Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge - Overview

NIWA Client Report: HAM2007-022
July 2007

NIWA Project: TACF062

Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge - Overview

Ngaire Phillips
Dave Rowe
Stephanie Parykn
Ian Kusabs

Prepared for

Te Arawa Lakes Trust

NIWA Client Report: HAM2007-022
July 2007

NIWA Project: TACF062

National Institute of Water & Atmospheric Research Ltd
Gate 10, Silverdale Road, Hamilton
P O Box 11115, Hamilton, New Zealand
Phone +64-7-856 7026, Fax +64-7-856 0151
www.niwa.co.nz

Contents

Reviewed by:

E. Williams

Approved for release by:

D. Roper

Formatting checked

Acknowledgements

We are grateful for the contributions from the following people:

Roku Mihinui and Hera Smith, Te Arawa Lakes Trust.

Bella Tait, Rotorua District Council.

David Hamilton and Joseph Butterworth, University of Waikato.

Jacques Boubée, John Clayton, Tracey Edwards, Max Gibbs, Chris Hickey, Kristel van Houte-Howes, Clive Howard-Williams, Weno Iti, Mike Martin, John Quinn, David Roper, Apanui Skipper, Charlotte Severne and Thomas Wilding, NIWA.

Willy Emery, Te Arawa.

This project has been funded by FRST/HRC Māori Development under contract C01X0512 "Sustainable Management Framework for Te Arawa Lakes Customary Fishing".

1. Introduction

NIWA and the Te Arawa Lakes Trust, with support from the New Zealand Foundation for Research Science and Technology and the Health Research Council, are developing a sustainable management framework for customary fisheries in Te Arawa lakes, as part of a joint 3 year research programme. Figure 1 shows the location of the Te Arawa lakes, which include lakes Rotoehu, Rotomā, Rotoiti, Rotorua, Ōkataina, Ōkareka, Rerewhakaaitu, Tarawera, Rotomāhana, Tikitapu, Ngahewa, Ōkaro, Ngāpouri and Tutaeinanga. As part of this programme it is envisaged that tools, monitoring methods and guidelines based on customary knowledge and sound scientific principles will be developed, specifically focusing on culturally important mahinga kai and taonga species. It is hoped that the outcomes and outputs of this programme will provide Te Arawa with the capacity to manage their lakes non-commercial fisheries sustainably and in a manner that is consistent with their tikanga and kawa.

There are three main components to this research programme — (1) Characterisation of selected taonga and mahinga kai species of the lakes (in terms of both cultural and scientific values); (2) Assessment of the likelihood of changes to these resources in the face of anthropogenically-induced environmental variability; and (3) Identification of potential management options that fit into a regional management framework for the lakes. The focus of the project is on freshwater crayfish, mussel and fish species, including kōura (*Paranephrops planifrons*), kākahi (*Hyridella menziesi*), kōaro (*Galaxias brevipinnis*), common smelt (*Retropinna retropinna*) and tuna (*Anguilla australis* and *A. dieffenbachii*).

This report presents the outcomes of the first year of investigations from the programme. Specifically, it reports on current traditional and scientific knowledge of the five study species. Additionally, it presents conceptual models of current understanding of the factors influencing the distribution and abundance of these species in Te Arawa lakes. These models have allowed us to identify gaps in knowledge, some of which we will aim to address in subsequent years of the programme. We have also developed preliminary illustrations of these complex scientific models, which will provide useful tools for dissemination of this information to the wider community. Finally, we have begun development of a numeric-based predictive models known as Bayesian Belief Networks (BBN) for kōura, using our conceptual model as the basis for describing relationships between the factors identified as being of importance in determining the distribution and abundance of these species in the Te Arawa lakes. This BBN is under development and will be reported on separately at a later date.

