4.2 Land/Seascape Values

Sites 2, 3 and 5 have documented land/seascape values (Bennett, 1990; Davidson, et al., in prep), while sites 1 and 4 probably also have seascape values but were not included in either study. All seascapes located in the areas proposed as marine farms have low levels of modification and will be regarded as having a high degree of vulnerability to alteration through structures in the marine environment. A decision on weather the proposed subsurface algae farms threaten these values should consider farm distance from the shore, structure size, number and visibility from both the sea and the land.

5.0 MONITORING

Virtually no information on the impact of marine algal farms on the marine environment of New Zealand is known. It is therefore important that any approvals for such farms be seen as an opportunity to document potential impacts. It is strongly suggested that monitoring be part of any approval granted and that the appropriate regulatory authority also encourage research from appropriate educational or science institutions on some of the more complex issues raised by these types of farms.

It is suggested that monitoring programme be initiated following a thorough baseline study. It is suggested a baseline study include: 1) soft bottoms (sediment compositions, organic content, biota composition); 2) rocky shores (community assemblages related to substrata and depth); and 3) marine farms (biota associated and settled into the marine farms). The collection of a wide ranging baseline will potentially deal with the major problem in monitoring which is knowing what factors will change as a result of the impact of event.

6.0 CONCLUSION

The aims of the study were to provide a biological description of the benthos under and adjacent to five proposed marine farm sites and to identify potential threats to any conservation values posed by the proposed marine farms. This first aim was achieved, however, the second aim proved difficult to answer as no documented information was sourced on the impact of subsurface algae marine farms on the New Zealand environment.

The benthic soft and hard shore communities recorded from the present study contained no species that were "unexpected" ie. most species are commonly found in subtidal soft shores around the coast of New Zealand (Dell 1951; Estcourt 1967; McKnight 1969, 1974; Roberts and Asher 1993; McKnight and Grange 1991). Of particular conservation value was the horse mussel bed (*Atrina zelandica*)(Hay, 1990) identified from the underwater video at site 1. Little is known about the importance of this species in subtidal ecology but it seems that horse mussels increase species diversity and may function as juvenile fish nurseries. Certainly in the horse mussel bed identified in the present study, considerable numbers of juvenile blue cod (*Parapercis colias*) were observed in the video.

Potentially, a marine algae farm may protect benthic communities directly below the farm from impacts such as dredging, provided, however, the impact of such a farm did not itself threaten communities such as horse mussels. The impacts of subsurface marine algae farms should be the focus of monitoring programmes. It is possible that subsurface marine farms utilizing indigenous species of algae may have relatively little impact on benthic communities in New Zealand.

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APPENDIX

(Tables 2, 3, 4, 5, 6)

Table 2 List of species recorded from shallow subtidal adjacent to site 1.

Algae	Common name	Invertebrates	Habitat	Common name
Caulerpa sediodes		SPONGIA		
		Ancorina alata	rock	grey sponge
		Aplysilla sulfurea	rock	sulphur
		Aaptos aaptos	rock	
Carpophyllum maschalocarpum	flap-jack	Callyspongia sp.	rock	finger sponge
Carpophyllum flexuosum		Tethia sp	rock	golf ball
Cystophora torulosa		MOLLUSCA		
Ecklonia radiata	paddle weed	Chromodoris amoena	rock	nudibranch
Glossophora		Cryptoconchus porosus	rock	butterfly chiton
Hormosira banksii	Neptunes necklace	Eudoxochiton nobilis	rock	noble chiton
Marginariella		GASTROPODA		
Zonaria		Amalda australis	sand	olive shell
		Anomia	rock	window oyster
Asparagopsis		Astrea	rock	saw shell
		Cominella maculata	rock	whelk
		Cookia sulcata	rock	cook's turban
		Haliotis iris	rock	paua
		Haliotis virginea	rock	paua
		Haustrum haustorum	rock	
		Lepsiella scobina	rock	oyster borer
		Maoricolpus roseus	rock	spire shell
		Mauria punctulata	rock	
		Nemocardium pulchellum	sand	
		Notocallista multistriata	sand	
		Nucula sp	sand	
		Scutus	rock	
		BIVALVIA		
		Chlamys	rock	queen scallop
		Dosinia	sand	
		Trochus sp.	rock	
		POLYCHAETA		
		Brachiomma sp.	sand	fan worm
		Galeolaria hystrix	rock	tube worm
		CRUSTACEA		
		Pagurus sp.	sand	hermit crab
		Plagusia chabrus	rock	reef crab
		ECHINODERMATA		
		Coscinasterias calamaria	soft	11 arm star
		Evechinus chloroticus	rock	kina
		Patiriella regularis	rock	cushion starfish
		Pectinura maculata	sand	
		Pentagonaster	rock	broach star
		Stichopus mollis	sand	cucumber

Table 3 List of species recorded from shallow subtidal adjacent to site 2.

