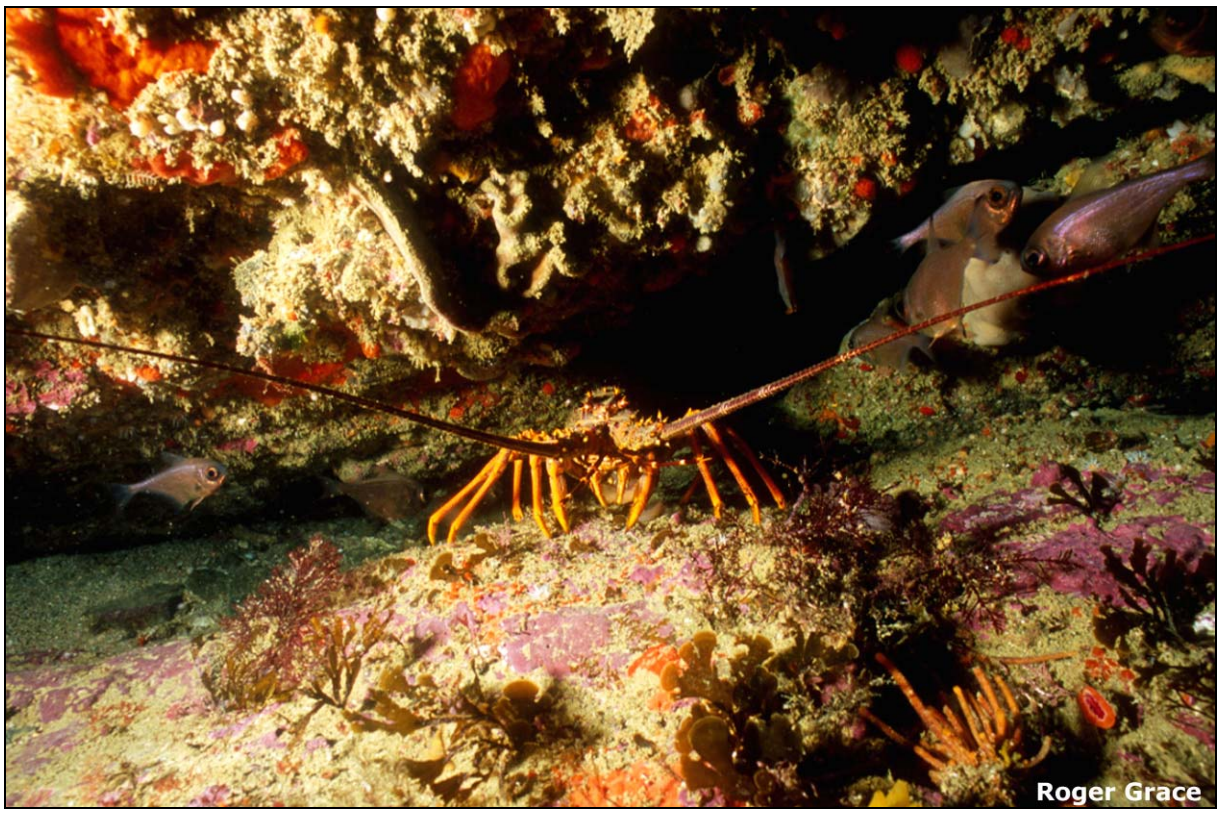
Mimiwhangata Marine Monitoring Programme

Summer & Autumn Sampling 2006

Roger Grace and Vince Kerr



For

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Abstract

In March, April and May 2006 monitoring of six permanent fish and crayfish transects at Mimiwhangata was completed. As well four new 'reference site' permanent transects were established. One to the north of the Mimiwhangata Marine Park and three to the south on the Whananaki coast.
Red crayfish numbers continued to be at very low levels. Only one legal-sized crayfish was found on the ten transects surveyed. This is the lowest result for legal-sized red crayfish on record, and suggests that the red crayfish population is in serious trouble. On some of the transects small numbers of sub-legal red crayfish were present. Packhorse crays continue to be absent from all transects. Fish populations appear to have remained relatively stable. After a bad year for recruitment in 2004, and a good recruitment year in 2005, red moki juveniles are present again on several transects in average numbers. This year a single spotted black grouper was seen, along with the subtropical mimic blenny, a one-spot demoiselle and a Graham's gudgeon. The new bed of juvenile tuatuas, which appeared in 2005 on the north end of Mimiwhangata Beach, is still present but was not surveyed this year. Decadal analysis of historic crayfish data for Mimiwhangata and Tawharanui suggests that red crayfish numbers at Mimiwhangata are heading for a crash, as happened in the open-fishing area at Tawharanui nearly 20 years ago. This contrasts with the recent spectacular increase in red crayfish numbers and sizes within the no-take area at Tawharanui Marine Park.

Introduction

The Mimiwhangata Marine Monitoring Programme was established in the winter of 1976, and was designed to provide long-term information on marine resources, particularly popular edible species, to aid in their management.

A Marine Park was established in 1984 in the waters surrounding Mimiwhangata. Special Fisheries Regulations were established, which restricted recreational fishing by limiting what fishing methods could be used and which species could be taken. The intention was for all species to be protected, apart from those which could stand a moderate amount of fishing pressure. The intent was to provide a healthy natural "background" of marine life for the non-extractive enjoyment of visitors to the Marine Park.

Commercial long-lining and potting for crayfish was allowed to continue until 1994, leaving limited recreational fishing as the only extractive activity at Mimiwhangata within the Marine Park boundary.

In 1994 it was realised that an omission in the drafting of the special fisheries regulations for Mimiwhangata meant that, although species and gear restrictions were included in the regulations, all other marine life was NOT protected as intended. The regulations were effectively unenforceable and in practice many people have continued fishing in the Marine Park in accordance with normal recreational fishing regulations. So we have a Marine Park in which commercial fishing has been absent since 1994, and recreational fishing has continued with little change from normal recreational fishing practices.

In 2004 the Department of Conservation published a proposal (DoC 2004), calling for a marine reserve to be put in place at Mimiwhangata. There was an extensive community consultation effort carried out at that time. The proposal attracted significant support and some opposition from fishing interests and some tangata whenua. The marine reserve proposal at the time of writing this report is pending waiting on the details of the recently announced Marine Protected Areas policy.

Monitoring was carried out regularly in the early years, but became more intermittent over the period up to 1986 when the last comprehensive monitoring was done before a gap of approximately 17 years. Monitoring was resumed in the winter of 2001 when only intertidal sites were assessed. From 2002 to the present monitoring of the fish and crayfish transects have been completed and reported on (Grace & Kerr 2002a, 2003, 2004, 2005a). Other significant works at Mimiwhangata include a habitat mapping project (Kerr & Grace 2005) and fish and crayfish studies completed by the University of Auckland (Denny & Babcock 2002, Usmar et. al. 2003). As well two international publications have focused on multi-reserve analysis of data sets to explore the efficacy of partial protection regimes verses full protection under marine reserve status (Denny & Babcock 2004, Shears et. al. 2006). In both the later studies the partial protection regime compares poorly with comparable marine reserve areas for exploited fish species and crayfish.

In a report (Grace 2005) commissioned by the Department of Conservation, Roger Grace examined the monitoring history at Mimiwhangata and made a series of recommendations on the future objectives and specific monitoring that should be carried out. These aimed to keep the valuable historical data sets intact while at the same time make the best use of modern methods and statistical approaches in order to understand any future changes in biodiversity. A review of the monitoring approach at Mimiwhangata was especially timely considering the possibility of the area becoming a marine reserve. The report detailed the methodology used for the historic work and summarised the findings to date. Specific recommendations were made for the historical UVC transects which involve discontinuing 4 of the 10 original transects and establishing 4 new transects outside of the proposed marine reserve boundary. These recommendations have been implemented in the work completed this year.

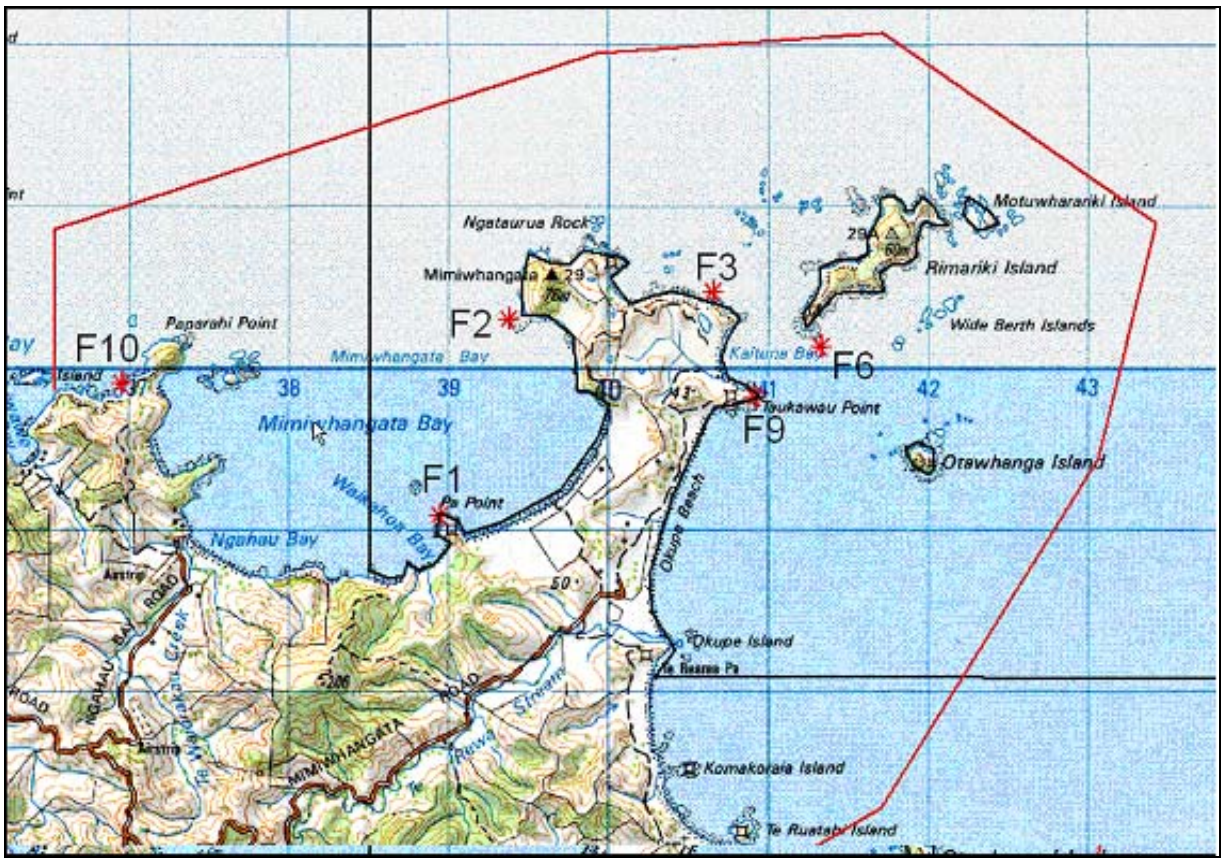

Figure 1. Mimiwhangata Fish and Crayfish Transects – red line marks Marine Park boundary, black line marks proposed Marine Reserve boundary (DoC 2004). Red stars mark zero point of transect.

