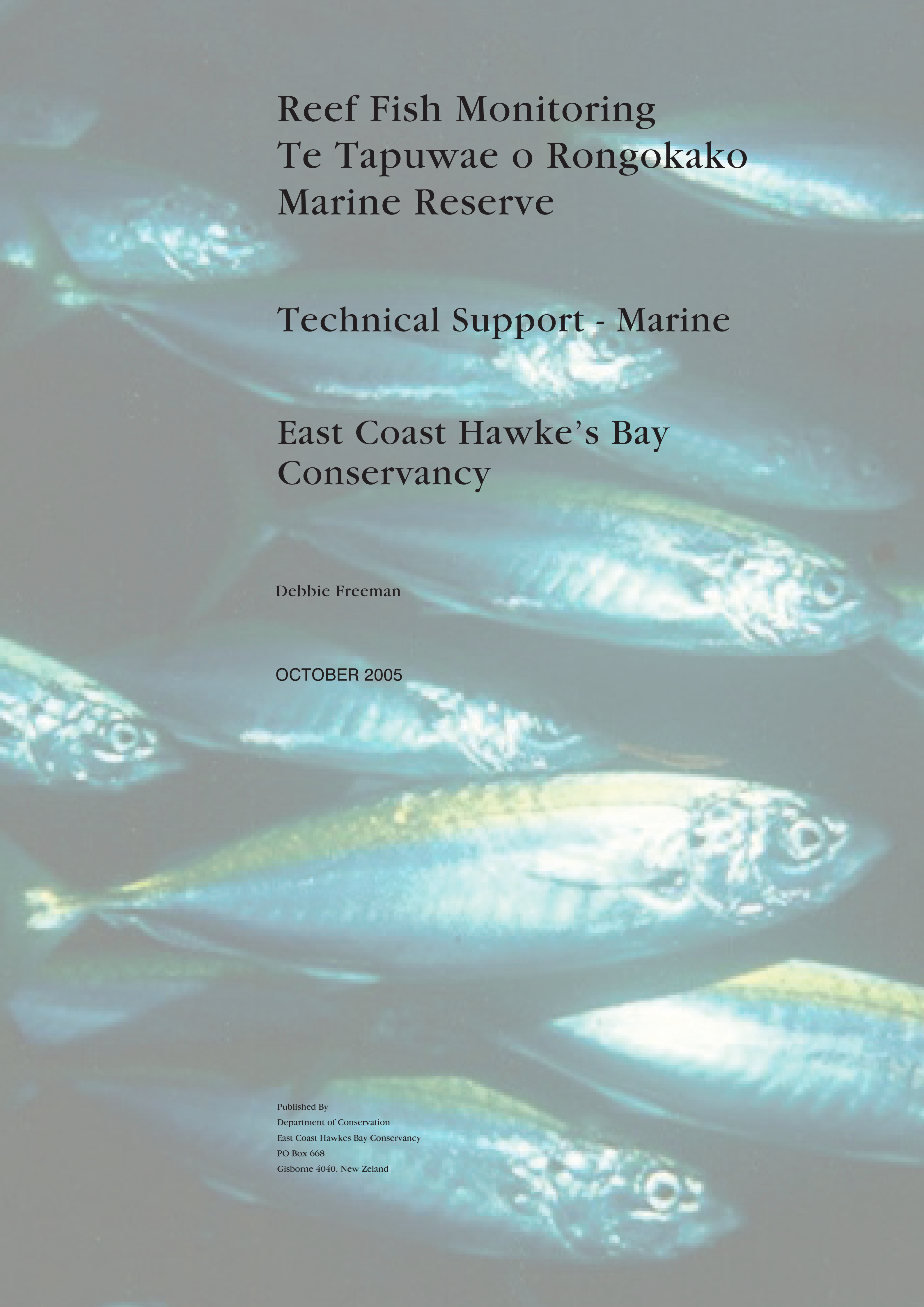

Reef Fish Monitoring Te Tapuwae o Rongokako Marine Reserve

Technical Support - Marine

East Coast Hawke's Bay Conservancy

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OCTOBER 2005

Published By
Department of Conservation
East Coast Hawkes Bay Conservancy
PO Box 668
Gisborne 4040, New Zeland

Cover: Banded wrasse
Photo: I. Nilsson

Title page: Koheru
Photo: M. Blackwell

Acknowledgments: Blue maomao
Photo: J. Quirk

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ISSN 1175-026X
ISBN 978-0-478-14143-6 (paperback)
ISBN 978-0-478-14193-1 (Web pdf)

Techincal Support Series Number: 25

In the interest of forest conservation, DOC Science Publishing supports paperless electronic publishing. When printing, recycled paper is used wherever possible.

CONTENTS

Abstract

Reef fish monitoring was undertaken within and surrounding Te Tapuwae o Rongokako Marine Reserve, on the North Island's East Coast, between 2000 and 2004. The objective of the monitoring was to describe the reef fish communities and to establish whether populations within the marine reserve were demonstrating any changes in abundance or size that could be attributable to the removal of fishing pressure.

The underwater visual census method was used to survey the four locations (marine reserve and three non-reserve locations). It was found that all four locations were characterised by moderate densities of spotties, scarlet wrasse and reef-associated planktivores such as blue maomao, sweep and butterfly perch. All other species, with the exception of schooling pelagic species, were recorded in low densities. Species that were previously harvested from the marine reserve, such as snapper, tarakihi, blue cod and blue moki, demonstrated no apparent response to the cessation of fishing in the reserve. A number of potential explanations for the lack of protection effect are discussed, including reserve age and design, experimental design and monitoring method, illegal fishing and environmental influences.

Introduction

In terms of its marine fish communities, the region between East Cape and Gisborne is seen as a biogeographic transition zone, where most reef fishes are widespread New Zealand species, with a moderate northern component and a small southern component (Francis 1996, Roberts & Stewart 2005). Reef fish surveys have demonstrated a decrease in northern species and a reciprocal increase in widespread species progressively around the East Cape Region (Roberts & Stewart 2005).

Te Tapuwae o Rongokako Marine Reserve was established in November 1999. Located 16km north of Gisborne on the North Island's east coast (Figure 1), the reserve protects 2452 hectares of coastal and marine habitats that are representative of the East Cape Region (Department of Conservation 1998).

