Earth Sciences New Zealand

Ngaa taonga tuku iho o ngaa roto o Tahaaroa

Ngaa Parenga Aroturuki Wai
Tahaaroa Catchment Monitoring Plan

Prepared for Tahaaroa Lakes Trust

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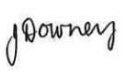	Formatting checked by:	Jo Downey
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Overview:

This report, Ngaa taonga tuku iho o ngaa roto o Tahaaroa, presents the findings of recent monitoring and research undertaken through the partnership between the Tahaaroa Lakes Trust, Earth Sciences New Zealand (ESNZ formerly NIWA), and The Stream, supported by the participation of Ngaati Mahuta ki te Hauaauru (Ngaati Mahuta).

It provides a comprehensive assessment of the ecological and cultural health of the Tahaaroa lake system: Tahaaroa, Numiti, and Rotoroa; and establishes the foundation for a long-term, hapuu-led catchment monitoring plan.

The work combines maatauranga Maaori, tikanga-based indicators, and scientific data to form a holistic understanding of the state and trends of these taonga. It reflects the Trust's ongoing commitment to restoring the mauri of the roto and reaffirming mana whakahaere for future generations.

Vision:

"E rere ana ngaa wai o ngaa roto o Tahaaroa hei oranga moo te roto, moo ngaa koiora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru." The waters of the Tahaaroa lakes flow to sustain the lake, the land, the environment, the people, and future generations of Ngaati Mahuta ki te Hauaauru.

This vision underpins every aspect of the monitoring programme. It recognises that the wellbeing of people and the environment are inseparable, and that the health of the roto reflects the health of the hapuu.

Key Findings:

Ecological Condition

- Tuna populations show signs of stress and ageing, with slower growth rates and high parasite loads indicating habitat and water-quality pressures.
- Kaiaua are declining in both abundance and shell condition, often smothered by sediment and algae.
- Tupu wai communities are dominated by invasive *Lagarosiphon major*, with native charophytes restricted to shallow, sheltered areas.
- Water quality data confirm elevated nutrient levels and reduced water clarity, consistent with eutrophic conditions.
- These combined pressures have reduced habitat diversity and resilience, although remnant native vegetation and healthy kaiaua beds remain as ecological strongholds.

Cultural and Tikanga Indicators

- Whaanau observations record the loss of traditional tohu such as deep-water visibility, abundance of juvenile tuna and kaiaua, and seasonal cues aligned to the maramataka.
- Despite these changes, tikanga indicators identify remaining signs of mauri, including areas where native vegetation persists and healthy tuna continue to move through traditional pathways.
- Kupu whakarite such as tuna waha haumaru, kaiaua piritahi, and kaawau pukukai express ecological truths through cultural metaphor and remain integral to how lake health is understood and communicated.

Pressures and Change:

- The dominant drivers of decline include invasive weeds, sediment and nutrient inputs, bird-mediated enrichment, and the cumulative effects of land use.
- Emerging pressures linked to climate change such as warmer water temperatures and altered rainfall patterns are likely to amplify these challenges in the future.

He Anga Aroturuki Wai Maaori – Monitoring Framework:

The Trust has adopted He Anga Aroturuki Wai Maaori as the guiding framework for the catchment monitoring plan. It weaves together three pou: Pou Taiao, Pou Taangata, and Pou Taawhirimaatea with six hau known as Ngaa Hau o te Hauaauru, representing kaitiakitanga, hauora, innovation, identity, unity, and wisdom.

This framework ensures that monitoring reflects both cultural values and scientific rigour. It grounds assessment in tikanga, ensuring that mauri, whakapapa, and people remain central to how change is measured and acted upon.

Digital Tools and Innovation:

Through collaboration with The Stream and ESNZ, a suite of digital tools was co-developed to support data sovereignty and enable hapuu-led environmental monitoring:

- **Rongo** – records real-time kaitiaki observations and tikanga indicators.
- **StreamDASH** – visualises data from multiple sources on a centralised dashboard.
- **StreamMAP** – displays spatial information about sites, habitats, and pressures.
- **Tūhono** – integrates cultural and scientific data for catchment-wide analysis.

These tools allow mana whenua to collect, analyse, and report environmental data in ways that are meaningful to them, strengthening both transparency and capacity for informed decision-making.

Whaanau Priorities:

During the April 2025 waananga, whaanau identified actions, these were prioritised using an Effort-Based Framing approach. The top priorities include sediment and water sampling, hornwort delimitation surveys, hessian-matting trials for weed control, bird management, and strengthened relationships with kura, landowners, and Taharoa Ironsands Ltd.

Equally important are opportunities for tamariki participation, cultural storytelling, and intergenerational learning ensuring that restoration remains rooted in whakapapa and whanaungatanga.

Catchment Monitoring Plan – Ngaa Parenga Aroturuki Wai:

The catchment monitoring plan provides a structured pathway for ongoing monitoring, reporting, and adaptive management across the lakes and catchment.

It integrates cultural, ecological, and digital components through five key domains:

1. **Governance and Partnerships** – led by the Tahaaroa Lakes Trust under principles of mana whakahaere and co-governance.
2. **Monitoring and Research** – biannual surveys of tuna, kaiaua, and tupu wai combined with continuous water-quality logging and tikanga indicators.
3. **Restoration and Management** – riparian enhancement, bird control, and weed management at identified strongholds.
4. **Capacity and Knowledge Building** – waananga, training, and kura engagement to grow local expertise.
5. **Funding and Sustainability** – multi-year resourcing through MPI, MfE, Te Wai Māori Trust, and regional council partnerships.

Key Recommendations:

- Uphold Ngaati Mahuta's mana whakahaere as the foundation for all environmental decisions.
- Continue integrated monitoring using He Anga Aroturuki Wai Maaori and digital tools.
- Protect remaining native habitats and restore degraded zones through targeted interventions.
- Strengthen partnerships with ESNZ, WRC, and The Stream through agreements.
- Invest in whaanau capacity and succession planning to ensure intergenerational leadership.
- Secure sustainable, long-term funding to embed monitoring within the Trust's core operations.

This report affirms that the Tahaaroa lakes remain taonga tuku iho of immense cultural, ecological, and spiritual significance. While the monitoring results confirm environmental

decline, they also reveal resilience in the persistence of life, in the strength of tikanga, and in the resolve of Ngaati Mahuta to restore and protect their roto.

Through continued partnership, innovation, and whaanau leadership, the mauri of these waters will once again flow strongly sustaining the lake, the land, the taiao, the people, and the generations yet to come.

“E rere ana ngaa wai o ngaa roto o Tahaaroa hei oranga moo te roto, moo ngaa koiora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru.”

Whakarewa o ata ki runga i te hauaauru

Tii hei mauriora!

E wehi ana ki te atua

Whakahoonoretia te Arikinui

A Kuiini Nga Wai Hono i te po, Paimaarire.

E tangi tonu ana te motu i te hinganga o tana paapaa o Kiingi Tuuheitia.

Me kii, ko te Kiingi kei te rangi, ko Kuiini kei te whenua.

Haere atu e ngaa mate taaruru, whakangaro atu raa.

Taatou te hunga ora, teena hoki taatou.

Tau ana taku manu ki te karamatamata o Oorangiwhao

Titiro whakararo ko te Oohaakii, ko Te Arohanui ki runga i a Kooraha

Rere atu ki te pito o te Tahaaroa a Ruapuutahanga, ki runga Aaruka

Rewa whakateraki mai i te tara o Mangatangi ki Te Maika

Ka reetoo te ruku i moana hiinarunaru o Kaawhia

Tatuu atu ai taku manu ki Tangi-te-korowhiti, ka tau ki te Ahurei o Tainui

Ki a Hani raaua ko Puna, ko Te Ruuruhi, ko Te Tini

Ka tau taku manu ki te roro o te whare o Auaukiterangi ki runga o Maketuu

Huri huri noa ko Ngaati Mahuta ki te Hauaauru, tau, tau, tau ana e!

Teenei te whakarewanga o te aroturuki wai Maaori o Ngaa Roto o Tahaaroa

Ko Ngaa Parenga Wai Aroturuki o Tahaaroa!

Teenaa whakarongo mai ki te reo koorihi o te manu taawhiorangi

E topa ana ki ngoo koutou rekereke

Teenei te reo mihi ki ngaa ringaringa haapai, ki ngaa waewae whiikoi

Ki ngaa tuaraa hiki, ki ngaa hope whati

Ki ngaa upoko pakaru, ki ngaa whakapeto ngoi

I whakapau werawera nei ki te whakatutuki i teenei taonga kaamehameha

Teenaa koutou, teenaa koutou, teenaa raa koutou katoa.

We stand in awe of the divine.

We honour the great leader, Queen Nga Wai Hono i te poo, Paimaarire.

The nation still mourns the passing of the father of King Tuuheitia.

It is said: The King is in the heavens, and the Queen remains on Earth.

Go forth, departed spirits, and disappear beyond.

To us, the living, greetings to you all.

My bird settles on the highest peak of Oorangiwhao.

Looking down, I see Te Oohaakii and Te Arohanui upon Kooraha.

Flying out to the centre, to Tahaaroa of Ruapuutahanga, onto Aaruka.

Ascending from the tip of Mangatangi to Te Maika.

Diving deep into the rough seas of Kaawhia.

My bird finally lands at Tangi-te-korowhiti, settling at the Ahurei of Tainui.

To Hani and Puna, to Te Ruuruhi, to Te Tini.

My bird comes to rest at the entrance of the house of Auaukiterangi at Maketuu.

Turning around, surrounded by Ngaati Mahuta of the West, it settles, it settles!

This is the launch of the Tahaaroa Catchment Monitoring Plan.

It is called Ngaa Parenga Wai Aroturuki o Tahaaroa!

Listen to the melodious song of the wandering bird, Soaring at your heels.

Here is our acknowledgment to the hands that upheld,

To the feet that walked,

To the backs that carried, to the waists that bent,

To the heads that broke, to the efforts exhausted,

And to the sweat poured out in achieving this treasured taonga.

Greetings, greetings, greetings to you all.

Kupu Whakataki

Ngaa mihi nui ki a taatou katoa e whai waahi ana ki teenei kaupapa whakahira o te oranga o ngaa roto o Tahaaroa.

This Catchment Monitoring Plan has been prepared for the Tahaaroa Lakes Trust to uphold the vision:

"E rere ana ngaa wai o ngaa roto o Tahaaroa hei oranga moo te roto, moo ngaa koiora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru."

The waters of the Tahaaroa lakes flow to sustain the lake, the land, the environment, the people, and future generations of Ngaati Mahuta ki te Hauaauru.

Our lakes are living taonga, sources of sustenance, knowledge, and identity. This Plan reflects the collective aspiration of our hapuu and whaanau to restore and protect the mauri of these taonga tuku iho for the wellbeing of all who depend on them.

Through the guidance of He Anga Aroturuki Wai Maaori, the plan brings together maatauranga Maaori, tikanga, and science to form a single, integrated approach to monitoring and management. It strengthens our capacity as mana whenua to exercise kaitiakitanga and mana whakahaere, ensuring that the knowledge gathered through monitoring is owned, controlled, and interpreted by our people.

We acknowledge the partnerships that have supported this mahi particularly ESNZ, and The Stream, whose collaboration has enabled new ways of combining technology, maatauranga, and whaanau leadership. We also mihi to the kaitiaki, ruruhi, tamariki, and rangatahi who have contributed their time, insights, and energy in the field and at waananga.

This plan is a living document. It will continue to evolve as we learn, adapt, and respond to the changing needs of our roto and our people. Through shared effort and enduring commitment, we reaffirm our responsibility to ensure that the waters of Tahaaroa continue to flow with life, memory, and hope for generations to come.

Ngaaku mihi, naa

Ngahuia Herangi

Chair

Tahaaroa Lakes Trust

1 Introduction

1.1 Project Scope

The name 'Tahaaroa' has derived from 'Te Tahaaroa a Ruapuutahanga', referring to the long calabash carried by the renowned Taranaki ancestress, Ruapuutahanga. The name acknowledges the puuraakau of Ruapuutahanga and her husband, Whatihua, our esteemed ancestor. According to this narrative, Ruapuutahanga journeyed back to Taranaki through Kaawhia and Tahaaroa to escape Whatihua's pursuit. Along her return, she marked out significant landmarks, including a spring where she stopped to refill her calabash. In an unexpected mishap, her calabash broke, giving rise to the name Te Tahaaroa a Ruapuutahanga, *'the long calabash of Ruapuutahanga'* (Waitangi Tribunal, 2013a, 2013f; King, 2024; Te Ruunanga o Ngaati Mahuta, 2025).

An extension of Ruapuutahanga's story is woven into the origins of the Tahaaroa lakes system, which is said to have formed when her calabash cracked during her journey home to Taranaki. Ngaa roto o Tahaaroa are vital to the survival and identity of Ngaati Mahuta, the lakes have sustained the cultural connection and provided resources for their people. Ngaati Mahuta remains the kaitiaki of ngaa roto o Tahaaroa (Taharoa A7A2A, 1958, 2021; Waitangi Tribunal, 2013a, 2013f; Te Ruunanga o Ngaati Mahuta, 2025). This whakapapa provides the foundation for this project.

Building on this cultural narrative, the scope of this project is to protect and restore the mauri of ngaa roto o Tahaaroa through an integrated monitoring and research programme. This section defines the purpose and objectives of the project. The scope also recognises the role of the Tahaaroa Lakes Trust (The Trust), Ngaati Mahuta, and research partners in guiding, undertaking, and applying this work to strengthen both maatauranga Maaori and scientific knowledge for long-term management of the lakes.

While this plan provides the long-term framework for monitoring the Tahaaroa catchment, it is informed and supported by a wider programme of work funded through the Vision Maatauranga Capability Fund (VMCF). The scope of that project extends beyond the boundaries of this plan and includes additional research, tool development, and capacity building initiatives designed to strengthen Ngaati Mahuta's role as kaitiaki.

The VMCF initiative, running from June 2023 to June 2025, focused on:

- Building local capability in environmental monitoring and data management.
- Advancing maatauranga Maaori and scientific knowledge integration for lake restoration.
- Developing digital tools and platforms to support decision-making and mana whenua-led monitoring.
- Undertaking targeted ecological surveys, including aquatic weed assessments, macrophyte (tupu wai) diversity monitoring, and tuna (short and longfin eels) and kaiaua (freshwater mussels) population research.
- Addressing key data gaps to inform both customary management and statutory processes.

This project was delivered through a collaborative approach involving The Trust, Ngaati Mahuta, ESNZ and The Stream. Its outputs and learnings will contribute directly into the ongoing implementation and periodic review of this catchment plan, ensuring that the plan remains grounded in the latest evidence, cultural knowledge, and community priorities.

The two VMCF themes that align with the projects research aims are presented in Table 1-1. The project centres on the development of a Ngaati Mahuta-driven monitoring and capability programme to reconnect and revitalise whaanau understandings of current state, and to identify actions needed to enhance current state and customary fisheries and mahinga kai across the Tahaaroa lakes catchment.

Table 1-1: Vision Maatauranga themes and research aims aligned. The project aligns with two VMCF themes focused on strengthening Ngaati Mahuta-led monitoring and capability. Its aim is to reconnect whaanau with the current state of the Tahaaroa lakes, revitalise traditional knowledge, and identify actions to improve lake health, customary fisheries, and mahinga kai.

Vision Maatauranga Themes		Research Aims	
TAIAO	1. To discover distinctive and successful approaches to environmental sustainability by exploring iwi and hapuu relationships with land and sea.	A. To develop a Ngaati Mahuta mahinga kai Tahaaroa lakes catchment monitoring plan.	▪ Relevant mahinga kai datasets held by NIWA, MPI, WRC and other are collated for repatriation to Tahaaroa Lakes Trust in accordance with the principles of Maaori data sovereignty. ▪ The datasets/reports will be summarised for further interrogation by Ngaati Mahuta to determine the strengths and weaknesses of the approaches previously implemented by agencies through their lens. ▪ Waananga will inform the development of a Tahaaroa catchment monitoring plan designed to meet the decision-making needs of Ngaati Mahuta. The results (e.g., species composition, distribution, abundance, size) will be analysed and prepared for future publications including the fisheries module of Lakeside Monitoring Tools for Communities Field Guide.
		B. To facilitate waananga of NIWA's Draft Lakeside Monitoring Tools for Communities	▪ Relevant modules of NIWA's Draft Lakeside Monitoring Tools for Communities Field Guide will be piloted and adapted to a Ngaati Mahuta context. ▪ A fit-for-purpose Health and Safety Plan, iterative development of the draft

Vision Maatauranga Themes		Research Aims	
		Field Guide for Ngaati Mahuta.	Tahaaroa Lakes catchment monitoring plan and the rationalisation of the NIWA's Draft Lakeside Monitoring Toolkit will be informed by the outcomes of waananga held.
		C. To identify mahinga kai sites according to Ngaati Mahuta – kaiaua survey.	▪ Wadeable mahinga kai sites within the lake Tahaaroa catchment are identified for longer term monitoring. ▪ Survey methods are informed by annual assessment of Wairarapa Moana freshwater mussel populations. ▪ Survey results (e.g., species composition, distribution, abundance, shell length and erosion) will be analysed and prepared, to inform (what worked well, what didn't) the finalisation of a freshwater fisheries module for the Lakeside Toolkit.
		D. To identify mahinga kai sites according to Ngaati Mahuta – tuna stocktake.	▪ Wadeable and accessible (e.g., safe) mahinga kai sites within the lake Tahaaroa catchment are identified for longer term monitoring. ▪ Sites, methods, results and interpretation used previously by NIWA, MPI and WRC to evaluate tuna populations are adapted and re-designed to meet the decision-making needs of Ngaati Mahuta and the Tahaaroa Lakes Trust. ▪ Survey results (e.g., species composition, distribution, abundance, length distribution) will be analysed and prepared, to inform (what worked well, what didn't) the finalisation of a freshwater fisheries module for the Lakeside Toolkit.

Vision Maatauranga Themes		Research Aims	
MAATAURANGA	2. To develop a distinctive body of knowledge at the interface between indigenous knowledge and research, science and technology.	E. To publish and disseminate the Tahaaroa lakes catchment monitoring plan and Lakeside Toolkit.	▪ Waananga will be held to share learnings, reflect on the success of the approaches used to implement the project, to determine and prioritise the next steps required to support mahinga kai aspirations. ▪ The results generated by this research will inform (1) a final report for the Tahaaroa Lakes Trust, (2) a Ngaati Mahuta mahinga kai – Tahaaroa lakes catchment monitoring plan, and (3) final lakeside Monitoring Toolkit modules for kaiaua and tuna that will be made available to other hapuu/iwi through NIWA's website.

In addition to the research aims, short to medium-term outcomes were proposed for implementation one-year, two-years and five years after the project end date. The outcomes are actions to be implemented locally, regionally and nationally by The Trust. The proposed outcomes are outlined in Table 1-2.

Table 1-2: Proposed outcomes for implementation one-year, two-years and five-years after the project end date. In addition to the research aims, the project identifies short- to medium-term outcomes for implementation one, two, and five years after completion. These outcomes guide actions for The Trust to undertake at local, regional, and national levels.

Outcomes after one-year	Outcomes after two-years	Outcomes after five-years
Tahaaroa Lakes Trust are empowered to communicate the outcomes of their Lakes catchment monitoring plan to Ngaati Mahuta marae, hapuu and whaanau first and foremost, then regional and central government agencies and industry.	Regional and central government agencies and industry actively support the outcomes sought by the Tahaaroa catchment monitoring plan by implementing complimentary actions and providing co-funding to support ongoing capacity and capability of Ngaati Mahuta monitoring team and restoration actions.	Regulatory support and funding have been secured by Tahaaroa Lakes Trust to implement tuna and kaiaua enhancement initiatives that support ongoing harvest.
The capability and capacity of Ngaati Mahuta are retained and mobilised (including resourcing) to undertake annual surveys of tuna and kaiaua populations in the Tahaaroa Lakes catchment.	The capability and capacity of Ngaati Mahuta are retained and mobilised (including resourcing) to undertake annual surveys of tuna and kaiaua populations in the Tahaaroa Lakes catchment.	Tahaaroa Lakes Trust has seven years of qualitative and quantitative data demonstrating the health of tuna and kaiaua populations in the Lake Tahaaroa catchment. Tahaaroa Lakes Trust have developed on outward facing tool to communicate the health of tuna and kaiaua populations, and the health of the catchment in general, based on qualitative and quantitative datasets.

Although Lake Tahaaroa was the initial focal point of fieldwork and research due to its scale and known pressure from invasive aquatic weeds, the project scope intentionally includes Lakes Numiti and Rotoroa, which together form an interconnected and culturally significant lake system. Each lake contributes to the ecological and whakapapa integrity of the wider catchment. The inclusion of Lakes Numiti and Rotoroa ensures a comprehensive and catchment-wide approach, enabling The Trust to investigate spatial patterns in tuna and kaiaua populations and macrophyte diversity across varied sites.

This holistic view supports the refinement of lake-specific management responses while affirming the unified guardianship role held by the hapuu.

The research will address critical knowledge gaps for data-deficient taonga species and inform the suite of restoration activities required by Ngaati Mahuta and The Trust to realise their mahinga kai aspirations. Maatauranga Maaori and conventional science approaches will be woven together to enhance the skills, capacity, and networks of hapuu members engaged in freshwater kaitiakitanga.

1.2 Report Structure

This report, Ngaa taonga tuku iho o ngaa roto o Tahaaroa, Tahaaroa catchment monitoring plan, is structured as follows:

- Section 1 outlines the objectives, the guiding values of Ngaati Mahuta, and the collaborative approach taken to integrate cultural and scientific perspectives.
- Section 2 summarises historical use, cultural significance, and previous environmental assessments. The section also situates the project within the wider Treaty, co-governance, and Te Mana o te Wai policy context.
- Section 3 identifies existing knowledge gaps and demonstrates the need for a locally led monitoring framework that reflects both maatauranga and science.
- Section 4 explains how tikanga and cultural indicators are used alongside ecological measures to assess the mauri of freshwater systems.
- Section 5 introduces the integrated approach linking tuna, kaiaua, tupu wai, and water-quality monitoring to a shared catchment vision.
- Section 6 covers tuna, kaiaua, tupu wai, and water-quality sampling approach, followed by an overview of digital tools developed in partnership with The Stream and ESNZ. Each method is presented with diagrams, site maps, and summary tables to support transparency and repeatability.
- Section 7 summarises findings for tuna, kaiaua, and tupu wai, including species composition, abundance, depth distribution, and habitat quality. Whaanau observations and tikanga indicators are also included, supported by photographs and charts.
- Section 8 outlines the key recommendations for restoring and protecting the mauri of the Tahaaroa lakes. These cover governance, monitoring, restoration, capacity building, funding, and communication. The recommendations form the operational foundation for implementing the catchment monitoring plan.
- Section 9 outlines digital partnerships, data management protocols, reporting cycles, roles and responsibilities, funding arrangements, and the implementation pathway.

The following section provides the ecological and cultural background necessary to understand the current state of the Tahaaroa lakes and the significance of this monitoring programme.

2 Background

Te Tiriti o Waitangi forms the underlying foundation of the Crown-Maaori relationship with regard to coastal and freshwater resources in Aotearoa-New Zealand. Maaori fear that a failure to recognise and provide for their cultural beliefs, values, and their customary practices will ultimately destroy many of the foundations of their culture and identity. This tension has surfaced in many forums, where the challenge Maaori confront is not being decision makers in their own right, and/or to convey to decision makers how decisions affect their cultural interests, since many of the existing management methods and models are dominated by western science techniques which emphasise physical and biological values rather than specifically responding to cultural needs (e.g., Tipa 2012). If the needs and aspirations of Te Tiriti partners are to be seriously considered, new approaches are required to manage Aotearoa-NZ's ecosystems in culturally appropriate ways (Tipa et al. 2016).

Collaboration with Maaori is essential for the success of lake research and restoration projects in Aotearoa-NZ. Iwi and hapuu partners are entitled to participate in formulating strategies, undertaking research and monitoring, and working towards achieving lake catchment restoration outcomes that support their cultural values and knowledge systems. The prior experience of The Trust highlights that the concerns and aspirations of Ngaati Mahuta are not factored into the information sharing, and monitoring and management priorities of resource users and government agencies.

The hypothesis is that more strategic and active collaboration with Maaori in lake monitoring and research will build consensus, foster communities of learning, aid hapuu decision-making, and contribute to local, social and environmental change by fostering a long-term commitment and understanding of the parties involved. The resulting outcomes are more likely to strengthen and add value to existing hapuu and community initiatives, thus increasing efficiencies when capacity and capability across different expertise and multiple government initiatives (e.g., freshwater governance, environmental regulation, and infrastructure reform) are in demand. This requires a commitment (by agencies and funders) to move beyond conventional understandings of who is 'qualified' to engage in lake monitoring, research and restoration initiatives.

Ngaa taonga tuku iho o ngaa roto o Tahaaroa (Project) aims to address the aspirations of the Tahaaroa Lakes Trust (The Trust) and Ngaati Mahuta. Underpinning this project is a line taken from **Tau ana** – ***"Whaatoro atu ki te ruku hiinaki, o te roto o Tahaaroa" –*** a paatere unique to Ngaati Mahuta, referencing the practice of customary fishing in the Tahaaroa lakes, which were once a well-stocked pantry full of tuna, kaiaua (*Echyridella menziesii),* kanae and poorohe (Strickland, 1985). Sadly, that is no longer the case (Taharoa A7A2A, 2006; Tukotahi Tuteao Trust, 2009; Taharoa A7A2A, 2009a, 2009b). Reconnecting whaanau with their freshwater taonga, developing a Ngaati Mahuta monitoring programme, and building the capacity and capability of Ngaati Mahuta to participate in the ongoing assessment of their freshwater are outcomes of the project. This presents an opportunity to gather maatauranga and koorero on species, habitats, distribution and local place names to inform the development of a Tahaaroa lakes catchment monitoring plan.

2.1 Ngaati Mahuta ki te Hauaauru

Ngaati Mahuta is a hapuu of Waikato, descended from the eponymous ancestor Mahuta, son of Hekemaru and Hekeiterangi (Te Ruunanga o Ngaati Mahuta ki te Hauaauru, 2025). Mahuta traces his lineage to Hoturoa and Tama-te-kapua, the esteemed captains of the Tainui and Te Arawa migratory waka (Waitangi Tribunal, 2013b).

The tribal rohe of Ngaati Mahuta extends south from Te Puia Springs in Kaawhia to Motaunau Rocks below Lake Harihari, and out to sea to Karewa or Gannet Island (Figure 2-1). Ngaati Mahuta maintains enduring ancestral and contemporary ties to Kaawhia and Tahaaroa, with deep whakapapa connections to three principal marae – Maketuu, Te Kooraha, and Aaruka. The marae, together with The Trust and Te Ruunanga o Ngaati Mahuta ki te Hauaauru (Te Ruunanga), form a collective foundation for governance, advocacy, and whaanau engagement across the rohe (Figure 2-2).

Figure 2-1: The indicative rohe boundaries of Ngaati Mahuta ki te Hauaauru extend south from Te Puia Springs in Kaawhia to Motunau Rocks south of Lake Harihari, and out to sea to Karewa/Gannet Island. [Graphic: Ruby Mckenzie Sheat, ESNZ]

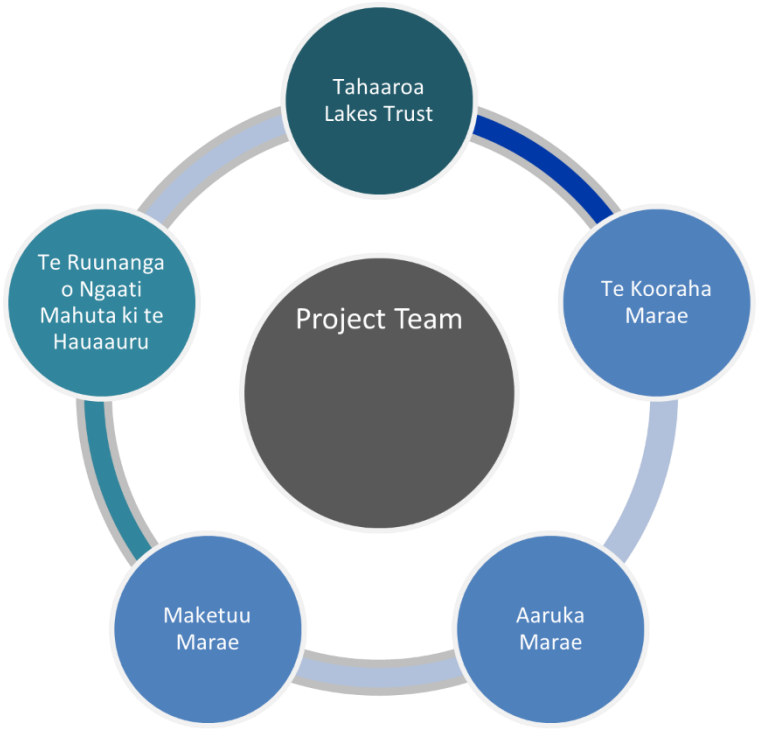


Figure 2-2: Tahaaroa Lakes Trust, Ngaati Mahuta marae and Te Ruunanga o Ngaati Mahuta ki te Hauaauru form a collective foundation for governance, advocacy and whaanau engagement across the rohe.

2.2 Tahaaroa Lakes Catchment Overview

The Tahaaroa Lakes are a unique cluster of coastal dune lakes, recognised as ecologically significant freshwater dune ecosystems and wetlands located on the west coast of the Waikato region, within the rohe of Ngaati Mahuta (Scott, 1996; David et al. 2015). The principal lakes, Lake Tahaaroa, Lake Numiti and Lake Rotoroa sit within a dynamic dune landscape, bordered by sand country, wetlands, and modified pasture. The lakes are interconnected through surface and groundwater flows, with catchment boundaries that extend into surrounding farmland and native vegetation remnants.

Lake Tahaaroa, the largest of the three, covers approximately 220 hectares, with a maximum depth of over 9 metres. It is connected to Lakes Numiti (15.8 ha) and Rotoroa (22.4 ha), approximately 3 km inland from the Tasman Sea (Bayler et al., 2020) (Figure 2-3). Two smaller lakes further south, Lakes Piopio (0.2 ha) and Rototapu (2 ha), are likely to interconnect only intermittently during high flow events or through subterranean water exchange (Bayler et al, 2020). South of Waiohipa Stream rests Lake Harihari (18.39 ha) (Figure 2-4). Most dune lakes in the North Island are thought to have formed less than c. 5000 years ago; however, the Tahaaroa Lakes are thought to have formed c. 50,000 years ago (Viner, 1987).

The shoreline is a mix of steep sandy escarpments, extensive reed beds dominated by raupoo (*Typha orientalis*), and jointed rush (*Baumea articulata*), and open sandy beaches. Several small streams and seepage zones flow into the lake, including the Wainui Stream, which is the primary surface water inflow and outflow to the Tasman Sea.

The lakes have long been recognised for their high ecological value, supporting a diverse range of native aquatic plants, fish, and birdlife.

However, over recent decades they have experienced a decline in water quality and habitat condition. Monitoring by Waikato Regional Council (WRC) and ESNZ has documented elevated nutrient levels, periodic algal blooms, declining water clarity, and spread of invasive aquatic plant species. Sedimentation from land use changes and erosion of exposed dune slopes continues to affect nearshore habitats.

The climate of the Tahaaroa Lakes catchment is characterised by mild winters, warm summers, and prevailing westerly winds. Seasonal variations in rainfall and temperature influence lake levels, water temperature, and water clarity, with summer stratification likely occurring in the deeper basins of Lake Tahaaroa. Climate change projections for the region indicate a potential increase in extreme rainfall events, drought frequency, and elevated lake temperatures, all of which may exacerbate existing pressures on water quality and ecosystem health.

