Return to previous file: Part 2

3. Maori marine indicators

INTRODUCTION

Objective 2 set out to develop and document a process that identified and monitored tohu/signs or indicators that Maori could use to measure the health of the marine environment. The tohu would also assess the success of management systems for the marine environment (including marine reserves, taiapure, mataitai and Tangata Kaitiaki).

This section presents the main outcomes of work by Ngati Kere (DOC et al. 2007) and Ngati Konohi (Gibson 2006) towards this objective, and reflects on the contribution that tohu could make to marine management practices in New Zealand.

BACKGROUND

Pohutukawa in flower is a tohu/sign for harvesting ripe kina

Tohu are indicators that are measured regularly to show trends or changes in the health of an environment. Simply, they are signs that show whether things are getting better or worse. Tohu can encompass what exists in the marine environment itself and how management processes are affecting marine species. Indicators can relate directly to the size, condition and availability of individual species, or they can be more holistic and ecosystem or process-based. For example, flowering of the kowhai and/or pohutukawa tree is used to indicate when kina are ripe and ready for harvesting; and the frequency of observations of seasonal feeding patterns, 'boil ups' of baitfish, and the presence of predator fish, dolphins and seabirds are recognised as important indicators of productivity and the health of the food chain.

When used alongside western scientific monitoring methods, tohu can help to draw a fuller, more holistic picture of the marine environment and thus highlight the management practices best suited to a specific marine area. Since tohu are developed and used on a continuous basis, they can provide communities with management information that can help them to work towards their vision for their local environment.

The use of established tohu for monitoring can enable traditional information about the health of the environment to be communicated to groups or individuals who make decisions on the management of natural resources. Tohu can be used to integrate iwi and hapu values and customary practices into the resource management system. They can also be used to develop effective working relationships with western science monitoring measures.

Butterfly perch

Scarlet wrasse

Crayfish

The Te Tapawae o Rongokako Marine Reserve has become a popular place for educational and recreational visits, to explore the marine environment

METHODOLOGY

This project aimed to explore how tohu were developed and used to assess the health of marine areas. How did Ngati Kere and Ngati Konohi decide which tohu to use (traditional or not)? How were methods to measure the tohu determined (traditional or western)? How would tohu be tested to ensure that reliable information about the health of the marine environment was produced? What was learnt by the two hapu in the process of monitoring the tohu they developed?

To develop and document the process of identifying and monitoring tohu that relate to marine health, the Ngati Kere project team:

- Identified the tohu that Ngati Kere believe signify the health of the values they want managed in their marine environment (identified in objective 1 of the project).
- Determined how to measure tohu in order to detect changes over time (for monitoring purposes, the tohu needed to be consistent and repeatable to create robust information).
- Measured these tohu to determine the health or state of the marine environment (this meant establishing criteria against which they could measure health).
- Developed ways to communicate the health of their rohe to other agencies (for example, summary statements that could feed into regional council reports on the state of the environment with respect to tangata whenua values).

This process of tohu development was carried out by the project focus group and included the gathering of information from the wider community at the hui a hapu.

GIANT FOOTSTEPS OF RONGOKAKO

The footprint of Rongokako (Te Tapuwae o Rongokako), an ancestor of East Coast tradition, is embedded in one of the rocky structures of the marine reserve, close to shore.

Many traditions abound regarding Rongokako. There is general agreement that he was a man of immense athletic prowess and dexterity; a giant who could stride enormous distances. His origins are unclear. Some say he was the father of the famous Tamatea and came from Hawaiki in the Takitimu canoe. Others say he came in the Horouta canoe. Another version suggests that his arrival was as mysterious as his departure.

Local tradition suggests that Rongokako was sent by Kiwa to investigate the late arrival of the Horouta waka to Turanganui-a-Kiwa. On his arrival at Ohiwa, a disagreement arose between Rongokako and Paoa and they engaged in a titanic struggle. This culminated in a chase by Paoa of his fleet-footed adversary down the East Coast shoreline.

Paoa was no match for him.

To help overtake Rongokako, he had set a large rat trap to snare the giant's pet, an enormous kiwi. The wily Rongokako sprang the trap, which flew inland forming Mount Arowhana. The site of the trap became Tawhiti, an area of land between Te Puia and Tokomaru Bay.

In this epic encounter, Rongokako left footprints in the flat rocks as he strode down the eastern seaboard of the North Island. The first of these tapuwae (footprints) is at Wharekahika (Hicks Bay). The second is at Kaiora, south of Whangara mai tawhiti, from which is derived the name of this marine reserve, Te Tapuwae o Rongokako. The next footprint is located at Turanga, and another is at Nukutaurua, on Mahia Peninsula.

Rongokako then stepped over to Te Matau-a-Maui (Cape Kidnappers), then to the shores of Raukawa (Cook Strait). He crossed the Strait and was gone.

Kaiora, the settlement that overlooks the marine reserve, was a well-populated papa kainga (village). The famous East Coast chief, Porourangi, lived here and is buried close by.

Konohi, the local chief, also inhabited the district. He had three sons—Marukauiti, Te Riwai and Wahakapi—from whom the present tribe of Whangara mai tawhiti claims descent.

Ohinemuhu and parekouau

FINDINGS

Ngati Kere

The Ngati Kere project produced a range of defined outcomes and deliverable products:

- A kete tohu/indicator tool box for monitoring the state of and changes in the rohe moana
- Proposed methods for monitoring (a monitoring programme)
- A survey method and results that assess the level of hapu knowledge and perceptions about the state of the rohe moana
- Some key findings about the development of tohu and monitoring programmes
- A reported process for developing tohu and implementing a monitoring programme

In the process of creating the overall kete/basket of tohu, Ngati Kere asked five questions for each tohu:

1. Which stated goal of Ngati Kere has been addressed by the tohu?
   e.g. arresting the depletion of marine life
2. What aspect of the goal will the tohu specifically address?
   e.g. prevent a decline in koura
3. What will the tohu measure?
   e.g. number or size of koura
4. How will the tohu be applied in the field?
   e.g. counting koura in knee-deep water
5. Does the tohu tell us what we need to know?

The following is the final list of tohu that resulted. Together they form the kete tohu.