A baseline survey of Te Tapuwae o Rongokako Marine Reserve and several non-reserve locations was completed in 2000 and 2001 (Freeman 2001). In terms of the reef fish fauna, the most abundant species within and outside the marine reserve were the small labrids *Pseudolabrus miles* (scarlet wrasse) and *Notolabrus celidotus* (spotty). The densities of all other species, with the exception of schooling and pelagic species, were generally low. The majority of the reef fish species recorded during the baseline survey were widespread species (Francis 1996), with some warm temperate species.

Monitoring of reef fish communities has been undertaken within many of New Zealand's marine protected areas (McCrone 2001). Effort has generally been focused on those species that have been previously harvested (either targeted or taken as bycatch). For example, baited underwater video was used to survey snapper *(Pagrus auratus)* populations within the Poor Knights Marine Reserve (Denny *et al.* 2004) and line fishing and diver transects were used to monitor blue cod *(Parapercis colias)* in Long Island – Kokomohua Marine Reserve (Davidson 2001). However, monitoring of reef fish on a community scale can provide useful and often unexpected insights into the effects of protection on the reef community. For example, Willis & Babcock (2000) reported an increase in the abundance of the herbivorous fish parore *(Girella tricuspidata)* within Cape Rodney to Okakari Point Marine Reserve, suggested to be a result of the reported increase in algal biomass within the reserve (Babcock *et al.* 1999). Similarly, Willis & Anderson (2003) reported a decrease in cryptic reef fish within that marine reserve, which was suggested to possibly be a result of an increase in predatory reef fish within the reserve.

This report presents the results of five years of reef fish monitoring in Te Tapuwae o Rongokako Marine Reserve, aimed at describing the reef fish communities of the area and determining whether any changes have taken place within the reserve that may be attributable to protection.

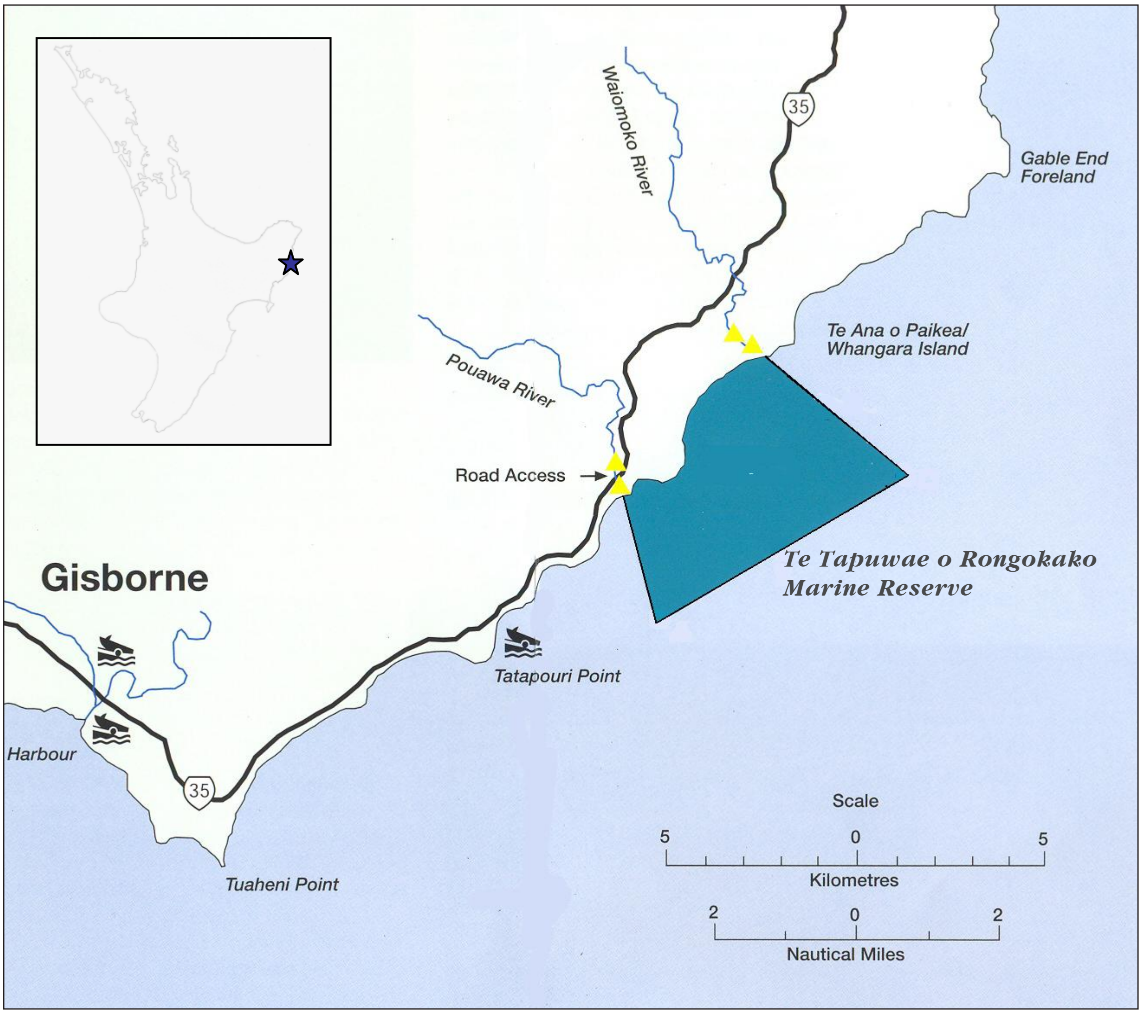

Figure 1. Map showing the location of Te Tapuwae o Rongokako Marine Reserve.

Methods

Monitoring of reef fish populations was carried out in the summer months between 2000 and 2004. At each of four locations (marine reserve, Makorori, Turihaua and Whangara), between 1 and 3 sites were chosen and 100x5x3m transects were completed within up to three depth strata at each site (Figure 2, Table 1). Adverse sea conditions, in particular poor underwater visibility, frequently prevented the completion of reef fish surveys at all locations, and prevented the initiation of reef fish surveys in 2005.

