Fisheries in the Ngāti Kahungunu Rohe, New Zealand

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Abstract

To ensure sustainability of fisheries resources, commercial fisheries in New Zealand are monitored by direct control of harvest levels using the Quota Management System. However, there is currently no overall harvest amount for any fishery in New Zealand, which includes harvest amounts across all sectors of fishing: commercial, recreational, customary and other sources of fishing mortality. Having reliable information and data is important when setting and varying harvest levels for each species in each geographical area to ensure the sustainable use of that fishery.

This research focuses on the fisheries harvest within Ngāti Kahungnu rohe, between the 2007-2010 fishing years, of 10 key species in New Zealand waters. A variety of different data sources from all sectors, including; commercial, recreational, customary and illegal fishing were used in this research to estimate overall harvest amounts. These estimates are also displayed geographically using heat maps. In order for more reliable estimates of overall harvest to be made there is a need for more consistent data collection between the different fishing sectors, as well as a higher quality of data collection relating to the harvest of fisheries in New Zealand for all sectors of fishing. This research highlights the difficulty of making such estimates and provides an initial template for similar research in other areas around New Zealand.

This research also highlights the difficulties faced by Iwi/Māori when attempting to participate in fisheries management. This is not only due to the complexity of fisheries management in New Zealand, with current management and traditional Māori concepts not always aligning, but also the lack of high quality data across all fishing sectors available.

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“There’s no such thing as a silly question – if I asked every silly question I ever had I’d be a much smarter person” – Mike O’Donnell.

This thesis is less than 30,000 words.

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Chapter 1

Introduction

Define Māori, Iwi, hapu and Tāngata whenua. (people of the land)

New Zealand's marine environment has provided important resources throughout history in New Zealand, from the arrival of the first Māori settlers in New Zealand to the modern era fishing fleets, the marine environment has played a key role in defining the social, cultural and economic development of New Zealand [75].

New Zealanders value the marine area for many reasons including transportation, fishing, recreation, tourism, and its spiritual and cultural significance. New Zealand's ocean also offers economic opportunities through activities such as fishing, aquaculture, hydrocarbon exploration, extraction of mineral deposits, ocean tourism and biotechnology [19]. Seafood exports in New Zealand rank as the fourth or fifth largest export earner and New Zealand's seafood industry harvests about 600,000 tonnes from wild fisheries and aquaculture each year [48]. The value of this harvest ranges from \$1.2 to \$1.5 billion per annum, of which the aquaculture industry contributes about \$200 million per annum [48]. The sustainable development and management of these resources is important for not only a healthy economy, but also a healthy marine environment. Being an island nation, the health of the ocean, the land and the people are inextricably linked [19].

New Zealand's marine environment is more than 20 times larger than its terrestrial landmass and includes coastal waters, territorial sea, the Exclusive Economic Zone (EEZ), and extends out to the limit of the continental shelf. New Zealand has the fourth largest EEZ in the world, which extends to 200 nautical miles (over 350km) from the coastline and is home to

over 1,000 species of fish, 110 of which are native to New Zealand [75]. The absolute extent of the continental shelf over which New Zealand has jurisdiction is still being defined [75].

Today fishing is a popular activity throughout New Zealand. Māori have their own customary fishing rights (to be defined in detail in later chapters), in 2008 the commercial fishing industry had an estimated value of \$3.97 billion [75], and recreational fishing is popular in New Zealand. The Ministry of Fisheries is primarily responsible for fisheries management within New Zealand's EEZ.

Māori significance

The Treaty of Waitangi is New Zealand's founding document, and is an agreement, in Te Reo Māori (the Māori language) and English, that was made between the British Crown and about 540 Māori rangātira (chiefs). Historically, New Zealand law has largely been based on the English version of the Treaty, which, due to translation, differs from the Māori version. However, today the Māori version of the Treaty of Waitangi is also used, resulting in a unique situation in New Zealand where the indigenous people have both a significant influence on, as well as a significant interest in, New Zealand's natural resources for social, cultural and economic purposes.

Māori have gained significant recognition of their rights and interest in the marine environment, largely since 1992, with the Treaty of Waitangi (Fisheries Claims) Settlement Act and the more recent Māori Commercial Aquaculture Claims Settlement Act 2004 and the Māori Fisheries Act 2004. In 2010, New Zealand also recognised and signed The Declaration of Indigenous peoples rights, set up by the United Nations. The Declaration emphasizes the rights of indigenous peoples to maintain and strengthen their own cultures and traditions. The marine environment is vital to Māori as part of their culture and both the Declaration and the Treaty are important documents supporting them with their need to uphold their cultural traditions.

In New Zealand there is also an organisation, Te Ohu Kaimoana, established through the 1989 Interim Fisheries Settlement, who work to advance Maori interests in the marine environment, including customary fishing, aquaculture and providing policy and fisheries management advice and recommendations to Iwi and the wider Maori community [39].

A glossary of common terms used throughout this thesis, including definitions for Te Reo Māori words used, is given in Appendix A.

1.1 Objectives and purpose of this research

There are four (legal) mechanisms through which kai moana (seafood) are taken from the coastal waters of Aotearoa New Zealand, which are:

1. Customary
2. Recreational
3. Commercial
4. Aquaculture

For the purpose of this thesis Customary fishing can be further broken down into Customary commercial fishing and Customary non-commercial fishing. Customary non-commercial fishing includes harvesting for non-commercial purposes including under the customary regulations but also under recreational regulations.

Data of high quality on the commercial catch are reported to the Ministry of Fisheries, whereas data on the recreational catch are very patchy, being based on voluntary reporting. Customary catch data are collected through Kaitiaki, the hapū (small tribal groups) representatives who issue customary permits, and summary data are reported to the Ministry of Fisheries quarterly. Currently commercial fisheries harvest is published at very high aggregate level (Quota Management Areas) only, which do not allow for analysis or monitoring at finer spatial scales.

Customary fishing information collected by Kaitiaki and reported to the Ministry of Fisheries (Under the Fisheries (Kaimoana Customary Fishing) Regulations 1998) can only be used for the setting or varying sustainability measures or developing management controls. For example the level of reported customary catch is taken into consideration when making allowances for recreational fishing, or setting or varying commercial catch limits in New Zealand. To date no research has been done using the customary fishing information collected by the Ministry of Fisheries, and one of the goals is to investigate these data within Ngāti

Kahungnu rohe, at a fine spatial scale, for the first time.

This research uses the customary fishing information from the Ngāti Kahungunu rohe moana (traditional sea area associated with the Iwi boundaries), held by the Ministry of Fisheries, which was obtained with explicit permission from local Kaitiaki. It includes overall estimates of fisheries from all sectors using a variety of different data sources, including; commercial, recreational, customary and illegal fishing.

As mentioned above Māori have a significant interest in the marine environment and its resources. Fisheries have always been important to Māori as fishing has provided food, a tradable commodity and a way of showing mana (pride and honor) [46]. Within New Zealand there are different Iwi, or tribal groups, and each Iwi has a recognised rohe, or territory, which can overlap, see Figure 1.1. Māori individuals belong to one or more Iwi, based on where their ancestors came from.

This research focuses on fisheries within Ngāti Kahungunu rohe moana and aims to provide valuable information to members of Ngāti Kahungunu Iwi by assessing and analysing all fisheries catch information specific to their rohe, at a finer geographical scale than is currently available. Note: Ngāti Kahungunu Iwi is made up of all of the blue sections on the East coast of the North Island, in Figure 1.1. Ngāti Kahungunu is the second largest Iwi by geographical area and has the third largest population in New Zealand. This research also provides valuable information to other users such as the Ministry of Fisheries and recreational fishermen.

Overall purpose of the research

The overall purpose of this research is as follows:

1. To gain an improved view of all of the fisheries data collected in the Ngāti Kahungunu rohe (customary, commercial, recreational and illegal).
2. To assess the quality of the data being collected.
3. To make estimates of the total catch of kai moana in the Kahungunu rohe for 10 key target species.

Figure 1.1: Map of showing the location of the Iwi (Māori tribal groups) in New Zealand [28]

4. To recommend improvements to the data collection process to make the information collected more useful to all users.
5. To provide Tāngata whenua with a more holistic understanding of the resources being utilised from their moana.
6. To provide a template for other Iwi or groups wanting to collect information on fisheries catch in another area.

Research goals

The goals for this research are as follows:

1. Assess the quality of existing catch data including customary non-commercial data (from Kaitiaki) and recreational data (from voluntary reports by individuals and boat clubs)
2. Formulate a way to combine these data sets with each other, with other available data, and with the commercial data from the Ministry of Fisheries.
3. Provide total catch estimates for the key species of interest including temporal and spatial variation.

Research Questions

The questions this research will aim to answer are:

1. What information on fisheries catch is available in the Ngāti Kahungunu rohe?
2. What is the quality of this information?
3. Can all forms of catch information be standardised (and scaled where only samples of the total catch are available), to provide total fisheries catch within Ngati Kahungunu rohe?
4. What can Kaitiaki do in future to make the information they have more useful to themselves and to other users, for example the Ministry of Fisheries?

1.2 Thesis layout

This thesis begins in Chapter 1 where the objectives, goals and research questions are stated. Chapter 2 then explains the background of New Zealand’s fisheries, followed by a review of the relevant literature both in New Zealand and Internationally in Chapter 3. Chapter 4 – 5 describe the study site and the species this thesis focuses on. The data are then described in Chapter 6 in four separate sections relating to the four types of fishing harvest that are used in this thesis: Commercial, Recreational, Customary and Illegal.

Chapter 7 describes how maps of fishing harvest were produced using ArcGIS and Chapter 8 shows how harvest amounts from different sources were converted into kilograms.

To make estimates of total fishing harvest in the Ngāti Kahungunu rohe moana different data sets have been used from different sectors of fishing. Methods relating to each individual data set are then given in Chapters 9, 10, 11 and 12, again relating to the four types of fishing in New Zealand: Commercial, Recreational, Customary and Illegal. Fisheries harvest estimates for each separate data set are given in each of these chapters.

The estimates across all data sets are then combined to give overall harvest estimates, which are displayed by totals for each species and fishing year in both tables and heat maps in Chapter 13. Bias and the relative margin of error are also discussed for the overall harvest estimates.

The final harvest estimates and the data used are then discussed and recommendations for future data collection are given in Chapter 14.

Chapter 2

New Zealand Fisheries background

The United Nations Convention on the Law of the Sea (UNCLOS) is the international agreement that defines the rights and responsibilities of nations in their use of the world's oceans. It defines the extent of the territorial sea and the exclusive economic zone, and outlines the rights and duties of both the coastal state and other nations in relation to these areas [44]. It also establishes guidelines for businesses, the environment, and the management of marine natural resources. The area from the shore out to 12 nautical miles is known as the nation, or state's, territorial sea, where they are free to set laws, regulate use, and use any resource. The area from 12 nautical miles out to 200 nautical miles is known as the state's Exclusive Economic Zone (EEZ) and within this area the coastal nation or state has exclusive exploitation rights over all natural resources and any area beyond a nation's EEZ is known as international waters, or high seas [41]. Fishing on the high seas is governed through international treaties agreed between nations. New Zealand has signed up to many of these treaties, and as a result, has a range of international obligations that are incorporated into New Zealand law [44].

Fisheries in New Zealand are split into four main sectors; Commercial, Recreational, Customary fishing and Aquaculture. While fisheries catch in New Zealand is managed as a whole, Commercial, Recreational, Customary fishing and Aquaculture are all very different types of fishing and are managed in different ways. In this thesis Aquaculture is not included in total fisheries harvest as fish and shellfish are farmed specifically for harvesting. The following sections will describe New Zealand's fisheries as a whole, as well as Commercial, Recreational, Customary fishing.

Other sources of mortality form a fifth component of the harvest in New Zealand waters,

which includes illegal fishing and fishing for research purposes. Although there is limited information currently available on illegal fishing in New Zealand we consider it in Section 6.4 and Chapter .

2.1 New Zealand fisheries legislation and management

The current legislation relating to the management of New Zealand's fisheries resources is the Fisheries Act 1996, which establishes a broad framework for managing commercial, recreational and customary fishing, as well as highly migratory species and the effects of fishing on the environment. The purpose of this act is to provide for the utilisation of fisheries resources, while ensuring sustainability [44]. This legislation also establishes the regime for the Quota Management System (QMS), as well as fishing regulations, benthic protected areas (BPAs), seamount closures and Customary fishing and management, including Mātaitai & Taiapure (types of marine protected areas) and Rāhui (a custom used by Māori to prohibit the use of a resource and is explained in detail in Section 2.5.4).

As well as the Fisheries Act, New Zealand's marine environment is currently managed by other key pieces of legislation including:

- **The Resource Management Act (RMA) 1991** The RMA is the main piece of legislation that sets out how environmental effects should be managed. After the Aquaculture Reform 2004, the RMA also governs existing, and all new aquaculture management areas (AMAs).
- **New Zealand Biodiversity Strategy (NZBS), 2000** This strategy is led by the Department of Conservation with the Ministry for the Environment, and included input from 13 other government agencies. The strategy was implemented to fulfil, in part, New Zealand's commitments made under the Convention of Biological Diversity. It takes up the challenge to halt the decline of our indigenous biodiversity - our unique plants and animals and the places they live [43]. One objective of the NZBS is to develop a network of Marine Protected Areas (MPAs), using both marine reserves and other forms of legal protection, so that the protected area in New Zealand represents the full range of the coastal and marine ecosystems and habitats.

- **The Marine Reserves Bill 2002** This legislation governs marine reserves, which are usually no-take zones. The Bill helps to implement the NZBS. One of the priority actions in the NZBS is to review the Marine Reserves Act 1971 to better provide for the protection of marine biodiversity. The Marine Reserves Bill is the result of that review [42], however is still a work in progress.
- **The Marine Mammals Protection Act 1978** All dolphins, whales seals and porpoises are fully protected under this act; it is an offence in New Zealand to harass or disturb marine mammals.

Māori also have a significant role in managing the marine environment. In particular, Māori have an important role in fisheries and aquaculture that are allowed for in the following pieces of legislation:

- **Treaty of Waitangi (Fisheries Claims) Settlement Act 1992** This act obliges the Crown to involve Tāngata whenua in fisheries management decisions and recognise Māori customary (non-commercial) fishing rights and management practices. The Fisheries Act provides for a number of tools and processes that are available to Māori in recognition of customary rights, explained in Section 2.5.
- **Māori Fisheries Act 2004** This act provides Iwi, through Te Ohu Kaimoana, 20% of quota for any new quota management stocks brought within the Quota Management System
- **Māori Commercial Aquaculture Claims Settlement Act 2004** This act provides Māori with the provision of 20% of new space in Aquaculture Management Areas (areas reserved for future aquaculture farms) and the provision of 20% equivalent of existing space allocated since September 1992

As well as government agencies, New Zealanders have a crucial role in the management of the marine environment. This could be in their day-to-day use of the marine environment or a more involved approach in the management of marine resources. An example of a community group who are committed to the protection and management of their local area is the Fiordland Marine Guardians. The Fiordland Marine Guardians are community representatives who advise central and local government agencies on how to manage the Fiordland marine environment. The Guardians have developed a community management model that not only includes the community in the management of the marine environment

and its resources but also includes all factors affecting Fiordland’s coastal marine environment. The regulations put in place by the Guardians are designed to improve the sustainability of fishstocks and protect the notable features of the Fiordland marine environment [23].

2.1.1 Iwi Fisheries Management Unit

Ngāti Kahungunu Iwi established a Fisheries Management Unit in April 2010 to help manage and protect their marine and fresh water resources.

Ngāti Kahungunu developed a strategy called “Kahungunu ki Uta, Kahungunu ki Tai” Marine and Freshwater strategy through consultation with hapū and technical support from the Ngāti Kahungunu Iwi Incorporated, Kahungunu Asset Holding Company, Te Ohu Kai Monana and the Ministry of Fisheries. The strategy was launched at the Iwi’s Annual General Meeting in November 2008.

The primary function of the unit is to implement the strategy. Information is a key priority for Iwi and hapū who would like access to good quality information to inform management decisions, hence agreement to support this research.

Kahungunu ki Uta, Kahungunu ki Tai, Marine and Freshwater Fisheries Strategic Plan (KKUKKT) sets out the aspirations of Kahungunu Iwi for the use and management of marine and freshwater fisheries within the Kahungunu rohe. It seeks to reintegrate Kahungunu customary non-commercial and customary commercial fisheries and this vision has three main elements [30]:

- Tangaroa (which represents the god of the sea) - a healthy, abundant and sustainable fishery sourced from thriving ecosystems,
- Kaitiakitanga (which represents care for the marine environment and all the creatures that reside within it) - effective management by all sectors (commercial, non-commercial and the wider community), and
- Tāngata (which represents the people and their connections with the environment and each other) the rangatiratanga of Kahungunu (hapū and Iwi) is recognised and respected.

Overall New Zealand currently has a wide range of marine management tools and legislation, all of which are focused on sustainable use of resources combined with the protection of the environment. These tools tend to be used separately, but can be integrated to achieve marine management goals and outcomes.

2.2 New Zealand’s Quota Management System (QMS)

New Zealand’s fisheries are managed under the Fisheries Act, which established the QMS. The QMS was introduced in 1996 with the aims of conserving major fisheries stocks and helping make the seafood industry more efficient. It has given New Zealand a reputation as a world leader in sustainable fisheries management [12]. The QMS helps ensure sustainable utilisation of fisheries resources through the direct control of harvest levels for each species in a nominated geographical area. A fish species can consist of numerous geographically isolated and biologically distinct populations. Each fish species in the QMS is subdivided into separate fish stocks defined by Quota Management Areas (QMAs) [57].

The QMS controls the total commercial catch from all the main fish stocks found within New Zealand’s EEZ. New Zealand is not the first country to use quotas to manage fisheries, but it is the first to use them on such a broad scale across multiple species. Most countries manage fisheries by controlling inputs, such as the number of boats, the size of boats, mesh size of the nets and so on [51], whereas New Zealand manages its fisheries by assessing the population size of all species within the QMS in their major fishing grounds (QMA’s), and setting an annual Total Allowable Catch (TAC) limit for each species group independently [57]. The TAC includes a quantity of stock set-aside for customary or recreational fishers, as well as a Total Allowable Commercial Catch (TACC). The TAC is set conservatively, so that enough fish remain to maintain breeding future populations [12]. Setting and adjusting TAC to limit annual catch is the primary mechanism for managing fisheries in New Zealand [53].

New Zealand currently has 100 species (or species groupings) subject to the QMS, which are divided into 636 separate stocks (regional areas specific to each species) [57]. QMAs for a species are determined when that species is introduced into the QMS, and are based on a combination of biological and administrative factors at the time of introduction. The New Zealand EEZ is divided into 10 areas, each known as a Fishery Management Area (FMA),

see Figure 2.1, and these are the starting points for determining QMA boundaries for each species. FMAs are based on likely stock boundaries as well as administrative considerations. The standard FMAs are the basis of QMAs for most fish stocks [57].

Figure 2.1: General Fisheries Management Areas in New Zealand

As an example Figure 2.2 shows the QMAs for Snapper and Pāua. The FMA that includes the Kahungunu Rohe is FMA2. Therefore, the QMA for Snapper and Pāua that includes the Kahungunu rohe are SNA2 and PAU2, which is the species stock code followed by the QMA number. Both of these areas are highlighted in Figure 2.2.

(a) Snapper QMAs

(b) Pāua QMAs

Figure 2.2: Quota Management Areas for Snapper and Pāua

The QMAs in FMA2, for the species this research focuses on (explained in Chapter 5) are:

Rock Lobster and Shellfish

- CRA4(Rock Lobster)
- PAU2 (Pāua)
- SUR2 (Kina)

Finfish

- FLA2 (Flatfish)
- GUR2 (Gurnard)
- KAH2 (Kahawai)
- RCO2 (Red Cod)
- SNA2 (Snapper)
- TAR2 (Tarakihi)
- TRE2 (Trevally)

It is important to note that while the general FMAs are the basis for QMAs, as biological features and stock boundaries change from species to species, there is a different QMA for each species. The QMA for each individual species this research focuses on are discussed in Chapter 5.

While most species in the QMS are managed independently, sometimes groups of species are considered together for management purposes. These groups tend to be either groups of similar species that are caught together or where identification or differentiation by fishers is difficult [57]. One example of this is the QMS stock Flatfish, which includes seven different species within a defined QMA, which is one of the target species groups in this research.

Under the QMS, the Minister of Fisheries is responsible for ensuring that fishstocks are maintained at or above a level that can produce the Maximum Sustainable Yield (MSY). MSY reflects the greatest yield that can be achieved over time while maintaining a stock's

productive capacity, having regard to the population dynamics of the stock and any environmental factors that influence the stock [57].

In 2010, there was sufficient information to report on the status of 119 stocks or sub-stocks out of a total of 633 stocks managed under New Zealand's Quota Management System. Of the 119 stocks or sub-stocks with known status, 82 (69%) have been determined to be at or above their management targets based on a recent assessment up from 79 (67.5%) one year previously [58].

In 2010, 14 stocks were considered to be overfished: southern bluefin tuna (a highly migratory species over which New Zealand has limited influence), three stocks of black cardinalfish, six stocks or sub-stocks of orange roughy, and one stock or sub-stock each of Pāua, Rock Lobster, scallop and Snapper. Rebuilding programmes involving TAC or TACC reductions are in place in all these fisheries to allow them to rebuild to target levels [58].

Note in addition to QMA's for each species New Zealand's EEZ is also divided into Statistical Areas, which are also used for information collection management purposes. Figure 2.3 shows the general statistical areas in New Zealand. Note Rock Lobster and Pāua have different statistical areas, see Figure 2.4 and 2.5.

Figure 2.3: Statistical Areas in New Zealand

Figure 2.4: Pāua Statistical Areas in New Zealand

Figure 2.5: Rock Lobster Statistical Areas in New Zealand

2.3 Commercial Fishing

An Individual Transferable Quota (ITQ) is the right to harvest a defined amount of a stock (percentage by weight of the TACC) in a QMA during one fishing year. ITQ is a percentage of TACC, but ACE is an actual amount (in kg) that the ITQ corresponds to. For example if someone holds ITQ for 6% of the TACC for a particular fishstock, they hold the right to harvest 6% of that fishstock's TACC [12]. Quota shares, or ITQ, generate an amount of Annual Catch Entitlement (ACE) for each fishstock at the beginning of each fishing year. This means that each person who owns quota shares will be allocated an amount of ACE in kilograms at the beginning of each fishing year, which may change, depending on if there is a stock assessment that alters the the TACC volume. There are 100 million quota shares for each quota stock, and ACE is allocated as a proportion of that [13]. ITQ can be transferred to another person or company through sale, which could involve a multiple year sale.

In most fisheries the only requirement before commercially fishing in New Zealand is that a fisher hold a valid fishing permit [45]. Permit holders must report their catch and are required to obtain ACE to cover their catch, which can be obtained either before or after the fish is caught. If a fisher catches fish and they do not have ACE for their catch, they can either purchase ACE or they must pay the appropriate deemed value, a price paid per kilogram of catch. Usually the deemed value is set at a level higher than the value of the catch and is designed to encourage fishers to obtain ACE to cover catch. This means fishers are able to obtain ACE before they go fishing, obtaining it after they have taken the catch, or pay the deemed value to cover their catch. A monitoring process is set in place to ensure that landed catches are always matched against someone's quota to prevent a species' TACC from being exceeded [12].

The deemed value acts as the primary deterrent to fishers taking catch they will not be able to cover with ACE. If a deemed value is not paid, a fisher's permit is suspended and fishing without a valid permit is a serious criminal offence [45]. Note if the deemed value is set at a price that is more profitable for a fisher to pay, a fisher is able to sell fish caught without ACE, and pay the deemed value. The deemed value usually increases with the amount of fish harvest to deter fishers harvesting large amounts without AVE to cover their catch. For stocks listed in Schedule 8 of the Fisheries Act 1996, all commercial fishers must hold the minimum amount of ACE specified in Schedule 8 for that stock before they go fishing.

2.3.1 Māori role in Commercial Fishing

As part of a Treaty Settlement Māori were provided with a stake in commercial fishing. When the QMS was introduced in 1986 the government subsequently bought back 10% of the quota shares it had allocated to fishers based on their prior catch history and passed this to the then Treaty of Waitangi Fisheries Commission, for the benefit of Māori. In 1992, when a final settlement was agreed to, the government also provided Māori a cash settlement that was used to buy half of New Zealand's biggest fishing company - Sealord, and provided that 20% of the commercial quota shares of any new species brought into the QMS would be allocated to Māori [49]. Māori now control or influence more than 30% of New Zealand's commercial fisheries [49]. This only includes Commercial fishing, and is independent from Māori Customary fishing rights.

2.4 Recreational fishing

The basic legal right underpinning recreational fishing is an access right for all people to go fishing for personal use. Recreational interests are recognised in the Fisheries Act, which establishes an allowance for total recreational take within the TAC, and provides for consultation with recreational interests before setting or varying a TAC or TACC [44].

The public access right is subject to restrictions under the 1983 Ameture fishing regulations. At an individual level recreational fishing is managed through daily bag limits and a range of method restrictions, size limits, and seasonal closures. Recreational catch cannot be sold and there are no reporting requirements for recreational catch [44].

Charter fishing vessels are also included in the recreational fishing category because they do not sell their fish, but rather provide transportation services for recreational fishers [44]. In 2009 the government decided to create a register of charter vessels and operators, and to put in place an activity and catch reporting system. This now means charter vessels are required to report to the Ministry of Fisheries. This is the only type of recreational fishing in New Zealand that currently requires reporting.

2.5 Customary Fishing

This section describes customary fishing in New Zealand.

2.5.1 Customary fishing historically

Fisheries have always been important to Māori. Fishing provided food, a tradable commodity and a way of showing mana (respect to visitors) [46]. Before the arrival of Europeans the resource was managed by small hapū groups. Harvests were seasonal and rotational, relying on whatever species were prevalent and fish were preserved using traditional methods such as drying, smoking and preserved in fat. Eels (tunā) were an important source of protein and these resources were often traded with inland hapū for other resources.

Māori have many traditions related to harvesting and eating kai moana, including collecting it quietly, not eating it while you are still in the water, saying a karakia (prayer) before harvesting, knowing when to harvest for example it is said Kina are sweeter and fatter when the Pahutukawa species tree is in bloom (anecdotal evidence).

Rāhui is also a customary tool used by Māori, historically and today, to prohibit the use of a resource. This is described in Section 2.5.4.

2.5.2 Customary fishing changes: 1840 - today

When the Treaty of Waitangi was signed in 1840, it guaranteed Māori (collectively or individually) ‘undisturbed possession’ of their fisheries for as long as they wish. As New Zealand’s government began to introduce British common law it began to regulate the use of these resources. The QMS introduced a commercial practice based on property rights and the rights of Māori eroded through legislation [46]. However, Māori never gave up possession of their fisheries rights. Māori disputed these changes in the High Court and this led to one of the largest indigenous rights claims in New Zealand’s history [46]. After years of negotiation, in 1989 an interim agreement was reached and customary fishing was split into customary, commercial and recreational components.

In 1989, the first part of the commercial settlement saw the government attempt to buy back 10% of the quota shares it had allocated to fishers, which it passed over to the Waitangi Fisheries Commission [46]. In 1992 a full and final settlement of Māori commercial fishing

claims under the Treaty of Waitangi was agreed upon, known as the then Treaty of Waitangi (Fisheries Claim) Settlement Act. This included a cash settlement that was used to buy half of Sealord, New Zealand's biggest fishing company, and also included provisions for 20% of all new species brought into the quota system [72].

Customary Non-commercial rights were also addressed in 1992. It was based on the Crown introducing legislation that would allow for regulations that would recognise and provide for customary food-gathering and the special relationship between Tāngata whenua and places of importance to them for gathering kaimoana [46]. This led to the The Kaimoana Customary Fishing Regulations 1998 and The South Island Customary Fishing Regulations 1999, regulations that aim to recognise the control Tāngata whenua traditionally had over fishing practices and their significant fishing areas, and attempt to allow for this to continue today.

After 1992 there were disputes among Māori over the allocation of commercial assets amongst Iwi. Eventually this was settled and resulted in the Māori Fisheries Settlement Act in 2004 that formalised the settlement between the Crown and Iwi for commercial fisheries, including a final procedure for allocation of commercial fisheries assets among Iwi.

As part of this process the Treaty of Waitangi Fisheries Commission was reconstituted as Te Ohu Kaimoana Trustee Limited to manage all Māori commercial fishing settlement assets and to allocate Iwi assets held in trust through the interim 1989 and final 1992 Fisheries Settlements. Some of the settlement assets have been allocated and transferred to individual Iwi while others remain under the management of Te Ohu Kaimoana until the remaining Iwi have met the requirements of the Māori Fisheries Act 2004.

Today Iwi control or influence more than 30% of New Zealand's commercial fisheries. Although Māori commercial fishing assets were received as a result of traditional practices, it is not referred to today as customary fishing, rather it is more commonly described as Māori involvement in commercial fishing.

2.5.3 Customary fishing today

Today many components of what was once traditional customary fishing have been incorporated into New Zealand law, and allowed for in TAC allocations. As mentioned, traditional customary fishing included using kaimoana to barter and sell, fishing for everyday use and

special occasions such as hui, tangi and weddings, and also for management and protection of the resources. Today these traditional practices have been split into two separate components: Māori commercial fishing and Māori non-commercial fishing, which includes customary management. The right for Māori to harvest kaimoana for day-to-day use, to harvest for special occasions or hui, or to harvest kaimoana that is outside of recreational restrictions for customary purposes, is known as Māori non-commercial customary fishing and is referred to in this research simply as customary fishing. Māori commercial fishing is distinguished from other types of commercial fishing as there are trade restrictions on settlement quota which can only be traded with other Iwi or Te Ohu Kaimoana Group.

Customary fishing regulations allow Māori to catch fish for special occasions and day-to-day use. The Kaimoana Customary Fishing Regulations 1998 and The South Island Customary Fishing Regulations 1999, stem from the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 and are the main pieces of legislation that allow Tāngata whenua to manage their fisheries [55], [59].

To use these regulations Māori first have to obtain a permit. It is important to note that the customary fishing regulations do not remove the right of Tāngata whenua to catch their recreational limits under the amateur fishing regulations, therefore, Māori are free to exercise their recreational fishing rights, along with everyone in New Zealand. This means day-to-day use of fisheries resources are usually caught using these recreational rights, as no permit is required. Customary permits are usually sought and issued when the amount of kaimoana needed is more than the daily recreational bag limit, or when recreational restrictions prevent a resource being caught that is essential for customary purposes. For example catching small Pāua that would otherwise be undersized to give to tamariki (children) when they are teething, a common traditional practice amongst Māori. This is important to keep in mind throughout the results of this study. Currently there is no measure of the amount of customary fishing as a whole, as it is likely the majority of Māori fish using recreational rights, and currently there is no way to measure this activity (see Table 6.17). In this study we therefore define customary catch as that catch caught on customary permits.

The Kaimoana Customary Fishing Regulations 1998 is the specific piece of legislation that allows Kaitiaki to manage their fisheries resources, including issuing customary fishing permits. Once a rohe moana area has become gazetted, Iwi and hapū groups first decide who will act

as guardians for the area, known as Tāngata Tiaki/Tāngata Kaitiaki, or Kaitiaki for short. They then need to be appointed by the Minister of Fisheries and are able to issue customary permits and make decisions relating to the customary management of fisheries in their rohe moana, or gazetted area, explained below.

The Kaimoana Customary Fishing Regulations 1998 only relate to areas that have been gazetted. Figure 2.6 shows the current rohe moana in New Zealand. Note that Ngāti Kahungunu has a significant amount of their rohe gazetted, and a large number of gazetted areas in the North Island belong to Ngāti Kahungunu.

Once the Minister of Fisheries appoints a Kaitiaki, that person is able to issue permits to allow for customary fishing. At the end of each quarter each Kaitiaki aggregates all of the forms they have issued and report back to the Ministry of Fisheries. Reporting quarterly is a legal requirement, however, there is currently no penalty for not reporting (Personal communication with Kaitiaki).

Figure 2.6: Gazetted Rohe Moana in New Zealand [61]

Every customary fishing authorisation must specify the following information [55]:

- the date(s) when fishing is to occur
- who will be taking the fish
- species of fish to be caught
- the quantity and size limit of each species to be caught
- the fishing method for each species
- the area where fishing is to occur
- the purpose and venue for which the fish are needed
- any other matters the Tāngata Kaitiaki/Tiaki considers necessary, including what to do with any by-catch.

It should also be mentioned that while the main purpose of the Kaimoana Customary Fishing Regulations (“K-regs”) is to allow for customary fishing to continue, applying to Kaitiaki for a permit is not restricted to Māori. The principle of manaakitanga, or ‘looking after one’s neighbours’ is a major part of customary practice and if the Kaitiaki of an area decides it is appropriate to issue a customary fishing authorisation to someone who is not Tāngata whenua, then they are able to do so [55].

Regulation 27 and 27A

When an area is not gazetted, Māori can only take fish for customary purposes through Regulation 27 of the Fisheries (Amateur Fishing) Regulations 1986. These allow Māori to provide seafood at hui and other traditional gatherings, however they give no more control over their fisheries than this. These regulations were considered interim until “K-regs” were enacted.

For the time frame of this research there were no forms issued under Regulation 27 in the Kahungunu rohe, therefore customary fishing using these regulations has not been included in this research.

South Island Customary Fishing Regulations 1999

One thing to note in Figure 2.6 is that there are no gazetted areas for the Kaimoana Customary Fishing Regulations in the South Island of New Zealand. This is because the Kaimoana Fishing Regulations do not apply in the South Island. In the South Island, the Fisheries (South Island Customary Fishing) Regulations 1999 apply.

South Island Customary Fishing Regulations 1999 only apply in the South Island in an area when the Minister responsible for the regulations has confirmed the appointment of Tāngata Tiaki/Kaitiaki as notified by the Tāngata whenua for that area. If no Kaitiaki are appointed in an area customary fishing in the South Island can also take place under regulation 27 of the Fisheries (Amateur Fishing) Regulations 1986 [59].

It is important to note that while the North Island is home to many different Iwi, the majority of the South Island is made up of one Iwi, Ngāi Tahu, see Figure 1.1.

Customary management

There are three tools Kaitiaki are able to use under the Fisheries Act to allow them to manage their rohe moana. These tools are designed to give effect to the obligations stated in the Treaty of Waitangi Fisheries Claims Settlement Act 1992 to develop policies to help recognise use and management practices of Māori in the exercise of non-commercial fishing rights [60].

These tools include:

- **Mātaitai Reserves.** Tāngata whenua may apply to the Minister of Fisheries to establish a mātaitai reserve on a traditional fishing ground for the purpose of recognising and providing for customary management practices and food gathering. Commercial fishers may not fish in a mātaitai reserve, however recreational fishers can [60].
- **Taiāpure.** A taiāpure is a local management tool established in an area that has customarily been of special significance to an Iwi or hapū as a source of food or for spiritual or cultural reasons. All fishing (including commercial fishing) can continue in a taiāpure. This tool offers a way for Tāngata whenua to become involved in the management of both commercial and non-commercial fishing in their area [60].

- **Section 186 A & B Temporary Closures and Method Restrictions.** Section 186 A (North Island & Chatham Island) & B (South Island) of the Fisheries Act 1996 allows the Minister of Fisheries or the Chief Executive of the Ministry of Fisheries to temporarily close an area to fishing. The specific purpose is to provide for the use and management practices of Tāngata whenua in the exercise of their customary rights [60]. Section 186 A & B Temporary Closures are used to establish Rāhui, which is described in Section 2.5.4.

Note rāhui is a customary, traditional practice while Mātaitai Reserves and Taiāpure are relatively new concepts, created by the Ministry of Fisheries as tools for Māori to manage their fisheries resources.

2.5.4 Rāhui

A rāhui is a custom used by Māori to prohibit the use of a resource that has been used historically and today. Maxwell & Penetito [36] describe rāhui and how Māori have adapted the custom over time to suit New Zealand's changing social environment. This section is a summary of Maxwell & Penetito's article on rāhui.

The arrival of missionaries during European colonisation threatened this custom of rāhui to the point where it was deemed to be obsolete, however, Māori have changed the custom throughout time and it is still used today. Historically a rāhui could be installed either by a tohunga (an expert or skilled person) saying a karakia (prayer) or a chief or tohunga would simply state that he is placing a rāhui over an area and it would be so. There were three original uses of rāhui; to claim ownership, following the loss of life (to allow time for the tapu (sacredness) associated with a person's death to dissipate) and for replenishing resources. Today, rāhui are used following the loss of life, to replenish resources and for religious purposes. They are only used to protect a fraction of the original resources they were once employed to protect and, when installed following the loss of life, are put in place for much shorter periods of time. Note rāhui can be used to protect any resource including marine and freshwater kai moana, as well as resources on land.

Rāhui today can be grouped into two types, voluntary rāhui, where local Iwi voluntarily restrict kai moana gathering to replenish the mauri (life essence) of a resource, or temporary closures. The Ministry of Fisheries has introduced temporary closures/method restrictions,

to legislation. Section 186A (North Island) and Section 186B (South Island) of the Fisheries Act 1996 allows the Minister of Fisheries to temporarily close an area to fishing, or to restrict a method of fishing, in order to provide for the use and management practices of Tāngata whenua in the exercise of their non-commercial fishing rights. This legislation is designed to help Kaitiaki manage their fisheries resources in areas where there may be local depletion of fisheries resources which may be affecting the ability of Tāngata whenua to catch fish for customary purposes. The current Minister of Fisheries is the only person who can install these temporary closures, based on anyones recommendation, so long as they have the support of the majority of the community.

Chapter 3

Review of literature

This literature review is in two parts. Firstly, I review the relevant literature of similar work in New Zealand. The second section will give an overview of customary fishing and customary marine management in other areas of the world, with specific examples from New Zealand's closest neighbours.

