Providing the voice for kanakana: assisting with storytelling and being part of the restoration journey for this taonga species

by

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Executive Summary

The Pouched Lamprey (*Geotria australis*, Gray, 1851) is a jawless, boneless, native freshwater fish species in Aotearoa, New Zealand, which is also called kanakana. It is an anadromous and nocturnal species, so it migrates between freshwater rivers and in the ocean. They have been on earth for over 360 million years. Among the five lamprey species found in the southern hemisphere, *G. australis* is the only one which inhabits New Zealand, and parts of Australia and Chile.

For generations, the kanakana has been a taonga(treasure) species and mahika kai(gathering of food) to many Māori communities, and is a vital food source. Kanakana is considered 'Threatened - nationally vulnerable' (Dunn et al. 2018) as the population has made a gradual decline over the past decade, partially caused by natural and man made barriers that have made it harder for kanakana to migrate upstream. Barriers such as weirs, culverts, dams and stream alterations instigate direct stress on the fish. Furthermore, industrialisation and agriculture on the river banks poses additional threats to the survival of the species.

In the Mataura River specifically, the weir that was built above the Te Au Nui Pihapiha Kanakana, Mataura falls, obstructs the kanakana natural passage. The Mataura Mātaitai was the first fresh water mātaitai established in order to protect the kanakana as well as long fin and shortfin eels. The loss of the species would be detrimental to the Māori culture, traditions and identity.

Due to the behavioural traits inherent to this species, a plethora of knowledge gaps concerning the fish are evident. There are many different conservation projects established to answer these questions and learn more about the species. Hokonui Rūnanga (based in Gore) have a programme in the Mataura River to monitor the migration of the kanakana through barriers, population numbers and distribution during migration. Unfortunately, local communities in the catchment area lack awareness of the kanakana.

The purpose of this report is to design a narrative which can be used to educate people of the kanakana. The narrative format is an article which is aimed at primary school students but can be used by all ages. It is portrayed from the kanakana's perspective and it highlights the life cycle, barriers and conservation efforts occurring in its freshwater stages. This report and narrative is specific to the Mataura River but can apply to other rivers across New Zealand. It is important to inform people of the importance of the kanakana and its challenges to raise awareness of its decline, in hopes to encourage them to get involved and help protect this taonga species.

Acknowledgements

Starting this project, I had no experience in freshwater ecology and had no idea what the kanakana/lamprey was, and how it would become a big part of my life and help to challenge and change my perspective on culture and science. This project has been both a personal and educational journey where I have not only developed my research skills, but also acquired a deeper understanding of my own culture and learnt to look at my identity and the environment through a different lens. From the beginning, when I first met the kanakana at the Mataura Falls, to now, I had no idea the effect that such a small, mysterious, strange looking creature could have on me, nor the passion it evokes in the hearts and minds of those determined to save it. The exposure to this area of science has been an eye opening experience, it has helped me realise that culture is tied into all facets of life and community, and that I should always look more broadly at life, as there is much more out there that I am yet to experience, and that if given the opportunities to grow my knowledge and understanding of myself, my culture and world around me, I should take it.

I am forever thankful to my supervisor Jane Kitson and Nga Pae o te Maramatanga for offering this project and supporting me the entire way through, it has been an amazing experience working with both of you. I would like to thank the Hokonui Runanga Taiao Freshwater team and University of Canterbury Freshwater Ecology Research Group for the training and field work opportunities. It was a pleasure to work and learn from all of you, I could not have written this report or narrative without this experience.

Table of Contents

1.0 Introduction

The lamprey is a prehistoric species which has been around for over 360 million years and has been regarded as a 'living fossil' (Janvier, 2007). It is a difficult species to manage due to its andromous and nocturnal behaviours therefore making it difficult to gain knowledge on this species (Miller, 2022b). There are over 40 species with only five in the southern hemisphere split into two families, Mordaciidae and Geotriidae (Baker et al., 2021). *Geotria australis* is the only lamprey species found in New Zealand. It is characterised by two major morphological changes it undergoes during its migration out of and into the river (Potter & Strahan, 1968). It is a culturally significant species to many Māori communities but its decline is a threat to a part of the culture. For the kanakana to be saved, it needs recognition to gain help from the local communities for restoration of both the species and its ecosystem.

1.1 Purpose of Report

The purpose of this report is to conduct research and analysis of the kanakana with the aim of creating a narrative from the species perspective. The narrative will serve as a tool to aid in the restoration efforts of this taonga species by raising awareness of its struggles and decline in New Zealand rivers, specifically the Mataura River.

The kanakana is a 'nationally vulnerable' species (Dunn et al. 2018) with a declining population due to factors including extensive alteration of habitats and migration paths in the awa(river), intensive agriculture and urbanisation.

This research is a component of the Biological Heritage National Science Challenge (NSC) project called 'Freshwater for our Taonga'. The project contributes to a broader objective of preserving and restoring New Zealand's freshwater ecosystem and the treasured species which inhabit them.

1.2 Research Method

Before beginning any work I gained the necessary qualifications including, first aid, river safety and Electrofishing training. I spent the first 5 weeks of this project with the Hokonui Rūnanga located in Gore, Southland. During this time I worked with the Taiao freshwater team on their kanakana monitoring, this includes observing streams connected to the Mataura River which have cultural significance, to look for kanakana ammocoetes and any other fish that inhabit the stream. Throughout my placement there I was involved in the field work which included electro fishing, water quality testing, macroinvertebrate community index (MCI), habitat evaluation and Cultural assessments

The cultural assessment used is an adapted version of the Murihiku Cultural Water Classification System (MCWCS) (Kitson et al., 2018). The cultural assessment is designed to target Wai Noho and Wai Tuna. Wai Noho refers to a site that would have traditionally been used as a seasonal camping site and Wai Tuna is a site that was used to catch eels.

Electro fishing is a technique which uses an electric field to temporarily stun fish. It involves a battery pack which is usually strapped on the back of the person fishing, an anode which is held by hand and a cathode which trails behind. The electric field is created between the anode and cathode. The ability for the electricity to stun fish depends on the conductivity of the water and the current output of the battery. Death of the fish may occur if the voltage is too high (Thompson et al., 1998).

I observed barriers in the rivers that affect kanakana migration including the Mataura falls, weir and industrial buildings surrounding, as well as the altering of streams in the agricultural and industrial sector and the use of culverts. I also observed the difficulty of finding ammocoetes as there are limitations with electrofishing. By interviewing the Hokonui Rūnanga, I gained insight to the cultural importance of the kanakana to themselves, the local tangata whenua(local people) and Kāi Tahu. To gain factually correct information about the kanakana, I did extensive research which was incorporated into the narrative, I also researched narrative formats to select the best suited to this project and intended outcomes.

This report is based in Southland, New Zealand, therefore I have chosen to use the southern te Reo Māori dialect. When mentioning the New Zealand pouched lamprey, it is referred to as the Kāi Tahu name, kanakana. Other words are written as the southern dialect with the exception of official company names, place names or document titles.

2.0 What is the Kanakana

2.1 Taxonomy and Classification

Kanakana is a Kāi Tahu word for the pouched lamprey (Strickland, 1990). Scientifically it is known as the species *Geotria australis,* Gray, 1851, which is a part of the Geotriidae family. Within the Geotria genus there is one other species called *Geotria macrostoma* (Riva-Rossi et al., 2020). In Te Reo Māori, the species is generally known as Kanakana to South Island iwi, and Piharau to North Island iwi.