For each transect, the boat was anchored and the diver tied the end of a 100m tape measure to the anchor and then swum out in a haphazard direction. The diver's course was altered only to ensure that at least 90% of the transect was placed over rocky reef habitat. All fish seen resting or passing through the area 2.5m either side and 3m above the diver were counted but the diver did not stop at any point to search overhangs or caves. While winding in the tape on the way back to the anchor, the diver counted spiny lobsters *(Jasus spp)* 2m either side of the tape measure and also any fish seen were noted on the data sheet.

For blue cod *(Parapercis colias)*, blue moki *(Latridopsis ciliaris)*, red moki *(Cheilodactylus spectabilis)*, tarakihi *(Nemadactylus macropterus)*, snapper *(Pagrus auratus)* and butterfish *(Odax pullus)*, the total length of each individual was estimated, both on the way out and on the way back. The size classes recorded for these species are as shown in Table 2.

Reef fish counts were undertaken only when visibility exceeded 3 metres. Microcarnivores were deliberately excluded from the reef fish surveys and observations of cryptic species such as the slender roughy *(Optivus elongatus)* were generally recorded as presence / absence only, as accurate density measurements were difficult.

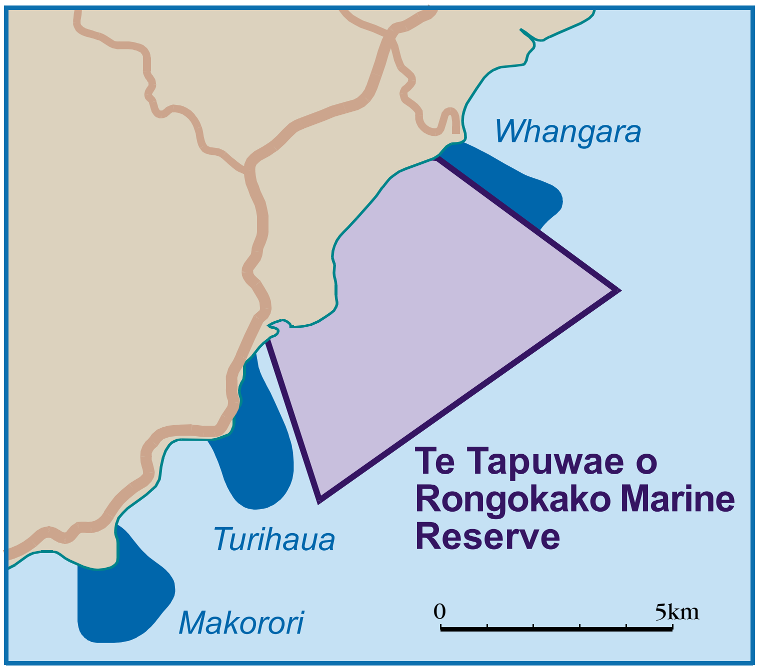

Figure 2. Map showing the sites surveyed.

TABLE 1. NUMBER OF TRANSECTS COMPLETED WITHIN AND OUTSIDE THE MARINE RESERVE BETWEEN 2000 AND 2004.

YEAR	LOCATION	SITE	DEPTH RANGE		
			0-4.9m	5-14.9m	15-30m
2000	Marine reserve	1*		2	4
		2*		3	8
		3*		2	3
	Makorori			4	6
	Turihaua			3	2
2001	Marine reserve	1		4	5
		2		5	5
		3	3	5	2
	Makorori			4	5
	Turihaua			5	5
	Whangara		3	5	
2002	Marine reserve	1		5	1
		2		5	
		3		5	
	Makorori			5	
	Turihaua			5	
	Whangara			5	
2003	Marine reserve	1		5	5
		2		5	3
	Makorori			5	1
	Turihaua			3	
2004	Marine reserve	1		5	5
		2		5	5
		3		5	5
	Makorori			5	5
	Turihaua			5	5
	Whangara			5	5

* Site 1 is the reef on the southern side of Pariokonohi Point; site 2 is the reef on the northern side of Pariokonohi Point; site 3 is the reef system just south of the northern boundary of the marine reserve (Figure 2).

TABLE 2. SIZE CLASSES OF REEF FISH RECORDED DURING THE SURVEY. THE SMALLEST SIZE CLASSES ARE 0^+ JUVENILES; THE MIDDLE SIZE CLASSES ARE IMMATURE JUVENILES; THE LARGEST SIZE CLASSES ARE MATURE FISH. FOR BLUE COD THERE IS AN EXTRA SIZE CLASS BECAUSE THEY ARE SEX-CHANGING HERMAPHRODITES – LARGE FISH ABOVE 35CM TL ARE GENERALLY MALES.

SPECIES	SIZE CLASSES
Blue cod	<150mm
	150-250mm
	250-350mm
	>350mm
Butterfish	<150mm
	150-300mm
	>300mm
Blue moki	<100mm
	100-400mm
	>400mm
Red moki	<100mm
	100-400mm
	>400mm
Tarakihi	<100mm
	100-400mm
	>400mm
Snapper	<100mm
	100-400mm
	>400mm

Results

Freeman (2001) presents the results of reef fish monitoring in 2000 and 2001. Since 2000, there have been no significant changes in the reef fish populations either within or outside Te Tapuwae o Rongokako Marine Reserve, in terms of either fish abundance or species composition.

The most commonly observed demersal reef fish species at all locations were small wrasses - scarlet wrasse and spotties (Table 3, Figure 3). Few other species were recorded in densities exceeding 1 individual per transect, with the exception of some schooling pelagic species such as sweep and blue maomao, which were occasionally recorded in high densities.

Species that were previously harvested from the marine reserve area (including targeted and bycatch species), such as blue cod, snapper, tarakihi, red moki and blue moki, have remained at low densities within and outside the reserve (Figure 4, 5), although snapper and tarakihi were observed more frequently within the reserve in 2004 than in previous years (Table 3). It is unclear at this stage whether this is a protection effect or a minor fluctuation related to some other factor, as tarakihi were seen more frequently in 2004 not only in the reserve but also at all three non-reserve locations.

Total reef fish density (excluding reef-associated planktivores and schooling pelagic species) was similar at all four locations surveyed, although densities at Turihaua tended to be slightly lower than densities at the other three locations (Table 4). The highest average fish density was recorded at Whangara in 2004, when a mean of 17.2 individual fish (SE=2.32) was recorded per $500m^2$ ($1500m^3$) transect. Scarlet wrasse comprised the majority of these fish. Within the reserve, total reef fish density ranged from 8.11 fish per transect (SE=1.43) in 2003, to 12.53 fish per transect (SE=2.92) in 2004.

