TE URUMINGI WHANAU TRUST

REPORT TO

TE WAI MAORI TRUST

PREPARED HEENI INVESTMENT COMPANY LIMTED

Acknowledgements

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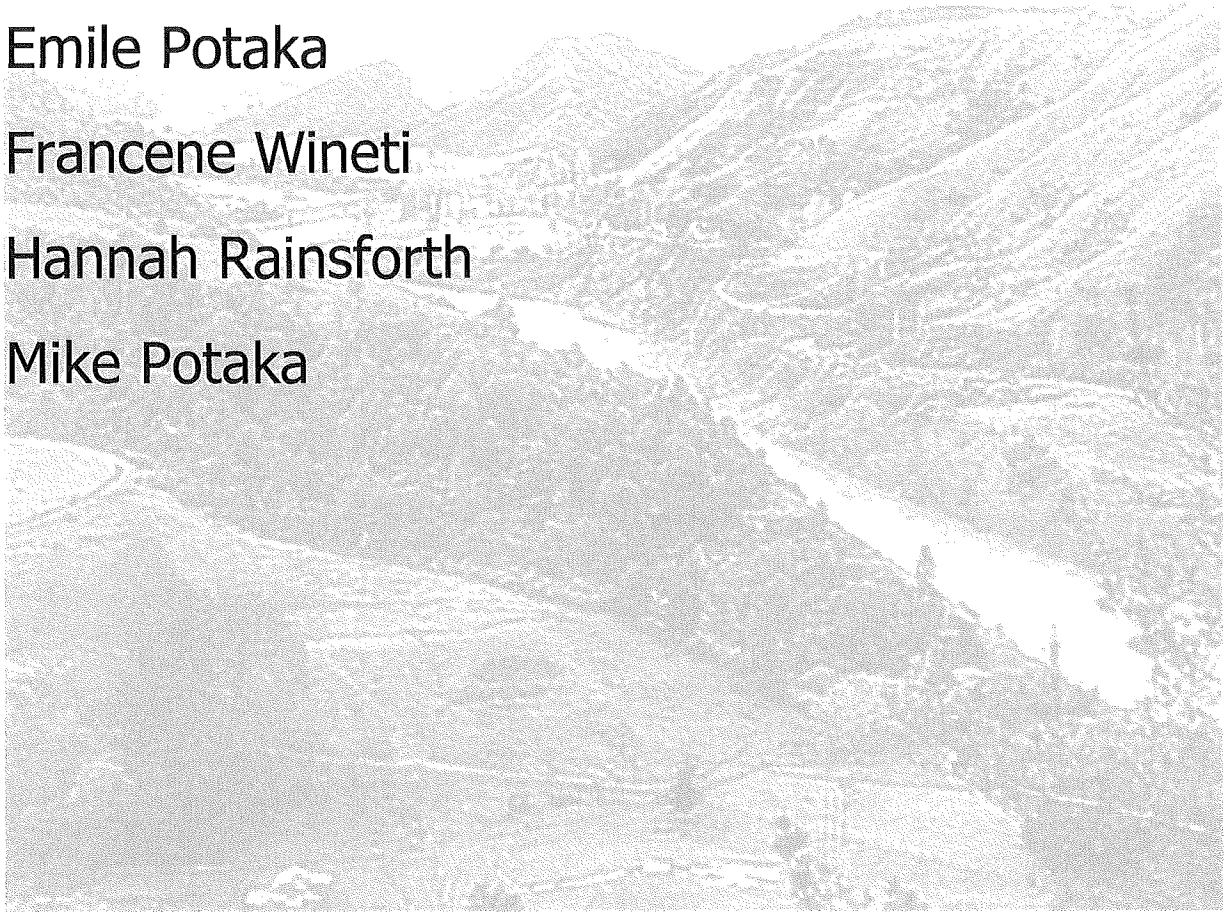

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Executive Summary

This report provides an overview on the potential of eel aquaculture and how it can be developed at Pungarehu Marae. Pungarehu Marae is approximately twenty kilometers from Whanganui City on the Whanganui River. Ngati Tuera is a hapu of Te Atihaunui a Paparangi Whanganui and is kaitiaki to approximately 30 kilometres of Te Awa o Whanganui.

Tuna aquaculture is still in its infancy in Aotearoa. There considerable potential for tuna farming and boosting wild tuna populations.

Tuna is an icon species for Ngati Tuera as it is with all Whanganui Iwi Hapu. Since the introduction of the Tuna in the North Island into the quota management system the river has been exempt from all commercial fishing of tuna. Although the tributaries of the river and the estuarine are not closed to commercial fishing of tuna.

Ngati Tuera hapu maintains its Customary Fishing rights held prior to and confirmed in writing by Te Tiriti O Waitangi and therefore the rangatiratanga over its Customary Fishing remain. Prior to the introduction of tuna into the QMS the river was heavily fished by commercial fishers. Ngati Tuera hapu noticed a decline in the tuna numbers as we were unable to catch tuna or at the best were only catching small tuna under 150 grams.

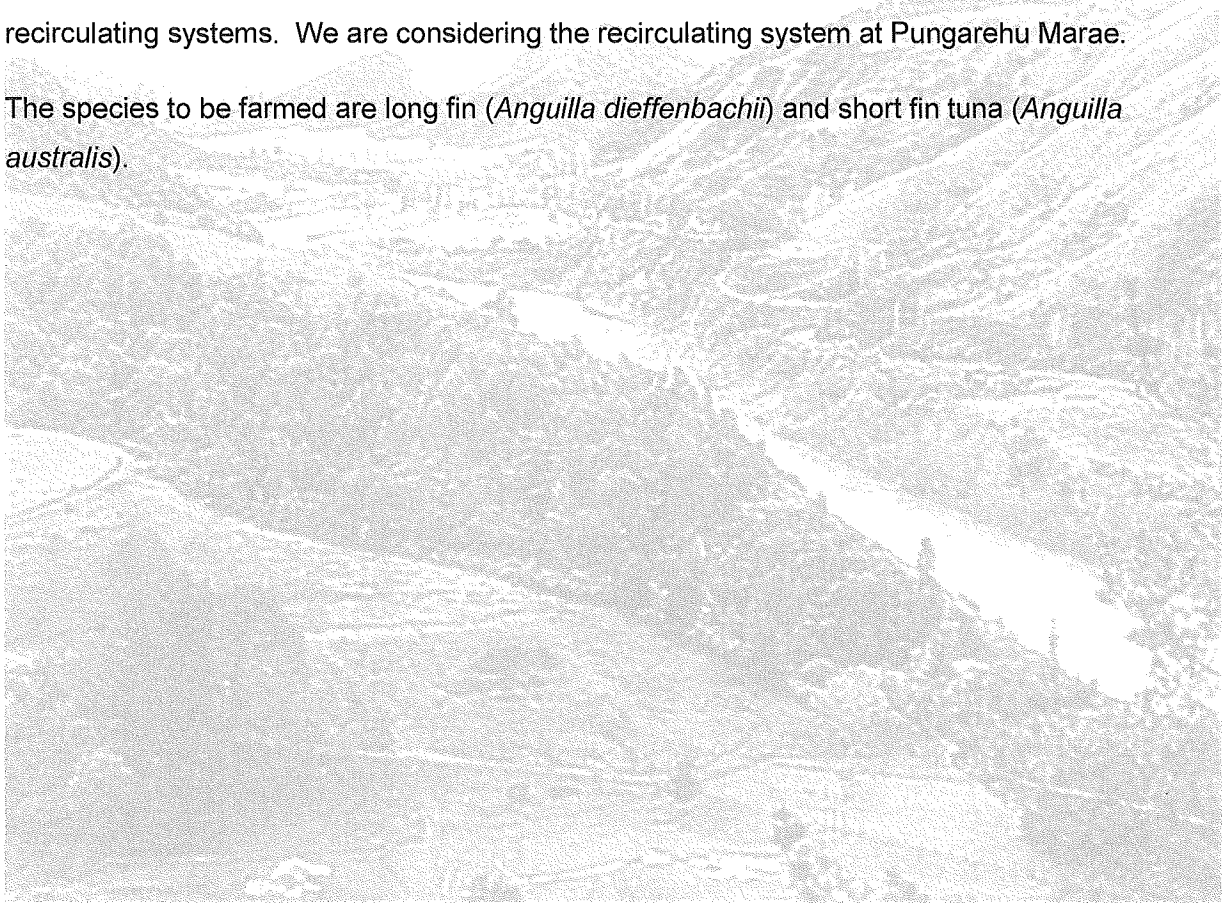
The Whanganui River Maori Trust Board have been successful with an application to the Ministry of Fisheries to carry out research on the Revitalisation of traditional fisheries management used by Whanganui Iwi. One of the objectives of the proposal is to ***is to assess the state of traditional fisheries and the fisheries habitat that supports these fisheries.***

A stretch of the river has been identified to carry out the assessment, which is within the Ngati Tuera rohe. The results from this research will be made available to Ngati Tuera.

Eel culture or farming involves catching juvenile tuna when they enter freshwater and ongrowing. Many factors need to be considered when collecting tuna for farming including harvesting, fishing gear, holding the catch, transport, quarantine, acclimation to hatchery conditions, water quality and feeding and nutritional requirements.

The three main eel farming techniques are pond, accelerated temperature facilities and recirculating systems. We are considering the recirculating system at Pungarehu Marae.

The species to be farmed are long fin (*Anguilla dieffenbachii*) and short fin tuna (*Anguilla australis*).



Introduction

Objective of this report

Provide an overview of the species to be farmed, ideal conditions and habitat, and processes and procedures required for the establishment of a tuna farm.

The funding for this project was provided by Te Wai Maori Trust, and is consistent with Strategic focus area 2 Research and education of their Annual Plan key issues.

Pungarehu Marae

Pungarehu: (include; site specific overview) Pungarehu Marae is approximately twenty kilometers from Whanganui City on the Whanganui River. Ngati Tuera is a hapu of Te Atihaunui a Paparangi Whanganui and is kaitiaki to approximately 30 kilometres of Te Awa o Whanganui. A map of the marae is attached.