2.2 Physical Characteristics

The kanakana is an anadromous species which has many morphological features that change throughout its lifecycle. It is a parasitic, jawless fish which has an oral disk mouth that allows the fish to attach to larger marine animals to feed off after metamorphosis and migration to salt water, but as a juvenile in fresh water they are filter feeders (Docker & Potter, 2019). They lack bones but instead have cartilage which gives it structure and can grow to 450-750mm long as a mature adult. General features of a kanakana include two eyes, a medial nostril, seven external gill slits, Anterior dorsal fin, posterior dorsal fin and a caudal fin (Hatcher et al., 1903). The colour of the kanakana changes from a brown-grey as ammocoetes to a silver colour with 2 blue-green stripes down the dorsal area of the body as the kanakana transitions to the salt water (Potter & Strahan, 1968). When the migration period back into fresh water as an adult, its colour changes to brown.

2.3 Habitat and Distribution

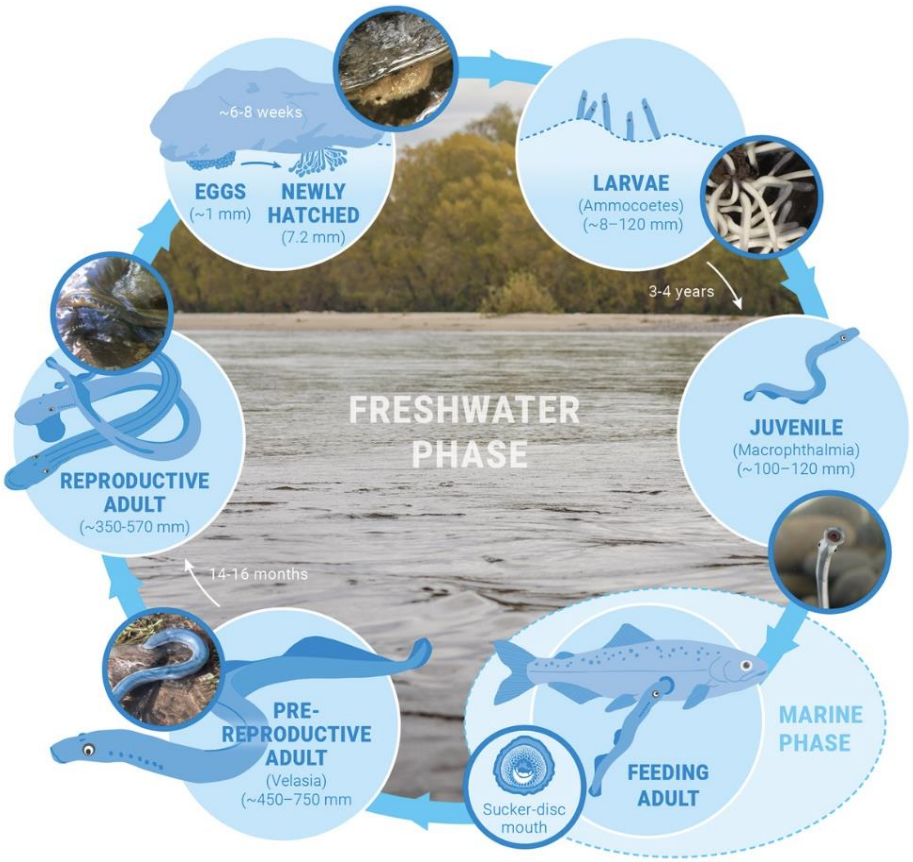
G. australis has an antitropical distribution and is only found in the southern hemisphere, it has a wide distribution area that includes Chile, Australia and New Zealand (Neira et al., 1988). The distribution of *G. australis* in New Zealand is uncertain as ammocoetes are difficult to detect, this is due to burrowing in sediment, inaccessible spawning sites and nocturnal behaviour, but the species has been identified in many locations all throughout New Zealand in the North, South, Chatham and Stewart Islands (James, 2008). Within the South Island, the largest populations of kanakana are seen in Southland, Otago, Banks Peninsula and the West Coast, with other sightings in Fiordland and Tasman. In the North Island, kanakana are mostly found on the west coast around Wellington, Taranaki and Hamilton (Williams et al., 2017). Although there is a wide distribution across New Zealand, they are a part of one population as there is gene flow between all the lamprey (Miller et al., 2022a).

2.4 Life Cycle

Due to the anadromous behaviour and the radical morphological changes of the kanakana, its lifecycle is vastly different to many other fish. It spends the majority of its life in freshwater but has a period that is spent in the ocean/saltwater. Spawning of the kanakana occurs in freshwater rivers located inland, after the larvae hatch, it attaches to the surface of a boulder or similar surface where they stay for about 3 weeks, as shown in figure 1 (Baker et al., 2017). The larvae become ammocoetes, which live in the sediment of the river bed and filter feeds for nutrients. The kanakana spends about 3.25-4.25 years in this stage before they metamorphosis into a macrophthalmia (juveniles) and migrate to the ocean. Metamorphosis occurs over about seven months where the kanakana develops eyes, the oral disc and changes colour (Potter et al., 1980). The kanakana spends

Figure 1

Life cycle of the Pouched lamprey (*Geotria australis)*



Note: From Taonga species series: Piharau by NIWA (NIWA., 2021) published on https://niwa.co.nz/te-kuwaha/piharau

approximately 3-4 years in the ocean and during this time they parasitically feed off of other fish flesh and fluids, as seen in figure 1. Once the kanakana becomes a Velasia (adult) and begins the migration up the freshwater river (James, 2008). As the kanakana enters the river, it stops eating and it gradually decreases in size. They are nocturnally active and travel during night when it is dark and hides under boulders, wood debris and overhanging vegetation during daylight. (Kelso & Glova, 1993, Maskell, 1929). The maturation period on a Velasia lasts approximately 14-16 months (Jellyman et al., 2002), and once sexually matured, a female and male pair build a nest. The male develops a gular pouch on the ventral surface, and the female a raised dorsal ridge (rope) in front of the first dorsal fin (Baker et al. 2021, Baker et al., 2017, Maskell, 1929). Once the Kanakana have laid their eggs, they continue to guard their nest for over 3 months before they die. (Baker et al., 2017)

3.0 Cultural Importance

3.1 Definition of Taonga Species and Mahika Kai

The Māori dictionary definition of taonga means ‘treasure, anything prized’, a taonga species is one that has any significance to a community or individual, such as being a key food source. It can include any living entity such as flora and fauna as well as their ecosystems (Hudson et al., 2021). Taonga species has also been defined as ‘a species that were present in New Zealand prior to the first European contact’ it is also explained that the definition includes all the bones and biological material of dead and living species due to their mauri and wairua still being present (Taiuru, 2022).

Mahika kai is a term which includes a taonga species/plant and the habitat that supports it. Kāi Tahu iwi define mahika kai as ‘the customary gathering of food and natural materials, and the places where those resources are gathered’ (Ngāi Tahu Claims Settlement Act 1998). It is crucial that both the species and habitat is protected for tangata whenua to continue to gather kai and resources in a traditional way just as their tūpuna did, protection will also ensure the sustainability of the mahika kai resource. Iwi can have different types of mahika kai depending on what species and resources live and grow in their specific areas (Environment Canterbury, 2018).

The kanakana is a taonga species as it has sustained many Māori communities for generations and has become a key part to the wellbeing of many Māori. The mātauranga (knowledge) about the kanakana has been passed down due to its importance as a food source. Within Murihiku (Southland) the kanakana and the Mataura River is considered mahika kai to the local iwi.

3.2 Wai262 Claim

The Wai262 claim was initially lodged in 1991 in an attempt to allow Māori to have a voice when it comes to their taonga species being commercialised or used for research. The roots of this claim comes from indigenous taonga plants being used without consent or discussion, stripping the iwi and hapū of their tino rangatiratanga(autonomy) as they lost control over their relationships with taonga (Waitangi Tribunal, 2011). This is a direct breach of article two in the Te Tiriti o Waitangi as the Māori version states Māori are able to ‘exercise of their chieftainship over their lands, villages and all their treasures’ (Kawharu, 1988) and the plants that were exploited are considered treasures to the Māori. The conclusion from this claim is that the Crown and Māori must form a treaty partnership in order to protect Mātauranga Māori as well as kaitiakitanga(guardianship) (Waitangi Tribunal, 2011). Thirty-one years after the initial claim being lodged, best practice guidelines were established for when scientists wanted to research a taonga species, these were

produced by the whanau of the claimants as well as leaders of the claimant iwi. The purpose of these guidelines is to give Māori the right to determine if and how taonga is used in research (Potter, 2022).