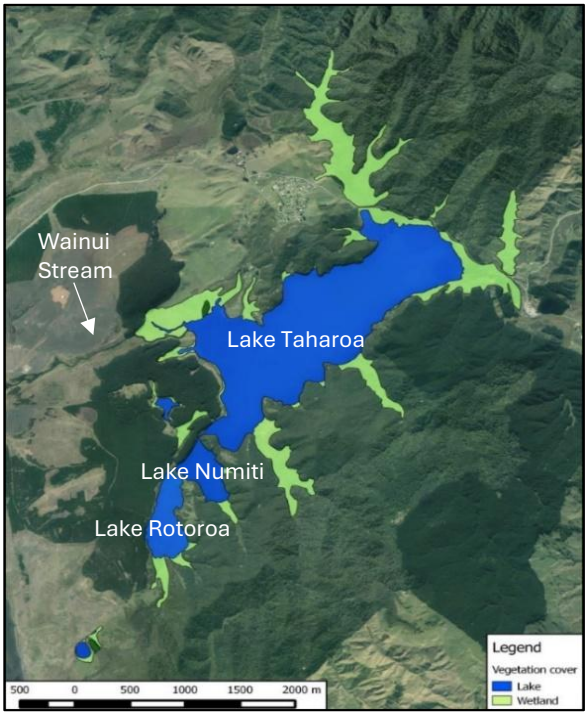


Figure 2-3: Interconnecting lakes of Tahaaroa, Numiti and Rotoroa and only outlet to sea via Wainui Stream. [Graphic: Ruby Mckenzie Sheat, ESNZ]

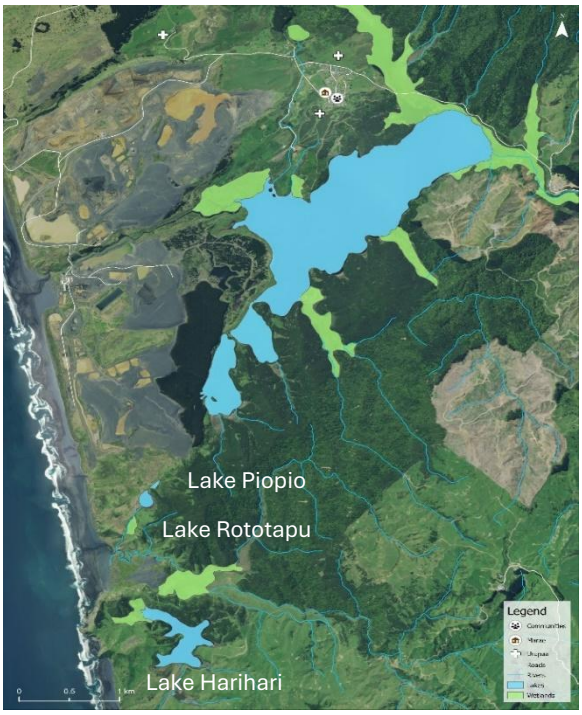


Figure 2-4: The six shallow coastal dune lakes including Lakes Piopio, Rototapu and Harihari south of Waiohipa Stream. [Graphic: Ruby Mckenzie Sheat, ESNZ]

2.2.1 Lake Tahaaroa

Lake Tahaaroa is the most significant of the Tahaaroa lake system. It has long been a central source of cultural identity, sustenance, and connection for Ngaati Mahuta (Strickland, 1985; Taharoa A7A2A, 1958, 2021, 2006; Waitangi Tribunal, 2013a, 2013b, 2013c, 2013f; John David Keepa Kupa Whaanau Trust, 2023; Te Ruunanga o Ngaati Mahuta ki te Hauaauru, 2025). Traditionally, the lake supported extensive tuna fishing and mahinga kai, valued particularly for its almost year-round supply of tuna and kanae, which featured prominently at important marae functions (Strickland, 1985; Waitangi Tribunal, 2013c, 2013d; Ngaa Marae o Ngaati Mahuta ki te Hauaauru & Tahaaroa Lakes Trust, 2023; Ngaati Mahuta ki te Hauaauru Collective, 2023).

However, since the commencement of mining operations by New Zealand Steel in the early 1970s, the lake has suffered multiple adverse impacts (Strickland, 1985; Taharoa A7A2A, 2009b, Waitangi Tribunal, 2013c, 2013d, 2013f). The construction of the Wainui Stream dam around 1977 to support mining operations obstructed the upstream migration of tuna and kanae to Lake Tahaaroa, Lake Numiti, and Lake Rotoroa, resulting in the dramatic collapse of their populations (Strickland, 1985; Waitangi Tribunal, 2013c, 2013d, 2013f; Ngaa Marae o Ngaati Mahuta ki te Hauaauru & Tahaaroa Lakes Trust, 2023; Ngaati Mahuta ki te Hauaauru Collective, 2023). Additional impacts include the loss of traditional fishing sites such as Turanga's Crossing, the disruption of teaching spaces where tamariki once learned customary practices, flooding of Penapena urupaa, degraded water quality, declining ecological integrity, and ongoing dust discharges from mine tailing stockpiles (Taharoa A7A2A, 2006, 2009a, 2009b; Tukotahi Tuteao Trust, 2009; Ngaa Marae o Ngaati Mahuta ki te Hauaauru & Tahaaroa Lakes Trust, 2023). Flooding has also contributed to land loss and the diminishing of cultural landscapes (Taharoa A7A2A, 2006, 2009a, 2009b; Tukotahi Tuteao Trust, 2009; John David Keepa Kupa Whaanau Trust, 2023).

Between 2022 and 2023, Lake Tahaaroa experienced a surface area increase of more than 15,000m^2, attributed to hydrological changes caused by mining activity (John David Keepa Kupa Whaanau Trust, 2023). Despite decades of internal and external hui, many of these long-standing concerns remain unresolved (Strickland, 1985; Taharoa A7A2A, 2006, 2009a, 2009b, 2013a; Tukotahi Tuteao Trust, 2009; Ngaati Mahuta ki te Hauaauru Collective, 2023).

2.2.2 Lake Numiti

Although Lake Numiti has shown no measurable change in overall surface area, satellite imagery suggests a shrinking open water footprint, likely due to vegetation encroachment or hydrological modification (John David Keepa Kupa Whaanau Trust, 2023). Historically, the lake was an important site for white baiting and tuna fishing, activities once supported by its natural connection to Lake Tahaaroa before this was disrupted by dam-related flooding (Taharoa A7A2A, 2009a, 2009b; John David Keepa Kupa Whaanau Trust, 2023). Despite long-standing concerns raised by kaitiaki over the loss of connectivity, degraded waterway function, and unmet restoration commitments, Lake Numiti endures as a symbol of cultural resilience and ancestral connection (Strickland, 1985; Taharoa A7A2A, 2006, 2009a, 2009b; Tukotahi Tuteao Trust, 2009).

2.2.3 Lake Rotoroa

Lake Rotoroa has experienced a reduction in surface area of approximately 2,500m^2 between 2022 and 2023, with satellite imagery revealing increased encroachment by aquatic pest weeds (John David Keepa Kupa Whaanau Trust, 2023). The spread of these pest weeds has diminished the lake's accessibility, hindered recreational use, and disrupted customary activities. Once a vital site for tuna harvesting and intergenerational transfer of maatauranga, the lake's declining open water area now compromises both its ecological function and cultural significance (John David Keepa Kupa Whaanau Trust, 2023).

Complementary Regional Council monitoring – Numiti and Rotoroa

In 2014 monitoring buoys were installed by WRC in Lakes Numiti and Rotoroa. The buoys mark sampling sites for WRC to capture monthly and bi-monthly data to measure algae, phosphorous, nitrogen, clarity and bacteria.

Although the monitoring buoys provide a valuable dataset, The Trust has had limited involvement and discussions about the design, interpretation, and application of the monitoring programme. Monthly and bi-monthly data collected on algae, nutrients, clarity, and bacteria offer useful insights into lake health, particularly the conditions affecting taonga species including submerged native vegetation.

However, without the active participation of The Trust in shaping monitoring priorities and methods, the cultural relevance of this data remains limited. Strengthening the role of The Trust in environmental governance is critical to ensuring that monitoring frameworks reflect both maatauranga Maaori and regional science, and that kaupapa Maaori values such as mauri, and mana whakahaere are fully recognised. In doing so, existing council datasets could be leveraged more effectively to inform culturally grounded restoration and management efforts.

2.3 Tahaaroa Lakes Trust

The Trust was established through a Maaori Land Court order on 20 October 1958, under Section 438 of the Maaori Affairs Act 1953 (Taharoa A7A2A, 1958). The Court vested Taharoa A7A2A (1958), comprising approximately 646 acres into a group of nine trustees on behalf of 360 beneficial owners. The purpose of The Trust was to manage and control the use of the lakes and their waters, including granting rights for fishing, boating, camping, and mineral extraction, with the clear intention that all revenue and activities would derive benefits for Ngaati Mahuta and the Tahaaroa community. This foundational decision formally recognised the mana whakahaere of Ngaati Mahuta over the lake system and laid the groundwork for The Trust's enduring role as kaitiaki.

Fast forward nearly seven decades, the current trustees continue the legacy of their tuupuna through a deep commitment to kaitiakitanga and mana whakahaere over the Tahaaroa lakes, on behalf of 1,611 beneficial owners (Taharoa A7A2A, 2021). At the 2023 Annual General Meeting, five hapuu members: Jodi Whitiora, Ngahinaturae Armstrong-Neild, Fleur Passau, Hera Denton, and Natasha Willison-Reardon were elected to join existing trustees; Ngahuia Herangi and Rhonda Kerr (Taharoa A7A2A, 2021). Together, this collective brings a blend of skills, experience, and perspectives to the governance of The Trust. Today, The Trust remains steadfast in its mission to protect and restore the mauri of the lakes and to uphold the long-term wellbeing of Ngaati Mahuta through kaupapa anchored in mana whakahaere, kaitiakitanga, and kotahitanga (Taharoa A7A2A, 2021).

In line with this enduring role and legacy, The Trust's vision for the lakes reflects the principles of Te Mana o te Wai. Placing the health and mauri of the water first, followed by the wellbeing of the people, and ensuring benefits for generations to come.

"E rere ana te mauri o ngaa wai o ngaa roto o Tahaaroa hei oranga moo te roto, moo ngaa koiora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru."

The mauri of the waters of the Tahaaroa lakes flows to sustain the lake, all living beings, the land, and the people, and to uphold the wellbeing of future generations of Ngaati Mahuta ki te Hauaauru.

3 Literature Review

To complete this review, readily discoverable literature relevant to Tahaaroa Lakes mahinga kai datasets held by NIWA, MPI and WRC and other organisations was compiled. Research undertaken in the Tahaaroa lake catchment vary from fisheries and macrophyte communities, ecological values and conservation and biodiversity outcomes. The database provides insights into the range of published material and datasets available for repatriation by The Trust in accordance with the principles of Maaori data sovereignty. In addition to agency and institutional publications, the review also draws on relevant reports, submissions, and literature produced by Ngaati Mahuta.

3.1 Past Studies, Present Gaps

Historically, research within the Tahaaroa Lakes have been driven primarily by external agencies, local government and organisations such as Ministry of Fisheries, NIWA and Waikato Regional Council. These studies have explored fisheries (Chisnall, 1993, 1994; Chisnall & Ruru, 2008), lake ecology and macrophyte health (de Winton et al. 2005; Edwards et al. 2003, 2007, 2008, 2010), water quality (Burns & Rutherford, 1998; Duggan, 2008; Allan & Baptista, 2023), fish passage (Tonkin & Taylor, 2011, 2014; Bennett, 2022), and biodiversity (David et al. 2014; Taylor Smith, 2019; Bayler et al., 2020) (Appendix A). Despite this extensive body of publicly available research, the role and authority of The Trust has frequently been marginalised in the design, governance, and implementation of these activities (Waitangi Tribunal, 2013f) (Table B-1).

More recently, The Trust and ESNZ recently completed a Customary Fisheries Research project from 2023-2025, funded by MPI's Customary Fisheries Research Fund. This mahi intentionally replicated the 2007 tuna survey (Chisnall & Ruru, 2008) to provide a direct long-term comparison of tuna population structure, abundance, and condition within Lake Tahaaroa. The 2025 dataset represents the most up-to-date customary fisheries assessment for the lake and addresses one of the key knowledge gaps previously identified for this taonga species.

The Trust asserts that all information and data generated from research involving the Tahaaroa Lakes and surrounding environments, including biological, ecological, hydrological, and cultural data, constitutes taonga and remains under the stewardship of The Trust. This aligns with the principles of kaitiakitanga, mana whakahaere, and data sovereignty, and reflects the expectations set out in the national Maaori data frameworks such as the Te Kāhui Raraunga Māori Data Governance Model (2021).

To that end, The Trust upholds the following expectations:

- Prior informed consent must be obtained before any research is undertaken.
- All data collected must be returned to The Trust, who retain ownership and custodianship.
- Use of data must align with tikanga and contribute to intergenerational wellbeing, not solely institutional or commercial interests.

The unauthorised collection, storage, or use of data from these lakes are no longer acceptable. Agencies and researchers must be accountable to The Trust's tikanga and responsibilities, including those recognised under Te Tiriti o Waitangi (Waitangi Tribunal, 2011; Waitangi Tribunal, 2013f). Effective collaboration must begin with recognition of The Trust's authority to lead research agendas that are culturally appropriate, community-defined, and locally governed.

Frameworks such as *Lakes380* have highlighted the importance of historical sediment records in understanding lake health (Wood & Vendergoes, 2019), but such insights must now be embedded within co-governance and consented kaupapa that reflect iwi aspirations. Future research efforts must shift from extractive science to relational science, grounded in partnership, reciprocity, and respect for iwi data sovereignty.

3.2 Taku Mana Maaori Motuhake

This call for a shift in research practice is not only grounded in policy and governance, but also deeply embedded in the cultural identity, history, and lived expression of mana motuhake by Ngaati Mahuta. A principle powerfully affirmed through waiata, such as 'Taku Mana Maaori Motuhake', taught and shared at waananga by Melaina Huaki from Ngaati Mahuta. The words originating from Haki Tuaupiki at the request of Rhonda Tuaupiki-Kerr to honour Koro Paeturi Tuaupiki's 90th birthday. The waiata carries a deeply rooted message of pride, place, and identity. A statement of self-determination grounded in the whenua and taiao of te hauaauru.

Though the words were first written a decade ago, the waiata found new life in 2024, when it was shared once again at Maketuu Marae to celebrate Koro Morris Tuaupiki's 80th birthday. It is more than a tribute, it is a cultural anchor that speaks to Ngaati Mahuta's enduring authority, whakapapa to place, and the collective obligation to protect what is theirs.

The imagery of the bellbird soaring westward (te hauaauru), proclaiming sovereignty from the sacred hills, resonates with The Trust's stance on data sovereignty. Just as the waiata declares that our mana motuhake lives within te taiao and echoes outward beyond our rohe, so too does The Trust assert its right to protect, govern, and guide the use of knowledge derived from its lands and waters.

In this way, Taku Mana Maaori Motuhake becomes both metaphor and method:

- a kaupapa declaration of tino rangatiratanga,
- a cultural taonga affirming mana whakahaere, and
- a reminder that all data and research related to the Tahaaroa Lakes must be handled with the same reverence as one would treat a waka huia, a vessel of treasures, held close to the heart.

As a final note, the waiata reminds us:

Hei pine titia
Ki te waka huia
O te ngaakau e

So too must our data and our knowledge be respected, protected, and returned. Not extracted or misappropriated. For in the hearts of our people lies the authority to define the future of our taonga.

Table 3-1: Taku Mana Maaori Motuhake is a waiata affirming Ngaati Mahuta's sovereignty and authority over their rohe. [Author & Composer: Haki Tuaupiki & Melaina Huaki, Ngaati Mahuta]

Taku Mana Maaori Motuhake	My Sovereignty My Authority
E rere atu naa	For all those who are listening
Te Komako rei	To the Bellbird (and the deliverer of this message)
Whakarewa o ata	Manifest another day
Ki runga i te hauaauru e	(Our identity exists) within te hauaauru
Whaakina to reo	Proclaim your sovereignty (and)
Ngaa puke tirohanga	Express your worldview
Ki waho kia korowaingia ngoo iwi ki te kupu	To all those outside your rohe
Hei pine titia	It is a cherished adornment
Ki te waka huia	A treasured keepsake
O te ngaakau e	Encapsulated within your heart
Taku Mana Maaori Motuhake	My sovereignty my authority

The affirmation of mana Maaori motuhake provides the foundation for how Ngaati Mahuta determines, leads, and protects research involving ngaa roto o Tahaaroa, and the catchment monitoring plan more broadly. To give effect to this authority, culturally grounded frameworks are required to guide the design, practice, and interpretation of monitoring. The following section sets out the cultural assessment frameworks that operationalise these principles, ensuring that monitoring and management align with tikanga, whakapapa, and hapuu aspirations.

4 Cultural Assessment Frameworks

Cultural assessment frameworks provide the practical expression of Ngaati Mahuta's mana whakahaere over ngaa roto o Tahaaroa. They ensure that monitoring approaches are shaped by tikanga, whakapapa, and maatauranga Maaori, rather than being confined to external scientific standards alone.

The need for whaanau/hapuu/iwi driven approaches in the creation of new environmental assessment frameworks and associated monitoring programmes, is in part supported by the increasing use of the terminology 'maatauranga Maaori' in national and regional strategies. This terminology explicitly implies that in order to achieve it, Maaori must be involved and resourced appropriately to deliver on such work programmes (e.g., the Mahinga Kai objective in the National Policy Statement for Freshwater Management)[1]. It also recognises that Maaori knowledge systems must be provided for and interpreted by whaanau experts within the unique context/place with which the knowledge was/is generated. As such, the development of a framework that encapsulates Ngaati Mahuta values, what and how they assess those values, and the appropriate methodologies for assessing those values, can only be determined by Ngaati Mahuta.

The term Cultural Assessment Framework (CAF) in the context of this work refers to a framework that is derived from Ngaati Mahuta values, incorporating a Ngaati Mahuta way of assessing state, assessment tools and approaches that are based on maatauranga Maaori, community and scientific knowledge. This leans heavily on work completed in the cultural indicators space such as the Cultural Health Index (Tipa and Teirney, 2003, 2006), Murihiku Cultural Water Classification System (Kitson et al. 2018), Maniapoto Freshwater Cultural Assessment Framework (Ratana et al. 2020), NIWA tuna training workshops (e.g., Williams & Boubée, 2014) and other eco-cultural frameworks developed specifically to support the freshwater management aspirations of Maaori.

Values based CAF approaches which focus on whaanau, hapuu or iwi and their unique freshwater values have been developed, such as Ngaai Tahu ki Murihiku's Wai Noho, Wai Tuna, Wai Pounamu (Kitson et al. 2018). Their framework includes a combination of indicators that support whaanau assessments of current state, key pressures/drivers and sometimes actions/restoration indicators. Each CAF will be uniquely shaped by the iwi, hapuu or whaanau, and guided by the outcomes they are seeking, however, commonalities in the benefits and outcomes sought are evident, including recognising whaanau as leaders, experts, designers, deliverers and communicators of their CAF (Figure 4-1).

[1] https://www.mfe.govt.nz/fresh-water/national-policy-statement/about-nps

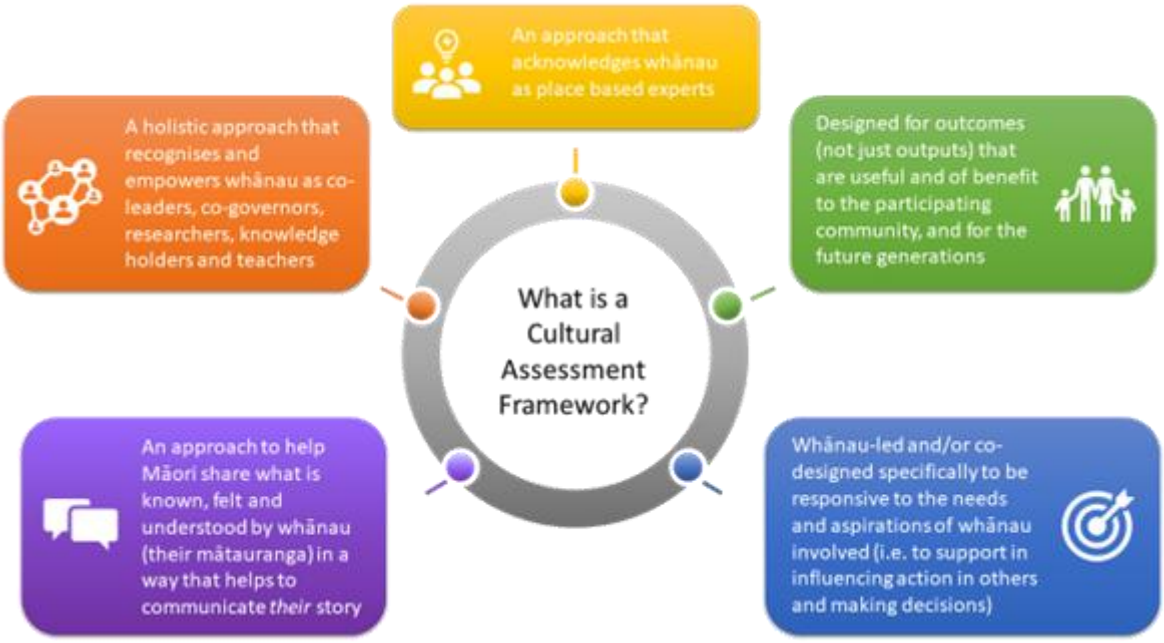


Figure 4-1: Common components underpinning the design of Cultural Assessment Frameworks.

5 Proposed Tahaaroa Catchment Monitoring Plan

'Huri Taiaawhio Ko Ngaati Mahuta E' is a cultural narrative that articulates the values, responsibilities, and knowledge that underpin Ngaati Mahuta's relationship with taiao including the Tahaaroa lakes and surrounding environment. The cultural narrative described is the title given to Ngaati Mahuta's environmental management plan (Te Ruunanga o Ngaati Mahuta ki te Hauaauru, 2025). It provides critical insight into how environmental changes are observed, interpreted, and responded to through a Ngaati Mahuta lens, particularly through the identification of tohu and the monitoring of taonga species such as tuna, kaiaua, kooura and iinganga (Figure 5-1).

The report describes how Ngaati Mahuta understand lake health not only through scientific measures, but through the condition and behaviours of taonga species, seasonal patterns, and the mauri of places. These cultural observations are relational, often transmitted through koorero tuku iho, and embedded in the lived experience of whaanau who actively engage with the lakes for kai, waananga, and ceremony. Importantly, Huri Taiaawhio presents tohu as a legitimate and necessary basis for environmental monitoring and management. These include changes in water clarity, abundance or absence of specific species, shifts in bird and insect behaviour, and other sensory or experiential markers that signal imbalance or resilience in the environment (Figure 5-2).

As such, this report complements and strengthens the project's kaupapa of integrating maatauranga Maaori into freshwater monitoring frameworks. It sets a precedent for recognising hapuu-observed indicators alongside conventional scientific methods, which is further expanded in Section 5 through a discussion of how these tohu and taonga species form the basis of a Ngaati Mahuta-led monitoring approach.

Figure 5-1: Freshwater taonga species identified in Huri Taiaawhio Ko Ngaati Mahuta E: Ngaati Mahuta ki te Hauaauru Environmental Management Plan (2025).

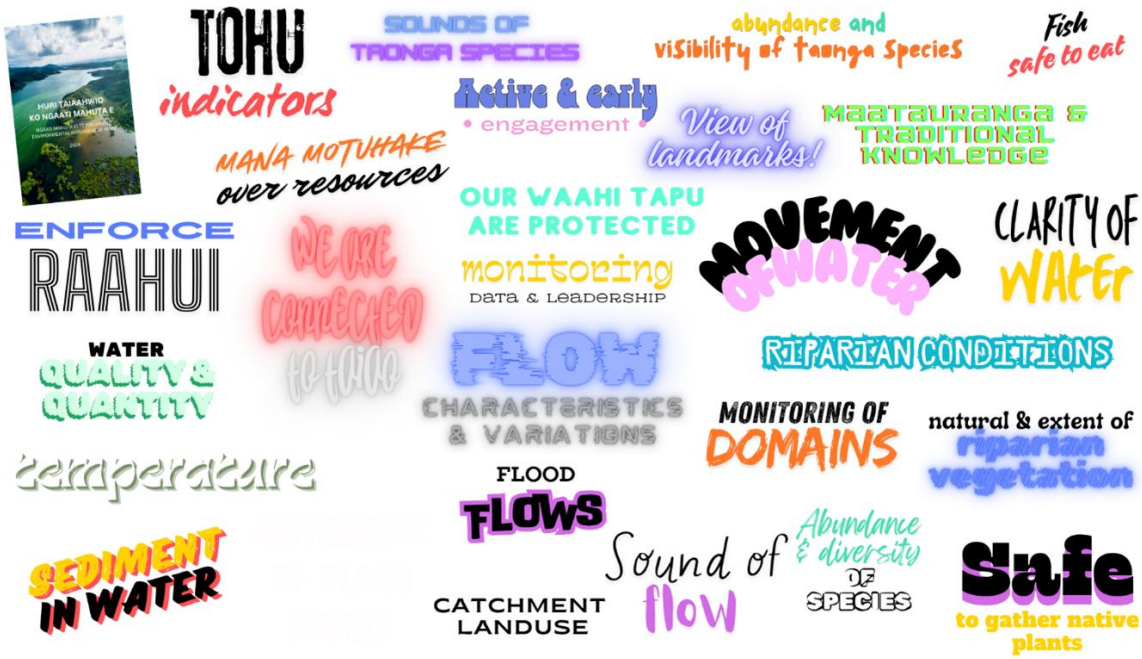


Figure 5-2: Tohu or indicators identified in Huri Taiaawhio Ko Ngaati Mahuta E, Ngaati Mahuta ki te Hauaauru Environmental Management Plan (2025).

5.1 Focus Areas

The Trust have been focused on building the monitoring capacity and capability of Ngaati Mahuta, required long-term to measure and evaluate the effectiveness of restoration actions and management to seek to improve the mauri of Lakes Tahaaroa, Numiti and Rotoroa. In the first instance three cultural values have been chosen to explore and build the first iteration of the Tahaaroa catchment monitoring framework. These are tuna (including the tuna heke); kaiaua and tupu wai.

The three cultural values reflect the aspirations and environmental responsibilities articulated by Huri Taiaawhio Ko Ngaati Mahuta E (2025). While these values have been selected to start with, both the monitoring methods and data collected have the ability to support other hapuu values and culturally-driven assessments in the future, as the framework is further developed and refined by kaitiaki.

5.2 Attributes and indicators – What to monitor

To support cultural harvest and taonga species, environmental management and restoration needs to consider the ways in which whaanau come together to engage in these activities as well as the lifecycle and habitat requirements of these species – which may take a much broader spatial area into consideration (Tipa et al. 2017). A brief summary of the environmental conditions required to support tuna and kaiaua are provided in Figure 5-3, Figure 5-4 and Figure 5-5.

5.2.1 Overview of Tuna Lifecycle

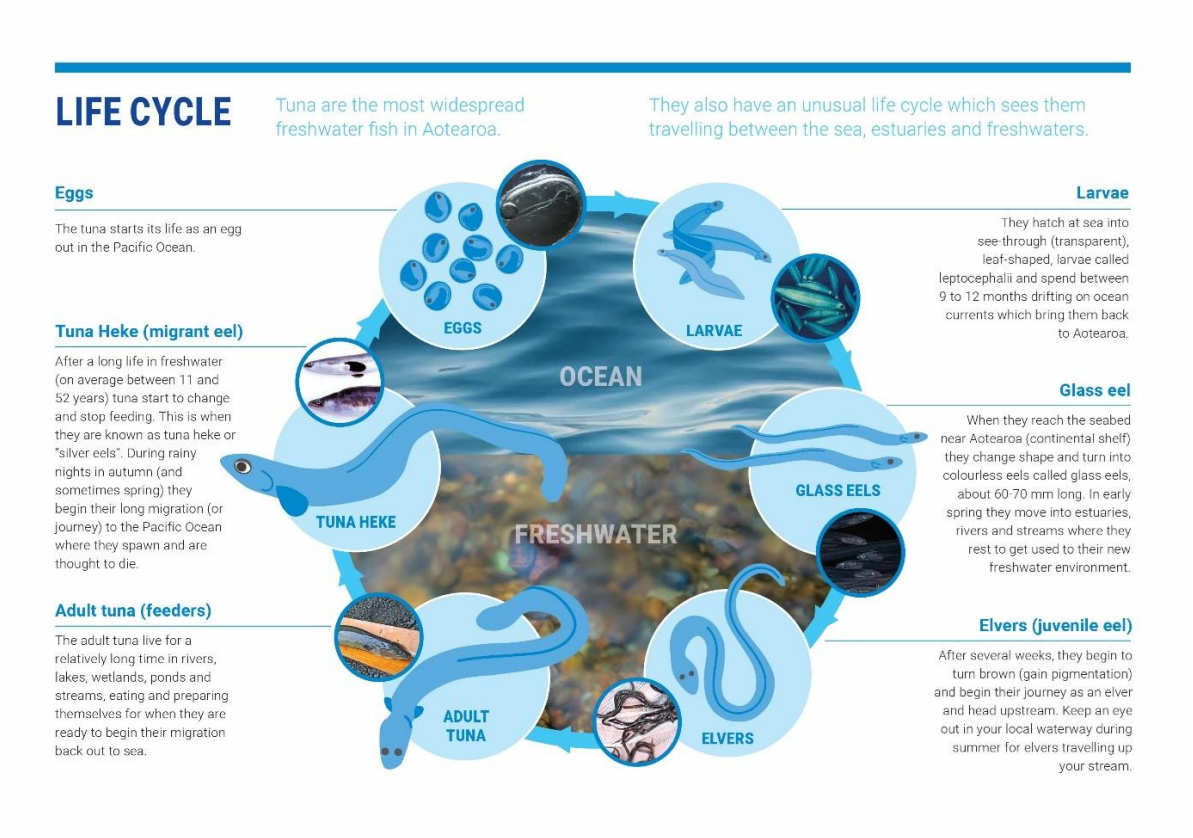


Figure 5-3: Overview of the tuna lifecycle. (Source: https://niwa.co.nz/taonga-species/taonga-species-series/tuna). (Source: https://niwa.co.nz/taonga-species/taonga-species-series/tuna).

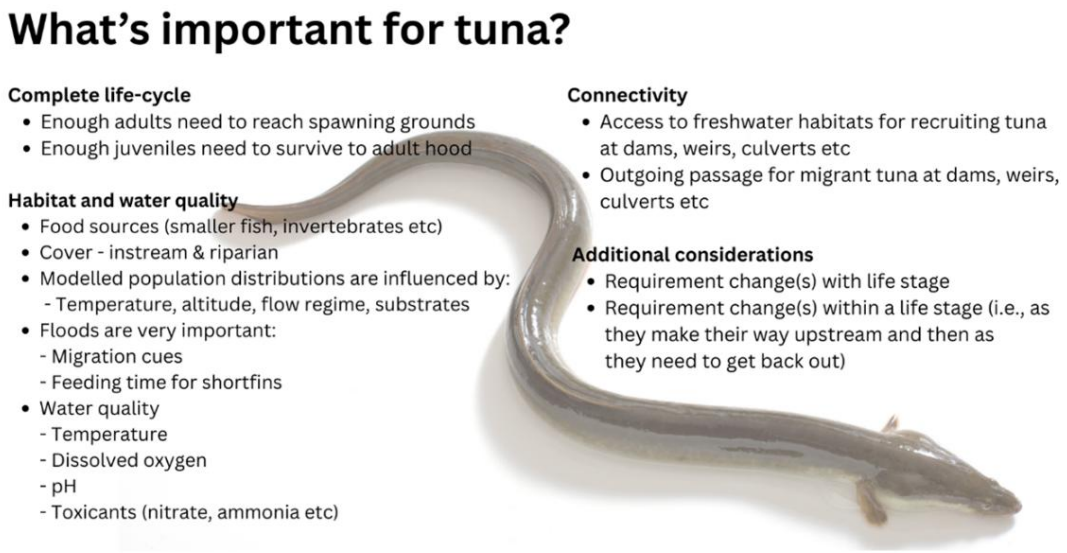


Figure 5-4: Summary of key environmental conditions required to support sustainable tuna populations. (Source: NIWA)

5.2.2 Overview of Kaiaua Lifecycle

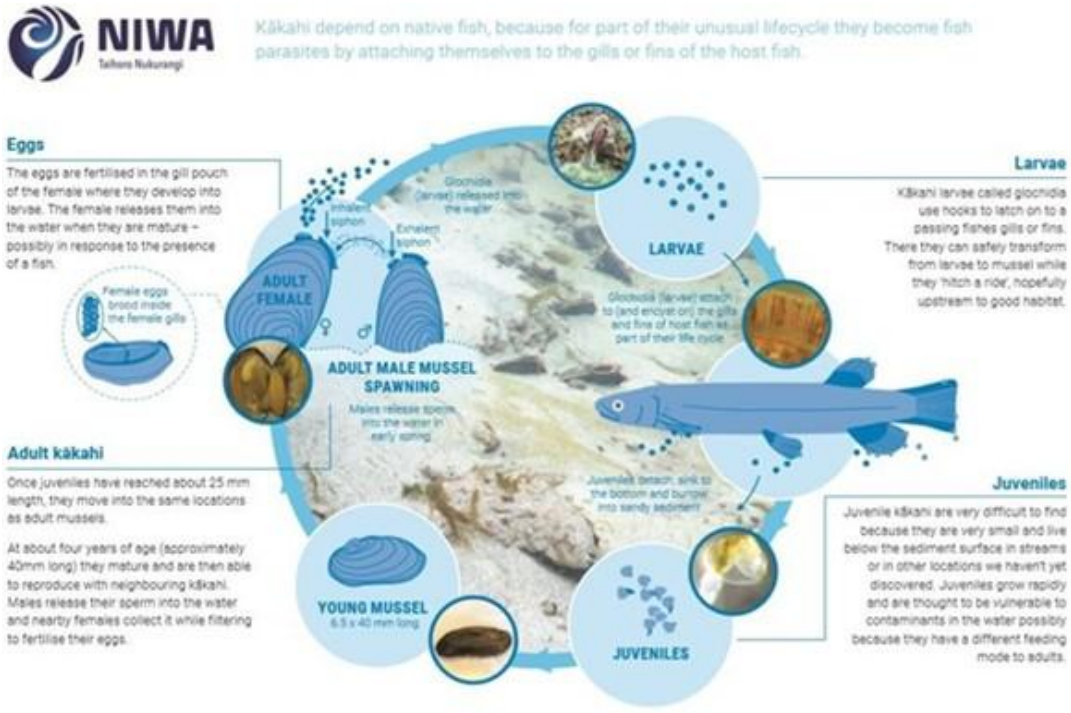


Figure 5-5: Overview of the kaiaua lifecycle. (Source: https://niwa.co.nz/taonga-species/taonga-species-series/kakahi).