Description of the Pungarehu fishery

O Te Wai Mana (Freshwater Fisheries)

The Ngati Tuera freshwater fishery includes:
Freshwater, non-migratory species: the upland bully, Crans Bully and the Giant Kokopu (giant whitebait);

Species that spawn in freshwater but have marine larval development: the common bully, red-finned bully, torrentfish, and various whitebait, including the inanga

Marine species that feed in freshwater: the yellow eyed mullet, grey mullet, black flounder, yellow belly flounder, and kahawai;

Marine species that also use the freshwater environment: the common smelt and the lamprey (piharau)

Freshwater species that must spawn at sea: the short and long finned tuna (eel).

Above the tidal area of the Tupuna Awa, supports: Short and long finned tuna Crans Bully and the Giant Kokopu (giant whitebait; common bully, red-finned bully, torrentfish, and various whitebait, including the inanga, grey mullet, common smelt, kakahi (freshwater mussel), the lamprey (piharau), and elvers (tuna ririki) are found in this area.

A overview of Ngati Tuera's history in freshwater fishing is attached, Appendix 1

Introduction to the species to be re-stocked and cultured

Tuna Para - Long Fin Eel (Anguilla dieffenbachii)

Tuna Para (*Anguilla dieffenbachii)* are the predominant species found in the Tupuna Awa and it's tributaries. This species will be grown from the glass eel stage to juveniles whereby they will be released into the wild as part of our reseeding and restocking program. (We are currently seeking advice from NIWA to ascertain the best size and age for release.)

For the long fin eel, annual recruitment has decreased by 75% since significant levels of commercial fishing began in the early 1970s (Doole G, 2005).

(Stocking rates will be carefully considered to avoid impacting the existing population).It would seem prudent that if re-seeding would be undertaken that there would be further assessments of wild populations to be undertaken first.

Tunaheke - Short Fin Eel (Anguilla australis).

Tunaheke are found mainly in our lakes and dams and only enter the river when migrating to sea for spawning. This species will be grown from the glass eel stage to juveniles whereby ten percent will be released into selected lakes and dams as part of our reseeding and restocking program and the rest on-grown for customary use and commercial production.

It should be noted that reseeding and restocking our wild fishery is priority and customary and commercial is secondary. We will still need to find a market for the commercial component of the project to pay for the first two components. The commercial viability and the sustainability of the project will be known within three to five years after it has been established and operating.

Current barriers

Consideration was taken to look into farming of tuna within earthen ponds. After researching into the requirements of earthen pond construction and the farming of tuna within earthen pond specific to Pungarehu, results suggested that due to environmental conditions earthen pond would not be suitable. Current barriers to land based eel aquaculture in the Whanganui Region are legislative and are yet to be overcome.

The Ministry of Fisheries manages Land Based Aquaculture under the Freshwater Farming Regulations 1983. The regulations cover both freshwater and marine species farmed on land. Species farmed must be one that is approved for farming under these regulations.

The Department of Conservation and the Ministry of Fisheries are jointly responsible for the management of tuna and eel fisheries in New Zealand.

The Manawatu Wanganui Regional Council (Horizons) are responsible for Resource Consents to take and discharge water from a fish farm and any other consents required to establish a fish farm.

The current policy environment

The South Island eel fishery was introduced into the Quota management system (QMS) in 200. In 2004 the North Island Eels (Both short fin and long fin eel species) were introduced to the QMS as separate species. Eels are the only freshwater fish species managed under the QMS. The minimum legal weight of eels that commercial fishers may take or possess is 220g.

Legislative barriers to Tuna ririki culture in Aotearoa

The main legislative barriers to tuna ririki culture in Aotearoa are as follows

- The capture of glass eels can only be used for enhancement of wild fisheries.
- Minimum legal size of 220g for tuna
- Tuna Ace for the commercial tuna fishery
- Fish receivers licence

It is illegal to harvest tuna ririki as they are below the minimum size limit. Research providers are able to collect tuna ririki under special permits from the M Fish for education and investigative research.

You are can farm tuna over 220 g but you have to source then from a commercial fisher or a licensed fish dealer.

Overview of past and present tuna aquaculture in Aotearoa

New Zealand experiences of Tuna Farming

Interest in eel farming in New Zealand began in the late 1960s. In the early 1970s there were five trial eels farms ranging from a traditional Japanese outdoor pond farm to an indoor intensive heated aquaculture system. Two of these were located in Meremere and at Pakuranga. The farm established at Te Kaha was a joint venture between Hourota Industries and Taiyo Fishing Company. The reasons for farm closures were due to a combination of high overheads, slow growth, persistent disease problems and associated mortality, along with uncertain supplies of glass eels.

Between 1970 and 1974 a significant fishery for glass eels became established on the Waikato river to supply culture stock for eel farming Aotearoa, a small surplus catch for export to Japan was also allowed. However with the decline of eel farming, this fishery also declined (Jellyman 1979).

By late 1975, only the Te Kaha farm remained operational, and in 1977 the farm was taken over by the Ministry of Agriculture and Fisheries (MAF) for research purposes. It remained operational until 1982 when it closed as a result of poor economies.

During the late 1970's several eel fattening companies arose, but unfortunately they could not compete with the wild fishery at time (Jellyman 1999). Eel fattening involved capturing juvenile eels, holding them in tank systems and feeding a formulated diet.

At present New Zealand does not have an industry based upon the cultivation of eels. Any scientific effort in this area has been limited to strategies for short-term fattening of wild sourced short-fin eels.

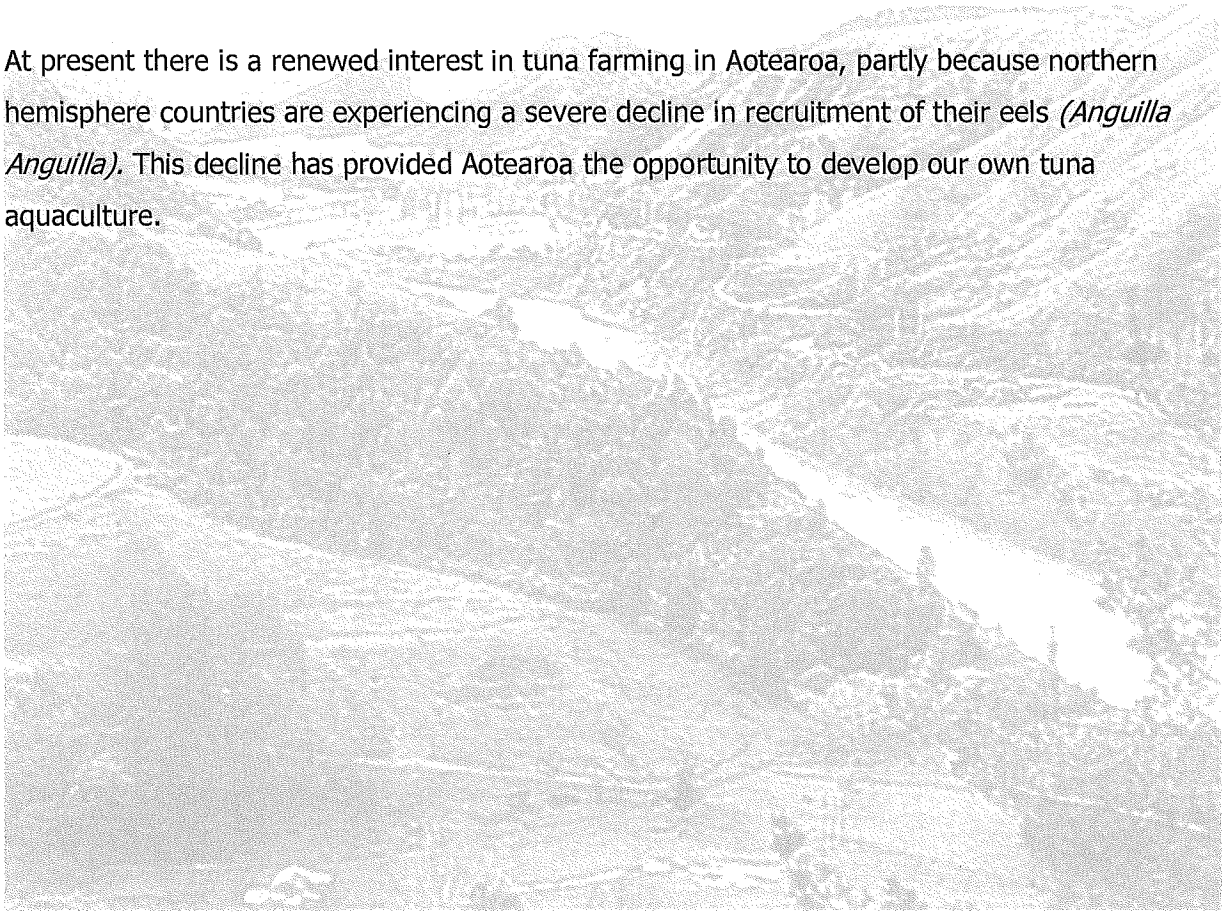
We can cultivate our native species. We have technologies used in other countries to successfully draw upon, and take into account lessons from other countries to learn from. Therefore the commercial opportunity lies in the supply of adequate supply and perhaps commercial volumes of quality glass eel.

Current Research & Development

Since the initial and somewhat unsuccessful foray into eel farming in New Zealand there have been significant advances in farm management practices and scientific understanding, particularly overseas. This application of new technology and understanding of aquaculture is reflected in the exponential growth of other area of the aquaculture industry, but this has not yet been applied to the farming of tuna in New Zealand.

Two principle reasons for the lack of tuna farming in New Zealand could be due to:

At present there is a renewed interest in tuna farming in Aotearoa, partly because northern hemisphere countries are experiencing a severe decline in recruitment of their eels *(Anguilla Anguilla).* This decline has provided Aotearoa the opportunity to develop our own tuna aquaculture.