Tohu tuatahi	Number and size of koura/crayfish in shallow water
Tohu tuarua	Number and size of hapuka/groper close to the coast
Tohu tuatoru	Level of Ohinemuhu rock above sand and abundance of pipi
Tohu tuawha	Level of involvement in marine management
Tohu tuarima	Availability of native plant resources, e.g. pingao
Tohu tuaono	Number and type of customary take permits issued
Tohu tuawhitu	Number, size and distribution of no-take areas
Tohu tuawaru	Number of prosecutions for illegal catches and take
Tohu tuaiwa	Level of knowledge about the rohe moana within the hapu and community

For each tohu, a range of monitoring options was discussed and progressed. The following is an example of monitoring methods for koura, paua, kina and pipi:

What is our goal?	What do we want to achieve?	Tohu—what will be measured?	How will we do it?	What do we need to know?
Arrest depletion of marine life	1. Prevent the decline in crayfish numbers 2. Have crayfish present in knee-deep water (hapuka come closer to shore) 3. Prevent decline in paua, kina and pipi Be able to go back to the time when you just went to moana to get a kai for your whanau	Number of crayfish Size of crayfish (small/medium/large) Number of paua (potential for counting paua at the same time as crayfish, using similar methods)	Crayfish counts: • Random transects • Fixed holes • Pots Criteria: • Only count individuals above a certain size Timing: • Twice yearly? • Times to be determined Record the weather and visibility (> 5 m, < 5 m)	Should we count paua at the same time? (Yes) Agreed counting methods, e.g. where do we count? What should we measure and how should we group them? What time of year should we count? (Once or twice a season; when they are at their fattest) How can we be consistent? (Roster) Do we want to collect other information, e.g. weather, rock type? (Yes; seaweed)

Ngati Konohi

In developing indicators for their rohe moana, Ngati Konohi identified a number of purposes for tohu. When used as environmental signs to indicate the health of the marine environment, and consequently when and where to fish and gather kaimoana, tohu can be used to:

- Measure change in an environment
- Lead the hapu in sustaining their vision for the environment
- Promote better relationships between Maori and non-Maori when managing their environment
- Gauge the success of environmental management systems

Tohu also help to place a 'line in the sand', so that Ngati Konohi can compare what they have now with what they had in the past, and compare one area with another.

Ngati Konohi members identified a number of indicators that they felt signalled that the marine environment was in good health. These were then grouped into primary tohu and secondary tohu.

Primary tohu are observations of the health of the kaimoana and of the natural processes that denote the health of the marine environment. Secondary tohu are scientific measurements of the kaimoana present and other things that denote the health of the marine environment.

Primary tohu and monitoring methods

1. The mana of Ngati Konohi is reflected in its manaakitanga:
   Te huhua o te kaimoana—the abundance of seafood.

Species tohu monitor the availability, accessibility, abundance and quality of key species identified by Ngati Konohi as underpinning manaakitanga—koura, kina, pupu, parengo and ika, these being the species that are 'put on the table' for the manuhiri.

SPECIES-FOCUSED TOHU	MONITORING METHOD
Availability: Can kaimoana be readily harvested, in season, to provide for customary needs?	Information collected from customary fishing permit holders is collected and reported back to tangata whenua and MFish by Kaitiaki twice per year
Accessibility: Can kaimoana be harvested easily (in shallow water) in season?	
Abundance: Can sufficient quantities of kaimoana be harvested, in season, to meet reasonable customary needs?	
Quality: Is the appearance, size, colour, smell and taste of kaimoana 'right' in season?	

2. Marine life in the rohe moana is enhanced and sustainably managed for the benefit of present and future generations of all New Zealanders.

Process tohu monitor the condition and presence of processes that are indicative of a healthy marine environment and reflect the Ngati Konohi holistic view of the moana.

PROCESS-FOCUSED TOHU	MONITORING METHOD
A series of land-based signs (kowhai bloom, pohutukawa flowering, karaka berry colour, and ti kouka flowering) can be used to indicate kina ripeness and readiness for harvesting	Information collected from customary fishing permit holders is collected and reported back to tangata whenua and MFish by Kaitiaki twice per year
The presence of a natural and diverse range of marine species	
The presence of a natural diversity of marine species in intertidal areas including seashore birdlife	
The seasonal observation of feeding aggregations of 'bait fish' (kahawai, trevally and tarakihi) together with predators, such as tuna, marine mammals, and sea birds	
Harvesting success is positively linked to lunar phases, as identified in the Maori fishing calendar (Maramataka)	

Secondary tohu and monitoring methods:

Baseline measurements for secondary tohu are established and re-measured as and when required over time.

SECONDARY TOHU	MONITORING METHOD
A series of plots are established at various locations in the rohe moana to quantify the quantity, size and location of key indicator species: koura, kina, paua, pupu, parengo and ika	A baseline survey and database is established by hapu members or other agencies, and future measurements are completed when necessary
Gisborne District Council marine environmental monitoring data is utilised to monitor water quality, shellfish health, beach bathing standards, etc.	Data obtained from the council as required

THE CHALLENGE OF IMPLEMENTATION

Once the tohu were developed, both Ngati Kere and Ngati Konohi faced significant challenges in implementing them. Establishing a monitoring programme using confirmed monitoring techniques and producing robust information about their marine environments remains a challenge.

Not only is it difficult to monitor regularly over time using consistent parameters and techniques, but monitoring also requires a significant level of capacity, resourcing and organisation, and a whole-of-hapu mandate. The need to work with a wide range of parties is a further challenge.

Presently, Ngati Kere are at a point where tohu have been developed and tested in a small-scale monitoring trial. The next stage for Ngati Kere is to use the kete tohu, test the usefulness of the tohu in practice and produce specific information against the tohu on the health of the Ngati Kere rohe moana. It is likely that in fully testing the tohu in the field, some refinement of the tohu and their specific monitoring techniques will be required.

Ngati Konohi felt that the majority of monitoring information would come from the issue of customary fishing permits by the Tangata Kaitiaki. The newly appointed Tangata Kaitiaki are still in the process of settling into their role as managers of customary fishing for the rohe. The development of a process and capability to collect, collate, analyse and report against the tohu is still in progress.

Few customary fishing permits were issued by the Tangata Kaitiaki during the period of the project and thus little monitoring or implementation of the tohu was possible within the timeframe of this project. Given that Ngati Konohi are relying on one source of information, it is possible that they may only be able to obtain a limited picture of their marine environment using the tohu.

Ngati Konohi acknowledged that more information is needed to provide a detailed picture of the quality of the marine environment, particularly with regard to the abundance of the most sought after species, their accessibility, and the quality or condition of the resource gathered. To produce this information, data collected from customary users by the Tangata Kaitiaki may need to be supplemented by information from other sources.

Other sources of monitoring information suggested by the project team and Ngati Konohi participants included:

- Monitoring information collected by the Gisborne District Council on marine (bathing) water quality, shellfish health (as a measure of water quality) and the chemical composition of freshwater entering the marine environment.
- Ecological and biological monitoring through a baseline survey that identifies the extent and distribution of the key marine species adjacent to Whangara Island. This could be developed and implemented by Ngati Konohi or other agencies, and repeated at a series of sites throughout the Whangara rohe moana. The information from such surveys could be used to identify and quantify changes in the marine environment that have been signalled by the primary tohu.
- Monitoring of commercial catches of crayfish and other marine species carried out by MFish. This would provide information about the quantities and locations of fish taken.
- Monitoring of changes within the Te Tapuwae o Rongokako Marine Reserve by DOC.