Low densities of the species for which size data were recorded prevented any analysis of size frequency distribution.

TABLE 3. FREQUENCY OF OCCURRENCE (%) OF FISH SPECIES WITHIN TE TAPUWAE O RONGOKAKO MARINE RESERVE AND AT 3 NON-RESERVE SITES (MAKORORI, TURIHAUA AND WHANGARA) BETWEEN 2000 AND 2004 (SAMPLE SIZE IN BRACKETS). SPECIES OBSERVED WHILE RETRIEVING THE TAPE MEASURE ARE INCLUDED.

	FREQUENCY OF OCCURRENCE (%)																	
	RESERVE					MAKORORI					TURIHAUA					WHANGARA		
	2000 (22)	2001 (29)	2002 (16)	2003 (18)	2004 (30)	2000 (10)	2001 (9)	2002 (5)	2003 (6)	2004 (10)	2000 (5)	2001 (10)	2002 (5)	2003 (3)	2004 (10)	2001 (8)	2002 (5)	2004 (10)
Banded wrasse	27	14	44	17	27	40	0	80	67	20	80	0	0	33	0	38	40	30
Blue cod	55	79	69	44	50	70	67	40	17	40	0	80	60	0	40	38	40	80
Blue maomao	23	28	31	17	17	20	0	40	33	10	0	20	0	33	10	13	0	20
Blue moki	9	7	13	6	0	0	0	0	0	20	20	10	0	0	10	0	0	0
Butterfish	0	14	6	6	3	20	0	60	0	0	40	0	0	0	0	0	0	0
Butterfly perch	36	28	19	33	33	60	44	20	33	40	0	50	0	67	30	0	20	50
Common roughy	0	0	0	0	3	0	0	0	0	0	0	0	0	33	10	0	0	0
Common warehou	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conger eel	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0
Copper moki	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
Demoiselle	5	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Dwarf scorpionfish	5	3	6	6	3	10	0	0	0	10	20	10	0	0	0	0	0	10
Eagle ray	5	0	0	0	0	10	0	0	0	0	0	0	0	0	0	13	0	10
Goatfish	9	0	31	6	10	10	0	0	0	20	0	20	20	33	0	0	0	0
Hiwihiwi	0	3	0	0	10	10	11	0	0	0	0	0	0	0	0	0	0	0
Jack mackerel	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	10
John dory	0	3	0	0	3	10	0	0	0	10	0	0	0	0	0	0	0	0
Kahawai	14	7	13	6	0	0	0	20	0	0	0	0	0	0	0	13	0	0
Kingfish	14	3	0	0	13	10	0	0	0	10	0	0	0	0	0	0	0	20
Leatherjacket	50	48	25	33	60	50	44	0	17	60	40	30	40	33	30	25	20	80

Continued on next page

Table 3 – continued

	FREQUENCY OF OCCURRENCE (%)																	
	RESERVE					MAKORORI					TURIHAUA					WHANGARA		
	2000 (22)	2001 (29)	2002 (16)	2003 (18)	2004 (30)	2000 (10)	2001 (9)	2002 (5)	2003 (6)	2004 (10)	2000 (5)	2001 (10)	2002 (5)	2003 (3)	2004 (10)	2001 (8)	2002 (5)	2004 (10)
Marblefish	23	24	13	22	17	30	11	20	50	20	60	10	0	0	10	13	0	40
Opalfish	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parore	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Porae	9	21	6	56	33	10	22	0	17	80	0	20	0	0	20	0	0	60
Red-banded perch	32	28	13	39	17	20	33	20	17	20	20	30	20	33	20	0	0	10
Red cod	0	0	0	0	3	0	0	0	17	0	0	0	0	0	0	0	0	0
Red moki	45	55	69	67	57	60	22	80	50	30	80	40	60	67	20	38	40	80
Scarlet wrasse	91	86	94	94	87	90	100	60	83	100	100	90	80	100	100	13	20	90
Sea perch	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0
Short tailed stingray	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slender roughy	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Snapper	0	3	6	17	23	0	0	0	0	0	0	0	0	0	0	0	0	0
Spotty	82	69	81	89	53	80	33	100	100	80	80	60	80	100	30	88	80	60
Sweep	77	62	63	56	40	70	44	80	50	50	80	70	80	67	70	13	60	60
Tarakihi	0	0	6	11	13	0	0	0	17	30	0	0	0	0	10	0	0	10
Trevally	23	0	0	0	0	0	0	0	0	0	20	0	0	0	0	13	0	0
Yellow-eyed mullet	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow moray	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0

TABLE 4. MEAN DENSITIES OF FISH WITHIN AND OUTSIDE TE TAPUWAE O RONGOKAKO MARINE RESERVE BETWEEN 2000 AND 2004. DENSITIES ARE GIVEN AS NUMBERS OF FISH PER $500M^2$ ($1500M^3$) TRANSECT (STANDARD ERROR IN BRACKETS). THERE ARE NO DATA FROM WHANGARA FOR 2000 AND 2003.

SPECIES	LOCATION	2000	2001	2002	2003	2004
Total reef fish (excluding planktivores and schooling pelagic species).	Reserve	10.68 (1.27)	9.17 (1.06)	10.69 (1.44)	8.11 (1.43)	12.53 (2.92)
	Makorori	19 (3.52)	11 (2.86)	10.2 (1.74)	9.83 (3.75)	13.3 (2.98)
	Turihaua	6.2 (1.36)	7.4 (1.08)	4 (0.71)	6 (1)	7.7 (1.51)
	Whangara		5.86 (0.63)	2.8 (0.73)		17.2 (2.32)
PLANKTIVORES						
Blue maomao	Reserve	1.45 (0.73)	5.62 (2.57)	3.88 (2.50)	5.06 (3.98)	2.63 (1.87)
	Makorori	21.5 (17.51)	0	0.2 (0.2)	10.17 (7.44)	3 (3)
	Turihaua	0	0.5 (0.40)	0	33.33 (33.33)	0.5 (0.5)
	Whangara		2.5 (2.5)	0		1 (1)
Butterfly perch	Reserve	4.95 (1.95)	2.97 (1.33)	1.75 (1.21)	4.61 (3.08)	5.63 (2.93)
	Makorori	7.3 (3.65)	2.44 (1.63)	0.2 (0.2)	10.83 (3.88)	3.9 (2.25)
	Turihaua	0	1.2 (0.88)	0	11 (7.37)	5 (4.01)
	Whangara		0	0.4 (0.4)		8.3 (3.85)
Common roughy	Reserve	0	0	0	0	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	1 (1)	0.1 (0.1)
	Whangara					
Common warehou	Reserve	0	0	0.06 (0.06)	0	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Demoiselle	Reserve	0.05 (0.05)	0	0	0	0
	Makorori	0.1 (0.1)	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0

