**Biological report on** 

a proposed log loading site

located in Waikakaramea Bay,

# **Queen Charlotte Sound**

**Research, Survey and Monitoring Report Number 441** 

A report prepared for: Wrightson Forestry Services P. O. Box 44 Blenheim

By: Rob Davidson and Laura Richards



JULY, 2003

#### **Bibliographic reference:**

Davidson, R. J.; Richards L.A. 2003: Biological report on a proposed log loading site located in Waikakaramea Bay, Queen Charlotte Sound. Prepared by Davidson Environmental Limited for Wrightson Forestry Services, Survey and Monitoring Report No. 441.

#### **©**Copyright:

The contents of this report are copyright and may not be reproduced in any form without the permission of the client.

#### Prepared by:

Davidson Environmental Limited P. O. Box 958 Nelson Phone 03 5468002 Fax 03 5468443 Mobile 025 453 352 e-mail davidson@xtra.co.nz July, 2003

## **1.0 INTRODUCTION**

The present study provides biological information on the head of Waikakaramea Bay in relation to a proposed log loading site. The applicant proposes to establish a small reclamation south-east of the present wharf to enable loading of pine logs directly onto a barge.

#### 1.1 Waikakaramea Bay

Waikakaramea Bay is located along the southern shoreline of Queen Charlotte Sound, some 22.5 km east of Picton and 16.6 km west of the entrance to Queen Charlotte Sound at Cape Koamaru. The Bay itself is approximately 464 m long and 665 m wide at its entrance. The Bay has two small streams that enter the sea along the southern shoreline of the bay. The total catchment of the Bay, including the Bay sides to the headlands, is approximately 128 ha, while the marine area of the Bay is 22 ha. All of the catchment of the Bay is privately owned, but Sounds Foreshore Reserve extends along all of the Bay edges.

### 2.0 METHODS

Waikakaramea Bay was investigated on  $5^{th}$  June, 2003. A variety of standard scientific techniques were used to sample the habitats and species living in the Bay.

#### 2.1 Intertidal invertebrate counts from small boulders

The invertebrate fauna from under and on small boulder-sized substrata were counted from one site adjacent to the wharf (impact) and from one site on the opposite side of the bay (control). At each site, two tidal heights were sampled (i.e. midtide at approximately 0.7 m to 1 m above spring low water and high tide at approximately 0.8 to 1 m above spring low water). At each site and tidal height, small boulders (250 mm to 350 mm length) were randomly selected and individually placed on a white tray. All invertebrate species living on and under each rock were recorded. Species such as barnacles, hoppers and crabs were recorded as present-absent, while individual molluscs were counted.

Data recorded from "on rocks" and "under rocks" were combined for the purposes of the present study. Rocks partially buried in the substratum were not sampled as they provided no animal habitat on their underside. Intertidal biota data were categorised into (a) number of all invertebrate species; and (b) number of individual molluscs. Raw data have been presented in Appendices 1-4.

#### 2.2 Subtidal transects

Three 50 m long transects were investigated during the present study. Transects extended perpendicular from the low tide mark at two impact and at one control site (Figure 1). Along the length of each transect, divers recorded

depth, distance and substratum. A list of conspicuous macroinvertebrates and fish present from the impact and control areas were also generated by divers.

#### 2.3 Subtidal counts

At all subtidal transects, the density of conspicuous surface dwelling macroinvertebrates from soft bottom shores were sampled. Within each 10 m interval along each transect, either five or ten  $1m^2$  quadrats were deployed randomly. These data have been presented in Appendix 5 and 6.

#### 2.4 Diver free swims

Wide-ranging diver swims were carried out in an effort to determine if the depths, habitats and associated species recorded from the transects were representative of the wider Bay. The approximate areas where divers searched have been presented in Figure 1.