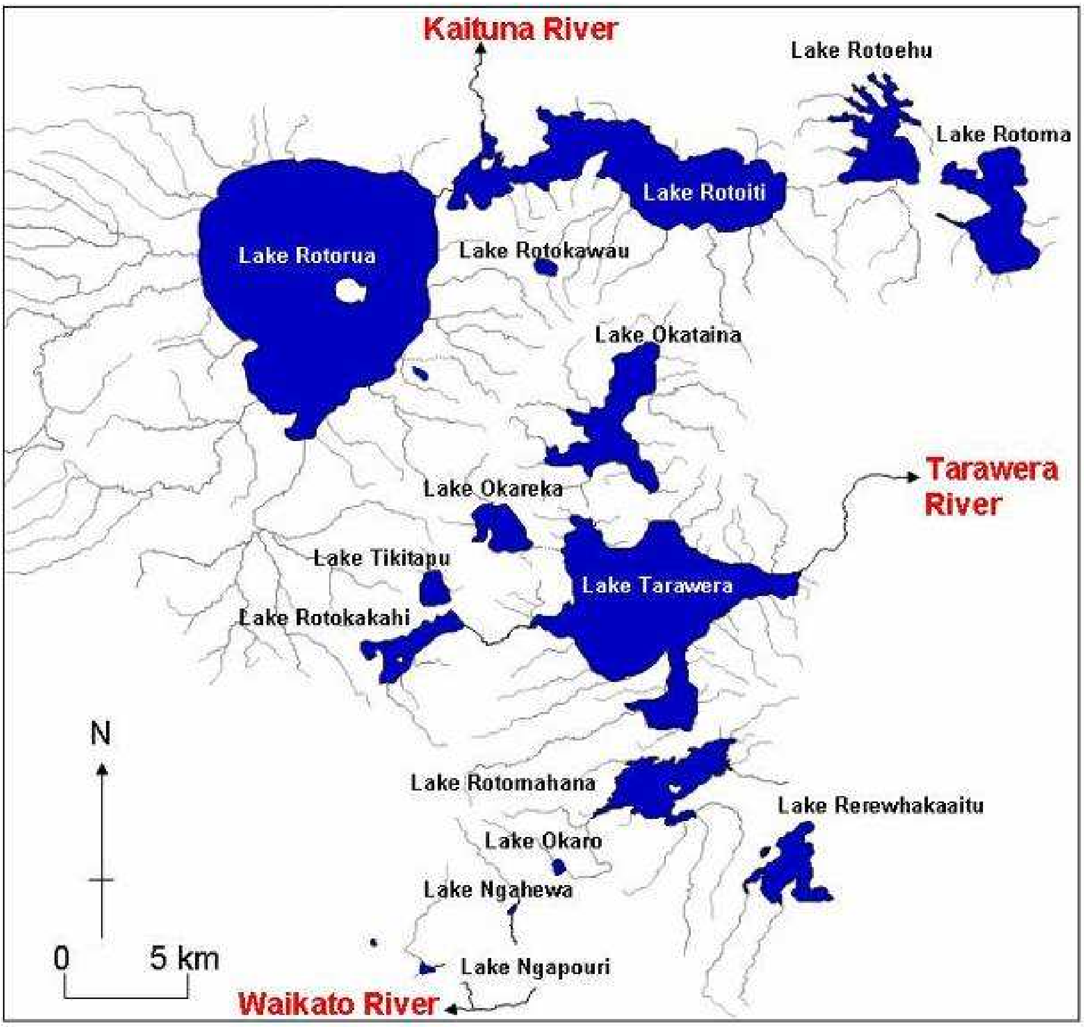

Figure 1: Te Arawa lakes.

2. Research methods

2.1 Review of traditional knowledge

Utilising kaupapa Māori methodologies and models of analysis (including hui and one-on-one discussions), we have developed a description of taonga and mahinga kai species, including whakapapa of the kōura, kākahi, kōaro, common smelt and tuna. This has allowed us to directly involve local hapū in the project outcomes. It is becoming apparent from ongoing research that much of the traditional knowledge of these mahinga kai species and traditional harvesting protocols are disappearing. For example, only 4 families (all from Te hapū o Ngāti Pikiao) in Te Arawa/Ngāti Tūwharetoa iwi continue to use tau to harvest kōura. Therefore, it seems to be an appropriate time to record this information for future generations. We have also reviewed previously recorded knowledge (e.g., Treaty of Waitangi evidence).