General Biology and Distribution

There are three freshwater species of eels in New Zealand. Long fin Eel (*Anguilla dieffenbachii*), Short Fin Eel (*Anguilla australis*) and the Australian longfins (*Anguilla reinhardtii*). The two main tuna that Pungarehu are wanting to culture and re-stock into the Whanganui River are the Short Fin Eel (*Anguilla australis*) and the Long fin Eel (*Anguilla dieffenbachii*),

Tunapara - Long fin Eel (Anguilla dieffenbachii)

Tunapara (*Anguilla dieffenbachii)* are the predominant species found in the Whanganui River and it's tributaries. Long fin tuna are the most widespread freshwater eel species in Aotearoa and were in abundance in the Whanganui River region. Ngati Tuera have a proud tradition of catching tuna and distributing to other hapu within the Te Atihaunui A Paparangi rohe.

Tunaheke Short fin Eel (Anguilla australis).

Tunaheke is not unique to Aotearoa, they are also found in South East Australia and Tasmania, New Caledonia and some South Pacific Islands.

Life Cycle of an Eel

Both the shortfin and longfin tuna have a unique lifecycle in which the sexually mature tuna migrate to the tropics to spawn. They breed only once at the end of their life.

The tiny larval tuna known as leptocephalus larvae, which are transparent and leave shaped. The Leptocephalus larvae are then carried back by ocean currents to the continental shelf before they metamorphose into the stage known as the tuna riki or the glass eel. The Tuna ririki are usually 8 – 10 months old on arrival to river mouths. The tuna ririki are carried by tides into estuaries and coastal rivers. The tuna ririki enter the Whanganui River between August and December. After a few weeks in freshwater they tuna ririki darken up and become known as elvers (up to 1 – 3 years of age), which have adopted the adult form in all respects other than age. (McDowall 1990, Gooley et al. 1999, Niwa Project:ENT03101). These elvers continue to migrate upstream until they settle in a suitable habitat.

Once the elvers (pigmented juveniles) have settled, growth rates are variable and dependant on food availability, water temperature, and the density of eels at a particular site.

The age when adult females undertake their spawning run is much greater for long fin than short fin.

Factors affecting the commercial establishment of tuna aquaculture in Aotearoa

The main bottleneck affecting the global tuna aquaculture industry is the inability to produce glass eels artificially in a laboratory. Tuna aquaculture is dependent on obtaining glass eels from the wild fishery.

Factors that determine the sex of a tuna also needs to be addressed. Current research suggests that the sex of a tuna, is determined by the density of tuna population (ie tuna found in high density lakes are likely to be male, in areas less densely populated the tuna are more likely to be female). Intensive tuna aquaculture generally involves placing tuna in tanks under high densities which would preferentially produce males (150g).

In Aotearoa, the main bottleneck facing tuna farming is uncertainty in trends and availability of tuna ririki stocks and legislative barriers involving their capture. At present there are significant stocks or supply from the Waikato River. Significant quantities of tuna ririki do enter other catchments, (ie Whanganui River has a tradition of catching tuna ririki, Ngarauru and Ngati Ruanui also have significant stocks which enter the Patea river).

Planning, regulatory and Treaty obstacles affecting tuna aquaculture in Aotearoa

The Department of Conservation and the Ministry of Fisheries are jointly responsible for the management of tuna and eel fisheries in New Zealand.

The Manawatu Wanganui Regional Council (Horizons) are responsible for Resource Consents to take and discharge water from a fish farm and any other consents required to establish a fish farm.

Ministry Of Fisheries (MFish)

Land-based Aquaculture

The Ministry manages land-based farming under the provisions of the Freshwater Fish Farming Regulations 1983. The regulations cover both freshwater and marine species farmed on land. The species must be one that is approved for farming under these regulations. Under these regulations, you need to hold a fish-farm licence to farm an aquatic species for sale.
When you apply for a fish-farm licence, you will need to provide:

- Any resource consents required to take and/or discharge water from the fish farm. If they are not necessary, include a letter from the council advising that such consents are not needed.
- Any other resource consent required to establish the fish farm.
- Evidence you have the right to use the land for your fish-farming licence (e.g. a copy of the lease agreement or ownership papers etc.).
- A fully completed application form and a client application form (unless you are already a client).

Applications can also be made to vary an existing licence (usually to add more species to the schedule of species that may be farmed), renew or transfer a licence or cancel the licence. You can seek information on what is required for making these applications from the Nelson or Auckland offices of the Ministry of Fisheries.

Fees and levies

The relevant fee must accompany an application (see appendix 1). The fee is related to the amount of time taken to process an application. In addition, annual levies are payable to cover administration and compliance costs - these can vary from year to year.

Application must be made to become a FishServe Client

Tuna Aquaculture at Pungarehu Marae (Ngati Tuera)

Te Urumingi Whanau Trust has initiated this project on behalf of their beneficiaries and nga uri o Ngati Tuera. This will be the first time any aquaculture will be attempted in the Whanganui River Region.

Pungarehu Marae has traditionally been renown for their tuna fishery, which included, piharau, tuna, ngaore, karohi, kanae, patiki, Tuna is a icon species for Ngati Tuera and an important food

The objective of the Te Urumingi Whanau Trust is:

To establish the sustainable development of land based tuna farming to assist in meeting the needs identified by whanau and to transfer to whanau, knowledge and technology on the **cultivation of tuna species, to restock our wild tuna stocks, provide a customary take for whanau and or commercial enterprise.**

Before tuna aquaculture can be established at Pungarehu, the issue of access to tuna ririki or juvenile tuna needs to be dealt with. There are a number of options:

- **Exercise our mana and rangatiratanga over the fishery and access the tuna ririki and juvenile tuna to ongrow**
- **Comply with the MFish requirements and apply for a special permit to access tuna ririki and or juvenile tuna**
- **Purchase tuna ACE and purchase tuna from a recognized Fish Supplier**
- **Lease tuna ACE from Te Whiringa Muka Trust (MIO)**
- **Join with a research provider who has access to the tuna and are already carrying out all of the preliminary research applicable to tuna aquaculture.**

Eel Farming

Eel farming involves catching juvenile tuna when they enter freshwater and ongrowing.

Fishing Gear

Traditionally Wanganui Iwi have caught tuna ririki using whitebait nets, both passive and active. Whitebait nets with traps are used as well as scoop nets although tuna ririki are generally harder to catch using the scoop net. Other methods, are to use a pah made of river stones utilizing whitebait nets to trap.

Harvesting the tuna ririki (glass tuna)

Tuna ririki have never been harvested commercially or for ongrowing in the Whanganui River or estuary. Most catches of tuna ririki are made during the karohi (whitebait) and ngaore (smelt) run between September and November. When using karohi set nets they must be manned at all times as the tuna ririki may swim right through a normal net.

Prior research has suggested that water temperature is a major influence for tuna ririki to migrate we believe that the biggest influence are the Maori lunar calendar, ie Te Maramataka[1] used by Ngati Tuera, shows the phase Otane – Mote Hi Tuna Ririki.

It is envisaged that all tuna ririki will be and can be caught on site or within one to two kilometers from the Pungarehu Marae our base.

Sorting and holding the catch

There are number of systems recorded to separate tuna ririki from the bycatch, with the dominant bycatch being ngaore or karohi, ngaore die within minutes of being taken from the river and can be separated easily by using a fine mesh strainer to separate as ngaore are a lot bigger than the tuna ririki, karohi are a very minor bycatch.

Tuna ririki can be held in fish bins of water aerated with 12v or 3v air pump. Densities of tuna ririki should be kept low in the field, a normal rule of thumb is 1 kilo to 10 litres of water with regular water exchange (Anon 2000).

[1] Te Maramataka attached to report

Transport of Tuna Ririki (glass tuna)

(Niwa Project:ENT03101) states that tuna ririki can be transported over long distances in double plastic bags filled 1/3 with water and 2/3 with industrial grade oxygen. Up to 2 kilograms of tuna ririki can transported for up to 6 – 12 hours. The bags need to be kept cool and insulated from extreme temperature change during transit.

Quarantine and Acclimation to hatchery conditions

Different countries like Japan, Australia and Holland have different approaches to quarantine and acclimation of tuna ririki (glass tuna).

General Tuna Culture

Tuna culture or farming involves catching juvenile tuna when they enter freshwater and ongrowing them to your desired sized.

Culture Methods

There are three main methods currently used for tuna, pond culture, accelerated temperature culture and the use of recirculating systems. Most tuna culture methods use freshwater, saltwater culture methods for tuna, thermal water sources and pond culture can be found in (NIWA Project ENT03101 Potential for Commercial Eel Aquaculture in Northland).

Accelerated temperature facilities

Tuna grow faster in warmer water, and temperatures of range 24 degrees C to 26 degrees C are thought to be optimum. Higher than ambient temperatures can be achieved by using thermal water resources, or enclosing ponds to utilize solar energy, or by heating and recirculating water directly via a heat pump.

Greenhouse System

Eel culture in Japan, by Bernard Gousset.

Bulletin de Vinstitutoceanographique, Monaco

***10* (1992) A review of the book by Jellyman**

In the late 1970s/early 1980s, experiments began with culturing eels within enclosures (greenhouses) to allow year-round growth. Initially outdoor ponds were simply covered but as

the advantages of the system became obvious, purpose-built units with supplementary heating were constructed. Together with better husbandry, this technique resulted in substantially better survival rates, a major benefit as catches of indigenous glass-eels continue to decline. Other benefits claimed for greenhouse culture are higher rearing densities, improved food conversion and growth rates, less dependence upon drugs and chemicals, and, most significantly, a 7-fold increase in production. Water consumption is greater than under pond culture but can be reduced using sedimentation units and biofilters. It is little wonder that many outdoor ponds are now reported to lie idle. Greenhouse culture has been the eel-farming success story of the 1980s and now contributes about 85% of the 40 0001 of eel farmed in Japan.