Methods

Six 10 x 50 metre historic fish and crayfish transects were selected for the monitoring program for this year, five of which are located within the proposed marine reserve area. The original rationale for the location of the historic transects and method used for counting is repeated here for clarity. The process for establishing four new reference transects is described below. The names and locations of the historic and 'new' reference transects is detailed in Table 1

Table 1. GPS coordinates of transect zero points (* denotes newly established transects)

		Zero Point	
Stn.	**Locality**	**Eastings**	**Northings**
F1	Pa Point	2638949	6639092
F2	Grey Rock	2639375	6640315
F3	Lunch Bay	2640656	6640479
F6	Porae Point	2641337	6640144

F9	Taukawau Point	2640917	6639824
F10	Suicide Cove	2636956	6639919
F11	Motutara*	2635502	6642016
F12	Otamuri*	2643748	6634032
F13	Barron's North*	2644122	6632270
F14	Barron's South*	2645046	6630964

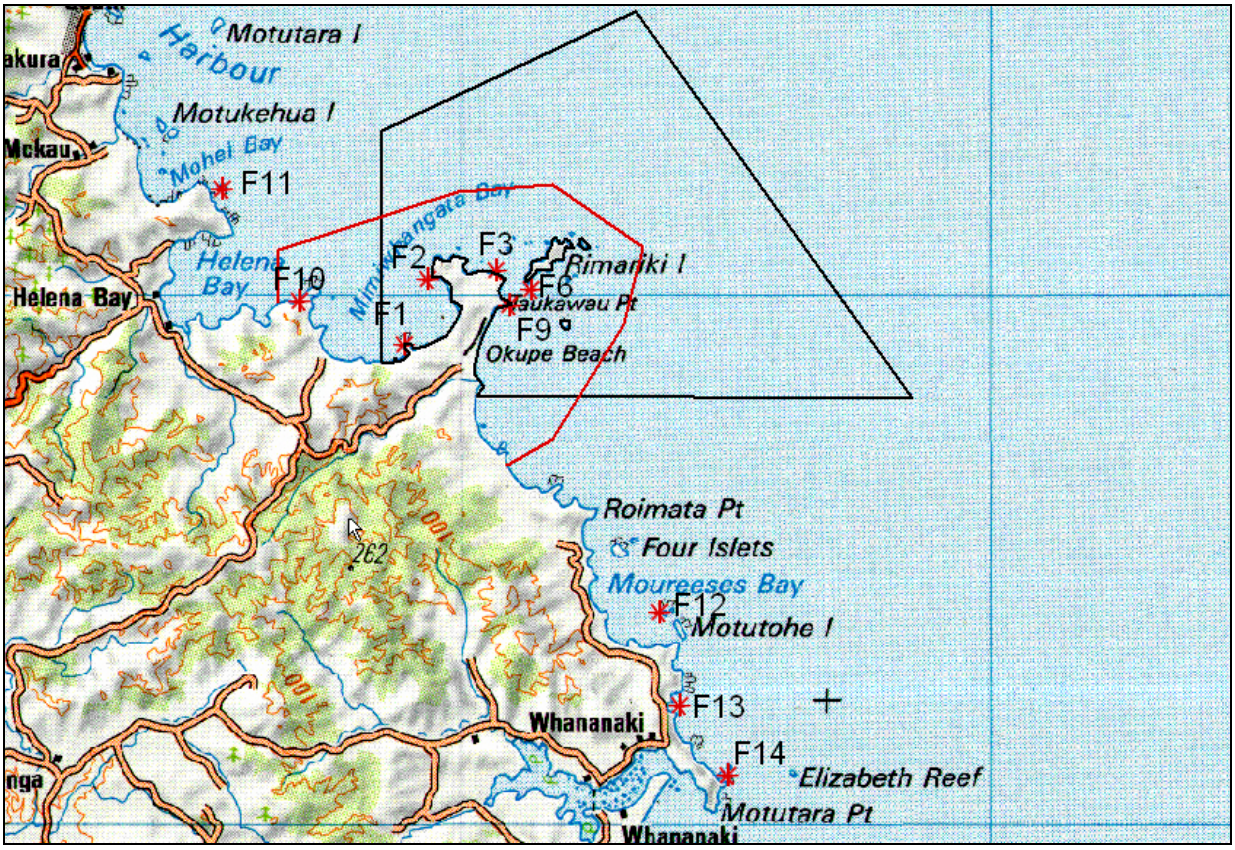

Figure 2. Mimiwhangata fish and crayfish transect locations and locations of newly established 'reference site'transects. Red line marks Marine Park boundary, black line marks proposed Marine Reserve boundary (DoC 2004).Red stars mark zero point of transect.

Below is a description of the establishment and counting method used for the historic transects taken from (Grace 2005). The method is reprinted here because it is the method used for the establishment of the 4 new reference transects. The only exception to the method was the omission of putting in the stainless steel bolts in epoxy at the zero point of each transect. With use of GPS and higher resolution aerial photography available now the marker bolts are no longer needed or cost effective.

Selection of historic transect sites and counting method (taken from historic method)

Location of each sampling station in the Mimiwhangata historic monitoring programme was influenced by the following considerations:

- ❖ known established beds of popular shellfish;
- ❖ ease of access from land or sea;

- likely focal points of activity for visitors to Mimiwhangata;
- range of habitats suitable for each species.

The locations of fish and crayfish sampling sites were decided on a subjective basis with consideration of the following criteria:

1. Approximately 10 sites were wanted to represent the study area, and spread around the area as well as possible, but with consideration also of the ability to dive at those areas reasonably reliably. There seemed little point, for example, in placing sites where it was unlikely we could dive on most occasions because of high swell or poor visibility.
2. As the primary purpose of the study was to assess human exploitation impacts on the populations, it was decided to locate stations where visiting divers would be likely to dive. There seemed little point in placing sites in what would seem "boring" areas for divers. With this in mind sites were chosen which were fairly prominent within the local area, looked interesting when nearby in a boat and where it was expected a diver new to the area would choose to dive.
3. The area at each site was explored to find the "best" location in which to place the permanent 50 x 10m transect. Given that crayfish and reef fish numbers are dependant to a large degree on the abundance of good habitat, which in turn means high topographical complexity of the reef, with plenty of holes, overhangs, caves and tunnels, sites were chosen which contained the best of these features.
4. In most cases the zero end of the transect was placed at or close to the low water mark on the rocky shore, with the transect running more or less perpendicular to the shore at that point.
5. There was no attempt to keep the 50 x 10m transect within a particular habitat. In fact the opposite was true - where possible each transect cut across habitat boundaries, to include as much habitat variety as possible within the transect.

Sites were marked on existing maps and on the most detailed aerial photographs available at the time (the 1950 black and white series). The location of the zero end of each transect was recorded as closely as possible on the aerial photograph, and if necessary a series of topside photographs was used to "zoom in" on the exact position. (More recently the exact sites have been located and recorded using a hand-held GPS).

Fish and crayfish transects were also located either using obvious physical landmarks, or sometimes with steel marker bolts. In these cases, the exact zero point was marked using a stainless steel bolt embedded head down in "expocrete" - a type of underwater cement - in a small hole drilled with a hand-held star-drill. The exposed end of the bolt was raised about 40mm above the rock surface. This formed a convenient peg to which the zero end of the transect line could be attached securely for each survey.

It is worth noting that, after some 29 years, most of the markers placed by this method are still in place and look almost as good as new. A few went missing as the piece of rock into which they were embedded broke away through natural erosion, but none were lost due to failure of the bolt or expocrete cement or the bond between the rock and the cement. At both Mimiwhangata and Tawharanui the rock type where this method was used is greywacke, a hard erosion-resistant rock which contributed to the

long-term success of this marking method. The rock is often jointed, resulting in chunks of rock containing the marker bolt sometimes falling out.

The fish and crayfish transects generally ran from the zero mark (usually close to low tide mark) offshore in a direction determined with reference to local landmarks. This was indicated either by a back-sight from the zero point to a landmark on shore, or a direction from the zero point toward a landmark or feature visible in the distance on the line of the transect. The transect line was usually swum out on the surface in the appropriate direction before the diver took the 50m end of the line to the bottom and secured it temporarily. Thus the transect line was placed in the same spot on the bottom during each survey.

Detailed topographic maps of each fish and crayfish transect were drawn, for all sites at Tawharanui, and for some sites at Mimiwhangata. The transect line was laid out on the bottom, and using a prepared underwater writing pad with scaled grids, major features were mapped in 5-metre squares along each side of the line, while swimming a few meters above the bottom.
The maps allowed major crayfish lairs, or specific reef fish holes, to be mapped, as well as the extent and nature of algal forests over the years. Any other features of special interest, such as individual sponges, could also be mapped and their growth or decline recorded over a long time frame. The maps also helped the divers (especially any new to the monitoring programme) to be confident they were sampling in the right place.

Fish and crayfish were counted concurrently on each transect. Counts were not attempted if underwater visibility was less than 5 meters. A diver ran out a 50m line after securing the zero end, and placed the reel at the 50m end. Generally two divers completed the counts. Starting at the 50m end the two divers headed along one side of the line, counting animals within a 5m wide strip. One diver concentrated on fishes swimming in open water, and stayed about one meter above the bottom, progressing reasonably quickly along the line. Upon reaching the zero end this diver then progressed back toward the 50m end along the other side of the line.
Meanwhile the other diver concentrated on fishes and crayfish more intimately associated with the bottom. This involved swimming a more complex course, making sure that every hole and crevice was examined. This took a lot more time than the first diver’s counts, particularly if there was good algal cover on the rocks. Counts of semi-stationary animals such as crayfish could be accurately made by this method. There was a danger of multiple counts of mobile fishes, or reef fish such as red moki, but by taking great care and recognizing some of the individual fishes, and by comparing the notes of the two divers, in practice there was little error. There were few fishes missed by this method, which could be easy in such complex topography if a more "aerial view" approach was adopted. Counts were recorded on pre-prepared underwater writing pads. Lengths of the more prominent individual reef fish were recorded. Recording length data for schooling or more abundant fishes such as sweep or spotty lengths of individuals was not attempted.