The Tangata Kaitiaki were identified by both hapu as being the key people involved in managing the marine environment and utilising environmental tohu (as well as scientific data). It was recognised that the more detailed, specific information they have access to, the more appropriate their decisions are likely to be on behalf of the hapu. With Tangata Kaitiaki leadership, both hapu can be involved in the range of possibilities that they identified to progress the implementation of their tohu for the marine environment.

CONCLUSIONS

The tohu development processes used by Ngati Kere and Ngati Konohi offer useful insights into how tohu can be used to assess and manage the marine environment. While these tohu have been developed within the rohe moana and management systems of the two hapu, it is anticipated that they could also be useful for other hapu and iwi. The tohu and their implementation methods can be adapted, adjusted and modified to suit other marine environments in different locations throughout the motu/country.

However, although many of the key lessons that were learnt from the case studies of these two hapu may be transferable, we cannot assume that this process will be the same for all tangata whenua. Just as management techniques are often locally specific, so too are the many and varied processes involved in the development of tohu to assess the health of specific marine areas. It is important that tohu are developed alongside the management goals and specific contexts of those who will use the tohu.

These projects are two of a small handful of examples where tangata whenua, in relationship with other agencies, have developed, used and documented indicators to assess the health of their marine areas and the management processes that govern them.

As leading case studies, the Ngati Kere and Ngati Konohi projects also indicate areas where further work could be done to support the development and use of tohu as important environmental monitoring and management tools in New Zealand.

Large crayfish readily observable in shallow water—a tohu of a healthy ecosystem

4. Meeting the objectives of marine management systems—an ecological assessment

INTRODUCTION

The aim of this component of the research project was to measure different species assemblages at a range of ecological levels in order to understand how marine reserves, taiapure, mataitai and open fished areas contribute to meeting iwi/hapu and conservation objectives.

Iwi/hapu objectives for the management systems within the two rohe of interest (Ngati Kere and Ngati Konohi) are identified in the application documents for the particular areas, in policy documents and in social science reports produced in fulfilment of the concurrent social science research component of this project.

In terms of its general marine conservation objectives, the New Zealand Government seeks to 'protect a full range of natural marine habitats and ecosystems to effectively conserve marine biodiversity, using a range of appropriate mechanisms, including legal protection' (DOC & MfE 2000). In relation to existing marine reserves, Section 3 of the Marine Reserves Act 1971 states that:

'(a) They shall be preserved as far as possible in their natural state:

'(b) The marine life of the reserves shall as far as possible be protected and preserved:

'(c) The value of the marine reserves as the natural habitat of marine life shall as far as possible be maintained:'

More specific objectives for the two marine reserves in the rohe moana of Ngati Konohi and Ngati Kere are stated in the reserve application documents. The objective identified in the application for Te Tapuwae o Rongokako Marine Reserve was:

> *'To preserve in their natural state for the scientific study of marine life a range of marine habitats that are so typical of those found on the east coast of North Island between Mahia Peninsula and East Cape that their preservation is in the national interest.'*
> (DOC & Ngati Konohi 1998)

The three principal objectives identified in the application for Te Angiangi Marine Reserve were:

- *'To give effect to the purposes and principles of the Marine Reserves Act 1971.*
- *'To contribute to the Department of Conservation's function to conserve and protect the natural character and quality of New Zealand's coastal and marine environments, and the establishment of a nationwide network of marine reserves that is representative of these.*
- *'To provide educational and recreational opportunities for non-extractive users of the Hawke's Bay coast.' (DOC 1994)*

Both Ngati Konohi and Ngati Kere have identified measurable objectives for the marine protected areas in their rohe. Ngati Konohi defined the following objective relating to Te Tapuwae o Rongokako Marine Reserve:

> *'Protection and restoration of the local area for education, as a kohanga (nursery for marine life), for spillover and a comparison.'* (DOC et al. 2007)

A key goal identified by Ngati Kere for their rohe moana was:

> *'To arrest the overall depletion of marine life in the Ngati Kere rohe moana.'*
> (Wakefield & Walker 2005)

Ngati Kere considered that one way in which the existing marine management tools in their rohe could help achieve this goal is if Te Angiangi Marine Reserve could act as a kohanga or nursery, by providing a source of larvae of species such as paua (Wakefield & Walker 2005). Although a taiapure has also been established in the rohe of Ngati Kere (Te Taiapure o Porangahau), no bylaws have been established for the Taiapure, so that the regulations for the surrounding area apply.

Therefore, the two coastal hapu involved in this research project have identified two key objectives for two of the marine protected areas in their rohe moana. The first objective, which coincides with the broad objectives of the New Zealand Government, relates to the **protection and restoration of marine life**. The second objective relates to the perceived ability of marine reserves to **supplement harvest** through the spillover of adults and larvae from the reserves to adjacent fished areas.

The ability of marine protected areas to achieve their objectives is dependent on a number of factors, including the design and management of the marine protected areas and the interactions between species within the protected areas. This research aimed to establish whether the marine protected areas that are currently in place within the rohe of Ngati Konohi and Ngati Kere, in particular Te Tapuwae o Rongokako and Te Angiangi Marine Reserves, were fulfilling or had the potential to fulfil not only the preservation objectives of DOC, but also the restoration, enhancement and sustainability objectives of the two hapu.

METHODOLOGY

Protection and restoration of marine life

Habitat mapping

The rohe moana of Ngati Konohi and Ngati Kere were mapped in order to describe the nature and extent of marine habitats within them. Several methods were employed to achieve this, including sidescan sonar (University of Waikato 2002; Funnell et al. 2005), bathymetry mapping (BTW Hydrographic Limited 2003; Funnell et al. 2005) and remote video surveying (ASR 2003; Funnell et al. 2005). In addition, qualitative data on habitat distribution were collected over several years by DOC divers during species monitoring work (D.J. Freeman, DOC, Gisborne, unpubl. data).

Species' responses to protection

Reef fish, lobsters, and intertidal paua and kina populations were monitored over several years at both Te Tapuwae o Rongokako and Te Angiangi Marine Reserves. Reserve and non-reserve sites were surveyed. Reef fish were surveyed using underwater visual census (Freeman & Duffy 2003; Freeman 2005), with divers recording species diversity, abundance and size. At both locations, lobsters were surveyed using divers; commercial pots were also used at Gisborne (D.J. Freeman, DOC, pers. comm.). At both locations, monitoring of paua and kina focused on populations in channels and pools in intertidal reef platforms (Freeman 2006).