## 3.0 RESULTS

#### 3.1 Intertidal and subtidal habitats

The head of Waikakaramea Bay supported a pebble-sand-shell beach fringed by pasture and exotic trees (Plate 1). The Bay sides were dominated by a boulder and cobble intertidal, fringed by broadleaf trees. Most of the hillsides were dominated by pine plantation.



Plate 1. Head of Waikakaramea Bay with proposed barge loading site in left background.

### 3.2 Intertidal invertebrate counts from small boulders

#### Mean number of species

The mean number of species recorded from impact and control sites, at both tidal heights in Waikakaramea Bay, were not significantly different (P < 0.14) (Appendices 1-4).

In Figures 2 and 3, the mean number of species recorded from mid tide in Waikakaramea Bay were compared with values from a variety of sites in the bays of Tory Channel (Davidson and Richards, 2003) and central Queen Charlotte Sound sampled as part of a fast ferry impact monitoring study (Davidson, 2002). The mean number of species recorded from the present study were higher than those recorded from the bays of Tory Channel, but these differences were only significant for particular sites (e.g. Deep Bay outer) (Figure 2). The mean numbers of species recorded from the present sites were comparable to sites away from ferry wash (e.g. Spencer Bay, Blumine north), but were significantly higher than sites subject to ferry wash (e.g. Arrowsmith, Picton Point) (P< 0.001) (Figure 3).

Plate 2 Boulder and cobble shore at the proposed barge loading site. The wharf is behind the photographer.



#### Mean total number of mollusc individuals

The density of molluscs recorded from impact and control sites at mid tide in Waikakaramea Bay were not significantly different. At high tide, significantly more molluscs were recorded from the control site compared to the impact site (T = 76.5, P = 0.034) (Appendices 1-4).

The mean numbers of molluscs recorded from Waikakaramea Bay were in the middle of the range of values recorded from the bays of Tory Channel (Figure 4). The mean numbers of molluscs recorded from the present sites were similar to sites located away from ferry wash (e.g. Arapawa, Spencer Bay), but were significantly higher than sites subject to ferry wash (e.g. Onapua Bay and Picton Point) (P < 0.001) (Figure 5).

#### 3.3 Subtidal shore profiles and habitats

The shore profiles from the two impact and one control sites have been presented in Figures 6, 7, and 8. All shore profiles, habitats and associated species were comparable from the three sites. The shores were initially dominated by extensions of the intertidal zone (i.e. boulder- and cobble-sized material). By 6 m to 11 m distance from low water, and at depths of 0.1 to 0.2 m depth below low water, the hard shore substrata ceased and was replaced by rippled fine sand substratum (Plate 3). This substratum extended to the end of impact transect 1 (Figure 6), and to 25 m to 30 m distance at the impact 2 and control transect (Figures 7 and 8). In the offshore areas of these latter transects, the benthos was characterised by a fine sand base with a component of dead shell (< 10%) (Plate 4). At the control transect, a pebble-granule material was also recorded in offshore areas of the transect.

Plate 3 Rippled fine sand habitat from shallow areas in Waikakaramea Bay. The fish is a stargazer.



Plate 4 Fine sand and shell habitat located in offshore areas of impact 2 and the control transect.



#### 3.4 Subtidal counts of surface dwelling species

Raw data for conspicuous surface dwelling invertebrates from the three shore profiles have been presented in Appendices 5 and 6. The abundance and number of conspicuous surface dwelling species was relatively low from transect 1 (Figure 9). The density of the most widespread species (i.e. cushion seastar, cats-eye snail and hermit crab), were highest at the impact 2 and control sites. Overall, the abundance of the most abundant species were lower from the shallow rippled sand habitat compared to the deeper sand and shell habitat (Figure 9).

### 4.0 **DISCUSSION**

#### 4.1 Intertidal and subtidal habitats

The intertidal and subtidal habitats of inner Waikakaramea Bay were comparable to numerous bays in central Queen Charlotte Sound. The Bay was characterised by a relatively narrow intertidal shore supporting fine material at its head and hard shores along the Bay sides and headlands. No alluvial flats supporting eelgrass or shellfish beds were found within this Bay.