Crayfish were recorded as legal or sub-legal in size, often with additional notes indicating, for example, if sub-legal specimens were all very small or just sub-legal etc. Large individuals were also noted, with an estimate of their size in terms of weight. No attempt was made to sex crayfish. Because of the complex topography on many transects, sexing individual crayfish would be very difficult or impossible in some holes. It generally took between 40 minutes and an hour to complete one transect.

Selection and establishment of new reference site transects

The monitoring plan called for the establishment of four new reference site transects outside of the proposed marine reserve area. In choosing these sites we attempted to fulfil all the original criteria as described above. In addition we looked for sites that could also fulfil a range of other future research and monitoring objectives. In particular we were interested in areas that had existing high quality aerial photos which would enable time series analysis of algal forest condition in parallel with the sites at Mimiwhangata itself. Using this approach we came up with a list of candidate sites based on the aerial photos sets (Grace & Kerr 2002 and 2005).

Blow–up aerial photos were prepared for each candidate site for the field evaluation. The field evaluation of each candidate site was done by snorkel, sonar side scan and visual assessment from the boat. The same criteria were applied as described for the historic transects above. Once the site was narrowed down to a favoured transect location we did an exploratory dive on snorkel. When satisfied that all the criteria were met we took GPS coordinates of the zero point of the new transect and still photos were taken of the shore from this zero point.

Each of the new transects was monitored for fish and crayfish using the same method as that described above for the historic transects. At the end of the counting an underwater map was drawn of the transect area indicating the main physical features of the site and indicating the habitat types. Aerial photographs of the four new reference transects and the historic transects selected for this monitoring program were prepared with the actual transect line drawn to scale.

The fifth reference site selected was the historic transect site (F10) Suicide Cove at Paparahi Point. This transect is outside of the proposed marine reserve but inside the present Marine Park. The Suicide Cove transect fits all the criteria of the permanent transects and is in an ideal position to be a reference site for the area of the proposed marine reserve. It has the added advantage of having some historic data as well.

In the new arrangement there are five historic transects located inside the proposed marine reserve area and five reference sites located outside of the proposed marine reserve area.

Results

Location of Transects

The criteria for selection of the new sites have been described above and the GPS coordinates for the zero points are detailed in Table 1. Aerial photographs taken by the authors in June 2004 were used in the field to accurately mark the zero points and layout of the new transects. In practice we have found that high resolution aerial photographs are a very good method in the field for locating the exact position of the zero point and the layout of the transect. In most cases individual rocks can be clearly distinguished in the photos as well as considerable amount of underwater structure. This photograph set is reproduced here in Figures 3-7.

Figure 3. Transect (F11) Moturoa at Otara Point, red line marks centre of 50m transect

Figure 4. Transect (F12) Otamuri at Whananaki, red line marks centre of 50m transect

Figure 5. Transect (F13) Barron's North at Whananaki, red line marks centre of 50m transect

Figure 6. Transect (F14) Barron's South at Whananaki, red line marks centre of 50m transect

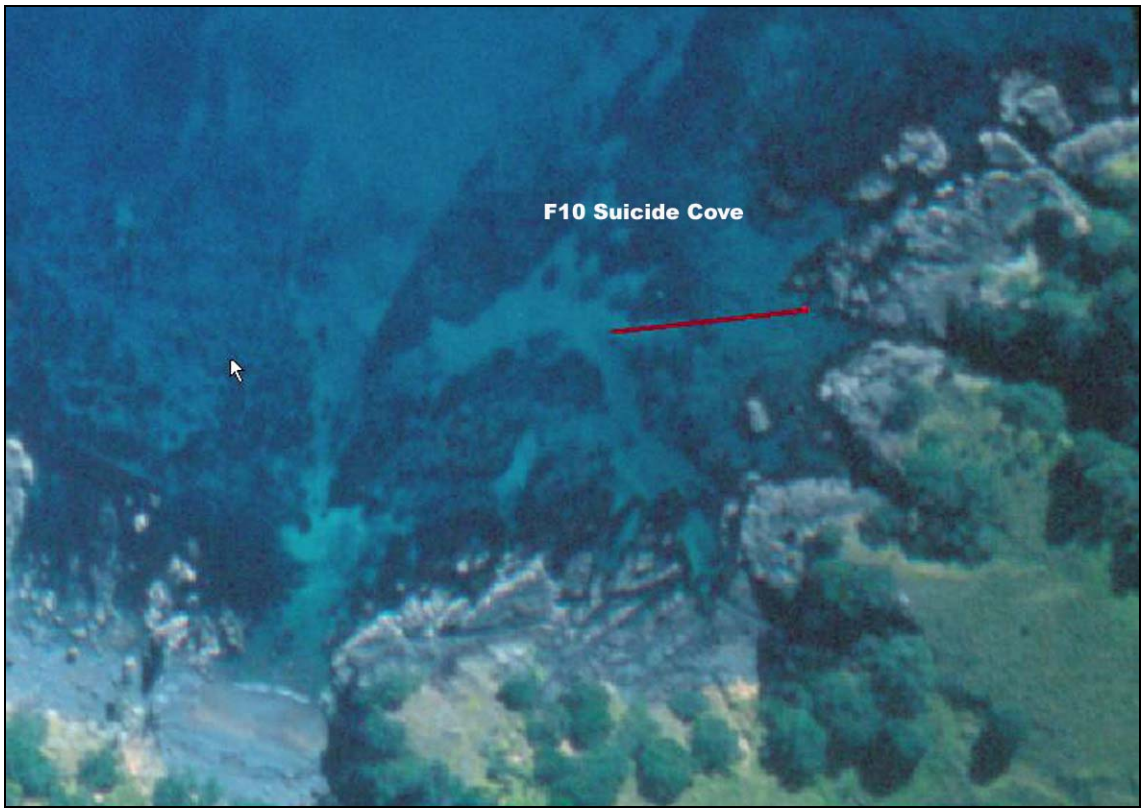

Figure 7. Transect (F10) Suicide Cove, Paparahi Point, red line marks centre of 50m transect

A set of aerial photos for the five historic transects within the proposed marine reserve area are included here in Figures 8-12.