Trophic interactions

Studies of the trophic interactions among species within the rohe of Ngati Konohi included lobster diet analysis and stable isotope analysis (D.J. Freeman, DOC, pers. comm.). This component of the research culminated in the development of an ecosystem model for Te Tapuwae o Rongokako Marine Reserve and the surrounding environment (Lundquist et al. 2006).

Enhancing harvest

Movement and dispersal patterns of key species

Two studies into the movement patterns of key species of interest to the hapu were conducted. A lobster tagging study was initiated in 2003, which involved tagging over 7000 lobsters both within Te Tapuwae o Rongokako Marine Reserve and in the area surrounding it, and conducting pot surveys every 3 months to obtain tag recaptures and thus data on the growth rates and movement patterns of the lobsters (D.J. Freeman, DOC, pers. comm.). A second study involved tagging a variety of reef fish species within Te Angiangi Marine Reserve and in the area around it, and subsequently completing gillnet surveys of the area to obtain information about the movement patterns of these species (C. Duffy, DOC, unpubl. data).

The dispersal patterns of the larvae of some key species of importance to Ngati Kere and Ngati Konohi were modelled using hydrodynamic modelling (Stephens et al. 2004; Oldman et al. 2006). Following the development and calibration of the models, larval dispersal from known populations of adults of the species was simulated for a range of sea states.

RESULTS AND DISCUSSION

Protection and restoration of marine life

Remote video, sidescan and bathymetric surveys of the central Hawke's Bay coast revealed that five distinct habitats were present: sand, *Ecklonia radiata* (kelp) forest, encrusting invertebrate/sponge flats, mixed algae and shallow *Carpophyllum*. All of these habitats were represented within Te Angiangi Marine Reserve, although only a small area of encrusting invertebrate/sponge flats was protected. The reserve boundaries enclosed a single reef system between Blackhead Beach and Aramoana, although the northern boundary of the reserve was demonstrated to cross this reef system through the mixed algal habitat at the northern end of the reef (Fig. 5).

Te Tapuwae o Rongokako Marine Reserve was demonstrated to contain representatives of most of the habitats identified in the remote video, diver, bathymetric and sidescan sonar surveys. Six distinct habitats were identified in the reserve: shallow *Carpophyllum*, coralline algal-covered reef, mixed algae, *Ecklonia radiata* (kelp) forest, sponge garden and sand (Fig. 6).

The structurally complex deep cobble habitat surrounding the two pinnacles comprising Monowai Reef, which is located to the northeast of the marine reserve, and indeed Monowai Reef itself, are habitats that are not well represented in the reserve. The deep cobble habitat is potentially biologically diverse and may be an important area not only for foraging but also as a nursery habitat for juvenile fish.

Habitat mapping also showed that Te Tapuwae o Rongokako Marine Reserve is large enough to completely enclose the intertidal and subtidal reef systems that extend from Pariokonohi Point. However, the northern boundary of the reserve crosses the reef system to the north of this main reef system and the southern boundary of the reserve also crosses an area of patchy reef.

Although both marine reserves have been designed for the purpose of protecting the marine life within their boundaries, the habitat mapping studies demonstrated that there is the potential for species utilising the reef systems within the reserves to cross the marine reserve boundaries. Whether or not this is viewed as potentially compromising the protection of marine life within the reserves, or providing an opportunity for species to spillover from the reserve into areas where they can be harvested, is debatable, but probably depends on the size of the marine reserve and its ability to remain viable despite significant spillover. The small size of Te Angiangi Marine Reserve (446 ha) may make it vulnerable to being compromised by such design features.

In terms of the restoration of marine life, monitoring of previously harvested species demonstrated that both marine reserves have been successful in increasing the biomass of some species. Lobsters in particular have shown a rapid and marked response to protection within both Te Angiangi and Te Tapuwae o Rongokako Marine Reserves (D.J. Freeman, pers. comm.). Lobsters were shown to be larger and more abundant within both reserves than in

