



TE ARAWA LAKES TRUST

TE KOMITI WHAKAHAERE



*Me huri whakamuri, ka titiro
whakamua*

In order to plan for the
future,
we must look to the past



MAHERE WHAKAHAERE

TE ARAWA LAKES FISHERIES MANAGEMENT PLAN

HAI TIMATANGA

On behalf of Te Arawa Lakes Trust and Te Komiti Whakahaere, it is with considerable pride that we present the Mahire Whakahaere – Te Arawa Lakes Fisheries Management Plan.

The focus of the Mahire Whakahaere is to empower Te Arawa to actively manage the customary and recreational harvest of ngā taonga in our Te Arawa Lakes.

In accordance with Te Arawa tikanga and kawa, this Mahire Whakahaere provides the management of resources and provision of cultural practices of Te Arawa as well as the customary food gathering utilising sustainable traditional practices and settling limits, measures and bylaws for the sustainable management of ngā taonga and included species.

To ensure the aspirations of collectively keeping this Mahire Whakahaere alive ngā hui, wānanga with hapu, iwi and various management authorities within Te Arawa will be conducted in respect of all matters relating to the active protection of our fresh water taonga and species.

We sincerely congratulate all those who have brought this Mahire Whakahaere together over the last five years, as we will launch Te Arawa on a new journey to protect our fresh water taonga and species for our present and future generations.



Sir Toby Cutis

Chairman, Te Arawa Lakes Trust



Laurence Tamati

Chairman, Te Komiti Whakahaere

HE MIHI

Te Arawa waka Te Arawa tangata

Mai i Maketu ki Tongariro

Ko tātau tēnei nga uri e mihi nei

Ki a tatau te hunga ora

Me te tangi

Ki a rātau kua wheturangitia.

Tukua mai kia piri! Tukua mai kia tata!

Tihei Mauri Ora

This Mahire Whakahaere reflects over five years of a collective contribution of knowledge, expertise, experiences and historical traditional korero.

Special mention must be made to the following contributors:

- Te Arawa Lakes Trust trustees and staff, particularly for their support of Te Komiti Whakahaere.
- The original and past Te Komiti Whakahaere members being Ken Raureti, Wally Lee, Rea Rangiheuea-Martin, Hakopa Paul, Ron Roberts, Tony Kapua for the formalising of Te Komiti Whakahaere and the development of policies and strategies for the sustainable management of customary fisheries in the Te Arawa Lakes.
- Te Arawa whanau whanui attending to numerous hui and helping Te Komiti Whakahaere to identify traditional practices and korero. (Further detail of those hui is set out in the appendices.)
- Te Arawa koeke for ensuring that this Mahire Whakahaere adheres to Te Arawa tikanga and kawa, and ensuring that our reo is contextualised appropriately.
- The current Te Komiti Whakahaere members for the final completion of this Mahere Whakahaere document.

Significant support, advice and technical assistance was provided during the development of this plan by:

- Erica Williams from National Institute of Water and Atmospheric Research alongside Ian Kusabs who provided a foundation for the scientific knowledge in this document and the development for a sustainable management framework. Ian also developed the supplementary report to this plan and contributed the comprehensive kōura research and the collation of our taonga species and management performance measures used in this document.
- Tracey Kingi alongside Roku Mihinui and Hera Smith for building a strong relationship between Te Arawa and the Ministry of Primary Industries, particularly in the development of the management objectives.

CONTENTS

HAI TIMATANGA.....	i
HE MIHI	ii
1.0 WĀHANGA TUATAHI – HAI ARATAKI	1
1.1 Overview	1
1.2 Vision and Purpose	1
1.3 Background	2
1.3.1 Te Arawa Lakes Trust.....	2
1.3.2 Te Komiti Whakahaere	3
1.3.3. Poutiriao	4
1.3.4 Other entities.....	4
2.0 WĀHANGA TUARUA - NGĀ MOMO TĀONGA O NGĀ ROTO	5
2.1 The Te Arawa freshwater fisheries tradition	5
2.2 Kākahi.....	6
2.3 Kōaro.....	7
2.4 Kōura.....	8
2.5 Morihana	10
2.6 Īnanga	10
2.7 Tuna	12
2.8 Trout fishery.....	13
3.0 WĀHANGA TUATORU – TE MANA WHAKAHAERE	14
3.1 Management objectives	14
3.2 Bylaws	16
3.3 Puka Whakamana	17
3.4 Conclusion.....	17
Appendix 1: Glossary	18
Appendix 2: Hui with Te Arawa hapu and iwi	20
Appendix 3: Illustrations.....	21
Appendix 4: Research Acknowledgements	22
Appendix 5: References.....	22

1.0 WĀHANGA TUATAHI – HAI ARATAKI

Mai Maketū ki Tongariro, ko Te Arawa te waka, ko Te Arawa māngai-nui ūpoko tū-takitaki.

From Maketū to Tongariro, Te Arawa the canoe, Te Arawa the determined people

1.1 Overview

This Mahire Whakahaere sets out the goals of Te Komiti Whakahaere for ngā kai o ngā roto. The Mahire Whakahaere is the management framework for customary fisheries in the Te Arawa lakes. It is a critical tool for the sustainable utilisation and management of ngā ika, according to the customs and cultural practices of Te Arawa.

For the Mahire Whakahaere to reflect Te Arawa aspirations it must be underpinned by Te Arawa tikanga and kawa. Te Arawa's history with the lakes begins with Ihenga's claims to the lakes, establishing Te Pera o Tangaroa - a fundamental practice for Te Arawa in maintaining mana and control of the Te Arawa lakes and customary fisheries. The historical event of Ihenga and his kuri discovering īnanga link successive generations of Te Arawa to ngā kai o ngā roto.

This further enhances Te Arawa rights to ngā ika as kai to sustain our whānau, hapū, and iwi. The rights for Te Arawa to have access to ngā taonga, based on mātauranga of many generations, is supported by cultural practices that continue today.

This Mahire Whakahaere will first describe the vision and background to this plan and explain the context in which it sits. The second part will explore the various customary fisheries in the Te Arawa lakes and examine their cultural significance and current state. Part three will set out the strategic objectives for the management of these fisheries. It will also explain that bylaws may be made to help achieve those objectives.

1.2 Vision and Purpose

This Mahire Whakahaere is designed to build towards the vision of:

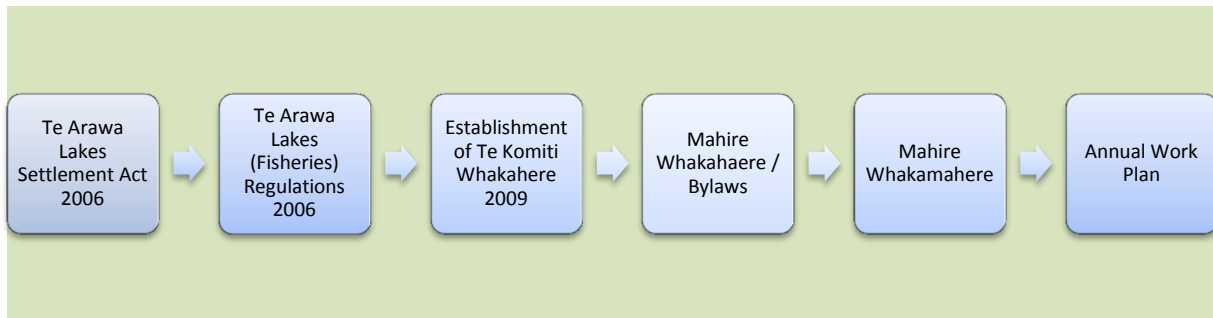
Te Arawa taonga fishery is healthy, plentiful, sustainably managed, and Te Arawa have undisturbed possession and access to Te Arawa taonga fishery, mo ake, tonu atu.

This vision also supports and aligns to Te Whakapapa o Te Wai, being the Te Arawa Cultural Values Framework, which focuses on Wai, Waiariki, Waiora, Wairua and Waiata. This strong relationship is accentuated in Te Wahanga Tuatoru.

The purposes of this Mahire Whakahaere are to ensure sustainability of the customary fisheries, gather more information, promote customary fishing practice, preserve the habitat of the fisheries and ensure safe consumption. These purposes are explored in detail in Wahanga Tuatoru.

1.3 Background

The Mahire Whakahaere is part of the wider context of the Te Arawa Lakes Settlement, as shown below.



1.3.1 Te Arawa Lakes Trust

Te Arawa Lakes Trust (formerly known as the Te Arawa Maori Trust Board) is the governance entity established to receive and manage the redress of Te Arawa Lakes Settlement on behalf of Te Arawa. The Trust is the owner of the lakebeds of the 14 Te Arawa lakes (not the streams or rivers that flow into them), on behalf of Te Arawa hapu and iwi. Te Arawa lakes¹ are:

- Rotoehu
- Rotomā
- Rotoiti (Te Roto- Whaiti-i-kite-ai-a-Ihenga-i-Ariki- ai- a Kahumatamomoe
- Rotorua (Rotorua-nui-a Kahumatamomoe
- Ōkātina (Te Moana i kātina a Te Rangitakaroro)
- Ōkareka
- Rerewhakaaitu
- Tarawera
- Rotomahana
- Tikitapu
- Ngāhewa
- Tutaeīnanga
- Ngāpouri (Opouri) and
- Ōkaro (Ngakaro)

¹ Lake Rotokākahi is located within the Te Arawa region however is under the legal guardianship of Tuhourangi and Ngāti Tumatawera iwi.