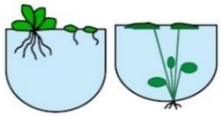
5.2.3 Overview of Tupu Wai Lifecycle

Tupu wai, with true roots, stems, leaves and flowers, are a natural and vital part of lake ecosystems. They improve water clarity, oxygenate waters, provide habitat and food for aquatic life, and absorb nutrients and pollutants. While native species support ecosystem health, introduced plants often grow rapidly and can harm lakes by smothering natives, blocking water intakes, disrupting habitats, and reducing water quality (Clayton & Edwards, 2006) . An overview of tupu wai lifecycle and a brief summary of the environmental conditions required to support tupu are provided in Figure 5-6 and Figure 5-7.

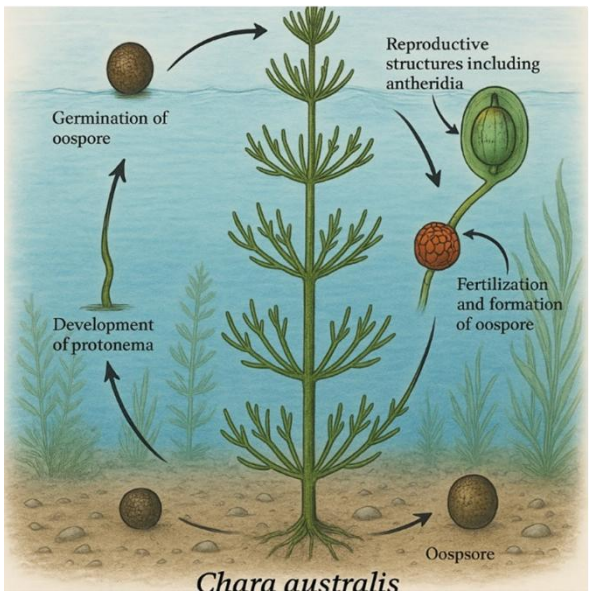
Aquatic plants can be grouped into three categories:

Emergent – plants are rooted and have stems or leaves that rise above the water surface. They grow in shallow water usually around the shoreline.

Submerged – plants that grow beneath the water's surface, though flowers may appear above the water surface.



Floating – plants that float freely or are rooted with leaves that float on the water's surface.



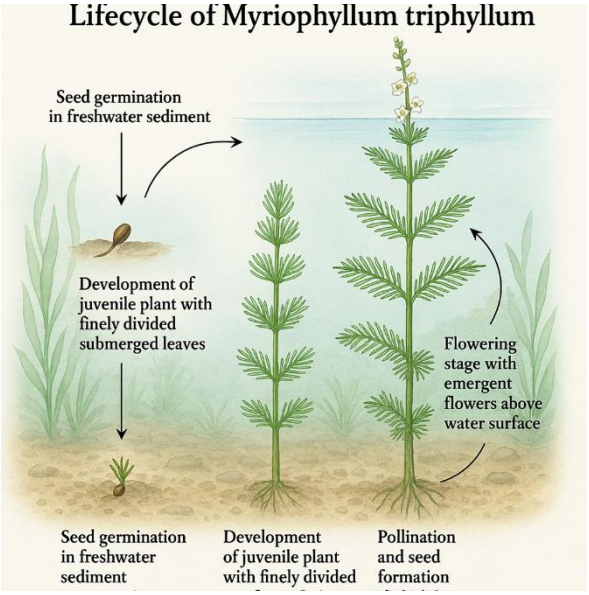


Figure 5-6: Overview of two submerged tupu wai lifecycle species. These are examples of *Chara australis* and *Myriophyllum triphyllum*.

Environmental Conditions to Support Tupu Wai

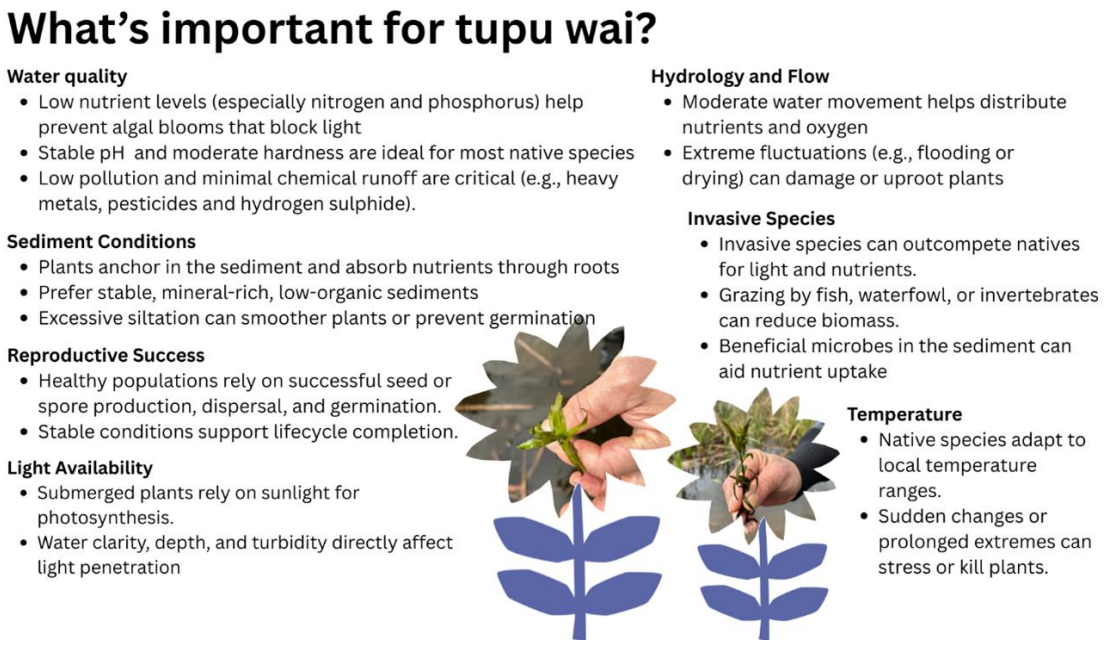


Figure 5-7: Summary of key environmental conditions required to support sustainable tupu wai.

The methods/tools chosen, needs to be taken into consideration with the time kaitiaki may have available (e.g., between 2-3 hours at each site, excluding travel), and the ability of whaanau to safely (including safety gear needed) and confidently use the survey methods in all weather conditions. The eventual package of methods also needs to be cost effective, accessible to whaanau (e.g., replacements available) and repeatable. A range of different waterbody types may need to be assessed in the future, including rivers, streams, lakes, and wetlands, which will need to be taken into account, in the design of the methods too. In addition, the approach needs to be semi-facilitated, structured and inclusive, enable whaanau to participate as themselves, value kaitiaki knowledge and expertise, and able to draw on both qualitative and quantitative datasets.

To design the first phase of this monitoring programme we have drawn on previous Ngaati Mahuta-driven research about historical and contemporary hapuu uses, values and associations with specific sites in the Tahaaroa lakes catchment. Through waananga and literature reviews, a number of key attributes and indicators have been identified by whaanau. We have also drawn on learnings from the development and short-medium term implementation of the Cultural Health Index (CHI)[2] (Tipa & Tierney 2006, Tipa & Associates Ltd. 2015), the Murihiku Cultural Water Classification System (Kitson et al. 2018), the Maniapoto Cultural Assessment Framework (Ratana et al. 2020), the Tūtira Mauri Ora Monitoring Action Plan (Ratana et al. 2024), the Wairarapa Moana Wetlands Project (Greater Wellington 2015) and the Waikato-Tainui Manaaki Tuna Community Programme (Watene-Rawiri et al. 2018).

[2] https://www.stats.govt.nz/indicators/cultural-health-index-for-freshwater-bodies

Based on the three cultural values; tuna, kaiaua and tupu wai we have collated a list of potential attributes and indicators and methods that could be deployed by kaitiaki to assess current state:

- To assess the current state of 'tuna' we have included attributes/indicators that cover: (1) the health of the tuna population (i.e., the fish), (2) whaanau satisfaction with the health of the habitat/ecosystem to support tuna populations (i.e., the ecosystem), and (3) the preferences and ability of whaanau to safely harvest and consume tuna (i.e., the fisher) (Table 5-1, Figure 5-8)
- To assess the current state of 'kaiaua' we have included attributes/indicators that cover: (1) the health of the kaiaua population, and (2) whaanau satisfaction with the health of the habitat/ecosystem to support kaiaua populations (i.e., the ecosystem) (Table 5-2, Figure 5-9).
- To assess the current state of 'tupu wai' we have included attributes/indicators that cover: (1) the health of tupu wai, (2) whaanau satisfaction with the health of the habit/ecosystem to support tupu wai; and (3) whaanau satisfaction with site access and amenities (Table 5-3, Figure 5-10).

Please note that this is not an exhaustive list of potential attributes and indicators, nor does it detail all the assessment tools or approaches possible. It is anticipated that this list will shrink/grow as kaitiaki test, refine and implement the framework into the future.

Tuna Attributes, Indicators and Monitoring Tools

Table 5-1: Potential tuna attributes of importance to whaanau, alongside some suggested indicators and monitoring methods. *Potential indicators that require an appropriate monitoring tool/method to be developed.

Tuna attributes	Potential indicators	Potential tools
Traditional practices	▪ Whaanau are using their traditional practices (e.g., Maramataka, paa tuna, tuna tickle). ▪ Traditional fishing resources are available. ▪ Whaanau are observing migrations up/down stream*.	– Assessment during whaanau determined sites and moon phase. – Visual site assessment of resources present.
Tuna species, abundance and distribution	▪ Longfins are present at whaanau fishing sites. ▪ Tuna are available in sufficient numbers to support harvest.	– Fyke-net fishing. – CHI.

Tuna attributes	Potential indicators	Potential tools
Tuna condition, size and safe to harvest/eat	▪ Tuna are in good condition. ▪ Tuna are parasite free. ▪ Tuna of a range of sizes are present. ▪ Tuna are safe to harvest and eat*.	– Fyke-net fishing. – CHI. – Visual assessment.
Health of the ecosystem to support tuna	▪ Plenty of kai available to support tuna population. ▪ Whaanau satisfied that human activities are not impacting tuna (e.g., Mining, farming, forestry). ▪ Whaanau satisfied with riparian vegetation, water flow and water quality to support tuna populations. ▪ No barriers to tuna migration.	– Macroinvertebrate assessment. – Gee minnow fishing. – Visual site assessment. – CHI. – Assessment of elver and tuna heke migration barriers*.
Safe to access	▪ Whaanau satisfied that riparian vegetation is not impacting access to the fishery. ▪ Whaanau satisfied that surrounding land ownership is not impacting access to the fishery. ▪ Whaanau satisfied that regulations are not impacting access to the fishery.	– Visual site assessment. – CHI.

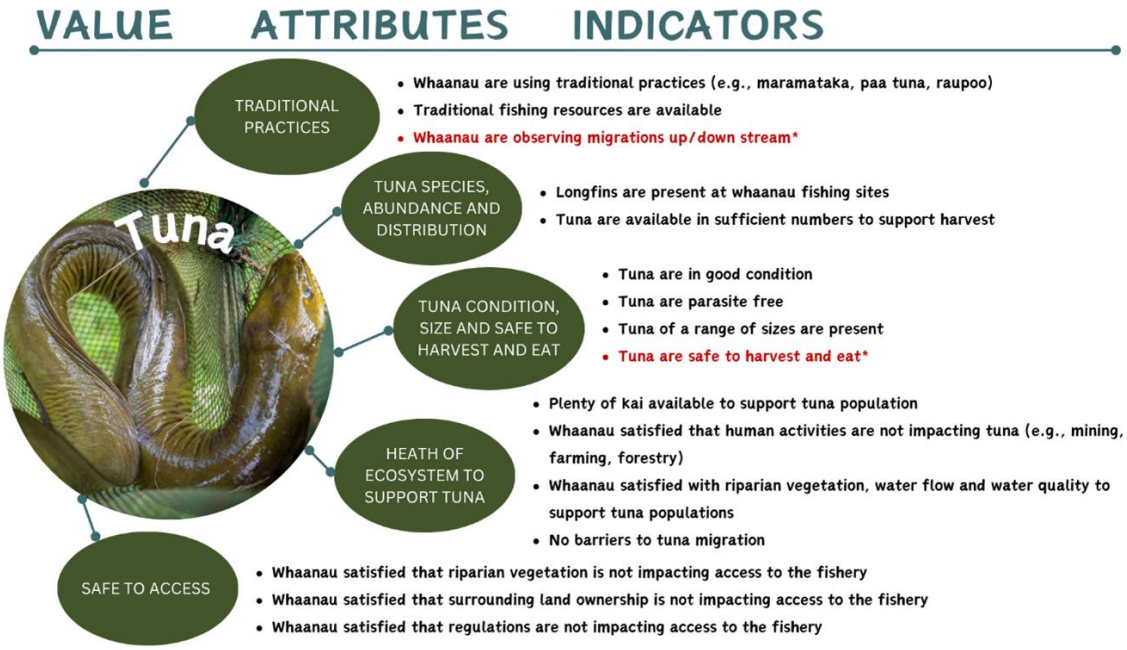


Figure 5-8: Indicators of Tuna and Ecosystem Health, and Whaanau Wellbeing showing the values, attributes, and measures used to assess the condition of tuna, their habitats, and the ability of whaanau to safely harvest and maintain traditional practices.

Kaiaua Attributes, Indicators and Monitoring Tools

Table 5-2: Potential kaiaua attributes of importance to whaanau, alongside some suggested indications and monitoring methods. *Potential indicators that require an appropriate monitoring tool/method to be developed.

Kaiaua attributes	Potential indicators	Potential tools
Traditional practices	▪ Whaanau are using their traditional practices (e.g., Maramataka). ▪ Traditional resources are available.	– Assessment at whaanau determined sites and moon phase. – Visual site assessment.
Kaiaua species, abundance and distribution	▪ Kaiaua are present at preferred sites. ▪ Kaiaua are available in sufficient numbers to support harvest. ▪ Potential host fish species are present.	– CHI. – Visual assessment. – Kaiaua timed search, Gee minnow fishing (for host fish).

Kaiaua attributes	Potential indicators	Potential tools
Kaiaua condition, size and safe to harvest and eat	▪ Kaiaua of a range of sizes are present. ▪ Kaiaua are in good condition*. ▪ Kaiaua are parasite free*. ▪ Kaiaua are safe to harvest and eat*.	– CHI. – Visual assessment. – Kaiaua timed search. – Condition index.
Health of the ecosystem to support kaiaua	▪ Whaanau satisfied that human activities are not impacting kaiaua (e.g., Mining, farming, forestry). ▪ Whaanau satisfied with riparian fencing and vegetation, water flow and water quality to support kaiaua populations. ▪ No barriers to kaiaua host fish migration (e.g., Host fish present in sufficient numbers).	– Visual site assessment. – CHI. – Assessment of host fish migration barriers. – Stream/Lakebed composition (Wolman Walk).
Safe to access	▪ Whaanau satisfied that riparian vegetation is not impacting access. ▪ Whaanau satisfied that surrounding land ownership is not impacting access. ▪ Whaanau satisfied that regulations are not impacting access.	– Visual site assessment. – CHI.

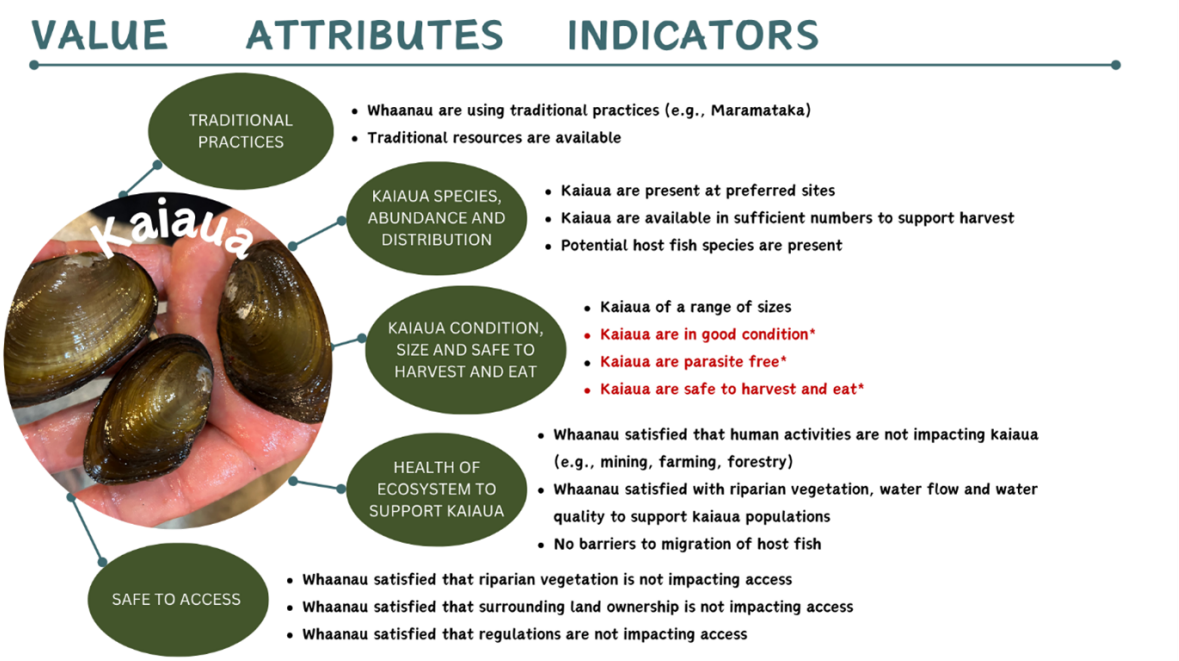


Figure 5-9: Indicators of Kaiaua and Ecosystem Health, and Whaanau Wellbeing outlining the values, attributes and measures used to assess kaiaua abundance, condition, and access for customary harvest.

Tupu Wai Attributes, Indicators and Monitoring Tools

Table 5-3: Potential tupu wai attributes of importance to whaanau, alongside some suggested indicators and monitoring methods. Potential indicators that require an appropriate monitoring tool/method to be developed.

Tupu wai attributes	Potential indicators	Potential tools
Traditional practices	▪ Whaanau are using traditional practices (e.g., Maramataka). ▪ Traditional resources are available (e.g., Rongoaa).	– Assessment at whaanau determined sites and moon phases. – Visual site assessment. – Whaanau interviews.
Tupu wai species, abundance and distribution	▪ Percentage cover and diversity of species at preferred sites. ▪ Proportion of invasive vs invasive species.	– Visual assessment. – Quadrat or transect surveys. – CHI. – Photopoint monitoring.

Tupu wai attributes	Potential indicators	Potential tools
Health of the ecosystem to support tupu wai	▪ Whaanau satisfied that human activities (e.g., Mining, farming, forestry) are not negatively impacting plant beds. ▪ Whaanau satisfied with riparian fencing and vegetation to support tupu wai. ▪ Whaanau satisfied with water clarity. ▪ Whaanau satisfied with water flow*. ▪ Whaanau satisfied with water quality and substrate (i.e., no heavy metals, pesticides and/ or sedimentation)*.	– Visual site assessment. – CHI. – Sediment and water quality testing*. – Riparian vegetation assessment.
Safe to access	▪ Whaanau satisfied that riparian vegetation is not impacting safe access. ▪ Whaanau satisfied that land ownership is not impacting access. ▪ Whaanau satisfied that regulations are not impacting access. ▪ Whaanau satisfied with signage (e.g., Biosecurity protocols and key messaging).	– Visual site assessment. – CHI. – Whaanau interviews.

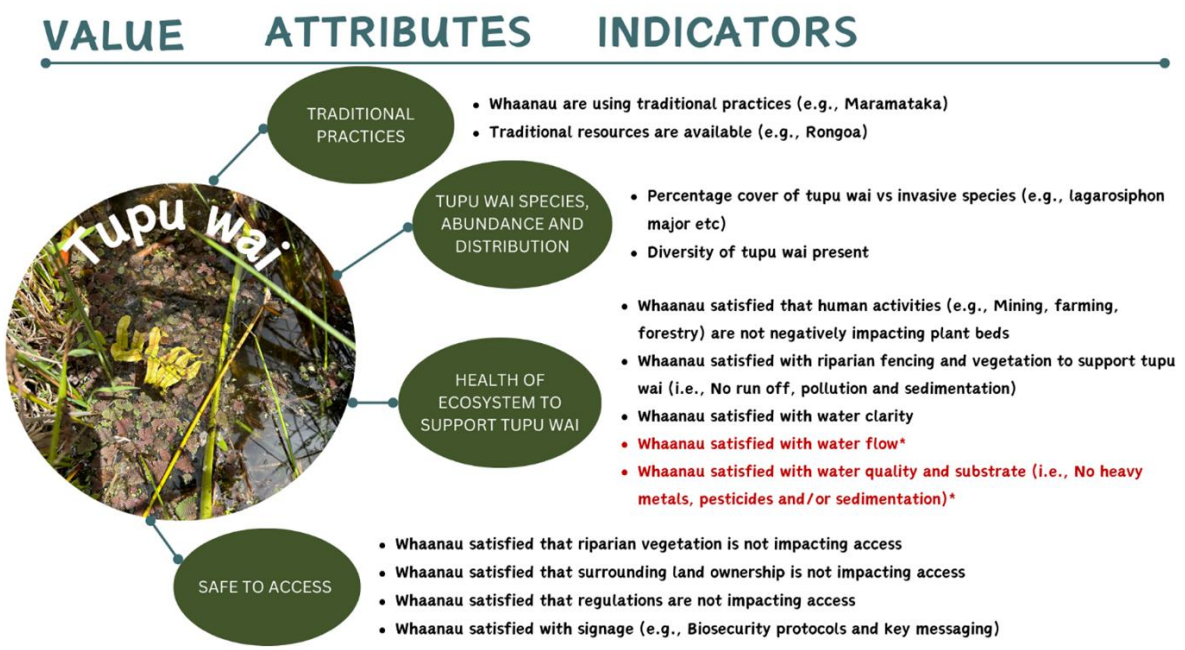


Figure 5-10: Assessing the health and accessibility of Tupu Wai, highlighting traditional practices, species abundance, ecosystem support, and safe access indicators for whaanau wellbeing.

5.3 Site selection – Where to monitor

This monitoring plan has been developed to assess waterways within the Tahaaroa lakes catchment. As such we anticipate that much of the monitoring will occur either in or around the lake, as well as interconnecting lakes Numiti and Rotoroa. Sampling and assessment may also occur in the surrounding tributaries and rivers that flow into and out of the lake (Figure 5-11). It is important that the monitoring sites chosen will allow for the activities to occur safely, that site selection covers places of importance to whaanau, and on-going access is possible into the future.

5.4 Frequency – When to monitor

We suggest that monitoring is completed at regular intervals as determined by the timing that best suits The Trust and kaitiaki and their understandings, needs and aspirations (e.g., monitoring tuna heke). In the future, The Trust and kaitiaki may also choose to follow the maramataka aa-hapuu to time their monitoring events. As a guide, monitoring four times per year is a reasonable number of monitoring events and could (if timed that way) provide data for the four seasons observed throughout the year.

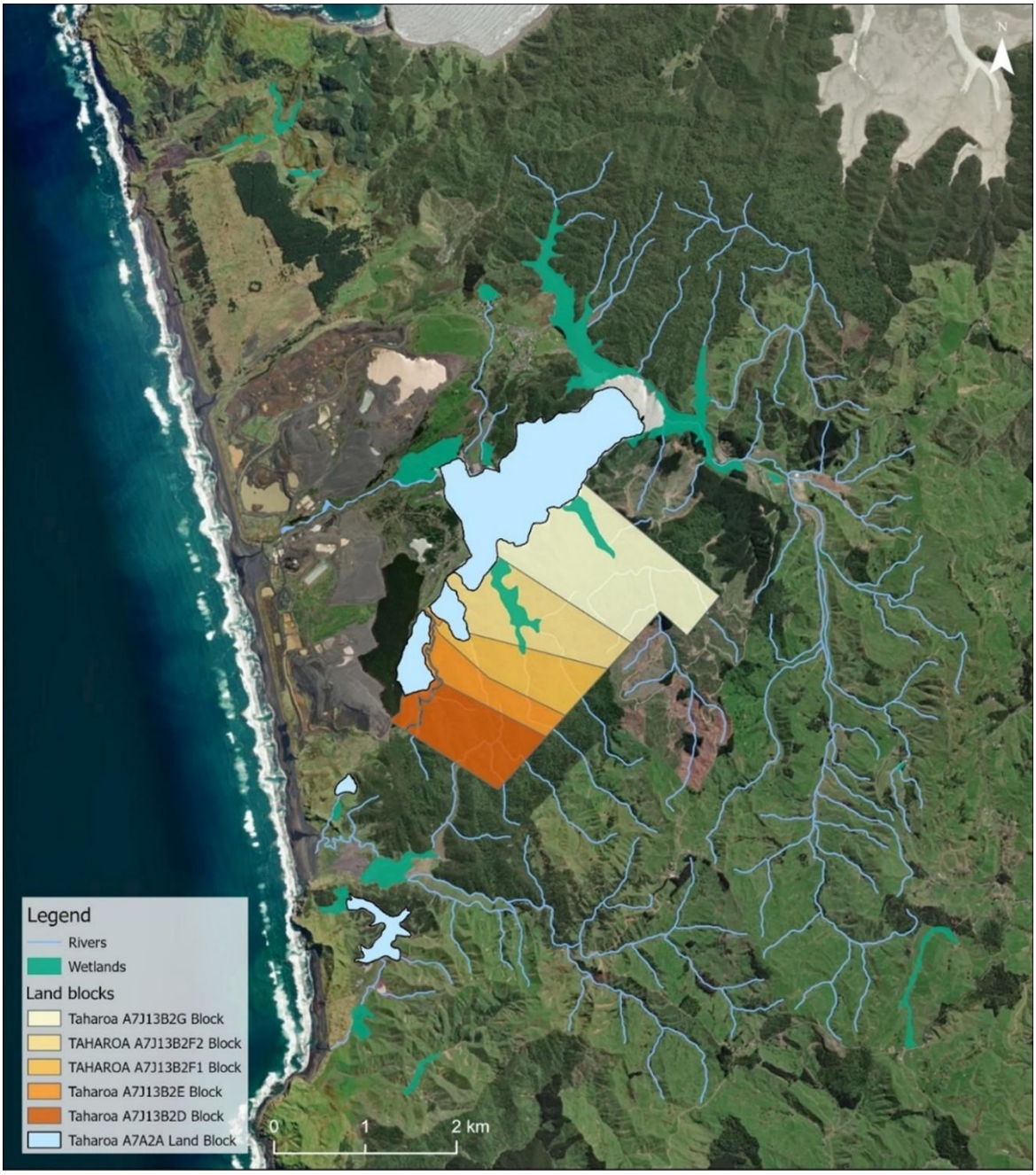


Figure 5-11: This map is a spatial overview of the Tahaaroa lakes catchment, highlighting key landscape features, wetlands, rivers and waterways. Relevant to this project are the Maaori land blocks in the catchment, including Tahaaroa A7A2A, A7J13B2B, A7J13B2E, A7J13B2F1, A7J13B2F2, and A7J13B2G. [Graphic: Ruby Mckenzie Sheat, ESNZ].

5.5 Methods – How to monitor

A mixed methods approach will be required to deliver the Tahaaroa catchment monitoring plan (see Table 5-1 to Table 5-3). This monitoring plan anticipates a 'train the trainers' approach, whereby The Trust and kaitiaki trained in various methods will hopefully become comfortable in transferring their skills to on-train other kaitiaki within the hapuu, as the framework grows and develops over time.

Between November 2023 to April 2025, The Trust, ESNZ and Ngaati Mahuta kaitiaki tested some of the potential monitoring tools (Table 5-4) at one site in Lake Tahaaroa. Monitoring waananga were training opportunities focused on ESNZ's Lakeside Monitoring Tools for Communities Field Guide modules such as water quality (clarity, conductivity, temperature, pH), fish (tuna), freshwater mussels (kaiaua) and aquatic plants (tupu wai).

An additional method that emerged through the evolution of the monitoring programme was the development of hapuu-led cultural health indicators, informed by the CHI (Tipa & Tierney, 2006) and implemented through the use of the Rongo App. The Rongo App is a purpose-built kaitiaki observation tool for Ngaati Mahuta. It enables real-time data collection through spatial mapping tools and multimedia inputs, including video, audio, images and text. This method empowers whaanau to express their level of satisfaction with qualitative attributes, for example, whether tuna are present in sufficient numbers in preferred harvest sites, whether they taste as expected, or whether the mauri of the lake is perceived to be intact. Unlike conventional approaches, this method does not rely on quantitative measurements, but instead privileges maatauranga-informed, whaanau-centred assessments of cultural values. Approaches like these have been successfully incorporated into Waitaki Cultural Health Programme (Tipa & Associates, 2015), the Murihiku Cultural Water Classification System (Kitson et al. 2018), the Maniapoto Cultural Assessment Framework (Ratana et al. 2020) and the Tūtira Monitoring Action Plan (Ratana et al. 2024).

Table 5-4: Potential monitoring tools and equipment required to assess the values in the Tahaaroa catchment monitoring plan. The methods outlined were developed and tested alongside kaitiaki between November 2023 to April 2025. However, the CHI component is an exception. The CHI was introduced in August 2024 through using Rongo App, subsequently tested in the fieldwork in April 2025. Rongo App is a purpose-built kaitiaki observation tool for Ngaati Mahuta, supports place-based monitoring and strengthens the recording and transmission of maatauranga in a format that aligns with contemporary tools and tikanga. Refer to Appendix F for a list of equipment (Table F-1).

Potential Monitoring Tools	Equipment Required	Value/s
Visual site assessment	Two or more whaanau, clipboard, survey form, pencil, Eye On Water App (optional), camera (optional)	Tuna. Kaiaua. Tupu wai.
Cultural Health Indicators	Three or more whaanau will be required to develop and test the CHI through use of Rongo App (e.g., do you think you can use this site in the same way as whaanau have in the past? Would you return to this site in the future?)	Tuna. Kaiaua. Tupu wai.
Fyke Netting (or Hiinaki)	Two or more whaanau, coarse mesh fyke nets, stakes, rope, bait (optional), weights (optional), buckets, scales, tuna holding bags, 2-3 large fish bins, Aqui-S, measuring tape or board, GPS, clipboard, survey form and pencil, camera (optional).	Tuna.

Potential Monitoring Tools	Equipment Required	Value/s
Gee-minnow Trapping	Gee minnow traps with clips, rope with small buoy, bait pottles (optional), bait (optional), stake, buckets and/or white trays, ruler or small measuring board, camera (optional), GPS, freshwater fish ID guide, clipboard, survey form and pencil.	Tuna.
Kaiaua timed search	Two or more whaanau, waders, stopwatch, bathyscope, vernier callipers or ruler, white trays, freshwater mussel ID guide, GPS, torch (optional), camera (optional), clipboard, survey form and pencil.	Kaiaua.
Water quality	Clarity tube, black disc and secchi, temperature probe, pH strips, clipboard, survey form and pencil.	Tuna. Kaiaua.
Wading knee deep	Measuring tape, bathyscope, grapnel (modified rake head), small spade or hoe, white tray, GPS, camera, aquatic plant ID guide, laminated field plant identification sheet, clipboard, survey form and pencil.	Tupu wai.

5.5.1 Health and Safety

The cultural and physical health and safety of kaitiaki in the field is paramount, and something that needs to be included at the forefront of each monitoring event (and at every monitoring site). It is important that all surrounding landowners (even if monitoring is not occurring on their properties) know what kaitiaki are doing and when, so that whaanau do not have to worry about any situations of conflict when they are doing their mahi, even if they have every right to be there.