A feature of the Greenhouse Culture is the use of solar radiation to maintain warm water temperatures during summer and supplementing the heating required during winter. The greenhouse unit is cheap shelter and a solar heating will promote the growth of phytoplankton, which mineralizes organic wastes (Jellyman 1995). The main advantages over static pond culture are:

- Easier stock management
- Reduced water consumption
- Higher rearing density
- Improved food conversion
- Improved growth rates
- Higher production

Land Based Aquaculture systems

Land based system are often associated with intensive aquaculture. Intensive systems are generally characterised by high stocking densities, flowing water systems, and often the use of devices for conditioning and treating the water, such as aeration/oxygenation and the removal of metabolites. Highly intensive culture is therefore normally carried out in tanks, raceways, cages (or pens) or in ponds lined with plastic or butyl sheeting.

The management of land based systems requires quite different approaches, with intensive culture requiring more technical expertise and a greater degree of overall management.

Advantages:

- Less land required
- Reduced water requirements
  - Control of temperature
- Potential for water quality control
- Potential for waste capture (point source)
- Potential for better food conversion ratio (FCRs)
- Monitoring and control of disease relatively easy – isolation of product from disease and pollution.
- Monitoring size and culling easy
- Harvesting easy, may be partial or selective
- Better inventory control (can see and collect mortalities)

Disadvantages:

- High initial investment compared to other production technology
- Risk of loss increases proportionally with intensification, due to inherent dependence on life support technology and the increased potential for contact with disease organisms.
- High feed costs
- Closer monitoring of water quality required
- If the system fails, have a very short period to respond
- More disease problems
- Require abundant water and subsequent high pumping costs

- Some systems have very poor tract record – failures are common, can be hard to finance, and economy of scale.
- Investors have to contact universities to build a relationship before finance companies will deal with you.

The degree to which any aquaculture venture is intensified will depend largely on prevailing economics.

Recirculating system

Te Urumingi Whanau Trust will consider this system for Pungarehu Marae.

Definition: An aquaculture Production system that recycles and renovates water for the culture of an aquatic organism (T. Losordo 2006).

Production capacity depends on the treatment system. Treatment system needs to be sized in order to handle the capacity you want to culture.

Site selection:

Accessibility

Possible requirements can include: land use permits, well permits, effluent permits, property easement, rights of way.

The Trust owns the land where the facility will be established and only a effluent permit will be required and this will be covered with our application for Resource Consents.

Building selection: Thermodynamics is often the main criterion, must be aware of the "greenhouse" can be inexpensive to build but expensive to operate if heating is required. Will need to look at installation of cost-effective heating and cooling. Moisture and humidity control for vapor barriers. Gravel floors can be in-expensive however have some disadvantages such as difficult to keep clean and disinfect, difficult to seal and drain and difficult to move heavy loads. Recommend concrete floors.

We are currently getting a building designed using our kohatu building brick which we will build for our aquaculture venture. The brick has been developed by the Trust and the R-Value (the insulation properties of the brick) is that of pink batts. We are confident that thermodynamics

of the building will be cost effective although heating will be required during the winter months. To what degree we do not know at this point. We will be using Solar Heating as the main source of heating. Once the building designs have been sent to us we will make available to Te Wai Maori Trust along with the costings for solar heating.

- Site preparation and earthworks
  A site plan has been produced to show the aquaculture site in relation to other marae facilities. The actual building site plan for aquaculture site is still under development.
- Instillation of buried piping
- Electrical systems – organized electrical distribution – main panel and sub panels
- Water supply systems – pipe sizing for sufficient flow to all systems, location of piping and valves for accessibility and protection of the piping system.
- Practical design considerations – design and build with operations and maintenance in mind such as building layout, sufficient space to move product and equipment and suitable floor materials, construction of the building so it can be maintained easily, working space.

Building recirculating systems

Jellyman and Coates (1976) reported that a constant temperature between 20-25 degrees C was optimal for culture of Aotearoa tuna. Since 1976 after findings from other researchers, and on the basis of those reports Jellyman (1995) now suggests that ayear round water temperature of 25-26 degrees C would be optimal for culture of Aotearoa tuna.

Water requirements and access–

The recirculating system will be fed by spring water. Water quality is yet to be tested. Water quality is highly dependant on the species being cultured for example, salinity, hardness, alkalinity, pH, mineral content. Some treatment is possible however can be costly.

Land requirements

- Proximity to markets and transport
  Wanganui city is on the west coast of the north island and is 45 minutes from Palmerston North, 2 hours from New Plymouth, 3 hours to Taupo, 4 hours to Rotorua, 5 hours to Auckland and 3 hours to Wellington.

Pungarehu Marae is 26 kilometres from Wanganui City and the airport, with the closest International Airport being Wellington which is approximately 3 hours from the marae.

- Disposal and treatment of effluent
- Soil types

  Pumice which has very good drainage.
- Proximity to streams

  The closest stream is 50 metres
- Proximity to future development

  Refer to attached map.
- Accessibility such as delivery of feed, liquid oxygen and propane

  There are no accessibility problems as the building is isolated from marae complex.
- Location on utilities such as power (single phase and three phase) and telephone

  Three phase power is available to the building as is phone connections.

Recirculation technology maintains life support for the culture organism and must:

- Remove solid wastes – settleable, suspended, and dissolved
- Convert ammonia and Nitrite to Nitrate
- Remove carbon Dioxide
- Add oxygen
- Maintain Proper pH
- Control Pathogens
- Keep up with generation of waste

Important water quality parameters

- Dissolved oxygen (continuously monitor)
- Ammonia – Nitrogen (NH3 & NH4 +)
- Nitrite – Nitrogen (NO2-)
- pH
- Alkalinity

Management and Operation of Recirculating systems

Pre-start up Activities:

- Development of a business/project plan
- Acquisition of permits
- Source water testing
- Effluent management plan
- Identification of glass eel supply
- Personnel training

Feeds and Feeding

Feed is usually the number one item in an operating budget. In a recirculating system you don't want to waste feed because it can be expensive plus is can put extra loading on your water treatment system.

It takes feed to produce fish, and a management plan always plays a key role in measuring your whether or not the operation is meeting expected annual production rates. This can be easily calculated by monitoring Food conversion ratios. For example:

If the operation is wanting to achieve a 45 tons per year production: (Note that on average each kilogram of glass tuna has the potential to achieve 750kg of harvestable product within 12 months)

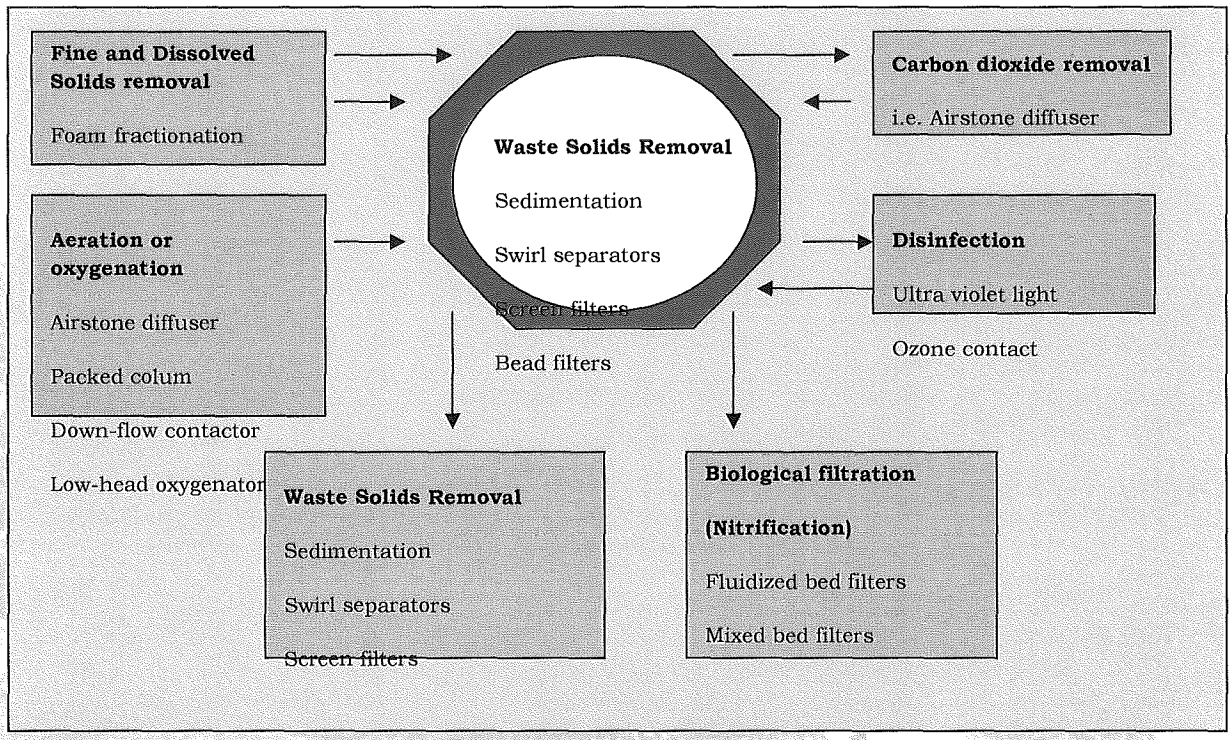
1. Assume a feed conversion ratio (FCR). Research into average FRCs for eel production. For this example we can assume 1.6 :1
2. Assume a desired production of 4 tones (4,000kg)

   -Then, you must feed 1.6 x 4,000 kg per year = 6,400 kg per year

   Or 6,400 kg ÷ 365 days = 17.53 kg per day

If you do not average 17.53 kg feed per day, you will not reach the production target of 4 tons per year.

Required Unit Processes for a Recirculation system



Water treatment

Bacteria within the system also make it function properly, therefore requires a biological filtration.

How does Biological filtration work?

Bacteria eat wastes and cause changes in water quality. These bacteria are called heterotrophic bacteria.