1.3.3. Poutiriao

All members of Te Komiti Whakahaere are also Poutiriao; individuals who can issue Puka whakamana (an authorisation for customary food gathering) within part or whole of the Te Arawa Lakes. The regulations allow for more than one Poutiriao to be appointed for a particular area, and not all Poutiriao are required to be members of the Komiti Whakahaere.

Poutiriao are able to issue Puka whakamana in accordance with the regulations. The roles and responsibilities of Komiti Whakahaere and Poutiriao are outlined in the Te Arawa Lakes (Fisheries) Regulations 2006

1.3.4 Other entities

Some of the other entities involved in the management of the customary fisheries in the Te Arawa Lakes are:

The Rotorua Te Arawa Lakes Strategy Group is a joint management collaboration consisting of representatives from the Te Arawa Lakes Trust, Bay of Plenty Regional Council and Rotorua District Council. The purpose of this body is to coordinate policy and action to promote the sustainable management of the lakes.

Ministry for Primary Industries who ensure that fisheries are used in a sustainable way and that we have a healthy aquatic ecosystem therefore getting the best value from this resource. This is achieved by researching fisheries, managing the process for access and allocation of fisheries and ensuring that everyone who uses New Zealand's fisheries comply with the rules and regulations that govern and protect them.

Fish & Game New Zealand who manage, maintain and enhance sports fish and game birds and their habitats in the best long-term interests of present and future generations of anglers and hunters. For freshwater fisheries Fish & Game New Zealand provides regulations for game bird hunting and fishing throughout New Zealand (except Taupo, where fishing is administered by Department of Conservation).

Bay of Plenty Regional Council's work guides and supports the sustainable development of the Bay of Plenty ensuring the region grows and develops in a way that keeps its values safe for future generations. A major focus involves looking after the environment by managing the effects of people's use of freshwater, land, air and coastal water, however have a broader responsibility with others for the economic, social and cultural well-being of the regional community.

2.0 WĀHANGA TUARUA - NGĀ MOMO TĀONGA O NGĀ ROTO²

2.1 The Te Arawa freshwater fisheries tradition

The association between Te Arawa, the lakes and the customary fisheries began many centuries ago with Ihenga. Ihenga was hunting kiwi in the Lake Rotoiti area, when his dog, called Potakatawhiti, pursued a kiwi into the lake. In the process of catching the kiwi it in its mouth, Potakatawhiti also ingested a large quantity of īnanga. When the dog returned to Ihenga, its fur was still wet this indicated that a body of water, perhaps a lake, was nearby. The dog then vomited the īnanga onto the ground, which made the party decide to seek out the lake. In this way, they came to the lake and could see for themselves the shoals of īnanga leaping in the water. They made a net of fern and when they caught enough they lit a fire, cooked and ate the fish, but kept several baskets to take back to Maketu.

Since that time Te Arawa have resided in the Rotorua area and the lakes of the region are the foundation of our identity, culture, wairua, tikanga and kawa. The lakes remain the centre of Te Arawa settlement. For centuries the lakes have also been the mainstay of the Te Arawa economy, as the lakes and their margins were an important source of freshwater fish, waterfowl and plants.

The taonga in the lakes, such as kōura, īnanga, tuna, kākahi, kōaro and morihana, are prized food sources; providing sustenance for generations of Te Arawa. These taonga maintain the delicate balance of the ecosystems in the lakes district and contribute to other species and organisms within the aquatic environment.

The main fisheries species harvested by Māori in the Te Arawa lakes in pre-European times included the juvenile and adult stages of the kōaro, termed īnanga and kōkopu respectively, adult toitoi (common bullies) kōura and kākahi. The Māori fisheries of īnanga, kōkopu, kōura and toitoi were widespread in many of the Te Arawa lakes up to the mid-1890s, and fishing grounds for these species were clearly delineated and managed.

Tuna were not present naturally in the Te Arawa lakes, apart from small numbers in the Lake Tarawera catchment, but eels were probably stocked from time to time into other lakes, resulting in the occasional capture of one or two eels.

Later introductions of fish by European settlers, especially rainbow trout, brown trout, morihana and common smelt had a large and mainly detrimental impact on the customary fisheries in the Te Arawa lakes. Trout quickly replaced kōkopu as the largest fish present, and as a result of their heavy predation on īnanga, the fisheries of both īnanga and kōkopu soon collapsed. Trout became very abundant, to the point where netting was required to reduce the trout population. Māori access to this new fishery was limited and restricted by regulations governing the licensing of anglers and the control of poaching.

Morihana proved to be a popular fish for eating, but were only abundant and large enough to be worth catching around the warm, geothermally influenced areas of Lake Rotorua such as Ohinemutu and Ngāpuna. They were later introduced to lakes Tarawera, Rotoehu and Rotomahana. Although this new fishery was popular with Māori, it was localised and did not replace the more widespread fisheries of īnanga and kōkopu.

² Detailed information on the customary fisheries in the Te Arawa Lakes is set out in the Supplementary Report to the Mahire Whakahaere, prepared by Ian Kusabs and available at <http://www.tearawa.iwi.nz/>

The Māori fishery for the much smaller toitoi was abandoned when the īnanga and kōkopu fisheries collapsed, even though common bullies remained abundant in the lakes and have since increased. In the 1930s, smelt became abundant in all the lakes as a result of stocking to increase the food base for trout. These smelt provided a localised fishery in the Ohau Channel and in Lake Rotoiti, but this did not replace the kōaro fisheries in the lakes.

At present, the only customary fisheries species currently utilised by Te Arawa whānau and hapū in any significant quantities are kōura and īnanga. The rama kōura fishery is the most popular customary fisheries activity with harvesting occurring in most Te Arawa lakes especially lakes Rotoiti, Rotomā, and Tarawera. Īnanga are very abundant in all of the Te Arawa lakes however they are only harvested during their seasonal migrations up the Ohau Channel where they are easily trapped by shore-based fishermen.

Customary traditions such as rahui are important management practices for Te Arawa, who seek the ability to utilise rahui for protection of tapu. Te Arawa are also concerned about the impact of pest species and predators e.g. rats and trout.

2.2 Kākahi



Figure 2: Kākahi

The kākahi was once a valuable food source for Te Arawa. Despite it being considered the least appetising of the fisheries resources in the Te Arawa lakes it was the most important in story, song and proverb. Kākahi were collected from all the lakes but were most plentiful and easily harvested in the shallower lakes such as Rotorua, Rotoehu and Rotokākahi. Kākahi were collected throughout the year, but were best in winter. Kākahi were eaten raw, lightly boiled or dried in the sun for use in stews. They were also used in the feeding of motherless infants and as rongoā - a medicinal food.

Kākahi are present in 10 of the fourteen Te Arawa lakes and in Lake Rotokākahi. However, little is known of the population dynamics of kākahi across the entire Te Arawa fisheries area.

While kākahi are still consumed today they are not as popular or as important as they were in the past. This may be mainly due to the taste of the kākahi rather than a decline in harvestable quantities. The propensity to accumulate pollutants may prejudice the health of consumers and this may be one of the reasons why kākahi are no longer exploited on a large scale by Te Arawa iwi and hapū.

Kākahi are considered a threatened species because of the loss of habitat associated with macrophyte invasion, river regulation, eutrophication, and other types of pollution, and possibly through loss of the host fish on which completion of the life cycle depends.

2.3 Kōaro

Kōaro were once the dominant fish species in most of the large, inland lakes of the central North Island and up until about 1900, kōaro supported important Māori fisheries.

In pre-European times, the main fish harvested by iwi and hapū in the Te Arawa lakes included the juvenile and adult stages of the kōaro termed īnanga and kōkopu respectively. These customary fisheries were widespread in many of the Te Arawa lakes up to the mid-1890s. Kōaro fishing grounds were documented for Lakes Rotorua, Rotoiti, Rotoehu and Rotomā.