Weather conditions

Before conducting any field work it is important to consider the weather conditions for the day(s). Sometimes the weather will dictate the most suitable times to do field work. It all depends on what you are trying to measure and whether the equipment you are using is easy to handle in all types of weather. Checking the weather to ensure that kaitiaki will be safe for the duration of the fieldwork scheduled should be at the forefront of all planning.

- Weather forecasts are available from a number of sources, including:
  - MetService: www.metservice.co.nz.
  - NIWA weather: https://weather.niwa.co.nz/.
  - Sky TV's Weather Channel (Channel 98).
  - Newspapers, television and radio news broadcasts.

Hazard identification

Before heading into the field, as a group, identify all hazards or threats of harm and risks, and establish safety controls to eliminate, where possible, any risks associated with the hazards identified. If risks cannot be eliminated, every effort should be made to minimise the likelihood of harm occurring. A plan should be prepared by the team before undertaking a monitoring event, which is then used on-site to reflect on as a team and add any additional hazards that are specific to each site/monitoring event. Appendix C and Appendix D provides examples of the Health and Safety Plan and Attendance Register that was prepared for fieldwork and customised overtime.

When you arrive at a site, it is necessary to also go through a site-specific hazard check list and discuss mitigation options as a monitoring team. Any risks identified should also be monitored regularly throughout the duration of fieldwork to ensure the plan is working. The best way to manage safety hazards is to discuss and agree to a safety plan with everyone involved in the field work (Figure 5-12). Don't leave anybody out, all concerns should be addressed. Be sure to capture the safety plan on paper. That way it can be shared and added to for the benefit of future monitoring events/teams when they come back to a site.

Figure 5-12: Example of one of our daily "pass the raakau", Health and Safety discussions at Lake Tahaaroa in August 2024. After our karakia, everyone in the team provided their insights into the hazards that they had identified at the site and the actions they suggested the team put in place to reduce risks. [Photo: Keith Kana, Ngaati Mahuta].

Team preparation and personal protection

Key preparations at the start of each fieldwork and monitoring event should include:

- At the start of each day (and at every new site) take some time, as a team to discuss the range of potential hazards and the actions that could be taken to reduce any risk.
- All kaitiaki having appropriate footwear for protection from sharp objects and appropriate protective clothing to deal with both hot and cold weather. If whaanau are spending time in the water, they will ideally need waders.
- Take a first aid kit with you and ensure someone in the team is first aid trained.

- Ensure that someone who is not with you in the field knows exactly where you are and when to expect you back – and that you have an agreed action in place if you do not arrive back at the expected time. For example, whaanau remaining at the marae can be added to the key contact list.
- Appropriate forms of communication are available, e.g., check cell phone coverage beforehand and make sure they are fully charged, if reception is not good take satellite phones or EPIRBs (emergency position-indicating radio beacon) wherever possible.
- Plenty of water and food to last for the full day's activities is available.
- Each team member is ready to manaaki themselves and all others in the team.
- Assign a Health and Safety observer for the site/day to make sure any late arrivals, landowners, and/or members of the public who approach the team are aware of the teams' health and safety protocols.

6 Monitoring Methods – November 2023 to April 2025

To help with the development and testing of the Tahaaroa catchment monitoring plan a team of kaitiaki from The Trust and Ngaati Mahuta, alongside ESNZ worked together to coordinate nine waananga over a two-year period from November 2023 to April 2025. The team tested potential monitoring tools that are readily available at Lake Tahaaroa (Table 5-4). The monitoring waananga focused on water quality (clarity, conductivity, temperature, pH), fish (tuna), freshwater mussels (kaiaua) and aquatic plant (tupu wai) modules in the Lakeside Monitoring Tools for Communities Field Guide. This section describes the specific monitoring tools used for each value.

6.1 Tuna

To assess the current state of tuna we used the following data monitoring methods, including:

- A visual site assessment that included:
  - recent site conditions (flood, land use, inputs, disturbances),
  - catchment and bankside characteristics, and
  - presence/absence of instream habitat for tuna.
- Two coarse-mesh fyke-nets and two Gee-minnow set overnight for catch characteristics that included:
  - species composition,
  - catch-per-unit-effort (CPUE),
  - size distribution,
  - condition,
  - presence/absence of tuna kai species (small fish and invertebrates), and
  - presence/absence of external parasites or lesions.
- An adaption of the CHI method (Tipa and Tierney 2006) to assess:
  - whaanau satisfaction with the state of the surrounding ecosystem to support tuna,
  - whaanau satisfaction with tuna abundance, and their ability to safely harvest and consume tuna, and
  - whaanau satisfaction with the instream and surrounding conditions that might impact on tuna.

Some of the methods required to assess commonly asked paatai like “are our tuna safe to eat? (i.e., risk of bioaccumulative contaminants in tuna flesh and comparing these levels to whaanau consumption patterns as part of a USEPA risk assessment, e.g., Stewart et al. 2014)”, were unable to be undertaken within the scope of this project.

In addition to the seasonal net-based monitoring undertaken by the Trust, MPI funded a complementary intensive tuna survey, carried out in February 2025 by ESNZ in partnership with The Trust and Ngaati Mahuta kaitiaki. All sites were georeferenced in the present study and then reviewed during planning to ensure spatial alignment with the previous survey (Figure 6-1). The purpose of this survey was to provide a detailed baseline of tuna abundance, size, sex, and health in Lake Tahaaroa, and to establish a benchmark for long-term monitoring and whaanau decision-making about the customary fishery.

Standardised set nets were deployed at multiple sites and depths across the lake to capture a representative sample of both shortfin (Anguilla australis) and longfin (A. dieffenbachii) tuna. All tuna were processed by an on-shore team who recorded species, length, weight, sex, and external condition, and examined individuals for parasites (including gill nematodes and black spot disease). A subset of individuals was assessed in greater detail to evaluate growth condition (weight: length ratio). Following measurement, tuna were returned live to the lake.

This intensive survey provides a one-off lake-wide snapshot that complements the Trust's repeated seasonal monitoring, allowing integration of tikanga-led and scientific approaches in the catchment monitoring plan. Together, these methods provide both depth and breadth, capturing whaanau observations at Maukore alongside a comprehensive scientific baseline for Lake Tahaaroa.

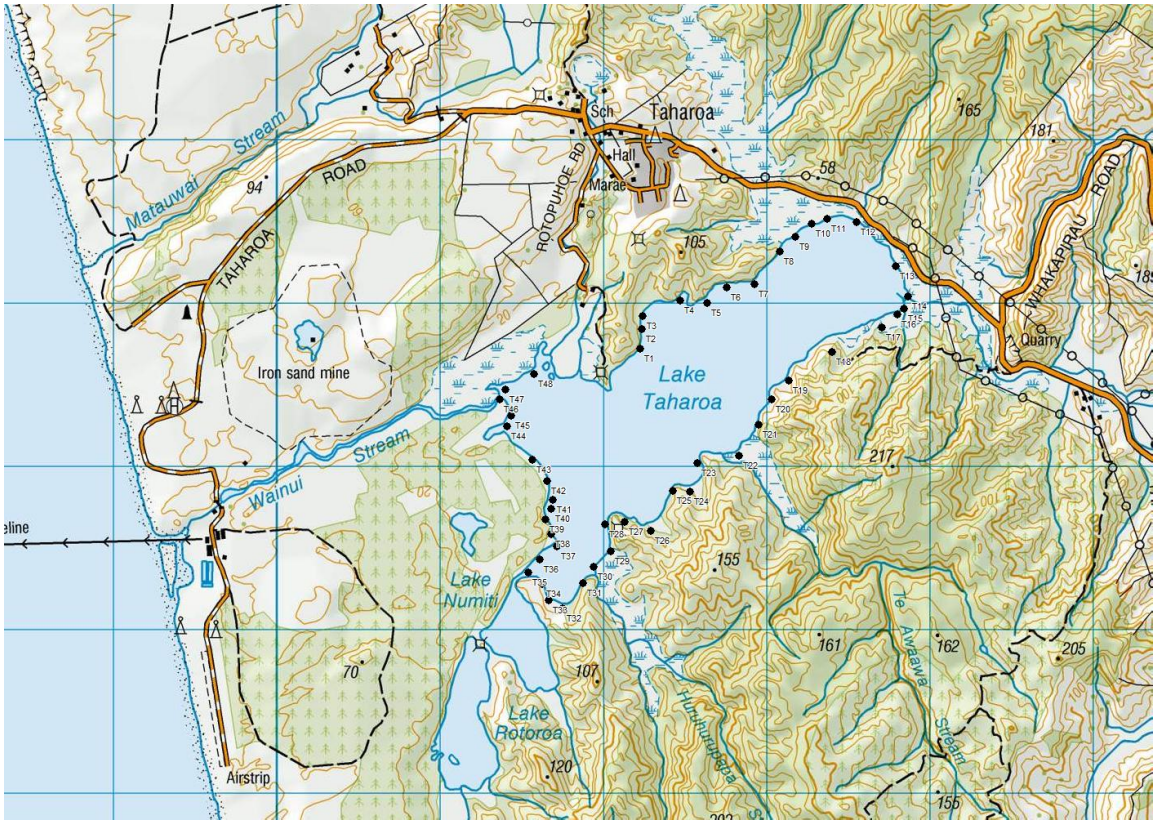


Figure 6-1: Map showing the 48 sampling sites surveyed for tuna monitoring around the perimeter of Lake Tahaaroa. Sites (T1–T48) were established at approximately equal intervals to provide comprehensive coverage of shoreline and inlet habitats. Each site was geo-referenced using GPS, and full coordinates. The survey design enabled consistent comparison of catch per unit effort (CPUE), species composition, and habitat characteristics across the lake.

6.2 Kaiaua

To assess the current state of kaiaua we used the following data monitoring methods:

- A visual site assessment that included:
  - recent site conditions (flood, land use, inputs, disturbances), and
  - catchment and bankside characteristics.
- Lakeside Monitoring Toolkit methods that included:
  - species composition,
  - catch-per-unit-effort (timed search of a set area), and
  - size distribution.
- Shell condition assessment – each shell examined for evidence of erosion using a four-grade scale adapted from Graynoth et al. (2013) and Watene-Rawiri et al. (2018):
  - Grade 1: intact periostracum, little/no erosion,
  - Grade 2: minor erosion, periostracum beginning to wear,
  - Grade 3: moderate erosion, ridges worn smooth and periostracum patchy, and
  - Grade 4: severe erosion, shell thin/brittle with periostracum largely absent.
- Cultural Health Index approach (Tipa and Tierney 2006), assessing:
  - whaanau satisfaction with the state of the surrounding ecosystem to support kaiaua (e.g., fish passage, invasive/pest species),
  - whaanau satisfaction with the condition of the instream habitat to support kaiaua (e.g., algal growth, substrate, water flow, and water levels, pollution), and
  - whaanau satisfaction with the access to a site (both physically and legally).
- Reproductive assessment – kaiaua were inspected for signs of gravidity (swollen gills). Juveniles were defined as <30 mm shell length. In addition, host fish (common bullies, *Gobiomorphus cotidianus*) were examined for encysted glochidia to provide indirect evidence of reproduction.

Limitations: Survey effort at Maukore was restricted to accessible shoreline sites (0.3–1.5 m depth), and deeper habitats or raupoo-dense margins could not be sampled. Results should therefore be interpreted as representative of monitored sites rather than a full lake census.

In addition to the lakeside monitoring undertaken by the Trust, Waikato-Tainui funded a complementary intensive diver-based survey of kaiaua populations, carried out in November 2024 by ESNZ in partnership with The Trust and Ngaati Mahuta.

The purpose of this survey was to establish a robust baseline of kaiaua distribution, density, mortality, and shell condition across the three interconnected lakes (Tahaaroa, Numiti, and Rotoroa), providing a reference point for long-term monitoring and kaitiaki decision-making. A vessel was used to transport the team to 15 transect sites (five per lake), selected from previous LakeSPI macrophyte survey locations (Figure 6-2). Divers followed transects from the shoreline to three depth zones (1 m, 3 m, and 5–6 m) where standardised quadrats (0.33 m^2) were placed (Figure 6-3). All kaiaua within quadrats were collected and transferred to the on-shore processing team to record species, count live and dead individuals, measure shell length (to the nearest 0.5 mm), identify sex, and assess shell condition. Live kaiaua were then carefully returned to their site of origin. This intensive survey complements the Trust's seasonal monitoring and strengthens the integration of tikanga-led and scientific approaches in the catchment monitoring plan.

Together, the intensive surveys of tuna and kaiaua provide robust lake-wide baselines that complement the Trust's seasonal monitoring. By aligning these approaches within the catchment monitoring plan, the results strengthen our ability to assess taonga species in relation to one another and to the wider habitat, supporting both kaitiaki decision-making and long-term ecological monitoring

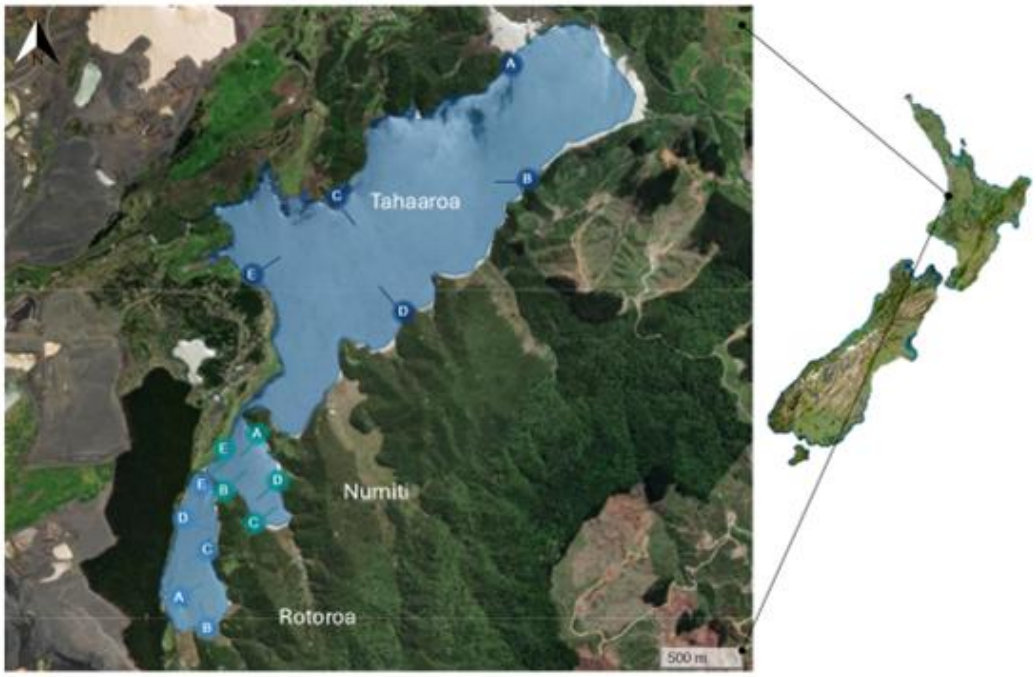


Figure 6-2: This map represents transect sites A-E surveyed for tupu wai and kaiaua in Lakes Tahaaroa, Numiti and Rotoroa in November 2024. The lines indicate the direction of each transect extending from the shoreline to a maximum depth of 5-6 m. The inset map shows the location of the Tahaaroa lakes on the west coast of the North Island.

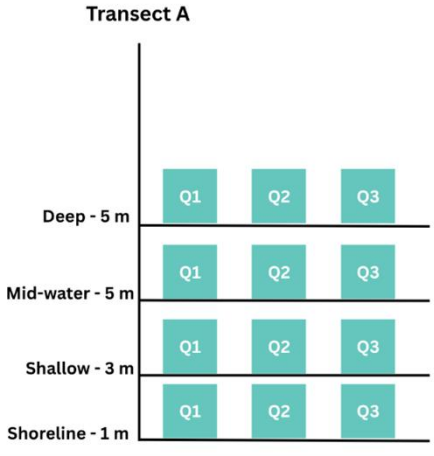


Figure 6-3: Schematic diagram illustrating the kaiaua sampling design used in Lakes Tahaaroa, Numiti, and Rotoroa (November 2024). Five transects were surveyed per lake, with samples collected at four depth intervals: shoreline (1 m), shallow (3 m), mid-water (5 m), and deep (5+ m) from three replicate quadrats (Q1–Q3) at each depth. This design enabled consistent spatial comparison of kaiaua abundance, condition, and habitat characteristics across all lakes.

6.3 Tupu Wai

To assess the current state of tupu wai we used the following data monitoring methods:

- A visual site assessment that included:
  - recent site conditions (flood, land use, inputs, disturbances), and
  - catchment and bankside characteristics.
- Use of tools from the Lakeside Monitoring Toolkit that included:
  - percentage cover and diversity of species at preferred sites, and
  - proportion of invasive vs invasive species,
- A Cultural Health Index approach (Tipa and Tierney 2006) was introduced to assess:
  - whaanau satisfaction with riparian vegetation not impacting access,
  - whaanau satisfaction with surrounding land ownership not impacting access,
  - whaanau satisfaction with regulations not impacting access, and
  - whaanau satisfaction with signage (e.g., Biosecurity protocols and key messaging).

To assess tupu wai cover in the shallow zone (approximately knee-deep water, ~0.5 m), the Lakeside Monitoring Toolkit includes a community-based method that establishes a shoreline survey area. Along the survey area, observers use an underwater viewer, rake or hoe to estimate percentage cover of tupu wai in the shallow zone (Figure 6-4).

Observations are repeated at 2–5 m intervals along the survey area, with percentage cover estimated to the nearest 5%, supported by photographs and collected samples. This approach provides a rapid, accessible measure of tupu wai extent and complements the more detailed LakeSPI assessments, whiles also supporting whaanau participation and building local monitoring capacity.

To provide broader ecological context for tupu wai abundance and distribution, a complementary macrophyte survey was undertaken by ESNZ's Aquatic Plant Group and Te Kūwaha in November 2024. Five representative sites within Lakes Tahaaroa, Numiti, and Rotoroa were surveyed using the nationally standardised Lake Submerged Plant Indicators (LakeSPI) method (Clayton & Edwards, 2006) (Figure 6-2). At each site, divers recorded aquatic plant diversity, abundance, depth extent, and cover of both native and invasive species, alongside site-specific information on substrate type, water depth, and underwater visibility. In addition, LakeSPI indices, the Native Condition Index, Invasive Impact Index, and overall LakeSPI Index, were calculated to track changes in ecological condition since previous surveys (2014), providing a longer-term measure of lake health.

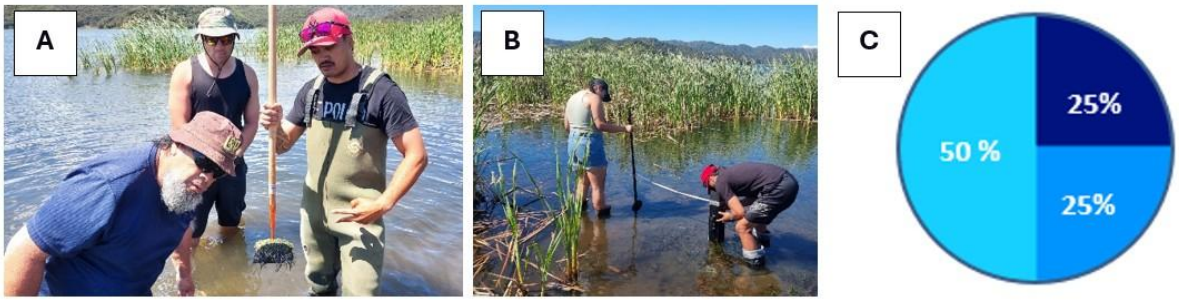


Figure 6-4: Tupu wai monitoring at Maukore, Lake Tahaaroa in November 2023. Photo A is Bryce Whitiora (front), Raymond King (back) and Luke Baker (middle) holding a hoe grab sample collected within the shoreline survey area. Photo B shows Luke Baker and Niwa Huaki-Otimi assessing tupu wai cover and species composition. Photo C provides a percentage cover estimate example. [Photos: Ngahuia Herangi, ESNZ].

6.4 Digital Tools –The Stream

A central component of the Tahaaroa catchment monitoring plan is the partnership between The Trust and The Stream, facilitated by ESNZ, to co-develop digital tools that integrate cultural and scientific knowledge for lake management. This collaboration embodies mana whakahaere and data sovereignty, ensuring that environmental information is collected, stored, and visualised in ways that are meaningful to Ngaati Mahuta.

The Trust and The Stream have worked together to design and customise a suite of digital applications that align with both He Anga Aroturuki Wai Maaori framework and the operational needs of the Tahaaroa lakes. These tools support the long-term goal of enabling whaanau and kaitiaki to manage and access their own environmental data, strengthening their role as decision-makers and guardians of the roto.

The Stream's digital suite includes:

- **StreamDASH** – a centralised dashboard for visualising data collected across multiple monitoring programmes (e.g., water quality, tuna, kaiaua, and tupu wai). It allows users to track changes over time and view indicators in a single, integrated interface.
- **StreamMAP** – an interactive spatial mapping tool that enables users to view lake and catchment features, sampling sites, and habitat areas using both scientific and cultural layers.
- **Tūhono** – a tool for catchment-wide analysis through a te ao Maaori lens. Tūhono integrates datasets, maatauranga, and indicators, helping users to interpret environmental change alongside tikanga-based frameworks such as He Anga Aroturuki Wai Maaori.
- **Rongo** – a mobile application designed for kaitiaki to record real-time field observations. Rongo enables the collection of tikanga indicators such as mauri, kai safety, and species condition, alongside scientific measurements (Figure 6-5).

Together, these tools enable mana whenua-led environmental monitoring. They allow the Trust and local kaitiaki to access, analyse, and share environmental data on their own terms, strengthening their capacity to monitor tuna health, assess tupu wai condition, and track environmental changes across the three lakes.

The partnership also supports the co-development of a shared, intergenerational knowledge base, combining existing scientific datasets with maatauranga Maaori and locally gathered observations. This integration provides a platform for the Trust to report on environmental health using both cultural and ecological indicators, influence regulatory processes, and inform restoration priorities.

Ultimately, this collaboration demonstrates how digital innovation can be grounded in tikanga, supporting self-determined management of taonga species and ecosystems. By aligning digital infrastructure with whaanau values and decision-making structures, the partnership between the Taharoa Lakes Trust, The Stream, and ESNZ contributes to a living model of mana whakahaere in action.

Data collected through these digital tools is directly aligned with the He Anga Aroturuki Wai Maaori framework, ensuring that cultural, ecological, and social indicators are recorded and interpreted together. Information gathered through Rongo, StreamDASH, StreamMAP, and Tūhono feeds into the Trust's reporting cycle, where kaitiaki evaluate trends in mauri, kai safety, species health, and habitat condition alongside scientific datasets. This integration allows the catchment monitoring plan to function as a living system, one that evolves through continuous observation, reflection, and action. It ensures that monitoring outcomes remain responsive to both the state of the roto and the aspirations of Ngaati Mahuta for restoration and long-term governance.

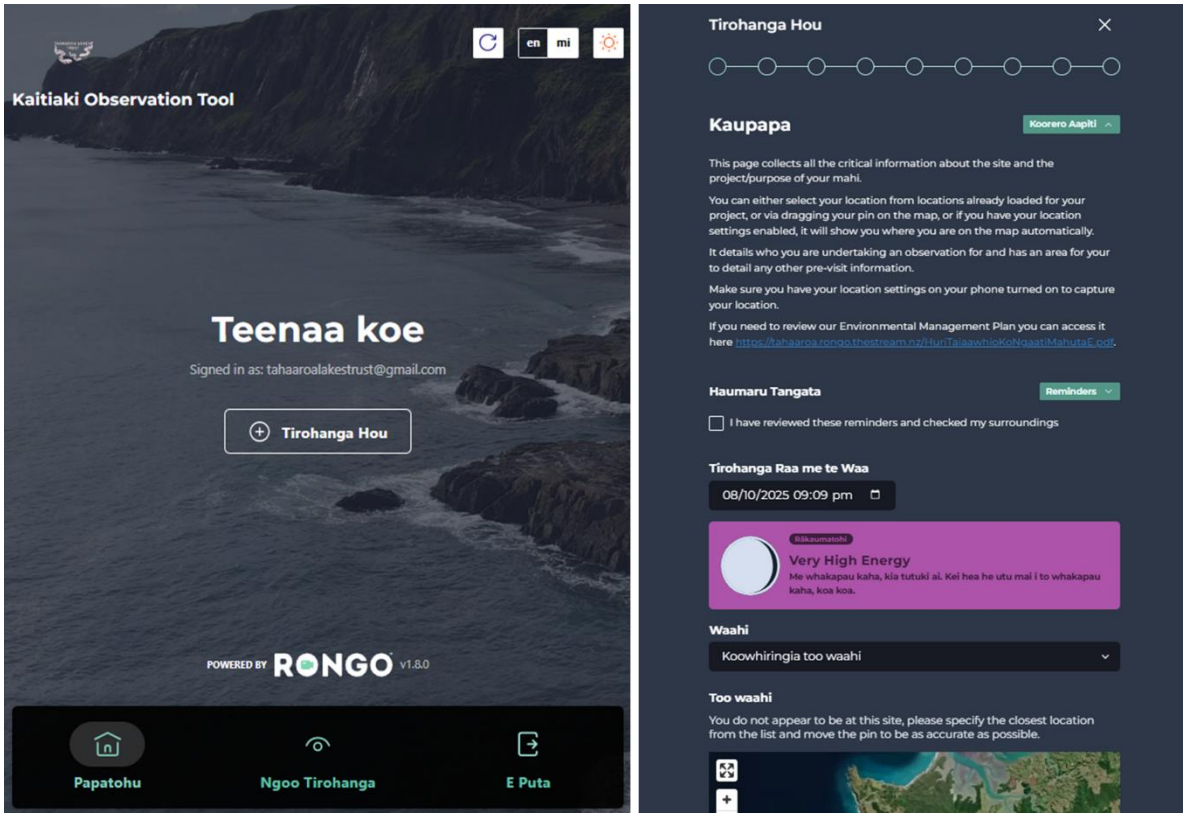


Figure 6-5: Rongo is a Kaitiaki Observation Tool that enables kaitiaki to record real-time field observations, including tikanga indicators such as mauri, kai safety, and species condition, alongside scientific measurements through the use of a mobile application. Tirohanga Hou is a new observation interface, which allows users to enter kaupapa details, record site conditions, and upload location data as part of ongoing environmental monitoring by the Taharoa Lakes Trust.

6.5 Data Management and Quality Assurance

Robust data management underpins the integrity of the Tahaaroa catchment monitoring plan. All environmental and cultural information collected through monitoring is treated as taonga, governed by the principles of mana whakahaere and data sovereignty held by Ngaati Mahuta through The Trust.

Data collected in the field including measurements, photographs, GPS coordinates, and tikanga observations are uploaded directly to the Rongo App or securely transferred to The Stream platform. Within this digital environment, information is stored and visualised through interconnected tools:

- **Rongo** – captures real-time field observations from kaitiaki, linking each record to metadata such as location, observer, and method.
- **StreamDASH** – centralises validated datasets for visual analysis, comparison, and time-series reporting.
- **StreamMAP** – manages spatial data layers, mapping sites, habitats, and land-use features relevant to the lakes and their catchment.
- **Tūhono** – integrates cultural indicators and maatauranga alongside scientific parameters for holistic interpretation.

To maintain quality assurance, all incoming datasets undergo a verification process that includes field cross-checks, photo validation, and periodic data audits by The Trust's monitoring coordinator with support from ESNZ and The Stream technical teams. Access to raw and processed data is permission-based, ensuring that ownership, use, and sharing remain under the control of The Trust.

Data are routinely backed up on both cloud and local servers, with encryption and version tracking applied to prevent loss or unauthorised modification. Summary datasets and dashboards are shared with partner agencies only when approved by The Trust, accompanied by metadata describing source, date, and level of confidence.

Together, these protocols ensure that information collected through the catchment monitoring plan remains accurate, secure, culturally protected, and fit for long-term decision-making, while upholding the integrity and sovereignty of Ngaati Mahuta over their environmental knowledge (Figure 6-6).

Figure 6-6: Ngaati Mahuta kaitiaki at Te Kooraha Marae during a monitoring waananga, November 2024. The hui provides opportunities for training, field coordination, and review of data collected through the Rongo App and The Stream digital platform. Whaanau participation ensures that data management and quality assurance processes remain grounded in tikanga and guided by collective responsibility for environmental knowledge.

7 Monitoring Results – November 2023 to April 2025

The following section presents the data gathered during six monitoring events at one site from Lake Tahaaroa in November 2023, April 2024, August 2024, November 2024, February 2025 and April 2026. At this early stage of the monitoring programme, the results should be interpreted with caution. This is because some measures will vary naturally with the seasons and site surveyed. As the monitoring methodologies are embedded and resulting datasets grow (both in space and time) kaitiaki from The Trust and hapuu will gain increasing confidence in the results being generated to inform future decision-making.

7.1 Tuna

Tuna are a taonga species central to the identity and hauanga kai of Ngaati Mahuta, and Lake Tahaaroa in particular has long supported an important customary fishery. Assessing their current state requires a combination of ecological and tikanga-based approaches. This section presents results on species composition and catch numbers, length and weight characteristics, and sex and parasite observations, before considering wider issues of migration and connectivity. Whaanau observations and tikanga indicators are also integrated to provide a holistic view of tuna health and availability. Together, these lines of evidence highlight both the present status of tuna in the Tahaaroa lakes and the next steps needed to ensure their long-term sustainability.

The monitoring team set two coarse-mesh fyke nets and 1-2 gee-minnow traps, approximately 10 m apart, at each “tuna” site. The nets/traps were left overnight with no bait. Each fyke net was secured at each end using stakes and/or weights (Figure 7-1). The fyke nets were used to target large fish, like tuna and the Gee-minnow traps were used to target small fish like common bullies.

All fish caught were anaesthetised (using a clove oil-based mixture called Aqui-S), identified by species, measured and (for tuna) weighed. Information about the other freshwater fish species caught (i.e., numbers captured and length) was also recorded

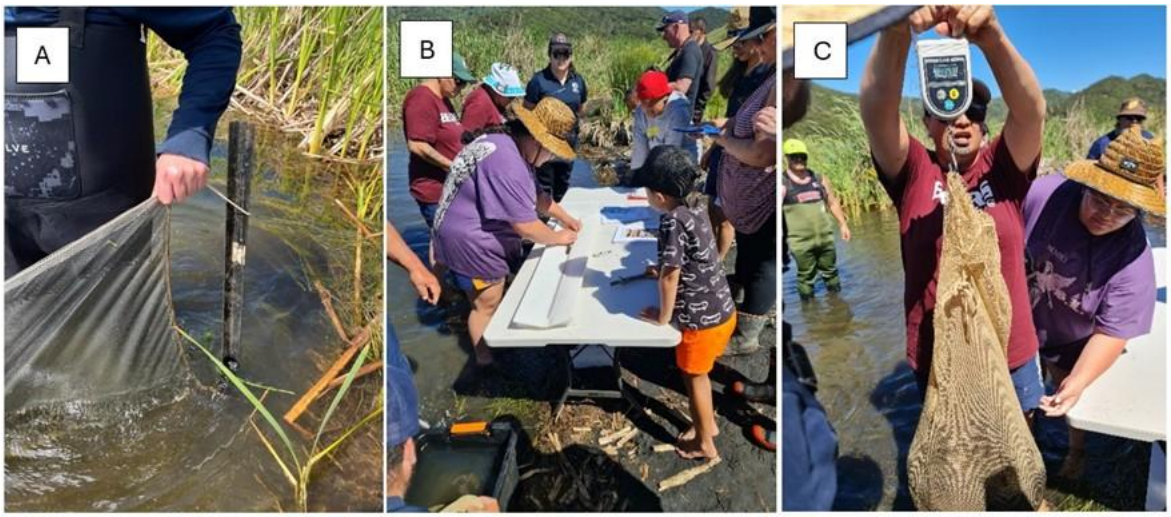


Figure 7-1: Photo A: Fyke nets are secured at each end to stakes, alternatively weights can be used. Photo B: Waimiria Willison measuring tuna length. Photo C: Rhonda Tuaupiki-Kerr measuring tuna weight. [Photos: Shannan Crow and Ngahuia Herangi, ESNZ].