The shallow subtidal environment was an extension of the adjacent intertidal shore (i.e. the Bay sides were dominated by a thin strip of subtidal boulders and cobbles). Immediately below these hard shores, the subtidal was characterised by rippled fine sand substratum. This was widespread across the shallow areas of the Bay head between impact and control transects (Figure 1). With increasing distance from shore and depth, the substratum changed to a fine sand base with a component of shell and, in places, pebbles and granule material. This material was also widespread across the Bay.

All intertidal and subtidal habitats and associated species recorded from Waikakaramea Bay are widespread in the Marlborough Sounds, particularly central Queen Charlotte Sound.

#### 4.2 Species abundance and composition differences

Few differences in habitat structure and community composition were recorded between impact and control sites in Waikakaramea Bay. The exception was significantly more mollusc individuals recorded from the high tide level at the control site compared to the impact site. This was due to the greater number of smooth topshell (*Diloma nigerrima*) at the control site. The reason for this phenomenon is unknown but may be related to shore aspect and exposure times to the sun.

The abundance and composition of intertidal species at the present sites were comparable to other sites in Queen Charlotte Sound and Tory Channel, away from the impact of ferry wakes. The number of intertidal species and the abundance of molluscs were higher at the present site than at ferry impacted sites. These patterns are consistent with many other sites in central Queen Charlotte Sound.

### 4.3 Biological impact of a barge loading site

The marine environment of Waikakaramea Bay is relatively free from widespread human impacts. The exception was the wharf and adjacent access way. This area has an associated access way that has been sufficiently widened to facilitate small vehicle-sized traffic. This area is therefore the most appropriate place in the Bay to construct the presently proposed barge loading site. It is the part of the Bay already modified and therefore localises human impacts to one part of the Bay.

Based on observations from around the wharf, and the access way, there has been no obvious negative impacts on the biota or habitats. If the proposed barge loading development is approved, a relatively small area of seabed and intertidal area will be covered by the reclamation. This represents a relatively permanent loss of a small area of seabed. The habitats and species located in the proposed reclamation area:

- 1 Do not support any rare or uncommon species or species with restricted distributions;
- 2 Do not support recreationally targeted species such as scallops or blue cod;
- 3 Are widespread in the Bay and are known from many other bays in central Queen Charlotte Sound.

It is, however, recommended that the reclamation sides be constructed using comparable hard shore material to the existing hard shores at the site. This substratum with thereby provide the opportunity for intertidal animals to colonise.

In conclusion, the proposed reclamation represents a permanent loss of intertidal and subtidal habitats. A larger area of intertidal hard shore habitats will be created by the proposal. This intertidal hard shore habitat will be colonised by the same range and abundances of species recorded from the site during the present study. The reclaimed subtidal habitat supports a relatively low number of species in low abundance. This habitat type is widespread in Waikakaramea Bay and in many bays in the Marlborough Sounds. Based on my personal observations adjacent to marina walls in the Marlborough Sounds, the construction of the proposed reclamation is unlikely to result in a detectable impact in the wider Bay. From a biological perspective, I consider the present site suitable for consideration of the proposed log loading development.