In the early 1920s, Gilbert Mair described the fishery situation as follows:

Re native trout or kōkopu. These used to be caught by baiting small circular nets with crushed “kōura” in deep water in Rotoiti in very large numbers. They were very fat and delicious eating. A rare species was taken on certain nights coming up out of the Awahou and Hamurana springs...The only fish in our lake are the kōkopu, īnanga or whitebait, toitoi and the rare fish which used to come out of the Waiteti, Awahou and Hamurana Springs called “kōaro”.³

He later described the capture of adult ‘kōaro’ coming out of the Hamurana Stream in Lake Rotorua in more detail⁴:

a long funnel-shaped net with a pocket was stretched across the riverthe net was lowered into position and pegged to the bottom with forked sticks at about 8 pm; then a 50 ft canoe was moored to a stake at the lower end. Two hours then elapsed, when the pocket was lifted, the end untied and several hundredweight of the fat little fish were emptied into the canoe. This process was repeated several times during the night till quite a ton of weight had been obtained....Of course the introduction of trout was the death-knell of the kōaro and I very much fear they will be destroyed utterly in Rotoaira Lake in like manner.⁵

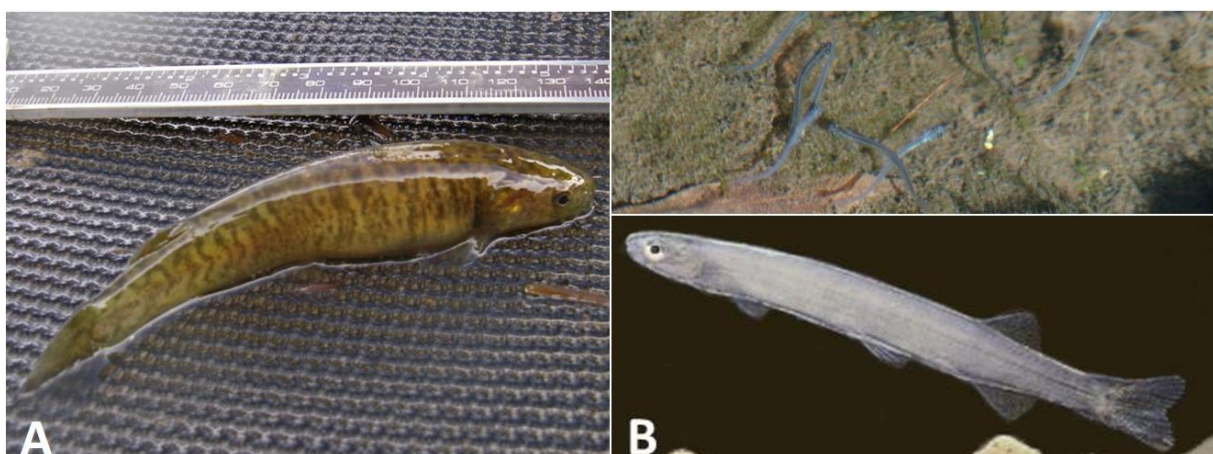


Figure 3: Photo (A) is an adult kōaro captured from a tau kōura set in Lake Ōkāreka. Photo (B) is a juvenile kōaro.

³ Letter from Gilbert Mair to Arthur Iles dated 14 March 1922, cited in Rowe and Kusabs (2007a)

⁴ This method of capture is now known as ‘fyke netting’.

⁵ See Mair G. (1923) *Reminiscences and Maori stories*.

In fact, the kōaro populations in the Te Arawa Lakes were decimated by the introduction of trout in the late 1800s to the point where the customary fishery collapsed. The introduction of smelt to Lake Rotorua in the 1920s, and to the other Te Arawa Lakes in the 1930s, caused a further decline in kōaro. Competition between juvenile smelt and kōaro for food and space, coupled with predation of kōaro larvae by large smelt, is likely to have resulted in the decline of the kōaro population to the point where they are now rare in these lakes. In addition, the clearance of native forestry has probably led to the disappearance of kōaro from many streams in the lakes' catchments.

Despite this reduction, the current status of kōaro is still largely unknown and there are very few management initiatives currently in place to secure relict populations or to restore lost populations in streams.

Populations still exist in a few of the inlet streams of lakes Ōkātina, Rotoiti, Tarawera, Ōkāreka and Rotorua (tributaries) but kōaro are thought to be extinct in ten of the Te Arawa Lakes (i.e. in lakes Rotoehu, Rotomā, Rotokawau, Rotokākahi, Rotomāhana, Rerewhakaaitu, Ōkaro, Ngāhewa, Ngāpouri and Tutaeīnanga). This species is only secure in Lake Ōkātina where it is still common in all six inlet streams. It is apparent that management will be required to prevent the known relict stream populations from declining further and to restore kōaro in streams where they are now absent, but where removal of trout and/or the creation of riparian buffers would help to restore them.

The introduction of exotic fish to the Te Arawa Lakes is a major and significant threat to customary fisheries, including kōaro. It is imperative that preventative measures are adopted and introduction for mitigation and remediation, such as contingency plans for eradication or containment strategy. Other threats to the few remnant populations of kōaro in the Te Arawa lakes streams include land-use changes (particularly deforestation) and culvert modifications that may improve upstream access by trout.

2.4 Kōura

Kōura are a valued mahinga kai species and considered a delicacy by Te Arawa. In the past they were a staple food item, and prized for their use as a bartering item with Māori from outlying districts.



Figure 4: Photo (Left): Adult kōura captured from Lake Ōkāreka. Photo (Right): Female kōura with eggs.

Although, found in many other freshwater streams and waterways, Te Arawa and Taupō lakes were considered among the most productive kōura fisheries in New Zealand. An example of this productivity was at the opening of Tamatekapua at Ohinemutu in 1873, where a reputed 500 rohe (where a rohe was roughly the equivalent of a modern sack) of dried kōura and īnanga were consumed.

A number of methods were, and are still used to capture kōura in the Te Arawa lakes, the tau kōura, the paepae or hao, collecting kōura by hand, rama kōura and hi kōura.

Tau kōura is the favourite traditional fishing method for harvesting kōura in Te Arawa lakes. This method involves the placement of bracken fern bundles (known as whakaweku) on the lake bed for kōura to take refuge in and then retrieving the bundles into a waka to harvest the kōura (Fig. 5). The traditional tau kōura was comprised of a surface line (tāuhu) which was attached at one end, to a surface reaching pole (tumu) and a float (pōito) at the other end and held in place by an anchor (punga), from which drop lines (pekapeka) that reached to the bottom with fern bundles (whakaweku) were attached. To harvest the kōura the fern bundles were lifted onto a net of woven flax or kōrapa, which prevented the kōura from escaping as they were lifted out of the water. Tumus were made out of rewarewa and ponga ferns (see Figure 5 below). Not only did they mark the fishing ground but they were also a mark of ownership and helped to delineate the boundaries of the various hapū and whānau.

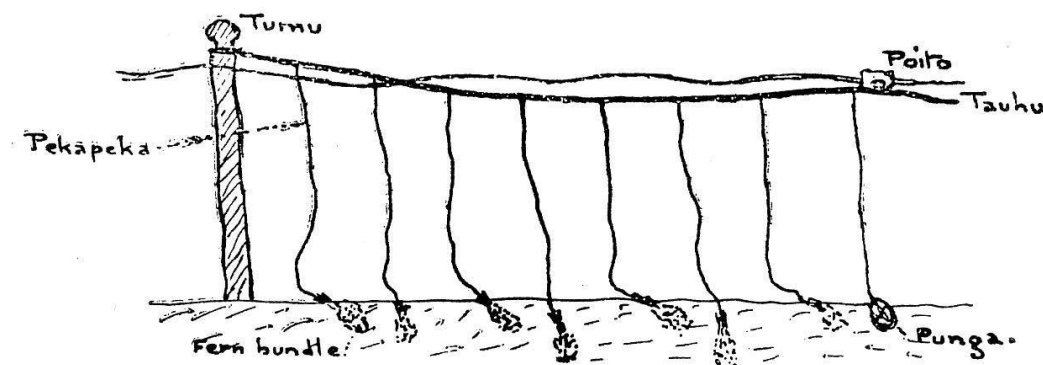


Figure 5. A traditional tau kōura

Since European settlement, the kōura population has declined due to environmental changes. This is due to the introduction of exotic fish and plants, and reduced concentrations of dissolved oxygen in the bottom waters of lakes owing to eutrophication.

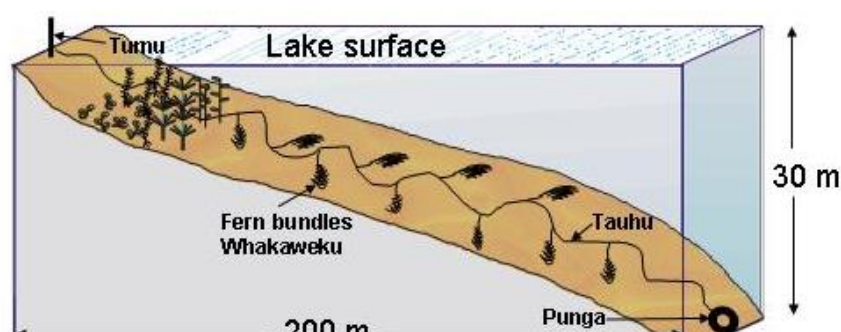


Figure 6: A modern tau kōura

Kōura are listed as a threatened species by the Department of Conservation. Nevertheless, they support limited recreational fisheries throughout NZ and important customary fisheries in the Te Arawa lakes and Lake Taupō where there are abundant populations of kōura. Improving water quality and preventing the introduction of pest species are important considerations to ensure the sustainability of kōura populations in Te Arawa lakes. Tuna, perch, catfish and trout are major aquatic predators of kōura when present in the same streams or lakes. A major threat to the kōura populations in the Te Arawa lakes is the introduction of exotic fish such as perch. This could be expected to impact heavily on populations of kōura as it has done in Lake Ototoa, near Auckland.