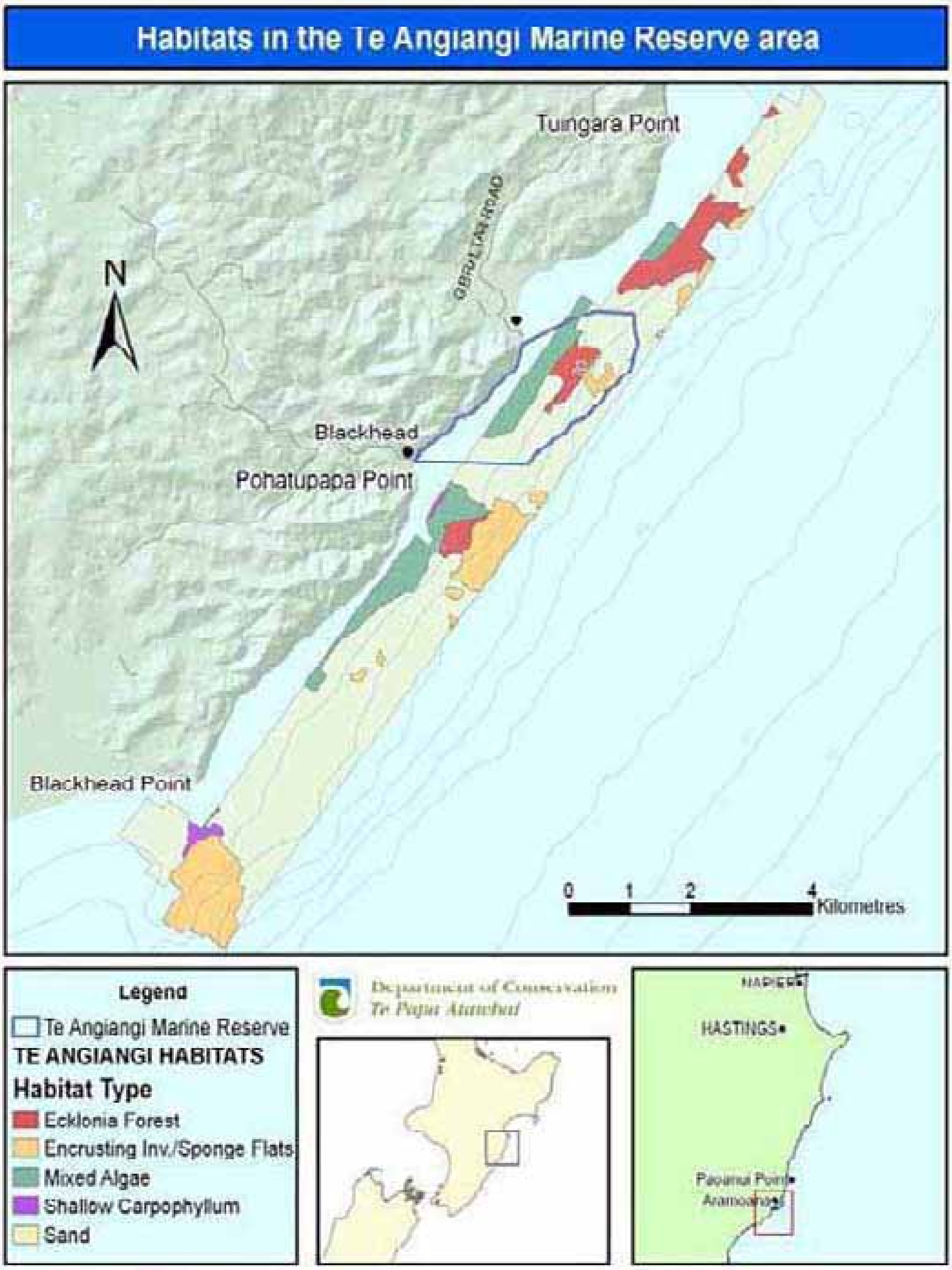


Figure 5. Habitat map of part of the rohe of Ngati Kere, showing the boundary of Te Angiangi Marine Reserve. This area was mapped using sidescan sonar and remote video surveys.

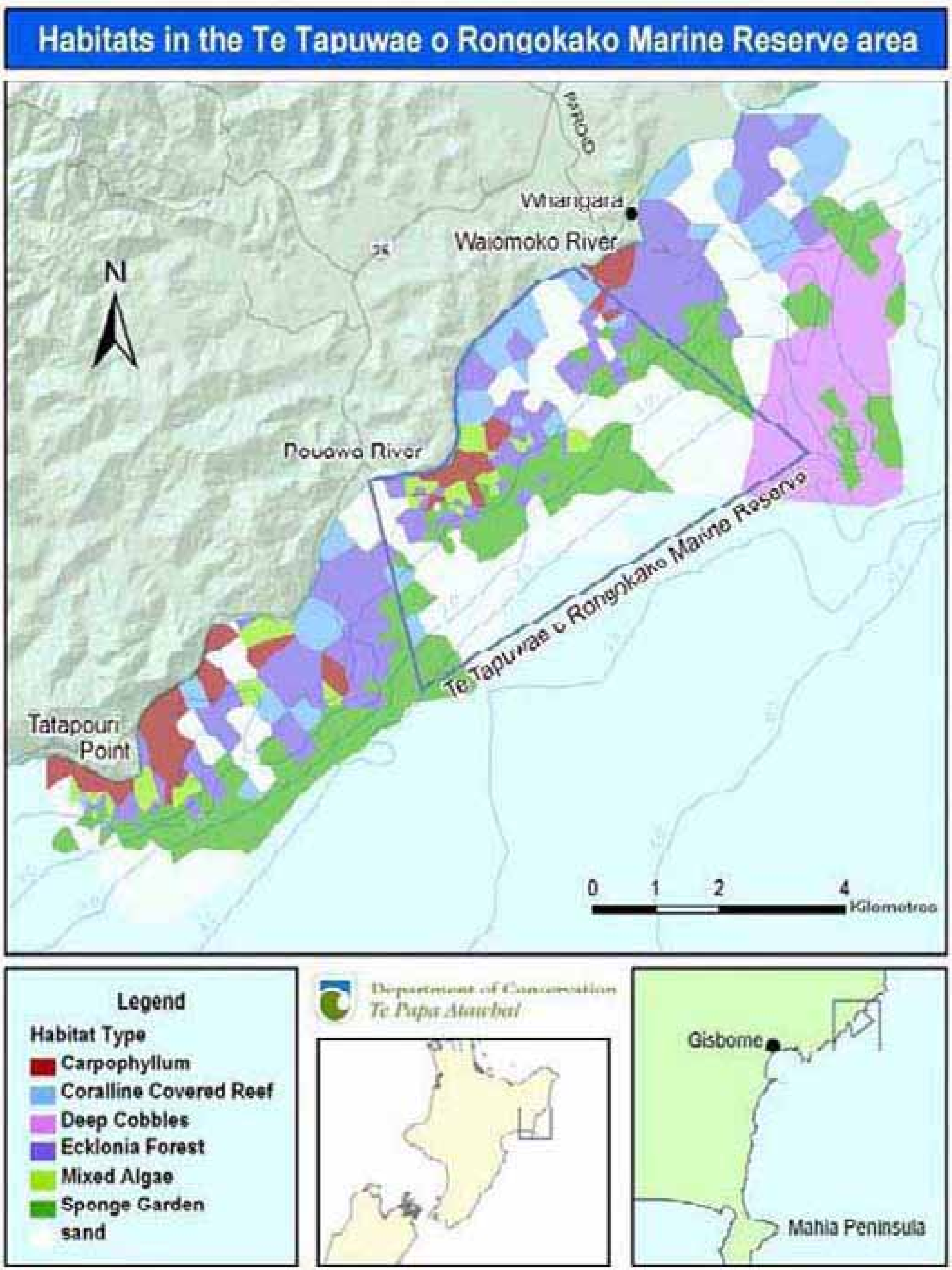
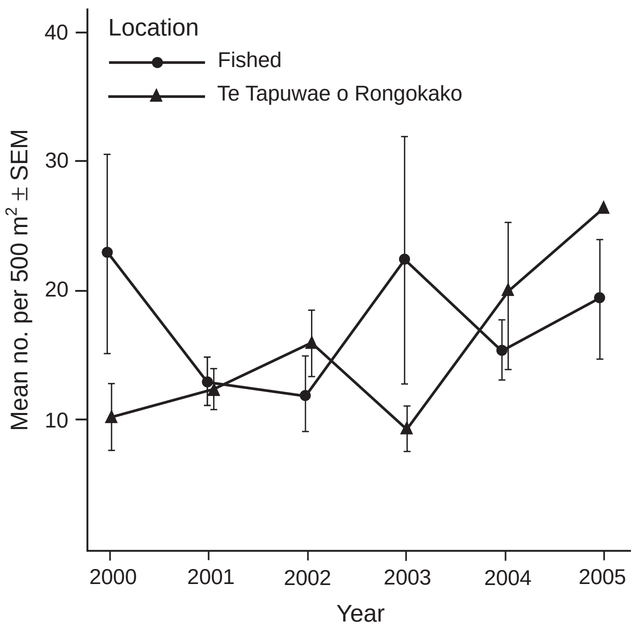


Figure 6. Habitat map of part of the rohe of Ngati Konohi, showing the boundary of Te Tapuwae o Rongokako Marine Reserve. This area was mapped using diver, sidescan sonar and remote video surveys.