7.1.1 Species Composition and Catch Numbers

Longfin (*Anguilla dieffenbachii*) only occur in New Zealand, unlike shortfin (*Anguilla australis*) that also occur in Australia and elsewhere in the Pacific. The numbers of large longfin (more than 650 mm in length, which are the females) appear to be declining throughout New Zealand. There are also concerns about the recruitment of juvenile longfin into New Zealand freshwaters. Further, some whaanau harvesters prefer (for eating), or are used to catching, either longfin or shortfin. For these reasons some whaanau pay particular attention to the species composition of their catch and want to monitor changes in the occurrence of longfin (Figure 7-2). However, it is also important to note that shortfin and longfin usually like/dominate different types of habitats, and this should also be taken into consideration when interpreting survey results.

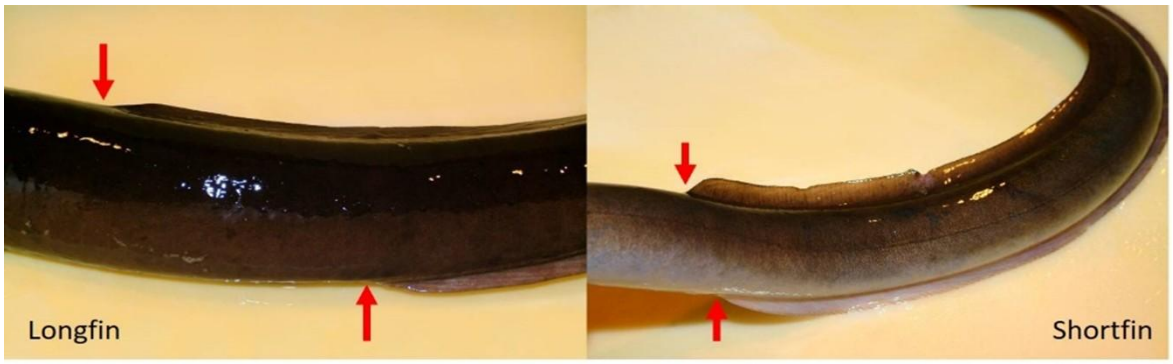


Figure 7-2: Checking the fins and identifying the species composition of our tuna catch: (Left) longfin, and (Right) shortfin. [Source: Peter Smith] .

The **catch per unit effort** (CPUE) for net/trap catches refers to the number of fish caught, per net, per night for each species. It is a useful way of standardising and comparing catch results between sites and is widely used in fisheries monitoring and management.

Across six monitoring events between November 2023 and April 2025, a total of 334 tuna was captured from Lake Tahaaroa sites (Figure 7-1). Longfin tuna comprised 6.9% of the catch, with the remainder being shortfin. Most tuna (93.1%) were taken from Maukore, also known as the boat ramp in Lake Tahaaroa. In addition, 738 bullies were recorded, dominated by the native common bully (Gobiomorphus cotidianus), with smaller numbers of Crans bully (Gobiomorphus basalis), giant bully (Gobiomorphus gobioides), and redfin bully (Gobiomorphus huttoni) (Table 7-1). While catch numbers provide a measure of relative abundance across lakes, analysing length and weight characteristics gives further insight into the age structure, recruitment potential, and overall condition of the tuna population. While catch numbers provide a measure of relative abundance across lakes, analysing length and weight characteristics gives further insight into the age structure, recruitment potential, and overall condition of the tuna population.

Table 7-1: Abundance (numbers caught) and catch per unit effort with fyke nets and bullies caught with Gee-minnow traps across six monitoring events between November 2023 and April 2025.
Generally, two un-baited course-mesh fyke nets and 1-2 Gee-minnow traps set at each site.

			Number of fish caught						CPUE (by number)					
					Bullies						Bullies			
Monitoring Date	Site	Method	Shortfin	Longfin	Common	Crans	Giant	Redfin	Shortfin	Longfin	Common	Crans	Giant	Redfin
11/11/23	Pump Station	2 fyke nets	52	7	–	–	–	–	26	3.5	–	–	–	–
12/11/23	Maukore	1 fyke net, 2 Gee-minnow traps	82	8	–	47	–	–	–	–	–	23	–	–
6/04/24	Maukore	2 fyke nets, 2 Gee-minnow traps	67	–	218	–	26	–	33.5	3.5	13	109	–	–
24/08/24	Maukore	2 fyke nets, 2 Gee-minnow traps	76	1	183*	3	–	–	38	1	139	2	4.5	1
23/11/24	Maukore	2 fyke nets, 2 Gee-minnow traps	21	2	37*	–	–	–	10.5	1	–	18.5	–	–
20/02/25	Maukore	2 fyke nets, 2 Gee-minnow traps	24	1	–	–	–	–	12	0.5	–	–	–	–
5/04/25	Maukore	2 fyke nets, 2 Gee-minnow traps **	27	4	128	–	–	–	13.5	2	64	–	–	–

* *The fins of bullies were found to host glochidia, indicating recent kaiaua reproduction.*

** *First time catching a kooura in fyke net 2.*

On 5 April 2025, a kooura measuring 147 mm (or 14.7 cm) was caught in fyke net 2 (Figure 7-3). A fully-grown kooura can average 12 – 15 cm in length, the orbit-carapace length (OCL) measurement is from behind the eye to the end of the carapace (above the tail) (Kusabs et al. 2018; Kusabs et al. 2015). Based on observations, the kooura appeared to be female. Small white cyst-like structures were observed on the kooura's exoskeleton (Figure 7-3C). Similar cyst-like structures on crustaceans are known to be metacercarial trematode stages in some aquatic systems, including New Zealand's intertidal environments (Leung et al. 2009). However, reports of such encysted parasites on freshwater kooura are absent from the scientific literature. The only significant disease documented in kooura is white tail disease, caused by a microsporidian parasite affecting internal tissues, making the identity of these surface cysts uncertain without further examination (Eimear et al. 2020).

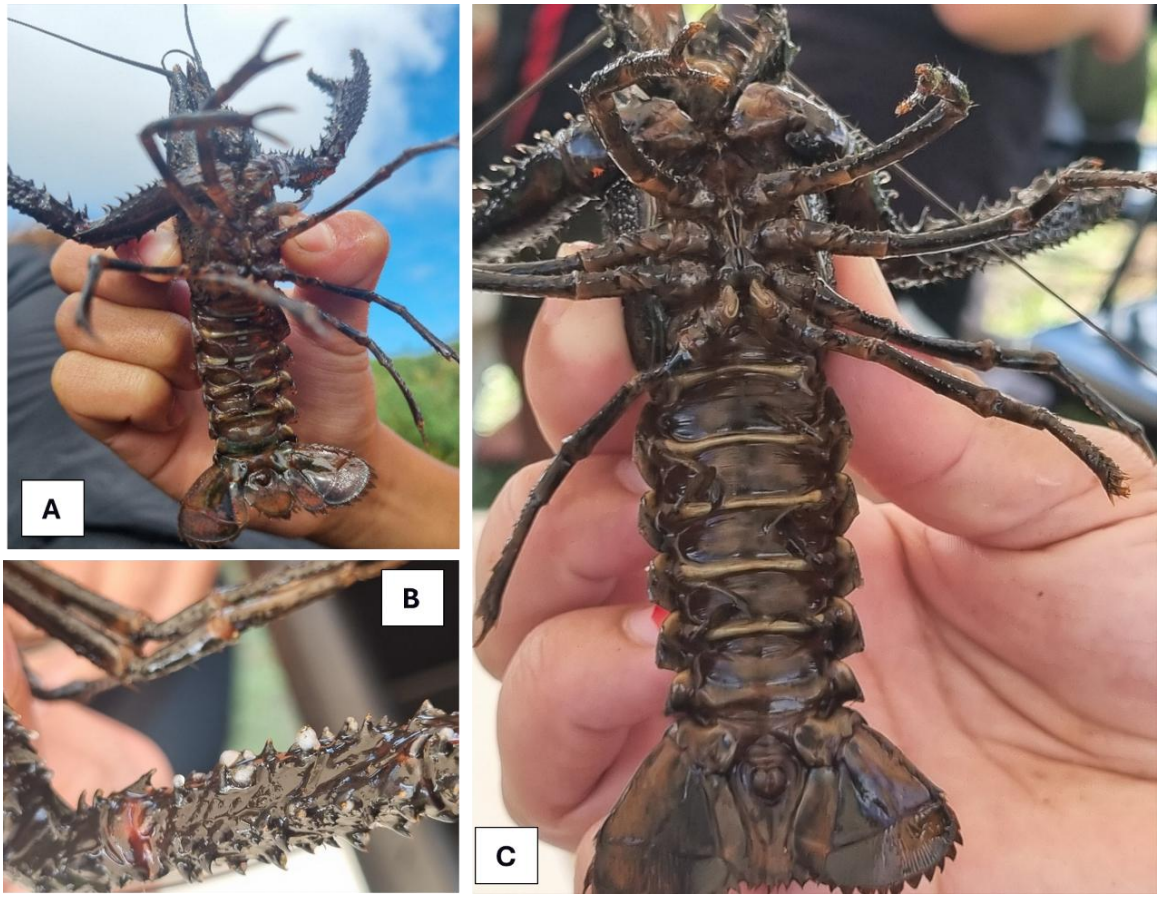


Figure 7-3: Kooura measuring 147 mm caught in fyke net at Maukore, Lake Tahaaroa in April 2025'. Photos A and C show rounded structures attached to the swimmerets (pleopods) under the tail, which are used to carry eggs/young. Photo B shows an unknown small white cyst-like structures on the kooura's exoskeleton. [Photos: Ngahuia Herangi, Ngaati Mahuta].

7.1.2 Tuna Length and Weight Characteristics

Length and weight data are a fundamental tool for assessing tuna populations in fisheries management. For example, understanding how weight changes as a function of length can help you calculate growth rates for tuna living in different habitats and understand age structures, once you have assessed/aged a few otoliths (Jellyman et al. 2013).

Coarse mesh fyke nets were the main sampling method used in the present survey nets which are recognised to be size selective, with tuna smaller than about 300-400 mm (i.e., juveniles) tending to be missing from the catch (Jellyman & Graynoth 2005). In the future, kaitiaki may want to use a mixture of net types to check if there are small, medium and large tuna present to ensure the sustainability of the population.

Overall, the length and weight data show that Lake Tahaaroa continues to support a wide size range of tuna, from small shortfin through to very large longfin exceeding one metre in length and weighing over 10 kg (Table 7-2). Shortfin were the most frequently encountered, with average lengths generally smaller than longfin, though some individuals exceeded 1,000 mm. Longfin were less abundant but included large, mature females, particularly at the Pump Station site. The scarcity of juvenile longfin across surveys suggests limited recruitment into the population, while the wide range of weights observed among both species highlights variability in growth and condition. These results point to an ageing stock with a few healthy individuals but potential constraints on population replacement.

Building on this, a comparison of the 2007 (reported in 2008) and 2025 customary tuna surveys highlights how length and weight characteristics have shifted over time. In 2007, the catch was dominated by smaller shortfin with relatively few larger individuals, whereas the 2025 survey recorded a broader size range, including more larger longfin and heavier shortfin than previously observed. Average weights of tuna in 2025 were generally higher for equivalent length classes compared to 2007, suggesting improved growth or condition in parts of the lake. However, the scarcity of juveniles in both surveys indicates limited recruitment, raising concerns for long-term sustainability. These changes point to an ageing population with pockets of healthy individuals, but with recruitment constraints that could limit customary harvest in future if not addressed.

In 2025, shortfin was most commonly between 400–560 mm (mean 454 mm), with fewer larger individuals compared to 2007 when average lengths were about 70 mm greater. Longfin showed a similar size distribution in 2025 (mean 460 mm), although a few exceeded 1 m, whereas the 2007 survey recorded more large fish (800–1300 mm) and a mean length about 120 mm greater. These comparisons highlight a clear reduction in the size of both species since 2007, suggesting limited recruitment and an ageing population.

Table 7-2: Length and weight characteristics of tuna and common bullies caught across six monitoring events between November 2023 and April 2025.

Monitoring Date		Average length (mm, with the range in brackets)			Average weight (g, with range in brackets)	
	Site	SF	LF	Common Bully	SF	LF
11/11/23	Pump Station	974 (300-750)	1377 (250-1350)	–	588 (700-360)	4157 (30-10,500)
12/11/23	Maukore	489 (280-660)	603 (430-900)	–	3280 (130-490)	809 (120-1,680)
6/04/24	Maukore	920 (75-730)	–	–	550 (40-1,110)	–
24/08/24	Maukore	1015 (320-770)	803	–	0.67 (0.10-1.20)	1.42
23/11/24	Maukore	1094 (450-645)	1404 (580-820)	44 (25-80)	1.11 (0.20-0.70)	60.07 (55-2.10)
20/02/25	Maukore	787 (300-665)	803	–	4 (0.04-0.60)	1.42
5/04/25	Maukore	886 (360-595)	1695 (390-1250)	–	5.4 (0.05-0.45)	543.19 (0.10-1,250)

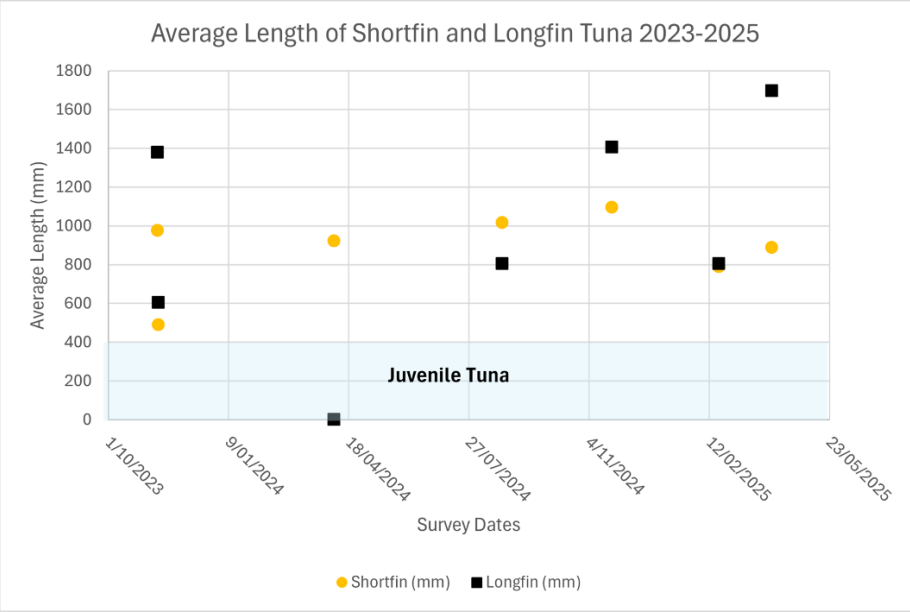


Figure 7-4: Average length of shortfin (orange circles) and longfin (black squares) tuna captured in Lake Tahaaroa during six monitoring surveys between November and April 2025. The blue shaded area indicates the juvenile size range (<400 mm). Data show a predominance of larger shortfin and longfin tuna, with juveniles largely absent across sampling events.

If whaanau are harvesting tuna for kai, removing the otoliths to determine their age and growth rates can provide valuable long-term information (e.g., how old are tuna in Lake Tahaaroa, when have they recruited into the lake, and where growth is occurring fastest) (Figure 7-5). To complement the monitoring described in this plan, the 2025 customary tuna study harvested 93 shortfin individuals. Out of that number, 50 shortfin otoliths were extracted across five length classes[3] (Chisnall & Ruru, 2008) (Table 7-3).

One otolith showed irregular growth patterns that made age estimation unreliable and was excluded from analysis. The remaining 49 shortfin were successfully aged and included in the study. Tuna were humanely euthanised using AQUI-S®, and their otoliths extracted and prepared for ageing following established protocols (Hu & Todd, 1981; Graynoth, 1999; Walsh et al. 2016). Much like the rings in a tree, otolith annuli provide a record of annual growth, allowing the number of years a tuna has lived to be estimated (Appendix A).

Freshwater growth rates were calculated as (total length – 60 mm)/age, where 60 mm represents the average length of glass eels (Jellyman & Lambert, 2003). Importantly, this method was the same as that used in the 2007 study, ensuring that growth rate estimates are directly comparable between surveys.

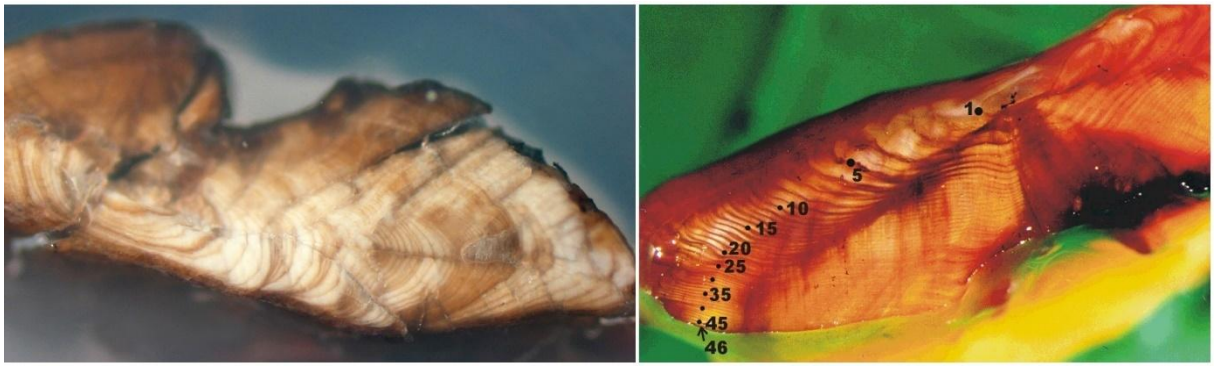


Figure 7-5: Example of a tuna otolith that has been prepared in the laboratory and aged under a microscope. [Photos: ESNZ]

The results showed that shortfin in 2025 were approximately twice the age of the same sized fish from 2007. Both studies aged similar sized fish, but the mean (±SE) growth rate of shortfin in 2007 (33.37 ± 1.16 mm/year) was approximately twice what it was in 2025 (17.22 ± 0.47 mm/year). These results show that shortfin growth rate has significantly declined in Lake Tahaaroa from 2007 to 2025 ($t=-15.33$, $DF=62.89$, $P<0.001$) (Table 7-3, Figure 7-6). Size and weight data also set the context for understanding the biological condition of tuna, including sex ratios and parasite loads, which influence growth, reproduction, and survival.

[3] The 50 shortfin sampled for ageing were stratified across five length classes following Chisnall & Ruru (2008): 0–99 mm, 100–199 mm, 200–299 mm, 300–399 mm, and ≥500 mm, with ten individuals collected per class.

Table 7-3: Aging results from the present study and 2007. We used age data from all shortfin tuna captured by Chisnall & Ruru (2007) regardless of sampling method. Standard errors (SE) are shown for all mean calculations.

Study	Mean growth rate (mm/year)	SE growth rate (mm/year)	Mean length (mm)	SE length (mm)	Number aged	Mean age (years)	SE age (years)	Min Age	Max age
2007	33.37	1.16	512.20	17.55	20	13.65	0.44	10	18
2025	17.22	0.47	564.57	11.96	49	30.20	0.98	17	47

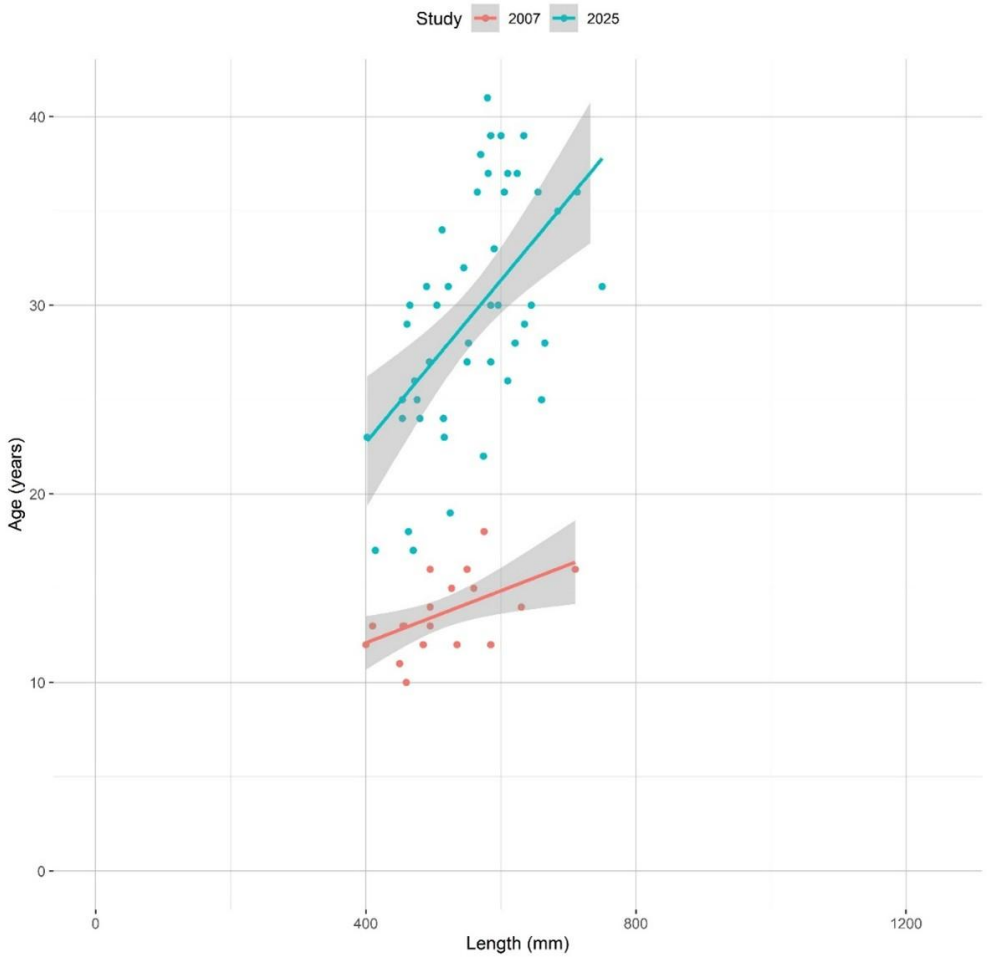


Figure 7-6: Relationship between age and total length of shortfin tuna sampled from Lake Tahaaroa in 2007 (Chisnall & Ruru 2008) and in 2025. Each point represents the age and corresponding length of an individual eel. The positive trend reflects increasing length with age.

7.1.3 Tuna Sex and Parasites

In all species of freshwater eels, the females grow to a much larger size than males. Therefore, in New Zealand, any eel above the maximum size to which males grow must be a female. However, anything smaller than this could be either male or female. For shortfins, males do not grow larger than 550 mm (about 350 g), so any eel larger than this is likely to be a female (e.g., Figure 7-7) while for longfins, males grow to a maximum of 750 mm (about 1,250 g), so eels larger than this are definitely females.

Figure 7-7: Female tuna grow to a much larger size than males. This is an example of a shortfin male (top) and shortfin female (bottom). [Photo: Jacques Boubée].

Tuna was not harvested during this study, as it wasn't a focus of the catchment monitoring plan. However, through the customary tuna research, the sex of most of the 49 shortfin harvested and aged were determined. There were 28 female and 13 male identified with 9 undetermined. This confirmed that Lake Tahaaroa continues to support a female dominant shortfin population, consistent with patterns reported elsewhere in Aotearoa.

A parasite assessment was carried out on 93 shortfin individuals (including those aged), it revealed 74% were infected, primarily with shagworm (*Eustrongylides* spp.), a parasite largely absent in 2007 (Table E-1). Other parasites included nematodes (*Anguillicola* spp.) found in swim bladders, putative trematodes embedded in stomach linings, and unidentified black lesions in body cavities. The mean parasite index score (37%) was well above the acceptable range of 0–2.7 reported by Richardson (1998), indicating a heavy parasite burden across the population.

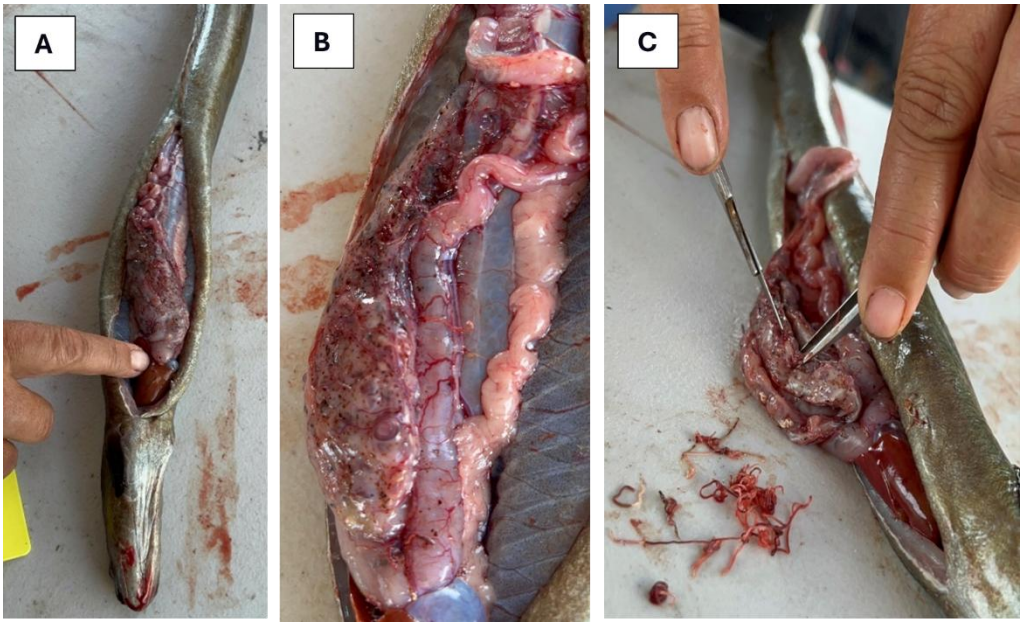


Figure 7-8: Photo A shows unidentified black markings along the body cavity and stomach wall of shortfin. Photos B and C indicates prevalence of Shagworm *(Eustrongylides sp.)* in Lake Tahaaroa shortfin. [Photos: Ngahuia Herangi, ESNZ].

Life cycle: the intermediate stage of this worm is passed in the body-cavity and the flesh of fishes, and maturity is reached in predatory birds. The immature worms, which are red in colour and attain a maximum length of approximately 60 mm are usually coiled in cysts attached to various organs within the body-cavity of the fish, but most frequently to the outer surface of the stomach (Stokell 1936). Parasite prevalence and sex ratios highlight pressures acting within each lake, but tuna wellbeing is also shaped by broader connectivity across the catchment. The ability to migrate between lakes and to the awa and moana is critical for sustaining populations.

7.1.4 Migration and Connectivity

Ecological connectivity links directly with cultural values, as whaanau observe and assess tuna abundance, accessibility, and the mauri of habitats in accordance with tikanga and hauanga kai practices.

7.1.5 Whanau Observations and Tikanga Indicators

During the comprehensive tuna survey, whaanau observed and described tuna behaviour in ways that drew directly on maatauranga and kupu whakarite. As the team travelled around the roto by boat, Taituwha King shared metaphors that connected what he was seeing in the taiao to the ways we live and interact as people. These reflections have since become integral to our mahi, forming part of the paatere and karakia “Kaiwaka,” which we recite before entering the field.

- **Tuna Waha Haumaru – Safe haven**
  This kupu whakarite describes tuna as protectors and carriers, moving kookopu safely through the waters of the roto, like guardians maintaining the pathways of life and connection across the lake. The term waha haumaru symbolises a whare tuupuna, a place of safety and belonging.

- **Kaiaua Piritahi – Bound together as one**
  Kaiaua are known to cluster closely, adhering to one another like magnets. This image captures the essence of whanaungatanga, kotahitanga, and aroha that underpin both ecological and human relationships. In the mahi of restoration, kaiaua piritahi reminds us that success comes through unity of purpose.

- **Kaawau Pukukai – The gluttonous cormorant**
  While navigating the Wainui Stream outlet, Taituwha observed kaawau perched on an old tree, fishing relentlessly despite their full bellies and regurgitating what they had eaten. This became a metaphor for excess and unsustainable behaviour, a tohu cautioning us against greed and the depletion of resources beyond need.

Together, these kupu whakarite express how observation of tuna and the wider taiao becomes a mirror for human conduct, revealing values such as balance, restraint, and interconnectedness. They highlight that kaitiakitanga is not only about measuring ecological health but also about reflecting on our collective responsibility to restore balance. It is also a reminder that our reo and tikanga are not static; they evolve through active engagement with the living environment. It is through direct relationship and participation watching, naming, listening, and caring for our roto and their species that language and knowledge continue to grow. Without this sustained connection, made possible through iwi and hapuu-led research, monitoring, and planning frameworks such as this, the pathways for developing and renewing maatauranga and reo risk becoming weakened. In this way, the act of observing and caring for the taiao becomes both a scientific and cultural practice of regeneration.

The following paatere, Kaiwaka, encapsulates these insights. It has become a spiritual anchor for The Trust's monitoring work:

Kaiwaka iii!
Kaiwaka huri noa
Ko Te Rua o Te Ata
Tuna waha haumaru
He whenua, he wai
Ko te mauri o te iwi
Noo Ranginui
Noo Papatuuaanuku
Noo ngaa maatua tuupuna e iii
He wai i heke mai
Ngaa roto o Tahaaroa
A Ruapuutahanga e i
Ka Mahuta ake raa
Kaiaua piritahi
Ko te puna aroha eee – hei!

Translation:
Kaiwaka encircling all,
The haven of Te Rua o Te Ata,
The guardian of safety.
Land and water,
The life force of the people.

From Ranginui and Papatuuaanuku,
From our ancestors,
Flows the water that descends
To the lakes of Tahaaroa.
It rises up,
Bound together as one,
The spring of love everlasting!

This paatere is both karakia and kaupapa, weaving together observation, whakapapa, and restoration practice into one expression of mauri.

Taken together, scientific measures and tikanga-based indicators provide a holistic understanding of tuna status. Building on these complementary approaches, the following section outlines next steps for monitoring and sustaining the customary fishery.

7.1.6 Next Steps for Tuna Monitoring

In summary, the tuna of the Tahaaroa lakes show signs of resilience in some areas, but also stressors that raise concern for long-term sustainability. Abundance and size distributions point to an ageing population with limited recruitment, while parasite loads and habitat pressures highlight the challenges tuna face in maintaining health. Whaanau observations confirm that access and availability no longer meet cultural expectations for hauanga kai. These findings emphasise that tuna status cannot be considered in isolation: their wellbeing is interconnected with the habitats they occupy and the other taonga species they depend upon. The following section therefore turns to kaiaua, another cornerstone of the lake ecosystem and customary fishery, to examine how their condition both reflects and influences the wider health of the roto.

7.2 Kaiaua

Like tuna, kaiaua are a taonga tuku iho and an important element of the customary fishery for Ngaati Mahuta. Their wellbeing is closely tied to the same habitat pressures that affect tuna, including sedimentation, invasive macrophytes, and water quality decline. Kaiaua also play a unique ecological role as filter feeders, influencing nutrient cycles and providing a direct link between lakebed habitat condition and overall ecosystem health. Building on the insights from the tuna section, this section presents results on kaiaua abundance, size structure, shell condition, and reproductive status, as well as whaanau observations of availability and habitat. Together, these findings highlight how the state of kaiaua both reflects and shapes the wider mauri of the roto.

A method to assess the health of kaiaua populations was tested at Lake Tahaaroa. We used a timed count to assess presence, absence and population density, with a minimum of two or more people wading for 30 minutes along a 10 - 20 m length stretch of the lake. Kaiaua was observed using a bathyscope or feeling through the substrate until either 50 was collected or the 30-minute timed count was reached. When 50 kaiaua was found within the 30-minute time-cap, that time was recorded on the survey. The kaiaua collected was assessed for species identification and length measurements by the onshore processing team including the dead (paired) or damaged kaiaua shells (Figure 7-9). Once the survey was complete, all of the kaiaua were returned to the lake.

Figure 7-9: Kaiaua species identification and length measurements are recorded by the onshore processing team.

7.2.1 Abundance and Mortality

Catch-per-unit-effort (CPUE) surveys at Lake Tahaaroa between November 2023 and April 2025 provide insight into kaiaua abundance and survival. The first survey in November 2023 recorded only four paired dead shells, with no live individuals detected. In all subsequent surveys, live kaiaua dominated the counts, although occasional dead shells continued to be observed (Figure 7-10).

The ratio of live to dead shells is a key indicator of population health and recruitment. Live individuals represent the current strength of the population, while paired dead shells may signal recent mortality events, environmental stress, or natural ageing process. The consistently high live:dead ratios observed after November 2023 suggest that large-scale mortality events were not occurring at the monitored site during this period.

It is important to interpret the November 2023 results with caution given the very small sample size. Continued monitoring of live and dead shell ratios will provide insight into whether recruitment is sufficient to balance natural mortality, or if the population is ageing with limited replacement. While overall mortality at the monitored site appeared low, analysis of shell lengths provides further insight into the structure of the population and the extent to which recruitment is occurring.