### References

- **Davidson, R.J. 2000.** Biological monitoring of boulder and cobble shores in Tory Channel and Queen Charlotte Sound in relation to ferry wakes: 1995 to 2000. Prepared by Davidson Environmental Limited for the Marlborough District Council. Research, Survey and Monitoring Report No. 341.
- **Davidson, R.J. 2002.** Biological monitoring of Tory Channel and Queen Charlotte Sound in relation to the 18 knot speed restriction. Prepared by Davidson Environmental Limited for Department of Conservation, Marlborough District Council and Ministry for the Environment. Survey and Monitoring Report No. 423.
- Davidson, R. J.; Richards L. 2003: Biological report on three sites in Tory Channel in relation to recent or proposed forestry activities. Prepared by Davidson Environmental Limited for Marlborough District Council. Survey and Monitoring Report No. 444.
- **Graynoth, E. 1992.** Long-term effects of logging practices in streams in Golden Downs State Forest, Nelson Chapter 7 in Mayer, J.W., Davis S.F. (eds) Proceedings of the Fisheries/Forestry Conference 27 28 February 1990 Christchurch Freshwater Fisheries Centre MAF.
- Hume, T.M.; Gibb, J.G. 1987. The Wooden-floor marker bed- a new method of determining historical sedimentation rates in some New Zealand estuaries. Journal of the Royal Society of New Zealand17, 1-7.
- Hume, T.M.; McGlone, M.S. 1986. Sedimentation patterns and catchment use change recorded in the sediments of a shallow tidal creek, Lucas Creek, Upper Waitamata Harbour, New Zealand. New Zealand Journal of Marine and Freshwater Research 20, 677-687.
- Knox, G.A. 1980. The Estuarine Zone: An Overview. Soil and Water. Vol. 16(2), 13 17.
- Lauder, G.A. 1987. Coastal landforms and sediments of the Marlborough Sounds. Unpublished Phd. Thesis, University of Canterbury, 327 p.
- Morgan, D.R.; Graynoth, E. 1978. The influence of Forestry practices on the ecology of freshwater fish in New Zealand: an introduction to the literature New Zealand Ministry of Agriculture and Fisheries; Fisheries Research Division Occasional Publication 14: 1 36.
- Newton, C.G.H. 1977. Sedimentary dynamics of Tory Channel. Unpublished MSc. Thesis, Department of Geography, University of Canterbury.
- Johnston, A.; Mace J.; Laffan, M. 1982. Possible forestry impact on Marlborough Sounds fisheries. *Catch* 9(2): 23-24.
- Johnston, A.; Mace, J.; Laffan, M.D. 1981. The saw, the soil and the Sounds. Soil and Water 17, 4-8.
- **Ryan, P.A. 1991.** Environmental effects of sediment on New Zealand streams: a review. New Zealand Journal of Marine and Freshwater Research. Vol 20: 37 46.





Figure 2 Mean number of species recorded from sites in the present study compared with sites located in bays of Tory Channel (Davidson and Richards 2003). Error bars = 95% CI. Reference lines = mean of all sites.



Figure 3 Mean number of species recorded from sites in the present study and those averaged from fast ferry monitoring 1995-2002. Sites in black are subject to ferry wash Error bars = 95% CI.

Nospec1.spw



Figure 4 Mean total number of molluscs from sites in the present study compared to those from sites in bays off Tory Channel . Error bars = 95% CI. Reference lines = mean of all sites in graph.



Figure 5 Mean total number of molluscs from sites in the present study compared to those averaged from fast ferry monitoring 1995-2002. Sites in black are subject to ferry wakes. Error bars = 95% CI.

Nospec2.spw



Figure 9 Mean density of particular species recorded from subtidal quadrats collected from the three sites. Error bars = 95% CI.

Submeans.spw

Appendix 1 Raw invertebrate data collected from intertidal cobbles.

Site name: Waikakaramea Bay (impact)	5/06/2003	<b>Recorders:</b>	Rob D
41 12.127 E, 174 15.299 S			