2.5 Morihana

Morihana is the common, aquarium goldfish, sometimes known as carp. This introduced fish was once a valued source of food and rongoā for Māori. The name morihana was derived from the name of Sub-Inspector H. Morrison of the Armed Constabulary who introduced them into Lake Taupō in 1872. Morihana were/are collected from the Ohau Channel and Lakes Rotorua, Rotoiti, Rotomā, Tarawera, Rotokākahi and Rotoehu.

Today, morihana are widely distributed throughout the Te Arawa fisheries area but are only abundant in localised areas (e.g. the arms of Lake Rotoehu). It is thought that the abundance of morihana in lakes has declined owing to drainage of wetlands for development around many lake shores.



Figure 7: Morihana captured from the Ohau Channel.

High density populations of goldfish are thought to increase turbidity and contribute to reduced water clarity in shallow lakes and ponds. The Waikato Regional Council Regional Pest Management Strategy currently lists goldfish as a pest fish species to “Contain, and where practicable, reduce or eradicate...” A categorisation like this in the Te Arawa lakes region may threaten customary harvest activities in the future.

Also, morihana have the potential to have high levels of mercury and arsenic from selected locations within the Te Arawa fisheries area, particularly given their preference for geothermal waters. As with other customary fisheries species, more comprehensive studies are required to determine the human health risk, safe consumption limits and identify areas of low and high contaminant levels.

2.6 Īnanga

Īnanga were traditionally native juvenile galaxids species that were preyed upon by Trout. Smelt were first introduced into Lake Rotorua in the 1920’s as a food for trout and once established, they were subsequently spread to all other Te Arawa lakes. Today juvenile smelt are referred to as Īnanga

and have replaced the traditional and native species of īnanga. Īnanga-smelt soon became the major prey species for trout in most of the large clear lakes, and an important supplementary prey in the smaller, more turbid lakes. The role of Īnanga in maintaining the trout fishery of the Te Arawa lakes is now well accepted.



Figure 8: Īnanga.

In the Ohau Channel between lakes Rotoiti and Rotorua, the large runs of kōaro that would once have occurred were replaced by large runs of īnanga. These formed the basis for a new Te Arawa customary fishery in the channel to replace that provided by juvenile kōaro. Today, schools of smelt are periodically harvested by members of Ngāti Pikiao as they move up the Ohau Channel from Lake Rotoiti to Rotorua. Large quantities of īnanga were harvested from this fishery prior to the installation of the control weir in the early 1990's. Whānau would use whitebait traps (elongated cylindrical nets) to harvest smelt, which migrate up the channel from about October to February, with juvenile smelt migrating from December to April. The nets are fished passively relying on the upstream movement of smelt, while the active scoop netting method commonly practiced in the whitebait fished is generally discouraged.

Īnanga were occasionally harvested from the sandy beaches of the Te Arawa lakes (particularly lakes Rotoiti and Rotorua) using seine nets (known locally as scrim nets). Adult īnanga were targeted in the spring when they were congregating to spawn. This method was used up until the 1970's but was discouraged by the Department of Internal Affairs - the fishery managers at the time. This harvesting method is no longer practiced but there is some interest in reviving the method as an alternative to catches from the Ohau Channel.

The relative abundance of īnanga varies within the Te Arawa lakes, with īnanga being more abundant in the clearer lakes than in the more turbid ones.

Īnanga numbers have been negatively impacted by the construction of the weir in the Ohau Channel (which is used to maintain the level of Lake Rotorua), by the increased trophic status in Lake Rotoiti and the diversion wall installed in 2008 across the outlet of the Ohau Channel.

Īnanga are one of the most sensitive New Zealand freshwater fish to pollutants like high water temperature or ammonia. The presence of Īnanga usually indicates that the water quality is suitable for most other fish. Improving water quality should result in an increase in Īnanga population abundance in the Te Arawa lakes.

Toitoi (common bully) were once an important food resource for Te Arawa iwi but are not included in this plan as they are no longer considered a taonga species although they are very abundant in the Te Arawa lakes they have no cultural, conservation or recreational value.

2.7 Tuna

Although, Te Arawa Lakes provided a bountiful supply of fisheries resources, such as kōaro, toitoi, kōura and kākahi, tuna-eel were, and remain, very rare. In contrast, tuna were abundant in many other waterways in the rohe, such as the Kaituna River where they are a valuable food source.

Tuna are not naturally occurring in the Te Arawa Lakes and their continued occurrence depends on



Figure 9: Short fin tuna.

stocking. Natural barriers (e.g. waterfalls and rapids on the Kaituna and Tarawera rivers) are the primary reason why tuna (and other native diadromous fish species) are rare as they prevent the upstream migration of juvenile tuna-elvers into the lakes.

In pre-European times, the transfer of elvers above barriers was a recognised means of maintaining populations where access was restricted or not possible. For example, soon after the discovery of the lakes, the absence of tuna was promptly recognised and liberations began, with Hatupatu credited with the first introduction of tuna into Lake Rotorua.



Figure 10: Long fin tuna.

Of all the Te Arawa Lakes, tuna were, and are, most common in Lake Tarawera. Tuna are still harvested using hīnaki, hi-tuna, and rama tuna, free diving, spear, gaff and bobbing. Traditionally there were also rauweri or pā tuna, where tuna would be held in a live state in large pools, and harvested when required. The fishery is comprised of low numbers of very large eels, which are female. The largest recorded tuna in recent times was a 20kg female long fin eel caught in Te Wairoa Bay in 1995 by John Waaka (Komiti Whakahaere member) and was aged at approximately 50 years old by NIWA scientists. These large tuna are a highly prized delicacy and are the subject of modern day legend.

Tuna have also been recorded in the following Te Arawa Lakes: Rotorua, Ōkareka, Rotoiti, Rotoehu and Rotomā and the Ohau Channel. The presence of tuna in these lakes is almost certainly due to deliberate or accidental liberations. For example, in the 1980's tuna were common in Lake Rotorua around Hinemoa Point, following the escape of tuna from cages belonging to two commercial eel fisherman which were situated in the Waingaehe.

Little is known of the species composition, abundance and distribution of tuna in the Te Arawa fisheries area because they are so scarce in the lakes. Information is limited to ad-hoc presence-absence fisheries surveys with the only regular monitoring carried out in the Ohau Channel where electric fishing (boat) surveys are used to assess the fish populations on an annual basis.

In New Zealand generally, tuna-longfin and shortfin have been heavily exploited by commercial fishing and numbers are now much reduced. Although, tuna remain widespread and common, tuna longfin is considered to be at risk and declining. Of particular concern is the vulnerability of longfins to overexploitation and the fact that these very long-lived fish (up to 100 years old) only breed once before dying. Fisheries regulations, including the Quota Management System (with a size limit of > 220g eels) and a ban on commercial harvest in some rivers and lakes, have recently been put in place in order to control overall harvest. Significant reductions in catch have been achieved. However wetlands are still being drained, new flood banks, flood gates and pumping stations continue to be installed, water-way channels and bankside vegetation removal is on-going with consequential loss of tuna habitat.

2.8 Trout fishery

The trout fisheries in Te Arawa fisheries area are managed by, and are, the statutory responsibility of Fish and Game New Zealand and the Te Arawa Lakes Trust cannot regulate them through bylaws. The Te Arawa Lakes contain a mixed fishery of introduced, rainbow and brown trout, with rainbow predominant. Brook char have been reported in the Tureporepo Stream, a tributary of the Puarenga Stream, Lake Rotorua. They have been stocked into Lake Tikitapu and hybrids (brook char x brown trout cross) are currently present in Lake Rotomā (Eastern Fish and Game Council). Rainbow trout are routinely stocked into a number of other Te Arawa lakes to supplement the limited natural reproduction.

Trout are considered an important mahinga kai species and are a significant source of wild-caught food for many Te Arawa iwi and hapū. Therefore maintaining plentiful stocks of trout in the lakes and their catchments is important for Te Arawa iwi and hapū. However, some heavy metals, such as mercury and arsenic, bioaccumulate in fish. Toxicant contaminant levels in trout are relatively well studied and the results of these studies need to be disseminated to Te Arawa iwi, especially the high levels of methyl mercury in trout from Rotoiti, Rotomahana, and Rotorua.

3.0 WĀHANGA TUATORU – TE MANA WHAKAHAERE

3.1 Management objectives

This Mahire Whakahaere proposes five objectives to work towards the vision of *Te Arawa taonga fishery is healthy, plentiful, sustainably managed, and Te Arawa have undisturbed possession and access to Te Arawa taonga fishery, mo ake, tonu atu.*

Objective 1: Ensure the sustainability of the customary fisheries in the Te Arawa lakes

Methods

- Ensure Te Arawa maintain exclusive rights to customary fisheries species.
- Customary fisheries species that are at risk are protected.
- Ban the taking of kōaro in the Te Arawa Lakes
- Support initiatives to restore kōaro populations in lake tributary streams.
- Protect breeding female kōura and undersize kōura (< 30 mm OCL).
- Establish a permitting and reporting system for all customary and recreational harvests of kōura, kākahi, common smelt, morihana and tuna.
- Support a network of trained Poutiriao with appropriate resources (e.g. field guide books and measuring equipment).