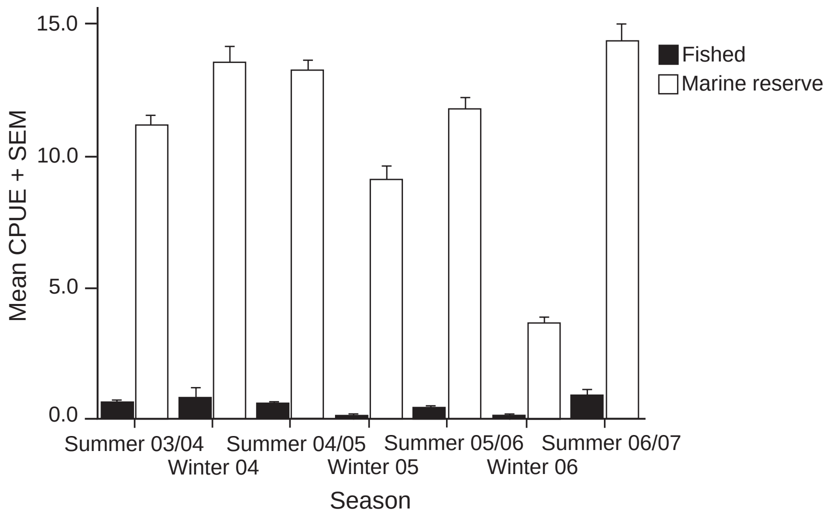
their respective non-reserve sites and these changes occurred soon after the establishment of the reserves. For example, diver underwater visual censuses showed that between 2000 and 2005, the mean density of lobsters within Te Tapuwae o Rongokako Marine Reserve increased from 10 to 26 individuals per 500 m^2 (Fig. 7).

Figure 7. Average density of lobsters (from diver surveys) within and outside Te Tapuwae o Rongokako Marine Reserve, between 2000 and 2005.



Pot surveys demonstrated that between November 2003 and November 2004, the mean catch per unit effort (CPUE), measured as the weight of legal-sized lobsters per pot, increased from 11 to 14.1 kg per pot lift within the reserve. A year later, in November 2005, the mean CPUE was 15.4 kg per pot lift within the reserve. In contrast, outside the reserve, the mean CPUE ranged between 0.1 kg per pot lift (May 2006) and 1.1 kg per pot lift (November 2003) (Fig. 8). In the last survey (November 2006), the mean CPUE within the reserve was 15 times higher than that outside the reserve.

Figure 8. Average catch per unit effort (kg legal-sized lobsters per pot) within and outside Te Tapuwae o Rongokako Marine Reserve between November 2003 and November 2006.



Diver surveys showed that in 2005, lobsters were over twice as abundant within Te Angiangi Marine Reserve than at the adjacent non-reserve location at Pourerere (Fig. 9).

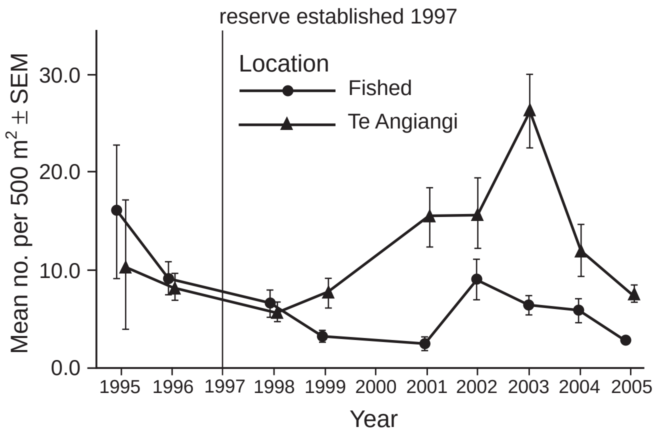


Figure 9. Average density of lobsters (from diver surveys) within and outside Te Angiangi Marine Reserve between 1995 and 2005.

In contrast to lobsters, the response of populations of previously harvested reef fish species to reserve protection has been minimal to absent. In Te Angiangi Marine Reserve, the densities of blue moki, red moki and banded wrasse (the latter two being gillnet bycatch species) increased slightly following the reserve's establishment, but densities still remained low (Freeman & Duffy 2003). Similarly, densities of reef fish within Te Tapuwae o Rongokako Marine Reserve have remained low since the reserve's establishment (Freeman 2005). Possible explanations for this lack of response to protection include reserve age (both reserves are relatively young), reserve design (for example, Te Angiangi Marine Reserve is a comparatively small reserve), experimental design (for example, only reef habitat at a depth of 8–12 m was surveyed at Te Angiangi Marine Reserve), monitoring method (underwater visual census may underestimate the abundance of diver-negative species), illegal fishing, and overriding environmental factors such as sedimentation or other factors influencing fish recruitment (Freeman & Duffy 2003; Freeman 2005). These factors need to be explored further before any definitive statement can be made regarding the restoration of reef fish populations within East Coast marine reserves.

Within both Te Angiangi and Te Tapuwae o Rongokako Marine Reserves, the densities of intertidal kina were low compared with their respective non-reserve sites, but a wider size range of kina was present within the reserves (Freeman 2006). Paua were more abundant within both reserves than at their respective non-reserve sites, and paua within the reserves were also larger on average. In 2003, paua within Te Angiangi Marine Reserve were on average 15 mm larger (shell length) than those outside the reserve.

One key aim of this research was to investigate trophic interactions among species and the potential for trophic cascade effects within marine protected areas following changes in the biomass of predator species. Studies of the diet of lobsters within Te Tapuwae o Rongokako Marine Reserve showed that they were feeding predominantly on coralline turf algae and turf-dwelling invertebrates (D.J. Freeman, DOC, pers. comm.). Thus, given the large increase in lobster biomass within the reserve, there existed the potential for change in some components of this community; ecosystem modelling confirmed this (Lundquist et al. 2006). It is clear that the interactions between species need to be taken into consideration when assessing the response of particular species and communities to protection, as protection may not always result in an increase in species abundance or biomass. In addition, the ecosystem modelling approach is useful for informing management decisions, such as the appropriate level of harvesting and species composition of the harvest in areas being managed for sustainable fishing. It would ensure that the linkages between species are taken into consideration, providing a more holistic ecosystem approach to protection and fisheries management.

Enhancing harvest

The incidental benefits of marine reserves to fisheries were highlighted as a key objective by hapu when supporting the establishment of both Te Angiangi and Te Tapuwae o Rongokako Marine Reserves.

The lobster tagging study revealed clear seasonal migrations of male lobsters, in particular medium-sized males with a tail width of 50–65 mm (D.J. Freeman, DOC, pers. comm.). These animals demonstrated distinct movements inshore for winter and offshore to deep (30–40 m) reef areas for summer. In contrast, females and large males tended to be more sedentary, moving only short distances between recaptures and demonstrating no significant seasonal movements. Some movement between reef systems was recorded, but most lobsters located on the main reef system around Pariokonohi Point tended to remain on that reef system. Only a small proportion of tagged lobsters moved across the soft sediment habitat between reef systems.