2.2 Review of scientific knowledge

We have undertaken a review of existing scientific information, searching past and present research in the published and unpublished literature. Using our collective scientific opinion, along with a review of existing information, we have developed conceptual models of our current understanding of physical (e.g., water quality) and biological (e.g., predation) variables influencing the distribution and abundance of the five taonga and mahinga kai species within lakes (see Appendices). We also held a "brainstorming" workshop in April 2006, in which scientists and iwi representatives participated. Conceptual models of current knowledge on factors influencing species distribution and abundance were presented and critically examined, allowing refinement of the models, as well as identification of key information gaps. This workshop also provided the opportunity for scientists to gain knowledge on the study species from members of Te Arawa.

2.3 Development of a Bayesian Belief Network (BBN) for kōura

For kōura, we have developed the conceptual model into a numerical predictive model, using the technique of Bayesian Belief Networking (BBN). This approach offers a sound but novel way of integrating large amounts of information from a variety of sources, as well as providing predictive capability within an easily understood framework. These models use scientific knowledge on the interactions between variables to describe current distribution and abundance of species and to predict responses to changes in variables (e.g., a response to increased nutrient levels). The BBN includes known and potential threats to maintenance and enhancement of kōura. The models will be used to predict what is likely to happen to species if current threats are increased, and what will happen if potential threats are realized. Examples of model outputs are available at http://www.niwascience.co.nz/maori/research. The models will be used by Te Arawa to describe lake attributes required for the restoration and long-term maintenance of sustainable populations. It is envisaged that ongoing monitoring will provide data to test and update the BBNs.

3. Background

Fish

The Te Arawa canoe arrived in New Zealand around 1350 (Stafford, 1967). When Ihenga discovered Lake Rotoiti, he had his dog to thank. While hunting kiwi in the area, his dog, called Potakatawhiti, pursued a kiwi into the lake and in the process of catching it in its mouth, also ingested a large quantity of inanga. When the dog returned to Ihenga, its fur was still wet which indicated that a body of water, perhaps a lake, was nearby. The dog then vomited the inanga 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 inanga 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 (Stafford, 1967).

The main fish species harvested by Māori in the Te Arawa lakes in pre-European times included the juvenile and adult stages of the kōaro, termed ‘inanga’ and ‘kōkopu’ respectively (Stafford, 1986). Adult common bully (*Gobiomorphus cotidianus*), or ‘toitoi’, were also caught. Eels, or ‘tuna’, were not present naturally in these lakes, apart from small numbers in the Lake Tarawera catchment, but elvers were probably stocked from time to time into other lakes, resulting in the occasional capture of one or two eels (Stafford, 1986). Invertebrates such as kōura or freshwater crayfish, and the kākahi or freshwater mussel were also harvested by Māori. The Māori fisheries for inanga, kōkopu 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 (Hiroa, 1921; Mair, 1923; Stafford, 1994 & 1996).

Later introductions of fish by European settlers, especially rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), goldfish or morihana (*Carassius auratus*), and common smelt, had a large and mainly detrimental impact on the Māori fisheries in the Te Arawa lakes (McDowall, 1987; Rowe, 1990). Trout quickly replaced kōkopu as the largest fish present, and as a result of their heavy predation on inanga, the fisheries for both inanga and kōkopu soon collapsed (Burstall, 1980 & 1983; Stafford, 1986; McDowall, 1987). Although trout became very abundant, to the point where netting was required to reduce the trout population (Hobbs, 1948), Māori access to this new fishery was limited and restricted by regulations governing the licensing of anglers and the control of poaching (Stafford, 1986). 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 Ngapuna (Stafford, 1986). They were later introduced to lakes Tarawera, Rotoehu and Rotomāhana, with Talbot (1882) noting that the 'carp' acclimatised successfully to Lake Rotomāhana where they thrived in its 'perpetual warm bath'. Although this new fishery was popular with Māori, it was localised and would not have replaced the more widespread fisheries for inanga and kōkopu. The Māori fishery for the much smaller toitoi was abandoned when the inanga and kōkopu fisheries collapsed, even though common bullies remained abundant in the lakes and have since increased in some (Rowe, 1999b). 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 inanga fisheries in the lakes.