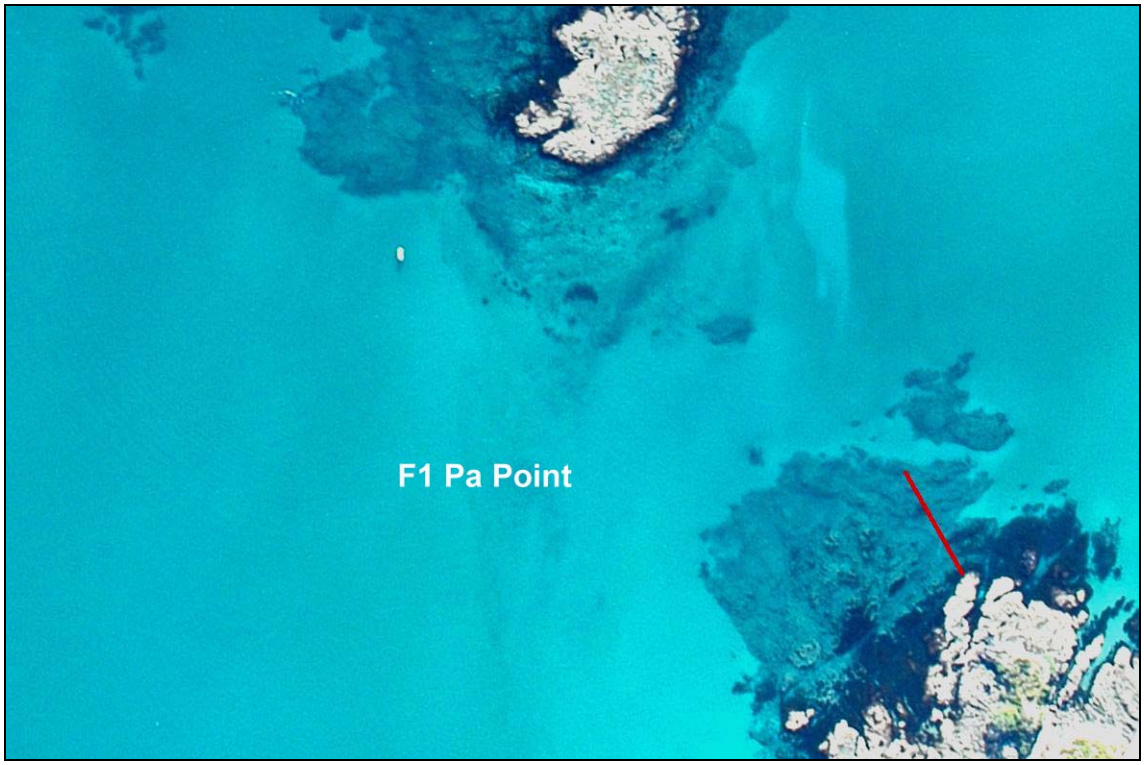

Figure 8. Transect (F1) Pa Point, red line marks centre of 50m transect

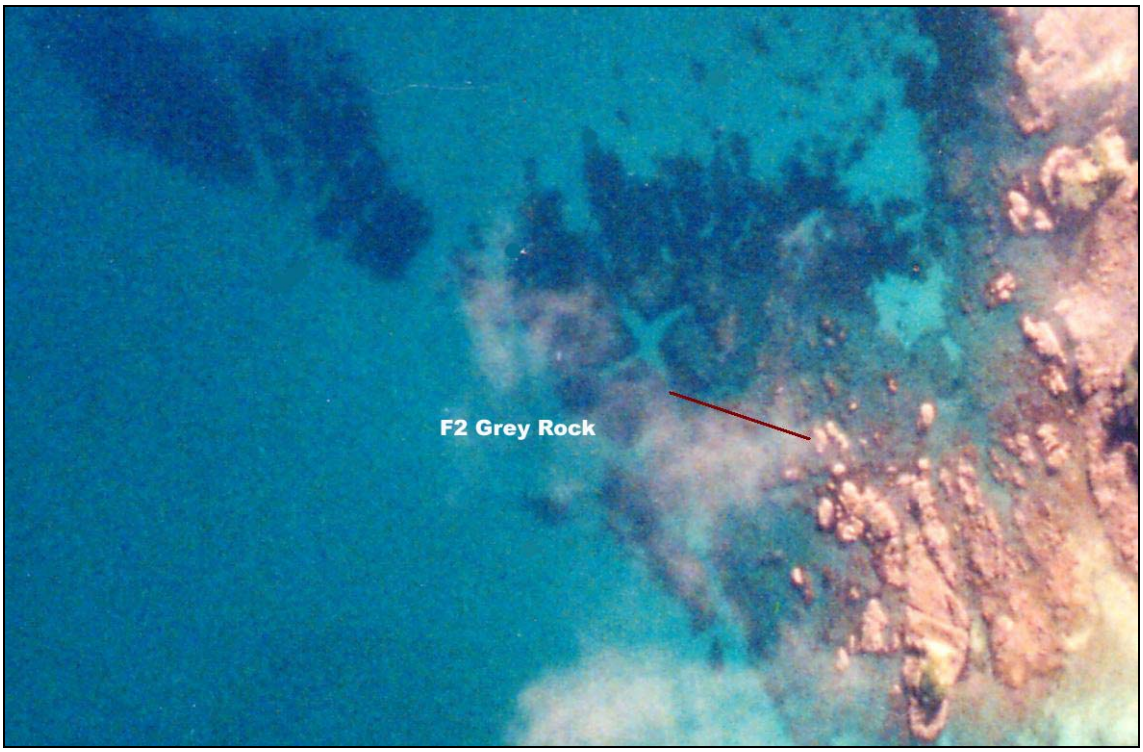

Figure 9. Transect (F2) Grey Rock, red line marks centre of 50m transect

Figure 10. Transect (F3) Lunch Bay, red line marks centre of 50m transect

Figure 11. Transect (F9) Taukawau Point, red line marks centre of 50m transect

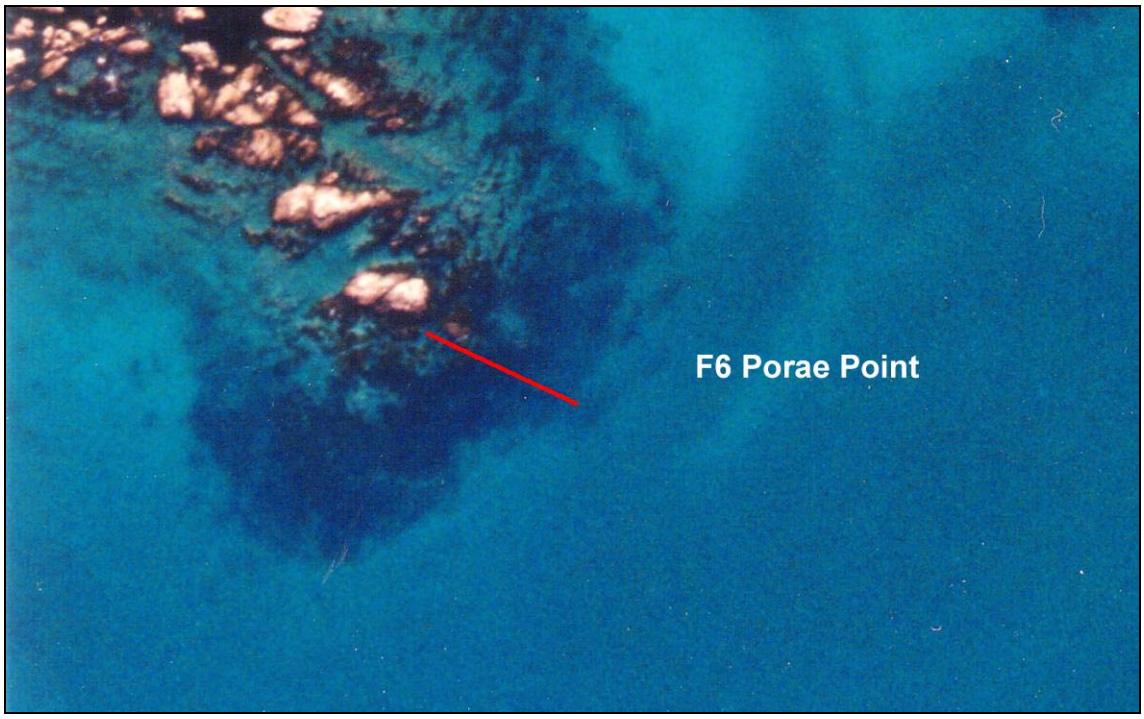

Figure 12. Transect (F6) Porae Point, red line marks centre of 50m transect

For each of the newly established transects and also (F10) Suicide Cove we drew an underwater map which indicates the basic terrain features and habitat types found there. These maps can be reproduced and laminated for use in the field and underwater. They are a useful reference to assist the survey diver to locate the transect and can also be used to identify any changes in habitat type over time. These new habitat maps appear in Figures 13-17 below.

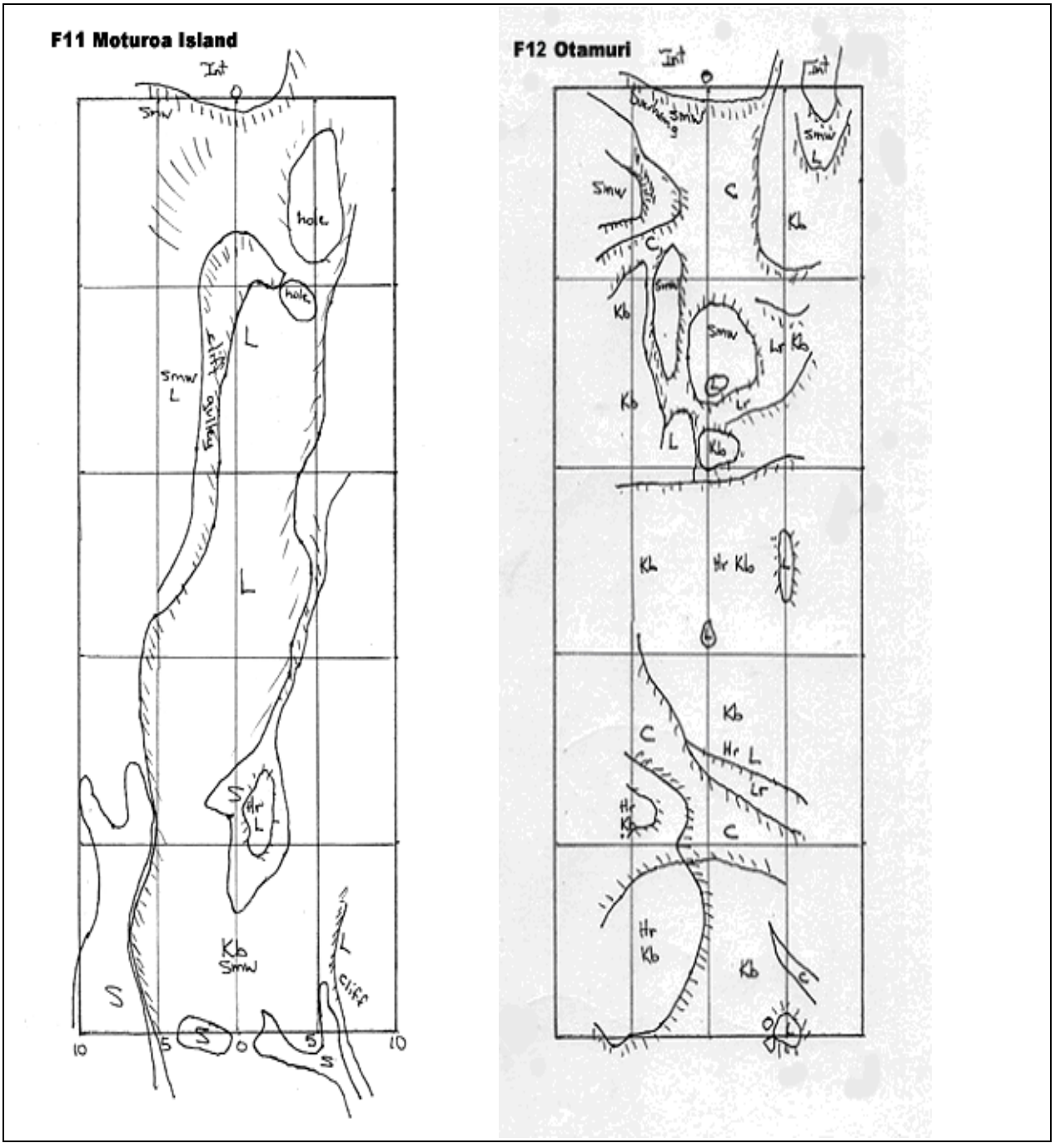

Figure 13. Underwater map of (F11) Moturoa transect (F12) Otamuri transect. Habitat Descriptors: sand = S, cobble = C, shallow mixed weed=smw, kina barren =Kb, *Lessonia variegatum* = L, *Ecklonia radiata* = Ek, high relief rock = Hr, low relief rock = Lr