Movements of tagged lobsters occurred across both the southern and northern boundaries of Te Tapuwae o Rongokako Marine Reserve (Fig. 10). Movements across the marine reserve boundary took place more commonly where the boundary crossed rocky reef habitat, with particularly significant movement of lobsters across the northern boundary of the reserve, which bisects a large area of rocky reef habitat. This finding was supported anecdotally by commercial fishermen, who reported unusually high catches of large lobsters in some areas of reef habitat within 200 m of the marine reserve boundary. On occasion, tagged lobsters that were proven to have originated from within the reserve boundaries were recorded among these catches. Estimates of lobster movement across the boundaries are affected by a number of factors, including tag loss, tag non-reporting, the distribution and intensity of sampling and fishing effort, and the effects of catchability on tag recaptures. However, it was evident that lobsters from the marine reserve were moving across the reserve boundaries, serving to supplement the catches of fishermen.

Preliminary results from the reef fish tagging study did not shed any light on whether fish actually crossed the boundary of Te Angiangi Marine Reserve. However, the distance travelled by tagged butterfish (in the order of several hundreds of metres) suggest that this species at least has the potential to cross the reserve boundary as it moves around the reef system within the reserve.

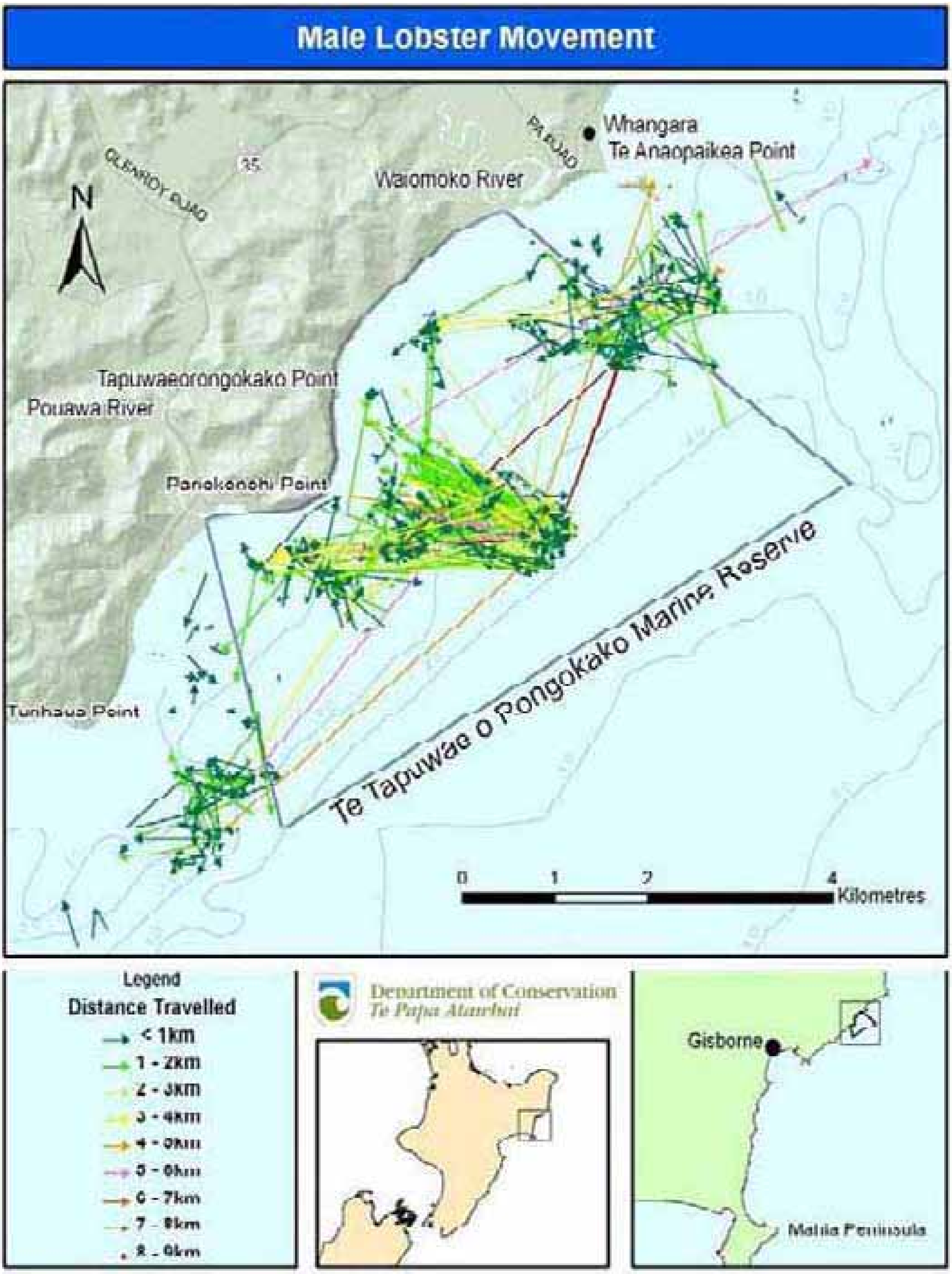


Figure 10. Map showing the movement of tagged lobsters within Te Tapuwae o Rongokako Marine Reserve and in the surrounding area.

At both sites, larval dispersal modelling demonstrated that the larvae of some species of cultural interest have the potential to disperse from the marine reserves into the surrounding marine environment (Stephens et al. 2004; Oldman et al. 2006). This potential was dependent not only on hydrodynamics, but also on features of the species, such as larval longevity, size and mobility. Long-lived larvae, such as kina, were able to disperse very widely from populations of adults within the marine reserves (Fig. 11), whereas species with large, short-lived propagules, such as bull kelp, were more restricted in their ability to disperse from the reserves (Fig. 12). Dispersal within Te Taonga o Ngati Kere (Porangahau Taiapure) and in the surrounding area was also simulated. It was established that there are potentially areas within the Taiapure that are largely dependent on self-recruitment, due to local hydrodynamics. These findings will have significant implications for any management change within the Taiapure and, in particular, may guide the future development of bylaws for the Taiapure.