Te Arawa Cultural Value: Waiora – the health benefits that derive from our Waimaori; gives life and sustains wellbeing; Health and wellbeing of our Lakes and everything they support (especially kai).

Objective 2: Obtain information on the customary fisheries in the Te Arawa lakes

Methods

- Maintain a database of all information pertaining to customary fisheries in the Te Arawa Lakes.
- Develop a long-term monitoring plan for the customary fisheries in the Te Arawa lakes. Ensure iwi are notified and, if possible, participate in all fisheries monitoring and research studies in the Te Arawa Lakes.
- Ensure that information from all fisheries surveys carried out in the Te Arawa lakes and their tributaries are made available to TALT and recorded in the New Zealand Freshwater Fish Database.
- Advocate for, and support research into, the biology, habitat and water quality requirements of customary fisheries species in the Te Arawa lakes.
- Meet with research providers to address these research priorities.
- Ensure that Te Arawa are notified and consulted on all research involving customary fisheries species.

Te Arawa Cultural Value: Waiata – the rhythm of wai as embodied and transmitted through waiata, including our whenua, whakapapa, hitori, wahi tapu, kai, nga ingoa; Te Arawa cultural identity is celebrated.

Objective 3: Promote customary fishing in the Te Arawa lakes.

Methods

- Ensure Te Arawa maintain traditional customary harvest methods.
- Protect cultural areas of significance for customary food gathering.
- Hold wānanga and workshops/fieldtrips to teach and encourage whānau and hapū to harvest customary fisheries.
- Identify opportunities to share information on customary fishing (e.g. pamphlets).
- Provide effective communication to promote the Te Arawa customary fisheries regulations, the mahire whakahaere, and bylaws.
- Te Arawa Lakes Trust and Ministry for Primary Industries communicate regularly and actively work together as treaty partners towards the sustainable management of customary fisheries in the Te Arawa Lakes.

Te Arawa Cultural Value: Wairua – our beliefs, our faith, our spirit, our attitudes – enhances growth and provides balance; the connection between Te Arawa whanau and our lakes are enhanced.

Objective 4: Prevent the degradation and support the restoration of fisheries habitats in the Te Arawa lakes

Methods

- Ensure that regional and district councils adequately provide for the protection of customary fisheries species from adverse effects activities on land and in water.
 - Advocate for fisheries surveys to be carried out on those resource consent applications that could adversely affect customary fisheries and their habitats in the Te Arawa lakes and their tributaries.
 - Ensure that the BOPRC consults with the TALT as to when a fishery survey is required as part of an Assessment of Environmental Effects (AEE).
- Support initiatives to prevent the introduction and spread of aquatic pest species (plants and animals) that pose a threat to customary fisheries.
 - Advocate for a pest plant and pest fish rapid response contingency plan.
 - Ensure that fish liberations/translocations of native fish species (e.g. elvers) are suitably screened to exclude pest species. Respond to factors that could adversely affect customary fisheries and aquatic values, e.g. invasive aquatic macrophytes.
- Support initiatives that enhance fisheries habitat values e.g. riparian fencing and planting and measures to reduce eutrophication of waterways.

Te Arawa Cultural Value: Waiariki – expresses the value of wai, regardless of type; shapes behaviour where different places have different uses: Te puna, te wahi tapu, te tohi, ko nga mahi kai, wahi horoi.

Objective 5: Safe consumption of customary fisheries species in the Te Arawa lakes

Methods

- Advocate for, and initiate studies into, heavy metal contamination of mahinga kai species in the Te Arawa Lakes, including fish (i.e., tuna, morihana, smelt and trout), kōura, kākahi and watercress.
- Advocate for a risk assessment analysis to be carried out to guide the safe consumption and collection of mahinga kai.
- Advocate for exclusion of stock from waterways (e.g. riparian fencing), better management of critical source areas on farms (e.g. races) and effluent irrigation.

Te Arawa Cultural Value: Wai – is our ‘connector’ to our past, present and future as well as to each other; physical representation: lakes, rivers, streams, groundwater aquifers, geothermal.

3.2 Bylaws

Bylaws will be one of the key tools to achieve the objectives outlined above. Other tools will include research, education, collaboration and advocacy.

The trustees of the Te Arawa Lakes Trust may make bylaws for customary fisheries in the Te Arawa Lakes. The Trustees may make bylaws to restrict or prohibit:

- The customary fisheries that may be taken or possessed;
- The quantity of each customary fisheries that may be taken or possessed;
- The taking or possession of customary fisheries that are smaller or larger than a specified size;
- The method by which an customary fisheries may be taken;
- The area or areas from which an customary fisheries may or may not be taken;
- Any other matter that the Trustees of the Te Arawa Lakes Trust consider necessary for the sustainable utilisation of customary fisheries.

Until bylaws have been made people may continue to take customary fisheries under the Fisheries (Amateur Fishing) Regulations 2013. Once the bylaws have been made, and dependent on the extent of the bylaws the Te Arawa Lakes (Fisheries) Regulations 2006 prevail over the Fisheries (Amateur Fishing) Regulations 2013 and the Freshwater Fisheries Regulations 1971.

Bylaws will be made, as appropriate, to contribute to the achievement of the objectives outlined above. The matters for which bylaws are required are methods, seasons, minimum sizes and limits on quantities gathered. The species that will be covered by the bylaws are kākahi, kōaro, kōura, morihana, īnanga and tuna.

3.3 Puka Whakamana

Regulation 14 of the Te Arawa Lakes (Fisheries) Regulations 2006 states that no person may take or possess a customary fisheries species for customary food gathering from the Te Arawa lakes, unless it is done in accordance with a puka whakamana issued by a poutiriao.

The limitations on the issuing of Puka Whakamana are that they may only be issued:

- for the purposes of the bylaws;
- by approved and trained poutiriao.

3.4 Conclusion

This Mahire Whakahaere represents a new stage in the intergenerational connection that Te Arawa has with the lakes and fisheries of our rohe.

We have historically acknowledged the connection in the names of cultural and significant sits along the Te Arawa lakes shores; ngā whakairo within Te Arawa whare tupuna, in our moteatea and ngā ingoa o ngā uri.

This Mahire Whakahaere seeks to strengthen that connection, the recognition of the mana whakahaere of Te Arawa and the exercise of our obligations to protect these taonga. To achieve the vision and objectives, we aspire to preserve and replenish the mana and mauri of our lakes for generations to come.

Appendix 1: Glossary

Customary fisheries	<p>The species in the Te Arawa lakes that are covered by the term “included species” in the Te Arawa Lakes Settlement Act 2006 i.e.</p> <p>(a) means fish and aquatic life as managed and administered under the fisheries legislation; and</p> <p>(b) excludes whitebait, sports fish, or unwanted aquatic life; but</p> <p>(c) includes whitebait, any specific whitebait species, or any other species if, at any time, they are managed and administered under the Fisheries Act 1996</p> <p>At the time of writing this plan, these species are Īnanga, kākahi, kōaro, kōura, morihana and tuna</p>
Hao	Dredge net
Hi kōura	Line fishing
Hi-tuna	Set lines
Hīnaki	Eel nets
Īnanga	<i>Retropinna retropinna</i> Juvenile kōaro (prior to the 1920’s) and common smelt (1920’s onwards)
Kākahi	<i>Echyridella menziesi</i> Freshwater mussel
Kōaro	<i>Galaxias brevipinnis</i>
Kokopu	Adult kōaro
Komiti whakahaere	A fisheries management committee established under regulation 4(1) of the Te Arawa Lakes (Fisheries) Regulations 2006
Kōura	<i>Paranephrops planifrons</i> Freshwater crayfish
Mahire whakahaere	A fisheries management plan made in accordance with regulations 12 and 13 of the Te Arawa Lakes (Fisheries) Regulations 2006
Moemoea	Vision
Morihana	Goldfish <i>Carassius auratus</i>
Nga kai o nga roto	Customary fisheries
Ponga ferns	<i>Cyathea dealbata</i>
Poutiriao	A person entitled to issue puka whakamana.
Puka whakamana	An authorisation for customary food gathering issued by a poutiriao in accordance with regulations 17 and 18 of the Te Arawa Lakes (Fisheries) Regulations 2006.
Rama kōura	Night-time spotlighting using small dip nets
Rama tuna	Spearing tuna at night using mataura or spears/gaffs

Rehita whakamana	The register of authorisations required by regulation 21 of the Te Arawa Lakes (Fisheries) Regulations 2006.
Rewarewa	<i>Knightia excelsa</i>
Rongoa	Medicine
Te Arawa lakes	<p>(a) means Lakes Ngāhewa, Ngāpouri (also known as Ōpouri), Ōkareka, Ōkaro (also known as Ngākaro), Ōkaimana, Rerewhakaaitu, Rotoehu, Rotoiti, Rotomā, Rotomahana, Rotorua, Tarawera, Tikitapu, and Tutaeīnanga; and</p> <p>(b) includes the water, fisheries, and aquatic life in those lakes; but</p> <p>(c) does not include the islands in those lakes or the land abutting or surrounding those lakes</p> <p>(d) does not include the streams and rivers flowing into the Te Arawa lakes</p>
Tuna	<i>Anguilla dieffenbachii</i> Long-fin eel
Tuna	<i>Anguilla australis</i> Short-fin eel