High tide (0.8-1.0 m above spring low)	Туре	1	2	3	4	5	6	7	8	9	10	Mean	SD
Diloma nigerrima (smooth tonshell)	Mollusca			12	27	5	20	7	1	7	6		
Bisellonsis varia (ridged topshell)	Mollusca			12	27	5	20	1	1	1	1		
Melagraphia aethions (topshell)	Mollusca				1			1		1	1		
Haustrum haustorium (dark rock shell)	Mollusca												
Lansialla scobina (ovster borer)	Mollusca												
Collana stallifara (large limpet)	Mollusca							1					
Cominella magulata (whelk)	Mollusca							1					
Cominella alandiformia (mudflat uhalla)	Mollusca												
Cominella gianaijormis (Indunat wherk)	Mollusca												
Cominetta daspersa (witetk)	Mallusca												
Buccinuum vinatum (siriped wheik)	Mallassa												
Zeacumantus subcarinatus (spire snell)	Mollusca								1		1		
Notoacmea neimsi (tiny limpet)	Monusca								1		1		
Atalacmea fragilis (fragile limpet)	Mollusca												
Onchidella nigricans (slug)	Mollusca						1						
Chiton pelliserpentis (snakeskin)	Mollusca						I						
Amaurochiton glaucus (green chiton)	Mollusca												
Mytilus galloprovincialis (blue mussel)	Mollusca												
Aulacomya ater maoriana (ribbed mussel)	Mollusca												
Turbo smaragdus (cats eye snail)	Mollusca												
Presence/absence: 1=present, blank=absent													
Chamaesipho brunnea (small barnacle)	Crustacean	1		1	1		1	1		1	1		
<i>Epopella plicata</i> (large barnacle)	Crustacean												
Petrolisthes elongatus (false crab)	Crustacean									1			
Hemigrapsis edwardsii (purple crab)	Crustacean												
Hemigrapsis crenulatus (hairy handed crab)	Crustacean												
Heterozius rotundifrons (play dead crab)	Crustacean												
Cvclograpsus lavauxi (smooth shore crab)	Crustacean	1	1					1	1				
Hoppers (amphipods)	Crustacean	1	1	1	1	1	1	1	1	1	1		
Actinia tenebrosa (red anemone)	Coelenterata												
Anemone sp.	Coelenterata						1						
												Mean	SD
Number of species		3	2	3	4	2	5	6	4	5	5	3.9	1.3703
Number of mobile mollusc species		0	0	1	2	1	2	3	2	2	3	1.6	1.075
Total number of molluscs		0	0	12	28	5	21	9	2	8	8	9.3	9.0805

Appendix 2 Raw invertebrate data collected	from intertidal cobb	es.											
Site name: Waikakaramea Bay (impact) 41 12.127 E, 174 15.299 S	5/06/200	)3						]	Record	lers:		Rob D	
Mid Tide (0.5-0.7 m above spring low)	Туре	1	2	3	4	5	6	7	8	9	10	Mean	SD
Diloma nigerrima (smooth topshell)	Mollusca	10	7	20	11	4	36	19	3	10	15		
Risellopsis varia (ridged topshell)	Mollusca	9	4		3		2	1	2	1	2		
Melagraphia aethiops (topshell)	Mollusca		1				1	1		1			
Haustrum haustorium (dark rock shell)	Mollusca					1							
Lepsiella scobina (oyster borer)	Mollusca			4			1	1	1	1			
Cellana stellifera (large limpet)	Mollusca		1										
Cominella maculata (whelk)	Mollusca												
Cominella glandiformis (mudflat whelk)	Mollusca												
Cominella adspersa (whelk)	Mollusca												
Buccinulum vittatum (striped whelk)	Mollusca												
Zeacumantus subcarinatus (spire shell)	Mollusca												
Notoacmea helmsi (tiny limpet)	Mollusca	3	4	5	1	3	1	1	2	3			
Atalacmea fragilis (fragile limpet)	Mollusca								3				
Onchidella nigricans (slug)	Mollusca												
Chiton pelliserpentis (snakeskin)	Mollusca	3	2	3	1		3		1				
Amaurochiton glaucus (green chiton)	Mollusca												
Mytilus galloprovincialis (blue mussel)	Mollusca												
Aulacomya ater maoriana (ribbed mussel)	Mollusca												
Turbo smaragdus (cats eye snail)	Mollusca												
Presence/absence: 1=present, blank=absent													
Chamaesipho brunnea (small barnacle)	Crustacean	1	1	1	1	1	1	1	1		1		
Epopella plicata (large barnacle)	Crustacean	1		1				1	1				
Petrolisthes elongatus (false crab)	Crustacean	1	1	1	1	1	1	1	1	1	1		
Hemigrapsis edwardsii (purple crab)	Crustacean												
Hemigrapsis crenulatus (hairy handed crab)	Crustacean												
Heterozius rotundifrons (play dead crab)	Crustacean	1	1	1						1	1		
Cyclograpsus lavauxi (smooth shore crab)	Crustacean												
Hoppers (amphipods)	Crustacean	1	1	1	1	1	1	1	1	1	1		
Actinia tenebrosa (red anemone)	Coelenterata												
Anemone sp.	Coelenterata	-											
			10				6		10			Mean	SD
Number of species		9	10	9	7	6	9	9	10	8	6	8.3	1.4944
Number of mobile mollusc species		4	6	4	4	3	6	5	6	5	2	4.5	1.354
Total number of molluses	1	25	19	32	16	8	44	23	12	16	17	21.2	10.486