Today, as the native fish stocks in the Te Arawa lakes, and the rights to manage them, come under closer scrutiny, Te Arawa are renewing interest in their customary fisheries and looking at ways of restoring and managing some of them. This is particularly so for kōaro in the Te Arawa lakes (Young and Smale, 2003). However, there is also interest in the restoration of kōaro in Lake Rotoaira and Rotopounamu near Taupō (Rowe and Konui, 2003). This revival begs the question of what is currently known about the life history, habitats and distribution of the species historically harvested by Māori, and what information is now required to manage these non-salmonid fish stocks in the lakes. In this report, scientific and historical information on the kōaro and common smelt populations in the Te Arawa lakes is reviewed. What is known about their life history, reproduction, feeding, growth and general ecology is described, and major information gaps are identified as a basis for future research. In addition, a conceptual model of fish abundance is developed. This model helps identify the main factors limiting the stocks, and so provides a useful long term tool for both management and restoration.

While tuna are not a significant component of the fish biomass of the Te Arawa lakes, they are of interest to Te Arawa and thus a review of current knowledge is also presented.

Invertebrates

In general, the macroinvertebrate fauna of the Te Arawa lakes is not markedly different from that of other New Zealand lakes. Some peculiarities occur due to abnormally high water temperatures (e.g., Rotowhero) or acidity (e.g., Opal lake). Chironomid larvae, oligochaete worms, and molluscs constitute more than 90% of the numbers of benthic macroinvertebrates in the Te Arawa lakes, which is typical of most New Zealand lakes (Forsyth, 1978).

One of the most important factors influencing the presence and abundance of the various macroinvertebrates is trophic status. Nutrients and productivity of plant material influences the degree of deoxygenation in summer. The animals most tolerant of low oxygen are the last to leave, and nutrient enriched lakes like Ngāpouri and Ōkaro may support only chironomid larvae and oligochaete worms, which may eventually retreat into shallower waters. The decomposition processes in Ōkaro are so rapid that the only animals present on the bottom are found close to the shoreline. In 1970, the size of the standing crop of a copepod species in the water column was used to predict the trophic status of lakes giving the order from least to most nutrient enriched as: Ōkareka, Rotomā, Rotokākahi, Ōkataina, Ōkaro, Ngāpouri. Similarly total zooplankton crops indicated that the most eutrophic lakes were Ōkaro and Ngāpouri and least as Tikitapu. It is thought that there are too few species of chironomids in these lake to be able to use them as indicators of trophic status as has been done in the northern hemisphere (Forsyth, 1978). However, numbers of chironomid larvae and total macroinvertebrates were highest in Ōkaro and Ngāpouri and lowest in Tikitapu, Ōkareka and Rotokākahi.

Mussels and snails are typical of the littoral zone (i.e., the zone that extends from the shoreline to extent of rooted plants) and of the cold water lakes. Only Lake Tikitapu does not support them, probably because of low carbonate levels (5.6 mg/l) and calcium (0.68 mg/l) that could be inadequate for shell formation. Mussels were found to be more abundant in lakes with higher trophic status, but they were absent from the most enriched lakes (e.g., Ōkaro apparently because of bottom deoxygenation). The ratio of snails to mussels decreased through the series Ōkareka, Rotokākahi, Ngāpouri, Ōkaro (Forsyth, 1978). It is thought that increasing numbers of filter feeders reflected an early phase in eutrophication and the decrease in grazers (i.e., snails) and the increase in filterers (i.e., mussels) from oligotrophy to meso-eutrophy in the Te Arawa lakes supports this.

Within the littoral zone there are three basic types of habitat, mud, sand and water plants. Kōura are mostly associated with the mud bottom of the littoral zone along with ostracods (*Chydorus* and *Ilyocryptus*), seed shrimp (*Darwinula*), the copepod (*Macrocyclops*), and larvae of Chironomid midges. Insect fauna are commonly associated with aquatic vegetation but snails may be found on either the sediments or vegetation. *Potamopyrgus antipodarum* is the most common and widespread snail, although *Lymnaea* and *Physa* can also be common. Only *Physa* is found in Lake Ōkaro (Forsyth, 1978). Other animals associated with the bottom muds are ceratopogonid larvae, leeches, nematodes and oligochaetes. Chironomids and snails are important in the diet of stream kōura (Parkyn et al. 2002) and it is likely that many of the species listed here are consumed by lake dwelling kōura.

Kōura and kākahi were both traditionally important species for Māori who occupied the Te Arawa lake region. There is renewed interest in traditional kōura harvesting methods (e.g., tau kōura), along with concern over the decline of kākahi populations in the Te Arawa lakes. A review of current knowledge on these important invertebrate species is presented, along with conceptual models detailing our understanding of factors influencing their distribution and abundance (Phillips, 2007).