3.3 Importance of Kanakana to Hokonui Rūnanga

Following the Ngāi Tahu Settlements Claim and the Te Rūnanga o Ngāi Tahu Act 1996, 18 papatipu Rūnanga were established in the South Island. These rūnanga uphold the mana of the surrounding land and sea, and maintain ahi kaa(continuous occupation). Each rūnanga operates in a specific region and are responsible for the marae and tangata(people) in their area. Although all separate, they collectively fall under Kāi Tahu iwi (Te Rūnanga o Ngāi Tahu, n.d.)

Established in Gore, Southland, in 1999, the Hokonui Rūnanga fulfils the purpose of benefiting individuals who whakapapa(descent) to Hokonui as well as the communities associated with Hokonui. Their key objectives of their work include health and well-being, cultural development, protection of the environment and employment (Hokonui Rūnanga, n.d.). Within the Rūnanga is Kaupapa Taiao, whose work is dedicated to the protection of the environment. The freshwater team has taken on projects including koura farming, Mataura Mātaitai and kanakana monitoring to improve the quality of the surrounding rivers and their species (Taiao, n.d.).

I interviewed members of the Taiao Freshwater Team to understand the importance of the kanakana to the Hokonui Rūnanga as well as their own personal connection to the kanakana. The interview involves six of the members who all work on the kanakana monitoring programme.

In the interview the first question asked was ‘what does the kanakana species mean to you personally?, the response by T. Tamati indicates that the kanakana is still traditionally harvest and eaten by Māori today, this means that it is still a significant food source to tangata whenua. In R. Parata’s response to the question, he highlighted that it is tradition which is important in sustaining a culture, and that by protecting the kanakana this also preserves cultural heritage.

The second question ‘When did you first learn about kanakana?’ showed a range of responses such as some learning from childhood and others not learning of the kanakana until working with them at the Hokonui Rūnanga. When learnt about as a child, the information would come from tipuna rather than external sources or school. There is a lack of external information of the kanakana which would inform those who do not have the information passed down through their whanau.

The third question was ‘What is the significance of the Kanakana to the Hokonui Rūnanga?’. The response from R. Parata relates to the purpose for the establishment of the Rūnanga to benefit the tangata whenua. He says that the Hokonui Rūnanga is comprised of tangata whenua members, therefore the importance of the kanakana as a taonga species and mahika kai influences the Rūnanga to protect the kanakana. T. Tamati has a more cultural aspect of the significance of the kanakana. ‘Whakapapa, we are them and they are us’, this refers to the narrative about Papatuanuku and Raki, whose children became gods of each domain in the natural world, and created all living entities such as humans and nature. Therefore forming the idea that everything in the world is related and both humans and kanakana whakapapa back to Papatūānuku and Raki and are seen as equals (Reilly et al., 2018).

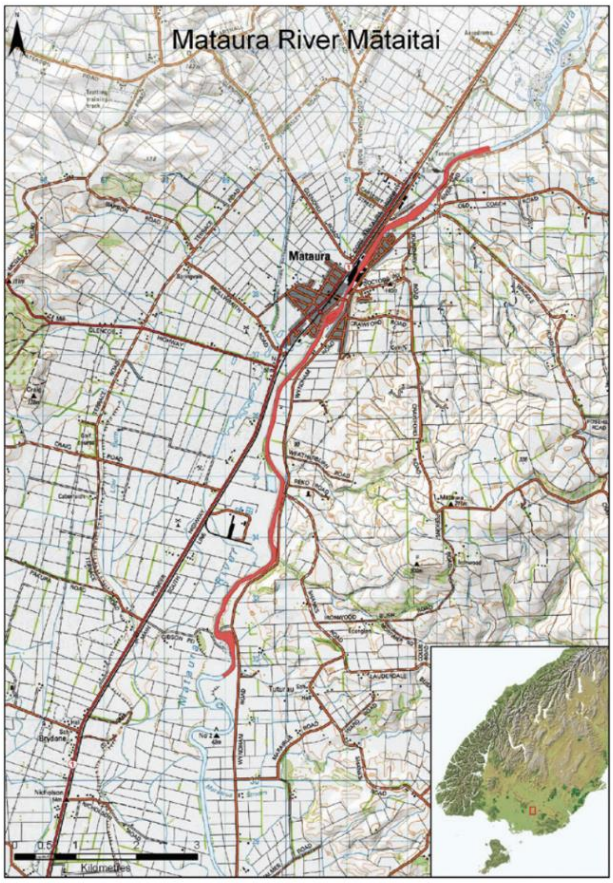
The last question asked was ‘Would the loss of the species affect you and/or your whanau/community?’, M. Little pointed out that the loss of the kanakana would result in the loss of a fragment of the Māori culture, this is reinforced by the response from R. Parata which says ‘We would lose a traditional food source and would be damaging to wairua’. The kanakana is a traditional food source that was originally harvested by Māori which sustained communities, it has been a part of Māori Mātauranga and customs for many generations, therefore is a major role in theri culture.

In summary, the Taiao Freshwater team emphasised that there is personal and cultural significance of the kanakana species, it is a taonga species and mahika kai. Learning about the kanakana often occurs through familial oral tradition, showing that there is a reliance on ancestral knowledge. The loss of the species is seen as a threat to Māori culture as it is a significant part of their identity. In order to protect the kanakana, there needs to be education around the importance of the species and increased restoration efforts from the community.

3.4 Mataura Falls Mātaitai

Figure 2

Mataura River Mātaitai



Note: Mataitai is shown in red. From Mataura River Mātaitai by the Ministry for Primary Industries (n.d.).

Mātaitai reserves were created as a management tool for Māori to protect their traditional fishing grounds in part nine of the Fisheries Act 1996, the purpose is to ensure that there are resources available for customary food gathering by Tangata whenua. A Tangata Tiaki(guardian) from the local iwi or hapū is allocated to manage the gathering of fish within the mātaitai. In the Fisheries (South Island Customary Fishing) Regulations 1999, it declares that a mātaitai may be established if there is a special relationship between the tangata whenua and the body of water, such as it being identified as a traditional fishing ground. It indicates that tangata whenua may apply to Ministry of Primary Industries to establish a mātaitai.

The Mataura River is an important mahika kai for Kai Tahu, it contains taonga species such as kanakana and tuna (eels). The Mataura Mātaitai was the first freshwater mātaitai to be established in 2006 and spans about 10km. The northern boundary is about 1.7 km up River road from the

entrance off Old Coach Road and the southern boundary 1 km downstream from Shanks Road, shown in figure 2. The Hokonui Rūnanga is the tangata tiaki of the Mataura Mātaitai and therefore are heavily involved in the protection and research of the area. The Mataura mātaitai restricts people from taking lamprey, Longfin or shortfin eel, but permission may be granted by the Tangata kaitiaki to take fish from the mātaitai (Ministry for Primary Industries, n.d.).

3.5 Kanakana Harvesting

Kanakana are harvested at the Velasia (adult) life stage, this is when they are transitioning from saltwater to freshwater as they migrate up the river, at this stage they are at their most optimum length and weight. The kanakana runs occur earlier in the North island then the South Island and therefore are harvested earlier in the north. In the South Island migration can occur from July to December (Jellyman et al., 2009, Maskell, 1929).