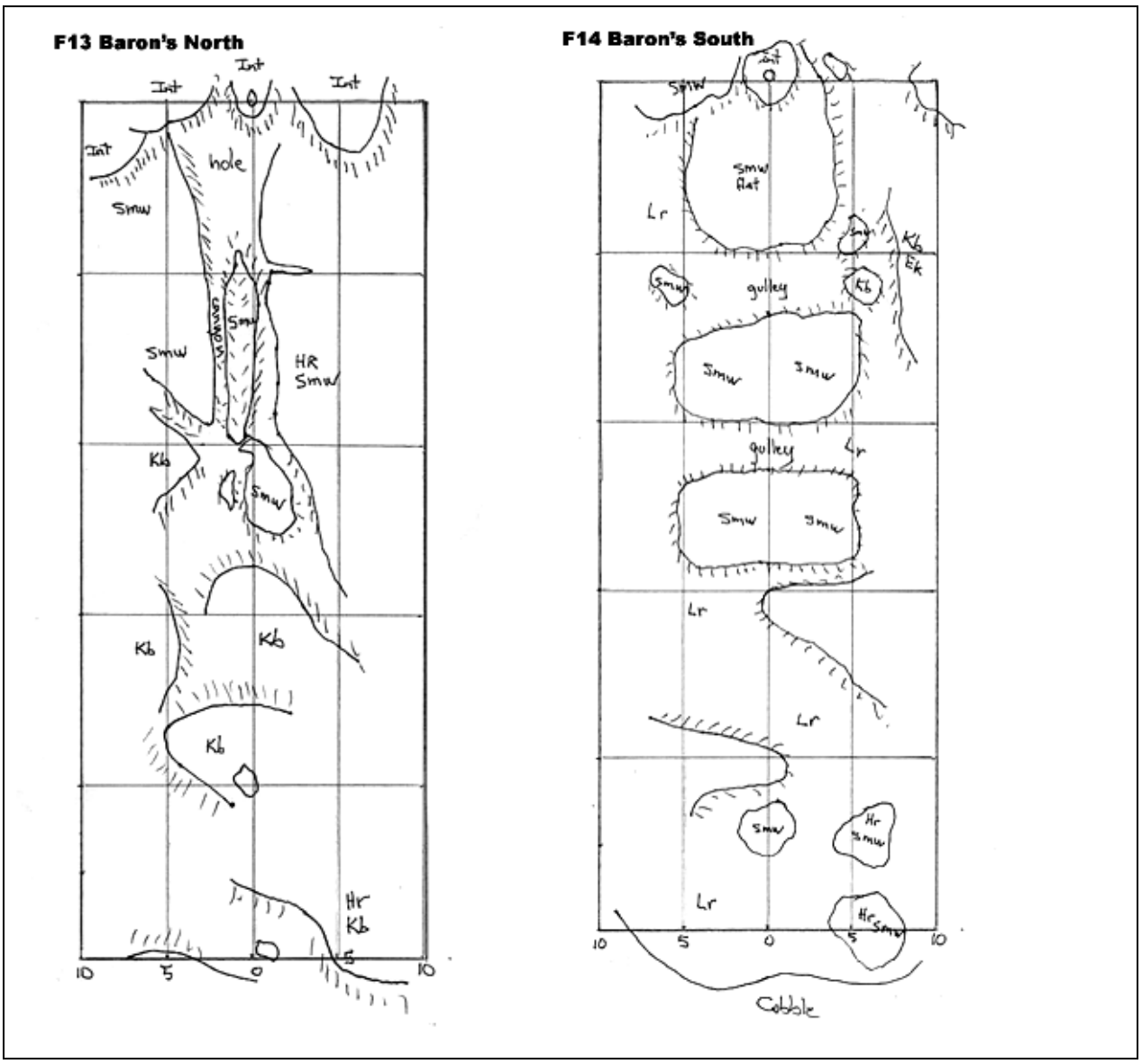

Figure 14. Underwater map of (F13) Barron's north transect (F14) Barron's south transect. Habitat Descriptors: sand = S, cobble = C, shallow mixed weed=smw, kina barren =Kb, *Lessonia variegatum* = L, *Ecklonia radiata* = Ek, high relief rock = Hr, low relief rock = Lr

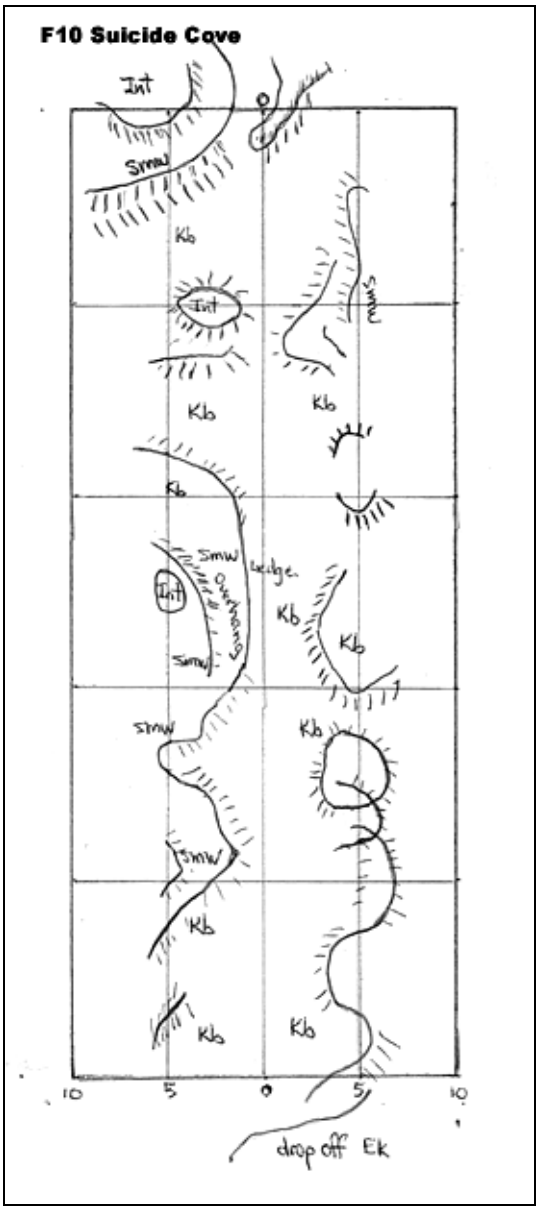

Figure 15. Underwater map of (F10) Suicide Cove transect. Habitat Descriptors: sand = S, cobble = C, shallow mixed weed=smw, kina barren =Kb, *Lessonia variegatum* = L, *Ecklonia radiata* = Ek, high relief rock = Hr, low relief rock = Lr

The depth and habitat characteristics of all the newly established transects (F11-14) are similar those of the six historic transects chosen for this year's program. All run from an inter-tidal shoreline location, usually a prominent rock, in a line roughly perpendicular to the shoreline. This line typically takes the transect over a gentle slope from zero to approximately 12-15 meters in depth, and over similar habitat types. A shallow mixed weed habitat is found in the first 5-10 meters and on top of any rocks that reach up to less than 5 meters of depth. This is often followed by varying degrees of 'kina barren' which may dominate right to the end of the transect at 12-15 meters depth; or there may be patches of *Carpophyllum flexuosum* or *Ecklonia radiata* forest appearing at about 6-15m. All except (F11) Moturoa, (F13) Barren's North and (F14) Barren's South would be described as semi-exposed sites. Transects (F11, F13 and F14) typically did not have *Carpophyllum flexuosum* present and had a greater percentage of *Lessonia variegatum* in their shallow mixed weed zone. The absence of

Carpophyllum flexuosum and the presence of *Lessonia variegatum* is a strong indicator of exposure.

Fish and Crayfish Monitoring

At Mimiwhangata counts for crayfish, especially legal-size crayfish, continued their trend of low numbers. The newly established transects also had very low counts despite the efforts made to include 'good structures and habitats' for crayfish similar to the historic transects. Results for this year's counts are found in Table 2 below and a comparison of abundance count results for the years 2002-2006 are in Table 3 below.

Table 2. Crayfish Abundance 2006 Number in 500 sq.m. (2 @ 50 x 5 m)

		Red Crayfish	
		Legal	**Sub-legal**
Stn.	**Locality**	2006	2006
F1	Pa Point	0	0
F2	Grey Rock	0	2
F3	Lunch Bay	0	26
F6	Porae Point	1	9
F9	Taukawau Point	0	7
F10	Suicide Cove	0	0
F11	Moturoa	0	0
F12	Otamuri	0	0
F13	Barron's North	0	0
F14	Barron's South	0	0
		Packhorse Crayfish	
		Legal	**Sublegal**
Stn.	**Locality**	2006	2006
F1	Pa Point	0	0
F2	Grey Rock	0	0
F3	Lunch Bay	0	0
F6	Porae Point	0	0
F9	Taukawau Point	0	0
F10	Suicide Cove	0	0
F11	Motutara	0	0
F12	Otamuri	0	0
F13	Barron's North	0	0
F14	Barron's South	0	0

Table 3. Crayfish Abundance 2002-2006 Number in 500 sq.m. (2 @ 50 x 5 m)

Stn.	Locality	Red crayfish									
		Legal					Sub-legal				
		2002	2003	2004	2005	**2006**	2002	2003	2004	2005	**2006**
F1	Pa Point	0	0	0	0	**0**	1	0	0	0	0
F2	Grey Rock	0	1	0	0	**0**	0	0	0	0	**2**
F3	Lunch Bay	10	3	2	0	**0**	28	18	4	11	**26**
F4	Awash Rock	0	ND	0	2	ND	1	ND	0	15	ND
F5	Cockers Rock Gut	0	0	1	0	ND	0	0	1	0	ND
F6	Porae point	2	1	6	0	**1**	5	2	12	13	**9**
F7	Black Beach Reef	0	ND	0	0	ND	0	ND	0	0	ND
F8	Flax Bush Bay	0	0	0	0	ND	0	0	0	0	ND
F9	Taukawau Point	2	ND	0	0	**0**	31	ND	22	14	**7**
F10	Suicide Cove	ND	ND	0	0	**0**	ND	ND	0	**1**	**0**
F11	Moturoa					**0**					**0**
F12	Otamuri					**0**					**0**
F13	Barron's North					**0**					**0**
F14	Barron's South					**0**					**0**
Stn.	**Locality**	**Packhorse crayfish**									
		Legal					**Sub-legal**				
		2002	2003	2004	2005	**2006**	2002	2003	2004	2005	**2006**
F1	PaPoint	0	0	0	0	0	0	0	0	0	0
F2	Grey Rock	0	0	0	0	**0**	0	0	0	0	**0**
F3	Lunch Bay	0	0	0	0	**0**	0	0	0	0	**0**
F4	Awash Rock	0	ND	0	0	ND	0	ND	0	0	ND
F5	Cockers Rock Gut	0	0	0	0	ND	0	0	0	0	ND
F6	Porae point	0	0	0	0	**0**	0	0	0	0	**0**
F7	Black Beach Reef	0	ND	0	0	ND	0	ND	0	0	ND
F8	Flax Bush Bay	0	0	0	0	ND	0	0	0	0	ND
F9	Taukawau Point	0	ND	0	0	**0**	0	ND	0	0	**0**
F10	Suicide Cove	ND	ND	0	0	**0**	ND	ND	0	0	**0**
F11	Motutara					**0**					**0**
F12	Otamuri					**0**					**0**
F13	Barron's North					**0**					**0**
F14	Barron's South					**0**					**0**

Since monitoring began in 1976 only two of the transects in the programme regularly have moderate numbers of red crayfish. These are Lunch Bay (F3) and Taukawau Point (F9). Porae Point (F6) sometimes has a few red crayfish. Other stations sometimes contain one or two red crayfish, but are often devoid of crayfish altogether. This emphasises the very site-specific nature of red crayfish populations. In a fished population of crayfish, as at Mimiwhangata, regularly occupied crayfish "lairs" occur in specific places, away from which only small numbers of crayfish may be found sporadically. Their presence is strongly related to the topography of the rocky seabed, as well as to the level of exploitation.