Continued on next page

Table 4 - continued

SPECIES	LOCATION	2000	2001	2002	2003	2004
Slender roughy	Reserve	0	0	0	0	0.03 (0.03)
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Trevally	Reserve	6.95 (6.81)	0	0	0	0
	Makorori	0	0	0	0	0
	Turihaua	0.4 (0.4)	0	0	0	0
	Whangara		0.25 (0.25)	0		0
HERBIVORES						
Butterfish	Reserve	0	0.10 (0.06)	0.06 (0.06)	0.06 (0.06)	0.03 (0.03)
	Makorori	0.3 (0.21)	0	0.4 (0.24)	0	0
	Turihaua	0.2 (0.2)	0	0	0	0
	Whangara		0	0		0
Marblefish	Reserve	0.27 (0.13)	0.10 (0.06)	0	0.22 (0.10)	0.17 (0.08)
	Makorori	0.7 (0.50)	0.11 (0.11)	0.2 (0.2)	0	0.1 (0.1)
	Turihaua	0.6 (0.24)	0	0	0	0.1 (0.1)
	Whangara		0.13 (0.13)	0		0.2 (0.13)
Parore	Reserve	0	0	0	0	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
GENERALIST CARNIVORES						
Banded wrasse	Reserve	0.45 (0.26)	0.07 (0.05)	0.5 (0.27)	0	0.17 (0.11)
	Makorori	0.7 (0.50)	0	1 (0.45)	0.83 (0.40)	0.1 (0.1)
	Turihaua	0.4 (0.24)	0	0	0.33 (0.33)	0
	Whangara		0.25 (0.16)	0.8 (0.49)		0.2 (0.13)

Continued on next page

Table 4 – continued

SPECIES	LOCATION	2000	2001	2002	2003	2004
Blue cod	Reserve	0.82 (0.22)	1.69 (0.44)	0.94 (0.27)	0.67 (0.30)	0.5 (0.16)
	Makorori	1.3 (0.47)	0.89 (0.31)	0.2 (0.2)	0.5 (0.5)	0.4 (0.22)
	Turihaua	0	1.1 (0.48)	0.4 (0.24)	0	0.4 (0.22)
	Whangara		0.25 (0.16)	0.2 (0.2)		0.7 (0.21)
Blue moki	Reserve	0.36 (0.32)	0.07 (0.05)	0.56 (0.50)	0.06 (0.06)	0
	Makorori	0	0	0	0	1.6 (1.6)
	Turihaua	0.2 (0.2)	0.1 (0.1)	0	0	0
	Whangara		0	0		0
Conger eel	Reserve	0	0	0	0	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0.2 (0.2)	0	0
	Whangara		0	0		0
Copper moki	Reserve	0	0	0	0	0
	Makorori	0	0	0	0	0.1 (0.1)
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Dwarf scorpionfish	Reserve	0	0.03 (0.03)	0	0	0.03 (0.03)
	Makorori	0	0	0	0	0
	Turihaua	0.2 (0.2)	0	0	0	0
	Whangara		0	0	0	0
Eagle ray	Reserve	0.05 (0.05)	0	0	0	0
	Makorori	0.1 (0.1)	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0.13 (0.13)	0		0
Goatfish	Reserve	0.09 (0.06)	0	0.38 (0.20)	0	0.07 (0.07)
	Makorori	0.1 (0.1)	0	0	0	0.1 (0.1)
	Turihaua	0	0.2 (0.13)	0.4 (0.4)	0.33 (0.33)	0
	Whangara		0	0		0

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Table 4 – continued

SPECIES	LOCATION	2000	2001	2002	2003	2004
Hiwihiwi	Reserve	0	0.03 (0.03)	0	0	0.07 (0.07)
	Makorori	0.2 (0.2)	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Jack mackerel	Reserve	0	0	0	0	0
	Makorori	0	0	1.2 (0.8)	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0.5 (0.5)
Kahawai	Reserve	0.05 (0.05)	1.45 (1.38)	0.13 (0.09)	0.33 (0.33)	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		1.25 (1.25)	0		0
Leatherjacket	Reserve	0.59 (0.25)	0.79 (0.25)	0.25 (0.11)	0.94 (0.61)	1.73 (0.47)
	Makorori	1.5 (1.18)	0.56 (0.24)	0	0.5 (0.5)	0.6 (0.4)
	Turihaua	0.4 (0.24)	0.1 (0.1)	0.6 (0.4)	0.33 (0.33)	0.2 (0.13)
	Whangara		0	0.2 (0.2)		1.1 (0.41)
Opalfish	Reserve	0	0	0	0.06 (0.06)	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Porae	Reserve	0.09 (0.06)	0.28 (0.13)	0	0.78 (0.22)	0.27 (0.08)
	Makorori	0.1 (0.1)	0.44 (0.34)	0	0.5 (0.5)	0.6 (0.16)
	Turihaua	0	0.2 (0.13)	0	0	0.2 (0.13)
	Whangara		0	0		0.7 (0.33)
Red-banded perch	Reserve	0.27 (0.10)	0.17 (0.09)	0	0.11 (0.08)	0
	Makorori	0.3 (0.21)	0.33 (0.33)	0.2 (0.2)	0	0.1 (0.1)
	Turihaua	0.2 (0.2)	0	0	0.33 (0.33)	0.2 (0.13)
	Whangara		0	0		0