Harvesting at the Mataura falls traditionally occurs around October and November, because it was a highly sought after resource in the early 1900's, only certain hapū could harvest from the falls and they each had a dedicated fishing spot which was passed down from their ancestors (Beattie, 1920). Kanakana are still consumed today in many parts of the country. Depending on location, harvesting methods can vary due to the characteristics of the river and resources available. There are many methods, past and present, which are used to harvest kanakana, some include hand picking off rocks, using a pole with an eel hook, using a net or building a weir (wooden and stone) (Kitson et al., 2012).

4.0 Conservation

4.1 Decline of population

The conservation status of the Lamprey in New Zealand is considered 'Threatened - Nationally Vulnerable' by the Department of Conservation, which means the kanakana is at high risk of extinction in the medium term. The category a species is allocated to is assessed by certain factors such as the current population size, decline in population in the past and is the population stable (Department of Conservation, n.d.) Although the kanakana is a very difficult population to manage and observe, there has been a noticeable decline over the past decade. In a report by Hokonui Rūnanga Taiao, they compare their monitoring results in the Mataura River with other data collected 11 years prior by the University of Otago. In 2010, over the kanakana migration period there were a total of 2000 sighted, whereas 47 sighted in 2021 and 53 in 2022, suggesting a drastic decline (Hokonui Rūnanga Kaupapa Taiao, 2023).

4.2 Lamprey Reddening Syndrome (LRS)

LRS is characterised as reddening along the gills, fins, and body and results in the death of the lamprey, similar symptoms are seen in Australian pouch lamprey with haemorrhagic septicaemia which is caused by infectious agents, but there is no correlations between the two (Miller et al., 2023). LRS was first observed back in 2011 due to a mass mortality event in rivers throughout New Zealand, during the testing of the cause, the bacteria *Aeromonas salmonicida* was isolated from the lamprey and deemed a potential cause. Since the 2011 testing, LRS has been reported multiple times, but there was no indication of the bacteria *Aeromonas salmonicida,* therefore it has been ruled as an incidental finding (Brosnahan et al., 2018). LRS is still currently prevalent with no known cause, cases are sporadic and have only been reported in the South Island (Miller et al., 2023).

4.3 Threats and obstacles

Mataura falls and weir

Both the Falls and the weir are barriers that the kanakana have to pass in order to migrate up the Mataura River and to their nesting site. The falls is a natural barrier which has been heavily modified due to industrialisation such as the establishment of the Mataura Paper Mill in 1876 and the Mataura Freezing Works in 1893, shown in figure 4 (Gore District Council. n.d.). The Falls and River have been drastically narrowed, reducing the paths that kanakana get up, there is also an increased flow of water down the remaining channel. The U-shaped weir is a man made barrier which was believed to be constructed in the 1920s or 1930s. The purpose of the weir is to divert water into two hydro races on either side of the river (Richardson, 2019). Shown in figure 3, the

unnatural design of the weir is an obstacle for the kanakana as there is a strong flow and minimal objects for them to attach to.

Figure 3

Downstream View of Weir

Note: From Use of the Mataura River Weir to dam and divert water by Alliance Group Limited (Richardson, 2019)

Note: Taken by Ariana Drabble

Predators

As kanakana migrate down and up the river and while at sea, they face numerous threats from predators. In fresh water rivers, young larvae and ammocoetes encounter predators such as trout, eels and other large fish which feed on them (NIWA, 2021b). While specific predators in the ocean remain unidentified, a study on a northern hemisphere lamprey species (*Petromyzon marinus*) and its predation rate in the ocean, showed that 80% of the lamprey they tagged and released into the ocean was consumed within a month (Boulêtreau et al., 2020). There have been accounts that seals and tuna have preyed upon kanakana in the ocean suggesting they are a predator (NIWA, 2021). As the kanakana return to the river as an adult, there are predators such as gulls and shags which pluck them off the rocks.

Habitat alteration

Prior to colonisation of New Zealand, it has been estimated that 450,000 ha of Southland land was freshwater wetlands, as of 2008, there is 47,000 ha of wetland, 10.8% left of the original estimate (Ausseil et al., 2008). The large difference in the amount of wetland over two centuries suggests that there has been major changes to habitats in the waterways in a short period of time. The major cause for the loss of wetland is to convert it into high producing grassland for agriculture purposes. Converting the land required drainage and removal of riparian vegetation, which destroyed the habitats for many freshwater species including kanakana (Robertson et al., 2018). As wetland was converted to farmland, dams, culverts, floodgates and stop banks were built in the remaining waterways, creating more barriers for the migrating species (NIWA, 2021).

Water quality

Water quality is influenced by several factors, including nutrient concentrations, temperature, sediment levels, and microbial presence. In freshwater ecosystems, the abundance and diversity of macroinvertebrates is crucial for the diet of freshwater species, but depends on the water quality. Dissolved oxygen, produced by algae and plants, is vital for aquatic life. Temperature variation can impact the growth, reproduction and survival of species. Excessive sediment can also affect the macroinvertebrates by smothering their habitat (Goldsmith et al., 2013).

Water quality data collected by Environment Southland (Southland Regional Council) shows that there is a range of water quality all along the Mataura River.

4.4 Conservation efforts

Bioheritage National Science Challenge - Fresh water for our Taonga programme

This collaborative project focuses on the health of tuna and kanakana/piharau in two different rohe in order to reverse the decline. There is collaboration between Waikato/Waipa Catchment river iwi, Hokonui Rūnanga, Kitson Consulting and University of Canterbury. It is Te Tiriti led research which overall aims to enhance and restore the freshwater rivers and the species which inhabit them.

Part of the research involved Hokonui Rūnanga kaimahi, Riki Parata and Mollie Lyders along with Kāi Tahu scientist, Dr Matthew Wylie, travelling to America to exchange knowledge of the kanakana with the First Nations People. There has also been wānanga on the Kanakana/piharau, to share knowledge between scientists and iwi about restoration mahi that is taking place, specifically in the Waiwhakaiho River.

Hokonui Rūnanga

Kaupapa Taiao within the Rūnanga has multiple freshwater projects including kanakana monitoring during the seasonal migration from August to December. This includes analysing the Alliance Hydro Scheme adjacent to the falls, and its effect on migrating Kanakana. Recently they have received approval for the trap and transfer of kanakana, to help them pass the falls and weir. Their aims involve investigating surrounding rivers and streams which flow into the Mataura River to find ammocoetes and to eventually determine spawning locations (Hokonui Rūnanga, n.d.).

NIWA

A research project was conducted and led by Dr Cindy Baker from NIWA, in order to understand the abundance, distribution, timing of spawning and location of spawning. This project was to help better understand the kanakana behaviour and to address some of the knowledge gaps. The results from this research showed that during migration, kanakana preferred to migrate towards larvae as well as pheromones. Spawning sites were also discovered in the Okuti River Catchment on Banks Peninsula (NIWA, 2021). Another project by NIWA was to make artificial spawning nests which were placed in the Waikawa River in Southland. These nests will hopefully give the kanakana an ideal place to spawn and if they choose to nest in there, scientists will be able to monitor and study the nesting period to better understand it (NIWA, 2019)

5.0 Narrative

The narrative is called ‘Kanakana: the pouched lamprey, a taonga species’, it is written by myself and illustrated by myself with the help of Jade Watkin who provided the drawings of the kanakana. The narrative can be found in appendix 2.

5.1 Purpose of Narrative

The purpose of the narrative is to give the kanakana a voice and to inform and educate people around Gore, Southland and even across New Zealand of its history and importance to Kāi Tahu. There is a lack of resources to inform the public about the kanakana, its cultural importance and the challenges it faces. Written from the perspective of the kanakana, the narrative highlights the unique lifecycle and struggles and barriers it faces when migrating up the Mataura River. Through interviewing the Hokonui Rūnanga freshwater team, I became aware that knowledge of the kanakana was very limited, as the people who work closest with them knew very little of the species until working for the Rūnanga. Therefore a narrative will potentially avoid this issue by giving information about the basic biology, reasons for the decline in the population numbers and the restoration needs required in order to save the declining species.