3.1 Similar work in New Zealand

There have been no studies in New Zealand that estimate total catch using all forms of fisheries harvest, including commercial, recreational, customary and illegal harvest. However, there has been one study by Miller and Abraham (2011) [38] that is similar to this research in that customary harvest information from Kaitiaki has been used, however, it differs from this research as the purpose of the study was to specifically characterize the New Zealand Kina fishery. It was also conducted in different QMA's in New Zealand [38], and is therefore not comparable to this study. The study by Miller and Abraham (2011) summarised dive and dredge Kina fisheries for 20 fishing years, from 1989/90 to 2008/09. They found the Kina fishery in New Zealand currently harvests around 750 tonnes of Kina per year, compared with a Total Allowable Commercial Catch (TACC) of 1147 t. A small amount of Kina by catch (an average of less than 5 t per year) is reported from fisheries targeting other species. The Kina industry is small, with 75% of the catch in the 2008/09 fishing year being harvested by nine vessels. Since the introduction of Kina into the QMS, the number of vessels fishing for Kina has decreased, and the average catch per vessel per year has increased. They also noted that recreational harvest of Kina have not been well quantified but a diary survey in

2000 suggests that for SUR1, 2, 8, and 9, this could comprise a large portion of the total harvest. The report concluded that the commercial Kina fishery should be monitored at a smaller spatial scale than currently occurs.

Since 1991, there have been a number of regional and national marine recreational fishing surveys carried out by the Ministry of Fisheries to estimate the harvest by recreational fishers in New Zealand. The Ministry of Fisheries has completed regional surveys in 1991-92 and 1993-94 (Tierney et al. 1997), and two national marine recreational fishing surveys (NMRFS), one in 1995-96 (NMRFS 1996) and the other in 1999-2000 (NMRFS 2000), as well as a follow up survey to the 1999-2000 survey in 2000-2001. This research will use the estimated harvest amounts and the methods used for the NMRFS's are described in Section 6.2.1.

3.2 Customary fishing outside New Zealand

Marine ecosystems and their resources are an essential part of the culture and tradition in coastal areas throughout the world, and in many cases they are essential to the livelihoods of the people living in those areas. Fisheries management is becoming even more important because of the economic, technological and environmental changes occurring as well as changes in the traditional use of marine resources [17]. Ruddle (2000) [67] refers to numerous examples of successful projects based on customary ecological knowledge and practices in tropical marine environments, such as species location, taxonomies, limited entry, seasonal and area closures, seasonal, spatial, gear and size restrictions, appropriation rights, stock assessments based on aggregating breeding stock, impact assessments, mapping, and local hydrography. In the past century, as legislative systems have begun to incorporate environmental laws, the question of integrating customary concepts and practices into the Western legal framework has come to the attention of many researchers and resource managers [27].

This section aims to give a summary of customary fishing and customary marine management in some of New Zealand's closest neighbours including New Zealand's dependent territories; The Cook Islands, Niue and Tokelau, as well as in Fiji, Australia and New Caledonia. A summary of the legislative framework surrounding the use and management of the marine resources in each area are identified and historical customary fishing and marine management techniques are compared with customary fishing and marine management techniques used

today, similarly to what has been given in Section 2.5 for New Zealand.

3.2.1 Pacific

The Indigenous peoples of the South Pacific have a strong connection with the sea, which extends from reliance on ocean resources for food and livelihoods to deeply rooted cultural practices involving the use of marine fauna and flora for ceremonies and celebrations [71]. Management of the marine environment to ensure sustainable use is perhaps more important for the Pacific Islands and other island nations than elsewhere as marine resources provide the local people with their main source of food and livelihood [71].

Polynesian cultures have a great amount of indigenous knowledge relating to fisheries management, which can be seen in the traditional marine management techniques that are still being used today. For example no take areas: taboo in Fiji and Kiribati, Ra’ui in the Cook Islands, and Rāhui in New Zealand and the islands of eastern Polynesia such as Moorea and Tahiti [31, 37]. Various forms of marine management based on traditional knowledge were in place throughout the Pacific pre-colonisation but in the past have often been dismissed by colonisers (Barclay 2001). However over the last 20 years they are receiving more attention and are being implemented more and more throughout the Pacific [31]. Pacific communities have traditionally used resource management techniques similar to those used by modern fisheries managers, including gear restrictions, seasonal restrictions, area restrictions, species restrictions, size limits and ownership of marine resources [9, 8]. These practices are also known as traditional management, taboos, customary management, and local management. These forms of management were traditionally rooted in ceremonies, religion, dietary restrictions, and other traditions, rather than explicitly carried out for conservation [9]. Today, communities spread widely throughout the Pacific are rising to the challenge of marine conservation and are adapting their traditional practices to fit contemporary circumstances [31].

One form of traditional management common in the Pacific Islands is Customary Marine Tenure (CMT), which is an agreement where individuals, groups or communities are recognised by local or customary laws as having ownership over a marine area and as such are given the right to access, and enforce rules of use, in that area [8]. CMT is most common in Japan, Melanesia, Polynesia, Micronesia, Indonesia and Australia and contrasts to the open-access system by which marine resources are governed in most Western societies [8].

Marine tenures are commonly referred to as a form of traditional management as they can exclude outsiders from accessing marine resources. It is widely agreed that CMT, as found in Pacific Island communities, holds valuable lessons for tropical fisheries management elsewhere. It is also argued that CMT should play a pivotal role in contemporary fisheries management in the Pacific [15].

3.2.2 New Zealand's dependent territories

The Cook Islands

New Zealand and the Cook Islands have a special relationship founded on close historical ties, unique constitutional arrangements and a common citizenship and currency. The Cook Islands became a dependent territory of New Zealand in 1901 when it was annexed. In 1965 the Cook Islands adopted a Constitution enabling self-government in free association with New Zealand. Free association is a status distinct from that of full independence in that it allows the Cook Islanders to maintain New Zealand citizenship, while the territory administers its own affairs [63].

Coastal fishing is carried out for mainly subsistence purposes except in those places where there are markets (such as Rarotonga and to a lesser extent, Aitutaki) or relatively easy access to those markets (e.g. Palmerston) [17]. Management of the marine environment has been practised in the Cook Islands since the ancestors of the present Polynesian populations inhabited these islands and has been important because of the small land areas and limited resources available [17].

Today the Marine Resources Act 1989 is the basis of the Cook Islands management framework for the utilization and management of their fisheries resources. There is no reference made in the Act to the use of CMT or traditional knowledge as a basis for management measures or regulations, however there is opportunity within the Marine Resources Act to formalize traditional fisheries management arrangements. The most significant features of the Marine Resources Act, in terms of incorporating customary management techniques in the management of the marine environment, are the provisions relating to designated fisheries, local fisheries committees and the establishment and functions of the Island Councils [15]. These features are briefly explained as follows:

Designated Fisheries In accordance with the Marine Resource Act 2005, a fishery can be declared a designated fishery if it is important to the national interest and requires management measures for ensuring sustainable use of the fishery resource. Formal management plans have been prepared for such important coastal fisheries, including those for parrotfish on Palmerston and for trochus on Aitutaki [17].

Local Fisheries Committees The Secretary may appoint a Local Fisheries Committee in any island to advise on the management and development of fisheries in relation to that island.

Functions of the Island Councils Each Island Council may recommend the promulgation of by-laws in respect of any designated fishery. The Minister must officially approve all by-laws.

These features provide the opportunity for modern fisheries management to be influenced by CMT and other customary management techniques, through Island Councils, which are most likely to comprise traditional leaders [15]. This can be seen from the establishment of Ra'ui by Island Councils and the by-laws that have been applied by Island Councils. Regardless of the lack of formal recognition in Cook Island law, island custom and traditions are part of the social structure of society and influence every day life for Cook Islanders [15].

The Ra'ui today is described as a traditional form of community-based resource management that has similarities to marine reserves whereby the harvesting of marine species in an area is prohibited for a designated period [15]. The Ra'ui of Rarotonga are a series of relatively small, new, traditionally managed marine protected areas (MPAs) [37]. Traditional societies of the Cook Islands had a complex system of marine and land tenure that allowed enforceable control over the use of land and sea. The customary prohibition known as a Ra'ui was one example of such control [17] and today the Ra'ui is the most common example of customary marine management in Rarotonga. Traditionally Ra'ui was often used to prevent taking fish, in order to preserve and accumulate supplies for a coming ceremony [15]. The use of Ra'ui in the Cook Islands decreased towards the end of last century, with the last Ra'ui on Rarotonga used sometime in the early 1970s [27]. However in 1998, the Koutu Nui (council of traditional leaders) reinstated Ra'ui to protect declining stocks in the lagoons, which was the first step to improve the inshore marine environment surrounding Rarotonga [27, 37]. Currently Ra'ui have no legal basis in the Cook Islands and rely on respect for traditional

authority and customs [17, 15, 37].

Niue

New Zealand and Niue have a special relationship founded on close historical ties, unique constitutional arrangements and a common citizenship and currency. Niue became a British protectorate in 1900 and was annexed by New Zealand in 1901. In 1974, similarly to the Cook Islands, the people of Niue adopted a Constitution providing for full self-government in free association with New Zealand, a status distinct from that of full independence in that it allows the people of Niue to maintain New Zealand citizenship, while administering their own affairs [63].

Vunisea, 2005 [73] gives an account of Community-based fisheries management in Niue:

“Most natural resources are customarily owned. Land is family owned, and cannot be bought or sold but can be leased under long-term agreements. Fisheries resources are under general government jurisdiction, but there exist unwritten rules of fisheries resource jurisdiction and use that people have followed for generations. Coastal areas directly beyond a village are considered to belong to that village and, under traditional resource use understandings, people seek permission to fish in village fishing areas from the village elders or the village council. Fishing access agreements allowing use of these areas are not specified under any of the existing regulations.

Each of the 14 villages in Niue has an elected village council who is responsible for the decision-making authority in each village. The village councils are responsible for environmental and development issues at the community level and provide the link between the government and the people. Their current powers allow them to make decisions on resource use and management. For example, when the striped goatfish (kalowama) is in season from December through to February, village councils can impose bans on swimming in certain areas when the fish is around. There are also bans placed on certain reef or fishing areas following the death of a prominent person. Bans on other species or fishing methods can also be imposed. Implementation of such bans is usually announced on the radio for the general

public's benefit.

Traditional knowledge and skills are still used by fishers who usually go out during certain moon phases, tides and winds. Seasonal occurrences of species such as kalowama and other reef fishes, whales, shellfish and other marine species are well known. Traditional mechanisms for communal food exchange or rituals are still followed. Some customary activities such as hair-cutting and ear-piercing ceremonies require a large amount of fish and other food."

Tokelau

Tokelau has been administered by New Zealand since 1926 and is a non-self-governing territory [63]. However, Tokelau is currently moving towards free association with New Zealand, similar to Niue and the Cook Islands [22].

The limited land availability in Tokelau has meant the community is highly dependent on the marine resources of their lagoon and the surrounding ocean, and despite Tokelau being an associated territory of New Zealand and having regular transport to Samoa, the people of Tokelau remain highly dependent on their marine resources for subsistence [14]. Today Tokelau has very few commercial fisheries but there is extensive subsistence fishing by most Tokelauans on a daily basis [2].

Traditionally the isolated conditions of the Tokelauan society, limited land for population growth and warfare may have meant there was no need for marine resource restrictions due to functionally unlimited marine fisheries [31]. It appears traditional fishing gear, lack of freezers, no regular transport to Samoa, along with the inati system (a communal fishing and distribution practice) and the taupulegas (village councils) rule, enabled to a certain degree the sustainable use and management of each of the atolls limited resources [14]. However, relatively small scale resource management in Tokelau has occurred in the past through a number of methods, for example, at certain times the taupulega would temporarily restrict resource harvesting from family owned land during times of drought or after cyclones. During these times, resources are harvested and distributed communally on the taupulega's command [14]. Post-harvest rules also existed and are still in use today for sacred species, for example, turtles must be shared with the whole village [14]. Other measures have also included prohibitions on taking eggs or turtles while nesting, establishing sea turtle protected

areas, and limits on the number of turtles caught [3].

3.2.3 Fiji

Indigenous Fijians, as with most of the south Pacific island communities, have always had a powerful connection with their marine areas and have traditionally had a land and marine tenure system embedded in their culture [70, 6, 8, 71]. Under customary law the traditional owners held land and this tenure system also incorporated a complex system of ownership of coastal waters and adjacent fishing grounds, known as qoliqoli [68]. These marine tenure areas were governed by customary law and informed by traditional ecological knowledge.

Traditional Fijian society was structured into four levels. The most senior group was the vanua. From an Indigenous perspective, the concept of vanua is both physical (including the land, sea and people) and abstract, representing the whole of all people and their relationships with others, the land, spirits, and natural resources [71]. Below the vanua was the yavusa, a grouping that was connected by its beliefs in the same God and recognition of the same chief. Then came the clan (mataqali) and finally the family unit (tokatoka). Customary fishing rights were traditionally held by the yavusa or vanua, but today they are usually registered in the name of the land-owning clan (mataqali) [71]. Historically, the use of marine resources within qoliqoli (beach, lagoon and reef areas) in Fiji were governed by customary law and informed by traditional ecological knowledge. Traditional conservation mechanisms for the maintenance of marine resource stocks included tabu, or no-take zones, as well as other customary legal mechanisms including seasonal bans and temporary closures of some fishing areas, the declaration of sacred fishing grounds, control over the number of villagers allowed to harvest fish, the practices permitted to be used and the amount of fish that could be harvested [71].

Today fish and fishing are extremely important to the economy of Fiji. A large number of people are employed in the fisheries sector and fish makes an important contribution to the diet of local residents [16]. Currently the Fisheries Act 1992 is the legal framework for the management of marine resources in Fiji. Fiji's coastal waters, foreshore areas and use rights are shared under a dual ownership system in which the state owns the land beneath the sea and the Fijian clans own the right to fish for subsistence purposes in their respective qoliqoli (traditional fishing areas) (Kuemlangan, 2004). This shared ownership system has come about from Fiji's long history of issues relating to the ownership of the land. Under the

Deed of Cession 1874, Fijian land was given to Queen Victoria with the belief that the Crown would take care of it and that eventually, the chiefs of Fiji would get it back [5]. However the land has not been returned to native landowners of Fiji, which has caused conflict within the islands. The most recent Fiji coup in 2006 was partially carried out as a response by the military commander, Commodore Frank Bainimarama to three pieces of legislation being debated by the then Qarase government. One of those proposed pieces of legislation was the Qoliqoli Bill [5]. The bill proposes proprietary rights of qoliqoli areas are transferred from the State of Fiji to the qoliqoli owners, ancestral Fijians. However at present this legislation has not been passed.

Within qoliqoli, people are expected to use their own allocations, and those seeking to use areas belonging to others are expected to get permission from the owners [35]. Fishing activities in the qoliqoli for members outside of the qoliqoli are subject to a licensing and permit system under the Fisheries Act. Permits are required for any type of fishing in the qoliqoli, and licences are required for commercial fishing. However, there are exceptions: any harvester is exempt from obtaining a permit when fishing is done with hook and line or with a spear or portable fish trap which can be handled by one person. Commercial harvesters do not need a licence if they fish with a line from the shore or with a spear, or are specially exempted from the license requirement by the Minister [71]. Customary rights holders must be consulted before granting inshore permits to any harvester wishing to gain entry to the qoliqoli. A decision to grant access to any harvester must therefore first be decided at the community level [71]. Owners of customary fishing areas may also establish closed areas to preserve the resources for an intended purpose [15]. Although commercial fishing in Fiji has increased, an increasing number of customary fishing owners are now restricting the number of licences issued for fishing in their qoliqoli due to growing awareness of the need to consider the interests of all members in the use of the qoliqoli [35].

The Locally Managed Marine Areas (LMMA) is now the leading programme for facilitating the revival of traditional resource use practices in Fiji in order to improve management, ensure the sustainability of fisheries resources, and maximize benefits to local communities [71]. The LMMA network is a regional association of non-governmental organisations. It uses a community-based and participatory method of managing coastal marine areas that is designed to address ecological challenges while promoting sustainable livelihoods for the customary owners [71]. The Fiji Locally Managed Marine Areas (FLMMA) provides a national

mechanism for coordinating and supporting management of LMMA sites by communities and partner organisations. Currently there are a total of 410 qoliqoli in Fiji, 385 marine and 25 freshwater, which cross all of Fiji's coastal and inshore waters, and contribute to the livelihoods of about 400,000 customary owners [71]. Roughly half of the qoliqoli areas in Fiji are now part of the FLMMA network and the Fisheries Department of the national government has formally adopted the LMMA system, and the Ministry of Fisheries and Forests is one of the partner organisations of the FLMMA network [71].

3.2.4 Australia

Aboriginal and Torres Strait Islander people are the indigenous people of Australia and are culturally diverse and belong to many language groups. Their lives were changed irrevocably after the British claimed Australia in 1788 [21]. The history of Australian policy towards Aboriginal peoples can be divided into four principal periods: (1) initial contact, 1788-1930; (2) protected status, 1860-1930; (3) assimilation, 1930-70 and (4) integration with limited self-management, 1967 [1]. Note that these dates are not clearly defined as laws changed in different Australian states at different times.

Assimilation in Australia did not just apply to Aboriginal peoples, but to all foreign migrants as well. Aboriginal peoples and migrants were expected to give up their own heritage and adopt the culture of the majority. From 1910 until 1970, between 10 and 30 per cent of Indigenous children were forcibly removed from their families under state and federal child welfare and protection laws. The Australian Government now recognises that the separation of Indigenous children from their families inflicted profound suffering and loss on many Indigenous Australians and in 2008 Prime Minister Kevin Rudd formally apologised to Indigenous Australians for the removal of children from their families and communities [20]. In 1972 policies of assimilation were officially abandoned and self-determination theoretically became the driving policy behind Aboriginal issues in Australia [66]. From this date Aboriginal people were free to practice their culture and religion, and to speak their language, however, in some parts of Australia, the assimilation policies had meant that many people had lost much of their traditional culture. With self-determination, Aboriginal communities began a process of cultural revival whereby community members began to gather information on traditional ways from their elders and from anthropological texts and many people who learned cultural laws and practices in secret in the 1950s and 60s were able to pass on this information to other members of the community [66]. It is important to note there has never

been a treaty in Australia to recognise Indigenous Australians' rights.

Indigenous people were the first owners and managers of Australia's fishery resources [26]. For indigenous people, fishing is not only important for food and nutrition, but also for ceremonial occasions, and trade. Fishing is an invaluable component of their cultural lifestyle and is connected to the traditional responsibilities of land management and kinship [26]. In Australia, there is a long history of indigenous people managing their land and sea resources using forms of sea closures, for example fish and wildlife sanctuaries where hunting and fishing could only take place in alternate seasons [66, 26], and like many other indigenous peoples, they do not distinguish between the land and sea, and refer to them as being inseparable. Unfortunately, much of this traditional knowledge has been lost or disregarded and indigenous people were rarely involved in the management of fishery resources during the past century. [26], however, many traditional practices are still used today.

Food collecting, hunting and fishing are all important aspects of indigenous Australians' culture, and social networks are reinforced through the customary sharing of gathered food. Hunting is used as an important educational tool for teaching younger people Aboriginal law through the expression of knowledge and reinforcement of spiritual beliefs [26]. Fisheries resources are also harvested for community celebrations and Dugongs (a marine mammal) form a very important part of ceremonies in East Arnhem Land in the Northern Territory [26].

Today fisheries resources within the Australian Fishing Zone (AFZ) are managed under both Commonwealth and State/Territory legislation. The demarcation of jurisdiction and responsibilities among these various governments has been agreed to under the Offshore Constitutional Settlement (OCS), which was set up in 1979 in response to the then forthcoming declaration of the 1982 United Nations Convention on the law of the Sea. [18]. Under OCS, the states and territories have jurisdiction over localized, inshore fisheries and the Commonwealth has jurisdiction over offshore fisheries or fisheries extending to waters adjacent to more than one state or territory. The Australian Fisheries Management Authority (AFMA) is the Australian Government statutory agency responsible for the management and sustainable use of fisheries resources, however, each government has separate fisheries legislation and differing objectives [18].

Without the advantage of a treaty recognising indigenous rights Indigenous fishers in Australia

have lost their position in the fishing industry, despite the lucrative trades that existed prior to European settlement [66]. Indigenous people are a comparatively small proportion of the total Australian population. The Australian Bureau of Statistics reported an indigenous population of about 420,000 people, representing approximately 2.2% of the Australian population, in the 2001 national census (ABS, 2002). However, an estimated 37,000 indigenous people, or 91.7% of the indigenous population, aged 5 years or older and living in communities in northern Australia, fished at least once [64].

To this day, many indigenous communities maintain an active interest in the conservation, management and use of these resources, in particular; fish, crustaceans and molluscs are of major nutritional, economic and cultural importance for coastal indigenous people [26].

Modern fishing laws generally do not distinguish between indigenous fishing and recreational or commercial fishing, therefore, indigenous fishers are required to conduct their fishing activities according to the rules in place for recreational and commercial fishing communities [26]. As such, indigenous fishers are required to adhere to the relevant bag and size limits, closed areas and seasons, licences and restrictions on fishing gear and methods in force throughout Australia [26]. However, most state governments now recognise that traditional, cultural and community fishing activities have become increasingly impacted by modern fisheries laws and current fisheries legislation, in many cases, is simply not appropriate for traditional and cultural resource use. Most state governments have begun a process of consultation with indigenous community leaders to develop more appropriate fishing laws and management arrangements for indigenous Australians [26].

Although the assimilation policies were ended almost 40 years ago, many people in Australia, and in Queensland in particular, still maintain an assimilationist approach to Aboriginal issues. They believe that Australia should be one single nation with a single set of laws for all peoples, regardless of race and culture [66]. This can often cause racial issues towards aborigines, resulting in unfair treatment. For example, the following is an example of where aborigines were treated unfairly, and their traditional knowledge of their fishing grounds was exploited.

In 1995, commercial fishers approached representatives of some Aboriginal communities seeking their help as suppliers of the commercial sea cucumber species known as Sandfish.

Many Aboriginal and non-Aboriginal people believed that Aboriginal communities could gain increased financial independence by harvesting Sandfish under their own commercial licence, however, government authorities were not ready to expand the fishery because they had limited knowledge about the species [7]. A 4 year program of community-based fisheries research with Aboriginal Australians was implemented to assess the viability of indigenous Australians involvement in the wild-stock fishery. The research involved extensive and intensive indigenous participation during field survey and habitat mapping, complemented by commercial catch data modelling and discussion of its implications [7]. Field surveys produced Sandfish distribution and site-specific density, and revealed some areas that were not commercially fished. Catch data modelling results suggested that no additional catch effort could be sustained, however commercial fishers increased their effort, expanding their operations into the newly mapped areas. These actions effectively precluded indigenous peoples aspirations of entry into the commercial fishery [7].

Torres Strait Islanders

Torres Strait Islanders are referred to as a separate group from Australian Aborigines and are indigenous people who reside in Australian Northern Territories on Islands between Australia and Papua New Guinea. Seafood consumption by Torres Strait Islanders has been ranked among the highest in the world [32]. Torres Strait have a treaty between Australia and Papua New Guinea signed in 1985 and recognises indigenous offshore rights to fish [40]. It establishes a protected zone to safeguard traditional ways of life and livelihoods of traditional inhabitants, like fishing and free movement rights. As its name suggests, the treaty applies to Torres Strait Islander people only, not to Australia's other indigenous group, the Aboriginal people [40].

Chapter 4

The study site: Ngāti Kahungunu Rohe

Ngāti Kahungunu has the second largest tribal rohe by land area in New Zealand, and its coastal boundary is within FMA2. FMA2, the Central East region, extends from Cape Runaway on the top of the East Cape to Titahi Bay north of Wellington on the west coast. FMA2 supports significant commercial Rock Lobster fisheries along the Gisborne and Hawke Bay-Wairarapa coastlines, and an important Pāua fishery centered on the Wairarapa coast. The majority of the commercial finfish catch is from a mixed-trawl fishery, targeting mostly Tarakihi and Gurnard but also Red Cod, Snapper, Trevally, Blue Warehou and Flatfish. There is also a midwater trawl fishery targeting Bluenose, Gemfish and Rubyfish; a bottom long-line fishery targeting mostly Bluenose and hāpuku/bass; and a set-net fishery targeting Blue Warehou, Butterfish, and Blue Moki [62].

The Ngāti Kahungunu rohe moana spans the majority of FMA2 however other Iwi are also included in FMA2 including; Whanau a Apanui, Ngāti Porou, Rongowhakaata, Aitanga a Mahaki, Ngāi Tamanuhiri, Rongomaiwahine, Rangitane, Ngāti Toa, Te Atiawa, Muauupoko and Ngāti Raukawa, and these areas also claim mana whenua and mana moana over this area. Ngāti Kahungunu has the third largest Iwi population and the coastal boundaries, as enacted by the Deed of Settlement, and span from Paritū, north of Mahia (however the northern boundaries are currently in dispute resolution with Rongomaiwahine), to Turakirae Cape Palliser, in South Wairarapa. However, for the purpose of this research Ngāti Kahungunu boundaries are defined as stated above.

Ngāti Kahungunu has the third largest Iwi population. The 2006 NZ Census statistics show that 59,946 people or 12 percent of the Māori population, belong to Ngāti Kahungunu. This was 8394 more than at the 2001 Census. A large percentage of Kahungunu people reside outside the traditional Iwi boundaries and many more, not included in the census count, reside overseas. Figures 4.1 and 4.2 show the overall population and the Māori in Ngāti Kahungunu by meshblock for the 2006 census [74].

The majority of people live in the main centers, Wellington, Masterton and Napier. Also note the population is given for mesh blocks outside of Ngāti Kahungunu rohe too, Figure 1.1 shows the area of Ngāti Kahungunu rohe.

The geographic distribution of the Māori population within the Ngāti Kahungunu rohe, in general, is similar to the rest of the general population, and the majority of Māori also live in the main urban centres. One feature of the Māori population is the relatively large population size of Māori in Wairoa. Wairoa, in comparison to the other main centres in Ngāti Kahungunu rohe is more secluded and out of the way, which may contribute to the smaller amounts of Europeans or other cultures residing there.

Table 4.1 shows the population count for the overall population and the Māori population by territorial authority, for territorial authority in Ngāti Kahungunu rohe.

When looking at these maps it is important to keep in mind that the place where someone lives does not restrict which rohe moana they fish in, for example someone living in Masterton could quite easily fish in Pāpāuma, Hinewaka or Nga Tūmapuhiārangi and Ngāti Hamua, provided they were issued a form from the Kaitiaki in one of those rohe moana. This is common between neighbouring rohe moana (gazetted areas), for example if kai moana can't be harvested due to weather, a person may ask for a permit in a neighbouring rohe moana.

Total population by meshblock, 2006

Figure 4.1: Total population by mesh block for the usually resident population from the 2006 Census and rohe moana areas

Maori population by meshblock, 2006

Figure 4.2: Total Māori population by Mesh block from the 2006 Census and rohe moana areas

Table 4.1: Usually resident population count for the overall population and the Māori population by territorial authority, for territorial authority in Ngāti Kahungunu rohe, from the 2006 census. Source: Statistics New Zealand.

Territorial Authority	Usually resident population count, 2006	Māori ethnic group, 2006	Māori % of Territorial Authority
Wairoa District	8,481	4,797	56.56
Hastings District	70,842	16,236	22.92
Napier City	55,359	9,810	17.72
Central Hawke's Bay District	12,957	2,694	20.79
Tararua District	17,634	3,489	19.79
Masterton District	22,626	3,726	16.47
Carterton District	7,098	681	9.59
South Wairarapa District	8,889	1,089	12.25
Total	221,520	46,011	20.77

For all territorial authorities, excluding Wairoa, the percent of the population who are Māori compared to the overall population is similar, and ranges from 9.59-22.92%.

Māori residing in Ngāti Kahungunu are likely to belong to Ngāti Kahungunu Iwi, however, some Māori from other parts of New Zealand may have moved and may now reside in Ngāti Kahungunu rohe. Therefore, the percentage of Māori by territorial authority in Table 4.1 do not exactly represent the percentage of Ngāti Kahungunu Iwi members living in Ngāti Kahungunu rohe, however, it is likely most of the Māori people living within Ngāti Kahungunu are of Ngāti Kahungunu descent. Note Table 4.1 relates to ethnic group i.e which ethnic group people identify themselves as belonging to, whereas being of Māori decent is biological, and these are two different groups. For example a person of Māori decent may not identify themselves as belonging to the Māori ethnic group, which makes it difficult to quantify exactly how many people belong to each of these two groups. The figures in Table 4.1 will be used as our estimate for the number of people belonging to Ngāti Kahungunu Iwi.

4.1 History

History tells that Kahungunu and Rongomaiwahine were married five or six hundred years ago and through their children, grandchildren and great grand children, created the Iwi we know today as Ngāti Kahungunu. Since the 1830's the area from Mahia to Wairarapa has

been known as Ngāti Kahungunu ([29]).

Rongomaiwahine is currently the northern most rohe moana (gazetted area) of Ngāti Kahungunu although some members from the Mahia area have asserted that Rongomaiwahine has always maintained a separate Iwi status from the rest of Kahungunu stretching from the Nuhaka River northward to Paritū, an area that Ngāti Kahungunu has also asserted as part of the wider Iwi rohe ([29]). For the purpose of this research Ngāti Kahungunu rohe includes Rongomaiwahine but customary data was not used from this area due to the tensions mentioned.

Having such a large coastline fisheries and kai moana have always been important within Ngāti Kahungunu Iwi and this thesis has a particular focus on customary fisheries.

4.2 Rohe moana

Ngāti Kahungunu rohe has 9 rohe moana, or gazetted areas, however other areas, such as Ngāti Konohi, extend into the Kahungunu rohe moana, see Figure 4.3. This section gives background into each rohe moana individually, and aims to highlight differences and similarities between rohe moana.

Figure 4.3 shows the gazetted sub-areas (rohe moana) in the overall Ngāti Kahungunu Rohe Moana. Note that the rohe moana do overlap in places, and are not therefore exclusive partitioning of the area. Also note that some areas are not yet gazetted and customary fishing takes place in these areas under Regulation 27a, see Section 2.5.3.

Figure 4.3: Gazetted areas in the Ngāti Kahungunu Rohe Moana. Source Ministry of Fisheries (NABIS [61]).

Figure 4.4 shows the rohe moana in Ngāti Kahungunu only, with more clarity.

Note towards the end of this thesis a new rohe moana was gazetted, which is located directly to the North of Ngāi Te Ruruku o Te Rangi and is called Ngāti Pahauwera. Given this gazetted area is very new and customary data is not yet available in this area this gazetted area has not been included in this thesis, however should be considered for all future research.

Gazetted rohe moana in Ngāti Kahungunu rohe

Figure 4.4: Gazetted areas in the Ngāti Kahungunu Rohe Moana

Table 4.2 gives information on each rohe moana, its size, the number of registered/confirmed Kaitiaki, its location in New Zealand and the time frame the data for this research is available for.

Table 4.2: Information on the rohe moana (gazetted areas) within Ngāti Kahungunu rohe moana and the dates data was available for this research. Kaitiaki customary data, 2007-2010 fishing years.

Rohe moana	Size (km ²)	Registered Kaitiaki	Location	District	Data available (fishing years)
Rongomaiwahine	107500	15	Mahia Peninsula	Wairoa	NA
Ngāi Te Ruruku o Te Rangi	540	2	Hawke Bay	Napier	2008-2010
Nga hapū o Waimarama and Ngāti Hawea	26270	7 ¹	Hastings	Hastings	2007-2010
Ngā hapū o Waimārama	9190	4	Hastings	Hastings	2007-2010
Kairakau Lands Trust	12730	5	Pourere	Napier	NA
Ngāti Kere	1930	9	Porangahau	Napier	2006-2010 ²
Te Hika o Pāpāuma ³	1607	5	Owhanga/Whareama/ Mataikona/Poroporo	Tararua	2006-2010
Ngāi Tūmapuhiārangi, Ngāti Hamua	1190	6 ⁴	2009-2010		
Ngāti Hinewaka me ōna Karangaranga	3630	8	South Wairarapa	South Wairarapa	2007-2010

¹4 from Waimarama, 3 from Ngāti Hawea

²No data was collected for the 2007 and 2008 calendar years

³Te Hika o Pāpāuma is split into two areas, which overlap (see figure 4.4). The size of the area that overlaps between the two areas is 620km². The details for northern and southern areas are shown in Table 4.3

⁴4 from Ngāi Tūmapuhiārangi, 2 from Ngāti Hamua

Note that there are two gazetted sections, both part of the rohe moana Te Hika o Pāpāuma. Table 4.3 give details for northern and southern areas of Te Hika o Pāpāuma.

Table 4.3: Information on Te Hika o Pāpāuma rohe moana (North and South) and the dates data was available for this research. Kaitiaki customary data, 2006-2010.

Rohe moana	Size (km ²)	Registered Kaitiaki	Location	District
Te Hika o Pāpāuma (North)	627	2	Owhanga/Whareama	Tararua
Te Hika o Pāpāuma (South)	980	1	Mataikona/Poroporo	Tararua

For all rohe moana the main species caught throughout the study period (2007 - 2010 fishing years) are Rock Lobster, Pāua, Kina, Mussels and Pipi. Occasionally other species are caught using customary allowances including Kahawai & other finfish, and Paddle Crabs. This research focuses on customary harvest of Rock Lobster, Pāua and Kina only, as these are the main Kai Moana species issued over all gazetted areas, and these species are of high cultural importance for the whole Iwi.

Chapter 5

Species

This chapter first identifies all species that are used in the research. A picture of each species is then given along with an individual map showing each species QMA boundaries, which also highlights the QMA specific to this research. Biological information and any restrictions related to the catch of each species, for example size, method or quantity restrictions are then given along with commercial catch for each species, which includes the amount of commercial catch by fishing year of each species in its relevant QMA, alongside the corresponding TACC and the total catch of each species nationally. This aims to give the reader a basic understanding of each species and its importance commercially, as well as an idea of the level of commercial fishing taking place within the relevant QMAs in comparison to New Zealand as a whole.

The commercial catch information in this section has been taken from the Ministry of Fisheries information website [58], as was the biological information and fishing restrictions for each species. Direct quotations from this website and are indicated by the symbol □.

It is important to note the the commercial data used in this chapter differs from the data used to estimate harvest in this research. The commercial catch data used for this research has been obtained directly from the Ministry of Fisheries New Zealand. Two separate data sets were obtained; Catch Effort and Monthly Harvest Returns. The Catch Effort data are estimated figures based on the information of commercial fishing collected by the Ministry of Fisheries and, where available, GPS co-ordinates are given for the catch (the positions have been truncated to the nearest 0.1 degrees). They are different to the official landed/MHR (monthly harvest return) figures. MHR figures as reported in the annual plenary reports

released by the Ministry of Fisheries and are generally weighted amounts, which relate directly to ACE/Quota/TACC etc. MHR figures are only recorded by fishstock and are therefore not suitable for this research. Therefore, The Catch Effort data set will be used for this research and it is the MHR data, which is published on the Ministry of Fisheries website, that is used in this chapter.

Based on significant species within Ngati Kahungunu rohe, and species with high cultural importance, this study focuses mainly on 10 species, which are as follows:

Rock Lobster and Shellfish

Rock Lobster	<i>Jasus edwardsii</i>
Pāua	<i>Haliotis iris</i>
Kina	<i>Evechinus chloroticus</i>

Finfish

Flatfish	
Gurnard	<i>Chelidonichthys kumu</i>
Kahawai	<i>Arripis trutta</i>
Red Cod	<i>Pseudophycis bachus</i>
Snapper	<i>Chrysophrys auratus</i>
Tarakihi	<i>Nemadactylus macropterus</i>
Trevally	<i>Caranx georgianus</i>

Note: Flatfish includes the following species:

- Sand flounder (dab, white, diamond, or square flounder) (*Rhombosolea plebeia*)
- Lemon sole (*Pelotretis flavilatus*)
- New Zealand sole (*Peltorhamphus novaezeelandiae*)
- Flounder (“yellow belly”) (*Rhombosolea leporina*)
- Brill (*Colistium guntheri*)
- Turbot (*Colistium nudipinnis*)
- Black flounder (*Rhombosolea retiaria*)
- Greenback flounder (*Rhombosolea tapirinia*)

Figure 5.1 shows the QMA within Ngāti Kahungnu rohe for each species, as well as a picture taken from the Ministry of Fisheries information website [57].

(a) Kina fisheries management areas

(b) Kina (*Evechinus chloroticus*)

(c) Pāua fisheries management areas

(d) Pāua (*Haliotis iris*, *Haliotis australis* and *Haliotis virginea*)

(e) Rock Lobster fisheries management areas

(f) Rock Lobster (*Jasus edwardsii*)

Figure 5.1: Quota Management Areas by species and species identification

(g) Flatfish fisheries management areas

© NIWA

(h) Flatfish (Multiple species)

(i) Gurnard fisheries management areas

© NIWA N. Bagley

(j) Gurnard (*Chelidonichthys kumu*)

(k) Kahawai fisheries management areas

© NIWA M. Francis

(l) Kahawai (*Arripis trutta*)

Figure 5.1: Quota Management Areas by species and species identification

(m) Red Cod fisheries management areas

© NIWA M. Francis

(n) Red Cod (*Pseudophycis bachus*)

(o) Snapper fisheries management areas

© NIWA A. Blacklock

(p) Snapper (*Chrysophrys auratus*)

(q) Tarakihi fisheries management areas

© NIWA

(r) Tarakihi (*Nemadactylus macropterus*)

Figure 5.1: Quota Management Areas by species and species identification

(s) Trevally fisheries management areas

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(t) Trevally (*Caranx georgianus*)

Figure 5.1: Quota Management Areas by species and species identification

Table 5.1 shows the harvest allowances by species for the different types of fishing for the current fishing year, 2011. Each species allowance is explained in more detail in Sections 5.1 and 5.2.