Algae	Common name	Invertebrates	Habitat	Common name
Ulva	sea lettice	SPONGIA		
		Ancorina alata	rock	grey sponge
		Aplysilla sulfurea	rock	sulphur
		Tethia sp	rock	golf ball
Carpophyllum maschalocarpum	flap-jack	MOLLUSCA		
Carpophyllum flexuosum				
Caulerpa brownii		Cryptoconchus porosus	rock	butterfly chiton
Ecklonia radiata	paddle weed	Eudoxochiton nobilis	rock	noble chiton
		GASTROPODA		
Halopteris		Anomia	rock	window oyster
Hormosira banksii	Neptunes necklace	Astrea	rock	saw shell
Landsbergia		Cookia sulcata	rock	cook's turban
		Haliotis iris	rock	paua
		Haliotis virginea	rock	paua
Asparagopsis		Haustrum haustorum	rock	
Euptilota		Lepsiella scobina	rock	oyster borer
		Maoricolpus roseus	rock	spire shell
		Mauria tigris	rock	tiger shell
		BIVALVIA		
		Trochus sp.	rock	
		POLYCHAETA		
		Brachiomma sp.	sand	fan worm
		Galeolaria hystrix	rock	tube worm
		CRUSTACEA		
		Jasus edwardsii	rock	crayfish
		Pagurus sp.	sand	hermit crab
		Plagusia chabrus	rock	reef crab
		ECHINODERMATA		
		Astrostole scabra	rock	
		Coscinasterias calamaria	soft	11 arm star
		Evechinus chorotious	rock	kina
		Patiriella regularis	rock	cushion starfish
		Pectinura maculata	sand	
		Pentagonaster	rock	broach star
		Stichopus mollis	sand	cucumber
		Stegnaster inflatus	rock	ambush star
		BRCHIOPODA		
		Notosaria nigricans	rock	black brachiopod

Table 4 List of species recorded from shallow subtidal adjacent to site 3.				
Algae	Common name	Invertebrates	Habitat	Common name
Caulerpa sedioides		SPONGIA		
		Ancorina alata	rock	grey sponge
		Aplysilla sulfurea	rock	sulphur
		Aaptos aaptos	rock	
Carpophyllum maschalocarpum	flap-jack	Callyspongia sp.	rock	finger sponge
Carpophyllum flexuosum		Tethia sp	rock	golf ball
Carpomitra		MOLLUSCA		
Cystophora torulosa		Cryptoconchus porosus	rock	butterfly chiton
Ecklonia radiata	paddle weed	Eudoxochiton nobilis	rock	noble chiton
Glossophora		GASTROPODA		
Hormosira banksii	Neptunes necklace	Anomia	rock	window oyster
Landsbergia		Astrea	rock	saw shell
Zonaria		Cookia sulcata	rock	cook's turban
		Haliotis australis	rock	paua
Asparagopsis		Haliotis iris	rock	paua
Euptilota		Haliotis virginea	rock	paua
		Haustrum haustorum	rock	
		Lepsiella scobina	rock	oyster borer
		Maoricolpus roseus	rock	spire shell
		Mauria tigris	rock	
		Turbo granosus	rock	cats eye
		Scutus	rock	
		Trochus sp	rock	
		BIVALVIA		
		Chlamys	rock	queen scallop
		Dosinia	sand	
		Trochus sp.	rock	
		POLYCHAETA		
		Brachiomma sp.	sand	fan worm
		Galeolaria hystrix	rock	tube worm
		CRUSTACEA		
		Jasus edwardsii	rock	crayfish
		Pagurus sp.	sand	hermit crab
		Plagusia chabrus	rock	reef crab
		ECHINODERMATA		
		Astrostole scabra	rock	
		Coscinasterias calamaria	soft	11 arm star
		Evechinus chloroticus	rock	kina
		Patiriella regularis	rock	cushion starfish
		Pectinura maculata	sand	
		Pentagonaster	rock	broach star
		Stichaster	rock	reef star
		Stichopus mollis	sand	cucumber
		Stegnaster inflatus	rock	ambush star