Continued on next page

Table 4 – continued

SPECIES	LOCATION	2000	2001	2002	2003	2004
Red cod	Reserve	0	0	0	0	0
	Makorori	0	0	0	0.67 (0.67)	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Red moki	Reserve	0.45 (0.14)	0.38 (0.10)	0.63 (0.20)	1 (0.27)	0.73 (0.24)
	Makorori	1.2 (0.68)	0.22 (0.22)	0.4 (0.24)	1.17 (0.60)	0.4 (0.22)
	Turihaua	1.2 (0.49)	0.7 (0.40)	0.2 (0.2)	1 (0.58)	0.2 (0.13)
	Whangara		0.5 (0.38)	0.4 (0.24)		0.8 (0.33)
Scarlet wrasse	Reserve	4.59 (0.74)	3.72 (0.61)	4.06 (1.13)	2.33 (0.67)	4.8 (0.82)
	Makorori	6.9 (1.48)	8 (2.66)	1.6 (0.75)	2.17 (1.38)	6.9 (2.43)
	Turihaua	1.6 (0.4)	4 (0.80)	1.2 (0.73)	2 (0.58)	5.7 (1.48)
	Whangara		0	0.2 (0.2)		8.2 (2.02)
Short-tailed stingray	Reserve	0	0.03 (0.03)	0	0	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Snapper	Reserve	0	0.03 (0.03)	0	0.39 (0.33)	0.27 (0.14)
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Spotty	Reserve	2.64 (0.83)	1.62 (0.39)	3.25 (0.81)	1.44 (0.33)	1.07 (0.34)
	Makorori	5.5 (2.34)	0.33 (0.17)	6.2 (1.77)	3.33 (1.26)	1.9 (0.80)
	Turihaua	1.2 (0.37)	1 (0.30)	1 (0.32)	0.67 (0.33)	0.5 (0.34)
	Whangara		3.88 (0.85)	1 (0.55)		5.2 (2.47)
Sweep	Reserve	8.05 (3.02)	10.72 (4.71)	10.19 (3.00)	6.22 (3.96)	12.3 (4.14)
	Makorori	17.8 (15.29)	4.56 (2.79)	18 (6.87)	3.17 (2.32)	22.2 (10.97)
	Turihaua	16 (7.46)	24.1 (9.14)	18 (8)	34 (17.78)	26.6 (14.5)
	Whangara		0.38 (0.38)	3.8 (3.07)		6.2 (3.07)

Continued on next page

Table 4 – continued

SPECIES	LOCATION	2000	2001	2002	2003	2004
Tarakihi	Reserve	0	0	0	0.06 (0.06)	2.57 (2.50)
	Makorori	0	0	0	0.17 (0.17)	0.3 (0.21)
	Turihaua	0	0	0	0	0.1 (0.1)
	Whangara		0	0		0.1 (0.1)
Yellow-eyed mullet	Reserve	0	0	0	0	0
	Makorori	0	0	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Yellow moray	Reserve	0	0	0	0	0
	Makorori	0	0.11 (0.11)	0	0	0
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
PISCIVORES						
John Dory	Reserve	0	0.03 (0.03)	0	0	0.03 (0.03)
	Makorori	0.1 (0.1)	0	0	0	0.1 (0.1)
	Turihaua	0	0	0	0	0
	Whangara		0	0		0
Kingfish	Reserve	0.14 (0.10)	0.59 (0.55)	0	0	0.23 (0.12)
	Makorori	0.4 (0.4)	0	0	0	0.1 (0.1)
	Turihaua	0	0	0	0	0
	Whangara		0	0		0.3 (0.3)

Figure 3. Average densities of the two most common reef fish species recorded within and outside Te Tapuwae o Rongokako Marine Reserve between 2000 and 2004.

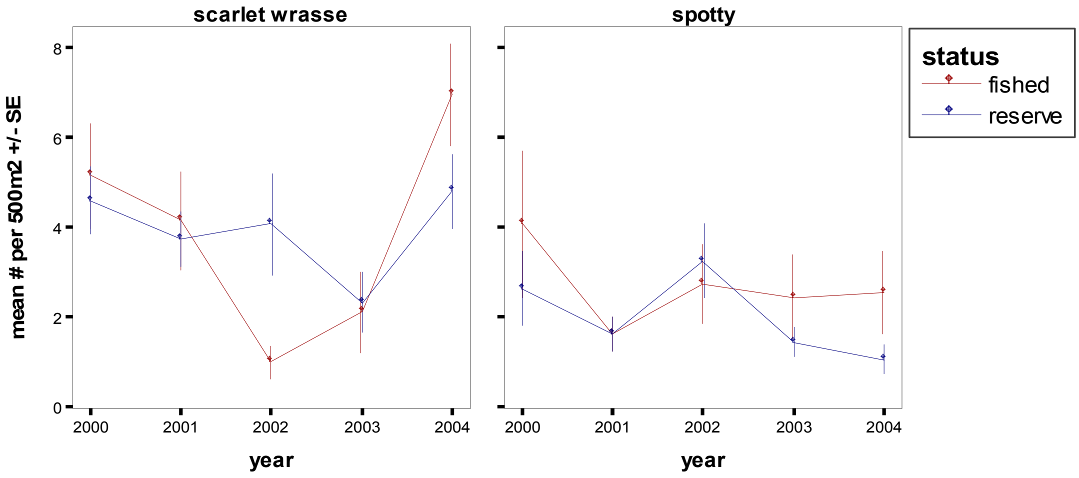


Figure 4. Average densities of blue cod and snapper within and outside Te Tapuwae o Rongokako Marine Reserve between 2000 and 2004.