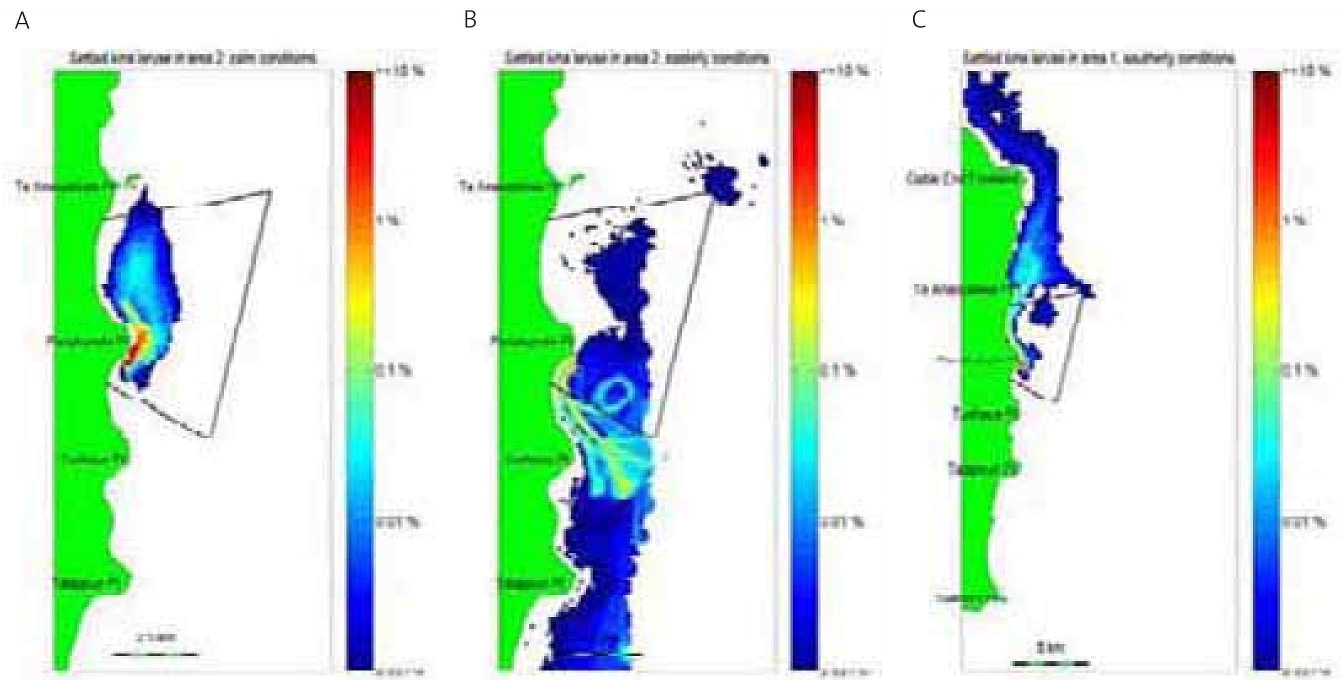
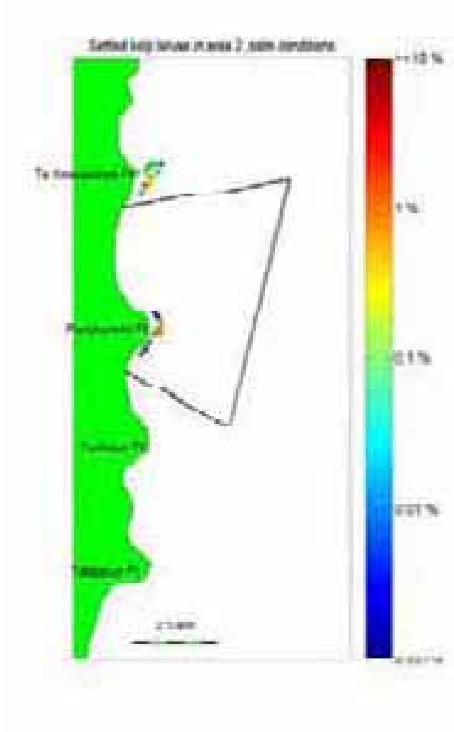


Figure 11. Modelled dispersal patterns of kina larvae released at Pariokonohi Point within Te Tapuwae o Rongokako Marine Reserve under A. calm conditions, B. easterly conditions and C. southerly conditions.

Figure 12. Modelled dispersal patterns of bull kelp spores released at Pariokonohi Point within Te Tapuwae o Rongokako Marine Reserve and just to the north of the marine reserve under calm conditions.



CONCLUSIONS

The ecological research that was undertaken as part of the Maori Methods and Indicators for Marine Protection project has gone some way to establishing whether the marine protected areas that are in place within the rohe of Ngati Kere and Ngati Konohi are fulfilling the identified objectives. A range of ecological research was completed, from habitat mapping, species monitoring and studies of the movement patterns of key species of interest to hapu, to studies of the trophic interactions among species. The research culminated in the development of an ecosystem model for Te Tapuwae o Rongokako Marine Reserve, which enabled exploration of the trophic interactions between species within and outside marine protected areas on the North Island's East Coast.

This study has highlighted the importance of identifying the objectives of marine protected areas and obtaining basic ecological data from the area prior to their establishment, to ensure that the design and management regime is appropriate, and thus that their potential to fulfil these objectives is maximised. Monitoring at Te Angiangi Marine Reserve has demonstrated that some species within the reserve, in particular lobsters, have responded to protection. It is unclear to what extent the reserve's design, in terms of the size and location of the boundaries, is affecting the response of other species to the area's protection. Larval dispersal modelling showed that there is the potential for larvae produced within the reserve to disperse out of the reserve and supplement other populations. It remains unknown whether the adults of species within the reserve are crossing the reserve's boundary, although some cross-boundary movement is possible, particularly across the northern boundary, which bisects a reef system. To what extent this opportunity for cross-boundary migration should be seen as a threat to the integrity of the reserve is unclear, but warrants further investigation, particularly because of the reserve's small size.

Species within Te Tapuwae o Rongokako Marine Reserve have also responded to protection in a way that is consistent with restoration towards a more 'natural' state. The ability of this reserve to protect marine life may be greater than that of Te Angiangi Marine Reserve, due to its larger size and the fact that it completely encloses a reef system. Te Tapuwae o Rongokako Marine Reserve also has boundaries that cross reef systems, which appears to provide an opportunity for the cross-boundary movement of reef-dwelling species such as lobsters. Therefore, it appears that this reserve may be better placed to provide incidental benefits to fisheries without compromising the ecological integrity of the reserve.

The key to successful marine protection is to have clearly defined objectives for the marine environment and use the appropriate tool or combination of tools to achieve those objectives. Ngati Konohi have developed the concept of a 'Tangaroa Suite', where a marine reserve works in conjunction with mataitai and taiapure to protect and restore marine life, while providing for sustainable fishing via export from the reserve and appropriate management of the surrounding area. Similarly, Ngati Kere have recognised that a marine reserve could be used as a nursery to support the surrounding fishery. Such a combination of protection and management tools may be the most appropriate way to ensure that the objectives of both the Government and the local community for the marine environment are met.

Continue to next file: Part 4