Appendix 3 Raw invertebrate data collected from intertidal cobbles.

Site name: Waikakaramea Bay (control)	5/06/2003								Reco	rders:		Rob D	
41 12.211 E, 174 15.223 S													
High tide (0.8-1.0 m above spring low)	Туре	1	2	3	4	5	6	7	8	9	10	Mean	SD
Dilong vicerring (smooth topshall)	Mollusso	22	10	10	22	16	12	51	21	10	5		
Bisellongis varia (ridgod tonshall)	Mollusca	22	10	10	22	10	15	51	21	10	1		
Malagnanhia acthiona (topshell)	Mollusca	2									1		
Haustrum haustorium (dark rock shall)	Mollusca	2											
Lansiella scobing (ovster borer)	Mollusca							1					
Cellana stallifara (large limpet)	Mollusca							1					
Cominolla magulata (wholk)	Mollusca												
Cominella alandiformis (mudflat whelk)	Mollusca												
Cominella adsparsa (whelk)	Mollusca												
Buccinulum vittatum (striped whelk)	Mollusca												
Zacumantus subcarinatus (spire shall)	Mollusca												
Notogemag helmsi (tipy limpet)	Mollusca		4			2				1			
Atalacmaa fragilis (fragile limpet)	Mollusca		4			2				1			
Onchidella nigricans (slug)	Mollusca	1											
Chiton nellisernentis (snakeskin)	Mollusca	1											
Amaurochiton glaucus (green chiton)	Mollusca	1											
Mytilus galloprovincialis (blue mussel)	Mollusca												
Aulacomya ater maoriana (ribbed mussel)	Mollusca												
Turbo smaraadus (cats eve snail)	Mollusca												
<i>Turbo shuruguus</i> (cuts eye shuri)	Wionusca												
Presence/absence: 1=present, blank=absent													
Chamaesipho brunnea (small barnacle)	Crustacean		1	1				1	1	1	1		
Epopella plicata (large barnacle)	Crustacean												
Petrolisthes elongatus (false crab)	Crustacean	1	1										
Hemigrapsis edwardsii (purple crab)	Crustacean												
Hemigrapsis crenulatus (hairy handed crab)	Crustacean												
Heterozius rotundifrons (play dead crab)	Crustacean												
Cyclograpsus lavauxi (smooth shore crab)	Crustacean							1	1	1	1		
Hoppers (amphipods)	Crustacean	1	1	1	1	1	1	1	1	1	1		
Actinia tenebrosa (red anemone)	Coelenterata									1			
Anemone sp.	Coelenterata												
Nambar of an air		6	5	2	2	2		5	4			Mean	SD
Number of species		0	2	5	2	3	2	2	4	0	2	4.1	1.524
Number of mobile moliuse species		4	2	10	1	10	12	52	21	2	2	1.8	0.919
I OTAL NUMBER OF MOLIUSES		- 20	14	-10	22	18	13	52	21	11	0	19.3	13.02

Appendix 4 Raw invertebrate data collected from intertidal cobbles.