On the historic transects a trend of decline in numbers of legal-size red crayfish continued. This year only 1 legal-size crayfish was counted at Porae Point making this year's count the lowest on record.. Numbers of juvenile red crayfish appear to be near

constant overall on the historic transects for the time period 2002-2006 with the 2006 counts being a little higher in transects (F3) and (F2) and lower than previous seasons in transects(F6) and (F9). (F1) and (F10) continue to have either very low or zero counts for red crayfish as they have done each year since 2002.

The newly established transects (F11-F14) contained no juvenile or adult red crayfish. This was a disappointing result given that the habitat was selected to represent ‘good habitat’ for crayfish. We did encounter a few individual crayfish, mainly sub-legal sized, as we scouted around during the laying out of the transects, but overall there were very few crayfish present. We are confident that the zero counts we recorded were not atypical of the area.

Packhorse crayfish have continued to be totally absent from the transect counts and are now rarely seen at Mimiwhangata. A few have be found in some of the deeper and more exposed parts of the Marine Park.

Reef Fish Abundance

Results for the reef fish abundance counts are summarised in Table 4 for the current season. Table 5 includes results for the 2005 monitoring season put alongside the 2006 results for comparison. Table 6 summarises a diversity measure in the form of the number of species appearing on the transect for the years 2002 -2006.

Table 4. Reef fish abundance 2006 survey results, (Number in 500 sq.m. (2 @ 50 x 5 metres) Note: x indicates presence.

Species	F1	F2	F3	F6	F9	F10	F11	F12	F13	F14
Anchovy										
Banded wrasse	c.8	8	3	6	4	c.10	5	2	3	2
Bigeye	x	x	x	x	x	x	x	x	x	x
Black angelfish			6	4					7	
Blue cod										
Blue maomao	1	3	c.60	c.30	1	c.10	1	2	c.20	
Butterfish	2	2	1	c.15	2	1	2		1	3
Conger eel (northern)					1					
Demoiselle		c.35						11	3	1
Eagleray							1			
Goatfish	c.24	c.10	c.30	15	9	13	3	11	4	3
Grahamichthys*	2	3				1				
Grey mullet							6			
Jack mackerel		10	c.100	c.200	5	c.70	c.290		c.140	30
John dory										
Kahawai				12	c.100		4	c.60		
Kelpfish	10	c.28	6	9	14	16	9	c.10	7	5
Kingfish				2						
Koheru							c.100			
Leatherjacket	2	8	7	c.10	1	2	9	3	6	c.6
Long-snouted pipefish*										
Longtail stingray								1	1	
Marblefish			4	1	3	2	2	1		1
Mado			1	2						
Oblique-swimming blenny	x	c.200	c.120	c.290			c.70	x	x	x
One-spot demoiselle		1								
Orange wrasse										
Parore	c.12	c.10	9	8	c.8	c.20	11	4	c.10	c.20
Piper					1					
Plagiotremus							1			1
Porae				1		2				
Red-banded perch										1
Red moki	4	16	13	c.8	c.5	c.10	c.8	2	c.5	5
Red pigfish		1	4		1		3			
Rock cod	2	1								
Sandagers wrasse		1	2							
Scorpionfish (dwarf)	3	1								
Short-tail stingray										1
Silver drummer		1	3	12	c.5					7
Slender roughy	x	x	c.6	x	x	x			x	c.16
Snapper			1	1		5	1		3	
Spotted black groper				1						
Spotty	c.60	c.25	c.30	c.170	c.35	c.70	c.80	c.20	c.22	45
Sweep	4	c.12	19	c.200		c.35	3	3	c.55	10
Trevally	1		c.40	c.35		c.15			3	15
Yellow moray						1		1		
Number of species*	17	22	22	24	18	19	21	16	19	20

Table 5. Reef fish abundance 2005 and 2006 survey results, (Number in 500 sq.m. (2 @ 50 x 5 metres)

	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2006	2006	2006	2006
Species	F1	F1	F2	F2	F3	F3	F6	F6	F9	F9	F10	F10	F11	F12	F13	F14
Anchovy					3		c.30									
Banded wrasse	10	c.8	8	8	10	3	5	6	9	4	4	c.10	5	2	3	2
Bigeye		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Black angelfish					9	6	2	4							7	
Blue cod					1											
Blue maomao	8	1	3	3	c.40	c.60	2	c.30	46	1	c.22	c.10	1	2	c.20	
Butterfish	1	2	2	2	2	1	c.12	c.15	6	2	1	1	2		1	3
Conger eel (northern)			1							1	1					
Demoiselle			c.85	c.35										11	3	1
Eagleray					1				1		1		1			
Goatfish	40	c.24	3	c.10	14	c.30	7	15	6	9	7	13	3	11	4	3
Grahamichthys*		2	1	3					1		2	1				
Grey mullet													6			
Jack mackerel			c.550	10	c.300	c.100	c.400	c.200	3	5	c.500	c.70	c.290		c.140	30
John dory	1															
Kahawai								12		c.100	c.300		4	c.60		
Kelpfish	c.12	10	c.18	c.28	c.14	6	12	9	19	14	7	16	9	c.10	7	5
Kingfish								2								
Koheru			c.250				8		20				c.100			
Leatherjacket	2	2	4	8	4	7	6	c.10	1	1	9	2	9	3	6	c.6
Long-snouted pipefish*							1				3					
Longtail stingray														1	1	
Marblefish			1		4	4	1	1	4	3	1	2	2	1		1
Mado						1		2								
Oblique-swimming blenny	x	x	x	c.200	c.80	c.120	c.150	c.290	x				c.70	x	x	x
One-spot demoiselle				1												
Orange wrasse																
Parore	15	c.12	c.12	c.10	13	9	7	8	7	c.8	8	c.20	11	4	c.10	c.20
Piper										1						
Plagiotremus			1		1								1			1
Porae	1							1				2				
Red-banded perch																1
Red moki	c.9	4	c.17	16	c.30	13	c.14	c.8	c.11	c.5	c.10	c.10	c.8	2	c.5	5
Red pigfish				1	2	4				1			3			

	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2006	2006	2006	2006
Species	F1	F1	F2	F2	F3	F3	F6	F6	F9	F9	F10	F10	F11	F12	F13	F14
Rock cod	2	2	1	1			1		1							
Sandagers wrasse				1	1	2										
Scorpionfish (dwarf)	4	3		1							2					
Short-tail stingray																1
Silver drummer				1	5	3	4	12	12	c.5						7
Slender roughy	4	x	c.24	x		c.6	3	x	2	x	9	x			x	c.16
Snapper	1					1		1			1	5	1		3	
Spotted black groper								1								
Spotty	c.100	c.60	c.90	c.25	c.50	c.30	c.40	c.170	c.50	c.35	c.70	c.70	c.80	c.20	c.22	45
Sweep	13	4	2	c.12	c.65	19	c.50	c.200	10		3	c.35	3	3	c.55	10
Trevally	c.33	1			6	c.40	c.18	c.35	c.110		1	c.15			3	15
Yellow moray			1									1		1		
Number of species*	18	17	21	22	23	22	21	24	20	18	20	19	21	16	19	20

Table 6. Diversity of Fish Species, 2002 – 2006, number of species counted on each transect (ND indicates not sampled)

Stn	Location	Number of fish species						
		2002	2003	2004	2005	2006	Mean	S Error
F1	Pa Point	15	19	16	18	17	17	1.4
F2	Grey Rock	19	19	22	21	22	20.6	1.3
F3	Lunch Bay	20	22	18	23	22	21	1.8
F6	Porae Point	24	20	20	21	24	21.8	1.8
F9	Taukawau Point	14	ND	16	20	18	17	2.3
F10	Suicide Cove	ND	ND	11	20	19	16.7	4.3
F11	Moturoa	ND	ND	ND	ND	21		
F12	Otamuri	ND	ND	ND	ND	16		
F13	Barron's North	ND	ND	ND	ND	19		
F14	Barron's South	ND	ND	ND	ND	20		

On the historic transects the Reef fish abundance recorded was very similar to the pattern now established over many years of measurements. It is likely that natural variation can be considered to account for the relatively minor fluctuations in numbers. Two notable exceptions occur that are worth mentioning. In the method we use we pay very careful attention to the surface and mid-water species who swim through the transect during the counting period. Species that feature in the surface and mid-water zones are the pelagic species such as kingfish, trevally, the mackerels and kahawai. These species tend to be either present in good numbers or absent. This trend is clearly seen in the historic data and is to be expected from a roving pelagic feeder. This results in a large variation in the abundance counts for these species, limiting to some extent our ability to interpret trends. However, over all transects or over a very long time series, trends in this data may be detectable. This extensive analysis has not been done with the data yet.

Results for the new transects (F11-F14) are very similar to those of the historic transects with no dramatic differences in the species composition or abundance. This tends to justify the selection process that we followed to select these sites. At this stage if the assumption that both the reference areas and the Marine Park are subject to heavy recreational fishing pressure is correct, then the design set-up appears to be suitable to detect any changes that might come about if the management regime within the Marine Park changes in the future.

In this year's survey juvenile snapper were seen on the (F3), (F6), (F10), (F11) and (F13) transects in small numbers. At (F10) Suicide Cove 5 small snapper were counted and in each of the others 2 fish were counted. No legal-size snapper were observed on any of the transects or dives this season. Although the UVC method used is not ideal for estimation of abundance of snapper, the low numbers observed are consistent with the trend of observations on all surveys conducted since 2002. Juvenile snapper especially are not as 'diver shy' and will normally be seen by the diver if they are present.