Note that the allocation of the TAC for Pāua is not separated between the different types of fishing like most other important customary and recreational species.

Note a large portion of the Kahawai and Tarakihi commercial, recreational and customary harvest is allocated to FMA2 and a large portion of Rock Lobster customary and recreational harvest is allocated to FMA2. Flatfish and Gurnard are also relatively important commercial species in FMA2.

There is no customary or recreational allowance set for Trevally outside of FMA2.

Table 5.1: Harvest allowances by species for the different types of fishing in 2011. For example in 2011 14.8% of the total allowance (TAC) made for Rock Lobster in FMA2 (CRA4) was allocated to commercial fishing. Source: Ministry of Fisheries [58].

	Commercial allowance		Customary allowance		Recreational allowance		Other sources of mortality	
Species	FMA2	% of NZ total	FMA2	% of NZ total	FMA2	% of NZ total	FMA2	% of NZ total
Rock Lobster	415625	14.8	35000	22.5	85000	25.8	75000	25.5
Kina	80000	7.0	60000	14.9	60000	18.5	4000	14.8
Pāua	121188	11.4	0	—	0	—	0	—
Flatfish	725,900	13.4	0	—	0	—	0	—
Gurnard	725,462	14.0	0	—	0	—	0	—
Kahawai	556,620	20.4	185000	30.0	610000	26.6	30000	26.1
Red Cod	500,018	6.0	0	—	0	—	0	—
Snapper	315000	5.0	14000	19.2	90000	2.9	31000	5.1
Tarakihi	1,796,000	27.9	100000	53.2	150000	23.0	36000	28.2
Trevally	241,263	6.1	1000	100.0	100000	100.0	7000	100.0

5.1 Rock Lobster and Shellfish

5.1.1 Kina

Kina is found throughout New Zealand and the sub-Antarctic Islands and are found on rocky substrates to depths of up to 50 m. Kina is herbivorous and competes for food with Pāua. The growth of Kina varies regionally but can grow larger than 100 mm in diameter. Kina have a maximum age of at least 20 years and the size at maturity varies from 30 mm to 75 mm. Spawning takes place annually from November to March ☐.

There is no MLS for Kina but the recreational daily bag limit is no more than 50 taken on one day ☐.

(a) SUR2A

(b) SUR2A

(c) SUR2B

(d) SUR2B

Figure 5.2: Commercial catch of Kina in SUR2A and SUR2B shown with the corresponding TACC allowance (a,c), and the total Kina catch in New Zealand (b,d), by fishing year.

Note the commercial catch of Kina within SUR2B is relatively low compared with the total New Zealand harvest such that it does not show up in the graph.

5.1.2 Pāua

Pāua inhabit shallow waters (generally less than 6 m) off the coastline of New Zealand. Pāua are broadcast spawners that reach maturity at a length of 93-133 mm and inhabit reefs in shallow subtidal water around New Zealand. Pāua are herbivores that can form large

aggregations on reefs in shallow subtidal coastal habitats. Movement is over a sufficiently small spatial scale that the species may be considered sedentary □.

The MLS for Pāua across all sectors of fishing is 125mm. The recreational daily bag limit is no more then 10 taken on one day and as well as this, no person may possess more than 20 Pāua at one time □.

Figure 5.3: Commercial catch of Pāua in PAU2 shown with; the corresponding TACC allowance (a), and the total Pāua catch in New Zealand (b), by fishing year

5.1.3 Rock Lobster

Red Rock Lobster are found all around New Zealand and are slow growing and long lived. Red Rock Lobster females reach maturity at 60-120 mm carapace length. Spawning occurs after moulting in autumn. The MLS for red Rock Lobster in CRA4 is 60 mm Tail Width (TW) for females and 54 mm TW for males. The daily bag limit for Rock Lobster is no more than 6 taken on one day ☐.

The following types of Rock Lobster are protected by law and must be returned immediately to the water:

- Undersized Rock Lobsters.
- Any female Rock Lobster carrying external eggs (these are carried between the pleopods on the underside of the tail).
- Any Rock Lobster in the soft shell stage.
- Any Rock Lobster that cannot be measured (e.g. because of damage to the tail preventing accurate measurement).

These restrictions apply to Rock Lobster across all sectors of fishing ☐.

Commercial

Figure 5.4 shows the QMA's for Rock Lobster in New Zealand. The area this study focuses on is CRA4.

Figure 5.4: Commercial catch of Rock Lobster in CRA4 shown with; the corresponding TACC allowance (a), and the total Rock Lobster catch in New Zealand (b), by fishing year

Note the TACC was reduced in the 2010 fishing year.

5.2 Finfish

In the Central Fishery Management Area there is a combined daily bag limit for recreational fishers of 20 finfish, consisting of any combination of:

- Blue cod
- Elephant fish
- Kahawai
- Red gurnard
- School shark
- Blue moki
- Flatfish
- Parore
- Red moki
- Tarakihi
- Bluenose
- Grey mullet
- Porae
- Red snapper
- Trevally
- Butterfish
- John Dory
- Red cod
- Rig

There is no limit on species not named above ☐.

5.2.1 Flatfish

Flatfish are shallow water swimmers found in inshore areas such as estuaries, mudflats, and sand flats. Flatfish are shallow-water species, generally found in waters less than 50 m depth. There are eight species of flatfish; Yellow-belly Flounder, Sand Flounder, Greenback Flounder, Lemon Sole, NZ Sole, Brill, and Turbot. Flatfish move offshore for first spawning at 23 years of age during winter and spring ☐.

Figure 5.5: Commercial catch of Flatfish in FLA2 shown with; the corresponding TACC allowance (a), and the total Flatfish catch in New Zealand (b), by fishing year

5.2.2 Gurnard

Red Gurnard are found throughout New Zealand coastal waters at depths of 10-200 m. They feed on shellfish, crustaceans, and crabs and can grow to a maximum length of 55 cm with

females growing faster and larger than males. Red Gurnard have a maximum age of 16 years. They reach maturity at 23 cm in length and 2-3 years of age. Spawning occurs in spring-summer. Maximum age is about 16 years and maximum size is 55+ cm □.

Figure 5.6: Commercial catch of Gurnard in GUR2 shown with; the corresponding TACC allowance (a), and the total Gurnard catch in New Zealand (b), by fishing year

5.2.3 Kahawai

Kahawai are mostly found north of Cook Strait at depths to 150 m. They feed on other fish, crustaceans and copepods. Kahawai reach a maximum length of 79 cm. They reach maturity at 39-40 cm in length, corresponding to about 4 years old. Kahawai grow rapidly, attaining a length of around 15 cm at the end of their first year, and maturing after 3 to 5 years at about 35 to 40 cm, after which their growth rate slows. The maximum recorded age of kahawai is 26 years □.

Kahawai are highly prized by some recreational fishers, who employ a range of shore and boat based fishing methods to target and/or catch the species. The regulatory restrictions on recreational fishing for kahawai are the multi-species bag limit of 20 fish and a minimum set net mesh size of 90 mm. Kahawai is one of the fish species more frequently caught by recreational fishers, and recreational groups continue to express concern about the state of kahawai stocks □. Kahawai is also a very important customary stock in FMA2.

Figure 5.7: Commercial catch of Kahawai in KAH2 shown with; the corresponding TACC allowance (a), and the total Kahawai catch in New Zealand (b), by fishing year

5.2.4 Red Cod

Red Cod are present throughout New Zealand, but are most commonly found around the South Island. They are found at depths from 0-600 m. Red Cod live over sand or muddy substrates and near rocky caves in shallow waters. Red Cod have an estimated maximum age of 6 years and reach maturity at 45-55 cm in length and 2-3 years old. Spawning differs with latitude, but mainly occurs between August and October. They can grow to a maximum length of 77 cm, though most adults are 40-70 cm $\square$.

Figure 5.8: Commercial catch of Red Cod in RCO2 shown with; the corresponding TACC allowance (a), and the total Red Cod catch in New Zealand (b), by fishing year

5.2.5 Snapper

Snapper are found in central and northern areas of New Zealand to depths of 200 m. They are one of the most abundant inshore fishes in New Zealand. Snapper feed on a range on invertebrates including crabs, worms and shellfish. Their growth varies with region, but can reach a maximum of 105 cm. Snapper have a maximum age of 60 years and reach maturity at 3-4 years old and 20-28 cm. They are serial spawners and release numerous batches of eggs throughout spring and summer ☐.

The snapper fishery is one of the largest and most valuable coastal fisheries in New Zealand and is the largest recreational fishery in New Zealand. Snapper is the major target species on both coasts of the North Island ☐.

The recreational daily bag limit for Snapper, over and above the combined finfish bag limits, is no more than 10 taken on one day ☐.

(a)

(b)

Figure 5.9: Commercial catch of Snapper in SNA2 shown with; the corresponding TACC allowance (a), and the total Snapper catch in New Zealand (b), by fishing year

5.2.6 Tarakihi

Tarakihi are found throughout New Zealand inhabiting depths of 100-500 m. They feed on worms, crabs, brittlestars and shellfish. Tarakihi have a maximum age of over 40 years and reach maturity at 25-35 cm length and 4-6 years. They can grow to a maximum length of 70 cm $\square$.

Figure 5.10: Commercial catch of Tarakihi in TAR2 shown with; the corresponding TACC allowance (a), and the total Tarakihi catch in New Zealand (b), by fishing year

5.2.7 Trevally

Trevally are commonly found around the North Island and the north of the South Island. Until the age of 2, Trevally inhabit shallow areas like bays, estuaries and harbours. They then move to reefs or open waters with depths to 150 m. They feed on planktonic organisms on the surface and a variety of crustaceans on the bottom. Trevally can reach ages of over 40 years. They have a moderate growth rate until reaching maturity at 3-5 years of age and 32-37 cm in length and they can grow to a maximum length of 80 cm. Spawning occurs over summer, with small batches of eggs released over several weeks or months □.

Figure 5.11: Commercial catch of Trevally in TRE2 shown with; the corresponding TACC allowance (a), and the total Trevally catch in New Zealand (b), by fishing year

Chapter 6

The Data

To make overall harvest estimates I have used a number of different data sources. This chapter describes the survey methodology used for each data set separately and outlines the processes used to access each data set for this research . This chapter also gives comments on the quality of each data set used.

6.1 Commercial fishing harvest

The commercial catch data used for this research has been obtained directly from the Ministry of Fisheries New Zealand. Two separate data sets were obtained; Catch Effort and Monthly Harvest Returns. The Catch Effort data are estimated figures based on the information of commercial fishing collected by the Ministry of Fisheries and, where available, GPS coordinates are given for the catch (the positions have been truncated to the nearest 0.1 degrees). They are different to the official landed/MHR (monthly harvest return) figures. MHR figures as reported in the annual plenary reports released by the Ministry of Fisheries and are generally weighted amounts, which relate directly to ACE/Quota/TACC etc. MHR figures are only recorded by fishstock and are therefore not suitable for this research. Therefore, I have used the Catch Effort data set for this research.

Note the MHR figures are given in Chapter 5 only.

6.1.1 Catch Effort data

As part of the conditions for accessing this data the following restrictions were placed on the information to protect commercial fisher privacy:

- Latitudes and longitudes must be truncated to a 1 degree (or statistical area) level of resolution;
- data must be grouped so that individual vessels or persons cannot be identified and;
- dates must be truncated to a one month level of resolution.

Also, the vessel or fisher names were not requested from the Ministry of Fisheries. The information requested was relating to the catch only, for example: location, amount, catch, species and type of fishing.

These conditions were met by taking the following steps:

- No raw data is published in this research
- To assign data to locations on maps used in this research all data has been assigned to a grid square, $0.2^{\circ} \times 0.2^{\circ}$ in size, based on the location information available. A new location is assigned to the total harvest amount for each grid square, which is the centroid of each grid square, see Section 7
- All data (once assigned to the centroid of a grid square) has been interpolated using Inverse Distance Weighting to smooth data out over the geographical area it was caught, see Section 7.
- Once maps have been created harvest increment amounts were adjusted separately for each map to ensure the data was as ‘smooth’, and as confidential as possible, see Section 13.2.

Variables in the Commercial harvest dataset are given in Table 6.1.

Table 6.1: Ministry of Fisheries catch effort variables information

Variable	Description
event key	Unique code for each fishing event
start datetime	Date and time of the start of the fishing event
end datetime	Date and time of the end of the fishing event
fishing duration	Duration of the fishing event
species code	Species Code
catch weight	Harvest weight in kilograms
target species	Species targeted for the fishing event
start stats area code	Statistical area fishing event started in
display fishyear	Fishing year
trunc start lat	Truncated latitude of fishing event starting position
trunc start long	Truncated longitude of fishing event starting position
trunc end lat	Truncated latitude of fishing event end position
trunc end long	Truncated longitude of fishing event end position
trip	Trip number for the vessel. Note there may be multiple fishing events within a trip.
primary method	Fishing method, for example bottom trawl, long line etc
trip start date	Date the vessel left port
trip end date	Date the vessel returned to port

Notes on quality

- In New Zealand commercial catch must be reported by law and there are heavy penalties for mis-reporting. This means commercial data collected by the Ministry of Fisheries is of a very high quality
- Some co-ordinates for the catch in the Catch Effort data set appear on land. The reasons for this are:
 - the positions have been truncated by the Ministry of Fisheries to the nearest 0.1 degrees and;

- Occasionally fishers do report positions which are believe to be on land, either mistakenly or, because they were indeed very close to land (i.e. in a river mouth or estuaries etc)
- Many of the fishing events only have a recorded start position. This means harvest is allocated to the start position of each event and the exact location of the harvest is unknown, for example a boat may trawl away from the starting position in any direction, or the boat may trawl in a circle ending at the start position etc.
- Many of the events have no specific co-ordinates and the exact locations are estimated

6.1.2 By-catch and fish-dumping

By-catch and fish-dumping are both important aspects of commercial fishing that should be taken into account when making total harvest estimates.

By-catch is the term used to describe fish caught unintentionally in a fishery while intending to catch other fish [34]. By-catch is not illegal as when fish (or sometimes seabirds and marine mammals) are caught it is accidental, and there are measures in place in New Zealand to minimise the risk of by-catch. For example fishing in a way that ensures that birds and marine mammals are discouraged from interacting with and are protected from the activity of fishing [34] and gear restrictions in certain areas.

Fish-dumping is the illegal practice of getting rid of less valuable fish, including small and damaged fish, from a vessels catch at sea [54]. This allows catches to be made up of more valuable fish. For example sometimes bigger fish, or different species fetch a better price, so small individuals are dumped. Damaged fish are also sometimes dumped as they are less valuable [54].

Fish-dumping is illegal in New Zealand as New Zealands fisheries are carefully managed under the Quota Management System, which sets annual limits for how much of each species can be caught so enough fish are left to breed and ensure the population will be sustainable in the future, see Section 2.2. When fish is dumped at sea without any reporting, these fish are not accounted for and are essentially over the limits set under the QMS, which puts the sustainability and future of the fishery at risk [54].

We do not make estimates for the amount of by-catch or fish-dumping, however, allowances are made for these factors in our final harvest range estimates, see Section 13.1.

6.2 Recreational fishing harvest

This section describes the survey methodology used for the recreational fishing harvest data used in this research, and outlines the processes used to access each dataset. This section also gives comments on the quality of each dataset used.

Three separate recreational surveys are used in this research. One survey is a national survey carried out by the Ministry of Fisheries (NMRFS 2000), another survey has been conducted during fishing competitions and the third survey has been conducted from boat ramps. The latter two surveys were conducted in the Hawkes Bay, New Zealand. Both are voluntary surveys, one carried out by a local boat club and the other carried by members of the public. The following sections describe these surveys.

Note a summary of all meetings I attended throughout this research can be found in Table 6.23.

6.2.1 National Marine Recreational Fishing Survey

Table 6.2 gives information on the 1999/2000 National Marine Recreational Fishing Survey (NMRFS 2000).

Table 6.2: National Marine Recreational Fishing Survey 2000 (NMRFS 2000) information

Survey	National Marine Recreational Fishing Survey 2000
Objective	To estimate the harvest of Recreational fishers in New Zealand for the main fishstocks
Target population	All recreational fishers in New Zealand aged 15 years and over
Survey population	Recreational fishers in New Zealand with a home telephone line who said they would “probably”, “possibly” or “definitely” go fishing in the next 12 months, excluding people living on the Chatham Islands.
Sponsor	Ministry of Fisheries

Table 6.2: (Continued)

Surveyor	Ministry of Fisheries (using recruited diarists)
Sample size	2500-3000 diarists
Response rate	22.5%
Survey date	1 December 1999 to 30 November 2000
Information collected	Number of fish harvested species, number of recreational fishers, average size of fish harvested
Survey design	A stratified, systematic sample was used to selected households in areas with a probability proportional to the areas size

Variables collected during the NMRFS 2000 are given in Table 6.3.

Table 6.3: National Marine Recreational Fishing Survey 2000 (NMRFS 2000) variables

Variable	Description
Species	Species
HarvestedNZ	Total estimated harvest in NZ
HarvestedFMA2	Total estimated harvest in FMA2

From 1999-2000 the Ministry of Fisheries carried out the second national recreational fishing survey in New Zealand (referred to in this research as the NMRFS 2000), with the main objective of the survey being to estimate the harvest by recreational fishers of the main fishstocks from the 1 December 1999 to 30 November 2000. This estimated harvest is used in this research.

The harvest estimates were made using four separate, but related, surveys, which included:

- A 12 month nation-wide face-to-face survey to estimate fisher prevalence.
- A telephone survey to obtain demographic data on marine recreational fishers and recruit recreational fishers for a diary survey.

- Dairies kept by recreational fishers recruited in the telephone survey over the 12-month period from 1 December 1999 to 30 November 2000, to make estimates of harvest per person.
- A boat ramp survey to estimate the mean weight of recreationally harvested fish and shellfish.

Using these four surveys the data was then weighted up (increased based on the number of recreational fishers each surveyed person represented) to make estimates of the total recreational harvest for each fishstock or species in numbers of fish or shellfish. Note the numbers of fish or shellfish estimated were rounded to the nearest 1000 and where estimated harvests for a fishstock are greater than zero but less than 500, they are given as < 500 [4]. The weighting process, described by Reilly (2002) [65] included:

- calculation of inverse probability weights, to account for the sample design and observed fisher prevalence;
- non-response adjustments, which correct bias introduced by diarist drop-out and other forms of non-response; and
- incomplete post-stratification, which adjusts for any remaining bias that are evident in the diarist database, relative to the fisher population profile.

To weight up the harvest amounts for recreational fishing in the NMRFS 2000, to account for the entire population of New Zealand, the population count for the most recent census at the time, 1996, was used. As the population count for the census could be broken down by geographical areas, the harvest estimates could be weighted up for individual areas based on the population size of that area. The harvest estimates were then weighted up again based on the 1999 total New Zealand population count estimate, to give a more accurate harvest estimate of recreational fishing for the NMRFS 2000, which was carried out in 1999-2000. Note at the time of this survey the 1996 population count was the most reliable, as it was not an estimate. After 1996 the census the next census was not run until 2001.

One weight, w_k , for diarist k , was then produced for each diarist and each diary period for which the diarist provided data that control for the factors above. By adding up the product of these weights and the relevant harvest numbers recorded by diarists, the harvest estimates for separate fish-stocks are obtained [65]. The final harvest estimates are given by:

$$\hat{Y} = \sum_{k \in s} w_k y_k$$

where w_k = diarist weight and y_k = the value for diarist k in sample s .

For this research, as the weight given to each individual diarist, w_k , is not available, the final catch estimates are taken from the NMRFS 2000, see Section 6.2.1 . These estimates will be scaled down to represent the population of recreational fishers within Ngāti Kahungunu rohe using a more recent estimate of fisher prevalence estimated in 2007-08 by Sport and Recreation New Zealand (SPARC), see Section 6.2.3. This methodology is described in Section 10.1.

Coefficients of variation (c.v.s) for the 1999-2000 harvest estimates have been calculated using the extended delete-a-group jack-knife method. This is a re-sampling method, so it involves repeatedly calculating harvest estimates on sub-samples carefully selected from the original data set to reflect the original sample design. These results are then combined to estimate the sampling errors, which are expressed in the NMRFS 2000 as c.v.s [4]. A large c.v.s for each estimate suggests that recreational harvest estimates are less reliable. Note very few (<10) of the harvest estimates from the NMRFS 2000 have c.v.s of less than 20% [4]. CRA4 has a c.v.s of 24%, which was relatively low compared with other Rock Lobster fishstocks. However, the PAU2 harvest appears implausibly large, and has a c.v. of 46% which suggests it is not reliable. The c.v.s for most of the other estimates in the NMRFS 2000 for species of interest in this research are well over 20%, indicating that they have a low to moderate degree of reliability [4].

Table 6.4 shows recreational catch estimates for Shellfish by species in both individual numbers and kilograms for FMA2 from recreational fishing surveys run by the Ministry of Fisheries (1993, 1996, 2000, 2001). It also gives the total estimated recreational catch of Shellfish by species in New Zealand and shows the percentage of the total catch that was taken from FMA2 only. Note all of these surveys are similar to the NMRFS 2000 described above, however, the 1993 survey was run in different sections of New Zealand at different times, so is not regarded as a national survey, the 1996 survey was similar to the 2000 survey (although there were small differences in the design of the surveys, for example to estimate of fisher prevalence, which resulted in quite different estimates) and the 2001 survey was a follow up survey to the 2000 survey.

Table 6.4: Estimated recreational harvest for Shellfish in FMA2 vs. total catch in New Zealand, shown in estimated number of individuals harvested and kilograms, from recreational fishing surveys run by the Ministry of Fisheries (1993, 1996, 2000, 2001). For example the estimated of harvest from the 1996 NMRFS of Kina from SUR2 was 61,000 individuals, equating to 15.1t and the estimated harvest of Kina for in New Zealand was 484,000 individuals. The estimated harvest of Kina in SUR2 in 1996 was 12.6% of the New Zealand total.

QMA	Fishing year	Estimated catch (Individuals)	Estimated catch (t)	Estimated catch (NZ)	% of total catch of this species
SUR2 (Kina)	1996	61,000	15.1	484,000	12.6
	2000	1,026,000	254.7	3,066,000	33.5
PAU2 (Pāua)	1993	37-89	—	—	—
	1996	45-65	—	—	—
	2000	224-606	—	—	—
	2001	152-284	—	—	—
CRA4 (Rock Lobster)	1993	65,000	40	90,000	72.2
	1996	118,000	73	534,000	22.1
	2000	371,000	310.9	1,302,000	28.5
	2001	419,000	—	1,425,000	29.4

Table 6.5 shows recreational catch estimates for Shellfish by species in both individual numbers and tones for FMA2. It also gives the total estimated recreational catch of Shellfish by species in New Zealand and shows the percentage of the total catch that was taken from FMA2 only.

Table 6.5: Estimated recreational harvest for Finfish in FMA2 vs. total catch in New Zealand shown in estimated number of individuals harvested and tonnes, from recreational fishing surveys run by the Ministry of Fisheries (1993, 1996, 2000, 2001). For example the estimated of harvest from the 1993 Northern survey of Flatfish from FLA2 was 3,000 individuals, equating to 0 to 5t and the estimated harvest of Flatfish for in New Zealand wad 523,000 individuals. The estimated harvest of Flatfish in FLA2 in 1993 was 14.0% of the estimated New Zealand total.

QMA	Year	Estimated catch (Individuals)	Estimated catch (t)	Estimated catch (NZ)	% of total catch of this species
FLA2 (Flatfish)	1993 (North)	3,000	0-5	523,000	14.0
	1993 (Central)	73,000	20-40	116,200	62.8
	1996	67,000	13-35	532,000	12.6
	2000	380,000	82-238	1,591,000	23.9
GUR2 (Gurnard)	1993 (North)	2,000		151,000	1.3
	1993 (Central)	156,000	50-125	334,000	46.7
	1996	38,000	16	394,000	9.6
	2000	209,000	127	820,000	25.5
KAH2 (Kahawai)	1993	195,000	298	195,000	100.0
	1996	142,000	217	1,233,000	11.5
	2000	1,808,000	2937	4,418,000	40.9
	2001	492,000	799	3,198,000	15.4

Table 6.5: (Continued)

QMA	Year	Estimated catch (Individuals)	Estimated catch (t)	Estimated catch (NZ)	% of total catch of this species
RCO2 (Red Cod)	1993	151,000	105-1055	152,000	99.3
	1996	88,000	92	236,000	37.3
	2000	39,000	11	290,000	13.4
SNA2 (Snapper)	1993	28,000	36	105,000	26.7
	1996	31,000	73	2,916,000	1.1
	2000	322	268,000	7,883,000	3.4
	2001	144,000	173	8,775,000	1.6
TAR2 (Tarakihi)	1993 (North)	7,000	0-5	340,000	2.1
	1993 (Central)	48,000	20-40	105,800	45.4
	1996	114,000	65	733,000	15.6
	2000	310,000	191	1,533,000	20.2
TRE2 (Trevelly)	1993	10,000	20	270,000	3.7
	1996	9,000	13	272,000	3.3

Table 6.5: (Continued)

QMA	Year	Estimated catch (Individuals)	Estimated catch (t)	Estimated catch (NZ)	% of total catch of this species
	2000	153,000	160	933,000	16.4
	2001	32,000	339	640,000	5.0

Table 6.6 shows the harvest estimates by species for the NMRFS 2000, the Recreational allowance by species in 2011, and the actual amount of harvest by species for commercial fishing (using the MHR figures from Chapter 5). For each value the percentage of the total harvest from FMA2 only is given, to show the level of fishing in FMA2 in comparison with the rest of New Zealand. The values of total harvest or total harvest allowances are taken from the corresponding source, for example the NFRFS 2000 estimates of fishing harvest in FMA2 are given as a percentage of the total NMRFS 2000 harvest estimates for New Zealand and allowances of recreational fishing harvest in FMA2 are given as a percentage of the total New Zealand allowance, and so on.

Table 6.6: Recreational harvest estimates (Source: NMRFS 2000), recreational allowances (Source: Ministry of Fisheries) and commercial harvest (Source: Ministry of Fisheries MHR figures) by species in FMA2, also shown as a percent of activity in New Zealand. For example 28.5% of the estimated total New Zealand harvest of Rock Lobster from the NMRFS 2000 was caught within CRA4 (FMA2) and in 2011 the allowance for Rock Lobster recreational harvest was 25.8% of the total New Zealand harvest. Also in 2011 14% of the total New Zealand commercial harvest was of Rock Lobster was harvested from CRA4.

Species number	Species (<i>i</i>)	NMRFS 2000			Recreational allowance, 2011		Commercial harvest (MHR), 2011	
		NZ Total (kg) (T_i)	FMA2 (kg)	% of total harvest ($p_i \times 100$)	FMA2 (kg)	% of total harvest	FMA2 (kg)	% of total harvest
1	Rock Lobster	1302000	371000	28.5	85000	25.8	355922	14.0
2	Pāua	2037000	1277000	62.7	0	—	83124	12.8
3	Kina	3066000	1026000	33.5	60000	18.5	4020	1.6
4	Flatfish	1591000	380000	23.9	0	—	135455	13.8
5	Gurnard	820000	209000	25.5	0	—	234846	16.5
6	Kahawai	4418000	1808000	40.9	610000	26.6	556620	56.3
7	Red Cod	290000	39000	13.4	0	—	139233	11.2
8	Snapper	7883000	268000	3.4	90000	2.9	105726	1.7
9	Tarakihi	1533000	310000	20.2	150000	23.0	630096	35.8
10	Trevelly	933000	153000	16.4	100000	100.0	116132	6.9

Figure 6.1 displays the percentages from Table 6.6 in a clustered bar chart.

Care should be taken when interpreting Table 6.6 and Figure 6.1, as the NMRFS 2000 figures are estimates of the actual harvest for the 2000 fishing year, the recreational allowance figures

are guidelines for the 2011 fishing year set by the Ministry of Fisheries and the commercial harvest figures are actual commercial catch amounts for the 2011 fishing year.

Figure 6.1: Percentages from Table 6.6 displayed as a clustered bar chart by species.

To check the recreational harvest estimates from the NMRFS 2000 are consistent with other types of fishing in New Zealand, given the small amount of information that is available on recreational catch, it is beneficial to look at harvest patterns for other types of fishing. As previously established, commercial harvest information is complete and of high quality. For most species, the harvest estimates from the NMRFS 2000 within FMA2, compared with the harvest estimates for New Zealand as a whole, are consistent with harvest amounts for commercial fishing. For example the relatively small amount of estimated recreational harvest of Snapper within FMA2 compared with the rest of New Zealand (3.4%) is similar to the commercial snapper harvested within FMA2, compared with the rest of the country (1.7%). In addition, the estimated percent of total Kahawai harvested in FMA2 is relatively large (40.9%), as is the percentage of total Kahawai harvested in FMA2 commercially (56.3%).

The percentage of total harvest estimated from the NMRFS 2000 for Rock Lobster, Pāua and Kina are all larger than the percent of total harvest in the commercial fishery, however, the percent of recreational allowance within FMA2 is also larger than the commercial percent, indicating the recreational activity for Rock Lobster, Pāua and Kina, relative to the rest of the country, is greater than the commercial activity within FMA2 for these species.

Notice in all cases where a recreational allowance for FMA2 has been specified, the estimated harvest amount is larger than the recreational allowance.

6.2.2 Voluntary recreational surveys

Data from two surveys carried out by volunteers in the Hawke’s Bay, New Zealand were available for this research. Neither of these surveys are used for the final catch estimates due to the uncertainty in the surveys, which are discussed in Section 10.2. Basic analyses and results for both surveys are given in Section 10.2. The harvest estimates from the two surveys are then combined and used for comparison against the final recreational estimates used to make estimates of total fishing harvest in Ngāti Kahungunu rohe moana (modified harvest estimates from the NMRFS, see Section 10.1. This has been done as a comparison exercise only.

The data from the HBSF Survey and the Moremore Reserve Survey were recorded on paper forms and no electronic copies of either survey was available. This meant entering all data into spreadsheets before any analyses was done. Once the data from both surveys were entered into spreadsheets I printed these and went back through each data entry by hand to ensure all data was correctly entered.

In this section basic information is given for both surveys individually and then results from both surveys are displayed together. The combined section is referred to as Voluntary recreational surveys.

Voluntary recreational survey: Hawke’s Bay Sport Fishing Club Finfish Survey (HBSFC Fishing Survey)

Table 6.7 gives information on the Hawke’s Bay Sport Fishing Club Finfish Survey.

Table 6.7: Hawkes Bay Sport Fin Fish Survey information

Survey	Hawkes Bay Sport Fishing Club Fin Fish Survey
Objective	To gather information on the complete recreational catch per trip, and how catch changes over time to provide a complete picture of the local fishery

Table 6.7: (Continued)

Target population	All recreational fishers taking part in fishing competitions run by the HBSFC
Survey population	Recreational fishers taking part in fishing competitions run by the HBSFC who agreed to take part in the survey
Sponsor	Colin Murray (Hawkes Bay Sport Fin Fishing Club)
Surveyor	Colin Murray
Sample size	2930 (Average of 732 boats surveyed per year)
Response rate	56% of all boats registered to fish in fishing competitions and 100% of all competitions during the time frame of the survey
Survey date	November 2006 to April 2010
Information collected	Number of fish harvested species, number of anglers, number of boats

Table 6.8 gives information on the variables collected during the Moremore Reserve Survey.

Table 6.8: Hawkes Bay Sport Fin Fish variables information

Variable	Description
Species	Species name
Day	Fishing day for the season, for example the first competition day for the season is 1, the second competition day is 2 and so on.
Date	Date the fishing took place
Fishing Year	Fishing year the fishing took place
Caught	Number of fish that were harvested i.e caught and not released
Released	Number of fish that were caught and released
Target Species	The species that were being targeted during each competition
No. Boats	Total number of boats fishing in the days competition

Table 6.8: (Continued)

Variable	Description
No. Boats Surveyed	Total number of boats surveyed for the days competition
No. Anglers	Total number of anglers (fishers)

Colin Murray from the Hawke Bay Sport Fishing Club began a recreational boat ramp survey in 2006. This data set includes four years of data collected during fishing competitions run by the Hawkes Bay Sport Fishing Club, from September to April each year (excluding the 06-07 fishing year where data was collected November-April).

During competitions Colin and other volunteers would survey boats when they returned from the days fishing. The surveys focused on 19 main species (other species were recorded if present) and numbers of landed and released were collected. The number of anglers on each boat and the number of boats fishing in each competition were included in each survey. The target species for each competition were also noted. Please refer to Appendix D for a copy of the survey form.

During the Hawke's Bay Sport Finfish Survey many species, aside from those of interest to this research, were harvested. Table 6.9 shows all harvest amounts by individuals for all species by fishing year. As mentioned only those species of interest are used, see Chapter 5.

Table 6.9: Total harvest amounts by individuals from the Hawke's Bay Sport Finfish Survey by species and fishing year

Species	2007	2008	2009	2010
Albacore	738	575	482	606
Barracoutta	76	103	104	34
Blue Cod	170	301	164	192
Carpet Shark	0	3	9	0
Crayfish	0	1	0	0
Groper	0	0	0	0
Gurnard	3706	4389	4678	3217
hapūku	397	253	169	221
John Dory	2	2	2	0
Kahawai	586	807	941	805
Kina	0	0	0	0
Kingfish	65	80	62	116
Mackerel	22	0	90	75
Mako	0	0	1	0
Marlin	0	3	3	1
Mussel	0	0	0	0
Other	27	0	12	0
Other Sharks	0	0	0	0
Pāua	0	0	0	0
Red Cod	58	136	48	51
Rig	16	10	7	4
School Shark	12	7	6	4
Skate	0	1	0	0
Skip Jack	12	22	187	21
Snapper	1600	2491	2226	1499
Spiny Back Shark	0	0	0	44
Tarakihi	758	1022	1015	1087
Thresher	0	0	0	0
Trevally	254	300	205	259
Trumpeter	10	44	10	14
Tuna	0	0	0	0
Yellow Fin	0	1	0	0

Voluntary recreational survey: Moremore Reserve Survey

Table 6.10 gives information on the Moremore Reserve Survey.

Table 6.10: Moremore Reserve Survey information

Survey	Moremore Reserve Survey
Objective	To ascertain how much shellfish is being harvested from the Moremore Reserve
Target population	All recreational fishers in Napier
Survey population	Recreational fishers fishing from boats and returning to one of four boat ramps in Napier, who agreed to take part in the survey
Sponsor	Rangi Spooner (Local Kaitiaki) and Wayne Ormsby
Surveyor	Local periodic detention (PD) workers
Sample size	275 boats
Response rate	Unknown
Survey date	January 2008 to January 2009
Information collected	Number of fish harvested species, number of anglers, fishing method, shellfish returned

Variables collected during the Moremore Reserve Survey are given in Table 6.11

Table 6.11: Moremore Reserve Survey variables information

Variable	Description
Date	Date of fishing
Fyear	Fishing year
Time	Time the form was filled in
Species	Species name
Harvested	Number of individuals harvested by species
RampCode	Code given to each ramp
Day	Day of the week

Table 6.11: (Continued)

Variable	Description
Fished	Whether the people on the boat fished or not
Participate	Whether the people on the boat would participate in the survey or not
Type	Fishing type (recreational, customary, commercial, etc)
GroupSize	Number of people on board the vessel
Gatherers	Number of people on board the vessel who harvested seafood
Area	Area number between 1-10
Shellfish	Whether the fishers were collecting shellfish (yes or no)
Finfish	Whether the fishers were collecting finfish (yes or no)
Method	Method type for Rock Lobster only e.g snorkel, scuba or harvesting by using pots
Pots	Number of pots used
Females	Number of female Rock Lobster harvested
Pāua.returned	Number of Pāua caught and returned
Rocklobster.returned	Number of Rock Lobster caught and returned
Sea	Number between 1-4 used to describe the sea state
Rain	Number between 1-4 used to describe the rain
Sky	Number between 1-4 used to describe the sky
Wind	Number between 1-4 used to describe the wind strength

This survey was designed by local Kaitiaki Rangi Spooner and Wayne Ormsby from the Ministry of Fisheries. Periodic detention workers were used to collect the data.

Four ramps were surveyed; Hawkes Bay Fishing Club, Napier sailing club, Napier city council and Napier Marina. Surveyors would wait on each boat ramp and approach boats when they came in, asking if the crew would participate in a survey. Note as there is no record of the number of boats fishing from each boat ramp on the days the survey was run the response rate is unknown.

The survey was carried out between January 2008 and January 2009, however, only three survey days were carried out between January 2008 and September 2008. Survey days were more frequent between October 2008 and January 2008. In total surveys were carried out on 20 different days, 17 of these days between October 2008 and January 2009.

The survey focused on shellfish, in particular Rock Lobster, Pāua, Kina and Mussels, however other species including finfish were recorded if caught.

During the Moremore Survey many species, aside from those of interest to this research, were harvested. Table 6.12 shows all harvest amounts by individuals for all species surveyed by fishing year. As mentioned only those species of interest are used, see Chapter ??, and these are listed first.

Table 6.12: Harvest amounts by individuals for the Moremore Reserve Survey by fishing year.