Site name: Waikakaramea Bay (control) 41 12.211 E, 174 15.223 S	5/06/2	2003						]	Reco	rders	:	Rob D	
Mid Tide (0.5-0.7 m above spring low)	Туре	1	2	3	4	5	6	7	8	9	10	Mean	SD
Diloma nigerrima (smooth topshell)	Mollusca	19	1	8	12		6	4	7	5	4		
Risellopsis varia (ridged topshell)	Mollusca		2	1			1			3			
Malaguanhia anthiona (tonshall)	Mallusaa	1			1	2		4		1	2		

Risellopsis varia (ridged topshell)	Mollusca		2	1			1			3			
Melagraphia aethiops (topshell)	Mollusca	1			1	2		4		1	3		
Haustrum haustorium (dark rock shell)	Mollusca												
Lepsiella scobina (oyster borer)	Mollusca												
Cellana stellifera (large limpet)	Mollusca												
Cominella maculata (whelk)	Mollusca												
Cominella glandiformis (mudflat whelk)	Mollusca												
Cominella adspersa (whelk)	Mollusca												
Buccinulum vittatum (striped whelk)	Mollusca												
Zeacumantus subcarinatus (spire shell)	Mollusca												
Notoacmea helmsi (tiny limpet)	Mollusca	9	10	11	23	18	23	1	12	7	19		
Atalacmea fragilis (fragile limpet)	Mollusca	1							3				
Onchidella nigricans (slug)	Mollusca					1			1				
Chiton pelliserpentis (snakeskin)	Mollusca	3	3			8		1		4	2		
Amaurochiton glaucus (green chiton)	Mollusca												
Mytilus galloprovincialis (blue mussel)	Mollusca												
Aulacomya ater maoriana (ribbed mussel)	Mollusca												
Turbo smaragdus (cats eye snail)	Mollusca												
Presence/absence: 1=present, blank=absent													
Chamaesipho brunnea (small barnacle)	Crustacean	1		1		1				1			
Epopella plicata (large barnacle)	Crustacean												
Petrolisthes elongatus (false crab)	Crustacean	1	1	1	1	1	1	1	1	1	1		
Hemigrapsis edwardsii (purple crab)	Crustacean												
Hemigrapsis crenulatus (hairy handed crab)	Crustacean												
Heterozius rotundifrons (play dead crab)	Crustacean			1	1		1	1	1	1	1		
Cyclograpsus lavauxi (smooth shore crab)	Crustacean												
Hoppers (amphipods)	Crustacean	1	1	1	1	1	1	1	1	1	1		
Actinia tenebrosa (red anemone)	Coelenterata				1	1	1			1			
Anemone sp.	Coelenterata												
												Mean	SD
Number of species		8	6	7	7	8	7	7	7	10	7	7.4	1.075
Number of mobile mollusc species		5	4	3	3	4	3	4	4	5	4	3.9	0.738
Total number of molluscs		33	16	20	36	29	30	10	23	20	28	24.5	8.114

Appendix 5 Raw data collected from subtidal habitats. Values represent 1 sq m.