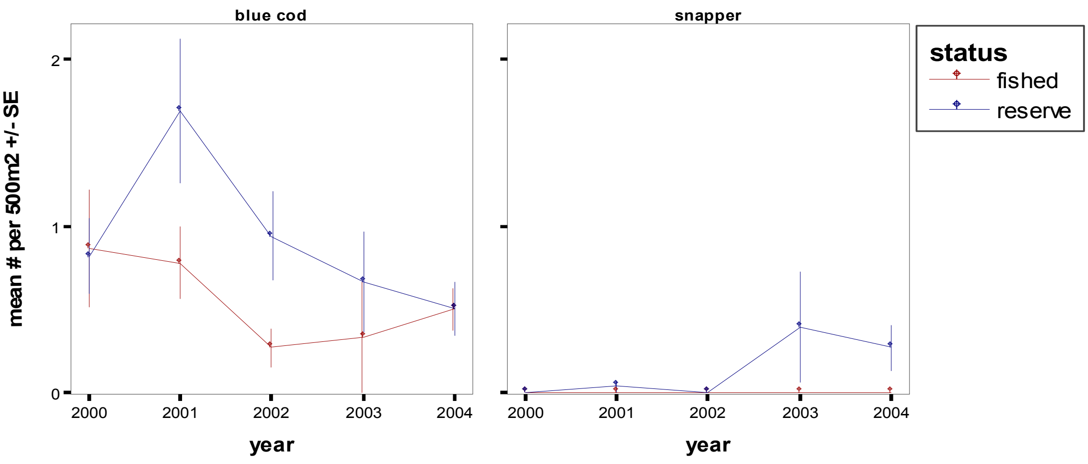
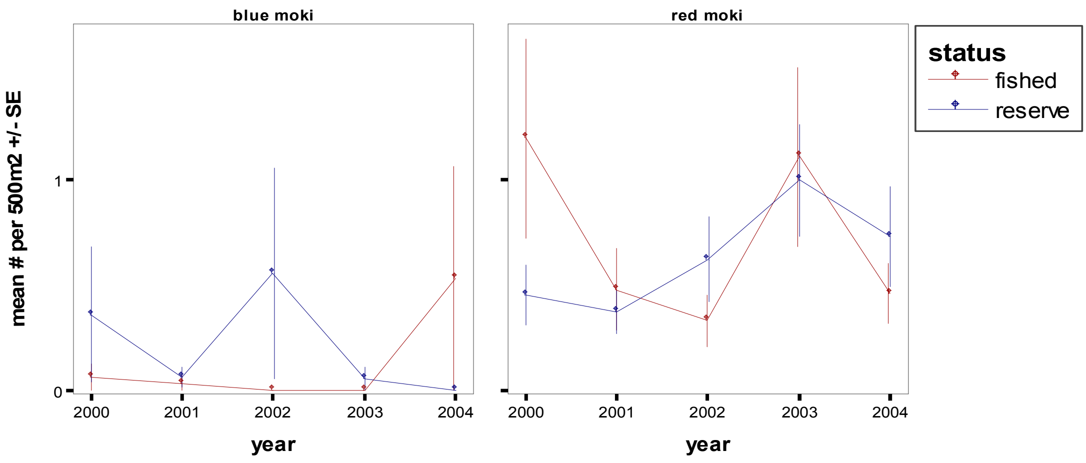


Figure 5. Average densities of blue moki and red moki within and outside Te Tapuwae o Rongokako Marine Reserve between 2000 and 2004.



Discussion

FISH FAUNA

The reef fish fauna of Te Tapuwae o Rongokako Marine Reserve and adjacent non-reserve locations was characterised by moderate numbers of labrids (scarlet wrasse, *Pseudolabrus miles*; spotty, *Notolabrus celidotus*) and reef-associated planktivores (predominantly butterfly perch, *Caesioperca lepidoptera*; sweep, *Scorpis lineolatus* and blue maomao, *Scorpis violaceus*). All other fish species were recorded in low densities, with the exception of schooling pelagic species such as kahawai, *Arripis trutta*; kingfish, *Seriola lalandi*; trevally, *Pseudocaranx dentex* and jack mackerel, *Trachurus novaezelandiae*, which were occasionally recorded in high densities as schools passing through the transect area.

The densities of reef fish were generally similar to those recorded along the Central Hawke's Bay coast (Freeman & Duffy 2003), although butterfish *(Odax pullus)*, marblefish *(Aplodactylus arctidens)*, banded wrasse *(Notolabrus fucicola)*, spotty and blue moki *(Latridopsis lineatus)* tended to be more abundant at the Hawke's Bay locations surveyed. Some species recorded from Central Hawke's Bay were not recorded during the Gisborne surveys, and vice versa. For example, rock cod *(Lotella rhacinus)*, southern bastard cod *(Pseudophycis barbata)* and golden snapper *(Centroberyx affinis)* were not recorded from Gisborne, and common warehou *(Seriolella brama)*, demoiselle *(Chromis dispilus)*, parore *(Girella tricuspidata)*, copper moki *(Latridopsis forsteri)*, opalfish *(Hemerocoetes monopterygius)*, snapper *(Pagrus auratus)*, yellow-eyed mullet *(Aldrichetta forsteri)* and yellow moray *(Gymnothorax prasinus)* were recorded from Gisborne but not Hawke's Bay. These differences are largely explained by differences in sampling effort, habitat and the latitudinal differences between the two regions. North of Mahia Peninsula, the main oceanic influence on the coast is the southward flowing East Cape Current; south of Hawke Bay, the coast is also influenced by the cooler, northward flowing Wairarapa Counter Current (Barnes 1985, Heath 1985, Chiswell & Roemmich 1998, Chiswell 2002) and both of these currents influence the composition of the regional fish fauna (Francis 1996). Surveys in both regions were undertaken during the summer months, when cool temperate species are less likely to be observed. In addition, it has been noted that the southern limits of northern fish species extending along the East Coast probably vary over time depending upon a combination of adult breeding success, pelagic larval survival rate and prevailing hydrographic conditions (Roberts & Stewart 2005).

During the surveys, several notable observations of reef fish species were recorded. In 2000, demoiselles were recorded at Makorori and within the marine reserve. Demoiselles occur at least as far south as Castlepoint

(Francis 2001) but are extremely rare south of Mahia Peninsula. The nearest population of adults to the marine reserve is located on Ariel Bank, approximately 17 nautical miles east of Gisborne (pers. obs.). In 2001, an individual yellow moray eel was observed at Makorori. Adult yellow moray occur infrequently south to Hawke Bay but have never been recorded south of Cape Kidnappers. In 2004, a sand tiger shark *(Odontapsis ferox)* was observed over deep reef within the marine reserve, and in summer 2004/2005 rig *(Mustelus lenticulatus)* were observed in a channel bisecting the intertidal reef platform within the marine reserve. It is possible that the rig were predating on lobsters, which have been recorded in abundance around the intertidal reef platforms within the reserve since its establishment (pers. obs.).