Species	2008	2009
Rock Lobster	82	87
Pāua	60	24
Kina	136	547
Flounder	1	0
Gurnard	79	442
Kahawai	36	212
Snapper	13	131
Tarakihi	0	66
Trevally	1	15
Blue cod	0	15
Rig	12	0
Crab		8
Red Moki	7	0
Mackerel	5	2
Kingfish		6
Barracuda		6
Hoki		6
Butterfish		5
Hapuku		15
Lemon fish	0	3
Shark	0	3
Groper	0	3
Albacore	0	3
Tuna	0	2
Starfish	0	1
Mullet	0	1
Cod	0	1
Other	107	1

Voluntary recreational surveys

Figure 6.2 shows the number of boats surveyed in both volunteer recreational surveys. Notice the HBSFC Fishing Survey surveyed boats over a much longer period of time compared with the Moremore Reserve Survey, and more boats were also surveyed during the HBSFC Fishing Survey. The response rate for the HBSFC Fishing Survey is 56% so the number of boats fishing in each competition is close to double what is shown in Figure 6.2. The response rate for the Moremore Reserve survey is unknown.

Figure 6.2: The number of individual boats surveyed throughout the period of the Hawkes Bay Sport Finfish Club Survey.

Clear bars are boats surveyed during the Hawkes Bay Sport Finfish Survey and the filled bars represent the number of boats surveyed during the Moremore Reserve survey.

During the Moremore Reserve Survey boat ramps were only surveyed for three months during the 2008 fishing year; January, June and August.

Table 6.2.2 shows the amount of fish harvested, by fishing year and species, for both volunteer recreational surveys. Harvest amounts were recorded in both volunteer surveys by individuals. These amounts have been converted to kilograms using the methods described in Chapter 8.1.

Table 6.13: Total catch amounts in individual amounts and kilograms for each species by fishing year for the two volunteer recreational surveys: HBSFC Fishing Survey and the Moremore Reserve Survey. For example in 2008 1 Rock Lobster was during the HBSFC Fishing Survey and 82 Rock Lobster were caught during the Moremore Reserve Survey.

Species	Fishing year	HSRFS		Moremore	
		Individuals	kg	Individuals	kg
Rock Lobster	2007	0	0.0	—	—
	2008	1		82	68.8
	2009	0	0.0	87	73.0
	2010	0	0.0	—	—
Pāua	2007	0	0.0	0	0.0
	2008	0	0.0	60	19.5
	2009	0	0.0	24	7.8
	2010	0	0.0	—	—
Kina	2007	0	0.0	0	0.0
	2008	0	0.0	136	33.8
	2009	0	0.0	547	135.8
	2010	0	0.0	—	—
Flatfish	2007	0	0.0	—	—
	2008	0	0.0	1	0.4
	2009	0	0.0	0	0.0
	2010	0	0.0	—	—
Gurnard	2007	3706	2249.5	—	—
	2008	4389	2664.1	79	48.0
	2009	4678	2839.5	442	268.3
	2010	3217	1952.7	—	—
Kahawai	2007	586	951.7	—	—
	2008	807	1310.6	36	58.5
	2009	941	1528.2	212	344.3
	2010	805	1307.3	—	—
Red Cod	2007	58	16.8	—	—
	2008	136	39.3	0	0.0
	2009	48	13.9	0	0.0

Table 6.13: (Continued)

Species	Fishing year	HSRFS		Moremore	
		Individuals	kg	Individuals	kg
	2010	51	14.7	–	–
Snapper	2007	1600	4284.8	–	–
	2008	2491	6670.9	13	34.8
	2009	2226	5961.2	131	350.8
	2010	1499	4014.3	–	–
Tarakihi	2007	758	466.9	–	–
	2008	1022	629.6	0	0.0
	2009	1015	625.2	66	40.7
	2010	1087	669.6	–	–
Trevally	2007	254	265.7	–	–
	2008	300	313.8	1	1.0
	2009	205	214.4	15	15.7
	2010	259	270.9	–	–

The harvest amounts for both volunteer surveys are scaled up in Section 10.2 to represent recreational fishing harvest (harvest from boats and fishing competitions) in Ngāti Kahungunu rohe moana. Due to the uncertainties in these estimates they are not used in the total harvest estimates in Chapter 13, but are compared with the estimates we have used in Section 10.2.3.

6.2.3 Recreational fisher prevalence

An estimated of fisher prevalence is required to scale the recreational estimates from the NMRFS2000 sample survey to adjust for the whole New Zealand population. Note during the NMRFS2000 an estimate of fishing prevalence in New Zealand was made and used for the estimates, however, I have chosen to use a different estimate of fisher prevalence. This section explains why I have chosen a different estimate of fishing prevalence in New Zealand and describes the survey used to make the estimate.

There have been a number of different attempts to estimate the fishing prevalence of the New Zealand population. Table 6.14 shows the estimated participation in fishing annually, as a % of the total NZ adult population (15-16+) from different sources from 1987 - 2009.

Table 6.14: Estimated participation in fishing, as a % of the total NZ population [33].

Source	Survey type	Individual Fishing Prevalence (%)
Sylvester et. al. 1994, 1987 Department of Statistics survey	Face-to-face contact and follow-up telephone interviews	17.3 ¹
National Research Bureau 1991		38 ²
Bell & Associates 1996	Telephone recruitment for 1996 NMRFS	9.7
AC Nielsen 2000	Telephone recruitment for the 1999/00 NMRFS	39
AC Nielsen National Readership & Finance Surveys 2000	Face-to-face for the 1999/00 NMRFS	31
AC Nielsens interests & activities 10 year average	Questionnaire	19.5
SPARC 2009 ³	Diary survey	19.5 ⁴

In the two previous national recreational fishing surveys run by the Ministry of Fisheries, the NMRFS 1996 and the NMRFS 2000, the estimates for fisher prevalence for the 1996 and 2000 surveys were 9.7% and 31.0% respectively. Note in the NMRFS 2000 two estimates of fisher prevalence were made, 39% and 31%, and the estimate of 31% was used to make the estimates of fishing harvest in New Zealand. In 2002 Dr. Robert Kearney from the University of Canberra reviewed these fishing prevalence estimates and in particular looked into why there was so much variation between the two surveys and concluded that the the 1996 figure for fisher prevalence is too low and although the 2000 estimates were an improvement in quality/reliability, there were still concerns over this estimate due the the definition of fisher prevalence in the study leading to estimates that were “perhaps more closely aligned with the percentage that have fished in the last few years, and as such, it could reasonably represent those who consider themselves fishers” [33].

Due to the uncertainties in the 1996 and 2000 NMRFSs, a more recent estimate of fisher prevalence in New Zealand estimated by SPARC in 2007-08 is used. Note the estimate of fisher prevalence by SPARC is also currently used by the Ministry of Fisheries [50].

Sport and Recreation New Zealand

Table 6.15 gives information on the 2007/08 Active New Zealand Survey used to estimate fishing prevalence in New Zealand.

Table 6.15: 2007/08 Active New Zealand Survey information

Survey	2007/08 Active New Zealand Survey
Objective	To provide information on participation in fishing among New Zealand adults aged 16 years and over
Target population	All New Zealanders aged 16 years and over
Survey population	Adults 16 years and over sampled randomly from households
Sponsor	Sport and Recreation New Zealand (SPARC)
Surveyor	Sport and Recreation New Zealand (SPARC)

¹Note the Department of Statistics Report gives a figure of 19%, not 17.3% as reported by Sylvester et al.

²38% includes marine and freshwater recreational fishing, the estimate for marine fishing only is 33%.

³Not included in [33].

⁴19.5% includes marine and freshwater recreational fishing, the estimate for marine fishing only is 16.6%.

Table 6.15: (Continued)

Sample size	4,443 adults aged 16 years and over
Response rate	61%
Survey date	March 2007 - February 2008
Information collected	Participation levels, profile of participants, participation patterns and volunteering levels
Survey design	Stratified sample (by month and by the 17 regional sports trust catchment areas)

In the 2007/08 Active NZ Survey [69], participants reported whether they had participated in marine/saltwater fishing or freshwater fishing as separate activities. Estimates were made for marine and freshwater fishing prevalence separately, and were combined.

A total of 4,443 adults aged 16 years and over participated in the 2007/08 Active NZ Survey (note the 1996 and 2000 NMRFS sampled people 15 years and over). The 4,443 interviews were completed over a 12-month period beginning in March 2007 and were stratified by month and by the 17 regional sports trust catchment areas, three of which are within Ngāti Kahungunu rohe (Sport Wellington, Sport Manawatu and Sport Hawkes Bay).

The Active NZ Survey (an interviewer-administered, face-to-face self-report survey) consisted of two data collection tools:

1. a sport and recreation survey used to collect information about participation levels in various sport and recreation activities. Participants reported the sport and recreation activities they participated in over three different timeframes: during the 12 months, four weeks and seven days preceding the interview; and
2. a seven-day physical activity recall diary, which was used to assess the frequency, intensity and duration of sport and recreation activities participated in during the seven days preceding the interview. The data collected included the specific activities participated in (e.g. fishing), the day on which the activity was undertaken (e.g. went fishing on Monday and Saturday) and the time spent, and intensity of, the activities participated in. The information from the diary was used to determine the

time spent and the intensity at which adults participated in fishing during any one week.

Over 12 months, 19.5 percent (95% CI: 17.7-21.2) of all New Zealand adults aged 16 years and over (633,768 people) had participated in fishing at least once, 16.6 percent (95% CI: 15.0-18.3) had participated in marine/ saltwater fishing and 5.7 percent (95% CI: 4.66-6.8) had participated in freshwater fishing. Among adults who participated in fishing at least once over 12 months, 13.5 percent (85,406 people) had participated in an organised fishing competition or event.

People were also asked if they belonged to different types of clubs or centres in order to participate in sport and recreation. The clubs/centres examined in this survey included: sport and physical activity clubs, social clubs, fitness centres and some other type of club/centre. Among adults who participated in fishing during any one month: 8.4 percent (20,434 people) belonged to any type of club or centre in order to participate in fishing; 3.8 percent (9,281 people) were members of a social club in order to participate in fishing; and 3.1 percent (7,406 people) were members of a sport or physical activity club in order to participate in fishing.

During any one week, 2.5 percent (95% CI: 1.8-3.2) of all New Zealand adults (81,054 people) participated in fishing at least once. On average, adults participated in fishing on two days out of seven and it is interesting to note that, for this survey, participation levels on weekdays did not differ significantly to the weekend participation level.

We use this estimate of fisher prevalence in Section 10.1 to scale our estimates of recreational fishing to the population of recreational fishers in Ngāti Kahungunu rohe.

6.3 Customary fishing harvest

This section describes the survey methodology used for the customary fishing harvest data and outlines the processes used to access the data for this research. This section also gives comments on the quality of the data set used.

6.3.1 Kaitiaki Data

Once Kaitiaki are appointed by the Minister of Fisheries, they are able to issue permits to allow for Customary fishing. At the end of each quarter Kaitiaki aggregate all of the forms for the permits they have issued and report back to the Ministry of Fisheries. Reporting quarterly is a legal requirement however there is currently no penalty for not reporting.

As mentioned previously, customary permits must specify the following information [55]:

- the date(s) when fishing is to occur
- who will be taking the fish
- species of fish to be caught
- the quantity and size limit of each species to be caught
- the fishing method for each species
- the area where fishing is to occur
- the purpose and venue for which the fish are needed
- any other matters the Tāngata Kaitiaki/Tiaki considers necessary, including what to do with any by-catch.

For access to Customary data I contacted Kaitiaki directly to ask for permission to use the information they had collected and reported to the Ministry of Fisheries.

Note a summary of all meetings I attended throughout this research can be found in Table 6.23.

Table 6.16 gives information on the variables collected for the customary harvest information.

Table 6.16: Customary harvest variables information

Variable	Description
SpeciesCode	Species code
RoheMoana	Rohe moana (gazetted area)
Year	Year
Quarter	Quarter e.g Jan-Mar, Apr-Jun etc
Actual	Amount harvested
Issued	Amount issued on form to be harvest

Initially I attended a hui (meeting) in the Wairarapa in December 2010, organised by one of my supervisors (Dr. Whyte), where I had the opportunity to present my research project and to discuss access to customary data with Kahungunu Kaitiaki and an article about this research was also published in the Kahungunu Fisheries Newsletter: Hurumanu. I then sent a letter to Kaitiaki outlining my research, which also included a consent form to allow access to the Customary data. A draft of this letter was originally taken to an Iwi fisheries hui and Kaitiaki were asked for their suggestions for the permission form. Kaitiaki who permitted me to use their data filled in this form and sent it back to me and a copy of all forms I received were then forwarded to the Ministry of Fisheries who released the Kaitiaki customary data. A copy of this letter is included in Appendix C.

I met with individual Kaitiaki on a number of occasions to discuss my research and ask for permission to use their data. As Kaitiaki operate on a voluntary basis, this involved traveling between Wellington, Wairarapa, Manawatu and Hawke's Bay to meet with Kaitiaki when it was convenient for them. Gaining permission from at least one Kaitiaki in each gazetted area took 18 months. Permission was granted for all rohe moana (gazetted areas), except one: Kairakau Lands Trust.

Once permission from Kaitiaki in each gazetted area was given, the data for all of the gazetted areas were released by the Ministry of Fisheries, with the exception where the data from Ngāi Te Ruruku o Te Rangi was released directly from the Kaitiaki and the data from Kairakau Lands Trust was unavailable.

Notes on quality

- Customary catch must be reported by law, however, there is currently no penalty for not doing so and this can result in missing data and uncertainty
- The unavailable data from Kairakau Lands Trust has also been treated as missing, resulting in some additional uncertainty in our overall estimates of the harvest under customary catch regulations
- On occasions Kaitiaki may write a permit for “one sack” or “one bag” of a certain species. While the data collected from the Ministry of Fisheries did not include measurements of these quantities, it is likely the Ministry of Fisheries has made prior conversions, see Section 8.
- As mentioned previously it is likely that much of the customary fishing in New Zealand takes place under recreational regulations and the majority of the data collected on Kaitiaki permits are for amounts larger than the recreational limits, see Table 6.17

Table 6.17 shows the number of forms filled in for Rock Lobster, Pāua and Kina separately and of the forms filled in it shows the number of times forms were issued for amounts under or equal to the recreational daily bag limits. Note the daily bag limits for Rock Lobster, Pāua and Kina are 6, 10 and 50 respectively.

Table 6.17: Number of forms filled in for Rock Lobster, Pāua and Kina and the number of those forms that issued an amount less or equal to the daily bag limit for each species. For example during the four year period of this research 177 customary permits were issued for Rock Lobster and only 2 of those (1.1%) issued an amount less or equal to the daily bag limit, which is 6. Kaitiaki customary data, 2007-2010 fishing years.

Species	No. of permits	No. of permits issued for quantities less than or equal to the daily bag limit	Percent
Rock Lobster	177	2	1.1
Pāua	204	0	0.0
Kina	109	6	5.5

Note the daily bag limit for Pāua is 10 and the daily bag limit for Kina is 50.

6.4 Illegal fishing harvest

Three different sets of information on illegal data were obtained: conviction data from the Ministry of Fisheries, conviction data from the Ministry of Justice and information of illegal that has been reported by the media. This section describes the survey methodology used, and outlines the processes used to access each dataset. The only data set which I used was the information gained from the Ministry of Fisheries as the Ministry of Justice data do not include catch amounts and the media report information is too incomplete.

6.4.1 Ministry of Fisheries - conviction data

Information on illegal fishing, including catch amounts and fishing locations were requested from the Ministry of Fisheries. The Ministry of Fisheries provided information for incidences captured within the ‘Napier Region’ that included one of the species of interest from 1 January 2006 to 31 December 2010.

Table 6.18 gives information on the variables collected by the Ministry of Fisheries on illegal harvest information.

Table 6.18: Ministry of Fisheries illegal harvest variables information

Variable	Description
Variable	Description
DetectionDate	Date the illegal fishing was detected
SpeciesCode	Species code
CatchWeight(kgs)	Harvest in kg
Catch Units	Harvest in individuals
AnalysisGroupDesc	Fishing type (recreational, customary, commercial, etc)
BaseRegionCodeDesc	Region codes used by the Ministry of Fisheries for internal management
BaseDistrictCodeDesc	A subset of regional areas

There are a number of points to note about this data set:

- This does not include offences where a species count was not generated. For example

area or gear (netting, potting, etc) offences.

- This does not include a number of ‘at sea’ Commercial offences (ie. those off the coast) as these have a different geographical bounding.
- No determination has been made between greenweight (non-processed weight or live weight) and weight at different stages of processing
- There is some degree of cross-over between the different types of fishing. Incidents of Customary offending will most often be recorded as ‘Poaching/Black Market’ or Recreational, depending on how a customary permit is breached.
- Some incidents of Commercial offending relate to catch documentation (ie. a legitimate Monthly Harvest Return that is filed after the due date). In this situation it does not indicate that the species was in fact taken illegally. Note for Rock Lobster over the period of this study (2007-2010 fishing year) >30 individuals were illegally harvested under commercial regulations and no Pāua or Kina was illegally harvested under commercial regulations.

The Ministry of Fisheries has noted these data do not provide sufficient information to make an estimate of illegal take. Therefore no estimates will be made from this data and we will use this data as is, and add it to the total harvest estimates in Chapter 13.

Table 6.19 shows the illegal harvest amount for Rock Lobster, Pāua and Kina by district and fishing year for harvest recorded by individuals (CatchUnits). Conversions are made to kilograms using methods described in Chapter 8.1 and are displayed in Chapter 13.

Table 6.19: Illegal harvest amount recorded by individuals for Rock Lobster, Pāua and Kina by district and fishing year recorded by the Ministry of Fisheries

Species	Fishing year	Wairarapa	Napier	Hastings	Gisborne	Central Hawkes Bay	Total Individuals
Rock Lobster	2007	17	206	15	573	23	834
	2008	164	139	0	701	11	1015
	2009	45	51	0	156	14	266
	2010	154	117	9	237	67	584
Pāua	2007	2348	2644	63	1994	315	7364
	2008	1382	1647	0	1082	219	4330
	2009	660	3317	28	1897	971	6873
	2010	1103	1021	167	1967	1203	5461
Kina	2007	0	0	0	261	0	261
	2008	0	66	0	0	0	66
	2009	0	0	0	122	0	122
	2010		551		57	0	608

Table 6.20 shows the illegal harvest amount for Rock Lobster, Pāua and Kina by district and fishing year for harvest recorded by kilograms (CatchWeight). These harvest amounts are added to the harvest amounts in Table 6.19 (after they are converted into kilograms) and are displayed in Chapter 13.

Table 6.20: Illegal harvest amount recorded in kilograms for Rock Lobster, Pāua and Kina by district and fishing year recorded by the Ministry of Fisheries

Species	Fishing year	Wairarapa	Napier	Hastings	Gisborne	Central Hawkes Bay	Total Individuals
Rock Lobster	2007	0.5	101.7	0	0	0	102.2
	2008	2.83	0	0	429.9	0	432.73
	2009	6.0	0	0	0	0	6.0
	2010	926.0	0	0	1088.0	0	2014.0
Pāua	2007	0	7.0	0	0	0	7.0
	2008	806.0	0	0	0	0	860.0
	2009	1.0	0	0	0	0	1.0
	2010	0	0	0	0	0	0
Kina	2007	0	0	0	0	0	0
	2008	0	0	0	0	0	0
	2009	0	0	0	0	0	0
	2010	0	0	0	0	0	0

Note only Rock Lobster Pāua and Kina have been used as they were the only species (of the species this research focuses on, see Chapter 5) that were harvested in quantities $> 1\%$ of the total illegal harvest. See Section 12.1 for more details.

6.4.2 Ministry of Justice - conviction data

Information on illegal fishing, including catch amounts and fishing locations were requested from the Ministry of Justice directly however, the only information that was available was the number of people found guilty under the Fisheries Act by court from 2004-2009, by district. This data was released from the Ministry of Justice under the Official Information Act. The relevant District Courts included are: Dannevirke District Court, Masterton District Court, Hastings District Court, Napier District Court and Waipukurau District Court. The offences relate to marine finfish and shellfish only, they do not include offences relating to freshwater fish. For a list of offence codes for these fisheries offences please see Appendix B.1.

Table 6.21 gives information on the variables collected by the Ministry of Justice on illegal harvest information.

Table 6.21: Ministry of Justice illegal harvest variables information

Variable	Description
Variable	Description
Court	Court the offence was recorded in
Year	Year the offence took place
Count	Number of offences in each court for each year
Case number	A number given to each individual fishing event
Offense description	A short description of the offense, for example ‘Exceeded daily quota of Pāua’

This information does not include catch amounts and therefore is not used in this research.

6.4.3 Media reports - illegal catch

These data were collected by collating incidences taken from media articles from 2007-2010, where there was mention of illegal fishing relating to a specific species. All of the media reports are available via the Ministry of Fisheries website in the latest news section [56]. Other New Zealand online media sites were also checked including www.stuff.co.nz and www.scoop.co.nz, however, there were no extra articles relating to illegal catch that were not already reported by the Ministry of Fisheries.

The data are reported by fishing year (1 October - 30 September) and give both the catch amount as mentioned in each media report and a conversion to kilograms. It is also noted whether the incident took place inside the Kahungunu rohe. A summary of the media articles for the 2007 calendar year is given in Appendix B.3 to give an idea of the types of offences.

Table 12.2 summarises the the incidences from the media reports relating to illegal fishing from the 2006 fishing year to the 2010 fishing year for Rock Lobster, Pāua and Kina.

Table 6.22: Summary of incidences from media reports relating to illegal fishing between the 2007-2010 fishing years for Rock Lobster Pāua and Kina. A summary of the number of media reports relating to illegal catch is given, alongside the number of reports where catch amount (in individuals) was given, the total individuals caught, the total number of individuals caught that were under the legal size limit and the number of individuals caught per illegal fishing incident

Species	Total incidences reported n_i for species i	no. incidences where catch amount was reported m_i	Total individuals caught t_i	Total number of undersize individuals t_{iu}	% of illegal catch reported as undersized $\frac{t_{iu}}{t_i}$	No. individuals caught per incident $\frac{t_i}{n_i}$
Rock Lobster	23	17	736 ¹	150 ^{1 2}	$\approx 20\%$	43.29
Pāua	59	53	14,603 ¹	6,670 ^{1 2}	$\approx 46\%$	275.5
Kina	4	4	195 ¹	—	—	48.5

The data used can be found in Appendix B.2.

6.5 The data collection process

During the course of this research I met with a number of different people and organisations to request access to the different data sets and to talk with members of the fishing community about personal experiences either managing fisheries or fishing themselves. Table 6.23 summarises these meetings.

Note Table 6.23 only includes face-to-face meetings. I have also had numerous email and

¹Only catch amounts where whole individuals were reported were used, to avoid conversion errors. This excludes catch reported by any other measure and excludes catch reported without shells, or in green weight, as the original size of each individual may not be known

²Where the catch was reported as being "mostly" or "mainly" undersize, it was assumed the entire reported catch amount was undersize, for consistency

phone conversations with many people that have not been included in this table.

Table 6.23: Meetings and hui attended during the course of this research

Date	Person/organisation	Purpose
August-10	Wayne Ormsby, Ministry of Fisheries	To discuss data availability of data from customary permits issued by Kaitiaki and the Moremore Reserve recreational survey
August-10	Colin Murray, Hawkes Bay Sport Fishing Club	To obtain the data from the HBSFS and discuss local recreational fisheries
October-10	Te Ohu Kai Moana	To discuss commercial fishing data (e.g. what is reported, what the data is like) and to discuss plans to develop an online program for Kaitiaki to enter customary fishing permits (e-fish). No data was obtained from Te Ohu Kai Moana, however, they did provide valuable advice.
December-10	Ngāti Kahungunu Iwi Fisheries Hui, Wairarapa.	To give my first presentation to Kaitiaki about my intentions with this research. I presented a draft permission form (which was sent to Kaitiaki a week prior to the hui) and asked Kaitiaki for any suggestions before a final copy was sent out.
January-11	Kaitiaki, Ngāti Kahungunu Iwi office, Hastings	Met with three Kaitiaki in different meetings to discuss my project in detail and to request permission for access to their data.
January-11	Kaitiaki, Waimarama Marae	Met with a Kaitiaki to discuss my project in detail and to request permission for access to their data.

Table 6.23: (Continued)

Date	Person/organisation	Purpose
March-11	Ministry of Fisheries, Wellington	I met with Craig Loverage, Edwin Massey and Merryn Jones to discuss access to both commercial and customary fishing harvest data.
April-11	E-fish training, Hastings	This was a training session for Kaitiaki to introduce them to the program (e-fish, mentioned above) for Kaitiaki to be able to issue customary permits online. This program was developed by Te Ohu Kaimoana. I attended to talk to Kaitiaki and to listen to any concerns they may have had when entering data online.
July-11	Kaitiaki, Masterton	Met with a Kaitiaki to discuss my project in detail and to obtain permission to use their data
July-11	Kaitiaki, Eketahuna	Met with a Kaitiaki to discuss my project in detail and to obtain permission to use their data
August-11	NZ Statistics Association Conference, Auckland University	To present my research.
December-11	Ngāti Kahungunu hui, Hastings	To present my results to Kaitiaki from the customary data and to ensure Kaitiaki were happy with the level the data was reported to i.e. to protect their privacy.
Pending		I would like to attend a hui to thank Kaitiaki for the use of their data

Chapter 7

Mapping and GIS

All maps in this thesis, unless otherwise referenced, are produced using ArcGIS. Final catch estimates for this research are also displayed on maps, see Section 13.2, produced using ArcGIS. This section gives a brief description as to how these maps are made and the problems faced when using sensitive spatial data and data collected in different geographical positionings.

Firstly, it is important to note the Ministry of Fisheries also has a tool (NABIS [61]) for members of the public to produce maps showing commercial harvest quantities by statistical areas. As an example Figure 7.1 shows the commercial harvested maps produced by NABIS for Kahawai and Rock Lobster for the 2010 fishing year. Note Kahawai use the general statistical areas and Rock Lobster uses statistical areas specific to Rock Lobster, see Chapter ?? for details on statistical areas for all species.

(a) Kahawai

(b) Rock Lobster

Figure 7.1: Commercial harvested maps produced by NABIS for Kahawai and Rock Lobster for the 2010 fishing year. Source NABIS [61]

The maps produced in NABIS used the geographic co-ordinate system World Geodetic System 84 (WGS 84), which is why the shape of New Zealand looks distorted.

The maps I produce in Section 13.2 differ from these maps as I aim to show harvest at a finer geographical scale, and I also include harvest amounts from recreational and customary harvest, as well as commercial harvest.

7.1 Different geographical areas

As this research uses a variety of different data sources, the geographical information associated with fisheries catch from each data set differs. For example commercial catch data is either reported as being caught within a statistical area, see Figures 2.3, 2.4 and 2.5, or by co-ordinates, giving a more specific catch location.

As mentioned in Section 2.5.3, when Kaitiaki issue permits for Customary fishing, the fishing must take place within a specific gazetted area, see Figure 4.3. This means the location of customary fishing catch correspond to these areas.

Recreational catch location for both recreation surveys is based on boat ramp locations and has been scaled up to give an overall estimate of catch within Ngāti Kahungunu rohe, see Section 10.2. The catch estimates have been allocated to specific locations using the Ministry of Fisheries statistical areas, similarly to Commercial catch with no trawl locations.

Figure 7.2 displays the different areas catch is associated with in this research.

Different geographic areas in Ngāti Kahungunu rohe moana

Figure 7.2: Different fisheries geographical areas in Ngāti Kahungunu Rohe

Data is represented in GIS using layers. The first step in producing maps was to have all of the data, from all of the different sources, in the same map layer. For example each set of data is entered into the map in individual layers e.g. a layer for each sector of fishing, and once combined these are represented on the map as a single layer with all sectors of

fishing combined. To do this the area in the ocean was divided into grid squares $0.2^\circ \times 0.2^\circ$ in size, see Figure 7.3. The catch data from all sources was assigned to these grid squares as is explained in the following section.

Figure 7.3: Map of grid squares used to allocate catch across Ngāti Kahungunu rohe

7.1.1 A note about the area of each grid square

As the surface of the earth is curved, not flat, sectioning an area on the earth's surface into grid squares, using a fixed edge length in degrees, will result in slight differences in grid square area by latitude. As the lines of latitude become closer to the poles they also become closer together, resulting in grid squares with a smaller surface area closer to the poles.

The area of any small grid square can be found using the equation

$$\text{area of a grid square} = r^2 \cos(\alpha)(\Delta\alpha)(\Delta\phi)$$

where r = the radius of the earth = 6378.1km, α = latitude, ϕ = longitude and Δ signifies a change, in this case either in latitude or longitude. Therefore,

$$\Delta\alpha = \text{grid square edge size in latitude (vertical on map)}$$

$$\Delta\theta = \text{grid square edge size in longitude (horizontal on map)} .$$

Note all angles must be expressed in radians. To convert degrees into radians the angle must be multiplied by the factor

$$\frac{\pi}{180}.$$

In this example each grid square is $0.2^\circ \times 0.2^\circ$, in radians 0.2° is equal to

$$0.2 \frac{\pi}{180}$$

and $\Delta\alpha = \Delta\theta = 0.003491\text{radians}$.

The physical size of the North–South sides of each grid square, see Figure 7.4, are the same at all latitudes. The length in kilometres of each side of a grid square, when each side of the grid is 0.2° is therefore

$$r\Delta\alpha = 22.264\text{km}.$$

As the distance between the lines of longitude shorten when moving closer to the poles, the top and bottom (East–West side) of each grid square differs, depending on the latitude of the grid square, see Figure 7.4.

Figure 7.4: An example of one grid square

For example, the latitude of Napier is -39.29° , therefore, the distance of the top and bottom side of a grid square in Napier is

$$r \cos \alpha \Delta \phi = 17.23\text{km}.$$

The area of a grid square in Napier is therefore;

$$(r\Delta)(r \cos \alpha \Delta \phi) = r^2 \cos \alpha (\Delta \alpha)(\Delta \phi) = 383.567\text{km}^2$$

.

As another example the latitude of Masterton is -40.57° , therefore, the distance of the top and bottom side of a grid square in Masterton is

$$r \cos \alpha \Delta \alpha = 16.91\text{km}$$

The area of a grid square in Masterton is therefore

$$(r\Delta)(r \cos \alpha \Delta \phi) = r^2 \cos \alpha (\Delta \alpha)(\Delta \phi) = 376.52\text{km}^2.$$

It therefore follows that area of the grid squares further south are slightly smaller than those closer to the north.

7.2 Assigning catch to specific locations

7.2.1 Commercial data

Firstly the commercial catch data was separated into fishing events with co-ordinate locations, and fishing events without co-ordinate locations. A fishing event is one fishing incident, and is associated with estimated catch and effort data. For example, one set or tow and all its effort data constitutes a fishing event [52]. There can be one or multiple fishing events within a fishing trip.

The data with co-ordinate locations is added to the map using the co-ordinates for the start of each fishing event. This resulted in a layer of points symbolizing the start of a fishing event and how much fish was caught during that event. The co-ordinates for the end of a fishing event are not always available, so only the start location for the event is used. We mentioned in Section 6.1.1 that some points are located on land, either mistakenly, or because they are very close to the land. To deal with this each data point with co-ordinates on land were moved into the nearest grid square to the west (in the ocean). This point layer was then joined to the grid square layer to assign the catch to a grid square, rather than a point.

The fishing events without co-ordinate locations did nevertheless have the statistical area (see Figure 7.5) in which the fish was caught, so this was used to assign catch to a grid square. The total catch for each statistical area (for all events without co-ordinate locations) are first divided amongst the corresponding grid squares for each statistical area, by species and fishing year separately. As there are no other locations associated with this commercial harvest, there is only a total harvest estimate for each statistical area, the data was assigned to grid squares using the locations from the commercial harvest with locations, as it is likely the commercial harvest with no location will follow similar geographical patterns to commercial harvest with recorded locations.

To do this catch was assigned to each square based on the proportion of commercial catch with locations assigned to each grid square. As a simple example, if the grid was made up of four grid squares and the total commercial catch with locations for the four grid squares was 100kg, 75kg in one square, 25kg in another and no harvest in the remaining two grid squares, the commercial catch with no locations is divided using these proportions (75%, 25%, 0% and 0%). From this example, if the total commercial catch with no location is 50kg, the grid

square with 75% of the commercial catch with locations is assigned 37.5kg of the commercial catch with no location, the grid square with 25% of the commercial catch with locations is assigned 12.2kg of the commercial catch with no location and the remaining two grid squares are assigned no commercial catch with no location.

As the precision of the locations of each fishing event differ, for example one fishing event's location may include the co-ordinates of the start of the event, making the location of the harvest very precise, and other fishing event's location may only include a statistical area, meaning we only know the statistical area the event started, and not it's exact location. Table 7.1 shows the number of fishing events by species and fishing year that included a co-ordinate location (with location) and with a statistical area only, i.e. no co-ordinate location (no location). As the fishing events with co-ordinate locations are geographically more precise than fishing events with a no co-ordinates, we can be more confident in knowing the precise location of the fishing harvest from those fishing events. Maps with final harvest amounts are displayed in Section 13.2.

Table 7.1: Commercial fishing events within Ngāti Kahungunu Iwi with no co-ordinate location. Catch Effort data, Ministry of Fisheries 2007-2010 fishing years.

Species	Fishing year	Number of events	Number with no location	% with no location
Trevally	2007	1549	1077	69.53
	2008	2757	12	0.44
	2009	3149	33	1.05
	2010	3067	27	0.88
Tarakihi	2007	2511	1497	59.62
	2008	4627	52	1.12
	2009	5259	54	1.03
	2010	5113	49	0.96
Snapper	2007	1683	1432	85.09
	2008	3143	16	0.51
	2009	3397	7	0.21
	2010	3463	25	0.72
Gurnard	2007	3487	2658	76.23
	2008	6501	94	1.45
	2009	6941	128	1.84

Table 7.1: (Continued)

Species	Fishing year	Number of events	Number with no location	% with no location
	2010	7074	106	1.50
Flatfish	2007	2040	1889	92.60
	2008	6172	306	4.96
	2009	4740	244	5.15
	2010	4842	180	3.72
Red Cod	2007	1520	994	65.39
	2008	3081	107	3.47
	2009	3458	161	4.66
	2010	4697	151	3.21
Kahawai	2007	503	401	79.72
	2008	1132	154	13.60
	2009	1447	161	11.13
	2010	1581	203	12.84
Rock Lobster	2007	7294	7287	99.90
	2008	6241	6238	99.95
	2009	4767	4763	99.92
	2010	4730	4727	99.94
Pāua	2007	592	592	100.00
	2008	608	608	100.00
	2009	580	580	100.00
	2010	631	631	100.00
Kina	2007	29	29	100.00
	2008	22	21	95.45
	2009	20	20	100.00
	2010	12	9	75.00

Main features to notice are:

- From 2008 most finfish events are recorded with co-ordinates

- Rock Lobster and Pāua have specific statistical area and catch location is recorded by theses, rather than co-ordinates. The Rock Lobster and Pāua statistical areas are smaller and more precise than the general statistical areas used for finfish and other species
- The location Kina is caught is mostly recorded using the general statistical areas and there are relatively few commercial fishing events

Excluding Rock Lobster and Pāua, all other species in this research are managed using the general statistical areas. As a reminder Figures 7.5, 7.6 and 7.7 show the general statistical areas, Rock Lobster statistical areas and Pāua statistical areas in New Zealand.

Figure 7.5: General Statistical Areas in New Zealand

Figure 7.7: Pāua Statistical Areas in New Zealand

7.2.2 Recreational data

As there are no locations associated with the recreational catch, there is only a total harvest estimate for FMA2, the data was assigned to grid squares using the locations from the commercial harvest, similar to the commercial catch with no locations, see Section 7.2.1. Note recreational fishing is likely to follow similar geographical patterns (in latitude) to commercial harvest as most species live, feed or breed in the same geographical areas. However, commercial fishing is likely to take place further off-shore as commercial fishermen often spend extended periods at sea, and are therefore able to travel further than the average recreational fisher. Many recreational fishers also fish from the shore. Care should be taken when interpreting maps in Chapter 13.2 as the it is likely recreational harvest takes place closer to the shore than what is displayed. This means the geographical spread of the harvest by latitude is of more interest than the longitudinal spread.

Recreational harvest was assigned to each square based on the proportion of commercial catch assigned to each grid square. As a simple example, if the grid was made up of four grid squares and the total commercial catch for the four grid squares was 100kg, 75kg in one square, 25kg in another and no harvest in the remaining two grid squares, the recreational catch is divided using these proportions (75%, 25%, 0% and 0%). From this example, if the total estimated recreational catch was 50kg, the grid square with 75% of the commercial catch is assigned 37.5kg of the estimated recreational catch, the grid square with 25% of the commercial catch is assigned 12.2kg of the estimated recreational catch and the remaining two grid squares are assigned no recreational harvest.

Assumptions used in 7.1. Recreational fishing takes place in the same areas as commercial fishing

7.2.3 Customary data

The three main species caught using customary permits are Rock Lobster, Pāua and Kina. As Rock Lobster and Pāua are found on rocky substrate in shallow water, and it is illegal to catch either species using underwater breathing apparatus (unless specified on customary permits), the boundaries of the statistical areas for these two species are relatively close to the shore. As there are no co-ordinates attached to each fishing trip, or fishing event, we allocated the catch to the most likely location, taking into consideration the geographical range of each species using, a method similar to that used for the commercial data. Figure 7.2 shows some rohe moana extend further out to sea than the statistical areas for these species. As these statistical areas represent the likely catch area for Rock Lobster and Pāua, customary catch of these species will only be allocated within these likely areas. Figure 7.8 shows an example of the likely catch area for customary catch of Rock Lobster and Pāua caught in Ngāti Kere, using both the rohe moana boundaries and the Rock Lobster statistical areas. While the Pāua Statistical areas differ from the Rock Lobster statistical areas they extend out to sea by the same distance (in the southern part of Ngāti Kahungunu rohe moana), therefore only the Rock Lobster statistical area were used. In the northern part of Ngāti Kahungunu rohe moana the Pāua statistical areas extend further than the Rock Lobster Statistical areas, see Figure 7.2. However, commercial fishing for Pāua does not take place in the northern part of

Ngāti Kahungunu rohe, therefore, the statistical areas are less defined. With this in mind it is not likely customary (or recreational) catch of Pāua would be caught as far out to sea as the statistical areas for Pāua in the northern part of Ngāti Kahungunu extend, therefore the statistical areas for Rock Lobster have been used to redefine all of the rohe moana gazetted areas.