Table 5 List of species recorded from shallow subtidal adjacent to site 4.				
Algae	Common name	Invertebrates	Habitat	Common name
Ulva sp.	sea lettice	SPONGIA		
		Ancorina alata	rock	grey sponge
		Callyspongia sp.	rock	finger sponge
Carpophyllum maschalocarpum	flap-jack	Tethia sp	rock	golf ball
Carpophyllum flexuosum		MOLLUSCA		
Cystophora torulosa		Cryptoconchus porosus	rock,	butterfly chiton
Hormosira banksii	Neptunes necklace	Eudoxochiton nobilis	rock	noble chiton
		GASTROPODA		
		Amalda australis	sand	olive shell
		Anomia	rock	window oyster
		Cominella maculata	rock	whelk
		Cookia sulcata	rock	cook's turban
		Haliotis iris	rock	paua
		Haliotis virginea	rock	paua
		Haustrum haustorum	rock	
		Lepsiella scobina	rock	oyster borer
		Maoricolpus roseus	rock	spire shell
		Mauria punctulata	rock	
		Sigapatella novaezelandiae	shell	slipper shell
		Thias orbita	rock	white rock shell
		Turbo granosus	rock	cats eye
		BIVALVIA		
		Chlamys	rock	queen scallop
		Dosinia	sand	
		Gari sp.	sand	sunset shell
		Mytilus edulis	rock	blue mussel
		Pecten novaezelandiae	sand	scallop
		Tawera spissa	sand	
		Trochus sp.	rock	
		Venerocardia	sand	
		POLYCHAETA		
		Brachiomma sp.	sand	fan worm
		Galeolaria hystrix	rock	tube worm
		CRUSTACEA		
		Pagurus sp.	sand	hermit crab
		Plagusia chabrus	rock	reef crab
		ECHINODERMATA		
		Evechinus chloroticus	rock	kina
		Patiriella regularis	rock	cushion starfish
		Pentagonaster	rock	broach star
		Stegnaster inflatus	rock	ambush starfish
		Stichaster	rock	reef star
		Stichopus mollis	sand	cucumber

Table 6 List of species recorded from shallow subtidal adjacent to site 5.				
Algae	Common name	Invertebrates	Habitat	Common name
		SPONGIA		
		Aaptos aaptos	rock	
Carpophyllum maschalocarpum	flap-jack	Ancorina alata	rock	grey sponge
Carpophyllum flexuosum		Callyspongia sp.	rock	finger sponge
Cystophora torulosa		Cliona	rock	
Hormosira banksii	Neptunes necklace	MOLLUSCA		
		Cryptoconchus porosus	rock	butterfly chiton
		Eudoxochiton nobilis	rock	noble chiton
		GASTROPODA		
		Anomia	rock	window oyster
		Astrea	rock	saw shell
		Cookia sulcata	rock	cook's turban
		Maoricolpus roseus	rock	spire shell
		Mauria tigris	rock	
		Turbo granosus	rock	cats eye
		BIVALVIA		
		Glycimeris laticostata	sand	dog cockle
		Pecten novaezelandiae	sand	scallop
		Trochus sp.	rock	
		POLYCHAETA		
		Brachiomma sp.	sand	fan worm
		Galeolaria hystrix	rock	tube worm
		CRUSTACEA		
		Pagurus spinulomanus	sand	hermit crab
		Plagusia chabrus	rock	reef crab
		ECHINODERMATA		
		Evechinus choroticus	rock	kina
		Patiriella regularis	rock	cushion starfish
		Pentagonaster	rock	broach star
		Stegnaster inflatus	rock	ambush starfish
		Stichaster	rock	reef star
		Stichopus mollis	sand	cucumber
		BRCHIOPODA		
		Magasella sp.	rock	
		Waltonia inconspicua	rock	
		BRYOZOA		
		Celleporaria agglutinans	rock	coral