Fish food can have an impact on water quality as feed contains protein (organic material). Bacteria can break down uneaten feed and waste to create ammonia which is toxic to fish) and consumes oxygen (often referred to as BOD - Biochemical Oxygen Demand).

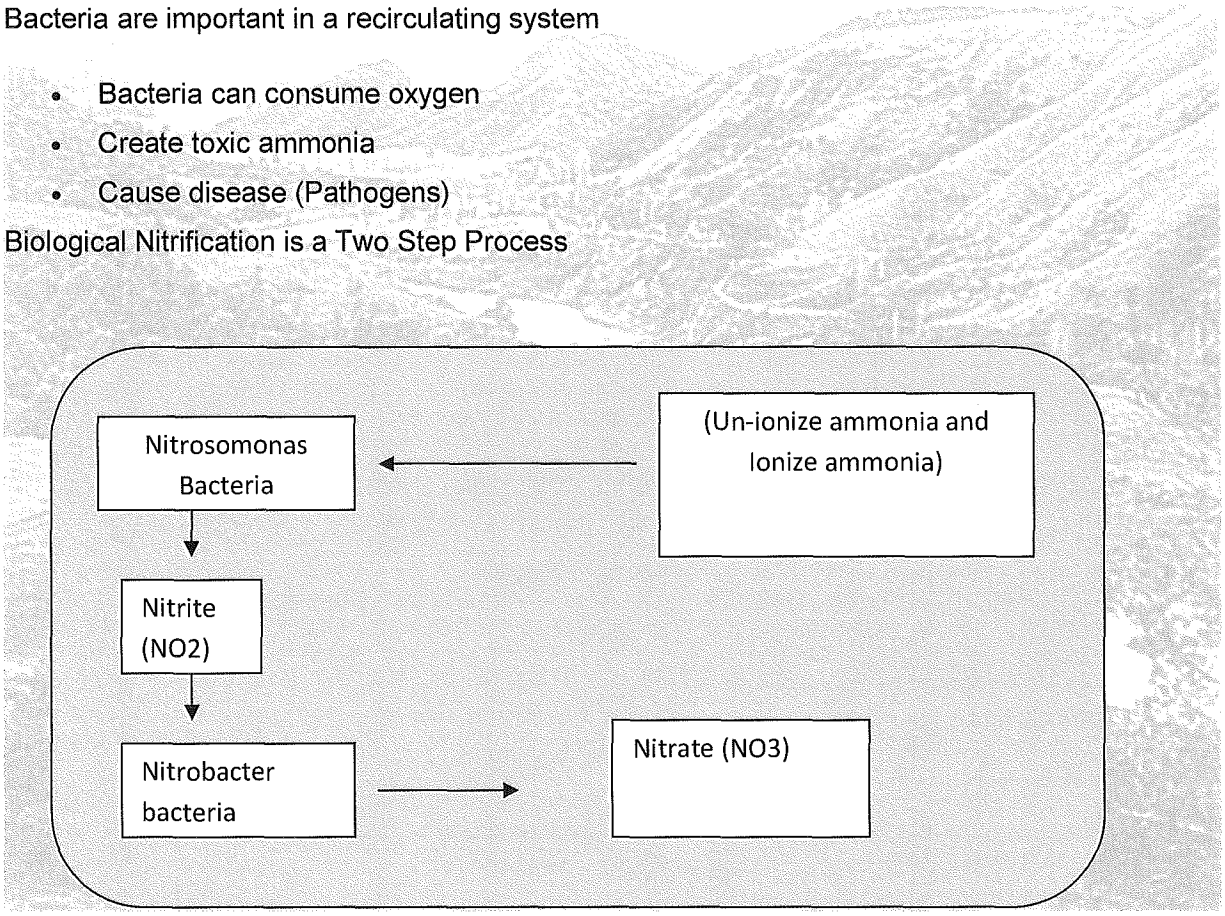
(generation of waste is from the amount of feed. What is the highest feed rate to determine what the water treatment capacity is)

Biofiltration and Nitrification Processes and Components

Bacteria are important in a recirculating system

- Bacteria can consume oxygen
- Create toxic ammonia
- Cause disease (Pathogens)

Biological Nitrification is a Two Step Process



Research Providers

NIWA

NIWA has the largest team of aquaculture specialists and dedicated facilities making it a major provider of aquaculture research and development. NIWA has a world class facility the Bream Bay Aquaculture Park

NIWA's current tuna aquaculture research is focused on refining aquaculture techniques to help make tuna farming a viable option in New Zealand.

Cawthron Institute

The Cawthron Institute has established an Aquacultural Group that works on algal culture, pond management and new aquacultural species. They are based at Nelson and have established ponds there for their research. The unit works with industry to add value.

Crop& Food Research (Mana Kai Rangahau)

Crop & Food Research is a New Zealand-based biological science company researching new knowledge in five main areas:

- sustainable land and water use
- high performance plants
- personalised foods
- high value marine products
- biomolecules and biomaterials

High value marine products

Creating 'fresher' extended shelf-life seafoods is critical to increasing market access and export returns for New Zealand seafoods. We research the micro-organisms associated with chilled seafood products and develop novel processes for eliminating pathogens and minimising the growth of spoilage bacteria. Modified atmosphere packaging and high pressure processing are two areas where we lead seafood research in the Southern Hemisphere.

Adding value through product innovation remains an important goal for seafood processors and exporters. We research seafood attributes at both the molecular and bulk property levels to

understand the interactions between molecular constituents, harvesting and processing conditions, and consumer-perceived quality. We then help develop innovative solutions to industry problems and help develop and evaluate new product lines.

Mahurangi Technical Institute

MTI offers a wide range of specialist Aquaculture Consultancy services, as detailed below.

Mahurangi Technical Institiute offers a full range of consultancy services to the ornamental fish industry, ranging from full design of aquarium store aquatic systems through to short term troubleshooting and staff training.

Our team has many years of hands on experience in the ornamental fish industry at a retail and wholesale level, as well as in the areas of fish breeding and distribution. This is augmented by real experience and qualifications in retail management.

We can cut your costs and improve your profits. We can help with all stages of fish production from larval production to market.

Mahurangi Technical Institute's sister company Decker Consultants Ltd. is the largest producer of Environmental Impact Assessments (EIA) relating to fish transfers and introductions in New Zealand.

Mahurangi Technical Institute is currently involved in leading edge research into the breeding of New Zealand short finned eels for use in aquaculture. We are also the only New Zealand breeder of Grass Carp and Silver Carp, including the production of triploid fish when sterility is required.

In addition we are involved in the breeding of a number of species of NZ native freshwater fish for environmental improvement.

Talk to us about your fingerling requirements. We are happy to discuss special requests and investigate new species. We can breed and supply you with fingerlings to grow on or develop systems for you to breed your own where applicable.

Using Dr Kurwie's unique skills in fish nutrition we are able to consult on all aspects of fish nutrition and even design a food specifically for your fish.

Individual aquaria and water gardens often experience problems and it can be hard to get good advice from a source that is not only expert but is not trying to sell you any products.

Mahurangi Technical Institute is able to offer expert troubleshooting service, produce reports to aid in dispute resolution or best of all, advise at the planning stage of your project to avoid those problems in the first place.

For those rare occasions when we are unable to meet your needs in-house, Mahurangi Technical Institute is able to draw on an extensive network of contacts within the aquaculture, environmental and aquarium industry fields. If we can't do it we probably know somebody who can.

Te Ohu Kaimoana Trust (Excerpts from the Research report)

It should be noted that Te Ohu Kaimoana is not a research provider and the excerpts are taken from a report produced for them by NIWA. Te Ohu Kaimoana asked NIWA to report on the biological and economic feasibility of culturing glass eels for aquaculture and reseeding purposes.

Economics of tuna aquaculture in Aotearoa (Pg 12 of the report)

Tuna farming currently appears to be profitable venture in Europe and Asia but there is little hard evidence to suggest that farming of tuna will be economic in New Zealand. Jellyman (1999) lists the main reasons for the failure of tuna farming in New Zealand in the 1970s and 1980s as:

- poor economy of scale and high overheads
- high juvenile mortality
- high feed and labour costs
- growth not uniform
- market uncertainty

New technologies have overcome some of these limitations and in 2003 NIWA established an experimental scale tuna culture unit at Bream Bay based on proven European recirculation tuna farming technology. This trial is ongoing, but preliminary results indicate that similar non-uniformity of growth rates, as were experienced in the 1970s, still occurs even when using recirculation systems. NIWA have constructed an outline economic model to provide an estimate of production costs for tuna in Aotearoa.

The feed price was a major driver at 31% of production cost. Labour cost was also an important driver for the model. The model estimated that a 100 tonne farm required a total of 8 full time staff (FTEs). The figure may vary depending on the technology used, but unlikely to be lower that the estimate.

Overall, given the current low sale prices of tuna, it is difficult to see hoe small scale tuna farming ventures could be profitable in Aotearoa at this time.

In conclusion,in the current economic climate it appears unlikely that small scale tuna farms in Aotearoa will be economically viable, although larger scale farms may be profitable (>200 tonnes).

Fees and levies

The relevant fee must accompany an application. The fee is related to the amount of time taken to process an application. In addition, annual levies are payable to cover administration and compliance costs - these can vary from year to year.

Application must be made to become a FishServe Client

Fresh Water Fish Farming Fees - As at 02 December 2004

Transaction Charge as at 02 December 2004

(incl. GST)

($/application)

Application for:

Freshwater Fish Farm Licence	Base application fee	$2,008.20
Variation of Freshwater Fish Farm Licence	Base application fee	$803.28
Transfer or renewal of a Freshwater Fish Farm Licence		$803.28
Application for approval of transfer of fish-farm licence		$803.28
Transfers of fish	Specific authorisations under regulations 17, 18 and 22 of Freshwater Fish Farming Regulations	$66.94

Annual Levy $143.30

Special Permits

At present the system isn't set up to allow the use of a special permit for commercial production. The capture of glass eels can only be used for enhancement of wild fisheries.