It is also likely that customary Kina is harvested close to the shore, however, the statistical areas for Kina are the general statistical areas, i.e. Kina does not have its own defined statistical areas like Rock Lobster and Pāua. We therefore assume Kina is not caught further out to sea than the Rock Lobster and Pāua statistical areas (30km from the coast).

Figure 7.8: Re-defining rohe moana to allocate customary catch. a) all three geographies, b) truncating Ngāti Kere to the Rock Lobster statistical areas boundaries and c) Truncating grid squares to nest inside Ngāti Kere.

We accept that the extent of the Rock Lobster boundaries from the shore (30km) is further from the shore than the likely harvest locations e.g. Rock Lobster, Pāua and Kina are likely to be caught within a few kilometers of the shore. We have used the statistical area

as a boundary for spreading out the data onto maps, however, care should be taken when interpreting the maps as once the data has been spread out to the 30km boundary it may seem as though these species are being harvest this far out from the shore. This means the geographical spread of the harvest by latitude is of more interest than the longitudinal spread.

Assumptions used in 7.2. Rock Lobster and Pāua are not caught further out to sea than their statistical areas extend from the coast (30km).

Kina is not caught further out to sea then the Rock Lobster and Pāua statistical areas (30km from the coast).

7.2.4 Illegal data

Illegal data taken from media reports does not include specific locations, therefore, is not included in any of the final harvest estimate maps in Section 13.2.

Section 13.2 gives final harvest estimates amounts for Ngāti Kahungunu rohe moana and each fishing sector (commercial, recreational, customary and illegal) are given as a proportion of total harvest. As illegal harvest amounts reported by the Ministry of Fisheries are relatively low proportions of the total harvest estimate the maps will not be greatly affected by not including the illegal fishing harvest estimate. However note this data does not include all incidences of illegal fishing, only those where a fisher has been prosecuted.

The portions of illegal fishing harvest that make up the total fishing harvest range from 0% (Rock Lobster and Kina) to 3.4% (Pāua). The illegal harvest amounts for finfish were not given as media reports are often not specific about the species of finfish harvest. For example often media reports will report an amount of finfish that were harvested, without giving a specific species e.g. “80-311t of fish”, or often media reports will report an amount of finfish that were harvested and give multiple species e.g. “5.1t of Snapper and Gurnard”, making it difficult to know how much of each species was harvested.

7.3 Technical aspects

This section briefly explains the technical aspects used to produce all of the maps in this research.

7.3.1 Co-ordinate systems

All information provided by the Ministry of Fisheries, including statistical area shapefiles (geospatial vector data), rohe moana shapefiles and commercial catch data uses the geographic co-ordinate system World Geodetic System 84 (WGS 84). All analyses are done using this geographic co-ordinate system and once analyses are finished all map layers are converted to the projected co-ordinate system WGS 1984 Mercator 41 for display purposes as the map shape is less distorted (New Zealand looks “squashed” when using the geographic co-ordinate system WGS 84).

7.3.2 Interpolation

Interpolation predicts values for cells in a raster layer (a matrix of cells organized into rows and columns) from a limited number of sample data points. It can be used to predict unknown values for any geographic point data, such as elevation, rainfall, chemical concentrations, noise levels, and so on [24]. We interpolated the values from each cell to spread out and smooth the harvest amounts to a) protect fisher privacy, and b) to spread the catch amount away from the start position as, for commercial harvest, only the start position of each event was used. For fishing methods such as trawling, the end position will differ from the starting position, therefore the catch would have been harvested close to the start location and interpolation is used to spread the harvest amounts to neighbouring cells. For other types of fishing it is likely the catch would be caught in a larger area than the start position co-ordinates indicate, so again interpolation has been used to spread harvest amounts to neighbouring cells.

Inverse Distance Weighting

Inverse Distance Weighting (IDW) is the method of interpolation used to smooth out the data in the maps presented in this research and is used in Chapter 13.2. IDW is a method of interpolation that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. The closer a point is to the center of the cell being

estimated, the more influence, or weight, it has in the averaging process [24].

A barrier along the New Zealand coast has been used when interpolating the data for each map, which is a polyline dataset (a shape file) used as a breakline that limits the search for sample points. This prevents the data being smoothed over the land.

7.4 Summary

This section gives a step-by-step summary of the methods explained in this chapter that were used to produce the maps in Chapter 13.2. It does not aim to give instructions on how to recreate these maps, but should give the reader an idea about the order of processes.

1. Divide the study area into grid squares
2. Define new rohe moana based on species natural boundaries
3. Divide the new rohe moana areas into the grid squares
4. As some grid squares belong to more than one rohe moana, or fall outside of rohe moana, these grid squares are snipped to fit within the rohe moana only. When a grid square is snipped we know the remaining size of the area. We then assign a proportion of area to each grid square within the different rohe moana areas, so the total sum of all grid squares within each rohe moana is equal to one.
5. Divide the statistical areas into grid squares
6. Assign a proportion of area to each grid square within the different statistical areas
7. Add commercial data with trawl co-ordinates
8. Sum all catch for trawls with the same latitude and longitude values to give an overall amount of catch to each location. Note it is common to have multiple fishing events at the same location
9. Do a spatial join (a way to join data tables in which fields from one layer's table are appended to another layer's table based on the relative locations of the features in the two layers [25]) between commercial catch at specific locations and the grid squares layer to assign a catch amount to each grid square

10. Add commercial data with statistical area locations only i.e. no trawl co-ordinates. A total catch amount for each species for each fishing year needs to be assigned to each statistical area.
11. Divide commercial catch for each statistical area between statistical area grid squares based on the proportion of commercial catch (with locations) in each grid square, see Section 7.2.1.
12. Do a spatial join between the grid squares for each statistical area and the complete grid squares to give a new catch amount to each grid square that now includes all commercial catch (This step needs to be done separately for finfish, Rock Lobster and Pāua as the statistical areas differ amongst these species).
13. Add customary data. A total catch amount for each species for each fishing year needs to be assigned to each rohe moana area, defined in step 2.
14. Divide customary catch for each rohe moana area between rohe moana grid squares based on the area proportion from step 3.
15. Do a spatial join between the grid squares for each rohe moana area and the complete grid squares to give a new catch amount to each grid square that now includes all commercial catch and customary catch.
16. Add recreational data. A total catch amount for each species for each fishing year needs to be assigned to each statistical area.
17. Divide recreational catch for each statistical area between statistical area grid squares based on the proportion of commercial catch (with locations) in each grid square, see Section 7.2.1, similar to step 11.
18. Do a spatial join between the grid squares for each statistical area and the complete grid squares to give a new catch amount to each grid square that now includes all commercial catch, customary catch and recreational catch (This step needs to be done separately for finfish, Rock Lobster and Pāua as the statistical areas differ amongst these species).
19. There is now one layer containing grid squares (polygons) with an overall catch amount for all species and fishing years individually, assigned to each grid square (There is a

separate, but similar, layer for Rock Lobster, Pāua and Kina, due to different species boundaries)

20. Find the centroid of each grid square
21. Based on the centroid in step 22, export this layer as a point layer. Each point will represent the amount of catch at the location of the point.
22. Export each species by fishing year separately, to produce separate maps for each species by fishing year.
23. Using the interpolation tool IDW, interpolate the point layer for each species and fishing year.
24. Note: the illegal catch from the media reports is not included in the final maps.

In this chapter we developed a method of producing maps using the different different data sets from the different fishing sectors: commercial, recreational and customary. We use this method to produce the maps in Section 13.2 using our final fishing harvest estimates by species and fishing year.

Chapter 8

Fish weight conversions

Catch data for are recorded in many different sets of units, including; tonnes, kilograms, by individuals caught or by the sack. In the case of illegal fishing, often catch amounts are not recorded, just that the catch took place.

To standardise all of the data, all of the catch amount needed to be converted into the same measure, kilograms (kg). There are no official fish conversion weights available in New Zealand for converting individual whole fish into a standard weight. As a reminder, as part of the NMRFS 2000, a boat ramp was run to estimate the average size of each species surveyed, see Section 6.2.1. These average fish weights are shown in Table 8.1 and are used to convert individual fish amounts into kilograms, for the following data sets:

- Hawkes Bay Fishing Club Fin Fish Survey (Section 6.2.2)
- Moremore Reserve (Section 6.2.2)
- The media reports relating to illegal catch (Ministry of Fisheries, Section B.2)
- Customary data (Kaitiaki, Section 6.3.1)

The two data sets that were received with harvest amounts in kilograms, and therefore individual fish to weight conversions do not need to be made are:

- Commercial fishing harvest Ministry of Fisheries, Section 6.1.1
- NMRFS 2000 (Ministry of Fisheries, Section 6.2.1)

From discussions with Kaitiaki and viewing original copies of customary permits, Kaitiaki do not always issue catch amounts by kg or individuals, for example it can be common for a Kaitiaki to issue in quantities such as a bag or a sack. I was prepared to convert these rough estimates and sought advice from Kaitiaki about how to do so, for example a sack. However, when the data was received from the Ministry of Fisheries it had all been converted into individuals caught, so no conversions other than individual to kilogram were made in this research.

Table 8.1: Mean weight (kg) and mean length (mm) of recreational fish and shellfish landed by fishstock or species from the 1999-2000 boat ramp survey used for estimating recreational harvest weights. NMRFS 2000 [4].

Fish stock	Mean Weight (kg)	Mean length (mm)
SUR ¹	0.2483	—
PAU2	0.325	138
CRA4 (F)	0.640	68
CRA4 (M)	1.014	67
FLA	0.422	325
GUR2	0.607	378
KAH2	1.624	470
RCO2	0.289	304
SNA2	2.678	497
TAR2	0.616	310
TRE	1.046	358

Note in New Zealand, under the Fisheries Act 1996, all references to the weight of fish must be in greenweight (non-processed weight or live weight) and all weights are in this research are given in greenweight.

8.1 Rock Lobster sexual dimorphism

Male and female Rock Lobsters show sexual dimorphism and have different tail width to weight relationships. In the 1999/2000 recreational survey [4] the sex ratios were obtained for Rock Lobster from the same boat ramp survey taken to estimate the mean weights of recreationally caught species, as shown in Table 8.1. The sex ratios were used to estimate

¹There is no estimate for the mean weight of Kina (SUR2) in the 1999-2000 boat ramp survey so the mean weight estimate has been taken from Ministry of Fisheries Plenary document on Kina (SUR) 2009 ??

the proportion of each sex harvested recreationally from each Rock Lobster fishstock. The mean weight determined for each sex from the boat ramp survey was then used to estimate the total Rock Lobster harvest weight by calculating the harvest weight separately for each sex and adding these estimates.

This same approach was used to convert the number of Rock Lobster caught into kilograms for this study to allow for this sexual dimorphism. In the 1999/2000 recreational survey [4] 47.44% of the total catch were female and 52.83% were male, see Table 8.2. Where Rock Lobster catch has been reported by individuals throughout this study, 47.44% of the total catch are converted using the mean weight 0.640kg for females, and the remaining 52.83% of the total catch is converted using the mean weight 1.014kg for males. For example if 10 Rock Lobster are harvested the weight is:

$$\begin{aligned}
 Weight &= (npw_{male}) + (n(1 - p)w_{female}) \\
 &= (10 \times 0.5283 \times 1.014) + (10 \times 0.4744 \times 0.640) \\
 &= 5.36 + 3.04 \\
 &= 8.4kg
 \end{aligned}$$

where n = the number of individuals, p = the proportion of males = 52.83%, w_{male} = weight in kilograms for males and w_{female} = weight in kilograms for females.

In all surveys in this study, where the Rock Lobster catch is recorded in kilograms, it is assumed sexual dimorphism has already been accounted for and no changes are made to the reported kilogram weight.

The datasets used in this study that are adjusted to account for Rock Lobster sexual dimorphism are:

- Hawkes Bay Fishing Club Finfish Survey (Section 6.2.2)
- Moremore Reserve (Section 6.2.2)
- The media reports relating to illegal catch (Ministry of Fisheries, Section B.2)

- Customary data (Kaitiaki, Section 6.3.1)

For the commercial fishing harvest dataset the weights are the actual harvest weights for and the customary data set, it is assumed sexual dimorphism has already been accounted for. Therefore, no changes are made to the reported kilogram weight for these two datasets. Sexual dimorphism has already been accounted for in the NMRFS 2000 recreational fishing estimates so again no changes to account for sexual dimorphism are made to the estimated harvest weight.

Table 8.2: The estimated harvest numbers and mean weight and length of Rock Lobster by sex for the 1999/2000 National Marine Recreational Fishing Survey (NMRFS 2000) [4] for CRA4

Fish stock	Sex	Unweighted harvest reported by diarists	Estimated harvest in numbers of shellfish	Mean Weight (kg)	Mean length (mm)
CRA4	All	997	371 000		
	F		176 000	0.640	68
	M		196 000	1.014	67

8.2 Undersize catch adjustments

The weights in Table 8.1 are also be used to convert the number of fish caught into kilograms for the Ministry of Fisheries illegal harvest data, see Section 6.4.1, and the illegal harvest reported in media reports, see Section B.2, however, to allow for undersized catch, adjustments will be made for the conversions for these two data sets.

Most of the illegally caught individuals that are undersize are likely to be just less than the legal limit and very few are likely to be at the lower end of the size range. This is because the smaller the individual the less likely a fisher would want to harvest it for food.

In the Ministry of Fisheries illegal harvest data the harvest is recorded by individuals. It is not known whether the individuals harvested were undersized, as illegal harvest can relate to individuals who were harvested in quantities over the legal amount, individuals who were harvested using banned or restricted gear, individuals who had been harvested in banned

or restricted areas (e.g. marine reserves) or individuals that were undersized. Therefore we assume all individuals are undersize for caution.

In the media report illegal harvest data for Pāua, it is often mentioned whether the individuals were undersize. This means we are able to make adjustments for undersize individuals only.

Figure 8.1 is a schematic diagram depicting the distribution of the weight of fish. The legal limit breaks the distribution into two pieces. The low weight, illegal, piece of the distribution is skewed, i.e. not symmetric. It is reasonable to assume most of the illegal catch is close to the legal limit, as the smaller the fish the less useful as a food it becomes. The mean of the weights of the illegal catch is therefore close to, but of course less than, the legal minimum size.

We therefore make the assumption that the mean illegal weight, which will be assigned to all catch that has been reported as being undersize, is 80% of the legal limit.

Figure 8.1: Schematic diagram depicting the distribution of the weight of fish. The distribution is cut by the legal limit into two pieces. We assume the mean illegal weight is 80% of the legal limit.

The weight that is assigned to Pāua in the Ministry of Fisheries illegal harvest data is 80% of the average weight of Pāua from Table 8.1, 0.325kg, which is 0.26kg. In the media report data, the size of Pāua, and whether or not it is undersize when harvested, is mentioned. As this information is available all Pāua reported as being harvested in media reports will not be assumed to be undersize. These methods are described in Section 12.2 .

The weight that is assigned to undersize Rock Lobster in both the Ministry of Fisheries data and the media report data is 80% of the average weight of Rock Lobster from Table 8.1, 0.325kg, which is 0.26kg. An allowance is also be made for Rock Lobster sexual dimorphism for both surveys, see table 8.2.

There is no minimum legal size for Kina in New Zealand therefore the mean weight of Kina from Table 8.1 is used.

Chapter 9

Methods and results: Commercial fishing harvest

There is only one set of data used to quantify commercial fishing harvest in the Ngāti Kahungunu rohe. This chapter describes how this data was used. Note this is a short Chapter as the data for commercial harvest is not a survey, therefore no estimates were needed, i.e. the data is used as is.

9.1 Ministry of Fisheries Catch Effort data

The commercial data obtained from the Ministry of Fisheries was clean (needed no editing) and as it is data for all commercial fishing, i.e. not a sample, no analyses are used for the Ministry of Fisheries Catch Effort data. The data is listed by individual fishing events (one fishing incident, associated with estimated catch and effort data), therefore the total harvest amounts by species and fishing year are found by simple addition and are added to the final harvest estimates.

The precision of the locations of each fishing event differ, for example one fishing event's location may include the co-ordinates of the start of the event, making the location very precise, and other fishing event's location may only include a statistical area, meaning we only know the statistical area the event started, and not it's exact location. This means adding the commercial data to maps was not straightforward and methods for the final maps are given in Chapter 7.2.1.

Note that the commercial fishing data does not include information about fish dumping or by-catch (when it is not landed). We make allowances for these in our final estimates.

Chapter 10

Methods and results: Recreational fishing harvest

The three recreational surveys used in this research are used in different ways. The NMRFS 2000 is used to make overall harvest estimates within Ngāti Kahungunu Iwi, by adjusting the harvest estimates from the NMRFS 2000. The Hawke’s Bay Sport Fishing Club Fin Fish Survey and the Moremore reserve survey are weighted up to represent recreational fishing in Ngāti Kahungunu Iwi however are not used in the final estimates in Chapter 13. The estimates produced by weighting up these two surveys are used for comparison with the adjusted estimates from the NMRFS 2000 survey.

This chapter describes the methods used for each dataset, and gives harvest estimates for recreational fishing in Ngāti Kahungunu rohe moana.

10.1 Recreational harvest estimates (NMRFS 2000)

This section describes the methodology used to estimate the recreational fishing harvest in Ngāti Kahungunu rohe for the 2007 - 2010 fishing years. A number of different sources are used to estimate the recreational fishing harvest for this time frame including:

- Total New Zealand harvest estimates from the NMRFS 2000 (T_i^{NMRFS} , where i = the species of interest for this research)

- An estimate of fisher prevalence from the NMRFS 2000 (θ_{NMRFS}) as well as a more recent estimate of fisher prevalence from SPARC, 2009 (θ_{SPARC})
- An estimate of proportion of fish caught within FMA2 relative to New Zealand as a whole from the NMRFS 2000 (p_i , where i = the species of interest for this research)
- The total adult New Zealand population size in 2001 from Statistics New Zealand (N_{2001})
- The total adult population size of New Zealand (N_{2006}^{NZ}), FMA2 (N_{2006}^{FMA2}) and Ngāti Kahungunu (N_{2006}^{NK}) from the 2006 Census from Statistics New Zealand

Note the estimates of fisher prevalence (θ_{NMRFS} and θ_{SPARC}) represent proportions of the adult population who fish, in New Zealand and all estimates of recreational fishing are given for the adult population. The adult population is defined as all people over 15 years of age. The estimate of fisher prevalence, θ_{SPARC} , actually relates to all adults aged 16 and over, however we make the assumption that the estimates of fisher prevalence θ_{SPARC} applies to the whole population aged 15 and over.

The methods we use to estimate the total recreational harvest in Ngāti Kahungunu rohe moana are broken down into the following steps:

- Step 1** We define several sets of (species dependent) geographical boundaries and give population sizes for these boundaries.
- Step 2** We state the estimated recreational harvest in all of New Zealand and in FMA2 for all target species from the NMRFS 2000
- Step 3** We use the estimated recreational harvest in FMA2 for each species from the NMRFS 2000 combined with the population sizes from Step 1 to obtain an estimate of mean catch per fisher per year from FMA2. This is the only information taken used from the NMRFS2000.
- Step 5** Using the estimate of mean catch per fisher per year from FMA2 and the number of recreational fishers in Ngāti Kahungunu rohe we calculate the final recreational harvest estimates for all species.

We now describe these steps in greater detail, further defining additional notation as required.

Step 1

In this step we use the different geographical boundaries among species to estimate the population size for the different FMA2 areas.

To estimate the population size for FMA2, as management areas defined in the ocean do not have an associated defined area on land, we first need to define land areas that correspond to the different FMAs used for the species in this research.

There are four different geographical areas used in this research, see Chapter 5, and for clarity are defined in this chapter as; FMA2 (General), FMA2 (Extended), FMA2 (CRA4) and an additional version of FMA2 specific to the Ngāti Kahungunu Iwi, FMA2 (NK).

The ocean area associated with the three standard FMA2 areas are shown in Figure 10.1. Note Ngāti Kahungunu does not have overall boundaries defined off-shore i.e. for the entire Iwi, rather than just gazetted areas (rohe moana), so no image is given.

(a) FMA2 (General)

(b) FMA2 (Extended)

(c) FMA2 (CRA4)

Figure 10.1: The ocean area associated with the three versions of FMA2. Source: Ministry of Fisheries.

The land areas assumed to be associated with these different areas are shown in Figure 10.2. These maps have been made using ArcGIS.

The species associated with FMA2 (General) are:

- Kina
- Gurnard
- Kahawai
- Snapper
- Tarakihi
- Trevally

The species associated with FMA2 (Extended) are:

- Pāua
- Flatfish
- Red Cod

And finally the FMA for Rock Lobster, which differs from all other species in this research and is slightly smaller than the general FMA2, and is referred to in this research as FMA2 (CRA4).

Notation:

$N_{2006}^{FMA2(General)}$ = Estimated adult population size within the general FMA2 boundaries from the 2006 population census [74] = 479154.

$N_{2006}^{FMA2(Extended)}$ = Estimated adult population size within the extended FMA2 boundaries from the 2006 population census [74] = 758528.

$N_{2006}^{FMA2(CRA4)}$ = Estimated adult population size within the Rock Lobster FMA2 (CRA4) boundaries from the 2006 population census [74] = 477330.

$N_{2006}^{FMA2(NK)}$ = Estimated adult population size within the Ngāti Kahungunu rohe boundaries from the 2006 population census [74] = 157563.

(a) FMA2 (General)

(b) FMA2 (Extended)

(c) FMA2 (CRA4)

(d) FMA2 (NK)

Figure 10.2: The land area assumed to be associated with the three versions of FMA2 and Ngāti Kahungunu rohe, by territorial authority

θ^{NMRFS} = Proportion of population that fish as estimated from the NMRFS 2000 = 16.6.
We assume $\theta_i = \theta$, i.e. all fishers harvest all types of fish.

θ^{SPARC} = Proportion of population that fish as estimated from the 2007/08 Active New Zealand Survey [69]. We assume $\theta_i = \theta$, i.e. for simplicity we assume all fishers harvest all types of fish.

$N_{2006}^{FMA2(NK_{fishers})} = N_{2006}^{FMA2(NK_{fishers})} \theta_{SPARC}$ = The number of recreational fishers in Ngāti Kahungunu rohe = 26151.

The population sizes used come from 2006 population census run by Statistics New Zealand [74]. It is important to note that while the census population counts are not estimates, these population counts for the FMA areas are estimates as the land areas in Figure 10.2 are a “best guess” at the land area associated with the FMA boundaries.

The population for each area in Figure 10.2 uses the 2006 population count by either Region or Territorial Authority [75]. Table 10.1 shows the population count for the area associated with FMA2 (General), Table 10.2 shows the population count for the area associated with the FMA2 (Extended) boundaries, and Table 10.3 shows the population count associated with FMA2 (CRA4), which differs from the other FMAs. The Ngāti Kahungunu population always remains the same and is given in Table 10.4.

Table 10.1: Adult population count for Territorial Authorities within FMA2 (General).
Source: Statistics New Zealand

Territorial Authority	Population count, 2006
Gisborne	32811
Wairoa	6264
Hastings	53739
Napier	43644
Central Hawkes Bay	10041
Tararua	13413
Masterton	17820
Carterton	5604
South Wairarapa	7038
Lower Hutt City	75354
Wellington City	147693
Porirua City territorial authority	35814
Upper Hutt City	29919
Total $N_{2006}^{FMA2(General)}$	479154

Table 10.2: Adult population count for Regions within the FMA2 (extended). Source: Statistics New Zealand

Region	Population count, 2006
Taranaki	81444
Manawatu-Wanganui	174003
Hawke's Bay	113799
Gisborne	32811
Wellington	356471
Total $N_{2006}^{FMA2(Extended)}$	758528

Table 10.3: Adult population count for Territorial Authorities within CRA4. Source: Statistics New Zealand

Territorial Authority	Population count, 2006
Hastings	53739
Napier	43644
Central Hawkes Bay	10041
Tararua	13413
Masterton	17820
Carterton	5604
South Wairarapa	7038
Lower Hutt City	75354
Wellington City	147693
Porirua City territorial authority	35814
Upper Hutt City	29919
Kapiti Coast	37251
Total $N_{2006}^{FMA2(CRA4)}$	477330

Note regions have been used for Table 10.2, and Territorial Authorities have been used for Tables 10.1 and 10.3 because the two latter areas are smaller, and Territorial Authority areas better match the FMA2 (General) area and the FMA2 (CRA4) area. As the FMA2 (Extended) area land area is larger, regional areas are used.

Table 10.4 shows the population counts for the Territorial Authority areas within Ngāti Kahungunu rohe only and the estimated amount of fishers using $\theta_{SPARC,i}$, see Section 6.2.3. Note that the Territorial Authority boundaries used by Statistics New Zealand differ from the boundaries of Ngāti Kahungunu rohe, however, all of the main towns have been included. See Figure 1.1 for the true Ngāti Kahungunu boundaries.

Table 10.4: Adult population counts for the Territorial Authority areas within Ngāti Kahungunu rohe, from the usually resident population account, 2006 [74], and the estimated amount of recreational fishers based on the 2009 SPARC estimate of 16.6% [69]

Territorial Authority	Usually resident population count, 2006	Estimated number of fishers (16.6%)
Wairoa	6264	1039
Hastings	53739	8920
Napier	43644	7244
Central Hawkes Bay	10041	1666
Tararua	13413	2226
Masterton	17820	2958
Carterton	5604	930
South Wairarapa	7038	1168
Total	157563	26151
	$N_{2006}^{FMA2(NK)}$	$N_{2006}^{FMA2(NK_{fishers})}$

In this step we have estimated the population size for each geographical boundary and estimated the number of fishers in Ngāti Kahungunu rohe.

Step 2

In this step we state the estimated recreational fishing harvest from the NMRFS 2000.

Notation:

T_i^{NMRFS} = The total New Zealand harvest from the NMRFS 2000 for species i .

$T_{i,FMA2}^{NMRFS}$ = The total FMA2 harvest from the NMRFS 2000

$p_i = \frac{T_{i,FMA2}^{NMRFS}}{T_i^{NMRFS}}$ = the proportion of the national total catch that comes from FMA2.

Table 10.5 shows the recreational estimates from the NMRFS 2000 for New Zealand, FMA2 and the proportion of fish harvested in FMA2 only.

Table 10.5: Recreational estimates from the NMRFS 2000 for New Zealand, FMA2 and the proportion of fish harvested in FMA2 only

Species	Total New Zealand harvest T_i^{NMRFS} (kg)	Total FMA2 harvest $T_{i,FMA2}^{NMRFS}$ (kg)	Proportion of fish harvested in FMA2 only p_i (%)
Rock Lobster	1302000	371000	28.5
Pāua	2037000	1277000	62.7
Kina	3066000	1026000	33.5
Flatfish	1591000	380000	23.9
Gurnard	820000	209000	25.5
Kahawai	4418000	1808000	40.9
Red Cod	290000	39000	13.4
Snapper	7883000	268000	3.4
Tarakihi	1533000	310000	20.2
Trevelly	933000	153000	16.4

Step 3

In this step we use the harvest estimates for FMA2 for each species from the NMRFS 2000 and the population sizes for each FMA2 (FMA2 (General), FMA2 (Extended) and FMA2 (NK), to obtain an estimate of mean catch per fisher per year. This information is not available in the NMRFS 2000 report [4]. Note the estimates of population size for each FMA may differ for the NMRFS 2000, which will result in different estimates of mean harvest per fisher compared with published estimates in the NMRFS 2000 report.

The NMRFS 2000 was run in during the 1999/2000 fishing so we therefore make the assumption that the mean catch per fisher during the 1999/2000 fishing year is the same during the whole timeframe of this study (2007-2010 fishing year).

As a reminder, during the NMRFS 2000 the total recreational harvest in New Zealand was estimated using a telephone survey, a boat ramp survey and by having between 2500-3000 recreational fishers keep diaries of recreational harvest over a 12 month period. See Section 6.2.1 for a more detailed summary about the NMRFS 2000.

Notation:

$T_{2000,i}^{NMRFS}$ The total New Zealand recreational harvest estimates from the NMRFS 2000, for species i .

$T_{2000,i}^{FMA2}$ = The recreational harvest estimates for FMA2 from the NMRFS 2000, for species i .

$\bar{t}_{2000,i}^{FMA2}$ = Mean catch per fisher from the NMRFS 2000 in FMA2, for species i .

We assume $\bar{t}_{2000,i}^{FMA2} = \bar{t}_i^{FMA2}$, i.e. the mean harvest amount for species i is constant over all fishing years.

Note the total New Zealand recreational harvest estimates from the NMRFS 2000 are:

$$T_{2000,i}^{NMRFS} = \theta^{NMRFS} N_{2001} \bar{t}_{2001,i},$$

where $\theta^{NMRFS} = 31\%$ = the NMRFS estimate of the proportion of the total New Zealand population that fish recreationally, $N_{2001} = 2889537$ = the total New Zealand adult population size [74] where $\bar{t}_{2000,i} \approx \bar{t}_{2001,i}$, and $\bar{t}_{2001,i}$ = the mean catch per person in 2001 for species i .

We assume the estimate of fisher prevalence, θ^{NMRFS} , is the same for all species. Therefore $\bar{t}_{2001,i}$ assumes all fishers harvest all types of fish.

Therefore the mean recreational harvest estimates per adult for FMA2 from the NMRFS 2000 are calculated by:

$$\bar{t}_{2000,i}^{FMA2} = \frac{T_{2000,i}^{FMA2}}{\theta^{NMRFS} N_{FMA_i}}$$

Note the true mean recreational harvest estimates for FMA2 from the NMRFS 2000 may differ due to a difference in the estimated FMA2 population size N_{FMA_i} . That is the population size for the NMRFS 2000 may have been different to the population size we used, as there is no single definition of the population that relates to FMA2, resulting in a different mean catch per person.

As an example the mean recreational harvest estimate for Rock Lobster in FMA2 per person per year is:

$$\begin{aligned}
\bar{t}_{2000,RL}^{FMA2(CRA4)} &= \frac{T_{2000,i}^{FMA2(CRA4)}}{\theta^{NMRFS} N_{FMA(CRA4)}} \\
&= \frac{371000}{0.31 \times 477330} \\
&= \frac{371000}{147972} \\
&= 2.5kg
\end{aligned}$$

These estimates are shown in Table 10.6.

Table 10.6: Recreational estimates from the NMRFS 2000 for FMA2 and the average harvest per person in kilograms

Species	Total $FMA2_i$ recreational harvest estimate (kg)	Mean harvest estimate per person (kg)
Rock Lobster	371000	2.5
Pāua	1277000	5.4
Kina	1026000	6.9
Flatfish	380000	1.6
Gurnard	209000	1.4
Kahawai	1808000	12.2
Red Cod	39000	0.2
Snapper	268000	1.8
Tarakihi	310000	2.1
Trevelly	153000	1.0

Note the estimate of mean recreational harvest per fisher in FMA2 only ($\bar{t}_i^{FMA2}$), for species i , calculated in this step will be the only information used from the NMRFS 2000 to estimate the recreational harvest in Ngāti Kahungunu rohe moana.

Step 4

In this step we calculate final recreational harvest estimates in Ngāti Kahungunu rohe moana.

This is done by simply taking the mean recreational harvest estimates in FMA2 for each species, from Step 3, and multiplying it by the number of recreational fishers the Ngāti Kahungunu rohe.

The total recreational harvest estimates for Ngāti Kahungunu rohe moana are:

$$T_i^{NK} = \bar{t}_{2000,i}^{FMA2} N_{2006}^{FMA2(NK_{fishers})}$$

.

As an example recreational harvest estimate for Rock Lobster in Ngāti Kahungunu rohe moana per year is:

$$\begin{aligned} T_{RL}^{NK} &= \bar{t}_{2000,RL}^{FMA2(CRA4)} N_{2006}^{FMA2(NK_{fishers})} \\ &= 2.5 \times 26151 \\ &= 65377.5kg \end{aligned}$$

These estimates are shown in Table 10.7.

Table 10.7: Recreational estimates from the NMRFS 2000 for FMA2 and the adjusted estimate of fish harvested in Ngāti Kahungunu rohe moana only

Species	Total FMA2 recreational harvest estimate (kg)	Harvest estimate (kg)
Rock Lobster	371000	65576.5
Pāua	1277000	142040.5
Kina	1026000	180661.4
Flatfish	380000	42267.3
Gurnard	209000	36801.4
Kahawai	1808000	318358.4
Red Cod	39000	4338.0
Snapper	268000	47190.3
Tarakihi	310000	54585.8
Trevelly	153000	26940.7

Assumptions used in 10.1. Recreational fishing in New Zealand was the same fromm 2006-2010, as it was in 1999-2000.

16.6% (θ^{SPARC}) of the New Zealand population over 16 years old fish (marine only) at least once per year

Both estimates of fisher prevalence (θ^{NMRFS} and θ^{SPARC}) are the same for all species. Therefore we assume all fishers harvest all types of fish.

Our assumption that all fishers are the same (catch the same amount, and catch all species) is reasonable since we are only using these calculations to estimates total catch in the whole region.

10.2 Volunteer recreational surveys

This section presents the methods used and overall findings for the two volunteer recreational surveys: the Hawkes Bay Sport Finfish survey and the Moremore Reserve survey described in Section 6.2.2.

The two volunteer recreational surveys are scaled up separately and the results are combined to represent the total recreational harvest in the Wellington Kahungunu rohe moana. Note the harvest amounts estimated in this section have not been used in the final harvest estimates for Ngāti Kahungunu rohe moana, but are used as a comparison only. The estimates in this section are compared with the modified recreational harvest estimates from the NMRFS 2000, see Section 10.1.

The methods used to scale the results to represent the recreational harvest amounts in Ngāti Kahungunu rohe moana for both surveys individually are explained. The results from both surveys are then displayed together in Section 10.2.3.

10.2.1 Hawke’s Bay Sport Fishing Club Finfish Survey

The Hawke’s Bay Sport Fishing Club Finfish Survey is a sample of recreational fishing, taken from the upper region of Ngāti Kahungunu rohe.

The recorded harvest amounts from the HBSFC Finfish Survey $T_{year,i}^H$, for species i , are scaled up to estimate the recreational fishing catch from all fishing clubs in Ngāti Kahungunu rohe $T_{year,i}^{Clubs}$, for species i

To make these estimates the number of members registered to fishing clubs within Ngāti Kahungunu rohe ($n_{members}$) and an average harvest amount for each species, per person, per fishing year, during the Hawke’s Bay Sport Fishing Club Finfish Survey ($\bar{t}_{year,i}^H$, for species i), is needed. This section estimates these values and uses them to estimate the total recreational fishing harvest during fishing competitions in Ngāti Kahungunu rohe moana ($T_{year,i}^{Clubs}$).

Boat clubs

To estimate the number of people registered to fishing clubs in Ngāti Kahungunu rohe moana ($n_{members}$) a list of all fishing clubs is needed. A list of fishing clubs can be found through the Fishing Website (www.fishing.net.nz), however, the other information was not freely available online.

Firstly, each club was contacted directly via email and phone and asked how many members

were registered to their club, as well as how many competitions they run each year. Of the 11 fishing clubs in Ngāti Kahungunu rohe six clubs replied and this information was given. Both the New Zealand Sport Fishing Council and the New Zealand Angling & Casting Association were then contacted for information about the remaining clubs, however, neither of these organisations responded to emails. The number of members is available for fishing clubs registered with the NZ Sport Fishing Council through their 2011 yearbook [11] and this information was used if the fishing club did not reply to emails. To estimate the number of members registered to the remaining clubs local fishermen were also asked to give a best guess at the size of the remaining clubs, however, no person asked was sure. We therefore estimated the number of members for these remaining clubs using the information from other clubs. It is known that the Hawkes Bay Sport Fishing Club is the largest club within Ngāti Kahungunu rohe, therefore, an average number of members for the known clubs was calculated, excluding the Hawkes Bay Sport Fishing Club to avoid overestimates i.e. the Hawkes Bay Sport Fishing Club is treated as an outlier. This also seems a reasonable thing to do as 4 of the 5 fishing clubs with no information are from areas with much smaller populations in comparison to the Hawke’s Bay, and are therefore likely to have substantially fewer members.

There are 10 fishing clubs registered with either the New Zealand Sport Fishing Council or the New Zealand Angling & Casting Association within the Ngāti Kahungunu rohe, and a further 11 fishing clubs close to the Ngāti Kahungunu boundaries, i.e. in Mahia, Gisborne and Wellington combined. Within the Kahungunu rohe the Hawkes Bay Sport Fishing Club is the largest of the fishing clubs. Table 10.8 shows a list of boat clubs within Kahungunu rohe, the number of competitions they run each year and the number of members registered to the club. The average number of members for the fishing clubs with a known number of members (excluding the Hawkes Bay Sport Fishing Club) is 246 members. This amount is assigned to fishing clubs that did not reply and is marked in Table 10.8 with an asterisk.

Table 10.8: Fishing clubs in the Ngāti Kahungunu rohe registered with either the New Zealand Sport Fishing Council or the New Zealand Angling & Casting Association, 2011, and the number of competitions run each year and the number of members registered to each club. For example the Akitio Boating Club Inc has 400 registered members, they are registered with the NZ Sport Fishing Council and it is unknown how many competitions the club runs each year.