PROTECTION EFFECTS

Some of the changes in species density among years are likely to be attributable to variation in environmental factors such as sea surface temperature, which influence settlement and recruitment processes. Changes in the densities of the labrids, for example, are probably due to such environmental variation.

There are several species that could be expected to show some response to protection within Te Tapuwae o Rongokako Marine Reserve. These include targeted fish species such as snapper, tarakihi *(Nemadactylus macropterus)*, blue moki and blue cod *(Parapercis colias)*, and also bycatch species such as red moki *(Cheilodactylus spectabilis)* and porae *(Nemadactylus douglasii)*. However, none of these species have demonstrated any significant response to protection using the underwater visual census method.

This apparent lack of response to protection may be explained by one or several factors, including reserve age, reserve design, experimental design, monitoring method and illegal fishing. Another explanation may be that some external environmental factor may be operating to override or suppress any potential recovery in the fish populations. Alternatively, it may be that fishing pressure in the reserve area prior to its protection was not high enough for its cessation to promote a recovery in the fish community. This latter explanation is unlikely.

RESERVE AGE AND DESIGN

Te Tapuwae o Rongokako Marine Reserve was established in November 1999 and so had only been established for four years when the last fish survey was undertaken. This length of time may be insufficient for many fish species to demonstrate a response. However, monitoring of marine protected areas elsewhere in New Zealand has demonstrated dramatic changes in fish populations, including those with long-lived species such as red moki and snapper, within relatively short time frames. For example, at Long Island – Kokomohua Marine Reserve in the Marlborough Sounds, blue cod within the reserve were significantly larger and more abundant than at the control site after only two years of protection (Davidson 2001). Further information on the growth and recruitment rates of common fish species in the Gisborne region would assist in elucidating whether a slower response to protection could be expected.

At 2452 hectares, Te Tapuwae o Rongokako Marine Reserve is currently the largest marine reserve on the mainland New Zealand coast. It completely encompasses one reef system towards the southern end of the reserve and part of a reef system at the northern boundary of the reserve. For fish species inhabiting the reef system encompassed by the reserve and that remain on reef systems for their entire life cycle and do not undergo extensive migrations, this reserve is likely to provide protection from fishing. Some migration of fish across the northern boundary of the reserve could be expected because this boundary bisects a reef system. However, given that the home range sizes and habitat use by many fish species occurring within the reserve remain unknown, it is unclear to what extent the design of Te Tapuwae o Rongokako Marine Reserve could be influencing the recovery of the fish populations.

EXPERIMENTAL DESIGN AND MONITORING METHODS

The underwater visual census technique is commonly used to monitor reef fish populations (e.g. Cole *et al.* 1990, McClanahan & Kaunda-Arara 1996, Russ & Alcala 1996). However, it may be an inappropriate method to use for fish species that react either positively or negatively to the presence of a diver in the water (Willis *et al.* 2000). It is possible that by using the underwater visual census method, the densities of diver-negative species such as snapper have been underestimated and the densities of diver-positive species such as blue cod have been over-estimated. To minimise the risk of the latter, divers swam at a constant speed and ignored fish following or overtaking them.

Baited underwater video was trialled during 2004, but interference with the bait by spiny lobsters was found to be a significant problem within the marine reserve – a problem not reported previously. Further trials, following some modification of the baited underwater video system, may be useful for establishing whether the diver census method is underestimating the populations of predatory reef fish species.

Adverse sea conditions, in particular poor underwater visibility, frequently prevented the completion and sometimes the initiation of fish sampling. Although this had a significant effect on the replication of transects, it was essential that monitoring only be carried out when underwater visibility exceeded 3 metres, to minimise the effects of encounter rate and detectability on the results. The use of baited underwater video may allow sampling in less than 3 metres visibility.

The underwater visual census method does not sample cryptic fish assemblages well (Willis 2001). It is likely that the cryptic fish fauna provides a significant component of the biomass of East Coast reef fish communities and may demonstrate some indirect response to protection as reported by Willis & Anderson (2003). The cryptic fish fauna is currently not being monitored within Te Tapuwae o Rongokako Marine Reserve, but has been surveyed prior to the area's protection (Roberts & Stewart 2005). It would certainly be worthwhile sampling this component of the reef fish community again to establish whether any significant changes in diversity or abundance have taken place since the reserve's establishment.

Some areas within the marine reserve were unable to be sampled using the transect method due to the complexity of the reef system. One particular site, a narrow channel bisecting an intertidal reef platform, supports an apparently resident population of large adult blue moki (pers. obs.). On every occasion that this site has been dived since the reserve's establishment, at least eight and up to approximately fifteen blue moki, averaging over 400mm total length, have been observed. One individual of approximately 950mm total length is regularly observed. Copper moki, blue cod and snapper have also been observed at this site, which due to its shallow, complex reef substrate, is unsuitable to monitor using the transect method. Prior to the establishment of the reserve, this site was regularly fished by recreational gill netters (J. Quirk pers. comm.). Alternative monitoring methods such as timed, stationary fish counts, or baited underwater video, would provide some insight into whether reef fish populations in this sort of habitat are demonstrating a response to protection.

ILLEGAL FISHING

A possible explanation for the apparent lack of protection effect may be illegal fishing. However, to produce effects similar to those on fished populations outside the reserve, illegal fishing within the reserve would need to be at least as intense as fishing outside it. Such a level of illegal take is not known to be taking place within Te Tapuwae o Rongokako Marine Reserve.

ENVIRONMENTAL FACTORS

It is possible that some environmental factor is suppressing the recovery of reef fish within Te Tapuwae o Rongokako Marine Reserve, such that it overrides the potential for recovery that the cessation of fishing provides. It is likely that there are a number of environmental factors influencing reef fish population dynamics within Te Tapuwae o Rongokako Marine Reserve (e.g. sedimentation, sea surface temperature, hydrodynamics etc), but the likelihood that any one or a combination of these factors could completely suppress the effects of fishing is unlikely. Further research may help establish the extent to which environmental factors influence reef fish population dynamics on the East Coast and their potential to respond to changes in fishing pressure.

Acknowledgments

Sampling was assisted by Jamie Quirk, Simon Hustler, Trenet Paenga, Hans Rook and Kerry Hogan.

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