You will need to submit a detailed proposal in support of your special permit application. For example, the type of information required may include:

- Number and size of eels proposed to be taken
- What species may be taken incidentally as a result of collection method employed
- Proposed method of collection (and measures to prevent capture of bycatch species)
- When the activity is likely to occur (commencement date and any seasonal elements, expected number of transfers required)
- Identification of proposed collection sites
- Presence of any pests at proposed collection sites, and how you will screen to make sure no pests are transferred
- How you will transport the eels (what measures to prevent, or minimise injury or death – eg, oxygenation of water)
- Where you intend to hold eels before release, and for how long
- Disease risks, and what you would do in the case of any disease outbreak
- Stocking rate if you are using holding ponds (expressed as kg /ha of juvenile eel)
- Location of proposed release sites, access points, and land ownership details if on private land
- Description of release site (eg size, inlets/outlets (seasonality), catchment vegetation, depth, expected range in seasonal temperature, presence of fish fauna including any rare species, and current density /size class of eel species already present in waterway)
- Proposed method of release at each site
- The views of other fishery interests (eg, industry, other iwi, recreational, land owners/managers)
- Proposed methods to monitor changes in fish fauna following release at appropriate intervals including size and species ratio of eel populations, and any observed change in species biodiversity

The Department of Conservation

DOC has an important role in the management of freshwater fisheries and their habitat and are to preserve so far as is practicable all indigenous freshwater fisheries, and protect recreational freshwater fisheries and freshwater habitats.

The department has no responsibility for the management of the commercial tuna fishery or allocation of tuna stocks.

In Taranaki, Ngati Tama have settled their Treaty of Waitangi Claims with the Crown and one of the provisions under the deed of settlement allows for the taking of undersized tuna as part of re-stocking of water ways and aquaculture projects.

Ngati Ruanui

Excerpt from Ngati Ruanui Deed of Settlement

The Minister of Conservation will consult with Ngati Ruanui on all matters concerning the management of indigenous freshwater fisheries by the Department of Conservation.

Provisions looking into the possibility of taking undersized tuna (eel) as part of stocking or re-stocking of waterways and aquaculture projects.

Ngarauru also have similar type clause in their deed of settlement.

Manawatu Wanganui Regional Council (Horizons)

The Manawatu Wanganui Regional Council (Horizons) are responsible for Resource Consents to take and discharge water from a fish farm and any other consents required to establish a fish farm.

Human Resources

The Whanganui River Maori Trust Board has established a co-sponsorship arrangement with Te Ohu Kai Moana and have sponsored a number of participants in the fishing industry. They have sponsored marine biology, management, environmental law. Three of the participants who

have graduated and who are working in the fishing industry are uri o Ngati Tuera and will be used for this project. Ngati Tuera also have uri who have gained qualifications from SITO.

All further training will be through the Seafood Industry ITO (SITO).

Government initiatives

The Government has launched a five-point plan to support the future growth of Aquaculture in New Zealand. The Ministry of Fisheries (MFish) leads the team of government departments that have joined forces to support sustainable aquaculture development. The team also includes the Department of Conservation, Ministry for the Environment, Ministry of Economic Development, New Zealand Trade and Enterprise and Te Puni Kōkiri.

Key areas of government support for aquaculture growth

1. Building the confidence to invest
Investing with confidence in aquaculture requires certainty. We are entering a new era for aquaculture in New Zealand. The planning framework is new and it will take time for everyone to get used to it. In some regions aquaculture planning is already underway, while other regions are still at the stage of exploring the possibilities for future aquaculture.

The government wants to encourage investment in aquaculture planning, particularly through supporting regional councils to create, where appropriate, new Aquaculture Management Areas and to make better use of existing aquaculture space.

Government support will focus on promoting a collaborative approach between stakeholders, and reducing the barriers councils and industry may face in the planning process.

2. Improving public support
Better public understanding of the benefits and effects of aquaculture is needed to help communities make informed decisions about new developments in their coastal neighbourhood.

Good information, sound resource management planning and inclusive community processes are all vital to successfully managing local environments for mutual benefit, and to ensuring that the aquaculture industry gains the confidence of local communities.

3. Promoting Maori success in aquaculture

Māori are significant players in the New Zealand aquaculture industry. Strengthening their involvement will further benefit Māori communities and ensure the prosperity of the wider industry.

The government will work with Māori to develop resources for a sustainable growth framework that takes into account both commercial and kaitiaki (stewardship) aspirations. This will include actively engaging Māori participation at all levels of the industry, including the planning process and its growth.

Te Puni Kōkiri is currently investigating a number of initiatives that will support and encourage Māori participation in aquaculture. One of these initiatives is funding to help establish a Maori Manager in Aquaculture New Zealand. The role will help develop even stronger relationships between industry and iwi groups.

4. Capitalising on research and innovation

New Zealand's aquaculture industry has the potential to be an international leader, providing high quality, sustainable seafood products to the world.

Our enviable 'clean, green' reputation gives the industry a huge natural advantage in the global market place; but it will be innovation, along with the application of technology and branding, that will sustain our competitive advantage long term.

Being at the forefront of technology and best practice will help increase the value we get from existing species. Even more importantly it will spur the development of new high value species and products such as nutraceuticals.

5. Increasing market revenues

New Zealand's aquaculture industry can help meet the world's growing demand for seafood. To achieve the industry's goal of $1 billion sales by 2025 we must boost the volume and value of exports to new and existing export markets.

Government assistance will include improving access to export markets and identifying opportunities for new species and products.

Tuna into QMS

Hon David Benson-Pope 6/08/2004

Eels glide into QMS with eye to improving fishery

The North Island eel fishery will be introduced into New Zealand's world recognised Quota Management System (QMS) from 01 October, Fisheries Minister David Benson-Pope announced today.

Mr Benson-Pope says introducing North Island eels into the QMS was just one of the steps aimed at improving the fishery, which included the introduction of new catch limits and other management controls. South Island eels were introduced into the QMS in 2000.

The North Island eel fishery is highly valued by customary Maori, recreational and commercial fishers. The two key species are the shortfin eel, found throughout mainly lowland waters of New Zealand, parts of Australia and the Pacific Islands, and the longfin eel, found typically in higher altitude waters of New Zealand.

The overall Total Allowable Commercial Catch (TACC) for the North Island shortfin eel is to be set 8.25 percent less than the amount commercially taken in recent years. The overall TACC for the longfin will be set 17.8 percent less than was taken in recent years.

"After consultation with fishery interests, I have decided on a management strategy designed to improve the size range and abundance of eels found within the North Island over the medium-term," Mr Benson-Pope said.

As well as catch limits, other controls included:

- Prohibiting commercial fishing in the Motu, Mohaka, and much of the Whanganui River catchments to ensure adequate escapement of adult eels in breeding condition
- Prohibiting commercial fishing in areas recognised as important customary fishing sites. These included:
  - The interconnected Lakes Taharoa, Numiti, Rotoroa and Lake Harihari, south of Kawhia
  - Whakaki Lagoon, east of Wairoa

- Lake Poukawa, Te Hauke, inland from Hastings
- Lake Kohangapiripiri and Lake Kohangatera (Pencarroe Lakes) and their respective tributaries, Wellington.

- Removing net mesh size restrictions to improve catch quality
- Amending reporting regulations to enable commercial fishers to report eel catch appropriately under the QMS.

New Zealand Aquaculture Ltd

With the establishment of new national body for aquaculture they dev eloped a ten point plan

The 10 point plan will::

1. Establish a new national sector organization

2. Strengthen the partnership with government

3. Strengthen other stakeholder partnerships

4. Secure and promote investment in aquaculture

5. Improve public understanding and support

for aquaculture

6. Promote success in aquaculture

7. Develop the market for New Zealand

aquaculture products

8. Maximise opportunities for innovation

9. Promote environmental sustainability and

integrity of aquaculture

10. Invest in training, education and workforce promotion

PROMOTE MAORI SUCCESS IN AQUACULTURE

Most of the actions relating to are incorporated in the various sections of the strategy. This point highlights the significance of the Commercial Aquaculture Claims Settlement Act 2004 for future aquaculture development. The new aquaculture planning system incorporates a process to settle claims to commercial aquaculture. Councils are required to allocate and transfer authorisations for new space to Iwi Aquaculture Organisations through Te Ohu Kai Moana Trustee Ltd, the trustee for the Takutai Trust. A successful sector strategy will ensure that iwi, as beneficiaries of the settlement, are informed and active participants in aquaculture. The scale of potential iwi involvement in the future of the industry is such that the sector as a whole will not reach its full potential unless iwi prosper. In addition, iwi have a range of interests as tangata whenua that are recognized in various statutes including the Resource Management Act 1991. These interests make them vitally important partners and allies in the regional development of aquaculture, quite independent of their own current and future interests in the sector.

Takutai Trust

The Maori Commercial Aquaculture Claims Settlement Act 2004 (the Maori Aquaculture Act) established the Maori Commercial Aquaculture Settlement Trust – the Takutai Trust - to receive aquaculture settlement assets and allocate them to iwi. The Maori Aquaculture Act provides for iwi to receive 20% of all new aquaculture space and the equivalent of 20% of aquaculture space also known as pre-commencement space established between 21 September 1992 and 31 December 2004.

The purpose of the Takutai Trust is:

- . To receive settlement assets from the Crown or Regional Councils
- To hold and maintain settlement assets on trust until they are transferred to Iwi Aquaculture Organisations (IAO)
- To facilitate steps by iwi to meet the requirements for the allocation of settlement assets and
- To allocate settlement assets to iwi

The Aquaculture Settlement is restricted to deal only with coastal aquaculture. Because the farming of tuna is done in fresh water and on land it does not fall under any responsibilities of the Takutai Trust or the Crowns obligations under the aquaculture settlement.

There are two parts to the Aquaculture Settlement,

1 Pre commencement space, that is 20% of aquaculture space that was established between 21st September 1992 and 31st December 2004. This can also be via the purchase of marine farms or a payment of the cash equivalent.