Club	Competitions per year	Members	Registered with
Akitio Boating Club Inc	–	400	NZ Sport Fishing Council
Hawkes Bay Sports Fishing Club Inc	10 (4 of which are open to the public)	1030	NZ Sport Fishing Council
Ngawi Sports Fishing Club Inc	13 (1 of which is open to the public, lasting three days)	620	NZ Sport Fishing Council
Porangahau Fishing Club	5 (3 of which are open to public)	143	NZ Sport Fishing Council
Twin Harbours Fishing Club Inc	6 ¹	54	NZ Sport Fishing Council
Wairarapa Sports Fishing Club Inc	–	246*	NZ Sport Fishing Council
Paikea Fishing Club	–	246*	NZACA
Pania Surfcasting Club	–	246*	NZACA
Wairoa North Clyde Surfcasting Club	–	246*	NZACA
Wairoa Surfcasting Club	–	246*	NZACA
Wairarapa Surfcasting Club	11	14	NZACA
Total n_{members}		3491	

¹ Club members go out on charters on average each 2 months and the catch totals accumulate through the year and count toward one competition.

* The number of members has been estimated using the mean number of members for all other clubs, excluding the HBSFC as it has been treated as an outlier.

The estimated number of people registered at fishing clubs within Ngāti Kahungunu rohe is estimated to be:

$$n_{members} = 3491$$

Fishing club harvest estimates

The total estimated harvest for fishing clubs within Ngāti Kahungunu rohe is:

$$T_{year,i}^{Clubs} = \frac{\bar{t}_{year,i}^H}{r} n_{members}$$

where i = species, r = the response rate (56%), $n_{members}$ = the number of members registered to fishing clubs in Ngāti Kahungunu rohe (3491) and

$$\bar{t}_{year,i}^H = \frac{T_{year,i}^H}{n_{HBSFC}}$$

where $T_{year,i}^H$ = the total harvest amount from the HBSFC Finfish Survey by fishing year and species i and n_{HBSFC} = the number of members registered to the HBSFC (1030).

As an example the total recreational harvest from fishing clubs for Kahawai during the 2007 fishing year in Ngāti kahungunu rohe moana is:

$$\begin{aligned} T_{2007,Kahawai}^{Clubs} &= \frac{0.9}{0.56} \times 3491 \\ &= 5610.5kg \end{aligned}$$

where:

$$\begin{aligned} \bar{t}_{2007,Kahawai}^H &= \frac{951.7}{1030} \\ &= 0.9 \end{aligned}$$

Note 586 Kahawai were caught during the HBSFC Finfish Survey and using the conversions

from Chapter 8.1 this equates to 951.7kg.

Table 10.9 shows the estimated harvest amount by species and fishing year for fishing that takes place during fishing competitions in Ngāti Kahungunu rohe. Table 10.9 also shows the catch per person, per year, from the Hawke’s Bay Sport Fishing Club Finfish Survey ($\bar{t}_{year,i}^H$). Note there were no Rock Lobster, Pāua, Kina or Flatfish caught during the Hawke’s Bay Sport Finfish Survey.

Table 10.9: Estimated harvest amount from fishing clubs by species and year, calculated using the Hawke’s Bay Sport Finfish Survey. For example in 2007 2249.5kg of Gurnard was caught during the survey, which equates to 3.93kg per person. The total estimated harvest of Gurnard from fishing clubs within Ngāti Kahungunu rohe in 2007 is 13714.6kg.

Species	Fishing year	Harvest amount (kg)	Harvest per person (kg)	Total estimated harvest (kg)
Gurnard	2007	2249.5	3.93	13714.6
	2008	2664.1	4.64	16208.2
	2009	2839.5	5.00	17455.0
	2010	1952.7	3.39	11844.5
Kahawai	2007	951.7	1.61	5610.5
	2008	1310.6	2.32	8104.1
	2009	1528.2	2.68	9350.9
	2010	1307.3	2.32	8104.1
Red Cod	2007	16.8	0.00	0.0
	2008	39.3	0.00	0.0
	2009	13.9	0.00	0.0
	2010	14.7	0.00	0.0
Snapper	2007	4284.8	7.50	26182.5
	2008	6670.9	11.61	40520.5
	2009	5961.2	10.36	36156.8
	2010	4014.3	6.96	24312.3
Tarakihi	2007	466.9	0.89	3117.0
	2008	629.6	1.07	3740.4
	2009	625.2	1.07	3740.4
	2010	669.6	1.25	4363.8
Trevally	2007	265.7	0.54	1870.2
	2008	313.8	0.54	1870.2
	2009	214.4	0.36	1246.8
	2010	270.9	0.54	1870.2

The estimates made from the Hawke’s Bay Sport Fishing Club Finfish Survey are uncertain for the following reasons:

- The true number of fishing clubs may be incorrect
- The number of registered members to fishing clubs is not known
- Only 56% of boats were surveyed during the competitions (over the four years the competition was run)
- If a fisher said they harvested more than 30 fish the surveyor would only record a maximum of 30 fish harvest, to avoid over estimates from the fishermen. This also implies the fish may not have always been counted
- The Hawke’s Bay Sport Fishing Club is the largest of all clubs and it is likely they would harvest more fish than other clubs, especially those who run less competitions per year
- It is assumed the number of members registered to the Hawke’s Bay Sport Fishing Club remained constant throughout the period of the survey (2007-2010)

Assumptions used in 10.2. The number of registered members to the Hawke’s Bay Sport Fishing Club is constant from 2007-2010.

The number of members registered to fishing clubs who were unable to be contacted was estimated to be 246 per club.

There are an estimated 3491 people registered to boat clubs in Ngāti Kahungunu who fish during competitions.

10.2.2 Moremore Reserve Recreational Survey

The Moremore Survey is a sample of recreational fishing, taken from the upper region of Ngāti Kahungunu rohe.

The recorded harvest amounts from the Moremore Reserve Survey $T_{year,i}^{MR}$, for species i , are scaled up to estimate the recreational fishing catch from all recreational fishing boats fishing

outside of competitions in Ngāti Kahungunu rohe $T_{year,i}^{Boats}$, for species i . To make these estimates the number of people who fish from boats each year is needed, however this number is not available. As a substitute the number of boat ramps and other boat launching locations in Ngāti Kahungunu rohe were collected.

This section estimates these values and uses them to estimate the total recreational fishing harvest from all recreational fishing boats fishing outside of competitions in Ngāti Kahungunu rohe moana $T_{year,i}^{Boats}$.

Boat Ramps, Beach Launching and Marinas

There are eight boat ramps within the Ngāti Kahungunu rohe, and a further seven close to the Ngāti Kahungunu boundaries, i.e. in Wellington and Mahia combined. There is one Marina in the Ngāti Kahungunu rohe, which is situated in Napier, and a further six close to the Ngāti Kahungunu boundaries, i.e. five in Wellington and one in Gisborne. Along the coast, from the south of Napier, to the southern boundaries of the Kahungunu rohe, launching boats is predominantly done on the beach. There are 15 beaches where boats are launched within the rohe.

Table 10.10 shows a list of Marinas, Boat ramps and beaches where it is known recreational and/or commercial fishers launch their boats within the Kahungunu rohe. Other than the location of the Wellington boat ramps this information was not freely available online so local councils were contacted directly. The Tararua, South Wairarapa and Masterton District Councils did not hold a list of boat launching locations (ramps or beach). The information for these areas was obtained from the Access and Recreation Technical Report prepared as part of the Wairarapa Coastal Strategy [10]. The Napier City Council was only able to advise the number of boat ramps in the Napier Inner Harbour, however, the Hawkes Bay Regional Council was able to provide a full list of all boat ramps, known beach launching locations and Marinas within the Hawkes Bay. As the Wellington City council has a full list of boat ramps and Marinas on their website so there was no need to contact them directly. Given only the Wellington and Hawkes Bay regions were able to provide full lists of Boat ramps, Marinas and shore launching locations, it is likely there may be missing locations between these two regions. Of the 38 locations listed in Table 10.10 27 are within Ngāti Kahungunu rohe. Only the 27 locations will be used for the estimates in Table 10.11, however, it is likely boats are launched from the other 11 locations fish within the Ngāti Kahungunu rohe moana.

Table 10.10: Boat ramps, shore launching sites and Marinas in or close to Ngāti Kahungunu rohe. Locations outside of Ngāti Kahungunu rohe are indicated with an asterisk.

Name	Type
Seaview Marina*	Marina (253 Berths)
Clyde Quay*	Marina (75 moorings)
Evans Bay Marina*	Marina (150 Berths)
Chaffers Maina*	Marina (165 Berths)
Mana Marina*	Marina (350 Berths)
Napier Marina	Marina
Eastland Port Marina*	Marina (69 Berths)
Evans Bay*	Boat ramp
Owhiro Bay*	Boat ramp
Lyllall Bay*	Boat ramp
Seatoun Beach*	Boat ramp
Makara Beach*	Boat ramp
Clive Boat Ramp	Boat ramp
Napier sailing club	Boat ramp
Ngaruroro river	Boat ramp
Clifton Marine	Boat ramp
Waimarama Boat Ramp	Boat ramp
Porangahau Boat Ramp	Boat ramp
Waioara Water Ski	Boat ramp
Waioara Sailing club	Boat ramp
Mahia fish and boat club	Boat ramp
Whangawehi	Boat ramp
Akitio	Shore launching
Tora	Shore launching
Castlepoint	Shore launching
Riversdale	Shore launching
Ngawi	Shore launching
Herbertvile	Shore launching
Meeanee Quay	Shore launching
Kairakau	Shore launching
Pourere	Shore launching
Aramoana	Shore launching
Black head	Shore launching
Porangahau Beach	Shore launching
Waikari river	Shore launching
Mohaka	Shore launching
Waikokopu	Shore launching

Recreational fishing boat harvest estimates

Unfortunately the size of the activity in terms of fishing harvest at each location was unknown. I therefore was unable to scale the total harvest from each boat ramp during the Moremore Reserve Survey in a sensible way, as it is likely each location has a varying amount of activity. For example there are likely to be more boats leaving a marina to fish, compared with a shore launching location, resulting in a larger amount of fishing harvest. For the purpose of making a total catch estimate we assume all boat launching locations have an equal amount of activity.

The recorded harvest amounts from the Moremore Reserve Survey $T_{year,i}^{MR}$, for species i , are first adjusted to represent fishing for the entire fishing year. The estimated harvest amounts for recreational fishing boats, launching from the boat ramps surveyed during the Moremore Reserve Survey are:

$$T_{year,i}^{MR*} = \frac{T_{year,i}^{MR}}{\phi},$$

where ϕ = the percentage of days surveyed in each fishing year.

During the 2008 fishing year only 3 days were surveyed, which equates to 0.8% of the year. During the 2008 fishing year only 17 days were surveyed, which equates to 4.6% of the year. During the 2007/08 Active NZ Survey [69], which has been used to estimate fisher prevalence in this research, see Section 6.2.3, it was found that the level of fishing activity does not differ over the days of the week. We therefore assume all days throughout the year have the same level of fishing activity. Note some species may show seasonal variation, however, due to the small timeframe of this survey, no adjustments have been made for this.

During the Moremore Reserve Survey four boat ramps were surveyed, therefore the average harvest per boat ramp is simply:

$$T_{year,i}^{Ramp} = \frac{T_{year,i}^{MR*}}{4}$$

As an example the estimated Rock Lobster harvest from boat ramps surveyed during the Moremore Reserve Survey in the 2008 fishing year is:

$$\begin{aligned}
T_{2008,RL}^{Ramp} &= \frac{\frac{T_{2008,RL}^{MR}}{\phi}}{4} \\
&= \frac{\frac{73.8}{0.008}}{4} \\
&= \frac{9225}{4} \\
&= 2306.25kg
\end{aligned}$$

Note 82 Rock Lobster were caught during the Moremore Reserve Survey and using the conversions from Chapter 8.1, including adjustments for sexual dimorphism, this equates to 73.8kg.

A very rough estimate of total fishing harvest from all recreational fishing boats fishing outside of competitions is given by:

$$T_{year,i}^{Boats} = T_{year,i}^{Ramp} \psi,$$

where ψ = the number of boat launching locations in Ngāti Kahungunu rohe (27), see Table 10.10.

Therefore, the total recreational fishing harvest from all recreational fishing boats fishing outside of competitions for Rock Lobster during the 2008 fishing year is:

$$\begin{aligned}
T_{2008,RL}^{Boats} &= 2306.25 \times 27 \\
&= 62268.8kg
\end{aligned}$$

Note this estimate is uncertain as this estimate has been made using data sampled over only three days of the fishing year. This estimate is made to show the how uncertain harvest estimates become with little information.

Table 10.11 displays the estimates for the total recreational fishing harvest from all recreational fishing boats fishing outside of competitions, in Ngāti Kahungunu rohe moana.

Table 10.11: Estimated harvest amount from fishing boats by species and year, calculated using the Moremore Reserve Survey. For example in 2008 73.8kg of Rock Lobster was harvested during the Moremore Reserve Survey, which has been scaled up to represent all harvest in Ngāti Kahungunu rohe moana and the estimate of this is 62268.8kg.

Species	Fishing year	Harvest amount (kg)	Total estimated harvest (kg)
Rock Lobster	2007	—	—
	2008	73.8	62268.8
	2009	78.3	11489.7
	2010	—	—
Pāua	2007	—	—
	2008	0	0.0
	2009	0	0.0
	2010	—	—
Kina	2007	—	—
	2008	0	0.0
	2009	0	0.0
	2010	—	—
Flatfish	2007	—	—
	2008	0.422	356.1
	2009	0	0.0
	2010	—	—
Gurnard	2007	—	—
	2008	47.953	40460.3
	2009	268.294	39369.2
	2010	—	—
Kahawai	2007	—	—
	2008	58.464	49329.0
	2009	344.288	50520.5
	2010	—	—
Red Cod	2007	—	—
	2008	0	0.0
	2009	0	0.0
	2010	—	—
Snapper	2007	—	—
	2008	34.814	29374.3
	2009	350.818	51478.7
	2010	—	—
Tarakihi	2007	—	—
	2008	0	0.0
	2009	40.656	5965.8
	2010	—	—
Trevally	2007	—	—
	2008	1.046	882.6
	2009	15.69	2302.3
	2010	—	—

The estimates made from the Moremore Reserve Survey are uncertain for the following reasons:

- The number of boat ramps and beach launching locations may be incorrect
- The response rate for the survey is not known
- There is no measure of the size of each boat ramp, shore launching location or marina, therefore all boat ramps are assumed to have the same level of activity
- The timeframe of the survey is relatively small and a full fishing year has not been surveyed. During the 2008 fishing year only 3 days were sampled and during the 2009 fishing year only 17 days were sampled.
- All days of the year are assumed to have the same level of fishing activity and no adjustments have been made for seasonal variation

10.2.3 Comparison with other recreational estimates

Recreational fishing can be split into three types; fishing during club competitions, fishing by boat outside of competitions, or fishing from the shore. During the 2007/08 Active NZ Survey [69], which has been used to estimate fisher prevalence in this research, see Section 6.2.3, it was found that 8.4% of people in New Zealand belonged to any type of club or centre in order to participate in fishing; 3.8% were members of a social club in order to participate in fishing; and 3.1% were members of a sport or physical activity club in order to participate in fishing. However, there were no estimates available for the amount of fishing activity by boat outside of competitions or shore fishing so we were unable to estimate the true amount of recreational fishing. The two volunteer recreational surveys only estimate recreational fishing from boats, during (HBSFC Finfish Survey) and outside of (Moremore Reserve Survey) fishing club competitions. These two estimates have been combined to represent recreational fishing and are displayed in Table 10.2.3. This estimate excludes all shore fishing i.e. from wharfs or beaches without a boat.

The estimates made in Section 10.2 are displayed with the estimates made in Section 10.1 (modified estimates of recreational harvest from the NMRFS 2000) in Table 10.2.3. Note this is done for interest only and the only estimates of recreational fishing used in the overall harvest estimates in the Ngāti Kahungunu rohe for this research are those made in Section

10.1 only. The recreational harvest estimates made in Section 10.2 are uncertain.

Table 10.12: Estimated harvest amounts from the Hawke’s Bay Sport Finfish Survey (HBSFS) and the Moremore Reserve Survey combined, and the NMRFS 2000. For example the harvest estimates of Rock Lobster in Ngāti Kahungunu rohe in 2007 from the HBSFS and the Moremore Reserve surveys combined is 0kg and the estimate we have used in this survey (modified estimate from the NMRFS 2000, see 10.1) is 65576.5kg.

Species	Fishing year	Volunteer surveys (kg)	NMRFS 2000 modified estimates (kg)
Rock Lobster	2007	0	65576.5
	2008	62269	65576.5
	2009	11490	65576.5
	2010	0	65576.5
Pāua	2007	0	142040.5
	2008	0	142040.5
	2009	0	142040.5
	2010	0	142040.5
Kina	2007	0	180661.4
	2008	0	180661.4
	2009	0	180661.4
	2010	0	180661.4
Flatfish	2007	0	42267.3
	2008	356	42267.3
	2009	0	42267.3
	2010	0	42267.3
Gurnard	2007	13715	36801.4
	2008	56669	36801.4
	2009	56824	36801.4
	2010	11844	36801.4
Kahawai	2007	5611	318358.4
	2008	57433	318358.4
	2009	59871	318358.4
	2010	8104	318358.4

Table 10.12: (Continued)

Species	Fishing year	Volunteer surveys (kg)	NMRFS 2000 modified estimates (kg)
Red Cod	2007	0	4338.0
	2008	0	4338.0
	2009	0	4338.0
	2010	0	4338.0
Snapper	2007	26183	47190.3
	2008	69895	47190.3
	2009	87636	47190.3
	2010	24312	47190.3
Tarakihi	2007	3117	54585.8
	2008	3740	54585.8
	2009	9706	54585.8
	2010	4364	54585.8
Trevally	2007	1870	26940.7
	2008	2753	26940.7
	2009	3549	26940.7
	2010	1870	26940.7

Figure 10.3 displays the information from Table 10.2.3 for Rock Lobster, Pāua and Kina.

Figure 10.3: Estimated harvest amounts (kg) from the Hawke's Bay Sport Finfish Survey (HBSFS) and the Moremore Reserve Survey combined, and the adjusted NMRFS 2000 recreational harvest estimates for Rock Lobster, Pāua and Kina, for the 2007-2010 fishing years.

The Hawke's Bay Sport Finfish Survey (HBSFS) and the Moremore Reserve Survey were both surveys run collecting harvest information from fishing boats, which means it is likely the fishers were harvesting finfish, as apposed to Rock Lobster, Pāua or Kina. These species are usually harvested by shore divers and a boat is not needed to harvest them, however Rock Lobster can be caught recreationally using pots, which do require a boat. This explains why no Pāua or Kina were harvested.

As a reminder only 73.8kg and 78.3kg of Rock Lobster were harvested during the Moremore Reserve Survey for the 2007 and 2008 fishing years, respectively. It is important to keep in mind the harvest estimates shown in Table 10.2.3 and Figure 10.3 have been made using this small amount of information and are not reliable.

Figure 10.4 displays the information from Table 10.2.3 for finfish.

Figure 10.4: Estimated harvest amounts (kg) from the Hawke's Bay Sport Finfish Survey (HBSFS) and the Moremore Reserve Survey combined, and the adjusted NMRFS 2000 recreational harvest estimates for finfish, for the 2007-2010 fishing years.

Snapper and Gurnard are the only two species where the estimates from the volunteer surveys are greater than the adjusted NMRFS 2000 estimates of recreational fishing. These are both species that are often targeted during fishing competitions.

As a reminder the volunteer surveys have been scaled up to represent recreation fishing with very little information and these estimates are very uncertain.

Chapter 11

Methods and results: Customary fishing harvest

In the customary harvest data set there are two types of missing data. Firstly the data from one rohe moana, Kairakau Lands Trust was unavailable. Secondly, there is missing data for a number quarters for the other areas. As mentioned in Section 2.5, while it is a legal obligation for Kaitiaki to report back to the Ministry of Fisheries quarterly, there is no penalty for not doing so, which means there are some quarters where Kaitiaki have not reported back to the Ministry of Fisheries, resulting in missing data.

Imputation will be used to estimate both of these sources of missing data, and this section describes this process. All harvest amount are converted from individuals caught to kilograms using the methods described in 8.1. The total customary harvest estimates are then given.

11.1 Missing data: Kairakau Lands Trust

As data for Kairakau Lands Trust was unavailable, the catch for this area is assumed to be an average of the neighbouring gazetted areas, Waimarama and Ngāti Kere.

The coast lines in Waimarama and Ngāti Kere are very similar to that in Kairakau Lands Trust, and the overall population size, as well as the Māori population size, are also similar in Waimarama, Ngāti Kere and Kairakau Lands Trust. Therefore it is reasonable to assume the harvest in Kairakau Lands Trust will be similar to the harvest in its neighbouring rohe moana. Both nearest neighbour and mean imputation has been used to estimate the harvest

in Kairakau Lands Trust, where the mean harvest in Waimarama and Ngāti Kere, by quarter, is estimated to be the harvest amount for Kairakau Lands Trust. Note any missing values for Ngāti Kere will be imputed first, and the mean harvest will be estimated from this amount, see Section 11.2.

The harvest estimate for Rock Lobster, Pāua and Kina in Kairakau Lands Trust are 6.6%, 4.9% and 8.7%, respectively, of the total customary harvest estimate for Ngāti Kahungunu rohe moana. Care should be taken when reading harvest estimates in this area, as this data is an estimate only, given the information that is available. Anecdotal evidence suggests this area has very active Kaitiaki, in terms of issuing permits, as it is easy reasonably easy to access Napier and Hastings, however no adjustment been made for this.

11.2 Missing data: Missing quarters

Missing quarters arise for each area when Kaitiaki don't report back to the Ministry of Fisheries. While the exact reason Kaitiaki don't report back to the Ministry of Fisheries is not available, it could be for any number of reasons including: the Kaitiaki is away, or sick, or busy, or chooses not to report etc. Some Kaitiaki may also not report when they haven't issued any forms, therefore no customary fishing took place. This means when the are missing values for any quarter it is not known, firstly if fish were harvested or not, and secondly if fish were harvested, we do not know the true amount. Table 11.1 shows the number of missing quarters out of the total available quarters for each rohe moana.

Table 11.1: Quarters of customary reports available and missing, by rohe moana

Rohe moana	Period data available	Total quarters	Quarters missing	% of quarters missing
Ngā hapū o Waimārama	April 2007 - April 2011	24	12	50
Te Hika o Pāpāuma	January 2005 - April 2011	26	0	0
Ngāti Kere	January 2005 - April 2011	26	17	65
Ngāti Hinewaka me ona Karangaranga	October 2006 - April 2011	19	1	5
Ngāti Hawea	January 2006 - April 2011	22	3	14
Ngāi Tūmapuhiārangi, Ngāti Hamua	July 2008 - April 2011	12	2	17
Ngāi Te Ruruku o Te Rangi	October 2006 - April 2011	15	7	47
Total		144	42	29

An unusual aspect of Waimarama is that Kaitiaki only issue customary fishing permits for tangi, or funerals. Based on this it is likely the missing quarters mean there were no deaths, and therefore no permits issued. Therefore the missing data for Waimarama are not imputed and the missing values are treated as true zeros. All other quarters, for all other rohe moana are imputed.

There are three types of imputation that best suit this data are as follows:

Nearest neighbour imputation which can be split into two suitable types:

Nearest neighbour imputation: same quarter previous year The last observation under similar circumstances is used. For example if the quarter April - June 2008 is missing, the harvest will be assumed to be the same as the same quarter in the previous year, April - June 2007.

Nearest neighbour imputation: previous quarter same year The closest prior observation is used. For example if the quarter April - June 2008 is missing, the harvest will be assumed to be the same as the previous quarter, January - March 2008.

Mean imputation The mean harvest of known observations is used. For example if the quarter April - June 2008 is missing, the mean harvest from the other quarters in 2008 is used. If there are two missing quarters for a given year, the mean for the year is worked out using the two available quarters only. If there are three or four missing quarters in a year the mean of the previous year is used.

As the customary data set is relatively small, and we know little to nothing about the missing data, it is hard to estimate the uncertainty of the estimates when imputation is used. Therefore, to give the reader an idea about the amount of variation that occurs when different types of imputation are used. We carry out a sensitivity analyses and use all three types of imputation for comparison. The results are shown in Table 11.2 by species. This is known as sensitivity analyses.

Table 11.2: Customary harvest totals (kg) from 2006-2010 by species and estimated totals using three types of imputation. The increase in total harvest amount is given for each type of imputation

Species	No imputation	Same quarter previous year	Increase (%)	Mean	Increase (%)	Previous quarter same year	Increase (%)
Rock Lobster	21089	27058	22	27448	23	25573	18
Pāua	21283	26416	19	24854	14	25052	15
Kina	5640	7046	20	6529	14	7021	20

After imputing the missing values the harvest amounts increase from 13-25%, which seems reasonable considering 29% of quarters are missing, see Table 11.1.

To choose the final method of imputation, given the small amount of information that is available on customary catch, it is beneficial to look at harvest patterns for other types of fishing. As we've established, commercial harvest information is complete and of high quality.

Figure 11.1 shows the commercial catch of Rock Lobster (CRA4), Pāua (PAU2) and Kina (SUR2A and SUR2B), for 2007-2011, by month.

Figure 11.1: Quota Management Areas by species and species identification. Source: Ministry of Fisheries Info Site fs.fish.govt.nz

Notice, on average, the harvest of all species is greater in the Spring and Summer months (Oct-Feb). With this in mind previous quarter same year imputation will not be used, as imputing a harvest amount for the April - June quarter, using harvest amounts from the January - March quarter will likely result in overestimates. The commercial harvest for all species is similar in each month from year to year, therefore the type of imputation that is used for the missing values in the customary data is same quarter previous year imputation. When a quarter was missing and the same quarter in the previous year was also missing, the imputation was taken from the previous year again.

11.3 Customary harvest estimates

Tables 11.3, 11.4 and 11.5 show total customary harvest estimates for Ngāti Kahungunu rohe moana for Rock Lobster, Pāua and Kina, respectively.

Table 11.3: Total customary harvest estimates for Ngāti Kahungunu rohe moana for Rock Lobster and the corresponding allowance for FMA2 (CRA4). For example in 2007 the estimated customary harvest of Rock Lobster in Ngāti Kahungunu rohe moana is 1412kg, the CRA4 allowance is 35,000kg and the estimate of harvest as a percent of the allowance is 4%.

Fishing year	Estimated harvest (kg)	FMA2 allowance	al-	% of FMA2 allowance
2007	1412	35000		4.0
2008	3808	35000		10.9
2009	8021	35000		22.9
2010	7448	35000		21.3

Table 11.4: Total customary harvest estimates for Ngāti Kahungunu rohe moana for Pāua and the corresponding allowance for FMA2 (PAU2). For example in 2007 the estimated customary harvest of Pāua in Ngāti Kahungunu rohe moana is 2386kg.

Fishing year	Estimated harvest (kg)	FMA2 allowance	al-	% of FMA2 allowance
2007	2386	Not allocated		Unknown
2008	4398	Not allocated		Unknown
2009	6271	Not allocated		Unknown
2010	4436	Not allocated		Unknown

There is no allowance amount specified for either recreational or customary Pāua harvest.

Table 11.5: Total customary harvest estimates for Ngāti Kahungunu rohe moana for Kina and the corresponding allowance for FMA2 (KIN2). For example in 2007 the estimated customary harvest of Kina in Ngāti Kahungunu rohe moana is 570kg, the KIN2 allowance is 95,000kg and the estimate of harvest as a percent of the allowance is 0.6%.

Fishing year	Estimated harvest (kg)	FMA2 allowance	% of FMA2 allowance
2007	570	95000	0.6
2008	1093	95000	1.2
2009	2566	95000	2.7
2010	1590	95000	1.7

Although the percentage of customary Rock Lobster and Kina harvested in FMA2 only represent small percentages of each allowance, this does not imply the allowances are set too high for customary harvest. A number of things should be noted:

- The allowance corresponds to the total FMA and the estimates are given for Ngāti Kahungunu rohe moana only. This area is smaller than FMA2.
- As mentioned in Section 2.5.3, there is no measure of the amount of customary fishing as a whole, as it is likely the majority of Māori people fish using recreational rights, and currently there is no way to measure this activity and customary harvest has been defined in this study as that harvest caught on customary permits.
- As there are missing quarters, we do not know the true value of the customary harvest, i.e. these are estimated amounts given the information available.

Chapter 12

Methods and results: Other fishing harvest

The only data relating to illegal harvest that has been included in the total harvest estimates for Ngāti Kahungunu rohe moana is the data from the Ministry of Fisheries, see Section 6.4.

This chapter displays the data from the Ministry of Fisheries and the data from media reports after they have been converted from individuals to kilograms and also gives summary information about each data set. All catch has been converted into kilograms for consistency, using the information in Chapter 8. The conversions take into consideration undersize catch for Pāua and Rock Lobster, and differences between males and female Rock Lobster size.

As there are no harvest amounts available in the data from the Ministry of Justice, see Section B.1, no analyses have been made using this data.

Section 12.3 then compares the results from the data sources relating to illegal fisheries harvest.

12.1 Ministry of Fisheries - illegal harvest

The data from the Ministry of Fisheries is converted from individuals to kilograms. As a reminder from Chapter 8.1 the weight that is assigned to Pāua is 80% of the average weight of Pāua from Table 8.1, 0.325kg, which is 0.26kg. The weight that is assigned to undersize Rock Lobster is 80% of the average weight of Rock Lobster from Table 8.1, 0.640 for females

and 1.014 for males, which is 0.512kg and 0.8112kg respectively. An allowance is also be made for Rock Lobster sexual dimorphism, see Table 8.2.

There is no minimum legal size for Kina in New Zealand therefore the mean weight of Kina from Table 8.1 is used.

Table 12.1 shows the illegal harvest amount for Rock Lobster, Pāua and Kina by fishing year. The total harvest by individuals comes from Table 6.19 and the total harvest by kilograms is the sum of the converted weights from Table 6.20 and the weights in kilograms from Table 6.20.

Table 12.1: Illegal harvest amount for Rock Lobster, Pāua and Kina by fishing year recorded by the Ministry of Fisheries, also shown as a percentage of the illegal harvested for each fishing year for the species shown. For example, for all Rock Lobster, Pāua and Kina harvested illegally in the 2007 fishing year, 24.6% were Rock Lobster, 72.9% were Pāua and 2.5% were Kina by weight.

Species	Fishing year	Total harvest (in- dividuals)	Total (kg)	harvest	% of total ille- gal harvest by weight
Rock Lobster	2007	834	648.7		24.6
	2008	1015	1097.83		35.4
	2009	266	180.3		9.0
	2010	584	2396.7		60.4
Pāua	2007	7364	1921.6		72.9
	2008	4330	1985.8		64.1
	2009	6873	1788		89.5
	2010	5461	1419.9		35.8
Kina	2007	261	64.8		2.5
	2008	66	16.4		0.5
	2009	122	30.3		1.5
	2010	608	151		3.8

Notice more Pāua (and often Rock Lobster) is harvested illegally compared with other species. There are a number of factors that may contribute to this including:

- The legal harvest limit of Kina is relatively high (50 individuals per person per day), which may be a large enough amount that addition Kina do not need to be harvested

resulting in illegal harvest. The legal harvest limit of Pāua is 10 per person per day, and no person may have more than 20 Pāua on them at one time. The legal harvest limit of Rock Lobster is 6 per person per day.

- Pāua live in aggregations and are relatively slow moving, which can make them easy to harvest in large quantities.
- There is a minimum size limit for Pāua (and Rock Lobster) and harvesting undersized individuals is considered illegal harvest. There is no legal size limit for Kina.

These factors do not aim to explain this illegal harvest. They are given to show that restrictions on harvesting differs among species and more rigorous restrictions for one species may result in more cases of illegal harvest. For example a fisher is able to take 50 Kina, but harvesting 50 Pāua is illegal.

12.2 Media reports - illegal harvest

Table 12.2 summarises the the incidences from the media reports relating to illegal fishing from the 2006 fishing year to the 2010 fishing year for Rock Lobster, Pāua and Kina.

Table 12.2: Summary of incidences from media reports relating to illegal fishing between the 2007-2010 fishing years for Rock Lobster Pāua and Kina. A summary of the number of media reports relating to illegal catch is given, alongside the number of reports where catch amount (in individuals) was given, the total individuals caught, the total number of individuals caught that were under the legal size limit and the number of individuals caught per illegal fishing incident

Species	Total incidences reported n	no. incidences where catch amount was reported n_i	Total individuals caught t	Total number of undersize individuals t_u	% of illegal catch reported as undersized $\frac{t_u}{t}$	no. individuals caught per incident $\frac{t}{n_i}$
Rock Lobster	23	17	736 ¹	150 ^{1 2}	$\approx 20\%$	43.29
Pāua	59	53	14,603 ¹	6,670 ^{1 2}	$\approx 46\%$	275.5
Kina	4	4	195 ¹	—	—	48.5

Note there is no size limit for Kina, and the daily bag limit is 50 per person. This means the illegal incidences will relate to harvest of more than 50 person per day or harvest that has been caught in protected areas.

Tables 12.3, 12.2 and 12.5 are summaries of the individual illegal harvest reports given in Tables B.2, B.2, B.2 and B.2, for Rock Lobster, Pāua and Kina, respectively. No overall summary has been given for Finfish due to lack of sufficient information for single species of interest.

Where an amount of undersize illegal Pāua catch was reported in the media report, for

¹Only catch amounts where whole individuals were reported were used, to avoid conversion errors. This excludes catch reported by any other measure and excludes catch reported without shells, or in green weight, as the original size of each individual may not be known

²Where the catch was reported as being "mostly" or "mainly" undersize, it was assumed the entire reported catch amount was undersize, for consistency

example 10 individuals were caught, 8 of which were undersize, the weight was converted using this information. Where individual Pāua are mentioned as being undersize, the weight is assumed to be 0.26kg. Where Pāua are not mentioned as being undersize their weight is assumed to be 0.325kg. As 46% of the Pāua catch were reported as being undersize (from Table 12.2), we also assume 46% of harvest, where size has not been mentioned, is undersize. For example if a media report reports 100 Pāua as being harvested illegally, but does not mention size, the weight will be:

$$\begin{aligned}
 \text{Weight} &= (npw_{\text{illegal}}) + (n(1 - p)w_{\text{legal}}) \\
 &= (100 \times 0.46 \times 0.26) + (100 \times 0.54 \times 0.325) \\
 &= 11.96 + 17.75 \\
 &= 29.51\text{kg}
 \end{aligned}$$

where n = the number of individuals, p = the proportion assumed to be undersize and w_i = weight in kilograms.

The weight that will be assigned to undersize Rock Lobster will be 80% of the average weight of Rock Lobster from Table 8.1, 0.325kg, which is 0.26kg. An allowance is also be made for Rock Lobster sexual dimorphism, see Table 8.2.

There is no minimum legal size for Kina in New Zealand therefore the mean weight of Kina from Table 8.1 will be used.

Where a range of catch has been mentioned, for example 500-600 individuals, or more then 500 individuals, the lowest catch amount has been used to avoid overestimation.

Where illegal catch was mentioned in media reports, but no catch weight was given (as indicated by a ✓ in Tables B.2, B.2, B.2 and B.2), the average number of individuals caught per incident, from Table 12.2, is used. Throughout Tables 12.3, 12.2 and 12.5, if this estimate is used, it is indicated by a * to symbolize it is an estimate of illegal catch, given all other incidences of illegal catch form the 2007-2010 fishing years. The average number of individuals caught per incident for Rock Lobster was 43.29 individuals, or 36.33kg after allowing for

sexual dimorphism. The average number of individuals caught per incident for Pāua was 275.5 individuals, or 81.3kg, after allowing for undersize catch by assuming 46% of the catch was undersize (from Table 12.2), and the average number of individuals caught per incident for Kina was 48.5 individuals, or 12kg.