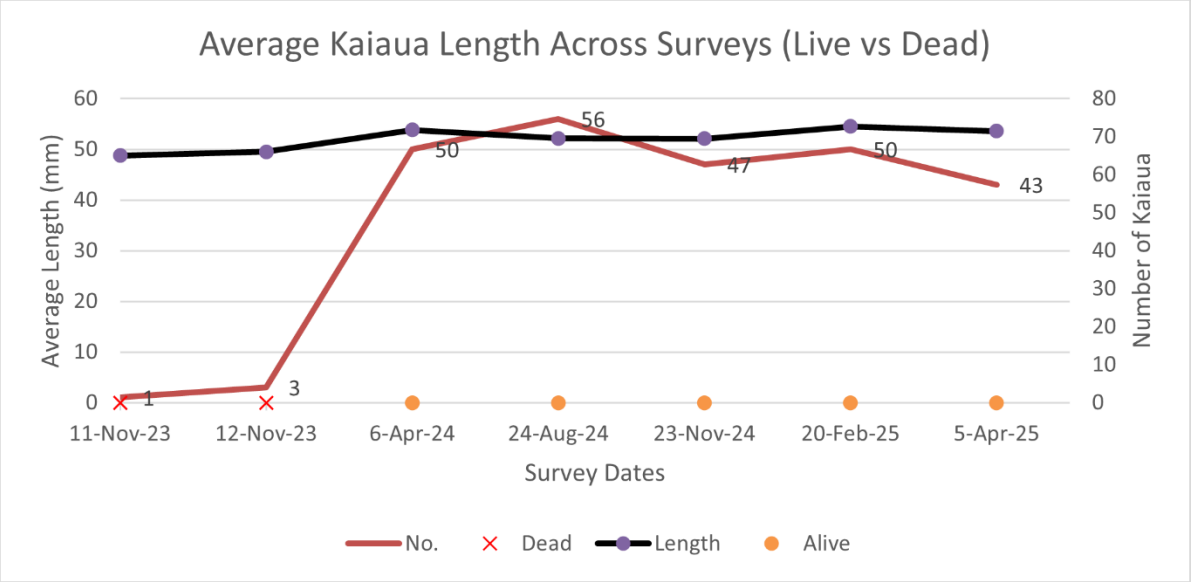


Figure 7-10: Average kaiaua length (mm) and number recorded across survey dates from November 2023 to April 2025. The black line shows the average length of live kaiaua (primary axis, left). The orange line shows the number of live kaiaua recorded (secondary axis, right). Red crosses mark surveys where only dead kaiaua were found, and orange circles indicate surveys where live kaiaua were observed.

7.2.2 Size Structure

Measurements of shell length across survey dates showed that the kaiaua population at Lake Tahaaroa is dominated by large adults, with very few juveniles recorded (Table 7-4). Mean lengths remained consistently between 69 and 72 mm across all surveys, with relatively low standard deviations (4–7 mm), indicating a uniform adult-dominated population. The November 2023 survey (n=4 dead shells) produced an average of 65 mm, but all subsequent surveys were dominated by individuals over 60 mm. Length-frequency histograms (Figure X) highlight the absence of kaiaua under 30 mm, suggesting that recruitment is limited despite evidence of reproduction within the lake. This skewed size distribution points to an ageing population, raising concerns about long-term sustainability if juveniles fail to replenish adult losses.

The dominance of larger individuals was reflected in the condition of shells, with erosion more common among bigger, older kaiaua. Although the majority of kaiaua assessed fell into intact (Grade 1) or minor erosion (Grade 2) categories, a consistent proportion of shells showed moderate erosion (Grade 3) (Table 7-5). The absence of severely eroded shells (Grade 4) suggests that while many kaiaua are ageing, catastrophic deterioration has not yet occurred at this site. Together, the size and condition data indicate a population composed largely of mature adults with limited evidence of juvenile recruitment, highlighting a potential bottleneck in population renewal.

Table 7-4: Summary statistics of kaiaua shell lengths measured at Lake Tahaaroa, between November 2023 and April 2025. Values show sample size (n), mean shell length, minimum, maximum and standard deviation. Dead shells were only recorded in November 2023. From April 2024 onwards, samples were dominated by large adults (mean ~70-72 mm) with low variability, indicating a relatively uniform adult population and limited evidence of juvenile recruitment.

Monitoring Date	Kaiaua Sampled (n)	Mean Length (mm)	Min (mm)	Max (mm)	Std Dev (mm)
Nov 2023	4*	65	50	65	13.93
Apr 2024	50	72	59	78	4.25
Aug 2024	56	70	40	84	6.84
Nov 2024	47	69	60	81	6.34
Feb 2025	50	73	55	89	5.81
Apr 2025	43	71	62	86	4.48

* Dead shells

7.2.3 Shell Condition Assessment

Assessments of shell condition provided further insight into the health and age structure of the kaiaua population at Lake Tahaaroa. Across all surveys, most kaiaua were classified as intact (Grade 1) or showing only minor erosion (Grade 2) (Table 7-5, Figure 7-11). However, a consistent proportion of individuals exhibited moderate erosion (Grade 3), indicating an ageing population with visible signs of wear. No severely eroded shells (Grade 4) were detected. These results suggest that while the majority of kaiaua remain in good condition, recruitment of younger cohorts is limited, and the population is increasingly dominated by older individuals.

In addition to counts and size measurements, the physical condition of kaiaua shells were assessed using a shell erosion and condition scale adapted from Wairarapa Moana surveys (Graynoth et al. 2013; Watene-Rawiri et al. 2018). This scale provides an index of shell condition and allows inference about the age structure, mortality, and environmental stressors acting on the kaiaua population. Each shell was visually examined and classified into one of four categories:

- **Grade 1 (Intact):** Shell surface intact, periostracum complete, little or no erosion.
- **Grade 2 (Minor erosion):** Slight shell surface wear, periostracum beginning to erode at umbo, ridges still distinct.
- **Grade 3 (Moderate erosion):** Clear erosion at the umbo, ridges worn smooth, periostracum patchy or lost in places.
- **Grade 4 (Severe erosion):** Advanced erosion, thin brittle shell, periostracum largely absent, ridges smoothed.

Table 7-5: Kaiaua shell condition scores.

Monitoring Date	Kaiaua Sampled (n)	Kaiaua Species	Shell Condition Assessment			
			Grade 1	Grade 2	Grade 3	Grade 4
Nov 2023	4*	*Echyridella Menziesii*	1	3	—	—
Apr 2024	50	*Echyridella Menziesii*	36	22	3	—
Aug 2024	56	*Echyridella Menziesii*	3	35	13	5
Nov 2024	47	*Echyridella Menziesii*	33	14	—	—
Feb 2025	50	*Echyridella Menziesii*	26	23	—	—
Apr 2025	43	*Echyridella Menziesii*	34	9	1	—

* Dead shells

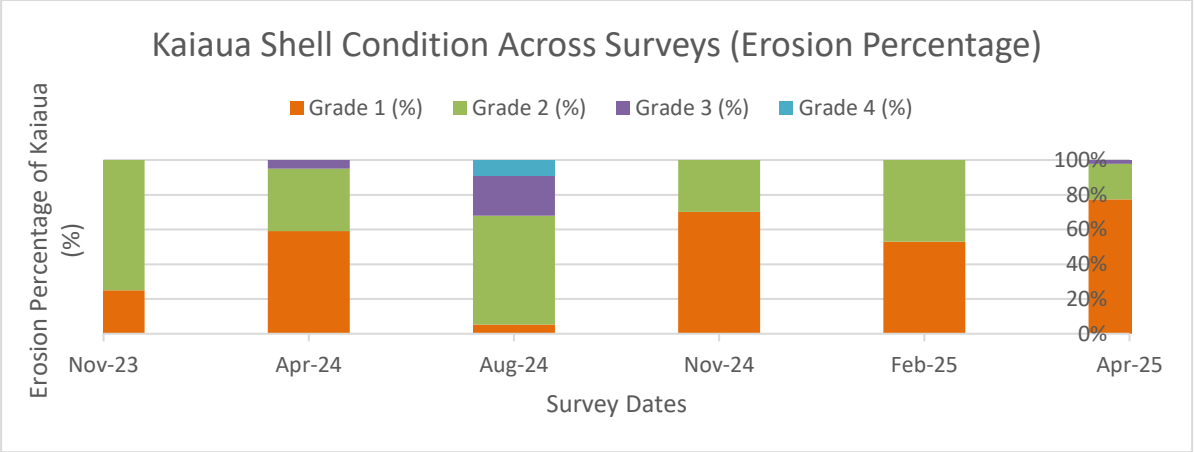


Figure 7-11: Percentage of kaiaua in each shell condition grade (1 = intact, 2 = minor erosion, 3 = moderate erosion) recorded across surveys at Lake Tahaaroa between November 2023 and April 2025. Most individuals were in good condition (Grades 1–2), but a consistent proportion of kaiaua showed moderate erosion (Grade 3). The persistence of Grade 3 shells across multiple surveys highlights an ageing population and limited evidence of new juvenile cohorts entering the population.

The dominance of intact and moderately eroded shells, combined with the absence of juveniles in size distributions, points to an ageing population. To better understand whether reproduction is occurring despite this recruitment gap, kaiaua were inspected for signs of gravidity and glochidia were assessed on host fish.

7.2.4 Juvenile Recruitment of Kaiaua

The presence of small size classes within kaiaua populations is a key indicator of successful recruitment and population renewal. Juvenile kaiaua (<30 mm shell length) represent new individuals entering the population, whereas their absence suggests limited reproduction or poor juvenile survival.

Across the monitoring surveys conducted between November 2023 and April 2025, very few juvenile kaiaua were observed at Lake Tahaaroa. The size distributions recorded were dominated by medium to large adults (>50 mm), with a noticeable gap in the smaller size classes (Table 7-5). In August 2024, most individuals measured fell within the 50–80 mm range, with only one individual with a recorded length of 40 mm. Subsequent surveys yielded no juveniles at all.

This lack of consistent representation of small size classes highlights a potential recruitment bottleneck, raising concerns about the long-term sustainability of the population. The findings are consistent with observations from other dune lakes, where kaiaua populations are often skewed towards older individuals due to habitat degradation, reduced availability of host fish for glochidia, or wider environmental stressors (Watene-Rawiri et al. 2018; Graynoth et al. 2013).

Shell length data confirm that the kaiaua population at Lake Tahaaroa was dominated by large adults. Aside from four dead shells recorded in November 2023, all subsequent surveys yielded live individuals with mean lengths consistently between 69 and 72 mm. Standard deviations were relatively low (4–7 mm), showing that most individuals clustered around the mean. The August 2024 survey showed the broadest spread (40–84 mm), yet no juveniles (<30 mm) were detected. This absence of small size classes suggests limited or sporadic recruitment into the population during the monitoring period.

Standard deviation is a measure of how much the sizes of kaiaua vary around the average. A small standard deviation (like 4–7 mm in our surveys) means most kaiaua were very similar in size, clustered close to the average length. A large standard deviation would mean there was a much wider spread, with some very small and some very large kaiaua. The low values recorded here show that the kaiaua population is quite uniform in size, with few smaller individuals present.

7.2.5 Reproductive Condition

Reproductive condition is an important indicator of kaiaua population resilience, as successful recruitment depends on kaiaua producing viable glochidia (larvae) that are able to attach to suitable host fish. During surveys, kaiaua were inspected for signs of gravidity (brooding), such as swollen gills or the presence of marsupial gill pouches. Although no gravid individuals were observed directly, this does not rule out reproduction within the population, as gravidity is seasonal and can be easily missed if sampling does not coincide with peak brooding periods (Table 7-6).

Evidence of glochidia was noted indirectly through host fish monitoring. Common bullies (*Gobiomorphus cotidianus*) captured in the same habitats occasionally carried encysted glochidia, confirming that some reproductive activity is occurring within Lake Tahaaroa. However, the low number of juvenile kaiaua (<30 mm) recorded across all surveys suggests that recruitment may be sporadic or that post-glochidial survival is limited.

These results align with national findings that highlight recruitment bottlenecks as a major threat to freshwater kaiaua persistence in degraded habitats (Graynoth et al. 2013; Watene-Rawiri et al. 2018). The apparent disconnect between evidence of glochidia on host fish and the scarcity of juvenile kaiaua points to wider environmental constraints such as sedimentation, invasive plant dominance, or water quality issues affecting juvenile settlement and survival.

Table 7-6: Evidence of kaiaua reproduction observed during surveys at Lake Tahaaroa, between November 2023 and April 2025. While no gravid kaiaua were directly observed, glochidia (larvae) were detected on common bully (*Gobiomorphus cotidianus*) host fish in August and November 2024, confirming that some reproductive activity is occurring in the lake. The absence of juveniles in length-frequency distributions, however, suggests that recruitment into the population remains limited.

Monitoring Date	Kaiaua Sampled (n)	Glochidia on Host Fish	Host Fish Species	Notes
Nov 2023	–	Not observed		
Apr 2024	50	Not observed		
Aug 2024	59	Present	Common Bully	Glochidia found on the fins of host fish.
Nov 2024	47	Present	Common Bully	Glochidia found on the fins of host fish. Observed kaiaua female brooding.
Feb 2025	50	Not observed		
Apr 2025	44	Not observed		

7.2.6 Habitat Associations

Kaiaua populations at Lake Tahaaroa was closely tied to habitat condition, particularly substrate stability, macrophyte cover, and water clarity. By aligning kaiaua monitoring results with site-level habitat data from ESNZ's 2024 macrophyte survey, clear patterns emerge that help explain population trends (Table 7-7).

Kaiaua were most abundant in areas of firm sandy substrate with moderate to high macrophyte cover (Sites A and C), where charophyte meadows and pondweed provided stable habitat. In these locations, the proportion of intact shells (Grade 1) was highest (68–70%), and only a small fraction of kaiaua showed signs of erosion. These findings are consistent with the macrophyte survey, which recorded dense charophyte beds (>75% cover) at several sites.

In contrast, sites with finer silts and soft mud (e.g., Site E along the raupoo fringe) supported far fewer kaiaua. Where kaiaua were present, they often exhibited higher erosion scores, with up to 40% of shells in Grades 3–4. This pattern aligns with the 2024 LakeSPI results, which showed a reduction in vegetation depth (from 5.7 m in 2014 to 4.4 m in 2024) and a decline in the Native Condition Index from 53% to 38%. Together, these changes suggest that declining water clarity and increased sedimentation are limiting both macrophyte extent and kaiaua habitat quality.

Intermediate sites (B and D), with mixed sand–silt substrates and lower vegetation cover, supported fewer kaiaua overall and higher proportions of eroded shells. The widespread

presence of invasive macrophytes, particularly Lagarosiphon major and Elodea canadensis, may further constrain habitat suitability by altering substrate conditions and shading benthic zones.

Overall, these results show that kaiaua persistence is tightly coupled to macrophyte condition and broader lake health. Firm sandy substrates with diverse native vegetation provide the most favourable habitats, whereas silty or invasive-dominated zones support fewer and less healthy kaiaua. The decline in LakeSPI indices for Lake Tahaaroa highlights that deteriorating macrophyte condition is likely a key driver behind the limited recruitment and ageing kaiaua population observed during this study.

Table 7-7: Kaiaua density and shell condition in relation to habitat characteristics at Lake Tahaaroa. Data sources from kaiaua and macrophyte survey in November 2024.

Site	Substrate Type	Vegetation Cover	Visibility	Max Transect Depth	Invasive Species Present	Kaiaua Density (ind./m^2)	% Grade 1	% Grade 3-4	Summary of key habitat-kaiaua relationship
A	Firm sand with charophytes, pondweed	40%	0.5 m	4.7 m	*Lagarosiphon major, Elodea canadensis*	1.1	68%	12%	Higher kaiaua density in sandy habitat with stable vegetation
B	Sand/silt, patchy pondweed	25%	1.0 m	4.5 m	*Elodea canadensis, Potamogeton crispus*	0.4	55%	20%	Lower density, more eroded shells in patchy habitat
C	Sandy base with dense charophyte meadow	85%	1.0 m	5.1 m	*Elodea canadensis, Potamogeton crispus*	0.9	70%	10%	Dense charophyte bed supports intact shells
D	Mixed sand silt, charophytes present	85%	1.0 m	5.9 m	*Elodea canadensis, Potamogeton crispus*	0.5	20%	40%	Moderate density, higher erosion where substrate less stable
E	Muddy/soft substrate with raupoo fringe	85%	1.0 m	6.0 m	*Elodea canadensis, Potamogeton crispus*	0.2	20%	40%	Few kaiaua; silty habitat linked with poor condition

Results from Table 7-7 show a clear relationship between kaiaua condition and habitat quality at Lake Tahaaroa. Sites with firm sandy substrates and dense native macrophyte cover (Sites A and C) supported the highest kaiaua densities and the largest proportion of intact shells (68–70% Grade 1). In contrast, silty or muddy habitats (Sites D and E) had far fewer kaiaua, with higher proportions of eroded shells (up to 40% in Grades 3–4). Intermediate sites (e.g., Site B) showed variable results, reflecting patchy vegetation and less stable substrates. These patterns confirm that sandy substrates with healthy native vegetation provide the most favourable conditions for kaiaua, while soft or invasive-dominated habitats limit both abundance and shell condition.

7.3 Tupu Wai

Tupu wai, the submerged aquatic plants of the Tahaaroa lakes, form a critical foundation of the ecosystem. They provide habitat and kai for tuna, kaiaua, and other taonga, stabilise lakebed sediments, and influence water clarity and nutrient cycling. The condition of these plant communities is therefore closely linked to both the mauri of the lakes and the resilience of customary fisheries.

This section presents results on the composition and cover of native and invasive species, the extent and depth of distribution, and habitat quality indicators derived from LakeSPI. It also incorporates findings from hapuu-led shoreline transects using Lakeside Monitoring Toolkit, alongside whaanau observations that reflect tikanga-based perspectives on the role of tupu wai as a puna oranga within the roto (Figure 7-12). Together, these results highlight that the condition of tupu wai is both a driver and a reflection of wider lake health, with direct implications for the sustainability of taonga species and hauanga kai.

Figure 7-12: Monitoring survey area (circled in red) along the edge of Lake Tahaaroa. The 10-20 m transect was established parallel to the shoreline, with repeated observations of tupu wai cover recorded at set intervals using the Lakeside Monitoring Toolkit. This rapid, hapuu-led method complements diver-based LakeSPI surveys by providing shallow-water estimates of macrophyte extent and condition. [Photos: Keith Kana, Ngaati Mahuta].

7.3.1 Species Composition and Cover

Species composition and cover are important indicators of roto health because they reveal both ecological integrity and cultural values such as hauanga kai and mauri. For Ngaati Mahuta, the condition of tupu wai beds is not only a scientific measure but also a tohu of whether tuna, kaiaua and other taonga can continue to thrive, and whether whaanau can rely on these ecosystems for kai and wellbeing.

Across all six monitoring surveys between November 2023 and April 2025, invasive macrophytes consistently dominated, ranging from 65–100% of total cover (Figure 7-13,Table 7-8). *Lagarosiphon major* in particular formed dense monospecific beds in both shallow and deeper zones. Native tupu wai was only observed intermittently, with a brief recovery in August 2024 when turf plants and pondweeds contributed up to 13% of cover. By the following survey, however, invasives again displaced natives. Sand and sediment were also frequently recorded (26–65%), highlighting large areas of bare or degraded lakebed.

Point-scale data from hoe grab samples further illustrate these patterns. For example, a shoreline transect at Maukore (Lake Tahaaroa, Nov 2023) recorded *Lagarosiphon major* dominating all five sampling points, with cover estimates ranging from 45–90% (Table 7-9). These grab samples provide direct evidence of dense monospecific beds in the shallow zone, consistent with the broader transect results shown in the stacked bar chart (Figure 7-13).

These hapuu-led shoreline transects using the Lakeside Monitoring Toolkit aligned closely with the results of the 2024 LakeSPI diver surveys. LakeSPI indices confirmed a long-term decline in native vegetation since 2014, with the Native Condition Index for Lake Tahaaroa falling from 53% to 38%, and the maximum depth of vegetation contracting from 5.7 m to 4.4 m. Native charophytes such as *Chara australis and Nitella cristata* were still present in places, but increasingly fragmented. Whaanau observations noted that areas once filled with healthy beds of tupu wai now appeared patchy and degraded, with reduced ability to shelter juvenile tuna and kaiaua.

Despite this overall decline, small patches of resilient native species remain. Turf plants such as *Glossostigma diandrum* were recorded in sheltered areas, and their persistence is significant (Figure 7-14). These plants are known to require clear water and stable sediments and provide critical nursery grounds for taonga species. Their survival, though limited, signals that restoration of native tupu wai communities is still possible if pressures are addressed.

From a cultural perspective, the reduction of diverse native beds diminishes the mauri of the roto. Whaanau explained that the decline in clarity, the encroachment of invasive weeds, and the shrinking of once-abundant beds has compromised the customary use and identity of the lakes. In effect, tohu of health once easily observed by kaitiaki are now absent, undermining hauanga kai and intergenerational knowledge transfer.

In summary, species composition and cover data confirm that invasive tupu wai are driving ecological change across the Tahaaroa lakes, displacing native tupu wai and reducing habitat quality. The persistence of small remnant patches of native turf and pondweed demonstrates resilience, but without intervention these may also be lost. Restoring native tupu wai communities is therefore essential to sustaining kaiaua, tuna, and the mauri of the roto.

These findings provide a baseline for targeted management actions and highlight the urgency of culturally-led restoration efforts to support the long-term aspirations of Ngaati Mahuta.

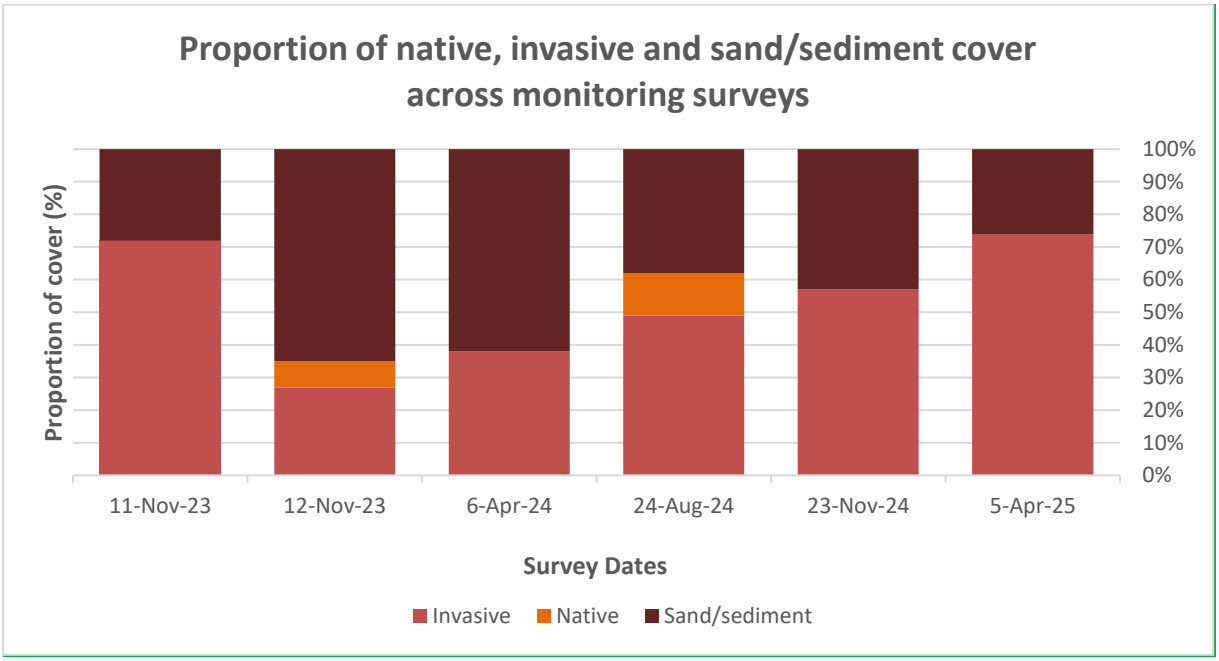
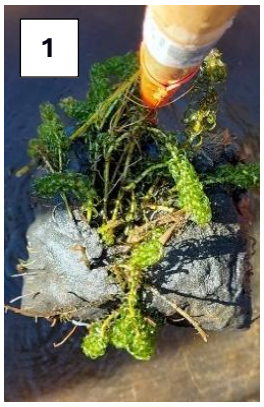


Figure 7-13: Proportion of invasive, native, and sand/sediment cover recorded in shoreline transect surveys (Nov 2023 – Apr 2025). Proportion of invasive, native, and sand/sediment cover Invasive macrophytes consistently dominated (65–100% of cover), with native tupu wai appearing slightly in Aug 2024 (13%). Sand/sediment cover was also notable across surveys (26–65%), reflecting large areas of bare or degraded lakebed.

Table 7-8: Summary of dominant invasive and native tupu wai species recorded across shoreline survey sites, 2023–2025. Values represent average percentage cover at each site. Invasive species (*Lagarosiphon major, Elodea canadensis*) consistently dominated, while native turf plants and pondweeds persisted only in sheltered areas.

Monitoring Date	Dominant Invasive	% Cover Estimate	Dominant Native	% Cover Estimate	Notes
11 Nov 2023	*Lagarosiphon*	90%	–	–	Elodea, milfoil, pondweed and sediment observed
12 Nov 2023	*Lagarosiphon*	65%	*Turf plant*	15%	Elodea, pondweed and charophyte observed
6 Apr 2024	*Lagarosiphon*	100%	–	–	No natives
24 Aug 2024	*Lagarosiphon*	100%	–	–	Eloedea and milfoil observed
23 Nov 2024	*Lagarosiphon*	95%	–	–	Small patches of terrestrial, milfoil and ruppia observed
5 Apr 2025	*Lagarosiphon*	95%	–	–	No natives

Table 7-9: Hoe grab samples collected along a 10 m shoreline transect at Maukore, Lake Tahaaroa on 11 November 2023. Each sample shows invasive Lagarosiphon major with estimated percentage cover ranging from 45–95% at 1–5 m survey intervals. These observations illustrate the dominance of invasive macrophytes in the shallow zone, with little evidence of native vegetation present at this site. [Photos: Inigo Maetzu-Zabarte, ESNZ].



Date	11/11/2023
Species	*Lagarosiphon*
Est. % Cover	75%
Survey Area	10 m
Survey Interval	0 m

Date	11/11/2023
Species	*Lagarosiphon*
Est. % Cover	65%
Survey Area	10 m
Survey Interval	2 m

Date	11/11/2023
Species	*Lagarosiphon*
Est. % Cover	45%
Survey Area	10 m
Survey Interval	4 m

Date	11/11/2023
Species	*Lagarosiphon*
Est. % Cover	85%
Survey Area	10 m
Survey interval	6 m

Date	11/11/2023
Species	Lagarosiphon
Est. % Cover	90%
Survey Area	10 m
Survey Interval	8 m

Figure 7-14: Example of remnant turf vegetation (*Glossostigma diandrum*) recorded in shallow sheltered zones. Turf plants are positive indicators of habitat quality, requiring clear water and stable sediments, and provide nursery grounds for kaiaua and juvenile tuna despite widespread invasive dominance. [Photos: Inigo Maetzu-Zabarte, ESNZ]..

7.3.2 Depth Distribution and Vegetation Extent

The depth distribution and spatial extent of tupu wai vegetation are sensitive indicators of lake health, reflecting water clarity, light penetration, and sediment stability. For Ngaati Mahuta, these patterns are also tohu of whether the roto can continue to provide for taonga species such as tuna and kaiaua, and whether hauanga kai remains intact.

Survey results show that aquatic plant beds in Lake Tahaaroa are now largely confined to shallower zones. The 2024 LakeSPI diver survey recorded a maximum vegetation depth of 4.4 m, a contraction from 5.7 m observed in 2014. Shoreline transects confirmed these findings, with large areas of bare sand and sediment recorded across mid-depth zones. This contraction of vegetation extent indicates declining water clarity and a reduction in suitable habitat at depth.

Invasive species dominated across the depth range surveyed. *Lagarosiphon major* formed dense beds from the shallow margin through to mid-depths, displacing native charophytes and pondweeds which were only observed in fragmented patches (Figure 7-15). Beyond 3–4 m depth, native vegetation was largely absent. The decline of deeper charophyte meadows is particularly significant: historically these communities stabilised sediments, enhanced water clarity, and provided important refuge habitat for juvenile tuna and kaiaua. Their absence signals a loss of ecological resilience.

From a whaanau perspective, these changes align with intergenerational knowledge and observations. Areas that were once characterised by clear water and extensive submerged beds are now patchy, dominated by invasive weeds, or reduced to bare sediment. This loss has diminished both the mauri of the roto and the customary ability to gather kai. The disappearance of tohu once easily observed by kaitiaki such as deep, healthy vegetation beds visible from the surface, reflects the broader decline in lake health.

The contraction of vegetation into shallow margins also increases vulnerability to wave action and sediment resuspension, further favouring invasive dominance. This feedback loop risks accelerating the loss of remaining native vegetation.

Protecting remnant deepwater habitats, and restoring native vegetation across the full depth gradient, will be critical to rebuilding resilience.

In summary, depth distribution and vegetation extent data provide clear evidence of declining ecological integrity. The shift of tupu wai communities into shallow zones reduces both biodiversity and cultural values, and highlights the urgency of interventions to restore water clarity and support the recovery of native tupu wai. These findings build on the patterns identified in species composition and cover (7.3.1) and provide the foundation for assessing habitat quality (7.3.3).

Figure 7-15: Dense beds of the invasive macrophyte *Lagarosiphon major* dominating the shallow zone of Lake Tahaaroa. Such monospecific stands illustrate the contraction of vegetation into shallower margins and the displacement of native communities. [Photos: Inigo Maetzu-Zabarte, ESNZ].

7.3.3 Habitat Quality Indicators

Habitat quality reflects the combined influence of species composition, vegetation extent, water clarity, and the physical condition of the lakebed. For Ngaati Mahuta, assessing habitat quality is not just a technical exercise, it is about understanding whether the roto can continue to sustain tuna, kaiaua and other taonga, and whether the mauri remains strong enough to provide for hauanga kai.

Survey findings across the Tahaaroa lakes show that habitat quality is being compromised by the dominance of invasive species, the contraction of vegetation into shallow margins, and the loss of deeper native communities.

Dense monospecific beds of lagarosiphon reduce structural diversity, limit habitat niches, and create conditions unfavourable for native invertebrates and fish. Where invasive tupu wai

collapse or leave bare sediment, the lakebed becomes unstable, further degrading habitat suitability (Figure 7-16).

Hapuu-led surveys identified areas once characterised by diverse, layered native beds now reduced to patchy turf plants or replaced entirely by invasive weeds. The disappearance of charophyte meadows, in particular has reduced sediment stability and nursery habitat for juvenile tuna and kaiaua. Without these deeper native beds, ecological resilience is weakened and cultural connections to the roto are further eroded.

Despite this overall decline, small remnants of native turf and pondweed communities persist in sheltered areas. These hold significant ecological and cultural value, acting as refuges for taonga species and as tohu that restoration remains possible. Their survival provides hope that with active management such as invasive tupu wai control, sediment stabilisation, and water clarity improvements – habitat quality can be rebuilt.

From a cultural perspective, habitat quality is measured not only in ecological terms but also by the presence of tohu that confirm a lake's mauri is intact. Whaanau have observed fewer signs of abundance: kaiaua are harder to find in their customary beds, tuna pathways are blocked or diminished, and clear waters once used to guide seasonal harvests are clouded. These observations align with the scientific evidence of declining habitat integrity.

In summary, habitat quality in the Tahaaroa lakes is currently low due to invasive dominance, reduced depth distribution, and loss of native diversity. Protecting and expanding the remaining native patches, alongside hapuu-led restoration initiatives, is essential to strengthen resilience. Together, these findings confirm the need for targeted management actions to restore the ecological and cultural foundations of the roto.