2 The aquaculture settlement provides that the iwi in a region collectively receive a minimum of 20% of any new space created for aquaculture designated as an Aquaculture Management Area (AMA), under the Resource Management Act (RMA) post 1st January 2005.

The Whanganui Regional Council does not have any coastal aquaculture. Therefore Iwi that are within the Regional Councils jurisdiction will not benefit from the allocation of pre commencement space from the Crown.

There are also no new developments of AMA's within Whanganui's Regional Council. Therefore iwi don't look to gain from the allocation of new space, unless an AMA is developed in the future and iwi will obtain the authorizations to 20% of that new space. The coast along the Regional Councils jurisdiction is rough and exposed and not accessible for coastal aquaculture, hence why there has not been any development in the past.

If there was pre commencement space, and possible AMA development, iwi of the region could agree to their entitlements and decide on a cash equivalent. The cash equivalent could be used to develop in land based aquaculture.

Whanganui River Maori Trust Board

O Te Wai Mana (Freshwater Fishery)

(Excerpt from the Boards response to He Anga Mua 2002).

Whanganui Iwi in the past had a very rich and extensive freshwater fishery. Whanganui Iwi share a relationship described as kaitiakitanga, which enables them to sustain their well being from its presence, to the tribe and its diverse collectives. This is a fundamental principle identified by the Whanganui Water Rights Charter[2].

[2] Whanganui River Water Rights Charter

Whanganui Iwi freshwater fisheries had large structures built to capture tuna and piharau.

The loss of and decimation of the Whanganui Iwi Fishery has been recorded as well as the destruction of fishing structures. This has had a huge impact on the loss of Whanganui Iwi matauranga that relates to freshwater fisheries.

Whanganui Iwi have further developed Policy Statements, which underpin the use management, protection and development of our Freshwater Fishery.

We have never relinquished our customary right to the Whanganui River and it's tributaries and have challenged through every legal forum to have that recognised by the Crown. Our Iwi have declared that the fisheries in the Whanganui River is a customary non-commercial fishery. Therefore we exercise our mana and rangatiratanga over the fishery.

Te Whiringa Muka

The Trust was recognized as the Mandated Iwi Organisation (MIO) to accept the fisheries allocation on behalf of Te Atihaunui A Paparangi, 29 August 2006. They were also recognized as the Iwi Aquaculture Organisation (IAO).

The Trust holds tuna ace and we maybe able to lease for a agreed period.

Tuna Aquaculture at Pungarehu Marae (Ngati Tuera)

Te Urumingi Whanau Trust has initiated this project on behalf of their beneficiaries and nga uri o Ngati Tuera. This will be the first time any aquaculture would be attempted in the Whanganui River Region.

Pungarehu Marae has traditionally been renown for their freshwater fishery, which included, piharau, tuna, ngaore, karohi, kanae, patiki, Tuna is a icon species for Ngati Tuera and an important food

The objective of the Te Urumingi Whanau Trust is:

To establish the sustainable development of land based tuna farming to assist in meeting the needs identified by whanau and to transfer to whanau, knowledge and technology on the **cultivation of tuna species, to restock our wild tuna stocks, provide a customary take for whanau and or commercial enterprise.**

Before tuna aquaculture can be established at Pungarehu, the issue of access to tuna ririki or juvenile tuna needs to be dealt with. There are a number of options:

- **Exercise our mana and rangatiratanga over the fishery and access the tuna ririki and juvenile tuna to ongrow, seeking only permission from ourselves**
- **Comply with the MFish requirements and apply for a special permit to access tuna ririki and or juvenile tuna**
- **Purchase tuna ACE and purchase tuna from a recognized Fish Supplier**
- **Lease tuna ACE from Te Whiringa Muka Trust (MIO)**
- **Join with a research provider who has access to the tuna and are already carrying out all of the preliminary research applicable to tuna aquaculture.**
- **Form a relationship with Trustees of Kaitoke and Wiritoa lakes for access to juveniles for ongrowing.**

A conceptualised tuna farm for Pungarehu Marae

The conceptualised tuna farm production cycle would take 18 to 24 months and would aim to produce 1.5 to 2 t per cycle. The first cycle produced, 1 t would be used to restock and reseed our wild fishery at selected sites to be determined, 250 kg would be made available to whanau for customary purposes and the rest would be used to showcase the research center and to develop tourism.

The second cycle of production would then look at commercial opportunities and a marketing plan will be developed.

The farm would employ two part time staff.
Potential costs to establish and produce 1.5 t of tuna over a 18 months period.

The key requirements for tuna aquaculture are:

- **Access to starting stock (tuna ririki)**

The Trust has the options to access tuna ririki for their venture and the decision they make will determine the outcome of the venture. (ie if we choose to Exercise our mana and rangatiratanga over the fishery and access the tuna ririki and juvenile tuna to ongrow, seeking only permission from ourselves) we will not be compliant with the Freshwater Fisheries Act 1983.

- **Access to high quality water**

Water quality tests need to be completed asap to be able to assess and choose the appropriate site.

- **Aquaculture site needs to flat and low lying**
    - Close to water
    - Close to a city
    - Have road access
    - Have electricity nearby
    - Have access to adequate freshwater supply

Site selection is one of the keys to successful commercial cultivation of tuna. Sites should be chosen to provide optimum environmental conditions in terms of water quality, temperature, and salinity to suit the species being farmed and methods of cultivation.

Possible requirements can include: land use permits, well permits, effluent permits, property easement, rights of way.

The Trust owns the land where the facility will be established and only a effluent permit will be required and this will be covered with our application for Resource Consents.

Building selection: Thermodynamics is often the main criterion, must be aware of the "greenhouse" can be inexpensive to build but expensive to operate if heating is required. Will need to look at installation of cost-effective heating and cooling. Moisture and humidity control for vapor barriers. Gravel floors can be in-expensive however have some disadvantages such as difficult to keep clean and disinfect, difficult to seal and drain and difficult to move heavy loads. Recommend concrete floors.

We are currently getting a building designed using our kohatu building brick which we will build for our aquaculture venture. The brick has been developed by the Trust and the R-Value (the insulation properties of the brick) is that of pink batts. We are confident that thermodynamics of the building will be cost effective although heating will be required during the winter months. To what degree we do not know at this point. We will be using Solar Heating as the main source of heating. Once the building designs have been sent to us we will make available to Te Wai Maori Trust along with the costings for solar heating.

- Site preparation and earthworks
  A site plan has been produced to show the aquaculture site in relation to other marae facilities. The actual building site plan for aquaculture site is still under development.
- Instillation of buried piping
- Electrical systems – organized electrical distribution – main panel and sub panels
- Water supply systems – pipe sizing for sufficient flow to all systems, location of piping and valves for accessibility and protection of the piping system.
- Practical design considerations – design and build with operations and maintenance in mind such as building layout, sufficient space to move product and equipment and suitable floor materials, construction of the building so it can be maintained easily, working space.

Feed conversion Example

It takes feed to produce fish, and a management plan always plays a key role in measuring your whether or not the operation is meeting expected annual production rates. This can be easily calculated by monitoring Food conversion ratios. For example:

If the operation is wanting to achieve a 2 tons per year production: (Note that on average each kilogram of glass tuna has the potential to achieve 750kg of harvestable product within 12 months)

1. Assume a feed conversion ratio (FCR). Research into average FRCs for eel production. For this example we can assume 1.6 :1
2. Assume a desired production of 2 tones (2,000kg)

   -Then, you must feed 1.6 x 2,000 kg per year = 3,200 kg per year

   Or 3,200 kg ÷ 365 days = 9 kg per day

   If the cost per kg of feed is $2.50 per kg you can assume that you will need to budget $8000 per year or $22.50 per day tuna feed.

If you do not average 9 kg feed per day, you will not reach the production target of 2 tons per year.

There are a number of different fish meals available.

The establishment costs would be very high and it is doubtful wether the Trust would recoup costs.

Tuna ongrowing system (Intensive) Recirculating System

Licence costs to establish a fish farm (MFish)	$ 4484.98
Capital setup costs	$ 75000.00
Production costs $50 per kg x 1500 kg	$ 75000.00
Total for 1 year	$154,484.00