Waikakaramea Bay												
Transect (Impact 1)												
Soft shores (10-20 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
Patiriella regularis (cushion seastar)	5	2	ч	1	1	4	5	1	0	0	2 20	1 93
Tuttettu regularis (cusitori scastar)	5	2	5				5			0	2.20	1.55
Soft shores (20-30 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
Patiriella regularis (cushion seastar)	1	0	0	0	0	0	0	0	0	0	0 10	0.32
runnenu regularis (eusmon seustar)			Ū	Ū	Ū		0			Ŭ	0.10	0.02
Soft shores (30-40 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
Patiriella regularis (cushion seastar)	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Soft shores (40-50 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
Patiriella regularis (cushion seastar)	0	1	0	0	0	0	0	0	0	0	0.10	0.32
Waikakaramea Bay												
Transect (Impact 2)												
Soft shores (10-20 m distance)	1	2	3	4	5	Mean	SD					
Hermit crab	2	0	0	0	0	0.40	0.89					
Cookia sulcata (Cook's turban)	0	1	0	0	0	0.20	0.45					
Turbo smaragdus (cats eye)	1	0	0	0	0	0.20	0.45					
Coscinasterias muricata (11 arm seastar)	1	0	0	0	0	0.20	0.45					
Patiriella regularis (cushion seastar)	8	7	7	0	0	4.40	4.04					
					- 1		0.5					
Soft shores (20-30 m distance)	1	2	3	4	5	Mean	SD					
Hermit crab	1	0	1	3	0	1.00	1.22					
Turbo smaragdus (cats eye)	1	2	1	4	0	1.60	1.52					
Patiriella regularis (cushion seastar)	3	5	4	3	4	3.80	0.84					
Soft shores (30-40 m distance)	1	2	3	4	5	Mean	SD					
Hermit crab	0	2	1	0	0	0.60	0.89					
Turbo smaragdus (cats eye)	6	3	4	4	2	3.80	1.48					
Patiriella regularis (cushion seastar)	11	14	6	9	8	9.60	3.05					
Soft shores (40-50 m distance)	1	2	3	4	5	Mean	SD					
Hermit crab	1	1	0	0	0	0.40	0.55					
Turbo smaragdus (cats eve)	1	2	3	2	1	1.80	0.84					
Evechinus chloroticus (kina)	1	0	0	0	0	0.20	0.45					
Coscinasterias calamaria (11 arm seastar)	0	1	0	0	0	0.20	0.45					
Patiriella regularis (cushion seastar)	11	7	5	7	3	6.60	2.97					

### Appendix 6 Raw data collected from subtidal habitats. Values represent 1 sq m.

Waikakaramea Bay												
Transect (Control)												
Soft shores (10-20 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
	I .											
Turbo smaragdus (cats eye)	1	0	0	0	0	0	0	0	0	0	0.10	0.32
Patiriella regularis (cushion seastar)	9	6	0	0	0	0	0	0	0	0	1.50	3.24
Soft shores (20-30 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
**					10			•	0	•		0.00
Hermit crab		1	1	1	10	1	1	0	0	0	1.60	2.99
Cominella adspersa (whelk)		0	0	0	0	0	0	0	0	0	0.10	0.32
<i>Turbo smaragdus</i> (cats eye)	5	1	2	1	0	0	0	0	0	0	0.90	1.60
<i>Coscinasterias muricata</i> (11 arm seastar)		1	0	0	0	0	0	0	0	0	0.20	0.42
Patiriella regularis (cushion seastar)	1	1	1	1	1	1	0	0	0	0	0.60	0.52
Soft shores (30-40 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
Hermit crab	1	2	1	0	0	0	0	0	0	0	0.40	0.70
Cominella adspersa (whelk)	1	0	0	0	0	0	0	0	0	0	0.10	0.32
Turbo smaragdus (cats eye)	1	1	1	5	0	0	0	0	0	0	0.80	1.55
Patiriella regularis (cushion seastar)	7	8	8	5	2	0	0	0	0	0	3.00	3.59
Soft shores (40-50 m distance)	1	2	3	4	5	6	7	8	9	10	Mean	SD
Hermit crab	2	4	1	1	1	0	0	0	0	0	0.90	1.29
Cominella adspersa (whelk)	1	4	1	0	0	0	0	0	0	0	0.60	1.26
Turbo smaragdus (cats eye)	1	1	0	0	0	0	0	0	0	0	0.20	0.42
Patiriella regularis (cushion seastar)	6	8	9	7	10	6	7	4	14	0	7.10	3.70