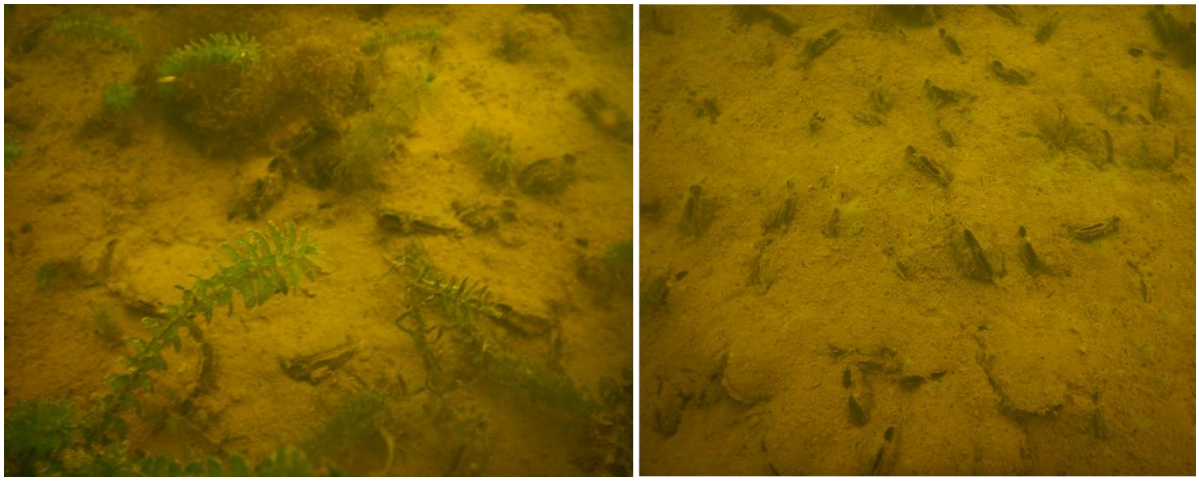


Figure 7-16: Patchy remnants of aquatic vegetation over unstable sediments in Lake Tahaaroa. The collapse of invasive beds and absence of deeper native meadows leave bare lakebed conditions, reducing structural diversity and degrading habitat quality for tuna and kaiaua. [Photos: Inigo Maetzu-Zabarte, ESNZ].

7.3.4 Pressures and Change Over Time

The condition of aquatic vegetation in the Tahaaroa lakes reflects both long-term pressures and recent changes. For Ngaati Mahuta, understanding these pressures is essential to guiding restoration, protecting hauanga kai, and ensuring the resilience of the roto for future generations.

Comparisons of current survey results with earlier LakeSPI assessments demonstrate a clear trajectory of decline in native vegetation. Since 2014, the Native Condition Index for Lake Tahaaroa has dropped from 53% to 38%, and the maximum depth of vegetation has contracted from 5.7 m to 4.4 m. These trends align with whaanau observations of diminishing water clarity, fewer areas of healthy native beds, and reduced tohu of lake mauri.

The dominance of invasive tupu wai such as *Lagarosiphon major* is the primary ecological driver of change. Dense weed beds outcompete native tupu wai, alter sediment dynamics, and reduce habitat diversity. When these beds collapse, they leave large areas of bare sediment, destabilising the lakebed and further compromising habitat quality. Sediment inputs, nutrient enrichment, and reduced light penetration compound these effects, limiting opportunities for native vegetation to recover.

Cultural perspectives emphasise that these pressures are not new. Whaanau recall times when the roto supported clearer water, deeper beds of native plants, and more abundant kai. The shift to weed-dominated, patchy lakebeds has eroded these values, and in doing so has undermined both ecological and cultural resilience. These intergenerational insights provide important context to the monitoring data, reinforcing that the current state represents a marked departure from traditional baselines.

Despite these challenges, the presence of remnant native patches and the persistence of turf species signal that recovery remains possible. Protecting these remnants, reducing pressures, and restoring native vegetation are priorities identified by both scientific evidence and whaanau knowledge. Long-term monitoring will be critical to tracking whether interventions are effective in reversing the observed declines (Figure 7-17).

In summary, pressures on aquatic vegetation in the Tahaaroa lakes are cumulative and long-standing, with invasive dominance, declining clarity, and sediment instability driving ecological change. The evidence of change over time highlights both the urgency of action and the opportunity to restore the mauri of the roto through hapuu-led management.

Figure 7-17: Hapuu-led monitoring using traditional and scientific tools to assess aquatic vegetation in the margins of Lake Tahaaroa. Involving rangatahi in this mahi ensures intergenerational transfer of knowledge about pressures such as invasive weeds, declining water clarity, and habitat loss. [Photos: Inigo Maetzu-Zabarte and Ngahuia Herangi, ESNZ]

7.3.5 Whaanau Observations and Tikanga Indicators

Tikanga indicators are culturally based measures of environmental health that arise from whaanau observation, participation, and values rather than from scientific instruments alone. They reflect whether the roto continues to uphold its mauri, provide safe and abundant hauanga kai, and support intergenerational practice. Examples include the visibility and clarity of the water, the taste and condition of tuna and kaiaua, the presence of manu and other taonga, and the overall feeling of balance or vitality sensed by kaitiaki. Alongside quantitative measures of species composition, depth distribution, habitat quality and pressures, the observations of whaanau provide essential insight into the mauri of the roto. Tikanga indicators grounded in customary practice and maatauranga, capture dimensions of change that scientific monitoring alone cannot (Figure 7-18).

During monitoring waananga, whaanau repeatedly noted the absence of tohu once commonly used to assess lake health. These included reduced visibility of deep vegetation beds, scarcity of juvenile tuna and kaiaua in customary harvest areas, and changes to the taste and appearance of kai species. Elders recalled times when the roto was a “well-stocked pantry” where tuna and kaiaua were readily gathered, and where tamariki were taught fishing practices along the shoreline. Many of these experiences are no longer possible, with areas once relied upon for teaching and harvest now degraded or inaccessible.

Tikanga-based observations also highlighted subtle markers of decline. Whaanau described unusual parasite loads in tuna, shell erosion in kaiaua, and shifting seasonal cues that no longer align with maramataka. These indicators confirm both ecological stress and the loss of intergenerational continuity in harvest practices. Importantly, whaanau did not only record absence or loss; they also identified remaining tohu of resilience. Patches of healthy turf plants, the persistence of mature longfin tuna, and the occasional appearance of kooura were celebrated as reminders that recovery is still possible if appropriate restoration actions are taken.

The integration of tikanga indicators into monitoring is being strengthened through the use of the Rongo App, a digital tool developed with kaitiaki to record observations of cultural health in real time. This includes questions about whaanau satisfaction with tuna and kaiaua abundance, the safety of harvesting sites, and whether the mauri of the lake is considered intact. These qualitative assessments complement scientific datasets and ensure that whaanau perspectives are privileged in decision-making. Wider reflection during these monitoring waananga also gave rise to kupu whakarite that speak deeply to tupu wai and the mauri of the roto. Expressions such as tuna waha haumaru, kaiaua piritahi, and kaawau pukukai arose from direct observation of the taiao and describe relationships of protection, unity, and balance. Although first shared within the context of tuna research, these metaphors extend naturally to tupu wai vegetation and broader lake ecosystem, reinforcing that all forms of life within the roto are interconnected. (See Section 7.1.5 for full explanation and paatere).

Taken together, whaanau observations and tikanga indicators present a holistic picture of change. They confirm that while scientific data show declines in vegetation and habitat quality, whaanau experience these losses as diminished access, reduced customary harvest, and weakened transmission of knowledge. By weaving these perspectives, the Catchment Monitoring Plan ensures that assessments of lake health remain grounded in the lived reality, tikanga, and aspirations of Ngaati Mahuta.

Figure 7-18: Whaanau of all ages participating in monitoring activities at Lake Tahaaroa, including shoreline transects and use of the bathyscope to observe aquatic plant vegetation. These images illustrate how tikanga-based indicators and intergenerational knowledge are integrated into the monitoring programme, strengthening the transmission of maatauranga and grounding assessments of lake health in lived whaanau experience. [Photos: Ngahuia Herangi, ESNZ; Keith Kana, Ngaati Mahuta].

7.3.6 Next Steps for Tupu Wai Monitoring

Together, the findings on species composition, depth distribution, habitat quality, long-term pressures, tikanga indicators, and future directions provide a holistic picture of tupu wai in the Tahaaroa lakes. The evidence is clear: invasive weeds dominate, native vegetation is in decline, and the ecological and cultural integrity of these habitats is under pressure. Yet the persistence of remnant native communities, the insights of whaanau, and the commitment to hapuu-led monitoring offer strong foundations for restoration. By weaving scientific surveys with tikanga indicators and intergenerational knowledge, the Catchment Monitoring Plan ensures that assessments of lake health remain culturally grounded, while also generating robust ecological baselines. This integrated approach provides both a warning and a pathway forward, confirming the scale of challenges facing the roto, while also affirming the role of Ngaati Mahuta as kaitiaki leading the recovery of mauri and hauanga kai.

7.4 Discussion

This section interprets the collective results of tuna, kaiaua and tupu wai monitoring alongside tikanga indicators and historical context. It explores what the patterns reveal about ecological change, mauri, and kaitiakitanga in the Tahaaroa lake system, and outlines how these insights inform future management.

7.4.1 Whaaanau Priorities and co-designed Actions

Whaanau participation throughout this kaupapa has provided essential direction for the next phase of mahi. Feedback gathered during the April 2025 waananga identified a set of practical actions and relationship priorities that will guide ongoing restoration and monitoring of the Tahaaroa lakes (Figure 7-19). These priorities were ranked using an effort-based framing (EBF) scale, which assesses the perceived difficulty of each action from *'no effort at all'* to '*extremely challenging*' (Table 7-10).

EBF Scale

1. No effort at all
2. Minimal effort
3. Moderate effort
4. Considerable effort
5. Extremely challenging

The activity identified three broad categories of action:

- **Technical and research tasks** requiring specialist input or consent (e.g., sediment sampling, weed control trials);
- **Management and restoration activities** requiring funding and coordination (e.g., fencing, bird culling, riparian weed control); and
- **Relationship and knowledge-building actions** requiring little or no funding but critical for sustaining engagement and intergenerational learning.

These priorities reflect both practical restoration goals and the deeper aspiration to reconnect tamariki and whaanau with their roto.

Table 7-10: Summarises the highest-ranked actions, including sediment and water sampling, hornwort delimitation surveys, bird culling, and trials of hessian matting to suppress Lagarosiphon major. Relationship-building with local kura, landowners, and Taharoa Ironsands Ltd was also highlighted as essential groundwork for long-term success.

Priority Action	EBF Scale	Notes
Mahi with kura (Tahaaroa)	2	Strengthens intergenerational connection
Relationship building (Harihari, Wainui)	2	Foundation for future collaboration
Sediment and water sampling (Numiti and Rotoroa)	3-4	Highest priority; informs lake health baseline
Bird culling (geese and swans)	3.4	Hapuu-led; links to kai and habitat quality
Hessian matting trial (Tahaaroa)	3.4	Low-cost restoration trial
Fencing and riparian maintenance	3-4	Practical ongoing task
Hornwort delimitation survey (Wainui)	4-5	Requires external approval
Diquat herbicide application	4-5	Requires external approval

Beyond these technical priorities, whaanau also emphasised the importance of whanaungatanga and tamariki engagement. Tamariki participation in fieldwork and storytelling was repeatedly described as the most rewarding part of the waananga. Suggestions included creating children's storybooks, incorporating lake monitoring into kura programmes, and inviting whaanau experts and weavers to share koorero tuku iho during future waananga.

"they [tamariki] were crazy interested when the nets were pulled."

Whaanau reflections also reinforced the connection between ecological and cultural recovery. Phrases such as *"We must treat our waterways the way they want to be treated"* capture the collective aspiration to restore both the mauri of the roto and the relationships that sustain it.

These whaanau-driven priorities now form the basis of the next stage of implementation under the Catchment Monitoring Plan. Actions with minimal to moderate effort such as kura partnerships, fencing, and relationship building will proceed first. Higher-effort actions such as herbicide trials, hornwort delimitation, and sediment analysis will be scoped with partner agencies to ensure regulatory and technical support.

Incorporating this guidance ensures that future mahi remains hapuu-led, culturally grounded, and achievable within available capacity, while continuing to uphold the mana whakahaere of Ngaati Mahuta.

Figure 7-19: Whaanau participating in the prioritisation activity during the April 2025 waananga at Te Kooraha Marae. Using an Effort-Based Framing scale, participants ranked potential restoration and monitoring actions by achievability and impact. The exercise encouraged koorero, reflection, and collective decision-making, ensuring that the next steps for the Tahaaroa lakes are grounded in whaanau priorities and lived experience, as described in Section 8.8 (Whaanau Priorities and Co-designed Actions). [Photos: Ngahuia Herangi, ESNZ]

Figure 7-20: Tamariki engagement during monitoring waananga. Young participants trying on dive gear used for macrophyte surveys at Te Kooraha Marae, November 2024. [Photos: Keith Kana, Ngaati Mahuta].

7.4.2 Overview of Findings

The collective findings from the tuna, kaiaua, and tupu wai monitoring programmes confirm that the Tahaaroa lakes are under sustained ecological pressure. While tuna catch rates suggest some population resilience, habitat quality and water clarity have declined markedly, and invasive aquatic plants now dominate most shallow lake zones. Kaiaua beds are smothered by sediment, while remnant native aquatic tupu wai persists only in small patches.

These physical and biological changes have direct cultural consequences. Whaanau describe the lakes as “less alive,” reflecting diminished mauri, reduced hauanga kai, and loss of intergenerational harvest practices. Scientific and tikanga-based indicators align closely; both reveal degradation of ecological integrity and the need for urgent restoration.

7.4.3 Recruitment and Population Resilience

The tuna research shows an ageing population dominated by older, slower-growing individuals. Although overall catch rates have increased since 2007, growth rates have halved from 33 mm/year to 17 mm/year, suggesting environmental stress and reduced recruitment success. The 2010 upgrade of the Wainui Stream fish pass may have improved access for juveniles, but its long-term effectiveness remains uncertain.

High parasite loads, affecting more than 70% of tuna, highlight ecosystem imbalance linked to increased bird populations and declining water quality. From a tikanga perspective, these findings correspond to whaanau concerns about the suitability of tuna for kai and the loss of confidence in the fishery's health.

Recruitment remains the foundation of population resilience. Ensuring that juvenile tuna, kaiaua and other taonga species can access and thrive within the roto will be critical to sustaining ecological and cultural renewal. Protecting the "elders" of the lake, large longfin tuna, mature kaiaua, and remnant vegetation, represents both a biological and spiritual responsibility within the principle of kaitiakitanga. From a customary perspective, these results raise significant concerns for the safety and suitability of tuna for kai. Whaanau expressed that the presence of parasites undermines confidence in the mauri of the fishery and requires ongoing monitoring.

Tuna Health and Mauri

From a customary perspective, the presence of parasites and other health indicators raises concerns about the mauri and suitability of tuna for kai. Complementary research such as the LTR-CTR (Liver and Central Tissue Research) provides important insights into contaminant accumulation and physiological stress in tuna. LTR focuses on liver tissue, a key site for assessing toxin load and metabolic response, while CTR examines muscle and central tissues to evaluate food safety and overall fish health. Together, these studies provide a fuller picture of tuna wellbeing when combined with ongoing habitat monitoring.

Together, these findings highlight the importance of combining habitat monitoring (as outlined in this plan) with complementary research such as the LTR-CTR to provide a fuller picture of tuna health.

7.4.4 Habitat Condition as a Driver

Habitat decline is the central driver of ecological change across the Tahaaroa lake system. Tupu wai monitoring revealed that invasive tupu wai such as *Lagarosiphon major* occupy up to 100% of surveyed areas, while native charophytes are confined to shallower, sheltered margins. The maximum vegetation depth has contracted from 5.7 m in 2014 to 4.4 m in 2024, signalling decreased light penetration and reduced habitat quality.

These patterns align with water quality data showing increasing nutrient enrichment and higher trophic level indices. Sediment inputs, loss of wetland buffering, and algal blooms have collectively shifted the lake from oligotrophic to eutrophic or supertrophic conditions. For kaiaua, these changes manifest as smothering and reduced recruitment; for tuna, as lower oxygen availability, altered prey abundance, and increased parasite exposure.

Within maatauranga frameworks, these habitat changes are visible through tohu such as the dulling of water colour, reduced reflections on calm days, and absence of bird calls once characteristic of the roto. Ecological decline and cultural decline are therefore inseparable, each reflecting the weakening of mauri.

7.4.5 System-wide Vulnerability and Strongholds (Tahaaroa vs Numiti vs Rotoroa)

The Tahaaroa lakes exhibit both vulnerability and resilience. System-wide, the lakes are highly sensitive to external pressures including nutrient loading, invasive species, and bird-mediated enrichment. The interconnected nature of the Tahaaroa, Numiti, and Rotoroa basins means that degradation in one lake quickly propagates to others through shared hydrology.

However, there remain ecological and cultural strongholds, areas of clearer water, remnant native tupu wai, and persistent kaiaua beds that continue to anchor the system's resilience. These sites also hold social and spiritual significance as places where whaanau still gather for karakia, monitoring, and teaching. Protecting these strongholds is central to restoration success. They provide seed sources for native recovery and tangible spaces for the reaffirmation of tikanga. The challenge ahead lies in strengthening these refuges while reducing stressors elsewhere, ensuring that recovery spreads outward from the remaining patches of vitality.

7.4.6 Climate Change and Cumulative Pressures

In addition to localised pressures such as sedimentation, nutrient enrichment, and invasive species, the Tahaaroa lake system is increasingly influenced by the wider impacts of climate change. Projected shifts in rainfall patterns, rising air and water temperatures, and more frequent extreme weather events are likely to affect water levels, clarity, and ecological stability within the roto. These changes can exacerbate existing pressures promoting algal growth, altering habitat availability for tuna and kaiaua, and increasing stress on native tupu wai communities.

Recognising these cumulative effects, the Catchment Monitoring Plan adopts an adaptive framework that enables early detection of climate-related changes through ongoing monitoring of water temperature, turbidity, and seasonal flow patterns. Integrating these parameters with tikanga indicators such as shifts in maramataka timing, tohu of weather and species behaviour will strengthen the ability of Ngaati Mahuta to anticipate and respond to future environmental challenges.

7.4.7 Tikanga, Hauanga Kai, Mana Whakahere

Tikanga has guided every stage of this research, from karakia and sample handling to interpretation and data custodianship. These practices ensure cultural safety, uphold mana whakahaere, and embed whaanau leadership at the centre of environmental governance.

Tikanga indicators such as mauri, kai safety, intergenerational participation, and the presence or absence of tohu like clear water or abundant birdlife, complement scientific measures of lake health. Together, they provide a holistic understanding that unites ecological evidence with cultural meaning.

The decline in hauanga kai opportunities, driven by habitat loss and parasite prevalence, has restricted customary harvest and eroded intergenerational practice. Yet the act of monitoring itself has become a form of restoration. Through involvement in fieldwork, rangatahi, pakeke ruruhi and koroheke have reconnected with the roto, revitalising relationships that underpin kaitiakitanga (Figure 7-21).

Mana whakahaere is reaffirmed when decision-making, data storage, and reporting remain under hapuu authority. Agencies such as MPI, ESNZ, and WRC have important roles to play, but their support must align with the principle that Ngaati Mahuta lead the restoration of their taonga.

Figure 7-21: Reconnection through whakapapa and mahi. Despite the decline in hauanga kai opportunities caused by habitat loss and parasite prevalence, the act of monitoring itself has become a form of restoration. [Photos: Unknown, Hawaaiian Whaanau and Ngahuia Herangi, ESNZ].

7.4.8 Implications for Management and Monitoring (ecological + tikanga responses)

The outcomes of this mahi define a clear pathway for future management and monitoring. Key priorities include:

- Restoration of native macrophyte beds through targeted invasive weed control and sediment management.
- Catchment restoration via fencing, riparian planting, and wetland rehabilitation to reduce nutrient and sediment loads.
- Bird population management (particularly black swan, paradise duck, and Canadian geese) to limit parasite transmission and nutrient enrichment.
- Enhanced monitoring integration, aligning tupu wai, tuna, kaiaua, and water quality programmes within a single, hapuu-led framework.
- Use of the Rongo App and CHI to record whaanau observations and tikanga-based assessments alongside scientific data.
- Long-term environmental logging (temperature, turbidity, oxygen, and water levels) to understand seasonal drivers and inform restoration targets.

Together, these actions will ensure that monitoring remains responsive, evidence-based, and culturally grounded.

7.4.9 Conclusion (synthesis, forward-looking, intergenerational)

The Tahaaroa lakes stand at a critical juncture. The findings of this research confirm ecological decline but also highlight enduring resilience, in the persistence of native life, in the depth of maatauranga, and in the unwavering commitment of whaanau to their role as kaitiaki.

Restoring mauri will require coordinated action: reducing pressures, rebuilding habitats, and reasserting hapuu authority over environmental management. The integrated monitoring approach developed through Ngaa taonga tuku iho o ngaa roto o Tahaaroa provides a blueprint for this future, one that unites science and tikanga, ecology and whakapapa.

Through continued monitoring, restoration, and the exercise of mana whakahaere, the winds of Ngaa Hau o te Hauaauru will once again flow strongly across the roto, carrying forward both the life within the lakes and the legacy of Ngaati Mahuta ki te Hauaauru for generations to come.

8 Recommendations

The following recommendations build directly on the priorities identified through the April 2025 whaanau waananga and the findings discussed in Section 8. Together, they represent a co-designed pathway for restoring and protecting the Tahaaroa lakes. Actions were shaped by whaanau guidance using the EBF scale, which balanced achievability with impact. Immediate actions focus on strengthening relationships, kura engagement, and practical habitat restoration, while more complex initiatives such as hornwort surveys, sediment analysis, and invasive weed control trials will be developed collaboratively with agency partners.

By grounding these recommendations in whaanau priorities and tikanga indicators, the Catchment Monitoring Plan ensures that management decisions reflect both the science and the lived experience of those who hold mana whakahaere for the roto.

8.1 Governance and Partnerships

Maintain The Trust as the lead governance body responsible for coordination, data sovereignty, and reporting on behalf of Ngaati Mahuta.

Continue to strengthen partnerships with ESNZ, The Stream, and WRC to align scientific and tikanga-based monitoring.

Formalise collaborative agreements that recognise mana whakahaere, intellectual-property protection, and shared investment in capacity building.

Hold annual review hui to evaluate progress, update indicators, and confirm next-year priorities.

8.2 Monitoring and Research Priorities

Implement the Tahaaroa Catchment Monitoring Plan using the He Anga Aroturuki Wai Maaori framework as the foundation for all monitoring activity.

Repeat comprehensive surveys of tuna, kaiaua, and tupu wai at least every two years, with additional targeted sampling after major storm events.

To ensure the continued integrity of the Tahaaroa catchment monitoring programme and support customary fisheries health, it is recommended that:

- The Trust continue to support complementary biological assessments, such as LTR-CTR (Liver and Central Tissue Research), alongside habitat monitoring. These analyses can help detect contaminants, parasites, and other stress markers, supporting whaanau confidence in the safety and mauri of customary fisheries.
- Further research partnerships be pursued with ESNZ and other institutions to integrate tuna health, mahinga kai safety, and ecosystem indicators within a holistic monitoring framework.

Establish continuous water-quality logging (temperature, turbidity, dissolved oxygen, and pH) at key lake sites to detect climate-related trends.

Include tikanga-based indicators (mauri, kai safety, tohu) in every field work through the Rongo App.

Undertake focused research on:

- Sediment dynamics and sources of nutrient loading.
- Parasite vectors and bird-population management.
- The efficacy of invasive-weed control trials (e.g., hessian-matting).

8.3 Restoration and Management Actions

Protect and enhance remaining native tupu wai beds and kaiaua habitats as ecological and cultural strongholds.

Prioritise riparian planting, fencing, and sediment-control measures within inflow catchments.

Develop a bird-management programme in partnership with WRC and DOC to reduce nutrient loading and parasite transfer.

Trial small-scale weed-control techniques (e.g., manual removal, shading mats) and monitor recovery responses.

Investigate opportunities for wetland restoration and re-establishment of natural hydrological buffers around lake margins.

8.4 Capacity Building and Knowledge Transfer

Deliver training programmes and waananga to grow local expertise in monitoring, data management, and environmental restoration.

Integrate kura kaupapa and rangatahi into annual monitoring to foster intergenerational learning.

Continue to document oral histories, kupu whakarite, and tikanga observations as valid environmental evidence alongside scientific datasets.

Support career pathways in environmental science, GIS, and digital technology for Ngaati Mahuta.

8.5 Funding and Implementation

Secure multi-year funding through MPI, MfE, Te Wai Māori Trust, and WRC programmes to sustain monitoring and restoration.

Embed monitoring costs within annual operational budgets of The Trust to ensure long-term continuity.

Use monitoring results to leverage co-funding for larger restoration and infrastructure projects.

Maintain transparent financial and performance reporting to partners and whaanau.

8.6 Communication and Reporting

Report monitoring outcomes through StreamDASH for hui aa-tau as a way of communicating data.

Prepare summary State-of-the-Lakes Reports every three years combining scientific results, tikanga indicators, and restoration progress.

Use findings to inform regulatory submissions and policy engagement under Te Mana o te Wai and regional freshwater plans.

Share results with marae, kura, whaanau and Tahaaroa community to encourage collective action for lake health (Figure 8-1).

Implementation of these recommendations will enable Ngaati Mahuta to uphold their role as kaitiaki and decision-makers for the Tahaaroa lakes and catchment. Through continuous learning, innovation, and partnership, the mauri of these taonga can be restored and maintained for the wellbeing of the roto, the whenua, the taiao, and the generations yet to come.

Figure 8-1: Sharing knowledge and results with marae, kura, whaanau and the wider Tahaaroa community strengthens collective kaitiakitanga. Through waananga, fieldwork and storytelling, Ngaati Mahuta continue to learn, innovate, and uphold their role as guardians of the Tahaaroa lakes and catchment. Restoring the mauri of these taonga for the wellbeing of the roto, the whenua, the taiao, and future generations.

9 Proposed Tahaaroa Catchment Monitoring Plan

The Tahaaroa Catchment Monitoring Plan sets out a hapuu-led framework for assessing and restoring the health of the Tahaaroa lakes and their surrounding catchment. Guided by the vision “E rere ana ngaa wai o nga roto o Tahaaroa hei oranga moo te roto, moo ngaa koi ora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru”.

The plan connects maatauranga Maaori and science through He Anga Aroturuki Wai Maaori, a cultural framework that weaves together the values, responsibilities, and relationships of Ngaati Mahuta. The integration of both cultural and ecological indicators, supported by digital tools developed in partnership with The Stream and ESNZ, to uphold data sovereignty and enable mana whenua-led decision-making. Implementation follows an adaptive, cyclical process, observing, analysing, reporting, and refining, ensuring that monitoring remains responsive to environmental change and hapuu aspirations.

Through this approach, the plan strengthens intergenerational learning, enhances the role of kaitiaki in governance, and ensures that the flowing waters of the Tahaaroa lakes continue to sustain life, knowledge, and identity for generations to come.

Hapuu-driven cultural monitoring and assessment programmes can add significant value to regional environmental monitoring by providing a more holistic and integrated understanding of ecosystem and cultural health. These approaches are grounded in tikanga and maatauranga, ensuring that measures of lake condition reflect not only ecological indicators but also the wellbeing of people, places, and whakapapa relationships.

For the Tahaaroa lakes, the proposed catchment monitoring plan builds on the kaupapa of ‘Ngaa taonga tuku iho o ngaa roto o Tahaaroa’, and the priorities identified by whaanau during recent waananga. It aligns with national freshwater management frameworks such as the National Policy Statement for Freshwater Management (2020), the National Environmental Standards for Freshwater (2020), and advice from the Parliamentary Commissioner for the Environment (2019), while maintaining the autonomy and mana whakahaere of Ngaati Mahuta.

Monitoring is viewed here as a continuous, adaptive process rather than a one-off task. Figure 9-1 illustrates a Monitoring Action Planning Cycle, adapted from ESNZ’s environmental monitoring framework, to show the iterative nature of this mahi. The cycle mirrors tikanga-based learning processes already used by kaitiaki: identifying issues, setting objectives, collecting and analysing data, evaluating outcomes, and refining approaches over time.

Figure 9-1: Monitoring Action Planning Cycle adapted from ESNZ's environmental monitoring framework. The cycle reflects the iterative process of establishing objectives, selecting indicators, undertaking monitoring, evaluating outcomes, and adapting approaches to improve management and decision-making. This structure parallels the tikanga-based learning cycles used by whaanau and kaitiaki at the Tahaaroa lakes. [Graphic: Kelly Ratana, ESNZ].

This adaptive framework provides a foundation for ongoing collaboration between the Lakes Trust, NIWA, and supporting agencies. It ensures that monitoring remains responsive to new knowledge, changes in lake condition, and the aspirations of whaanau for the restoration of mauri and hauanga kai.

9.1 Vision and Purpose

The vision of the Taharoa Lakes Trust for the lakes and their catchment is expressed as:

"E rere ana ngaa wai o ngaa roto o Tahaaroa hei oranga moo te roto, moo ngaa koiora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru."

The waters of the Tahaaroa lakes flows to sustain the lake, all living beings, the land, and the people, and to uphold the wellbeing of future generations of Ngaati Mahuta.

This vision affirms that the mauri of the lakes is inseparable from the wellbeing of the people and the surrounding taiao. It underpins the catchment monitoring plan by guiding how

knowledge is gathered, interpreted, and used to restore balance across ecological and cultural systems.

The purpose of the plan is to provide an enduring, hapuu-led framework for monitoring and reporting on the health of the Tahaaroa catchment. It aims to:

- Uphold the mana whakahaere of Ngaati Mahuta in environmental decision-making.
- Integrate maatauranga Maaori and science in assessing lake condition and pressures.
- Strengthen intergenerational learning and participation in environmental monitoring.
- Provide a robust evidence base to guide restoration, advocacy, and regulatory engagement.

Together, these objectives ensure that monitoring contributes to both ecological recovery and the revitalisation of relationships between people and place.

9.1.1 Treaty and Co-governance Context

This catchment monitoring plan has been developed within the wider context of Aotearoa's freshwater management reforms and the principles of Te Tiriti o Waitangi. It reflects the Trust's role as mana whakahaere for the Tahaaroa lakes, working in partnership with local and national agencies to uphold Te Mana o te Wai. The foundational principle that recognises the vital importance of protecting the health and mauri of freshwater systems above all else.

By embedding both maatauranga Maaori and scientific knowledge, the Plan gives effect to the three hierarchies of Te Mana o te Wai:

1. The health and wellbeing of the water body.
2. The health needs of people.
3. The ability of communities to use water for social, cultural, and economic wellbeing.

This approach complements the objectives of the National Policy Statement for Freshwater Management (2020) and the National Environmental Standards for Freshwater (2020), and aligns with the Waikato Regional Council's Te Mana o te Wai implementation framework.
It ensures that Ngaati Mahuta exercise genuine partnership in freshwater governance, not only as stakeholders, but as kaitiaki and Treaty partners whose ancestral rights, maatauranga, and responsibilities are central to decision-making and long-term restoration planning.

9.2 He Anga Aroturuki Wai Maaori – Cultural Framework Guiding the Plan

The Tahaaroa catchment monitoring plan is guided by He Anga Aroturuki Wai Maaori, a cultural framework that weaves together the values, relationships, and responsibilities of Ngaati Mahuta. This framework expresses how maatauranga and tikanga shape the way we observe, measure, and respond to the health of our roto and wider catchment.

It is grounded in three pou: Pou Taiao, Pou Taangata, and Pou Taawhirimaatea, and influenced by six hau known as Ngaa Hau o te Hauaauru. Together, they provide the foundation for our monitoring approach, ensuring that cultural, ecological, and social dimensions are in balance. Figure 9-2 illustrates how these pou and hau interact to guide assessment, decision-making, and restoration across the Tahaaroa lakes. Each element represents both a philosophical foundation and a practical guide for implementing monitoring actions and evaluating outcomes.