Capital Setup Costs

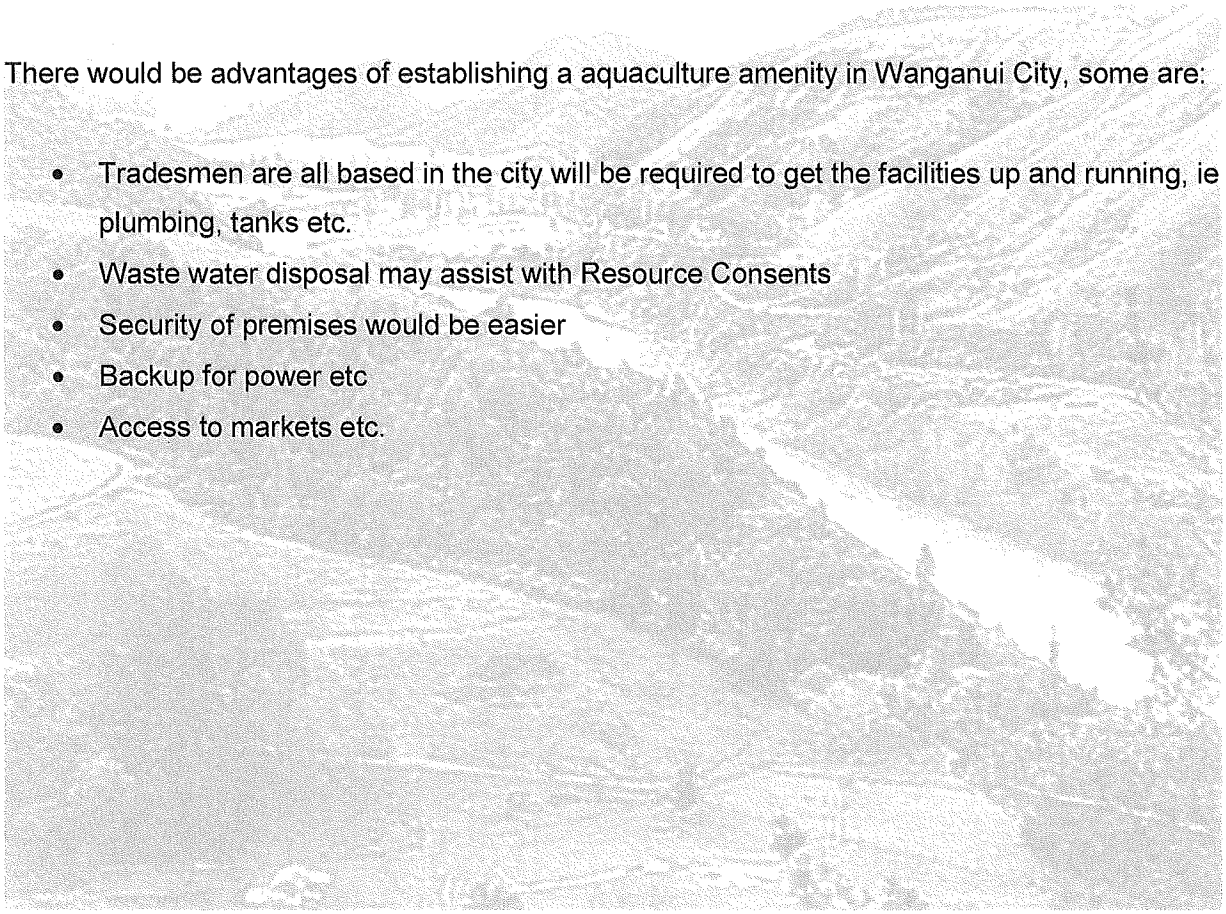
Include, building, tanks, vats for rearing and ongrowing tuna, plumbing, electrical wiring, solar heating system, pumps.

Production costs include Labour feed etc.

Other site options

Other options would be form a consortium of interested parties including Iwi and the Te Whiringa Muka IAO and any other investor to lobby the government for a special permit to set up a pilot plant in the Whanganui Region. The plant would to be strategically placed and the obvious option would be in or on the outskirts of Wanganui City. All the amenities are on hand including waste water which may assist with the Resource Consents.

There would be advantages of establishing a aquaculture amenity in Wanganui City, some are:



- Tradesmen are all based in the city will be required to get the facilities up and running, ie plumbing, tanks etc.
- Waste water disposal may assist with Resource Consents
- Security of premises would be easier
- Backup for power etc
- Access to markets etc.

A Summary of Key Points

- Three species of tuna found in Aotearoa
- Tuna culture or farming involves catching juvenile tuna (tuna ririki) when they enter freshwater and ongrowing
- Many factors need to be considered when collecting tuna ririki for farming including harvesting, fishing equipment, sorting and holding the catch, transport, quarantine, acclimation to hatchery conditions, water quality and dietary requirements
- Three main tuna culture methods are pond culture, accelerated temperature facilities and recirculating systems
- Temperature is important for tuna growth, 25 – 26C is optimal foe Aotearoa tuna
- Saltwater culture is possible and it suppresses fungal diseases
- Historical tuna culture efforts in Aotearoa were unsuccessful due to a number of reasons
- Ministry of Fisheries and Department of Conservation are jointly responsible for the management of tuna and tuna fisheries in Aotearoa
- Current research in Aotearoa investigating saltwater culture of tuna ririki and tuna fattening
- Current barriers to commercial tuna culture are legislative
- A number of other sites could be suitable although Pungarehu Marae is the preferred site
- NIWA have a high quality research center at Bream Bay Northland
- Iwi are getting access to tuna ririki through their claims settlement
- There is quality research on tuna culture
- Iwi who have achieved their fisheries settlement are now major players in the fishing industry and are looking at aquacultural projects to enhance their fishing portfolios
- Te Wai Maori is a major contributor to freshwater fisheries
- There are more Maori scientists working in the fisheries industry
- There is no provision for land based aquaculture in the Maori Commercial Aquaculture Claims Settlement Act 2004 (the Maori Aquaculture Act)

RECOMMENDATIONS:

- **Point 6 of the New Zealand Aquaculture Strategy. Need some focus on benefits for Maori on land based aquaculture.**

- **Availability of glass eels for aquaculture. It is important to decide on how to manage the take of glass eels so it is sustainable. Industry size will depend on regulatory and management decisions on glass eel capture.**

- **Development of a research scale tuna recirculating system.**

- **Feasibility study will help to identify, appropriate investment, at a commercial scale using the right technology. Species, site, technology, infrastructure, economics and consents.**

- **Research and development is expensive and risky – if the budget is limited need to stick to established technologies**

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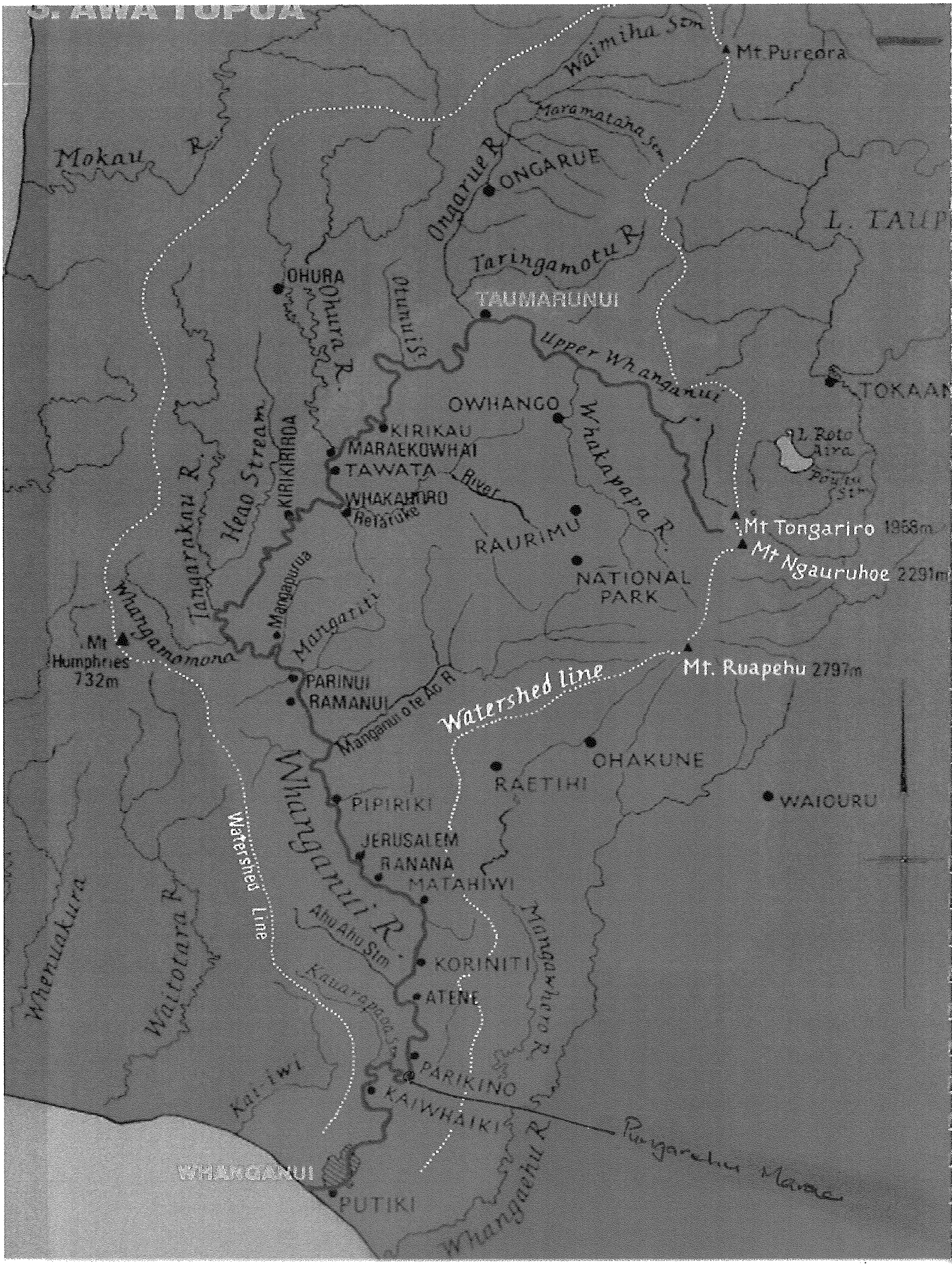
APPENDICES



3. AWA TUPUA
Mt Pureora
Waimiha Stm
Maramataha Stm
Mokau R.
Ongarue R.
ONGARUE
L. TAUP
Taringamotu R.
OHURA
Ohura R.
Otunui St.
TAUMARUNUI
Upper Whanganui
TOKAAN
OWHANGO
Whakapapa R.
KIRIKAU
MARAEKOWHAI
TAWATA
River
WHAKAHORO
Retaruke
L. Roto Aira
Poutu Stm
Heao Stream
KIRIKIRIROA
Tangarakau R.
Mt Tongariro 1968m
Mt Ngauruhoe 2291m
RAURIMU
NATIONAL PARK
Mangapurua
Mangaturi
Whangamomona
Mt Humphries 732m
Mt. Ruapehu 2797m
PARINUI
RAMANUI
Manganui o te Ao R
Watershed line
OHAKUNE
RAETIHI
WAIOURU
Whanganui R.
PIPIRIKI
JERUSALEM
RANANA
MATAHIWI
Watershed Line
Ahu Ahu Stm
Whenuakura
Waitotara R.
Mangawhero R.
KORINITI
Kauarapaoa Stm
ATENE
PARIKINO
Kai-iwi
KAIWHAIKI
Rangarehu Marae
WHANGANUI
PUTIKI
Whangaehu R.