Numbers of juvenile fish for each species are noted on the record sheets. To date only minimal analysis has been done on any trends. The settlement of juveniles varies from year to year, and from species to species. However one species, the red moki, has

been of particular interest to us and we have observed the fluctuations of recruitment quite carefully over the years. This seasons results are somewhat difficult to interpret in terms of the overall pattern because of the addition of the new transects, however from the records we have we can make some general remarks. Ten juvenile moki were counted on the ten transects done this season. Looking at the historic figures we would describe this as an average recruitment season. It is too soon to make any conclusions about the new transects in this regard as we need to watch them over some time to see if recruitment patterns run parallel to the historic transects. A summary of past results for juvenile moki is included here:

- In 1986 recruitment of juvenile red moki was the worst of previous records, with only 4 juveniles seen on a total of 10 transects.
- In contrast, the 1981 season produced 19 juveniles on 4 transects.
- In 2002, a total of 21 juveniles were seen on 9 transects.
- Year 2003 appeared to have been quite good for recruitment of young red moki, a total of 13 juveniles of around 15cm length appearing on 6 transects.
- In 2004 there were only 3 juvenile red moki of 15cm or less counted on 10 transects making this the worst recruitment year for red moki so far recorded in all years since 1976.
- Year 2005 was a particularly good recruitment year for red moki with 20 juveniles counted on 10 transects.

The reason for this variance in recruitment of juvenile red moki from year to year is not known.

As a result of its location and the currents that sweep the peninsula Mimiwhangata has always been a place of interest in terms of the subtropical species that colonise its reefs. This season was a poor year for sightings of the spotted black grouper with only one seen at (F6) Porae Point. Small mado were seen on two transects (F3 & F6) and were observed actively cleaning other fish which is somewhat unusual for this species. The mimic blenny *Plagiotremis* was observed on two of the new transects (F11 & F14). A Graham's gudgeon, *Grahamichthys sp.* was observed on (F10) Suicide Cove transect. This species is occasionally seen at Mimiwhangata. Some of the other subtropical species of note seen in previous years, such as bar tailed goatfish and painted moki, were not observed this year.

The diversity of species of fishes on transects have fluctuated from year to year since monitoring began in 1976, but commonly is in the range of 14 to 26 species. Table 6 above details the numbers of species found on transects from 2002 to present. Numbers of species this year falls within a very close range of the mean figure for each transect over this time period. It is also notable that the new transects appear to be quite similar to the historic transects in terms of this diversity count. Over the years 2002-2006 there are roughly equal numbers of transects that have increased, decreased and fluctuated up and down. The standard errors calculated for total species number for each transect over the five year period are all relatively low values, supporting the interpretation that the level of change is due to natural fluctuations and/or inherent sampling error. The exception to this is transect (F10) which has had fewer surveys. It will be worth watching the variation of diversity on this transect in the future.

Other marine life

During the collection of data notes are routinely made of significant invertebrate species observed on the transects. Table 7 details the results recorded for this season. The presence of the large purple kina *Centrostephanus* has been consistent over the years indicating the subtropical influences that occur at Mimiwhangata. The occasional appearances of the other invertebrates indicated below are also similar to results recorded in the past.

Table 7 Other marine life, 2006 monitoring

Station	F1	F2	F3	F6	F9	F10	F11	F12	F13	F14
Species										
Centrostephanus	1	19	15	7	1	6		35	5	1
Charonia sp.		1	2		1	3		1		
Octopus										1
Monoplex						1				
Coscinasterias							2	7		
Broad Squid								6	1	
Astrotole							1			
Chaetapteris									x	
Paua (blackfoot)		1					3		31	3

Tuatuas

A substantial settlement of tuatuas was observed and surveyed in 2005, and reported on in last year's monitoring report (Grace & Kerr 2005). Observations were made of the settlement, which is still there on the north end of Mimiwhangata beach, but no measurements were made this season to quantify the growth of individual animals or the abundance of the bed.

Algal forest observations

All transects have significant areas of kina barrens and the dominance of this ecotype in the depth zone of 3m-12m remains significant at Mimiwhangata sites. It is noticeable that the new reference sites contain a similar extent of kina barrens. This season we did not observe the same disease symptoms as those reported last year (Grace & Kerr 2005). We did observe a continuation of a minor level of kelp recovery at the transects (F3, 6, & 9) where small clumps (approx 30cm high) of *Carpophyllum flexuosum* are establishing where previously there were continuous kina barren areas.

Discussion

Establishment of reference transects

Four new transects were established this year following the strict criteria used to set up the historic transects at Mimiwhangata in 1976. Every effort was made to find suitable comparable sites to the Mimiwhangata sites. In the past there have been two problems when trying to analyse any changes over time as a result of the management regime applied at the Mimiwhangata Marine Park. Firstly there has been a difficulty of not having suitable reference or 'non-treatment sites'. This has been solved by establishing the new transects outside the Park. Secondly there has been the problem of establishing a 'non-fished' baseline with which to compare the Mimiwhangata partial protection area to. Even if we go back to historic data from 1978 we know that this is not a suitable 'baseline condition' because of the amount of fishing that occurred on the coast in the decades preceding 1978. On the whole of the northeast coast of New Zealand there are no remaining 'non-fished' reference sites for comparison. Fully protected marine reserves or marine parks such as Tawharanui are the closest we have to use to estimate non-fished or 'natural' baselines'. This leaves us with two options. We could create a no-take reserve area at Mimiwhangata such as in the 2004 marine reserve proposal. The new transects will then become ideal 'fished reference sites' for comparison with the natural condition, (non-fished control area), which would be the new reserve. The second option is to use results from the transects and compare them to similar fully protected areas such as the Leigh marine reserve and Tawharanui marine Park, which are the closest areas of this kind. In comparisons of this type some understanding can made of the natural condition or baseline for comparison with the full fishing areas and partial protection fishing areas currently at Mimiwhangata. This approach is further explained in the context of crayfish abundance studies that are summarised below.

Crayfish

Numbers of larger red crayfish have generally remained low in the area, and this is despite no commercial harvesting since 1994. It is now likely that amateur fishing is keeping crayfish numbers down. Experience from totally protected marine areas such as Goat Island, Hahei, and Gisborne, as well as the totally protected Tawharanui Marine Park, shows that under a total protection regime red crayfish numbers increase spectacularly within five years of protection where the habitat is suitable, (Kelly 1999, Kelly et. al., 2000, Hagget & Kelly, 2003). It is expected that the same would happen at Mimiwhangata under total protection.

During the same time that the Mimiwhangata monitoring was set up in the late 70's, Roger Grace also set up a system of transects both inside and outside the Tawharanui Marine Park which are similar habitats to Mimiwhangata. In 2004 and 2005 in May and June the authors repeated monitoring of the historic set of transects set up at Tawharanui Marine Park and at adjacent 'control sites' outside the Park. In collaboration with the Auckland University researchers lead by Nick Shears, the two data sets were analysed together as a paired study. We were then able to directly compare changes in abundance of crayfish over a long time span in a full fishing,

(Tawharanui outside of Park reference sites), a partially protected area (Mimiwhangata Marine Park) and a no take reserve area, (Tawharanui Marine Park). The results of this study are available in a *Biological Conservation* paper published this year (Shear et al. 2006). The methodology and statistical treatments of data and results are thoroughly explained in this paper so will not be repeated here although there are four important points to be made resulting from this work.

- Paired studies or multi-reserve/reference site studies allow for much more powerful analysis of the impacts of management or natural variation
- Permanent transects are an effective methodology for long medium time series studies
- In a typical exposed northeast coast shallow reef habitat, fully protected areas allow a massive rebuild of crayfish population in both numbers and sizes of individuals.
- The partial protection regime at Mimiwhangata is ineffective in terms of allowing crayfish abundance to restore in comparison to fully protected areas. Related to this conclusion is the secondary conclusion that recreational fishing in the Mimiwhangata areas is now keeping the crayfish population depressed to very low levels in the shallow reef habitat and may be causing even further declines.

Green crayfish or packhorse were present in the early days of monitoring as occasional individuals on several of the transects, particularly (F9) Taukawau Point. These soon disappeared, and packhorse have been effectively absent from the area throughout the recent monitoring period. Without substantial protection on a regional basis it is unlikely we will see large packhorse appearing in any significant numbers at Mimiwhangata.

Fishes

Overall since monitoring began in 1976 there has been no detectable trend in the fish numbers from the counts on the transects. Caution must be taken however in any long term analysis of the data because of the gap in monitoring which occurred between 1986 and 2002.

In relation to snapper monitoring in particular, it is important to note that the visual diver method used here is known to be inadequate for the monitoring of snapper because the larger fish from legal size upwards are diver shy (Willis & Babcock, 2000, Willis, et. al, 2000). However an indication of juvenile numbers can be made with this method. The observations of 2002-2006 contrast with the records of the 70's and the early 80's where juvenile snapper were consistently seen and schools of larger snapper were occasionally seen (Ballantine et. al., 1973, Darby &Darby 1973, Dart et. al., 1982, Commissioner for the Environment, 1982). Also appearing in these historic reports are anecdotal accounts of the period preceding the 70's, describing large snapper frequently seen and caught at Mimiwhangata and that commercial in-close trawling, long lining and set netting was having a detrimental impact on snapper abundance in the period leading up to 1970.

With the completion of this seasons work and the establishment of the 'reference transects' the first step in modernising the Mimiwhangata monitoring program has been made. This progress puts us in an excellent position to plan for the future. At Mimiwhangata we now have several options and methodologies which can approach management questions of the future in different ways. In 2005 the Department

commissioned Roger Grace to produce a discussion document (Grace 2005b) which would detail the future options and objectives of monitoring at Mimiwhangata. This report and the use of the Mimiwhangata historic transect data that is detailed in the Shears et al. (2006) report can now form the basis of future decision making. Mimiwhangata monitoring program now has great flexibility and potential to adapt to future management changes and demands.

In the past, modern statistical analysis of the fish transect data was not attempted; instead the data sets were simply studied each year looking for large trend over time changes. The Shears et al. (2006) paper has demonstrated the opportunity to do a paired study with Tawharanui and its full fishing reference sites and to do significant change over time analysis for fish species as was done for crayfish. This approach has significant potential to examine some of the more subtle changes that are going on within the reef fish community and most importantly will be useful for future analysis. This would represent a substantial project in itself. It would require Auckland and Northland Conservancies to collaborate in order to understand and carry out this work.

Now that the Mimiwhangata monitoring program is so well established and better understood it is an ideal time to look at the potential to integrate some of the objectives and field work with objectives that the tangata whenua have and are developing as part of traditional management and Kaitiakitanga of this area. The authors over the years have had numerous discussions with the local Maori community and leadership and it is clear that there are a number of important objectives that they have identified and that they are keen to fully participate and lead in this area.

Recommendations

Recommendations for the future monitoring work at Mimiwhangata have been discussed and detailed in (Grace 2005b) and the potential of the historic permanent transects is fully demonstrated in (Shears et al. 2006). There are some specific recommendations that we would like to make in summary of this report.