Appendix 2: Hui with Te Arawa hapu and iwi

Date	Marae / Venue	Tupuna Rohe	Attendees
7/12/10	Taheke	Te Kawatapuvarangi	?
8/12/10	Owhata	Te Ure o Uenukukopako	?
22/11/11	Te Pakira	Tuhourangi	?
23/11/11	Tarimano	Te Ure o Uenukukopako	?
30/11/11	Rangitahi	Tuhourangi	?
31/08/12	Nukuteapiapi	All	Kiri Potaka-Dewes, Hokimatemai Kahukiwa, Johnnie Jones, Pat Te Kowhai, Pop Bidois, Ropata Lindsay Scott, Raymond Staite, Joe Tahana, Marleina Nelson, George Haimona, Toro Haimona, William Newton, Wiremu Emery, Kelvin Cassidy and Ngaroma Grant
17/9/13	Taurua	Te Kawatapuvarangi	Sir Toby Curtis, Keita Emery, Hona Sergeant, Hilda Waimarama Groot, Merehira Savage, Mereheni Kupa, Ngawhakawairangi Hohepa, Nepia Te Rangi, Mariana Cassidy and Tania Curtis
18/9/13	Nga Mareikura Office	Tuhourangi	David Galvin, Faith Pitama, Remihio Heretaunga, Harry Dixon and Watu Mihinui
19/9/13	Tarimano	Te Ure o Uenukukopako	Rikihana Hancock, Kahuariki Hancock, Yvonne Te Rangikaheke Bidois, Toro Bidois, Harata Paterson, Gina Mohi, Brad Scott, Mike Halbert and John Mita Hodge

Appendix 3: Illustrations

Cover pictures

1. Retrieving a tau kōura from Lake Rotorua in the early 1900's. Picture retrieved on 13/9/2014 from <http://mp.natlib.govt.nz/detail?id=45043&l=mi>
2. A Picture of Willie Emery, Te Arawa Lakes Trustee and Komiti Whakahaere member retrieving a tau kōura at Lake Rotoiti. Note the korapa that is slipped beneath the tau to prevent kōura escaping when the tau reaches the surface. Picture retrieved on 13/9/2014 from http://www.niwa.co.nz/our-science/te-kuwaha/research-projects/all/monitoring-kōura/monitoring_kōura/background

Illustrations in the document

Figure 1: A Map identifying Te Arawa Lakes. Retrieved on the 13/9/2014 from <http://www.boprc.govt.nz/environment/water/swimming-water-quality/rotorua/>

Figure 2: Kākahi. Photo provided by I. Kusabs and NIWA.

Figure 3: Photo (A) is an adult kōaro captured from a tau kōura set in Lake Ōkāreka, photo provided by I. Kusabs. Photo (B) is a juvenile kōaro, photo provided by R. McDowall.

Figure 4: Photo (Left): Adult kōura captured from Lake Ōkāreka, provided by I. Kusabs. Photo (Right): Female kōura with eggs, photo provided by S. Parkyn.

Figure 5. A traditional tau kōura (Hiroa 1921)

Figure 6: A modern tau kōura (Kusabs and Quinn 2009)

Figure 7: Morihana captured from the Ohau Channel, photo provided by B. Hicks.

Figure 8: Īnanga, photo provided by I. Kusabs.

Figure 9: Short fin tuna, photo taken by R. McDowall.

Figure 10: Long fin tuna, photo taken by R. McDowall.

Appendix 4: Research Acknowledgements

The kōura research used in this report draws extensively upon Ian Kusabs PhD study which was funded by NIWA and the University of Waikato through the New Zealand Foundation for Research Science and Technology programme on Restoration of Aquatic Ecosystems (COIX0305) and the Ministry of Business Innovation and Employment programme on Maintenance and Rehabilitation of Aquatic Ecosystems (CO1X1002), respectively. In addition, the report relies heavily upon the knowledge collated during the MBIE-funded Sustainable Management Framework for Te Arawa Lakes Customary Fishing programme (CO1X0512) that was active between 2006 and 2011 (Martin, *et al.* 2007; Parkyn and Kusabs 2007; Phillips, *et al.* 2007; Rowe and Kusabs 2007a; Rowe and Kusabs 2007b).

Appendix 5: References

- Abell J. M., Ozkundakci D., Hamilton D. P. and Jones J. R. (2012) Latitudinal variation in nutrient stoichiometry and chlorophyll-nutrient relationships in lakes: A global study. *Fundamental and Applied Limnology* **181**, 1-14.
- Allibone R., David B., Hitchmough R., Jellyman D., Ling N., Ravenscroft P. and Waters J. (2010) Conservation status of New Zealand freshwater fish, 2009. *New Zealand Journal of Marine and Freshwater Research* **44**, 271-287.
- Allibone R. M. and Caskey D. (2000) Timing and habitat of kōaro (*Galaxias brevipinnis*) spawning in streams draining Mount Taranaki. *New Zealand Journal of Marine and Freshwater Research* **34**, 593-595.
- Barnes G. E. and Hicks B. J. (2003) Brown bullhead catfish (*Ameiurus nebulosus*) in Lake Taupo. In: *Managing Invasive Freshwater Fish in New Zealand* pp. 27-35. Proceedings of a workshop hosted by Department of Conservation, Wellington.
- Best E. (1929) *Fishing methods and devices of the Maori*. W.A.G. Skinner, Government Printer, Wellington, N.Z.
- Blair J. M., Hicks B. J., Pitkethley R. and Ling N. (2012) Diet of rainbow trout in Lake Rotoiti: an energetic perspective. *New Zealand Journal of Marine and Freshwater Research* **46**, 557-565.
- Brooks R. R., Lewis J. R. and Reeves R. D. (1976) Mercury and other heavy metals in trout of the central North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research* **10**, 233-244.
- Burggraaf S., Langdon A. G., Wilkins A. L. and Roper D. S. (1996) Accumulation and depuration of resin acids and fichtelite by the freshwater mussel *Hyridella menziesi*. *Environmental Toxicology and Chemistry* **15**, 369-375.
- Burstall P. J. (1980) The introduction of freshwater fish into the Rotorua Lakes. In: *Rotorua 1880-1980* (ed D. Stafford, Steele, R., Boyd, J.) pp. 115-121. Rotorua and District Historical Society Inc., Rotorua.
- Butterworth J. (2008) Lake Rotokākahi: the kākahi (*Hyridella menziesi*) in a general framework of lake health. In: MSc Thesis, University of Waikato: 83 pp.
- Chisnall B. L. R., D.K. (1997) Heavy metals in the muscle tissue of two eel species near the Ngawha geothermal field. Client Report. TSA07201. National Institute of Water and Atmospheric Research. Hamilton. 22 p.
- Clearwater S. J., Roper D. S., Hickey C. W., Martin M. L. and Williams E. K. (submitted) The reproductive cycle of the freshwater mussel *Echyridella menziesii* (Unionacea: Hyriidae) (Gray, 1843) in Lake Taupo, New Zealand. *Hydrobiologia*.
- Clearwater S. J., Wood S. A., Phillips N. R., Parkyn S. M., Ginkel R. V. and Thompson K. J. (2012) Toxicity thresholds for juvenile freshwater mussels *Echyridella menziesii* and crayfish *Paranephrops planifrons*, after acute or chronic exposure to *Microcystis* sp. *Environmental Toxicology* **16**.