Table 12.3: Summary of media reports relating to the illegal catch of Rock Lobster, 2007-201 fishing years

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
2007	15 January	✓	43.29*	32.77*
	25 May		36 individuals	27.25
	31 July		43.29*	32.77*
Total				92.79
2008	9 November		60 individuals	45.42
	26 March		49 individuals (all undersize)	20.13
	26 March		22 individuals	16.66
	12 May		93 individuals	70.41
	24 September		95 individuals	71.92
Total				224.54

Table 12.3: (Continued)

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
2009	17 November		67 individuals	50.72
	19 December		1 individual	0.76
	11 February		28 individuals (6 undersize)	21.03
	16 February		7 individuals	5.30
	17 February		41 individuals (9 undersize)	30.71
	31 March		43.29*	32.77*
	4 May		10 individuals	7.57
	14 May		43.29*	32.77*
	21 August		43.29*	32.77*
	8 September		95 individuals (86 undersize)	44.37
Total				258.77
2010	16 December		12 individuals	9.08
	7 January		60 individuals	45.42

Table 12.3: (Continued)

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
	21 January		43.29*	32.77*
	22 January	✓	60 individuals	45.42
	15 September		43.29*	32.77*
Total				165.46

Table 12.4: Summary of media reports relating to the illegal catch of Pāua, 2007-2010 fishing years

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
2007	25 May		500 individuals	125.87
	31 July		275.5*	81.3kg*
	8 August		45 individuals (42 undersize)	7.94
	8 August		47kg	47
Total				262.11
2008	2 October		500-600 individuals	125.87
	30 October		300kg (Dried)	300

Table 12.4: (Continued)

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
	22 November		30kg	30
	17 December		170kg	170
	16 January		104 individuals (all under-size)	17.24
	1 February		31kg	31
	26 March		311 individuals (all under-size)	51.55
	26 March		48 individuals	12.08
	27 May		9t green weight (or 36,000 individuals)	9062.82
	7 August		9 individuals (all undersize)	1.49
	8 August		500kg	500
Total				10302.05
2009	31 October		147 individuals (all under-size)	24.37
	7 November		275.5*	81.3kg*

Table 12.4: (Continued)

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
	14 November		145 individuals (135 under-size)	25.63kg
	14 November		275.5*	81.3kg*
	14 November		275.5*	81.3kg*
	14 November		294 individuals	74.01
	17 November		339 individuals (316 under-size)	59.85
	21 November		450 individuals (mainly undersize)	74.59
	25 November	✓	1257 individuals (985 under-size)	251.66
	8 December		250 individuals	62.94
	16 December		72 individuals	18.13
	19 December		196 individuals (all under-size - measured between 49mm-102mm)	32.49
	19 December		44 individuals (all undersize - measured between 82mm-110mm)	7.29

Table 12.4: (Continued)

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
2009	19 December	✓	250 individuals	62.94
	11 February		237 individuals	61.95
	16 February		172 individuals	43.30
	18 February		350 individuals	88.11
	18 February		500 individuals	125.87
	27 February		41 individuals	10.32
	9 April	✓	312 individuals	78.54
	23 April		100kg no shells (900 individuals)	100
	28 April		275 individuals	69.23
	7 September		1200 individuals and 15kg (meat ¹)	302.09
	8 September		166 individuals	41.79
	8 September		180 individuals	45.31
	18 September		112 kg	112
Total				1932.73

Table 12.4: (Continued)

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
2010	23 October		1200 kg	1200
	27 October		523 individuals	131.66
	8 December	✓	611 individuals	153.82
	16 December		143.5kg	143.5
	11 January		216 individuals	54.38
	22 January	✓	275.5*	81.3kg*
	26 January		420 individuals (all under-size)	69.62
	29 January		353 individuals (all under-size)	58.51
	2 March		183 individuals (182 under-size)	30.49
	14 April		40 individuals (all undersize)	6.63
	23 April		275.5*	81.3kg*
	28 April		274 individuals (239 under-size)	50.99

Table 12.4: (Continued)

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
	7 May		1,764 individuals (most undersize)	292.38
	1 July		511 individuals	128.64
	5 August		1182 (804 undersize)	256.11
	14 September		66 individuals (63 undersize)	11.41
	20 September		66 individuals (undersize)	10.94
Total				2725.86

¹20 individual Pāua = 2.5kg meat [47]

Table 12.5: Summary of media reports relating to the illegal catch of Kina, 2007-2010 fishing years

Fishing year	Date	In Kahungunu	Catch as reported in the Media	Catch in kg
2007				0.00
Total				0.00
2008	9 November		Several sacks ¹ ²	75
	24 September		38 sacks ²	950
Total				1025
2009	16 February		3 individuals	7.45
Total				7.45
2010	1 December		192 individuals	476.74
Total				476.74

Note there is no illegal harvest reported as being caught in Ngāti Kahungunu rohe moana.

Media report totals

Table 12.6 shows final harvest amounts in kilograms for illegal harvest that was reported as being harvested within New Zealand.

¹A standard sack is 25kg (Personal meeting with Wayne Ormsby, Ministry of Fisheries, 2011)

²Several = 3

Table 12.6: Total illegal harvest in New Zealand, by species, as reported in the media (2007-2010)

Species	Fishing year	Total harvest (kg)
Rock Lobster	2007	92.79
	2008	224.54
	2009	258.77
	2010	154.06
Pāua	2007	250.17
	2008	10302.05
	2009	1980.49
	2010	2737.8
Kina	2007	0.00
	2008	0.00
	2009	0.00
	2010	0.00

Table 12.7 shows final harvest amounts in kilograms for illegal harvest that was reported as being harvested within the Ngāti Kahungunu rohe moana. Note not all reports mention the area harvest was taken.

Table 12.7: Total illegal harvest in the Ngāti Kahungunu rohe moana, by species, as reported in the media (2007-2010)

Species	Fishing year	Total harvest (kg)
Rock Lobster	2007	37.33
	2008	0
	2009	0
	2010	45.42
Pāua	2007	0
	2008	0
	2009	393.14
	2010	223.18
Kina	2007	0.00
	2008	0.00
	2009	0.00
	2010	0.00

The illegal data from media reports are not used in the final harvest estimates however they are compared with the illegal harvest data that is used: the Ministry of Fisheries illegal harvest data in Section 12.3.

12.3 Illegal harvest comparisons

In this section we compare the three sources of data relating to illegal fisheries harvest; the Ministry of Fisheries data, the Ministry of Justice data and the data collected from media reports.

Figures 12.1 and 12.2 compare the final harvest amounts in kilograms for Rock Lobster and

Pāua, by fishing year, from the Ministry of Fisheries illegal harvest data and by what has been reported by the media. As the media are more likely to only report illegal take when a large amount of fish have been taken, we would expect the harvest amounts from the Ministry of Fisheries to be larger than what is reported as being harvest illegally by the media.

Figure 12.1: Harvest amounts in kilograms for Rock Lobster, by fishing year, from the Ministry of Fisheries illegal harvest data and by what has been reported by the media

Figure 12.2: Harvest amounts in kilograms for Pāua, by fishing year, from the Ministry of Fisheries illegal harvest data and by what has been reported by the media

We are unable to compare the three sources of data relating to illegal fisheries harvest; the Ministry of Fisheries data, the Ministry of Justice data and the data collected from media reports, for a number of reasons, including:

- Harvest amounts are not reported in the data from the Ministry of Justice
- The number of incidences in all three data sets is recorded differently, for example:
 - **Ministry of Fisheries** Each entry (prosecution) does not have a unique identifier so it is possible that multiple entries come from the same event. For example if a fisher was caught with both Pāua and Rock Lobster that had been illegally harvested during the same fishing event, these are recorded as two entries, and therefore as two separate fishing incidences.
 - **Ministry of Justice** Each entry (prosecution) is recorded separately however each has a unique identifier so we are able to identify the number of unique fishing events.

- **Media reports** Each entry does not have a unique identifier so it is possible that multiple entries come from the same event. For example if a fisher was caught with both Pāua and Rock Lobster that had been illegally harvested during the same fishing event and if these are recorded as two entries, they would appear as two separate fishing incidences.
- The area each fisher was prosecuted, or where the harvest was taken, is not always specific/clear
- The data from the Ministry of Fisheries is reported as totals by fishing year, whereas the data from the Ministry of Justice reports totals by calendar year.

The number of individual prosecutions reported by the Ministry of Fisheries between the 2007-2010 fishing years was 1671, the number of individual prosecutions reported by the Ministry of Justice between the 2006-2009 calendar years was 149 and the number of Media reports relating to illegal fishing during the 2007-2010 fishing years was 86.

Given the information above these numbers cannot be compared in a sensible way.

Assumptions used in 12.1.

46% of caught Pāua reported in media reports from 2006 - 2010 fishing years are assumed to be undersize

For Rock Lobster it is assumed 47.44% of the total catch were female and 52.83% were male

Where a species was mentioned as being caught, but no catch amount was reported, it is assumed 36.33kg, 78.89kg and 12kg was caught of Rock Lobster, Pāua and Kina respectively (see Section 12.2)

Chapter 13

Results

This chapter explains the systematic and random errors in our estimates and details how these are dealt with and final estimates are displayed by species in both tables and maps.

13.1 Sampling errors

The catch estimates we have created in this thesis are a combination of data from a variety of different sources, with systematic and random errors that are not straightforward to calculate. We have however attempted to provide range estimates to indicate our uncertainties, including some correction for bias. The basis for the range estimates are (i) statistical sampling errors from the surveys of recreational fishing, (ii) estimates of the uncertainties in customary catch and (iii) bias (undercount) in the commercial catch due to unreported by-catch and fish dumping. We give further details of each of these assumptions below and an estimate of the relative margin of error and bias are given for each fishing sector estimate. These are based on a “best guess”.

We are aware that these range estimates do not have the status of statistical confidence intervals, but they are nevertheless a reasonable indication of the uncertainties in our estimates.

The total harvest estimates by fishing year, for each species is

$$\hat{Y} = \sum_j y_j$$

where j = source of data (commercial, recreational customary or illegal), and the variance of the total harvest estimate, $\hat{Y}$, is

$$\text{Var}(\hat{Y}) = \sum_j \text{Var}(y_j)$$

We make estimates of the relative margin of error and relative bias for each fishery source, and we assume that these are the same for all species excluding the estimate of the bias for Rock Lobster, Pāua and Kina. This is because of how these species are caught, which make them less susceptible to by-catch. We now give details of these RMOEs and Biases

We estimate the relative margin of error for all species for the commercial harvest estimates to be 2%. This is because there are strict guidelines in place in New Zealand and all commercial fishing for the target species are reported therefore it is likely the commercial harvest amounts reported in this research are very close to the true commercial harvest amounts. For the recreational harvest we estimate the relative margin of error to be $\pm 15\%$ and for the customary harvest we estimate the relative margin of error to be $\pm 5\%$. The estimated $\pm 5\%$ in the customary harvest relative margin of error includes the imputation uncertainty from Kairakau Lands Trust and missing quarters (months where there was no reporting), see Section 11.2.

The relative margin of error is

$$\text{RMOE}_j = \frac{\text{MOE}(y_j)}{y_j}$$

where $\text{MOE}^2 = (1.96\text{SE})^2 = (1.96)^2\text{Var}$ and the relative bias is

$$\text{RBias}_j = \frac{\text{Bias}(y_j)}{y_j}.$$

We estimate the bias for all species excluding Rock Lobster, Pāua and Kina for the commercial harvest estimates to be -10%. This is our “best guess” for the levels of by-catch and fish dumping, (see Section 6.1.2), however this undercount estimate is itself subject to uncertainty. This has been adjusted for by estimating an overall RMOE of $\pm 2\%$ for the commercial harvest estimates. For the recreational harvest estimate the estimate of bias for all species is 0% and for the customary harvest estimate the estimate of bias is 0%. Note there is bias in the customary estimates due to missing quarters (months where there was no reporting), however, these missing quarters have been estimated, see Section 11.2.

For Rock Lobster, Pāua and Kina, the estimated bias for the commercial harvest estimate is 0% as by-catch is less likely as these species are usually caught by divers (who can see what they are taking), or by Rock Lobster pots.

Estimates for the relative margin of error and bias are not given for illegal fishing as our estimates for illegal fishing are relatively small. For all species and all fishing years the proportional of illegal fishing is $< 1\%$. As it is likely not all fishers who harvest fish illegally are caught, the amounts of illegal fishing reported are highly likely to be less than the true value of illegal fishing. However, with very little information available, it is not possible to say how many illegal fishers Fisheries Officers (Ministry of Fisheries officers who enforce fishing laws) prosecute, and how many fishers are not caught. Therefore, we know the amount of illegal fishing we have reported is likely to be a underestimate, but we don’t know by how much.

These estimates of relative margin of error and bias indicate that we think the true value of the commercial, recreational and customary harvest of finfish in Ngāti Kahungunu rohe is likely to be within 10%, 15% and 5% of our estimates for each fishing sector respectively.

As an example Table 13.1 shows simple harvest data fabricated for this example.

Table 13.1: Example data of estimated harvest amounts

	Commercial	Recreational	Customary	Illegal
Harvest amount (kg)	100	10	5	0
RMOE	2%	±15%	±5%	NA
Bias	-10%	0	0	NA

In this example the total harvest estimate is

$$\hat{Y} = \sum_j y_j = 100 + 10 + 5 + 0 = 115$$

and the relative margin of error is

$$\begin{aligned}
 RMOE &= \frac{1}{\hat{Y}} \sqrt{\sum_{j=i}^4 (MOE)^2} \\
 &= \frac{1}{\hat{Y}} \sqrt{\sum_{j=i}^4 y_j^2 (RMOE)^2} \\
 &= \sqrt{\sum_{j=i}^4 \left(\frac{y_j}{\hat{Y}}\right)^2 (RMOE)^2} \quad \text{units} \\
 &= \sqrt{\left(\frac{100}{115}\right)^2 \times (0.02)^2 + \left(\frac{10}{115}\right)^2 \times (0.15)^2 + \left(\frac{5}{115}\right)^2 \times (0.05)^2} = 0.0218
 \end{aligned}$$

The margin of error is then

$$\begin{aligned}
 MOE &= RMOE \times \hat{Y} \\
 &= 0.0218 \times 115 = 2.51
 \end{aligned}$$

Note the bias in this estimate is 10% of the total estimate amount for commercial fishing, 10kg.

Therefore the range of this estimate is:

$$(115 + 10) \pm 2.51$$
$$125 \pm 2.51 = (122.49, 127.51)$$

The range for each estimate for each species by fishing year will be given in the tables in the following sections. Although this is not a confidence interval it does provide insight to the amount of uncertainty in the final total harvest estimates for each species.

13.2 Final harvest estimates and maps

This section gives final harvest estimates by species and displays these estimates in maps. When interpreting maps a couple of key notes from Chapter 7 should be remembered:

Recreational harvest is assumed to follow the same geographic distribution as commercial harvest. Although recreational fishing is likely to follow similar geographical patterns (in latitude) to commercial harvest as most species live, feed or breed in the same geographical areas, commercial fishing is likely to take place further off-shore as commercial fishermen often spend extended periods at sea, and are therefore able to travel further than the average recreational fisher. Many recreational fishers also fish from the shore. It is likely recreational harvest takes place closer to the shore than displayed.

Rock Lobster, Pāua and Kina harvest is spread out to the Rock Lobster statistical area boundary (30km). The extent of the Rock Lobster boundaries from the shore (30km) is further from the shore than the likely harvest locations e.g. Rock Lobster, Pāua and Kina are likely to be caught within a few kilometers of the shore. We have used the statistical area as a boundary for spreading out the data onto maps, however, care should be taken when interpreting the maps as once the data has been spread out to the 30km boundary it may seem as though these species are being harvest this far out from the shore.

These notes mean the geographical spread of the harvest by latitude is of more interest than the longitudinal spread.

As a reminder illegal data is not displayed in any maps, see Section 7.2.4.

When interpreting the maps in this section an important thing to note is that the harvest increments from each species, from year to year, differ. The reason the maps are displayed in this way (when it would be more reasonable to have the same increments to better be able to compare differences in harvest through time) is to protect confidentiality. As harvest estimates differ among species from year to year the same map increments across years for the same species resulted in some reefs, or other areas, being identifiable. The increments are modified for each map to ensure specific locations are protected. This may mean comparing harvest amounts from year to year may be difficult using the maps alone, and the total harvest amounts should be referred to. The maps in this section are intended to give a general idea about the location of the fishing harvest within Ngāti Kahungunu rohe moana.

Note the Moremore Mātatai is located in the Napier Region and is closed to commercial fishing, Also, the area in the Northern Hawkes Bay known as Wairoa Hard is a protected area as it a a spawning area and an area where young juvenile finfish are known to live. This area is protected from using set nets to harvest fish, so no set nets should have been used to harvest the fish caught in this area.

And finally, due to the geographic boundaries the data is associated with and the way the maps have been created, often these boundaries will show in maps and it looks as though less harvest is caught along the statistical area boundaries, see Figure 13.1 for a clear example. When a grid square is intersected by a statistical area boundary line is is split into two, and harvest is allocated to the remaining portion of the grid square based on its size. This means the grid squares that fall on the statistical area boundary lines will be allocated less harvest than the grid squares that fall entirely into a statistical area. This is why the harvest along the statistical area boundaries looks as though less harvest is caught. We do not believe the harvest amount to be less along these statistical area boundaries.

13.2.1 Rock Lobster

Table 13.2: Total estimated Rock Lobster harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 466,839kg of Rock Lobster was harvested commercial, which equates to 87.4% of the total estimated harvest of Rock Lobster in 2007.

Fishing year	Fishing type	Harvest estimate (kg)	% of total harvest
2007	Commercial	466839	87.4
	Recreational	65576	12.3
	Customary	1412	0.3
	Illegal	649	0.1
	Total Range	534476 567597, 594722	
2008	Commercial	360567	83.6
	Recreational	65576	15.2
	Customary	3808	0.9
	Illegal	1097	0.3
	Total Range	431049 454907, 479304	
2009	Commercial	361228	80.9
	Recreational	65576	17.2
	Customary	8021	1.8
	Illegal	180	0.1
	Total Range	435006 458917, 483339	
2010	Commercial	411482	83.0
	Recreational	65576	15.5
	Customary	7448	1.5
	Illegal	2397	0.5
	Total Range	486903 515221, 540882	

Estimated Rock Lobster Harvest, 2007 fishing year

(a) 2007

Estimated Rock Lobster Harvest, 2008 fishing year

(b) 2008

Estimated Rock Lobster Harvest, 2009 fishing year

(c) 2009

Estimated Rock Lobster Harvest, 2010 fishing year

(d) 2010

Figure 13.1: Estimated Rock Lobster harvest in kilograms for the 2007-2010 fishing years

In comparison with other areas close to and in Ngāti Kahungunu rohe, the areas that are more heavily fished are:

- Southern Wairarapa
- Wellington

13.2.2 Pāua

Table 13.3: Total estimated Pāua harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 122879kg of Pāua was harvested commercially, which equates to 45.6% of the total estimated harvest of Pāua in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	122879	45.6
	Recreational	142041	52.8
	Customary	2386	0.9
	Illegal	1922	0.7
	Total	269227	
	Range	260067, 302963	
2008	Commercial	121333	45.1
	Recreational	142041	52.8
	Customary	4398	1.6
	Illegal	1986	0.4
	Total	269757	
	Range	260445, 303335	
2009	Commercial	123671	45.2
	Recreational	142041	52.7
	Customary	6271	1.6
	Illegal	1787	0.7
	Total	273770	
	Range	264686, 307589	
2010	Commercial	124883	45.8
	Recreational	142041	52.1
	Customary	4436	1.6
	Illegal	1420	0.5
	Total	272778	
	Range	263814, 306720

Figure 13.2: Estimated Pāua harvest in kilograms for the 2007-2010 fishing years

In comparison with other areas close to and in Ngāti Kahungunu rohe the areas that are more heavily fished are:

- Southern Wairarapa
- Wellington

13.2.3 Kina

Table 13.4: Total estimated Kina harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 466,839kg of Kina was harvested commercially, which equates to 9.1% of the total estimated harvest of Kina in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
Fishing year 2007	Harvest type	Estimated harvest (kg)	% of total harvest
	Commercial	18101	9.1
	Recreational	180661	90.6
	Customary	570	0.3
	Illegal	65	0.0
	Total	199396	
	Range	174105, 228308	
2008	Commercial	6159	3.3
	Recreational	180661	96.1
	Customary	1093	0.6
	Illegal	16	0.0
	Total	187929	
	Range	161445, 215645	
2009	Commercial	6634	3.5
	Recreational	180661	95.2
	Customary	2566	1.4
	Illegal	30	0.0
	Total	189891	
	Range	163455, 217654	
2010	Commercial	2106	1.1
	Recreational	180661	98.0
	Customary	1590	0.9
	Illegal	151	0.0
	Total	184509	
	Range	157620, 211819

(a) 2007

(b) 2008

(c) 2009

(d) 2010

Figure 13.3: Estimated Kina harvest in kilograms for the 2007-2010 fishing years

These maps do not give a clear indication about the location of the harvest. This is because only relatively small amounts of Kina have been harvested across all sectors the harvest amounts, once spread out geographically, look relatively even.

Note the “breaks in the distribution of the harvest are a result of the statistical area boundaries, and do not imply less harvest is caught along these boundaries.

13.2.4 Flatfish

Table 13.5: Total estimated Flatfish harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 136,736kg of Flatfish was harvested commercially, which equates to 76.4% of the total estimated harvest of Flatfish in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	136736	76.4
	Recreational	42267	23.6
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	179003	
	Range	185772, 199582	
2008	Commercial	54524	56.3
	Recreational	42267	43.7
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	96791	
	Range	95810, 108677	
2009	Commercial	45724	52.0
	Recreational	42267	48.0
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	87991	
	Range	86158, 98969	
2010	Commercial	59676	58.5
	Recreational	42267	41.5
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	101943	
	Range	101459, 114362

(a) 2007

(b) 2008

(c) 2009

(d) 2010

Figure 13.4: Estimated Flatfish harvest in kilograms for the 2007-2010 fishing years

The areas of high harvest for Flatfish differ from year to year.

Note the area in the Northern Hawkes Bay known as Wairoa Hard is a protected area as it is a spawning area and an area where young juvenile finfish are known to live. This area is protected from using set nets to harvest fish, so no set nets should have been used to harvest the fish caught in this area.

13.2.5 Gurnard

Table 13.6: Total estimated Gurnard harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 510,487kg of Gurnard was harvested commercially, which equates to 93.3% of the total estimated harvest of Gurnard in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	510487	93.3
	Recreational	36801	6.7
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	547288	
	Range	586730, 609943	
2008	Commercial	440403	92.3
	Recreational	36801	7.7
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	477205	
	Range	510850, 531640	
2009	Commercial	521854	93.4
	Recreational	36801	6.6
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	558655	
	Range	599033, 622647	
2010	Commercial	701299	95.0
	Recreational	36801	5.0
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	738100	
	Range	793157, 823303	

Estimated Gurnard harvest, 2007 fishing year

(a) 2007

Estimated Gurnard harvest, 2008 fishing year

(b) 2008

Estimated Gurnard harvest, 2009 fishing year

(c) 2009

Estimated Gurnard harvest, 2010 fishing year

(d) 2010

Figure 13.5: Estimated Gurnard harvest in kilograms for the 2007-2010 fishing years

In comparison with other areas close to and in Ngāti Kahungunu rohe the areas that are more heavily fished are:

- Napier Region
- Southern Wairarapa

Also note the majority of the harvest is taken close to shore.

13.2.6 Kahawai

Table 13.7: Total estimated Kahawai harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 153,622kg of Kahawai was harvested commercially, which equates to 32.5% of the total estimated harvest of Kahawai in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	153622	32.5
	Recreational	318358	67.4
	Customary	150	0.0
	Illegal	Unknown	Unknown
	Total	472130	
	Range	439640, 535345	
2008	Commercial	532308	62.6
	Recreational	318358	37.4
	Customary	15	0.0
	Illegal	Unknown	Unknown
	Total	850681	
	Range	854986, 952838	
2009	Commercial	761871	70.5
	Recreational	318358	29.5
	Customary	35	0.0
	Illegal	Unknown	Unknown
	Total	1080264	
	Range	1106326, 1206577	
2010	Commercial	233120	42.3
	Recreational	318358	57.7
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	551478	
	Range	526810, 622771

(a) 2007

(b) 2008

(c) 2009

(d) 2010

Figure 13.6: Estimated Kahawai harvest in kilograms for the 2007-2010 fishing years

In comparison with other areas close to and in Ngāti Kahungunu rohe the areas that are more heavily fished are:

- Mahia
- Gisborne

Note the areas of high harvest for Kahawai differ from year to year. In 2007 relatively more fish was harvested from Southern Hawkes Bay whereas in 2010 relatively more fish was harvested from the Napier Region.

13.2.7 Red Cod

Table 13.8: Total estimated Red Cod harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 112,809kg of Red Cod was harvested commercially, which equates to 96.3% of the total estimated harvest of Red Cod in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	112809	96.3
	Recreational	4338	3.7
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	117147	
	Range	126080, 130776	
2008	Commercial	136144	96.9
	Recreational	4338	3.1
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	140481	
	Range	151296, 156895	
2009	Commercial	111113	96.2
	Recreational	4338	3.8
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	115451	
	Range	124247, 128878	
2010	Commercial	204841	97.9
	Recreational	4338	2.1
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	209178	
	Range	225514, 233811	

Estimated Red Cod harvest, 2007 fishing year

(a) 2007

Estimated Red Cod harvest, 2008 fishing year

(b) 2008

Estimated Red Cod harvest, 2009 fishing year

(c) 2009

Estimated Red Cod harvest, 2010 fishing year

(d) 2010

Figure 13.7: Estimated Red Cod harvest in kilograms for the 2007-2010 fishing years

In comparison with other areas close to and in Ngāti Kahungunu rohe the areas that are more heavily fished are:

- Wellington
- West Coast

13.2.8 Snapper

Table 13.9: Total estimated Snapper harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 218,989kg of Snapper was harvested commercially, which equates to 82.3% of the total estimated harvest of Snapper in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	218989	82.3
	Recreational	47190	17.7
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	266179	
	Range	279754, 296402	
2008	Commercial	176789	78.9
	Recreational	47190	21.1
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	223979	
	Range	233745, 249570	
2009	Commercial	190614	80.2
	Recreational	47190	19.8
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	237804	
	Range	248826, 264906	
2010	Commercial	161496	77.4
	Recreational	47190	22.6
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	208686	
	Range	217055, 232617	

Estimated Snapper harvest, 2007 fishing year

(a) 2007

Estimated Snapper harvest, 2008 fishing year

(b) 2008

Estimated Snapper harvest, 2009 fishing year

(c) 2009

Estimated Snapper harvest, 2010 fishing year

(d) 2010

Figure 13.8: Estimated Snapper harvest in kilograms for the 2007-2010 fishing years

The areas where a high portion of Snapper is harvested changes from year to year.

13.2.9 Tarakihi

Table 13.10: Total estimated Tarakihi harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 856,806kg of Tarakihi was harvested commercially, which equates to 94% of the total estimated harvest of Tarakihi in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	856806	94.0
	Recreational	54586	6.0
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	911391	
	Range	978080, 1016064	
2008	Commercial	865152	94.1
	Recreational	54586	5.9
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	919737	
	Range	987110, 1025395	
2009	Commercial	1022597	94.9
	Recreational	54586	5.1
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	1077183	
	Range	1157412, 1201473	
2010	Commercial	1008155	94.9
	Recreational	54586	5.1
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	1062741	
	Range	1141794, 1185318	

Estimated Tarakihi harvest, 2007 fishing year

(a) 2007

Estimated Tarakihi harvest, 2008 fishing year

(b) 2008

Estimated Tarakihi harvest, 2009 fishing year

(c) 2009

Estimated Tarakihi harvest, 2010 fishing year

(d) 2010

Figure 13.9: Estimated Tarakihi harvest in kilograms for the 2007-2010 fishing years

The areas where a high portion of Tarakihi is harvested changes from year to year.

13.2.10 Trevally

Table 13.11: Total estimated Trevally harvest in the Ngāti Kahungunu rohe, by fishing type. For example in 2007 291,536kg of Trevally was harvested commercially, which equates to 91.5% of the total estimated harvest of Trevally in 2007.

Fishing year	Harvest type	Estimated harvest (kg)	% of total harvest
2007	Commercial	291536	91.5
	Recreational	26941	8.5
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	318477	
	Range	340536, 354725	
2008	Commercial	182471	87.1
	Recreational	26941	12.9
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	209412	
	Range	222214, 233104	
2009	Commercial	233672	89.7
	Recreational	26941	10.3
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	260613	
	Range	277802, 290158	
2010	Commercial	193937	87.8
	Recreational	26941	12.2
	Customary	0	0.0
	Illegal	Unknown	Unknown
	Total	220878	
	Range	234671, 245873

Figure 13.10: Estimated Trevally harvest in kilograms for the 2007-2010 fishing years

In comparison with other areas close to and in Ngāti Kahungunu rohe the areas that are more heavily fished are:

- Napier
- Wairarapa

Chapter 14

Discussion

This Chapter summarizes key findings and reviews the different data sets used in this research. Some of the main problems faced when combining many different data sets with varying levels of quality are highlighted. To answer one of our research questions “What can Kaitiaki do in future to make the information they have more useful to themselves and to other users”, recommendations to improve data collection are then suggested for Ngāti Kahungunu Iwi, in particular Kaitiaki and other people involved in fisheries management. This does not imply that customary information is the only sector that requires improvements, as there are many gaps in information in other fishing sectors. Suggestions are only made for customary data as this research aims to provide Tāngata whenua with recommendations to help manage their fisheries in future. However, it is important to note that fisheries are holistic, and while fisheries in New Zealand are managed differently for different sectors it is important for all sectors to work together to ensure sustainability of New Zealand’s fisheries.

14.1 Harvest estimates

This thesis has used available data from commercial, recreational, customary and illegal fishing to create combined estimates of total fisheries harvest in Ngāti Kahungunu rohe moana for a number of key species over four fishing years (2007-2010). Eight different sources of data relating to fishing harvest were available, and, based on quality and usability, five of these data sets are used to make these estimates.

Commercial fishing in New Zealand is highly regulated and all commercial harvest is reported to the Ministry of Fisheries. This data has been used in this research and is of high quality.

As all commercial harvest information is reported no estimates were necessary for commercial harvest. Customary fishing is also reported to the Ministry of Fisheries regularly, however, it is less strictly regulated compared with commercial fishing, resulting in an unknown amount of missing harvest reports. This data has also been used and this missing information has been estimated. The Ministry of Fisheries also records illegal harvest, however, the information does not provide sufficient information to estimate total illegal take for a number of reasons. Firstly, the data does not include harvest amounts for fishing incidences that do not have a corresponding species code, which can happen when a fisher is illegally fishing in a restricted area, or with restricted fishing gear. Secondly, the information includes commercial harvest where fishing forms have not been filled in correctly, for example if a legitimate Monthly Harvest Return is filed after the due date and the fisher has been prosecuted, and lastly, the information does not include “at sea charges”, i.e. commercial fishing off the coast. In addition to this the illegal harvest information recorded by the Ministry of Fisheries is only what is known, and it is not known how much illegal fishers harvest when they are not caught. Recreational fishing in New Zealand is not reported. We have used the results from a national recreational fishing survey, and adjusted these to represent fishers in Ngāti Kahungunu only, using additional data sources to estimate fisher prevalence and population size. Each data set has a varying level of quality, contributing to the quality of our final estimates, discussed in Section 14.3.

Table 14.1 shows the mean annual harvest in kilograms for the 2007-2010 fishing years, by species and fishing type for the Ngāti Kahungunu rohe only.

Table 14.1: Mean annual harvest in kilograms for the 2007-2010 fishing years, by species and fishing type. For example the estimated mean annual harvest of Rock Lobster for the 2007, 2008, 2009 and 2010 fishing years for commercial, recreational, customary and illegal fishing is 400029kg, 65576kg, 5172kg and 1081kg respectively. The total estimated mean annual harvest of Rock Lobster for the 2007, 2008, 2009 and 2010 fishing years is 471858kg.

Species	Mean annual estimated com- mercial harvest (kg)	Mean annual estimated recreational harvest (kg)	Mean annual estimated cus- tomary harvest (kg)	Mean annual estimated il- legal harvest (kg)	Mean annual estimated total harvest (kg)
Rock Lobster	400029	65576	5172	1081	471858
Pāua	123192	142041	4373	1779	271383
Kina	8250	180661	1455	66	190431

Table 14.1: (Continued)

Species	Mean annual estimated com- mercial harvest (kg)	Mean annual estimated recreational harvest (kg)	Mean annual estimated cus- tomary harvest (kg)	Mean annual estimated il- legal harvest (kg)	Mean annual estimated total harvest (kg)
Flatfish	74165	42267	0	0	116432
Gurnard	543511	36801	0	0	580312
Kahawai	420230	318358	0	0	738639
Red Cod	141226	4338	0	0	145564
Snapper	186972	47190	0	0	234162
Tarakihi	938177	54586	0	0	992763
Trevally	225404	26941	0	0	252345

Percentages are not given for Pāua, Red Cod, Flatfish and Trevally for recreational, customary and illegal harvest as there is currently no allowance set for for these species, these are shown in the table as –. This does not imply these species cannot be harvested (by these fishing sectors), as allowances are a guideline only. Where a 0 is shown in the table it represents no harvest was taken for species where an allowance is set, from the data I have used.

No estimates of customary or illegal harvest has been made for any finfish as there was no information on this harvest.

Table 14.2: The mean annual harvest for the 2007-2010 fishing years as a percentage of the allowance (set by the Ministry of Fisheries) for each fishing type. For example the mean annual harvest estimate for the 2007, 2008, 2009 and 2010 fishing years for Rock Lobster is 400029 and the mean commercial allowance for this period is 577000. The mean commercial annual harvest estimate for Rock Lobster is 69% of the commercial allowance.

Species	Estimated commercial harvest as a percentage of the commercial allowance	Estimated recreational harvest as a percentage of the recreational allowance	Estimated customary harvest as a percentage of the customary allowance	Estimated illegal harvest as a percentage of the illegal allowance
Species	Commercial	Recreational	Customary	Illegal
Rock Lobster	69.3	187.4	6.1	1.4
Pāua	101.7	—	—	—
Kina	1.5	38.0	0.3	0.2
Flatfish	10.2	—	—	—
Gurnard	74.9	6.5	—	—
Kahawai	59.6	172.1	0.0	0.0
Red Cod	28.2	—	—	—
Snapper	2.9	0.7	0.0	0.0
Tarakihi	52.2	54.6	0.0	0.0
Trevally	93.4	—	—	—

Interesting things to note are:

- All of the commercial allowance for Pāua was estimated to be harvested by commercial fishing and most of the commercial allowance for Trevally was estimated to be harvested by commercial fishing.
- The only species estimated harvest amount to exceed the commercial harvest allowance was Pāua, by a very small amount.
- The estimated harvest of Snapper for all fishing types is a very low percentage of the harvest allowances.
- The estimated recreational harvest of Rock Lobster is 1.87 times more than the recreational harvest allowance.

- The estimated recreational harvest of Kahawai is 1.72 times more than the recreational harvest allowance.
- Aside from Rock Lobster, of the species that have a specified customary allowance, < 1% of the customary allowance is estimated to be harvested using customary permits.

Customary allowances

Although the estimated customary harvest amounts in this research are a very small portion of customary allowance, this does not suggest that the customary need is less than the allocated allowance. The following are additional factors that should be taken into consideration:

- The allowance corresponds to the total FMA and the estimates are given for Ngāti Kahungunu rohe moana only. This area is smaller than FMA2.
- As all people are able to fish recreationally in New Zealand, it is likely a large portion of customary harvest is taken within recreational limits, meaning a customary form does not need to be issued. All customary harvest in this research is defined as that which has been harvested using a customary permit. Currently there is no way to quantify the customary harvest that is taken without a customary permit.
- As there are missing quarterly reports, we do not know the true value of the customary harvest, i.e. these are estimated amounts given the information available.
- Customary harvest may not always be accessible to all Iwi members, creating a difference between actual harvest and need. For example a boat may be required to harvest some species, which is not available to all people. If access was not an issue it is likely more fish would be harvested.
- Limitations are placed on harvesting some species by Kaitiaki due to concerns about sustainability due to lack of information about total harvest from Ngāti Kahungunu coastline. Concerns generally come from anecdotal evidence and Kaitiaki's own experiences. This restraint will decrease amounts issued by Kaitiaki and therefore harvest.

14.2 Harvest location

Maps are produced to show spatial and temporal variation in harvest intensity. The following summarises the results for each species:

Rock Lobster The Southern Wairarapa coastline is the most heavily fished area in Ngāti Kahungunu rohe moana. Note in 2005 the Moremore Mātaitai was established (see Section 2.5.3 for a description of a Mātaitai), which excludes commercial fishing. In 2009 and 2010 the harvest taken from this area is from recreational and customary fishing. Note the “breaks” in the distribution of the harvest are a result of the statistical area boundaries, and do not imply less harvest is caught along these boundaries, see Section 13.2.

Pāua The Southern Wairarapa is the most heavily fished area in Ngāti Kahungunu rohe moana. Note that the Southern Wellington coast is not open and fished by commercial fishers. The catch shown in the Pāua maps in Section 13.2 show less catch in this area. Note the catch shown in this area will be a result of the interpolation of the data from the South Wairarapa coast as this area is outside if Ngāti Kahungunu rohe and therefore there is no customary harvest included in this area. The location of the harvest of Pāua is very similar year to year.

Kina It is not possible to distinguish any variation in harvest intensity, as only relatively small amounts of Kina have been harvested across all sectors and the locations associated with Kina harvest are relatively wide-spread, for example general statistical areas, as apposed to co-ordinate locations. The harvest amounts, once spread out geographically, look relatively even.

Flatfish The areas of high harvest intensity for Flatfish greatly differ from year to year and harvest appears to be caught both close to shore and out at sea.

Gurnard The area just north of Ngāti Kahungunu rohe moana (Mahia and Gisborne) is fished more heavily than inside the Ngāti Kahungunu rohe moana. Note the majority of the harvest is taken close to shore.

Kahawai The areas where relatively more harvest of Kahawai is taken does differ slightly from year to year. An area just north of Ngāti Kahungunu rohe moana (Mahia and Gisborne) is fished more heavily than inside the Ngāti Kahungunu rohe moana. Within Ngāti Kahungunu rohe moana a relatively higher intensity of harvested occurred in Southern Hawkes Bay in 2007, whereas in 2010 relatively more fish was harvested from the Napier Region.

Red Cod The area just south of Ngāti Kahungunu rohe moana (Wellington and the West Coast) is fished more heavily than inside the Ngāti Kahungunu rohe moana.

Snapper The areas where a high portion of Snapper is harvested changes from year to year. In 2007 relatively more Snapper was harvested in the Southern Hawkes Bay, in 2008 relatively more Snapper was harvested in the Napier Region, in 2009 relatively more Snapper was harvested off the Wairarapa Coast and in 2010 relatively more Snapper was harvested in the Southern Wairarapa, Napier Region and north of Ngāti Kahungunu rohe moana.

Tarakihi The areas where a high portion of Tarakihi is harvested slightly changes from year to year, however, the location harvest is caught is also relatively even spread over the lower North Island.

Trevally The Napier Region and the Wairarapa Coast are the most heavily fished area in Ngāti Kahungunu rohe moana.

14.3 Data quality and limitations

As well as varying levels of quality, each data set has its own aims or purposes, which contribute to the way each data set could be used to create total harvest estimates. These are summarized for each data set.

Ministry of Fisheries Catch Effort Data. This data was complete and of high quality. As the purpose of this data is to quantify commercial harvest it was directly compatible with this research. However, this data does not capture any information on fish dumping during commercial fishing.

Ministry of Fisheries National Marine Recreational Fishing Survey 2000. Although the authors of these reports identified statistical issues with these reports, they were the most reasonable estimates to use in this research to estimate recreational harvest.