1. That there is medium and long term planning for the future of Mimiwhangata monitoring work which includes consideration of paired studies with Tawharanui and the multi-reserve work with Poor Knights Islands (Denny & Babcock 2004). The options are several and there is flexibility with the different sets of methodologies established. Long term funding commitment is needed to ensure that these plans are adhered to.

2. There is a clear opportunity to do further analysis of the reef fish data set at Mimiwhangata which will yield some useful information about the past, but even more importantly this analysis may assist in understanding any future changes. A specific project should be established to do this work.

3. A specific project should be established to attempt to integrate the Mimiwhangata monitoring work with tangata whenua katiakitanga and/or areas of possible collaboration should be identified and actively pursued. This should be recognised and resourced as an important project in its own right.

4. Efforts should be made to get the summary information and visual material from the monitoring program out into the local community and in the case of the crayfish study to be promoted nationally.

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Appendices

Appendix 1 Location of historic transects

Waypoint Comment	Waypoint Description	New Zealand Grid Eastings	New Zealand Grid Northings
F1	Pa Point	2638949	6639092
F2	Grey Rock	2639375	6640315
F3	Lunch Bay	2640656	6640479
F4	Awash Rock	2640992	6641222
F5	Cocker's Rock Gut	2641635	6641016
F6	Porae Point	2641337	6640144
F7	Black Beach Reef	2640452	6640720
F8	Flax Bush Bay	2641469	6640734
F9	Taukawau Point	2640917	6639824
F10	Suicide Cove	2636956	6639919

Appendix 2 *2002 - 2004 Fish monitoring* number in 500 sq.m. (2 @ 50 x 5 metres)

Fish Species															
	F1			F2			F3			F4			F5		
	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004
English Mackerel						c.20									
Painted moki						1									
Yellow moray				1	1			2		2		1		1	
Scorpionfish (dwarf)	1	2										1			
Kahawai	c100					C.200	c100								
Red mullet (goatfish)	121	32	12	c16	11	2	c32	8	10	2		4	16	9	5
Silver drummer							1	7					2	2	
Parore	30	19	5	13	c.12	12	1	4	2	10		8	c30	c.30	c.8
Blue maomao		4	1	8	5	1	5	7	1				5	c.40	2
Sweep	c40	24	c.15	c70	c.20	c.40	c130	c.20	c.100	3		c.12	c30	c.35	
Black angelfish							8	5	5	1		1	c13	c.10	c.22
Demoiselle				c25	c.34	8				c300		c.85	c30	c.28	7
Kelpfish	11	16	11	13	9	10	c12	7	14	10		9	3	8	c.20
Marblefish				2	1			4	2	3		1	1		1
Red moki	2	c.8	5	c20	c.12	c.15	c20	c.20	16	3		6	c10	c.15	c.20
Porae				1				1					1		
Spotty	c40	c.70	c.35	c20	c.30	c.40	c32	15	c.25	12		c.25	c20	c.28	c.35
Orange wrasse															
Banded wrasse	5	c.13	2	3	6	6	5	5	c.5	6		7	4	3	6
Sandagers wrasse										1		4	1		1
Red pigfish				2			2	3	3	3		2			1
Butterfish							1	1	1	1		1			
Leatherjacket	2	6	1	3	6	4	4	3	7	8		15	c8	7	4
Spotted black grouper															
Conger eel	1	1	1		1							1			
Red-banded perch													1		
Rock cod	1	3	1			1						1			
Koheru			c.100	7		c.6	6			c50		2			
Jack mackerel	c80			c20	c.400	c.200	c50	15							
Slender roughy	4	13	3	c60	c.64	c.20			5	1					
Bigeye	2	c.54		c60	x	1	c50	x						x	
Trevally					1		3	15	3						
Snapper		4	2									1	c6	2	
Long-snouted pipefish															
Eagleray						1	1		1						
Short-tail stingray										1					
Kingfish															
Piper		c.100				c.80		12							
Oblique-swimming blenny			c.20	c25	c.10	8, c.60		4	c.18	c350		c.200		x	c.40
Anchovy															
John dory		1	1			1						1			
Bar-tailed goatfish		2													
Plagiotremus		2			1			1							
Number of species	15	19	16	19	19	22	20	22	18	20		24	19	16	15

Fish Species															
	F6			F7			F8			F9			F10		
	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004
English Mackerel															
Painted moki															
Yellow moray	1														
Scorpionfish (dwarf)								1				1			1
Kahawai				c100											
Red mullet (goatfish)	15	4	8	2		1	20	18	8	14		11			4
Silver drummer			c.30	3						1		c.5			
Parore	12	6	6	c58		4	4	5	20	9		7			9
Blue maomao	1	c.5	c.20	c43		1				c15		18			8
Sweep	c90	c.25	c.100	1		c.50	18		2	c60		c.11			1
Black angelfish	3	3	3	5		4	2	1	1						
Demoiselle	1	1				8	1	1							
Kelpfish	6	8	9	14		c.20	7	8	4	16		8			11
Marblefish	2	1	2	1		1	2			4		2			
Red moki	c10	c.7	c.8	18		9	6	c.10	c.12	18		c.15			7
Porae	1	1				1									
Spotty	c34	c.42	c.200	c35		c.11	30	c.34	c.40	c31		c.50			c.70
Orange wrasse							1								
Banded wrasse	3	1	c.4	10		c.7		2		7		5			5
Sandagers wrasse				2											
Red pigfish						3	1								
Butterfish	5	7	c.15	5					1			2			
Leatherjacket	14	3	14	1		6	4	2	2	2		2			
Spotted black grouper										1					
Conger eel															
Red-banded perch															
Rock cod		1													
Koheru	c100	c.20													
Jack mackerel	5		c.400			c.80									
Slender roughy		2	2						1	1					9
Bigeye	c45		c.100	c20			c31			c43					
Trevally	c100		1												
Snapper			2					1							
Long-snouted pipefish	3		1									1			
Eagleray	1														
Short-tail stingray							1								
Kingfish	1	2		3											
Piper															
Oblique-swimming blenny		c.80	c.100						8			2			
Anchovy	1														
John dory	1														
Bar-tailed goatfish															
Plagiotremus															
Number of species	24	20	20	17		18	14	12	12	14		16			11

Appendix 3 Other marine life Years 2002 - 2004

	F1			F2			F3			F4			F5		
	2002	**2003**	**2004**	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**
Centrostephanus	2	2	**2**	15	14	**12**	23	14	**14**	13		**c.23**	5	4	**2**
Charonia sp.	0	0	**0**	0	1	**0**	0	-1	**0**	0		**0**	0	0	**0**
Octopus	0	1	**0**	0	0	**0**	0	1	**0**	0		**0**	0	0	**0**
Broad squid	0	0	**0**	0	0	**0**	0	0	**0**	0		**0**	c.100	0	**0**
Red shrimps	0	0	**0**	14	2	**0**	0	0	**0**	0		**0**	0	0	**0**
Astrostole scabra	1	1	**0**	0	0	**0**	0	0	**0**	0		**0**	0	0	**1**
Penion??															**1**
Wandering anemone															

	F6			F7			F8			F9			F10		
	2002	**2003**	**2004**	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**
Centrostephanus	6	4	**3**	5		**4**	16	17	**12**	1		**1**			**6**
Charonia sp.	0	0	**0**	0		**0**	0	-1	**0**	0		**0**			**2**
Octopus	0	0	**0**	0		**0**	0	-1	**0**	1		**0**			**1**
Broad squid	0	0	**0**	0		**0**	0	0	**0**	0		**7**			**0**
Red shrimps	0	0	**0**	0		**0**	0	5	**0**	0		**0**			**0**
Astrostole scabra	0	0	**0**	0		**0**	0	0	**0**	0		**0**			**0**
Penion sp.															
Wandering anemone						**1**									

Appendix 4 2006 fish transect data with juvenile fish counts

Species	F1	F2	F3	F6	F9	F10	F11	F12	F13	F14
Anchovy										
Banded wrasse	c.8	8	3	6	4	c.10	5	2	3	2
Bigeye	x	x	x	x	x	x	x	x	x	x
Black angelfish			6	3					c.6	
Black angelfish (juvenile)				1					1	
Blue maomao	1	3				c.10	1	2		
Blue maomao (juvenile)			c.60	c.30	1				c.20	
Butterfish	2	2	1	c.15	2	1	2		1	3
Conger eel					1					
Demoiselle		c.13						6	2	
Demoiselle (juvenile)		c.22						5	1	1
Eagleray							1			
Grahamichthys*	2	3				1				
Grey mullet							6			
Jack mackerel		10	c.100	c.200	5	c.70	c.290		c.140	30
Kahawai				12	c.100		4	c.60		
Kelpfish	10	c.28	6	9	14	16	9	c.10	7	5
Kingfish				2						
Koheru							c.100			
Leatherjacket	2	8	7	c.10	1	2	9	3	6	c.6
Longtail stingray								1	1	
Mado			1	2						
Marblefish			4	1	3	2	2	1		1
Oblique-swimming blenny	x	c.200	c.120	c.290			c.70	x	x	x
Orange wrasse										
Parore	c.12	c.10	9	8	c.8	c.20	11	4	c.10	c.20
Piper					1					
Plagiotremus							1			1
Porae				1		2				
Red moki	4	13	11	c.7	c.5	c.8	7	2	c.5	4
Red moki (juvenile)		3	2	1		2	1			1
Red mullet (goatfish)	c.24	c.10	c.30	15	7	8	3	4	4	3
Red mullet (juvenile)				1	2	5		7		
Red pigfish		1	4		1		3			
Red-banded perch										1
Rock cod	2	1								
Sandagers wrasse		1	2							
Scorpionfish (dwarf)	3	1								
Short-tail stingray										1
Single spot Demoiselle		1								
Silver drummer		1	3	12	c.5					7
Slender roughy	x	x	c.6	x	x	x			x	c.16
Snapper			1	1		5	1		3	
Spotted black grouper				1						
Spotty	c.60	c.25	c.30	c.170	c.35	c.70	c.80	c.20	c.22	45
Sweep	4	c.12	19	c.200		c.35	3	3	c.55	10
Trevally	1			c.35						
Trevally (juvenile)			c.40			c.15			3	15
Yellow moray						1		1		
Number of species	17	33	22	24	18	19	21	16	19	20

Appendix 5 1976 – 2004 fish transect data Mimiwhangata