- Coffey B. T. (1997) A contribution to a biological description of instream community structure along seven permanent transects across Lake Atiamuri, middle Waikato River. In: p. 53. Report prepared for the Waikato Regional Council.
- Cryer M. (1991) Lake Taupo Trout Production: A Four Year Study of the Rainbow Trout Fishery of Lake Taupo, New Zealand. In: Published by the Department of Conservation, Wellington, New Zealand.
- Dekker W. (2002) Monitoring of glass eel recruitment. In: Netherlands Institute of Fisheries Research. Ijuiden, the Netherlands. Volume 2A: Country reports; Northern part. Report C007/02-WD. 256 p.
- Dekker W. (2004) Slipping through our hands - Population dynamics of the European eel. PhD thesis University of Amsterdam, The Netherlands. 186 p. In.
- Devcich A. A. (1979) An ecological study of *Paranephrops planifrons* (White) (Decapoda: Parastacidae) in Lake Rotoiti, North Island, New Zealand. In: p. 247. University of Waikato, Hamilton, New Zealand.
- Donald R. (1996) An assessment of smelt migration over the Ohau Channel fish pass. Environmental Report 96/8. Environment Bay of Plenty, Whakatane. In.
- Ellis R. J. (1997) Biomonitoring of Waikato River water quality using the freshwater mussel *Hyridella menziesi*. In: University of Waikato.
- Fenwick M. C. and Marshall B. A. (2006) A new species of *Echyridella* from New Zealand, and recognition of *Echyridella lucasi* (Suter, 1905) (Mollusca: Bivalvia: Hyriidae). *Molluscan Research* **26**, 69-76.
- Feunteun E. (2002) Management and restoration of European eel population (*Anguilla anguilla*): An impossible bargain. *Ecological Engineering* **18**, 575-591.
- Fletcher J. H. (1919) The edible fish of Taupo-nui-a-Tia. *Transactions of the New Zealand Institute* **51**, 259-264.
- Forsyth D. J. (1978) Benthic macroinvertebrates in seven New Zealand lakes. *New Zealand Journal of Marine and Freshwater Research* **12**, 41-9.
- Glova G. J., Jellyman D. J. and Bonnett M. L. (1998) Factors associated with the distribution and habitat of eels (*Anguilla* spp.) in three New Zealand lowland streams. *New Zealand Journal of Marine and Freshwater Research* **32**, 255-269.
- Grimmond N. M. (1968) Observations on growth and age of *Hyridella menziesi* Gray (Mollusca: Bivalvia) in a freshwater tidal lake. In: p. 86. University of Otago, Dunedin.
- Habib G. (2001) Commercial freshwater fishing rights of Te Arawa. In: *Unpublished report prepared for the Volcanic Interior Plateau Project Directorate and Te Arawa Māori Trust board* p. 142.
- Happy S. (2006) Population structure of freshwater mussels (Kākahi) and the associated environmental parameters within six Rotorua lakes of Te Arawa Iwi jurisdiction. In: Bay of Plenty Polytechnic student report.
- Hayward R. and Hayward R. (1992) Eel history was a mystery. In: p. 18 mins. Auckland, Hayward historical film trust.
- Hickey C. W., Buckland S. J., Hannah D. J., Roper D. S. and Stuben K. (1997) Polychlorinated biphenyls and organochlorine pesticides in the freshwater mussel *Hyridella menziesi* from the Waikato River, New Zealand. *Bulletin of Environmental Contamination and Toxicology* **59**, 106-112.
- Hickey C. W., Roper D. S. and Buckland S. J. (1995) Metal concentrations of resident and transplanted freshwater mussels *Hyridella menziesi* (Unionacea: Hyriidae) and sediments in the Waikato River, New Zealand. *The Science of The Total Environment* **175**, 163-177.
- Hicks B. J., Tana R. and Bell D. G. (2013) Boat electrofishing surveys of fish populations in the Ohau Channel in 2011 and 2012. In: *Environmental Research Institute report No. 26*. Client report prepared for Bay of Plenty Regional Council, Environmental Research Institute, Faculty of Science and Engineering, The University of Waikato, Hamilton. 15 pp.
- Hiroa T. R. (1921) Māori food supplies of Lake Rotorua, with methods of obtaining them, and usages and customs appertaining thereto. *Transactions of the New Zealand Institute* **26**, 429-451.
- Hitchmough R. (2013) Summary of changes to the conservation status of taxa in the 2008–11 New Zealand Threat Classification System listing cycle. In: *New Zealand Threat Classification Series 1* p. 20. Department of Conservation, Wellington, New Zealand.
- Hobbs D. F. (1948) Trout fisheries in New Zealand, their development and management. In: *Fisheries Bulletin No. 9* New Zealand Marine Department, Wellington.
- Hobday D. K. and Ryan T. J. (1997) Contrasting sizes at sexual maturity of southern rock lobsters (*Jasus edwardsii*) in the two Victorian fishing zones: implications for total egg production and management. *Marine and Freshwater Research* **48**, 1009-1014.
- James M. R. (1985) Distribution, biomass and production of the freshwater mussel, *Hyridella menziesi* (Gray), in Lake Taupo, New Zealand. *Freshwater Biology* **15**, 307-314.
- James M. R. (1987) Ecology of the freshwater mussel *Hyridella menziesi* (Gray) in a small oligotrophic lake. *Archives für Hydrobiologie* **108**, 337-348.

- Jellyman D. J. and Graynoth E. (2005) The use of fyke nets as a quantitative capture technique for freshwater eels (*Anguilla* spp.) in rivers. *Fisheries Management and Ecology* **12**, 237-247.
- Jones J. B. (1981) Growth of two species of freshwater crayfish (*Paranephrops* spp.) in New Zealand. *New Zealand Journal of Marine and Freshwater Research* **15**, 15-20.
- Kim J. P. and Burggraaf S. (1999) Mercury bioaccumulation in rainbow trout (*Oncorhynchus mykiss*) and the trout food web in Lakes Okareka, Okaro, Tarawera, Rotomahana and Rotorua, New Zealand. *Water Air and Soil Pollution* **115**, 535-546.
- Kusabs I. and Butterworth J. (2011) Kōura abundance and distribution in Lake Rotorua and potential effects of hypolimnetic dosing and sediment capping. In: Report prepared for Bay of Plenty Regional Council. Ian Kusabs & Associates Ltd. 11pp.
- Kusabs I. and Butterworth J. (2013) Kōura abundance and distribution in Lake Rotoehu. In: Report prepared for Bay of Plenty Regional Council. Ian Kusabs & Associates Ltd. 12 pp.
- Kusabs I., Emery W. and Butterworth J. (2013) Ohau Channel Diversion Wall - An assessment of the kōura and kākahi populations in the Okere Arm and Lake Rotoiti. In: Report prepared for Bay of Plenty Regional Council. Ian Kusabs & Associates Ltd. 18 pp.
- Kusabs I. A. (1989) The biology and general ecology of the kōaro (*Galaxias brevipinnis*) in some tributary streams of Lake Taupō. MSc. Thesis, University of Waikato. In.
- Kusabs I. A., Hamilton D. P., Quinn J. M. and Hicks B. J. (submitted-a) Managing customary harvest of freshwater crayfish (kōura, *Paranephrops planifrons*) in the Te Arawa (Rotorua) lakes, North Island, New Zealand. *Journal of Ecological Management and Restoration*.
- Kusabs I. A. and Quinn J. M. (2009) Use of a traditional Maori harvesting method, the tau kōura, for monitoring kōura (freshwater crayfish, *Paranephrops planifrons*) in Lake Rotoiti, North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research* **43**, 713-722.
- Kusabs I. A., Quinn J. M. and Hamilton D. P. (submitted-b) Nutrient enrichment and sediment particle size affect kōura (freshwater crayfish, *Paranephrops planifrons*) population abundance in seven Te Arawa (Rotorua) lakes, North Island, New Zealand. *Australian Journal of Marine and Freshwater*.
- Kusabs I. A. and Swales S. (1991) Diet and food resource partitioning in kōaro, *Galaxias brevipinnis* (Gunther), and juvenile rainbow trout, *Oncorhynchus mykiss* (Richardson), in 2 Taupo streams, New Zealand. *New Zealand Journal of Marine and Freshwater Research* **25**, 317-325.
- Mair G. (1918) Fishing places in Rotorua and other observations on traditional fishing, from evidence given by Gilbert Mair in Ntve Land Court Hearing, October to November 1918, in Rotorua application for investigation of title of bed of Rotorua Lake. In Habib 2001.
- Mair G. (1923) *Reminiscences and Maori stories*. Brett Printing and Publishing, Auckland.
- Martin M., Boubee J. and Bowman E. (2010) Recruitment of freshwater elvers 2009-2010. Wellington, Ministry of Fisheries. In: *Research Progress Report EEL2008-01B Objective 1* Ministry of Fisheries, Wellington. 46 p.
- Martin M., Boubee J. and Kusabs I. A. (2007) Taonga and mahinga kai of the Te Arawa lakes: a review of current knowledge – tuna. In: NIWA client report: HAM-022. 23 p.
- McDowall R. M. (1987) Impacts of exotic fishes on the native fauna. In: *Inland waters of New Zealand* (ed A. B. Viner) pp. 333-347. Department of Science and Industrial Research Bulletin 241.
- McDowall R. M. (1990) *New Zealand freshwater fishes - a natural history and guide*. Heinemann Press, Auckland.
- McDowall R. M. (2000) *The Reed field guide to New Zealand freshwater fishes*. Reed, Auckland.
- McDowall R. M. (2011) *Ikawai : freshwater fishes in Māori culture and economy*. University of Canterbury, Christchurch, N.Z.
- Mills G. N. (1995) Mercury and arsenic in Waikato River fish. Consultancy Report. SCJ129/06. National Institute of Water and Atmospheric Research. Hamilton. 47 p. In.
- Muller R. and Frutiger A. (2001) Effects of intensive trapping and fish predation on an (unwanted) population of *Procambarus clarkii*. In: *Abstracts of the Annual Meeting of the North American Benthological Society*.
- Nobes R. G. (1980) Energetics of the freshwater mussel *Hyridella menziesi* Gray. In: *Biological Sciences* p. 84. University of Waikato, Hamilton.
- Ogilvie S. C. and Mitchell S. F. (1995) A model of mussel filtration in a shallow New Zealand Lake, with reference to eutrophication control. *Archiv für Hydrobiologie* **133** 471 - 482.
- Parkyn S. and Kusabs I. (2007) Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge – kōura. In: NIWA Client Report HAM2007-022.
- Parkyn S. M., Collier K. J. and Hicks B. J. (2001) New Zealand stream crayfish: functional omnivores but trophic predators? *Freshwater Biology* **46**, 641-652.