5.2 Target audience

The narrative I have designed is aimed towards primary school children around the ages of 10-12, but it can be useful for older ages and even adults. I chose this age group due to the sophisticated and scientific vocabulary needed when describing the kanakana and its story. The struggles and challenges of the kanakana as well as the conservation efforts can be difficult concepts for younger children to understand. By choosing a specific age group, the content can be engaging and educational with a balance between meaningful information and maintaining the attention of the audience. By learning about the kanakana from a young age, this lays the foundations for understanding the species and its cultural significance. If the kanakana is encountered later on in life then it can become a more enriching experience as there is already background understanding of the species.

5.3 Format of Narrative

Many formats of the narrative were considered, such as a poster, article and childrens book. A poster can include test, diagrams, graphs and pictures but is usually confined to an A4 or A3 sized piece of paper and only contains about 300-800 words. This format would be too small to convey

information that is likely to be new to many people, therefore not a good choice for this project (NYU Libraries, n.d.). A children's book is usually 32 pages long and has 500 to 1000 words, although this is an ideal amount of words, the writing and illustration requirements exceeded my abilities with the time constraints I had of 12 weeks. The format I decided on was a 6 page article, this allows for the essential information to be included and completed within a short period of time. An article focuses on one specific topic and conveys it in a concise manner. It can be more accessible than other formats and can easily be accessed online. The article has written paragraphs, images and illustrations, as it will help display the information in a more effective way while keeping the children's attention and interest.

6.0 Discussion

It is clear that the kanakana is an unknown species to majority of the general public. Although there are many scientific papers exploring the kanakana lifecycle and behaviour, very little is targeted at the public. It is a taonga species with major significance to Māori culture, but its population decline threatens the mauri(life force) and mana(authority) of Māori and their culture. To inform the public of the kanakana, a narrative must be produced to convey the information in an effective and easy way for people to understand.

A narrative has the ability to create a personal connection between the reader and the topic of the kanakana, it can motivate others to take action and support the conservation efforts. It is also a way to share and conserve the Mātauranga Māori around the species by incorporating the traditional knowledge. It is a powerful solution to raise awareness and create understanding of the environmental and conservation issues with the kanakana.

For the narrative to succeed in its purpose, it would need to be taken on by schools and integrated into their curricula. Without schools participation, it would be too difficult to get the information to the intended audience as at that age there would be no other platform to convey the information. A research unit with the focus of the kanakana could be an effective way to get exposure needed. Furthermore, an interactive session would be more effective, such as people working on the restoration talking to the students, or a field trip for students to see the rivers, habitat and potentially the kanakana, if possible.

Although the narrative is a tool to help promote restoration and engage people with the conservation efforts, it is the person's decision whether or not to take onboard the information and make the necessary changes to help the species. By making public sources, it is not an instant solution and requires more encouragement from people and iwi directly working on the restoration of the species.

The difficulty of targeting the narrative at multiple audiences means that it had to be targeted at one specific group, in this case, primary school children. In doing this, the narrative may not be read or accessed by others in the community such as adults or teenagers. Another audience that could potentially be beneficial to target is the farmers and property owners who have the Mataura River flowing through or beside their property. This could encourage them to be cautious about the river's health and how their property may be affecting it. In doing this, the format and the information in the narrative would have to be changed to target other communities, which would take much time and effort.

In conclusion, the narrative created serves as a tool to bridge scientific knowledge and public awareness. The narrative brings the life cycle, cultural importance and struggles to the attention of the reader to form a deeper understanding of the species, specifically primary school students. Despite its status as a taonga species to the Māori, it remains a relatively unknown species to the wider population. This narrative sets the groundwork for future generations to develop a connection with the species and the importance of its conservation. It is a crucial step in raising awareness for not only the kanakana but the freshwater ecosystems which support many species.

Appendices

Appendix 1

Interview Transcript from the Taiao Freshwater Team
Interviewee's: Riki Parata, Tāne Tamiti, LukaFinn, Mikey Little, Hannah Thorburn, Mollie Lyders
Interviewer: A. Drabble
Location: Hokonui Rūnanga, Gore
Date: Dec 14/15th 2023
List of Acronyms: IN = Interviewer, RP = Riki Parata, TT = Tāne Tamati, LF= Luka Finn, HT = Hannah Thorburn, ML = Mikey Little, MLY = Mollie Lyders.

IN: What does the kanakana species mean to you personally?'

RP: They are tradition, and sustain a culture, a taonga and mahinga kai species, It is our duty as a kaitiaki, using the true sense of the word, the word has been taken up by non Māori, the true meaning it to guard, to protect and to enhance, the role can only be passed down through whakapapa. Can't forget the true meaning of it.

TT: Mahinga kai.

IN: When did you first learn about the kanakana?

HT: 4 months ago.

RP: Since childhood.

ML: I knew of the lamprey as a child but not that New Zealand had them.

LF: Since a kid, grandparents had told me about them, but I didn't see them until working here

TT: I knew as a kid, but I didn't see them since working here, and I learnt about it at University (geology).

MLY: As a kid, I had eaten them and tried them, and I had heard nana talk about them. I knew they were different to eels but I didn't know much at all.

IN: What is the significance of the kanakana to the Hokonui Rūnanga?

RP: Significance to tangata whenua, it is sustenance to sustain a culture, the Hokonui Rūnanga membership is the tangata whenua, and those that work for the Hokonui Rūnanga represents the tangata whenua.

TT: Whakapapa, we are them and they are us.

ML: They have been around for so long, and survived so much.

MYL: It's all as one, species, land and people.

IN: Would the loss of the species affect you and/or your whanau/community?

ML: Yes, would lose a fragment of a culture.

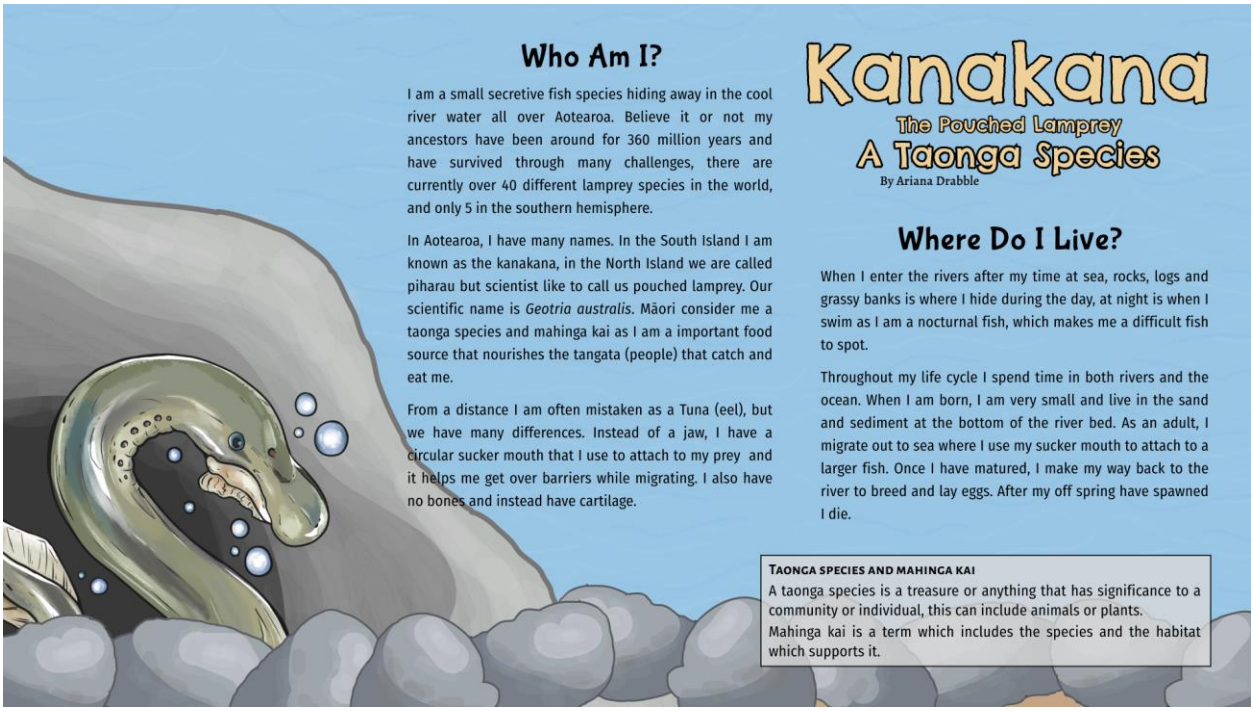
TT: We have already lost so much, (such as) the ability to go out and harvest.