4. Further reading

Further reading on each of the study species can be found in the following reports, available at http://www.niwascience.co.nz/maori/research.

Koura – Parkyn and Kusabs (2007).

Kakahi – Phillips et al. (2007).

Koaro – Rowe and Kusabs (2007a).

Smelt - Rowe and Kusabs (2007b).

Tuna – Martin et al. (2007).

5. References

Burstall, P. (1980). The introduction of freshwater fish into the Rotorua lakes. In. Stafford, D.; Steele, R.; Boyd, J. (eds.). *History of Rotorua 1890-1990.* Rotorua and District Historical Society Inc., Rotorua.

Burstall, P.J. (1983). Trout fishery: a history of management. In. Forsyth, D.J., Howard-Williams, C. (eds.) Lake Taupō – ecology of a New Zealand lake. *New Zealand Department of Scientific and Industrial Research Information Series 158.*

Forsyth, D.J. (1978). Benthic macroinvertebrates in seven New Zealand lakes. *New Zealand Journal of Marine and Freshwater Research 12*: 41-49.

Hiroa, Te 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 53*: 433-451.

Hobbs, D.F. (1948). Trout fisheries in New Zealand, their development and management. *Fisheries Bulletin No. 9.* New Zealand Marine Department, Wellington.

Mair, G. (1923). Reminiscences and Māori stories. Brett Printing and Publishing, Auckland.

Martin, M.M.; Boubée , J.; Kusabs, I. (2007a). Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge – tuna. NIWA Report HAM2007-022 July 2007.

McDowall, R.M. (1987). Impacts of exotic fishes on the native fauna. In: Viner, A.B (ed.). Inland Waters of New Zealand. *DSIR Bulletin 241*.

Parkyn, S.M.; Collier, K.J. (2004). Interaction of press and pulse disturbance on crayfish populations: Flood impacts in pasture and forest streams. *Hydrobiologia 527(1),* pp. 113-124.

Parkyn, S.M.; Kusabs, I. (2007). Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge – koura. NIWA Report HAM2007-022 July 2007.

Phillips, N. (2007). Review of the potential for biomanipulation of phytoplankton abundance by freshwater mussels (kakahi) in the Te Arawa lakes. NIWA Client Report HAM2006-125 24 p. NIWA, Hamilton.

Phillips, N.; Parkyn, S.M.; Kusabs, I.; Roper, D. (2007). Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge – kakahi. NIWA Report HAM2007-022 July 2007.

Rowe, D.K. (1990). Who killed the kōaro? *Freshwater Catch 43:* 15-18.

Rowe, D.K.; Konui, G. (2003). Review of the present and future status of kōaro in Lake Rotoaira. *NIWA Client Report No. HAM2003-074*. National Institute of Water and Atmospheric Research, Hamilton.

Rowe, D.K.; Konui, G.; Christie, K. (1999). Kōaro (*Galaxias brevipinnis*) in Lake Rotoaira. *NIWA Client Report ELE90232/2*. National Institute of Water and Atmospheric Research, Hamilton.

Rowe, D.K.; Kusabs, I. (2007a). Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge – koaro. NIWA Report HAM2007-022 July 2007.

Rowe, D.K.; Kusabs, I. (2007b). Taonga and mahinga kai species of the Te Arawa lakes: a review of current knowledge – koaro. NIWA Report HAM2007-022 July 2007.

Stafford, D.M. (1967). Te Arawa - a history of the Arawa people. Reed Books, Auckland.

Stafford, D.M. (1986). The founding years in Rotorua. A history of events to 1900. Ray Richards, Auckland.

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, Rotomā. Reed Books, Auckland.

Talbot, T. (1882). The new guide to the lakes and hot springs and a month in hot water. Wilson and Horton, Auckland.

Young, K.; Smale, S. (2003). Restoration of kōaro (*Galaxias brevipinnis*) in a New Zealand lake - integrating traditional indigenous resource management with contemporary conservation biology. *In* Beumer, J.P.; Grant, A.; Smith, D.C. (eds.). *Aquatic protected areas – what works best and how do we know?* World Congress on Aquatic Protected Areas, Cairns, Australia, August 2002.