- Parkyn S. M., Rabeni C. F. and Collier K. J. (1997) Effects of crayfish (*Paranephrops planifrons* : Parastacidae) on in-stream processes and benthic faunas: a density manipulation experiment. *New Zealand Journal of Marine and Freshwater Research* **31**, 685-692.
- Percival E. (1931) A note on the life history of *Diplodon lutulentus* Gould. *Transactions and proceedings of the Royal Society of New Zealand* **62**, 86-91.
- Phillipps W. J. (1924) The kōaro: New Zealand's subterranean fish. *New Zealand Journal of Science and Technology* **7**, 190-191.
- Phillipps W. J. (1924b) Food supply and deterioration of trout in the thermal lakes district, North Island, New Zealand. *Transactions and Proceedings of the New Zealand Institute* **55**, 381-391.
- Phillips N., Parkyn S. M., Kusabs I. and Roper D. (2007) Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge - kākahi. In: (ed N. C. R. HAM2007-022).
- Phillips N., Stewart M., Hickey C. and Olsen G. (2011) Contaminants in kai – Te Arawa rohe Part 2: Risk Assessment. In: NIWA p. 81. Report to the Te Arawa Lakes Trust & Health Research Council of New Zealand.
- Phillips N. R., Stewart M., Olsen G. and Hickey C. W. (2014) Human Health Risks of Geothermally Derived Metals and Other Contaminants in Wild-Caught Food. *Journal of Toxicology and Environmental Health, Part A* **77**, 346-365.
- Reynolds J. and Souty-Grosset C. (2012) *Management of freshwater biodiversity: crayfish as bioindicators*. Cambridge University Press, Cambridge.
- Roper D. S. and Hickey C. W. (1994) Population structure, shell morphology, age and condition of the freshwater mussel *Hyridella menziesi* (Unionacea: Hyriidae) from seven lake and river sites in the Waikato River system. *Hydrobiologia* **284**, 205-217.
- Roper D. S. and Hickey C. W. (1995) Effects of food and silt on filtration, respiration and condition of the freshwater mussel *Hyridella menziesi* (Unionacea: Hyriidae): implications for bioaccumulation. *Hydrobiologia* **312**, 17-25.
- Rowe D. K. (1984) Factors affecting the foods and feeding patterns of lake-dwelling rainbow-trout (*Salmo gairdnerii*) in the North Island of New Zealand. *New Zealand Journal of Marine and Freshwater Research* **18**, 129-141.
- Rowe D. K. (1990) Who killed the kōaro. *Freshwater Catch* **43**, 15-18.
- Rowe D. K. (1992) Research requirements for environmental impact studies on marron (*Cherax tenuimanus*) in New Zealand. In: *Freshwater Fisheries Miscellaneous Report No 113*. MAF Fisheries, New Zealand Ministry of Agriculture and Fisheries, Rotorua.
- Rowe D. K. (1993) Disappearance of kōaro, *Galaxias brevipinnis*, from Lake Rotopounamu, New Zealand, following the introduction of smelt, *Retropinna retropinna*. *Environmental Biology of Fishes* **36**, 329-336.
- Rowe D. K. (1999) Factors influencing the abundance of the common bully, *Gobiomorphus cotidianus* McDowall, in small, North Island, New Zealand, lakes. *Fisheries Management and Ecology* **6**, 377-386.
- Rowe D. K. (2004) Lake restoration. In: *Freshwaters of New Zealand* (ed M. M. Harding JS, Pearson CP, Sorrell BK ed.) pp. 39.1–39.16. Christchurch, New Zealand Hydrological Society and New Zealand Limnological Society.
- Rowe D. K. (2014) Biosecurity status of non-native freshwater fish species in Northland. *HAM2014-008 NIWA Project: ELF14220*.
- Rowe D. K., Konui G. and Christie K. (2002) Population structure, distribution, reproduction, diet and relative abundance of kōaro (*Galaxias brevipinnis*) in a New Zealand lake. *Journal of the Royal Society of New Zealand* **32**, 275-291.
- Rowe D. K. and Kusabs I. A. (2007a) Taonga and mahinga kai of the Te Arawa lakes: a review of current knowledge - Kōaro. In: NIWA Client Report: HAM2007-022.
- Rowe D. K. and Kusabs I. A. (2007b) *Taonga and mahinga kai of the Te Arawa lakes: a review of current knowledge - Smelt. July 2007*. NIWA Client Report: HAM2007-022.
- Rowe D. K., Richardson J., Boubée J. A. T., Dunford A. and Bowman E. (2006) Potential effects on smelt of diverting Ohau Channel water out of Lake Rotoiti. In: *NIWA Client Report HAM2006-116*. National Institute of Water and Atmospheric Research Ltd., Hamilton.
- Rowe D. K., Smith J. P. and Grayling S. (2008) Status of kōaro (*Galaxias brevipinnis*) populations in the Te Arawa lakes and options for their restoration. In: NIWA Client Report No. HAM2008-100.
- Rowe D. K. and Taumoepeau A. (2004) Decline of common smelt (*Retropinna retropinna*) in turbid, eutrophic lakes in the North Island of New Zealand. *Hydrobiologia* **523**, 149-158.
- Rowe D. K. and Wilding T. (2012) Risk assessment model for the introduction of non-native freshwater fish into New Zealand. *Journal of Applied Ichthyology* **28**, 582-589.

- Stafford D. M. (1986) *The founding years in Rotorua: a history of events to 1900*. Ray Richards.
- Stafford D. M. (1994) *Landmarks of Te Arawa. Volume 1: Rotorua*. Reed Books, Auckland.
- Stafford D. M. (1996) *Landmarks of Te Arawa. Volume 2: Rotoiti, Rotoehu and Rotoma*. Reed Books, Auckland.
- Stafford D. M. (2002) *Te Arawa: a history of the Arawa people*. Reed, Auckland.
- Stewart M., Phillips N. R., Olsen G., Hickey C. W. and Tipa G. (2011) Organochlorines and heavy metals in wild caught food as a potential human health risk to the indigenous Maori population of South Canterbury, New Zealand. *Science of The Total Environment* **409**, 2029-2039.
- Taylor M. J., Graynoth E. and James G. D. (2000) Abundance and daytime vertical distribution of planktonic fish larvae in an oligotrophic South Island lake. *Hydrobiologia* **421**, 41-46.
- Timms B. V. (1980) The macrobenthos of Lakes Rotorua and Rotoiti, South Island, New Zealand, with special reference to the influence of allochthonous organic detritus. *Archives für Hydrobiologie* **90**, 182-196.
- Timms B. V. (1983) Benthic macroinvertebrates of seven lakes near Cass, Canterbury high country, New Zealand. . *New Zealand Journal of Marine and Freshwater Research* **17**, 37-49.
- Tipa G., Nelson K., Emery W., Smith H. and Phillips N. (2010) A survey of wild kai consumption in the Te Arawa rohe. August 2010. In: *NIWA Client Report: HAM2010-096* NIWA, August 2010. 171 p.
- Vincent W. F. F., D.J. (1987) Geothermally influenced waters. In: Viner, A.B. (ed.). *Inland Waters of New Zealand*, pp. 349-377. DSIR, Wellington. In.
- Walker K. F., Byrne M., Hickey C. W. and Roper D. S. (2001) Freshwater mussels (Hyriidae) of Australasia. In: *Ecology and Evolution of the Freshwater Mussels Unionoida* (ed G. B. a. K. Wachtler) pp. 5-31. Springer-Verlag, Berlin Heidelberg.
- Walker K. F. B., M.; Hickey, C.W.; Roper, D.S. (2001) Freshwater mussels (Hyriidae) of Australasia. . In: *In: Bauer, G.; Wächtler, K. (eds). Evolution of the freshwater mussels Unionoida, pp. 5–31. Ecological Studies 145. Springer-Verlag, Berlin and Heidelberg.*
- Watters G. T. (2007) A brief look at freshwater mussel (Unionacea) biology. In: *Freshwater Bivalve Ecotoxicology* eds J. L. Farris and J. A. V. Hassel) pp. 51-64. Society of Environmental Toxicology and Chemistry, Pensacola, Florida.
- Weissberg B. G. and Zobel M. G. R. (1973) Geothermal mercury pollution in New Zealand. *Bulletin of Environmental Contaminants and Toxicology* **9**, 148-155.
- White M. A. (2000) Grazing impacts, growth and survival of *Hyridella menziesi* in Lake Rotorua: implications for biomanipulation. In: *Biological Sciences* p. 115. University of Waikato, Hamilton.
- Wood S. A., Phillips N. R., de Winton M. and Gibbs M. (2012) Consumption of benthic cyanobacterial mats and nodularin-R accumulation in freshwater crayfish (*Paranephrops planifrons*) in Lake Tikitapu (Rotorua, New Zealand). *Harmful Algae* **20**, 175-179.