RP: We would lose a traditional food source and would be damaging to wairua.

MYL: Yes, they are a prehistoric species.

Appendix 2

Narrative of Kanakana



Kanakana

The Pouched Lamprey
A Taonga Species

By Ariana Drabble

Who Am I?

I am a small secretive fish species hiding away in the cool river water all over Aotearoa. Believe it or not my ancestors have been around for 360 million years and have survived through many challenges, there are currently over 40 different lamprey species in the world, and only 5 in the southern hemisphere.

In Aotearoa, I have many names. In the South Island I am known as the kanakana, in the North Island we are called piharau but scientist like to call us pouched lamprey. Our scientific name is *Geotria australis*. Māori consider me a taonga species and mahinga kai as I am a important food source that nourishes the tangata (people) that catch and eat me.

From a distance I am often mistaken as a Tuna (eel), but we have many differences. Instead of a jaw, I have a circular sucker mouth that I use to attach to my prey and it helps me get over barriers while migrating. I also have no bones and instead have cartilage.

Where Do I Live?

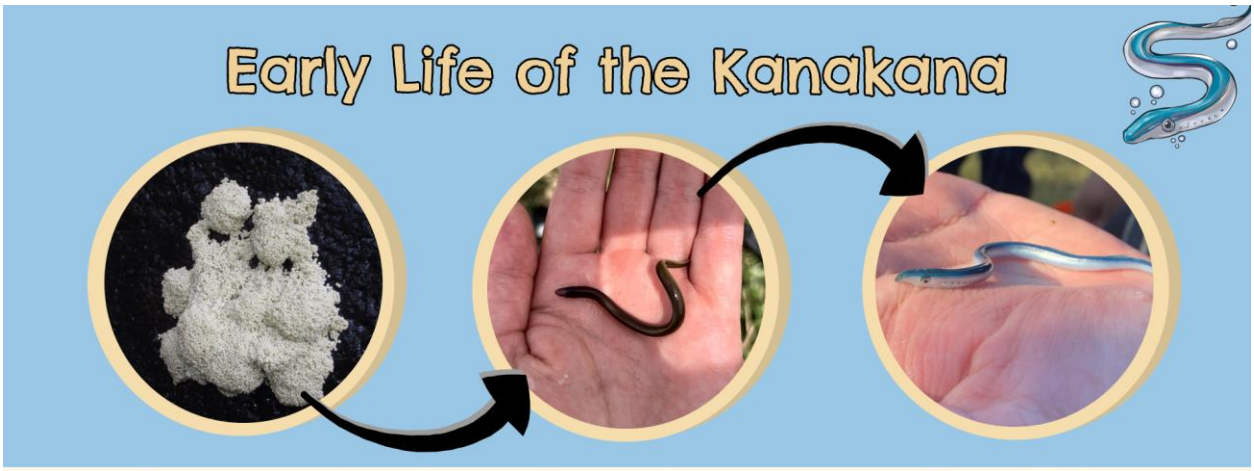
When I enter the rivers after my time at sea, rocks, logs and grassy banks is where I hide during the day, at night is when I swim as I am a nocturnal fish, which makes me a difficult fish to spot.

Throughout my life cycle I spend time in both rivers and the ocean. When I am born, I am very small and live in the sand and sediment at the bottom of the river bed. As an adult, I migrate out to sea where I use my sucker mouth to attach to a larger fish. Once I have matured, I make my way back to the river to breed and lay eggs. After my off spring have spawned I die.

TAONGA SPECIES AND MAHINGA KAI

A taonga species is a treasure or anything that has significance to a community or individual, this can include animals or plants.

Mahinga kai is a term which includes the species and the habitat which supports it.



Early Life of the Kanakana

Spawning nest

First, my egg along with thousands of other eggs are layed under boulders or in burrows to keep us hidden. When we hatch we stay attached to the boulder for approximately 3 weeks. During this time, my mother and father stay to protect the nest from predators and die shortly after hatching.

Ammocoetes

(am-o-seets)

Next, I grow into juvenile kanakana called ammocoetes and live in the sand and sediment of the rivers to hide from predators. The colour of my body is brown to help me blend in. Filter feeding algae and other small particles is how I gain nutrients to grow. This stage of my life cycle lasts for 3.25 to 4.25 years.

Macrophthalmia

(Mac-rof-thal-mi-a)

After, I change over 7 months into a macrophthalmia, also called a miniature adult. My back changes to a bright blue colour with silver underneath. Development of my eyes and circular sucker mouth occurs and I grow up to 12 cm in length. I begin migration down the river and into the ocean

Life at Sea

My time at sea is still a mystery to many as I am difficult to find. I spend about 3 to 4 years of my life out in salty ocean. During this time, my long blue body grows up to 75 cm long and I will eventually become a Velasia (Adult).

Velasia (Adult)

I become an adult as I enter the freshwater river for migration after my time at sea. Maturation occurs over the next 14 to 16 months and during this time I stop eating. Instead I use all my stored energy and shrink in size. My bright blue colour changes to a dark brown. When we reach sexual maturity, a male develops a pouch under his head and the females develops a ridge above the first dorsal fin.

Predators

Predators are a big threat to us as we migrate up and down the river and while at sea. Both marine animals and birds like to feed on us.

Way out to sea

When migrating out I am quite small and am an ideal food source for other fresh water fish. Predators include trout and eels.

While at sea

At sea, my predators tends to be larger marine animals such as seals and tuna fish. Gulls and shags also like to feed on us.

What do I feed on?

Previously I have been known as a vampire fish. This is because I parasitically feed on the flesh and blood of larger marine animals in the ocean, such as larger fish and even whales. My sucker mouth is used to attach to my prey and allows me to hold on for a long period of time.

Migration up the River

Challenges of Migration

Harvesting

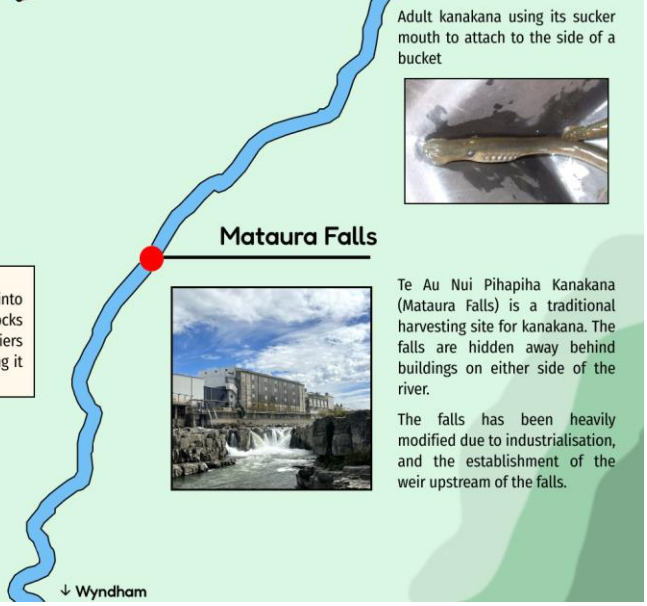
For hundreds of years, Māori have harvested us, cooked us up and eaten us to nourish the tangata whenua (people of the land). We are harvested by being plucked off the rocks and waterfalls we are trying to get over. At Mataura falls we are harvested in the months of October and November. This could potentially impact the amount of offspring we produce if our population numbers become very low

Habitat alteration

Due to the large amount of wetland in Southland being turned into farmland, we have lost a lot of our natural habitat. We have less trees, rocks and logs to hide under and build our nest. During alterations, other barriers are put into the river such as dams, flood gates and stop banks, making it more difficult for us to get upstream.