Hawke's Bay Sport Finfish Survey The data for the HBSF Survey has been recorded over a relatively long period of time for a recreational fishing survey. As boats and people register to fish in fishing competitions, it is known how many boats are fishing in any given competition. This makes it relatively simple to scale up the surveyed

fishers harvest amounts to represent all fishers fishing in a competition, to estimate the amount of fish harvest during a competition. Fishing competitions differ from other types of recreational fishing as there are prizes for largest catch so it is highly likely fishers are targeting large individuals. Therefore, the mean weight during a fishing competition is also likely to be heavier compared with other recreational fishing. This data has not been used to create final estimates as it records harvest during fishing competitions only, and is therefore not a complete survey of recreational fishing. The intensity of fishing during competitions is likely to differ from other recreational fishing, so this survey has not been used to estimate other types of recreational fishing.

Moremore Reserve Survey The aim for the Moremore Reserve Survey was to quantify recreational shellfish harvest, however the surveyors targeted fishing boats, when it is more likely shellfish is harvested by shore divers (i.e. their target population and survey population did not match). This resulted in low counts of Rock Lobster harvest and no Pāua or Kina harvest. The survey form was designed to record mainly Rock Lobster and Pāua harvest and the forms used were relatively complicated to fill in for finfish. This resulted in completed forms that were not always clear what species were caught. The nature of the survey means there is no information about the proportion of boats sampled compared to those that were fishing, which makes it difficult to scale up the data collected to represent recreational fishing from boats. Boat surveys are more useful when combined with aerial fly-overs, or other methods used to count recreational boats fishing at a given location and time. Overall the quality of this survey was low, and we were not able to produce reasonable estimates of recreational fishing from fishing boats using this data.

Kaitiaki data (Customary). Aside from the missing quarters and missing gazetted area, the data from the Kaitiaki is useful to produce estimates of customary fishing, where customary fishing is defined as that harvest caught on customary permits. However, it is likely a proportion of the recreational harvest is harvested for customary purposes and this information is not available.

Ministry of Fisheries - prosecution data (illegal) For the purpose of estimating total illegal harvest this data wasn't useful as it did not include harvest amounts.

Ministry of Justice - prosecution data (illegal) This data included illegal harvest amounts associated with prosecutions for breaking fishing laws. Although the Ministry

of Fisheries noted the data is not sufficient to make estimates of total illegal harvest, it was the most reasonable information available and therefore was included in our final estimates of total harvest. Note the data has not been used to create estimates of illegal harvest, the data has been used as is. As this data only captures cases where illegal fishers have been caught, the true amount of illegal fishing is unknown.

Media reports -illegal harvest. The information in the published media reports is reliable, however, the details are not always specific. For example harvest weights are not always reported. As media reports usually report prosecutions where only large amounts of illegal harvest are taken, this data is not complete, and therefore not useful for creating total harvest estimates.

The process for accessing data was also varied, and took varying amounts of time. For example all of the data requested from the Ministry of Fisheries took 10 days from the day it was formally requested, the owners of the volunteer data were happy to release their recreational surveys after a couple of meetings about the aims of this project. The Ministry of Justice data was available almost immediately after requesting it, the SPARC and Census information was freely available online and the customary data took 18 months and included numerous meetings with Kaitiaki across Ngāti Kahungunu rohe. The Kaitiaki are guardians of the customary data so Kaitiaki need to consult with other members of the Iwi before it can be released. Note that Kaitiaki are also volunteers so are not available at all times, which also contributes to the data access process taking relatively longer than other data.

The main problem faced when creating estimates using a range of different data sources is the lack of consistency. As the aims for collecting each set of data or running each survey differ, the data sets used were not directly comparable. The main examples of this are:

The locations associated with harvest amounts differ. The locations associated with harvest amounts included: specific GPS co-ordinates for the start of a fishing event, statistical areas a fishing event started in, rohe moana (gazetted areas) where harvest was taken, boat clubs or boat ramps where fishing boats return to, district courts illegal fishers were prosecuted and FMA's. This makes it difficult to analyse the different data together on a fine geographic scale.

The harvest amounts are given in different quantities. The units of harvested amounts were recorded in either kilograms or individual fish harvested. All harvest

amounts given by individual fish are converted into kilograms using a boat ramp survey conducted as part of the NMRFS 2000 in 2000. These conversions introduce uncertainty as the true weight of the actual fish harvested is unknown. In addition to this the illegal data that is converted from individuals to kilograms has even more uncertainty associated with it as all illegal harvest from the Ministry of Fisheries data is assumed to be undersize. As there is no mean weight available for undersize individuals this weight is estimated.

The human population sizes for different areas are not clearly defined. As fisheries management areas (FMA's, statistical areas and rohe moana (gazetted areas)) are defined off-shore, there are no clearly defined land areas for these off-shore areas, which also means there are no clearly defined population sizes. This makes it difficult to scale harvest amounts from sample data to represent true population sizes.

The definition of 'adult population' varies. The definition of adult population size used in the Active New Zealand survey is persons over 16 years and the definition used by the Ministry of Fisheries is persons over 15 years. The population counts used come from Statistics New Zealand, who group ages into categories (0-4, 5-9, 10-14, 15-19, 20-24, etc), therefore the definition of adults used for our recreational estimates is persons over 15. Note while recreational surveys usually estimate total harvest amounts for the adult population, it is common for persons under 15 to fish in New Zealand, both recreationally and customarily. This means estimates of recreational harvest exclude persons under 15 as they have been made from surveys including only persons over 15. Also harvest from all persons, including those under 15, have been included for customary harvest, as the data for customary harvest is based on actual catch and is not a sample.

The time frame of different data sources differ. The time frames in the data sources used vary from fishing years, to quarters, to calendar years, to specific dates, and covered varying amounts of time from years to sporadic days. All final estimates are made by fishing years.

Another problem faced when estimating total harvest amounts from a number of different data sources that aim to quantify different types of fishing (commercial, recreational, customary and other) is that some data sources may be missing. The main harvest source that would affect our estimates is by-catch and fish dumping, which have been adjusted for in our range

estimates. The recreational data from the voluntary sources (HBSF Survey and Moremore Reserve survey) fail to capture recreational fishing due to the survey populations used in each survey. That is, the HBSF Survey has surveyed boats fishing in fishing competitions and the Moremore Reserve Survey has surveyed boats fishing recreationally, therefore recreational fishing has been excluded. As a reminder these two volunteer surveys were not used to make final estimate of recreational fishing.

14.4 Recommendations for future data collection

Given the challenges faced in this research there are a number of things I can suggest to Ngāti Kahungunu Iwi members, in particular Kaitiaki and other people involved in fisheries management, to improve the quality of their data, and to assist in management of their fisheries. These points are given as recommendations only, based on the analyses made in this research. The recommendations are:

Simplify the process for access to customary data. In total gaining permission to access the customary data used in this research took 18 months. A simpler process would help to ensure future research takes place with ease. An example of a process that may be beneficial to borrow ideas from is the Ministry of Healths Multi-Region Ethics Committee. New Zealand is sectioned into different Regional Ethics Committees, who each have their own data and the Multi-Region Ethics Committee is a small group of people who are able to give permission for the data to be used. If a researcher wishes to use data from a number of Regional Ethics Committees across New Zealand, they are able to request data from the Multi-Region Ethics Committee. This means they are able to deal with a few nominated people, as apposed to needing to gain permission from all Regional Ethics Committees. For customary data, it would be useful to have a few nominated Kaitiaki who are able to act on behalf of all Kaitiaki within the Iwi, and permit the use of their data to be used in research.

Identify standard weights for important Kai moana species in Ngāti Kahungunu Iwi. Harvest information from customary forms is currently only available by individuals. The individuals harvested under customary regulations are converted in this research using a boat ramp survey conducted over a decade ago as part of the NMRFS 2000. These conversions introduced uncertainty in the weights produced, as the true weight

of each individual was not known. A more up to date boat ramp survey specific to Ngāti Kahungunu rohe moana could produce more reliable mean individual weights for species of importance with the rohe. Using these weights Kaitiaki could easily convert their information in kilograms, which would make it more comparable to other harvest information, including customary allowances, which are given in kilograms.

Identify the difference between the actual customary harvest take, and the customary harvest need. In Section 14.1 we show the large difference in actual customary harvest amounts and the specified customary allowance. While the estimates of customary harvest are very small portions of the specified allowances, this does not indicate that the allowances are set too high. More research is needed to identify the amount of customary harvest needed within Ngāti Kahungunu, which is work in progress for the Iwi Fisheries Management Unit, see Section 2.1.1. This research does not aim to estimate this need, and only estimates customary harvest amounts using available information.

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Appendix A

Glossary

ACE Annual catch entitlement

Customary marine tenure (CMT) An agreement where individuals, groups or communities are recognised by local or customary laws as having ownership over a marine area and as such are given the right to access, and enforce rules of use, in that area

Gazetted area An area that has been sectioned under the Fisheries (Kaimoana Customary Fishing) Regulations 1998, also referred to as rohe moana.

Deemed value A price paid per kilogram of catch when a fisher catches fish and holds no ACE.

EEZ Exclusive Economic Zone.

Fish stock Subpopulations of a particular species of fish, usually divided in New Zealand by QMAs.

GIS Geographical Information System. A computer spatial data management storage and display system used to create maps in this thesis.

Green weight The weight of any fish, aquatic life or seaweed before processing. Also referred to as non-processed weight or live weight.

Hapū Smaller groups within an Iwi (Sub-tribe).

Hui Meeting.

ITQ Individual transferable quota.

Iwi Tribe.

Kai moana Seafood.

Karakia Prayer.

Māori Indigenous peoples of New Zealand.

Mana Pride, power, control, honor.

Mauri Life essence.

Ngāti Kahungunu rohe The physical area of Ngāti Kahungunu Iwi.

Ngāti Kahungunu rohe moana The ocean next to the physical area of Ngāti Kahungunu Iwi.

Ngāti Kahungunu Iwi Ngāti Kahungunu tribe.

NMRFS National marine recreational fishing survey. One survey was run in 1996 and one in 2000.

Qoliqoli Beach, lagoon and reef (Fijian).

QMA Quota Management Area.

QMS Quota Management System.

Rāhui A custom used by Māori to prohibit the use of a resource.

Rangātira Chief.

Rohe Territory or boundaries of an area, such as an Iwi or other defined area.

Rohe Moana A coastal and marine area over which an Iwi or a hapū exercises its mana.

TAC Total allowable catch. The maximum catch allowance set by the Ministry of Fisheries for each fishstock annually.

TACC Total allowable commercial catch. The maximum catch allowance for the commercial fisheries set by the Ministry of Fisheries for each fishstock annually.

Tamariki Children.

Tāngata Tiaki/Tāngata Kaitiaki Guardian of a specific area nominated by Tāngata whenua. and appointed under the Fisheries (Kaimoana Customary Fishing) Regulations 1998 or the Fisheries (South Island Customary Fishing) Regulations 1999. Kaitiaki operate in the North Island and Chatham Islands Tāngata Tiaki in the South Island and Stewart Island.

Tāngata whenua People of the land.

Tangi Funeral.

Tapu Sacredness.

Tohunga Expert, skilled, learned.

Treaty of Waitangi A Treaty between the British crown and 540 Māori Chiefs, signed on 6 February 1840. Often referred to as New Zealand's founding document.

Appendix B

Illegal data information

B.1 Ministry of Justice - Offense codes

The Ministry of Justice provided data that included the number of people found guilty under the Fisheries Act by court from 2004-2009, by district. The offences relate to marine finfish and shellfish only, they do not include offences relating to freshwater fish. Table ?? shows the offence codes for these fisheries offences.

The data proved by the Ministry of Fisheries is described in Section .

Note this data has not been used in make estimates of illegal catch in this research.

Offence code	Description
6333	Breach of Fisheries Act
9063	Breach Fisheries (Record keeping) Regulations 1990
9223	Take Fish When Not Permitted or in Season
9331	Fishing in Closed Season
9334	Other Offence Fisheries Act
9335	Breach Commercial Fishing Regulations
9337	Breach Oyster Fishing Regulations
9339	Fisheries Infringement Sr2001/316
9341	Fail Comply with Director General Notice
9342	Fails Complete/Furnish/Produce/Return/Report
9391	Breach of Conditions/Requirements
9394	Knowingly using false document to obtain benefit or making false statement
9399	Other breach Fisheries Act 1996
9822	Exceed maximum daily number of snapper
9823	Took snapper less than 25cm in length
9824	Failed to return unlawfully taken fish

B.2 Media report data

The following Tables B.2, B.2, B.2 and B.2 are summaries of incidences taken from media articles [56] from the 2007-2010 fishing years, where there was mention of illegal fishing relating to a specific species. When the catch amount was mentioned it was recorded in the table as it appeared in the article, for example in kilograms or by individuals, etc. Where a species was mentioned as being caught illegally, but no catch amount was mentioned, a checkmark (✓) has been used in the table.

This data is described in Section and methods for its use are given in Chapter .

Table B.1: Illegal catch amounts taken from media reports for the 2007 fishing year

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
15 January	✓	✓				

Table B.1: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
31 January					✓	
9 March					✓	
29 May						2348 Cockles
25 May		36 individuals	500 individuals			
19 June					✓	
22 June					✓	
31 July		✓	✓		43 snapper (11 undersize)	
1 August					✓	
8 August			45 individuals (42 undersize)			
8 August			47kg			
7 September					✓	

Table B.2: Illegal catch amounts taken from media reports for the 2008 fishing year

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
2 October			500-600 individuals			
30 October			300kg (Dried)			
9 November		60 individuals		Several sacs		
22 November			30kg			
17 December			170kg			
20 December					✓	
16 January			104 individuals (all undersize)			
1 February			31kgs			
12 February					✓	
26 March		49 individuals (all undersize)	311 individuals (all undersize)		5 Snapper	

Table B.2: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
26 March		22 individuals	48 individuals		1 kingfish (undersize)	
30 April					5.1t snapper & gurnard	
12 May		93 individuals (84 undersize)				
27 May			9t (green weight, or 36,000 individuals)			
9 June					80-311 t	
7 August			9 individuals (all undersize)			111 mussels
8 August			500kg			
10 September						84 Scallops
14 August						100 green-lipped mussels

Table B.2: (Continued)

Date	In Kahun- gunu	Rock Lobster	Pāua	Kina	Finfish	Other shell- fish
17 September						285 Scallops (120 under- size)
22 September						168 Scallops (150 under- size)
24 September		95 individu- als		38 Sacs		
24 September						320 Toheroa

Table B.3: Illegal catch amounts taken from media reports for the 2009 fishing year

Date	In Kahun- gunu	Rock Lobster	Pāua	Kina	Finfish	Other shell- fish
10 October						984 Cockles
17 October					700t ling	
31 October			147 individ- uals (all un- dersize)			
7 November			✓			

Table B.3: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
14 November			145 individuals (135 undersize)			
14 November			✓			
14 November			✓			
14 November			294 individuals			
17 November			339 individuals (316 undersize)			
17 November		67 individuals (30 undersize)				
21 November			450 individuals (mainly undersize)			
25 November	✓		1257 individuals (985 undersize)			
4 December		✓		✓	✓	

Table B.3: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
8 December			250 individuals (all undersize)			
16 December			72 individuals (66 undersize)			
19 December					✓	
19 December			196 individuals (undersize - measured between 49mm-102mm)			
19 December		1 individual	44 individuals (all undersize - measured between 82mm-110mm)			
19 December	✓		250 individuals (95% undersize)			

Table B.3: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
11 February		28 individuals (6 undersize)				
11 February			237 individuals (most undersize)			
11 February			✓			
16 February		7 individuals (5 undersize)		3 individuals		
16 February			172 individuals (all undersize)			
17 February		41 individuals (9 undersize)				
18 February			350 individuals			
18 February			500 individuals			
19 February					85 Snapper	
19 February					✓	

Table B.3: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
27 February			41 individuals (all undersize)			
17 March					✓	
17 March						✓
31 March		✓			✓	✓
7 April			✓			
9 April	✓		312 individuals (55 undersize)			
23 April			Over 100kg no shells (900 individuals)			
28 April			275 individuals			
4 May		10 individuals				
14 May		✓			✓	
12 June					✓	

Table B.3: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
21 August		✓		✓		
2 September						216 Scallops (79 undersize)
7 September			1200 individuals and 15kg (meat ¹)			
8 September			166 individuals (all undersize)			
8 September			180 individuals (mostly undersize)			
8 September		95 individuals (86 undersize - measured between 66mm-105mm)				
16 September					273kg Trevally	
18 September			112 kg			

Table B.3: (Continued)

Date	In Kahun- gunu	Rock Lobster	Pāua	Kina	Finfish	Other shell- fish
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Table B.4: Illegal catch amounts taken from media reports for the 20010 fishing year

Date	In Kahun- gunu	Rock Lobster	Pāua	Kina	Finfish	Other shell- fish
2 October					✓	
23 October			1200 kg			
24 November						295 Scallops (a large number undersize)
27 October			523 individ- uals			
1 December				192 individ- uals		
8 December	✓		611 individ- uals			
16 December		12 individu- als	143.5kg			

¹20 individual Pāua = 2.5kg meat

Table B.4: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
7 January		60 individuals				45 Toheroa
11 January			216 individuals			
21 January		✓				
22 January	✓	60 individuals (mostly undersize)	✓			
26 January			420 individuals (all undersize)			
29 January			353 individuals (all undersize)			
3 February					115 Snapper	850 Mussels
18 February					12 Kingfish (all undersize)	
2 March			183 individuals (182 undersize)			

Table B.4: (Continued)

Date	In Kahungunu	Rock Lobster	Pāua	Kina	Finfish	Other shellfish
23 March					✓	
14 April			40 individuals (all undersize)			
15 April					130 Snapper (5 undersize)	
23 April			✓		✓	
28 April			274 individuals (239 undersize)			
7 May			1,764 individuals (most undersize)			
14 May						✓
24 June					✓	✓
1 July			511 individuals			
28 July					481t Ling 112t Silver Warehou	

Table B.4: (Continued)

Date	In Kahun- gunu	Rock Lobster	Pāua	Kina	Finfish	Other shell- fish
5 August			1182 (804 undersize)			
7 September						436 Scallops
7 September						3000 Scal- lops
9 September					✓	
14 September			66 individu- als (63 un- dersize)			
15 September		✓			✓	✓
20 September			66 individu- als (under- size)			

B.3 Summary of Media Reports from the 2007 calendar year

The following are the titles and short summaries of the press releases from the Ministry of Fisheries relating to illegal fishing in New Zealand for 2007 [56]. Note that data from 2007-2010 were used.

Most fishers keeping to the rules - 18 January 2007

“Most recreational fishers are keeping to the fishing regulations” Jim Anderton said today. The Ministry of Fisheries compliance figures for December 2006 bear that out with 95% of recreational fishers inspected meeting the regulations. Fewer than 5% of recreational fishers inspected in December 2006 were in breach of the regulations.

East coast fishers keeping to the rules - 15 January 2007

Ministry of Fisheries East Coast manager Neville Buckley said close to 400 boats and vehicles were stopped and checked over the holiday period between Mahia and Opotiki. Many other people were spoken to on the beaches.

From those checks only four people will be prosecuted for offences relating to undersize and excess Pāua as well as undersize Rock Lobster. A further seven \$250 infringement notices were issued for a range of offences mainly relating to undersize Pāua and Rock Lobsters.

Orange roughy fisherman jailed for forging catch returns - 31 January 2007

A 40-year-old Auckland commercial orange roughy fisherman was today sentenced to 18 months in jail when he appeared in the Auckland district court. He had earlier pleaded guilty to a number of serious charges of falsifying his fishing catch returns. These false returns claimed he was fishing in one location when he was actually catching fish in another over a seamount that had been closed for the season to guard against over fishing.

Commercial fishing company loses \$1 million dollar vessel - 9 March 2007

An Auckland-based fishing company has had its fishing vessel, Aramand Sea, forfeited to the crown after being convicted of charges of quota fraud in the Auckland District Court on March 8. The company was found guilty of a number of offences against the Quota Management System. These involved failures to report fish caught. Ministry of Fisheries District Compliance Manager, Ian Bright, says the company failed to file returns for several months last year, even though the vessel was catching and landing fish.

Fishers lose cars and get big fines for ignoring cockle limits - 29 May 2007

Two women who blatantly ignored the legal limits for collecting cockles were convicted and each received a fine of \$1800 plus court costs of \$130 when they appeared in the Manukau

district court on may 25. Both have also had their 4-wheel-drive vehicles confiscated and forfeited to the Crown. The pair was collecting cockles with three children and had what Fishery Officers describe as an astonishing 2348 cockles between them, nearly 22 times their daily limit.

Pāua poacher sentenced - 25 May 2007

A Kaikoura diver was sentenced to 140 hours community service and fined a total of \$5,000 and court costs after earlier pleading guilty to taking 500 Pāua and 36 Rock Lobster from the Kaikoura area in March this year.

Obstructive commercial fisherman loses license, banned from fishing - 19 June 2007

A commercial fisherman who refused to co-operate with Fishery Officers has been convicted and fined \$3000 and banned from all forms of fishing for three years. He was convicted of failing to comply with the lawful requirement of a fishery officer when he appeared in the Manukau District Court on June 15.

Poaching couples receive 1000 hours community service; lose cars, boat - 22 June, 2007

Two south Auckland couples that illegally caught large amounts of grey mullet and then sold them in the streets around their homes were sentenced to more than 1000 hours community service when they appeared in the Manukau District Court yesterday. Their two vehicles, boat, fishing nets and a fridge/freezer have also been forfeited to the Crown.

The court heard that, between November 2005 and February 2006, the couples set nets for grey mullet in the port Waikato area using two 80-metre long fishing nets (the maximum legal length for a recreational net is 60 metres). They would do this on average two-three times per week. They, their partners and children would then drive slowly along neighbouring streets offering the fish for sale. When interviewed, the two couples admitted they often earned up to \$1000 a week in this way.

Community support helps nab poachers - 31 July 2007

Community support was the key to Fishery Officers catching up with a couple of poachers in Northlands Te Ngaere Bay.

Ministry of fisheries Whangarei district compliance manager Darren Edwards said Fishery Officers caught two men last week with 43 snapper, 11 of which were undersized. The daily bag limit for snapper is nine per person. The men also had undersized kingfish, Pāua and Rock Lobster and have been issued infringement notices totaling \$1250 each.

Locals' concern leads to fisheries seizures - 1 August 2007

Information from concerned far-North locals has lead to Fishery Officers seizing a chiller truck and two small boats belonging to a commercial netting operation. Ministry of Fisheries Whangarei district compliance manager Darren Edwards said locals starting calling a few months ago concerned about the actions of a group of net-fishers working harbours in the far-North, targeting yellow-eyed mullet, flounder and kahawai.

Rock Lobster seized in Gisborne - 8 August 2007

Gisborne Fishery Officers have seized 50 Rock Lobsters from the boot of a car, following a two day operation. Neville Buckley, Ministry of Fisheries district compliance manager for the east coast, said that it was likely that the illegal fish had been taken from the Whangara area. Of the 45 Rock Lobster seized 42 were under the legal size.

Vehicles seized after harbour Pāua bust - 8 August 2007

Fifty kilograms of Pāua has been seized in the last two weeks in Wellington harbour as a result of two unrelated incidents detected by vigilant fisheries patrols. Two vessels and two vehicles have also been seized. Ministry of Fisheries Wellington District Compliance Manager, Ross Thurston, says that as a result of the patrol catches four men will be facing serious Fisheries Act charges.

On Monday 23 July Fishery Officers watched a man dive in the Wellington harbour and shuck 27 kilos of Pāua, which he then carried on his vessel to another area. After hiding the Pāua the same diver drove his vehicle to that area to recover the Pāua. He was intercepted

by Fishery Officers.

On Thursday 2 August a second unrelated man was seen by a fisheries patrol to dive and shuck 20 kilos of Pāua. He too took the Pāua to another location to be picked up by the divers associate. A fisheries patrol intercepted that haul.

Fish-dumping charges in east coast Hoki fishery - 7 September 2007

Three senior crew from a foreign-charter vessel have been charged with illegally dumping fish at sea under the Fisheries Act. These charges were called in the Christchurch District Court today and have been adjourned until 18 September. No pleas were entered.

The vessel was contracted to fish for a New Zealand fishing company and is registered in Malta and has a Polish crew.

Pāua offender sentenced - 30 October 2007

Trying to post more than 300 kilograms of dried Pāua overseas saw a man sentenced at the Wellington district court today. He has been sentenced to six months home detention on two counts relating to serious breaches against the Fisheries Act. The offending occurred between June and November 2004 and facilitated the export of illegally taken Pāua.

Three Pāua poachers apprehended - 2 October 2007

Fishery Officers on routine patrol together, and alerted by a tip off from the public, apprehended three Pāua poachers on the Wainuiomata Coast last night. The three men possessed 500 to 600 Pāua between them well above their daily limit of 10 Pāua per person, per day.

Fishery Officers swoop on alleged black market operation - 9 November 2007

Fishery Officers moved on an alleged black market operation yesterday involving seafood caught in northland and sold in Auckland. Ministry of Fisheries investigations manager Mark Nicholson said three men and two women are being interviewed by Fishery Officers and may face Fisheries Act charges. The group had about 60 Rock Lobster and several sacks of Kina when Fishery Officers and police spoke to them. It is illegal to catch fish for sale without a permit.

Black market Pāua convictions - 22 November 2007

Two Auckland men have been convicted of buying black market Pāua that had been poached from the Wellington coast. The Ministry of Fisheries investigations manager Mark Nicholson said in March the man bought 30 kilograms of illegal Pāua from a man in two separate purchases, paying \$48 per kg. Mr Nicholson said the man selling the Pāua had been supplied by a group of divers who had taken Pāua from the Wellington coast at Wainuiomata. Fishery Officers had been tipped off to the divers' operation and were able to trace the Pāua to the point of sale.

Mfish seizes a second foreign charter fishing vessel - 20 December 2007

The Ministry of Fisheries seized a Korean fishing vessel, the Melilla 201, in Dunedin on Tuesday. The investigation concerns misreporting catch from one fishing area to another, a practice commonly known in the fishing industry as trucking. The main species involved is ling, with the alleged offending potentially involving hundreds of tonnes of fish.

Boats and vehicles seized in Wellington Pāua busts - 17 December 2007

One hundred and seventy kilograms of Pāua, along with four vessels, four 4x4 vehicles and a flat deck truck, have been seized in the Wellington region as a result of pre christmas patrols by Fishery Officers. Earlier Fishery Officers watched a man dive in the Wellington harbour and shuck 27 kilos of Pāua, which he then carried on his vessel to another area. After secreting the Pāua the same diver drove his vehicle to that area to recover the Pāua. He was intercepted by Fishery Officers. Following that a second unrelated man was seen by a fisheries patrol to dive and shuck 20 kilos of Pāua. He too took the Pāua to another location to be picked up by the divers associate. A fisheries patrol intercepted that haul.

Late in november, two further vessels and a flat deck truck were seized after Fishery Officers saw divers shucking Pāua in the Wellington harbour. 115 kgs of Pāua was seized as a result of Ministry of Fisheries intervention.

Appendix C

Kaitiaki information sheet and permission form

The following document is the letter sent to Kaitiaki, both via email and through the post, to inform them of this project and request their permission to use their data (Section 6.3.1). A draft of this letter was originally taken to an Iwi fisheries hui and Kaitiaki were asked for their suggestions for the permission form. Kaitiaki who permitted me their data to be used filled in this form and sent it back to me. A copy of all forms received were then forwarded to the Ministry of Fisheries who released the Kaitiaki customary data.

Tēnā koutou:

Kia mātūtū tonu ai te whakaaro ki te hunga kua momotu ki tawhiti nui, ki tawhiti roa, ki tawhiti pamamao. Ō tātau mate ki a rātau, otirā tātau te tirohanga kanohi ki a tātau, nō reira tēnā koutou, tēnā koutou, huri noa tēnā tātau katoa.

Ko wai au?

Ko Tākitimu te waka
Ko Tararua te maunga
Ko Ruamahanga te awa
Ko Ngāti Kahungunu te iwi
Ko Te Poho O Tū Ta Wake te hapū

My name is Kylie Reiri and I am currently doing my Masters degree in Applied Statistics at Victoria University of Wellington. Last year I finished my Bachelors degree with Majors in Marine Biology and Applied Statistics. For my thesis I am now focusing on Fisheries in the rohe of my iwi, Ngāti Kahungunu. My supervisors are Dr. Richard Arnold and Dr. Adele Whyte, who is also Kahungunu.

He aha taku mahi?

Currently, customary, recreational and commercial fisheries data are all kept separately, and there is very little information on what the recreational catch really is, so we do not know how much kai moana is coming out of our coastline.

Having an overall understanding of the amount of kai moana being caught in the rohe, at a finer geographical scale than what is currently available, may result in improved management decisions to ensure kai moana will be sustainably fished for future generations.

The overall aims of my project are:

- to gain an improved view of all of the fisheries data collected in the Ngāti Kahungunu rohe (customary, commercial and recreational).
- to assess the quality of the data being collected.
- to make estimates of the total catch of kai moana in the Kahungunu rohe.
- to suggest possible improvements to the data collection process to make the information collected more useful to all users.
- to provide tāngata whenua with a more holistic understanding of the resources being utilised from their moana.

Kei te aha au ināianei?

I am currently in the process of finding out what information is available and bringing the different data sources together. I will hopefully have all of the data I need by early next year when I will start analysing the data and writing my thesis.

Me pehea e āwhina koe i a au?

Customary information from Kaitiaki is an important part of my project and I am hoping to gain permission from Kaitiaki to use the information from the permits they have issued.

This letter requests permission to use information collected by your Kaitiaki for your hapū rohe moana as part of this research.

Intellectual property considerations

I understand that the privacy of not only individual Kaitiaki but also specific fishing grounds is sensitive and this information will be kept confidential. The data you provide will be amalgamated into your hapū gazetted rohe moana areas. The information you make available to me will not be recognisable by other people, and will be used for research purposes only.

With your permission I can access the quarterly information provided by your kaitiaki to MFish directly or preferably Kaitiaki may wish to provide this information to us direct. Additionally, there may be extra information that is collected by your hapū Kaitiaki (e.g. recreational ramp surveys?) that you may wish to take the opportunity to allow us to analyse on your behalf?

A public presentation of the results of this research will be made and an electronic copy of my thesis (and/or key findings) will be made available to participating hapū. The thesis will be deposited in the Victoria University library and will also be accessible via the internet, thereby becoming a publically accessible resource available to all. The results of this study will be published in an international peer-reviewed academic journal. Results may also be made public via the media – should there be interest. However, it is my intention to allow participants to have the opportunity to view information and findings before the findings are made public.

The Science Faculty also has a programme designed specifically to support Maori students (Te Rōpu Awhina), which I have been a part of since 2007. Awhina is a whanau where students provide each other with on going cultural and academic support. I will present the results of this research at one of our monthly postgraduate seminars and a profile of my research will also appear in the postgraduate section of our Awhina website.

If you would like to take the opportunity to be involved in this research, I have included a consent form on the following page.

My supervisors and I are available to meet with you to discuss this work further at a time convenient to you. Please let us know if you would like to arrange a meeting.

Thank you for considering this request.

I can be contacted on kyliereiri@gmail.com or 021 024 33589 if you have any further questions.

Ngā mihi,

Kylie Reiri
Kahungunu Masters student

Consent Form for Customary Data Access
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I give consent for Kylie Reiri to use the information I have collected on customary fishing catch. This includes information from Te Ika-Ā-Matua Kaimoana forms issued under the Customary Fishing Regulations.

I understand a presentation of the results of this research will be given to participating hapū and participants will have the opportunity to view information and findings before the findings are made public.

I understand that this information will be used for research purposes only and when published individual kaitiaki privacy will be protected.

I understand that we can withdraw from this research at any time should we so wish.

Name of Hapū

Rohe Moana

Name of Signatory

Signature

Date

Appendix D

Harvest and survey forms

The following form was used to collect data for the Hawkes Bay Sport Finfish Survey, described in Section 6.7.

MARINE RECREATIONAL CATCH RECORD

Fishing clubs need better information on the complete recreational catch per trip, and how catch rates change over time to ensure recreational fishing interests are protected. Please fill out one of these forms accurately (whether successful or not) to provide a complete picture of your fishery.

COMPETITION:	DATE:
BOAT NAME:	No. OF ANGLERS:
FISHING TYPE (i.e. bottom fishing, trolling, set lines etc):	

NUMBER OF FISH CAUGHT

SPECIES	NO. KEPT	NO. RELEASED	SPECIES	NO. KEPT	NO. RELEASED
Blue Cod			Snapper		
Kahawai			Albacore		
Red Cod			Skip Jack		
Gurnard			Marlin		
Rig			Carpet Shark		
School Shark			Spiny Back Shark		
Tarakihi			Mackeral		
Trevally					
Hapuku					
Kingfish					
Barracoutta					

SPECIES AND LOCATION OF MARINE MAMMALS OR SHARKS SEEN:

GENERAL COMMENTS:

The following form was used to collect data for the Moremore Reserve Recreational Survey, described in Section 6.10.

CUSTOMARY / RECREATIONAL SHELLFISH SURVEY: MOREMORE RESERVE

Observer (your) Name _____ Date _____ Number _____

Camp Code Time of day Day Type 1 = Weekend or Public holiday
2 = weekday

Questions for Fishers

Did you fish today? Y / N Are you willing to participate in survey? Y / N
(if no – still record boat/shore and total in group)

Recreational (tick) _____ BOAT (tick) _____ Total in group No. of gatherers Area Fished
Customary _____ SHORE gathering _____ Refer to map for number

SPECIES - Did you gather shellfish? Y / N (circle) Did you gather finfish? Y / N

SHELLFISH	Rocklobster	Paua	Mussels	Kina	Other
Quantities taken					
Methods used = Snorkel = Spear					

RAMP CODES

A = Game Fish Club
C = Meeanee Quay
E = Tangoio Reef
G = Waipatiki South
I = Aropauanui

B = Bluewater Ramp
D = Harding Road Port
F = Tangoio Bluff
H = Waipatiki North

Fishing Area Map & Codes

Customary / Recreational Shellfish Survey Moremore Reserve

Local tangata kaitiaki Rangi Spooner is leading the way with a local initiative to ascertain how much **shellfish** is being harvested from the Moremore Reserve, along the Napier coastline.

The proactive initiative is being supported by Te Kupenga Whiturauoa a Maui, The Guardians of Hawke Bay Fisheries, the Corrections Department, Wayne Bicknell from the Hawkes Bay Sport Fishing Club, the Ministry of Fisheries, and various other aspects of the local community.

This voluntary recreational survey will begin on Saturday the 18th of October 2008 and will be conducted each Saturday until the end of February 2009.

Surveyors will be recording data at 5 local boat ramps in an effort to capture the shellfish harvest from the Napier Coastline. The information gathered will be used towards a planning tool for local sustainable fisheries management.

Your time and participation is appreciated, thank you.

If you have any further queries you are welcome to contact Rangi Spooner on 027 308 1275.

Survey area of interest

The following form is filled in by commercial fisheries who fish using lines, for example long-lining. The forms are returned to the Ministry of Fisheries and are used to collect information on commercial fishing. Note there are different forms for other types of fishing, for example using nets or trawling.

MINISTRY OF FISHERIES
 Te Kaitiaki / āra tira a Hāgarua

fi.form_type = "PCE"
 Default target species is "PAU"

fi.form_number

Form number **PCE**

Paua Catch Effort Landing Return

1. If this is a NIL return for an entire calendar month, then you only need to provide one PCELR for that month. Otherwise, provide a separate return for each day (in which diving for paua, or landing of paua, or both, occurred).

Is this a NIL return for a month?

Yes ☐ → Enter that month (e.g. "FEB") and year. **20** available via the nil_return view in warehouse → Go to section 5.

No ☐ → Enter the date that this return is for. / / **20**
 fi.start_datetime

2. Enter the paua quota management area dived. Complete a separate return for each QMA dived. **PAU**
 la.fishstock_code

3. Complete a separate line for each diver and each paua statistical area that they dived.

Name of diver first letter of first name then first four letters of surname	Paua statistical area	Time spent in water (h:mm)	Estimate (by fisher) of catch of blackfoot paua	Estimate (by fisher) of catch of yellowfoot paua	Diving conditions
fi.catcher_id	fi.start_stats_area_code	fi.fishing_duration	ca.catch_weight ca.species_code="PAJ" .0kg	ca.catch_weight ca.species_code="PAA" .0kg	fi.condition_type
			.0kg	.0kg	
			.0kg	.0kg	
			.0kg	.0kg	
			.0kg	.0kg	
			.0kg	.0kg	

Use an additional page if you run out of space when recording this day's diving.

The following form is filled in by Kaitiaki, and issued as a permit to allow fishers to harvest under customary regulations.

MARINE RECREATIONAL CATCH RECORD

Fishing clubs need better information on the complete recreational catch per trip, and how catch rates change over time to ensure recreational fishing interests are protected. Please fill out one of these forms accurately (whether successful or not) to provide a complete picture of your fishery.

COMPETITION:	DATE:
BOAT NAME:	No. OF ANGLERS:
FISHING TYPE (i.e. bottom fishing, trolling, set lines etc):	

NUMBER OF FISH CAUGHT

SPECIES	NO. KEPT	NO. RELEASED	SPECIES	NO. KEPT	NO. RELEASED
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Kahawai			Albacore		
Red Cod			Skip Jack		
Gurnard			Marlin		
Rig			Carpet Shark		
School Shark			Spiny Back Shark		
Tarakihi			Mackeral		
Trevally					
Hapuku					
Kingfish					
Barracoutta					
SPECIES AND LOCATION OF MARINE MAMMALS OR SHARKS SEEN:					
GENERAL COMMENTS:					