Mataura falls Weir

A weir is a type of dam which alters the flow of the water, in this case the water is diverted to the sides of the river and into a channels, leaving the center of the river with low water levels. For us, it is difficult to get over the weir due to its design and not many places for us to attach our sucker mouth to.



Adult kanakana using its sucker mouth to attach to the side of a bucket

Te Au Nui Pihapiha Kanakana (Mataura Falls) is a traditional harvesting site for kanakana. The falls are hidden away behind buildings on either side of the river.

The falls has been heavily modified due to industrialisation, and the establishment of the weir upstream of the falls.

Conservation Efforts

Bioheritage National Science challenge

Bioheritage run a programme called Fresh water for our Taonga. It is a collaborative project which focuses on the health of tuna (eel) and kanakana/piharau. Its overall aim is to enhance and restore freshwater rivers and the species which inhabit them. The research is led by Māori and incorporates traditional knowledge.

Hokonui Rūnanga

The Hokonui Rūnanga Taiao Freshwater team have multiple fresh water projects including kanakana monitoring. The purpose of this monitoring is to observe weather they are making it past the man made barriers put into the Mataura River such as the weir, and seeing if they are actively migrating to rivers and streams that run into the Mataura River.

NIWA

NIWA has taken on research projects to help fill in the knowledge gaps. Studies were conducted to help understand kanakana abundance, distribution and spawning location. They also designed and installed artificial nesting habitats to encourage kanakana to nest in a specific location. If successful, the nesting process will be studied.

What can you do?

Rivers and streams are amazing places where many fun activities take place. People go to rivers to to swim, fish, go boating or even just to look at. It is important that every time you go to a river or stream to remember that it is not only our home but home for many other creatures. The waterways need to be kept natural and clean for us to keep living there.

Things to do when around a waterway

- **Take your rubbish with you and pick up any you see on the ground or in the water**
- **Leave the rocks, trees, bushes and logs as they were in the river or on the bank**
- **If gathering kai(food), stay within the limits**

Other ways to help would be getting involved with conservation efforts. This can be done in many different ways such at joining a river clean up project or a tree planting project. This can improve the water quality and habitat in the river to help the species thrive.

Written By Ariana Drabble

Illustrations:
Drawings of kanakana by Jade Watkin
Backgrounds by Ariana Drabble

Images:
Page 2 left by Cindy baker
Page 2 middle by Ariana Drabble
Page 2 right by Mollie Lyders
Page 4 Top by Andrew Thomas
Page 4 bottom by Ariana Drabble

Glossary

Cartilage - A tough, flexible tissue that gives structure in the body

Industrialisation - the process of developing buildings and machines to do jobs traditionally done by people.

Juvenile - not physically mature

Nocturnal - active at night

Parasite - an organism which feeds off of a host organism

Sediment - solid material that settles at the bottom of a liquid

Additional Resources and References

NIWA: Taonga species series: Piharau https://niwa.co.nz/te-kuwaha/piharau

Bioheritage National Science Challenge: Freshwater for our Taonga https://bioheritage.nz/research/freshwater-for-our-taonga/

Hokonui Rūnanga Taiao: Kanakana monitoring https://hokonuitaiao.org.nz/sample-page/fresh-water-mahi/kanakana-monitoring/

References

Ausseil, A.-G., Gerbeaux, P., Chadderton, W. L., Stephens, T., Brown, D., & Leathwick, J. (2008). Wetland ecosystems of national importance for biodiversity: Criteria, methods and candidate list of nationally important inland wetlands.

Baker, C. F., Jellyman, D. J., Reeve, K., Crow, S., Stewart, M., Buchinger, T., & Li, W. (2017). First observations of spawning nests in the pouched lamprey (*geotria australis*). *Canadian Journal of Fisheries and Aquatic Sciences*, *74*(10), 1603–1611. https://doi.org/10.1139/cjfas-2016-0292

Baker, C. F., Rossi, C. R., Quiroga, P., White, E., Williams, P., Kitson, J., Bice, C. M., Renaud, C. B., Potter, I., Neira, F. J., & Baigún, C. (2021). Morphometric and physical characteristics distinguishing adult patagonian lamprey, geotria macrostoma from the pouched lamprey, geotria australis. *PLOS ONE*, *16*(5). https://doi.org/10.1371/journal.pone.0250601

Baker , C. (n.d.). *Kanakana: Sniffing out a place to spawn*. NIWA. https://www.niwa.co.nz/sites/default/files/niwa_2013_kanakana_research.pdf

Beattie, H. (1920). Nature-lore of the southern Māori. In *Transactions and Proceedings of the New Zealand Institute* (pp. 53–77). essay, M.F. Marks.

Boulêtreau, S., Carry, L., Meyer, E., Filloux, D., Menchi, O., Mataix, V., & Santoul, F. (2020). High predation of native sea lamprey during spawning migration. *Scientific Reports*, *10*(1). https://doi.org/10.1038/s41598-020-62916-w

Brosnahan, C. L., Pande, A., Keeling, S. E., van Andel, M., & Jones, J. B. (2018). Lamprey (*geotria australis*; Agnatha) reddening syndrome in Southland Rivers, New Zealand 2011–2013: Laboratory findings and epidemiology, including the incidental detection of an atypical *aeromonas salmonicida*. *New Zealand Journal of Marine and Freshwater Research*, *53*(3), 416–436. https://doi.org/10.1080/00288330.2018.1556167

Department of Conservation. (n.d.). *Conservation status of plants and animals*. Nature. https://www.doc.govt.nz/nature/conservation-status/

Docker, M. F., & Potter, I. C. (2019). Life history evolution in lampreys: Alternative migratory and feeding types. *Lampreys: Biology, Conservation and Control*, 287–409. https://doi.org/10.1007/978-94-024-1684-8_4

Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., Griffiths, M., Jack, D. C., Ling, N., Waters, J. M., & Rolfe, J. R. (2018). *Conservation status of New Zealand freshwater fishes.* https://www.doc.govt.nz/Documents/science-and-technical/nztcs24entire.pdf

Environment Canterbury. (2018). *Mahinga Kai: A guide for rural consultants and auditors*. Environment Canterbury Regional Council.

Environment Southland. (n.d.). *Environmental monitoring data for Mataura River*. Land, Air, Water Aotearoa (LAWA). https://www.lawa.org.nz/explore-data/southland-region/river-quality/Mataura-river/

Fisheries Act 1996 (N.Z.)

Fisheries (South Island Customary Fishing) Regulations 1999 (N.Z.)

Freshwater mahi. Taiao. (n.d.). https://hokonuitaiao.org.nz/sample-page/fresh-water-mahi/

Goldsmith, R., Olsen, D., & Ryder, G. (2013). Environmental Effects of Activities within the Riparian Zone: Technical Review. Prepared for Environment Southland by Ryder Consulting.

Gore District Council. (n.d.). *Mataura*. Mataura - Gore New Zealand. https://www.gorenz.com/our-stories/our-towns/Mataura

Hatcher, J. B., Scott, W. B., Stejneger, L., & Eigenmann, C. H. (1903). part III. In *Reports of the Princeton University Expeditions to Patagonia, 1896-1899: Princeton University Expeditions to Patagonia, 1896-1899* (pp. 232–234). essay.

Hokonui Rūnanga Kaupapa Taiao. (2023). *Kanakana (Lamprey - Geotria australis) Monitoring Results Report at Te Au-Nui Pihapiha Kanakana (Mataura Falls) 2022.* Report to Alliance Group Limited. Hokonui Rūnanga; Gore, New Zealand.

Hokonui Rūnanga. (n.d.). https://www.hokonuirunanga.org.nz/

Hudson, M., Thompson, A., Wilcox, P., Mika, J. P., Battershill, C., Stott, M., Brooks, R. T., & Warbrick, L. (2021). *Te Nohonga kaitiaki guidelines for genomic research on Taonga Species (with background)*. University of Waikato.

James, A. (2008). *Ecology of the New Zealand lamprey (geotria australis): A literature review*. Dept. of Conservation, Wanganui Conservancy.

Janvier, P. (2007). Living primitive fishes and fishes from deep time. *Fish Physiology*, 1–51. https://doi.org/10.1016/s1546-5098(07)26001-7

Jellyman, D. J., Glova, G. J., & Sykes, J. R. (2002). Movements and habitats of adult lamprey (*geotria australis)*in two New Zealand waterways. *New Zealand Journal of Marine and Freshwater Research*, *36*(1), 53–65. https://doi.org/10.1080/00288330.2002.9517070

Jellyman, D., Bonnett, M., Crow, S., & Anglem, R. (2009). *Mahika Kai Survey of the Mataura River Mātaitai Reserve*.

Kawharu, H. (1988). Appendix IV. In *Report of the Royal Commission on social policy* (Vol. 2). essay, The Commission.

Kelso, J., & Glova, G. (1993). Distribution, upstream migration and habitat selection of maturing lampreys, geotria australis, in Pigeon Bay Stream, New Zealand. *Marine and Freshwater Research*, *44*(5), 749. https://doi.org/10.1071/mf9930749

Kitson, J. C., Cain, A. M., Johnstone, M. N., Anglem, R., Davis, J., Grey, M., Kaio, A., Blair, S.-R., & Whaanga, D. (2018). *Murihiku Cultural Water Classification system: Enduring partnerships between people, disciplines and Knowledge Systems*. New Zealand Journal of Marine and Freshwater Research, 52(4), 511–525. https://doi.org/10.1080/00288330.2018.1506485

Kitson, J., Leith, V., Whaanga, D., et al. (2012). Kanakana Harvest Mātauranga: Potential tools to monitor population trends on the Waikawa River, Southland/Murihiku (a scoping project). Te Ao Mārama Inc., New Zealand.

Maskell, F. G. (1929). *On the New Zealand lamprey, geotria australis, gray*.

Miller, A. K., Brosnahan, C. L., Pande, A., Baker, C. F., Geoghegan, J. L., Kitson, J., Gemmell, N. J., & Dowle, E. J. (2023). Formalin-fixed paraffin-embedded (ffpe) samples help to investigate

transcriptomic responses in wildlife disease. *Molecular Ecology Resources*. https://doi.org/10.1111/1755-0998.13805

Miller, A. K., Timoshevskaya, N., Smith, J. J., Gillum, J., Sharif, S., Clarke, S., Baker, C., Kitson, J., Gemmell, N. J., & Alexander, A. (2022a). Population Genomics of New Zealand pouched lamprey (Kanakana; piharau;*geotria australis*). *Journal of Heredity*, *113*(4), 380–397. https://doi.org/10.1093/jhered/esac014

Miller, A. K. (2022b). Genomics of pouched lampreys (Geotriidae) for improved management (Doctoral dissertation). University of Otago, Te Whare Wānanga o Ōtākou, Dunedin, New Zealand.

Ministry for Primary Industries. (n.d.). *Mataura River Mātaitai*. https://www.mpi.govt.nz/dmsdocument/930-Mataura-River-mātaitai-Recreational-Fishing-Rules

Neira, F. J., Bradley, J. S., Potter, I. C., & Hilliard, R. W. (1988). Morphological variation among widely dispersed larval populations of anadromous southern hemisphere lampreys (Geotriidae and Mordaciidae). *Zoological Journal of the Linnean Society*, *92*(4), 383–408. https://doi.org/10.1111/j.1096-3642.1988.tb01730.x

Ngāi Tahu Claims Settlement Act 1998 (N.Z.) section 167

NIWA. (2019). *Scientists help lamprey to spread the Love*. https://niwa.co.nz/news/scientists-help-lamprey-to-spread-the-love

NIWA. (2021). *Taonga species series: Piharau*. https://niwa.co.nz/te-kuwaha/piharau

NYU Libraries. (n.d.). *Poster Basics*. How to Create a Research Poster - Research Guides at New York University. https://guides.nyu.edu/posters

Papatipu Rūnanga. Te Rūnanga o Ngāi Tahu. (n.d.). https://ngaitahu.iwi.nz/ngai-tahu/papatipu-runanga/

Potter, H. (2022). A wai 262 best practice guide for science partnerships with Kaitiaki for research involving Taonga: Lessons from Māori voices in the New Zealand Science Sector. Rauika Māngai.

Potter, I. C., Hilliard, R. W., & Bird, D. J. (1980). Metamorphosis in the southern hemisphere lamprey, *geotria australis*. *Journal of Zoology*, *190*(3), 405–430. https://doi.org/10.1111/j.1469-7998.1980.tb01435.x

Potter, I. C., & Strahan, R. (1968). The taxonomy of the lampreys geotria and Mordacia and their distribution in Australia. *Proceedings of the Linnean Society of London*, *179*(2), 229–240. https://doi.org/10.1111/j.1095-8312.1968.tb00980.x

Reilly, M., Leoni, G., Carter, L., Duncan, S., Paterson, L., Ratima, M. T., & Rewi, P. (2018). *Te Kōparapara: An introduction to the Māori world*. Auckland University Press.

Riva-Rossi, C., Barrasso, D. A., Baker, C., Quiroga, A. P., Baigún, C., & Basso, N. G. (2020). Revalidation of the Argentinian pouched lamprey Geotria Macrostoma (Burmeister, 1868) with molecular and morphological evidence. *PLOS ONE*, *15*(5). https://doi.org/10.1371/journal.pone.0233792

Richardson, D. (2019). *Use of Mataura River Weir to Dam and Divert Water* [Resource Consent Applications and Assessment of Environmental Effects] Alliance Group Limited 3. Application Alliance Mataura Re-Consenting Application Weir Dam and Diversion.pdf. Environmental Protection Authority. https://www.es.govt.nz/documents/alliance-Mataura-re-consenting-application/Weir-Dam-and-Diversion.pdf

Robertson, H., Ausseil, A.-G., Rance, B., Betts, H., & Pomeroy, E. (2018). Loss of wetlands since 1990 in Southland, New Zealand. New Zealand Journal of Ecology. https://doi.org/10.20417/nzjecol.43.3

Strickland, R. R. (1990). *Nga tini a Tangaroa: a Māori-English, English-Māori dictionary of fish names*. MFA Fisheries.

Taiuru, K. (2022). *Tikanga tawhito tikanga hou kaitiaki guidelines for DNA research, storage and seed banks with taonga materials*. karaitiana Taiuru.

Thompson, W. L., White, G. C., & Gowan, C. (1998). *Monitoring vertebrate populations*. Academic Press.

Waitangi Tribunal. (2011). *Ko aotearoa tenei: A report into claims concerning New Zealand law and policy affecting Māori culture and identity. Te Taumata Tuarua*. Legislation Direct.

Williams, E., Crow, S., Murchie, A., Tipa, G., Egan, E., Kitson, J., Clearwater, S., & Fenwick, M. (2017). *Understanding Taonga Freshwater Fish Populations in Aotearoa-New Zealand*.