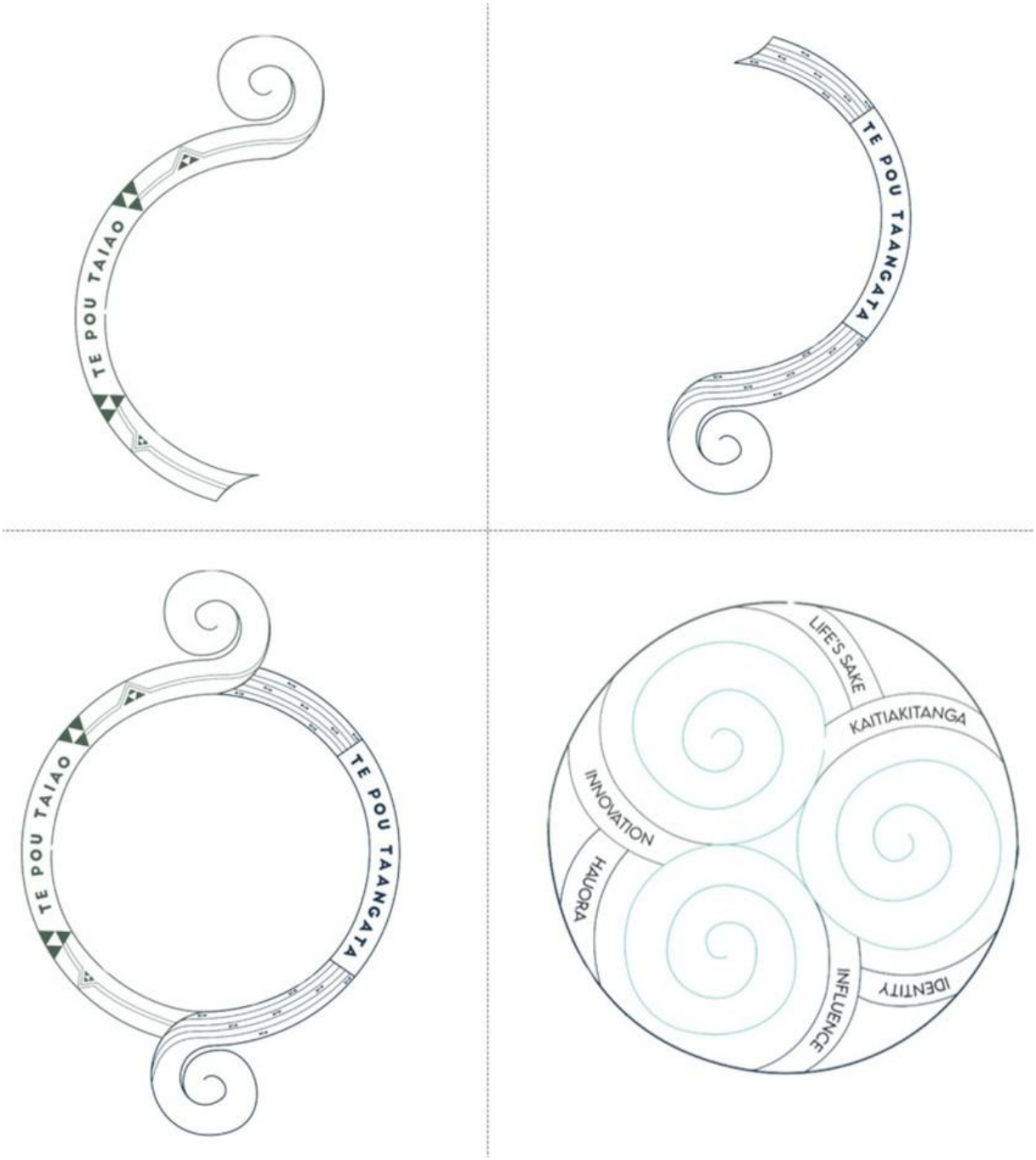


Figure 9-2: He Anga Aroturuki Wai Maaori – the cultural framework guiding the Tahaaroa Catchment Monitoring Plan. The framework is grounded in three pou (Taiao, Taangata, Taawhirimaatea) and shaped by six hau (winds) representing key values and aspirations of Ngaati Mahuta ki te Hauaauru. Together, they provide the foundation for assessing, understanding, and restoring the mauri of the Tahaaroa lakes. [Framework: Mahi Newton-King, Te Ruunanga o Ngaati Mahuta ki te Hauaauru]..

9.2.1 Ngaa Pou e Toru – Three Foundational Pillars

Pou Taiao – Stewardship of the Environment

Represents kaitiakitanga and guardianship of the taiao. It emphasises the need to protect and preserve our whenua, wai, and ecosystems for future generations. This pou guides environmental actions and sustainability practices that uphold the mauri of our roto and the integrity of taiao relationships.

Pou Taangata – Wellbeing of People

Embodies the social and cultural dimensions of the kaupapa. It focuses on nurturing foresight and intergenerational oranga through education, leadership, and the revitalisation of tikanga and reo. This pou reminds us that the wellbeing of people and the wellbeing of the roto are inseparable.

Pou Taawhirimaatea – Balance and Adaptation

Symbolises the balance between Te Ira Taane and Te Ira Waahine, the dual forces that sustain life. It represents change, resilience, and adaptation, guiding us to respond to environmental shifts while maintaining harmony between human wellbeing and environmental protection.

Together, these three pou form the structural foundation for the monitoring framework, ensuring that both environmental and cultural dimensions are upheld in a way that reflects Ngaati Mahuta values and responsibilities.

9.2.2 Ngaa Hau o te Hauaauru – Six Guiding Winds

Ngaa Hau o te Hauaauru provide the currents of influence, values that shape how we move, adapt, and stay aligned with our kaupapa (Table 9-1). Each hau represents a key driver and aspiration within the monitoring approach.

Table 9-1: Ngaa Hau o te Hauaauru represents the six guiding winds of the He Anga Aroturuki Wai Maaori framework. Each hau represents a key value and driver that shapes the catchment monitoring plan, connecting environmental, cultural, and social wellbeing. Together, these winds influence how Ngaati Mahuta observe, interpret, and respond to changes within the Tahaaroa lakes catchment.

Hau	Meaning and Application
Te Hauwhenua	Carries the winds of strength and protection of life itself. It reminds us of our duty to safeguard all that sustains us; land, water, and people.
Te Haumaiangi	Represents innovation and change, encouraging the hapuu to embrace new ideas and adaptive approaches as environmental conditions evolve.
Te Hautupua	Reflects the wisdom of the past, guiding us in the present and ensuring that ancestral teachings influence our decisions for the future.
Te Hauaawhio	The unifying wind that nurtures leadership and connection across generations, ensuring that the hapuu remains strong and cohesive.

Hau	Meaning and Application
Te Hauora	Symbolises health and wellbeing in all its forms; physical, mental, and spiritual. Ensuring that our monitoring restores both people and environment.
Te Hauaauru	Represents identity and whakapapa. It anchors us in who we are as Ngaati Mahuta and guides how we navigate challenges and opportunities.

These hau influence how we think, assess, relate, and respond within the Tahaaroa catchment. They transform the framework from a static model into a *living expression* of our values and aspirations.

9.3 Reporting and Evaluation

The integration of The Stream's digital tools within the catchment monitoring plan enables an adaptive, hapuu-led reporting cycle. Data and observations recorded through Rongo, StreamDASH, StreamMAP, and Tūhono are regularly reviewed alongside maatauranga-based indicators drawn from the He Anga Aroturuki Wai Maaori framework. This combined approach ensures that both quantitative and qualitative measures of lake health such as mauri, kai safety, water quality, and species condition inform annual and seasonal evaluations.

Each year, The Trust convenes hui with kaitiaki and partner agencies to review outcomes, update datasets, and refine priorities for the following monitoring season. These hui serve not only as reporting milestones but also as opportunities for reflection, learning, and intergenerational knowledge exchange. Over time, this cycle of data collection, analysis, and reflection will strengthen the Trust's ability to adapt management responses, communicate findings to whaanau, and uphold the principles of mana whakahaere and data sovereignty in freshwater governance.

9.4 Implementation Pathway

The implementation of the Tahaaroa catchment monitoring plan relies on a coordinated and iterative approach that brings together whaanau governance, technical partnerships, and digital innovation. At its foundation is He Anga Aroturuki Wai Maaori, the cultural framework that ensures every activity reflects the values and aspirations of Ngaati Mahuta.

The Taharoa Lakes Trust holds overall responsibility for plan delivery and coordination. Trustees and kaitiaki lead the scheduling of monitoring activities, verification of field data, and validation of tikanga indicators. Technical partners, including ESNZ, and The Stream, provide scientific, analytical, and digital support, while continuing to build capacity within the hapuu to operate and maintain these systems independently over time.

Implementation follows a rolling annual cycle:

1. **Planning and Preparation** – Confirm monitoring priorities for tuna, kaiaua, tupu wai, and water quality; align resources, training, and health and safety plans.
2. **Data Collection and Observation** – Field surveys are undertaken seasonally, combining scientific sampling with tikanga-based assessments recorded through Rongo.
3. **Analysis and Integration** – Data from The Stream platform are reviewed alongside maatauranga indicators to identify patterns and emerging pressures.
4. **Reporting and Review** – Results are presented through hui aa-tau and shared digitally via StreamDASH and StreamMAP dashboards, ensuring transparency and accessibility for whaanau.
5. **Adaptive Management** – Insights from each cycle inform restoration priorities, funding applications, and updates to the plan itself.

This cyclical process allows the monitoring programme to evolve as new knowledge emerges, maintaining relevance to both environmental conditions and community aspirations (Table 9-2, Figure 9-1). By embedding digital tools, whaanau participation, and tikanga-based evaluation within one pathway, the catchment monitoring plan becomes a living system, one that sustains learning, reinforces mana whakahaere, and secures the long-term mauri of the Tahaaroa lakes and their surrounding catchment.

Table 9-2: Summary of monitoring indicators for the Tahaaroa catchment monitoring plan. Indicators combine scientific and tikanga-based measures to assess the health and mauri of the lakes and their catchment. Frequency and responsibilities may be adapted through annual review hui.

Monitoring Domain	Key Indicatiors / Parameters	Method or Tool	Frequency / Timing	Lead and Supporting Roles
Tuna	Catch per unit effort (CPUE), size/age structure, parasite load, condition factor, recruitment signs	Fyke-net and trap surveys; biological sampling; Rongo App field entries	Biennially (late summer/early autumn)	*Lead:* The Trust, Ngaati Mahuta *Support:* ESNZ
Kaiaua	Abundance, shell condition, size distribution, recruitment	Transect and quadrat surveys (shore–deep zones); habitat observations via Rongo	Biennially (aligned with tuna survey)	*Lead:* The Trust, Ngaati Mahuta *Support:* ESNZ
Tupu Wai	Species composition, % cover, depth limit, native vs invasive ratio	Shoreline transects and diver LakeSPI method; Rongo App records	Biennially (spring) + opportunistic checks	*Lead:* The Trust, Ngaati Mahuta *Support:* ESNZ, WRC

Monitoring Domain	Key Indicatiors / Parameters	Method or Tool	Frequency / Timing	Lead and Supporting Roles
Water Quality	Temperature, clarity (Secchi), pH, DO, nutrients (TN, TP), chlorophyll a	In-lake profiles; laboratory analysis; sensor loggers	Quarterly (4× per year)	*Lead:* The Trust, Ngaati Mahuta *Support:* ESNZ, WRC
Tikanga Indicators / Cultural Health	Mauri assessment, kai safety, tohu presence (birds, plants, clarity), whaanau participation	Rongo App; CHI; waananga observations	Ongoing (real-time) + annual reflection hui	*Lead:* The Trust, Ngaati Mahuta *Support:* ESNZ, The Stream
Catchment Pressures and Habitat	Sediment loads, riparian condition, bird densities, land use activities	StreamMAP and drone imagery; field transects; photo-points	Annually (pre-winter)	*Lead:* The Trust, Ngaati Mahuta *Support:* ESNZ, The Stream
Governance and Reporting	Data integration, dashboard updates, annual hui outcomes	StreamDASH visualisation; Trust reporting template	Annual review and plan update	*Lead:* The Trust *Support:* All partners

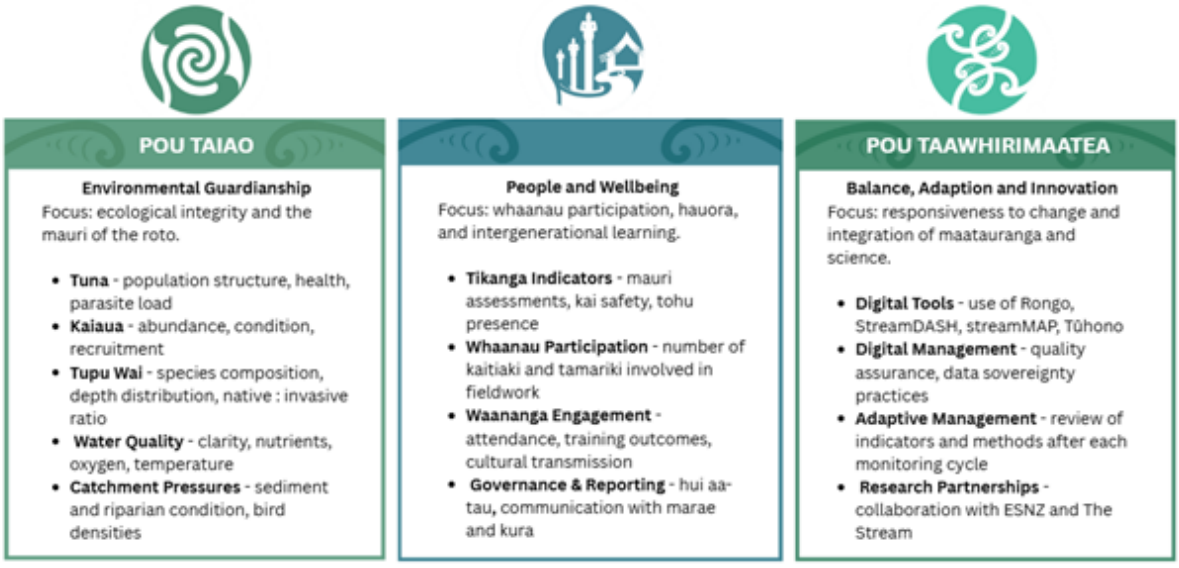


Figure 9-3: Alignment of ecological, cultural, and governance indicators within the He Anga Aroturuki Wai Maaori framework. Each Pou anchors a distinct aspect of monitoring: environmental integrity, whaanau wellbeing, and adaptive management, ensuring that all data and actions collectively sustain the mauri of the Tahaaroa lakes.

9.4.1 Roles, Responsibilities, and Partnerships

The success of the Tahaaroa catchment monitoring plan depends on strong collaboration between whaanau, technical partners, and agencies, each contributing their expertise and responsibilities. Clear roles ensure that the plan remains hapuu-led, scientifically robust, and administratively transparent (Table 9-3).

The Trust holds the mandate for governance and coordination on behalf of Ngaati Mahuta, while technical partners provide support to implement monitoring, manage data, and strengthen capacity. The plan is designed to evolve through shared learning and reflection, guided by tikanga and the principle of mana whakahaere.

Table 9-3: Roles and responsibilities for implementation of the Tahaaroa catchment monitoring plan. Governance is retained by the Taharoa Lakes Trust, supported by kaitiaki, marae, and technical partners to ensure monitoring remains hapuu-led, scientifically credible, and culturally grounded.

Entity / Group	Primary Responsibilities	Relationship / Support Functions
Tahaaroa Lakes Trust	Overall governance, coordination of the monitoring programme, protection of data sovereignty, approval of annual workplans and reporting.	Acts as the lead decision-making body and custodian of all data and intellectual property. Provides oversight of partnerships and ensures alignment with Trust vision and strategy.
Kaitiaki monitors	Undertake field observations and data collection for tuna, kaiaua, *tupu wai*, water quality, and tikanga indicators. Record information using Rongo. Participate in training and waananga.	Represent the lived knowledge and tikanga of the hapū. Provide intergenerational continuity and cultural validation of data.
ESNZ	Technical guidance on sampling design, analysis, and interpretation. Ensure scientific quality assurance and calibration of methods. Facilitation, project management support, and reporting assistance. Support integration of The Stream digital tools with Trust systems.	Partner organisation supporting integration of maatauranga Maaori and scientific research. Provides technical review and capacity building. Acts as a bridge between technical partners and the Trust. Provides training, documentation, and process alignment.
The Stream	Manage digital infrastructure (Rongo, StreamDASH, StreamMAP, Tūhono). Maintain data security, system updates, and user support.	Provides customised digital tools and training to ensure whaanau control and long-term sustainability of data platforms.
Waikato Regional Council	Alignment with regional freshwater monitoring frameworks and regulatory processes (e.g., Te Mana o te Wai).	Strategic partner supporting data sharing, funding access, and technical collaboration under co-governance arrangements.
Marae (Te Kooraha, Aaruka, Maketuu)	Provide venues, cultural guidance, and whaanau engagement for monitoring activities and waananga.	Maintain connection to place, whakapapa, and tikanga. Strengthen community participation and local ownership of outcomes.

The clarity of roles ensures that each organisation understands its function within the collective effort. Regular hui aa-tau will review roles, address capacity needs, and confirm ongoing alignment with the Trust's vision. E rere ana ngaa wai o ngaa roto o Tahaaroa hei oranga moo te roto, moo ngaa koiora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru.

9.4.2 Funding and Sustainability

Long-term sustainability of the Tahaaroa catchment monitoring plan depends on consistent resourcing, collaborative partnerships, and continued whaanau participation. The Trust will lead the development of a rolling funding strategy to ensure the ongoing operation, training, and refinement of monitoring activities.

Funding will be sought from a mix of sources, including central and local government environmental programmes, philanthropic and research partnerships, and mana whenua-led initiatives. Potential funding streams include:

- **Ministry for Primary Industries (MPI)** – supporting habitat restoration and customary fisheries research.
- **Department of Internal Affairs (Oranga Marae and Community Resilience Funds)** – supporting infrastructure and cultural revitalisation components.
- **Waikato Regional Council** – through Te Mana o te Wai implementation funding and catchment improvement programmes.
- **Ministry for the Environment (MfE) and Te Wai Māori Trust** – for freshwater ecosystem and taonga species recovery projects.
- **MBIE Vision Maatauranga and Research Partnerships** – for integration of maatauranga Maaori and science.

The Trust will maintain transparent financial reporting and will seek to embed funding for monitoring within multi-year operational plans to provide continuity beyond single project cycles.

Where possible, capability development and employment opportunities for local whaanau will be prioritised, ensuring that the plan continues to build intergenerational capacity and self-determination.

Through this approach, the catchment monitoring plan will remain a living, evolving programme sustained not only by external funding, but by the collective commitment of the people of Ngaati Mahuta to uphold the mauri of their roto and the wellbeing of future generations.

9.5 He Kupu Whakakapi

The Tahaaroa catchment monitoring plan is more than a technical document, it is a living expression of whakapapa, mauri, and kaitiakitanga. It connects the scientific and the spiritual, the old and the new, ensuring that each observation contributes to the long-term oranga of the roto and its people (Figure 9-4).

Guided by He Anga Aroturuki Wai Maaori and supported through partnerships that honour both maatauranga and science, the plan establishes a pathway for collective action and learning.

As expressed in the Trust's vision:
"E rere ana ngaa wai o ngaa roto o Tahaaroa hei oranga moo te roto, moo ngaa koiora katoa, moo te whenua, moo te tangata, aa, hei painga hoki moo ngaa uri whakaheke o Ngaati Mahuta ki te Hauaauru."

Through this plan, those flowing waters carry forward not only the life of the lakes but also the knowledge, values, and responsibilities that sustain the identity and future of Ngaati Mahuta.

Figure 9-4: Ngaati Mahuta kaitiaki gather at Maukore, Lake Tahaaroa to monitor and assess tuna health as part of the Tahaaroa catchment monitoring programme. Ngaati Mahuta kaitiaki gather at Maukore, Lake Tahaaroa to monitor and assess tuna health as part of the Tahaaroa catchment monitoring programme (November 2023). Reconnecting people, science and place through shared observation and maatauranga.

10 Acknowledgements

Heke iho raa ngaa roimata o Ranginui ki a Papatuaanuku, ko te wai tuku kiri o ngooku maatua tuupuna. Rere ana te wai-oo-rangi, te wai-oo-nuku ki runga i a taatou katoa, tatuu atu ai ki ngoo taatou awa, ngoo taatou puna, ngoo taatou hiirere. Kaiwaka huri noa, teenaa koutou, teenaa koutou, teenaa koutou katoa.

Kei ngaa ringa atawhai, kei ngaa waewae tutuki, kei ngaa tuaraa piikau e haapai nei i a maatou ngaa riporipo o ngaa wai o Tahaaroa, teenei maatou ka mihi ki a koutou katoa. Mei kore ko koutou kua kore teenei kaupapa e koke whakamua, e puta hoki ai ngaa hua o teenei kaupapa nui whakaharahara. Nei raa te whakamaanawa nei ki a koutou katoa, ko te whenua ko te wai ko te mauri o te iwi, teena koutou, teenaa koutou, teena raa taatou katoa.

The tears of Ranginui fall upon Papatuuaanuku, the sacred cleansing waters of our ancestors. The waters of the heavens and the waters of the earth flow over us all, reaching our rivers, our springs, and our waterfalls. Across all directions, we acknowledge you all, greetings, greetings, warm greetings to everyone.

To the caring hands, the tireless feet, and the steadfast shoulders who uplift us through the swirling waters of Tahaaroa, we extend our gratitude to you all. Without you, this endeavour would not progress, nor would its great outcomes be realized.

Here we offer our deep appreciation to you all, our land, our waters, and the life force of our people. Greetings, greetings, warm greetings to us all.

11 Glossary of abbreviations and terms

CTR	Central Tissue Research – analysis of tuna muscle or central body tissue to assess food safety and physiological stress.
LTR	Liver Tissue Research – analysis of tuna liver tissue to detect contaminants and assess metabolic response.
WRC	Waikato Regional Council
ESNZ	Earth Sciences New Zealand
VMCF	Vision Mātauranga Capability Fund

11.1 Glossary of Cultural Terms

Ngaa Parenga Aroturuki Wai	Tahaaroa Catchment Monitoring Plan
He Anga Aroturuki Wai Maaori	Cultural monitoring framework guiding the Tahaaroa Catchment Monitoring Plan
Tupu Wai	Native vegetation

11.2 Glossary of Scientific Terms

Catchment	Area from which rainfall and surface water drain into a river, lake, or reservoir
Ecological Indicator	A biological, chemical, or physical measure used to assess ecosystem condition
Habitat Monitoring	Observation of physical, chemical, and biological features supporting species health
Macrophyte	Large aquatic plant growing in or near water; indicator of lake health.
Contaminant	Substance that pollutes or degrades water or biota
Physiological Stress	Biological response to unfavourable environmental conditions or pollutants.
Water Clarity	Measure of light penetration through water; indicator of sediment and algae levels
Trophic State	Classification of a lake's productivity based on nutrient levels and biological activity

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Appendix A Examples of Otolith Ageing Results

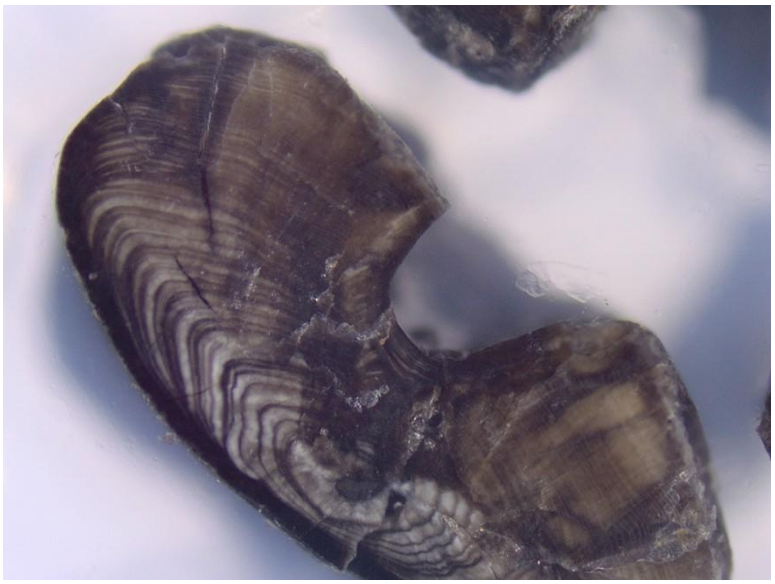

Figure A-1: Shortfin otolith from Lake Tahaaroa, showing distinct annual growth rings (annuli). Each dark/light band represents one year of growth in freshwater This specimen was 654mm and aged at 47 years. T34-I75#2, 13/02/25, SFE, 654mm, Age 47. [Ageing: Paul Lambert, Alex Rose, Kristy Hogsden].

Figure A-2: Paired otolith halves from Lake Tahaaroa shortfin. Multiple tightly spaced annuli are visible, with outer bands indicating slower growth in later life stages Estimated age 14 years at 454mm. T24-I82#1, 11/02/25A, SFE, 454mm, Age 14. [Ageing: Paul Lambert, Alex Rose, Kristy Hogsden].

Figure A-3: This shortfin otolith from Lake Tahaaroa. Despite fracturing, annuli remain visible and readable. This specimen was 505mm and aged at 30 years. T23-EX09#2,11/02/25A, SFE, 505mm Age 30. [Ageing: Paul Lambert, Alex Rose, Kristy Hogsden].

Appendix B Inventory of Publicly Available Research on Tahaaroa Lakes

Table B-1: Inventory of publicly available research on Tahaaroa Lakes and surrounding area.

Year	Title	Agency	Description	Focus Area	Reference/links
1985	Fisheries aspects of the Taharoa lakes and Wainui Stream	NZ Ministry of Agriculture and Fisheries	This report is one of a series of reports issued by Fisheries Research Division on important issues related to environment matters. The report highlights fisheries as a concern due to the construction of the Wainui Stream dam allowed by New Zealand Steel Mining Limited to abstract water for ironsand mining operation. A fish passage, which was a condition of their water right, was installed to allow fish access to the lake. Although it is negotiable by some species, it is impassable to mullet as a result the grey mullet fishery has been lost. The various surveys conducted, and reports produced on the fisheries problems at Taharoa are summarised and discussed. Recommended options to assist in restoring previous fisheries values are presented and action is required by the parties involved to resolve the problem.	Assessments undertaken at Lake Taharoa, Lake Numiti, Lake Rotoroa, Wainui Stream.	Fisheries Environmental Report No. 66
1993	Eel stock evaluation in Lakes Taharoa and Rotoroa	NIWA	Unable to source	—	—

Year	Title	Agency	Description	Focus Area	Reference/links
1994	Eels on the Taharoa Dune Lakes; a microcosm of national eel populations	NIWA	Unable to source	—	—
1998	Results of Monitoring New Zealand Lakes, 1992-1996 Volume 1 – General Findings	NIWA Prepared for Ministry for the Environment	This study developed and tested a systematic process for analysing lake monitoring data to detect whether monitored lakes were changing their trophic states or remaining stable, Lake Taharoa was included.	Lake Taharoa	NIWA Client Report: MFE80216
1998	Results of Monitoring New Zealand Lakes, 1992-1996 Volume 2 – Commentary on Results	NIWA Prepared for Ministry for the Environment	This study developed and tested a systematic process for analysing lake monitoring data to detect whether monitored lakes were changing their trophic states or remaining stable, Lake Taharoa was included.	Lake Taharoa	NIWA Client Report: MFE80216

Year	Title	Agency	Description	Focus Area	Reference/links
1998	Results of Monitoring New Zealand Lakes, 1992-1996 Volume 3 – Data and Results	NIWA Prepared for Ministry for the Environment	This study developed and tested a systematic process for analysing lake monitoring data to detect whether monitored lakes were changing their trophic states or remaining stable, Lake Taharoa was included.	Lake Taharoa	NIWA Client Report: MFE80216
1998	Review of the operation of the Taharoa fish-pass and associated fisheries issues	NIWA Prepared for BHP New Zealand Steel Mining, Taharoa	NIWA was consulted by BHP New Zealand Steel Mining, Taharoa, to provide a review of the long-term fish-pass data, evaluate eel recruitment, mullet transfer, and make recommendations for improvement of access to the Taharoa lakes.	Fish-pass, Wainui Stream	NIWA Client Report: BHP90202/1
1998	Enhancement of Māori customary eel fisheries in Lakes Taharoa and Harihari by transfer of juveniles	NIWA Prepared for Ministry of Fisheries	This report covers part of Project EEL9702 objectives relating to North Island: To evaluate and monitor the effects of the transfer of juvenile eels on eel populations. Objectives include (i) to transfer and record the species composition and numbers, and tag a representative sample, of juvenile eels transferred to two Māori customary fishing areas, appropriate for enhancement; (ii) to determine the size structure and growth rates of eels resident in the two Māori customary fishing areas identified above before the transfer of eels.	Surveys undertaken at Lake Taharoa and Lake Harihari.	NIWA Client report: Project code: EEL9702

Year	Title	Agency	Description	Focus Area	Reference/links
2000	Enhancement of Maori customary eel fisheries in Lakes Taharoa and Harihari by transfer of juveniles	NIWA	This report forms part of a Ministry of Fisheries contract to further study eel enhancement opportunities from juvenile (sub-commercial sized) eels, i.e., 220 g or less, in the North Island. Similar transfer programmes have been carried out in the South Island (Jellyman & Beentjes, 1998; Beentjes 1998).	Surveys undertaken at Lake Taharoa and Lake Harihari.	NIWA Technical Report 91 ISSN 1174-2631 ISBN 0-478-23218-7
2002	Evaluation of enhancement of Māori customary eel fisheries in Lakes Taharoa and Harihari	NIWA Prepared for Ministry of Fisheries	The purpose of this report is to evaluate and monitor the effects of the transfer of juvenile eels on eel populations in Māori customary fishing areas. The specific objectives included (1) recapturing and age a representative sample (up to 10% of release number) of tagged short-finned eels transferred from Lake Waahi to the Taharoa Lakes Māori customary fishing area; (ii) to age a sample (up to 200) of transferred untagged eels from the Taharoa Lakes to determine otolith band patterns; (iii) to assess the size structure, growth rates and survival of tagged and untagged transferred eels from the Taharoa lakes, and compare with known size structures and growth rates of eels from Lake Waahi.	Surveys undertaken at Lake Taharoa and Lake Harihari.	Project code: EEL2001/01

Year	Title	Agency	Description	Focus Area	Reference/links
2003	The condition of nineteen lakes in the Waikato Region using LakeSPI	NIWA	NIWA was contracted by WRC to assess the condition of nineteen lakes using LakeSPI; a method that uses Submerged Plan Indicators (SPI) to assess, monitor and report on lake condition. LakeSPI assessments were carried out on each lake to describe: - Pristine condition (lake plant communities in pre impacted times) - Historical condition (lake condition as described by historical data) - Present day condition (most recent data)	Assessments undertaken in Lake Taharoa.	NIWA Client Report: HAM2003-157 Project code: EVW03264

Year	Title	Agency	Description	Focus Area	Reference/links
2005	An assessment of the ecological condition of Lake Harihari	NIWA Prepared for Waikato Regional Council	NIWA was contracted by EW to assess the condition of 32 lakes in the Waikato Region, including Lake Harihari and Lake Taharoa using LakeSPI. A method that uses Submerged Plan Indicators (SPI) to assess, monitor and report on lake condition. LakeSPI assessments recorded: - Depths each plant species grew to - How many species of plants were present - How abundant they were - The extent of impacts by any invasive alien week present - Fish or other animal life seen and took photos as a record	Lake Harihari	NIWA Client report: HAM2005-132 Project code: EVW05277
2005	The condition of lakes in the Waikato Region using LakeSPI	NIWA	NIWA was contracted by EW to assess the condition of 33 lakes using LakeSPI.	Lake Tahaaroa	—

Year	Title	Agency	Description	Focus Area	Reference/links
2006	Interim results from a survey of the eel population of Lake Taharoa, 9-10 February 2006	NIWA	14 commercial fyke nets with 31 mm escape tube and 10 fine (5 mm) meshed nets were set along the shore and off shore region of Lake Taharoa. The nets were deployed on the evening on 21 February 2006 and lifted on the morning of 22 February. The commercial fyke nets were baited with chicken meat but the fine meshed fyke nets were un-baited.	Lake Tahaaroa	Jacques Boubee
2007	The condition of 41 lakes in the Waikato Region using LakeSPI	NIWA Prepared for Waikato Regional Council (formerly Environment Waikato)	NIWA was contracted by WRC to assess the condition of forty-one lakes using LakeSPI; a method that uses Submerged Plant Indicators (SPI) to assess, monitor and report on lake condition. LakeSPI assessments were carried out on each lake to describe: - Pristine condition (lake plant communities in pre impacted times) - Historical condition (lake condition as described by historical data) - Present day condition (most recent data)	Assessments undertaken at Lake Harihari, Lake Rotoiti, Lake Taharoa.	NIWA Client Report: HAM2007-108 Project code: EVW007209
2007	West Coast Hazard Project	Tonkin & Taylor	T&T were commissioned by EW undertake an assessment of coastal hazard information along the west coast of their region.	CMA related including Tahaaroa	Waikato Regional Council

Year	Title	Agency	Description	Focus Area	Reference/links
2008	Assessment of Biological Indicators of Lake Health in Waikato Shallow Lakes - a Pilot Study 2006/07	Waikato Regional Council (formerly Environment Waikato)	This was a multi-agency project that aimed to assess a number of biotic and functional variables as potential indicators of lake health with the intention to find one or more techniques that can be measured across a variety of lake types. University of Waikato analysed zooplankton communities, Cawthron Institute carried out identification of macroinvertebrate samples and LakeSPI assessments were undertaken by NIWA.	Assessments undertaken at Lakes Taharoa and Harihari.	https://www.waikatoregion.govt.nz/assets/WRC/WRC-2019/TR0818.pdf
2008	The condition of 43 lakes in the Waikato Region using LakeSPI	NIWA Prepared for Waikato Regional Council (formerly Environment Waikato)	NIWA was contracted by WRC to assess the condition of forty-three lakes using LakeSPI; a method that uses Submerged Plan Indicators (SPI) to assess, monitor and report on lake condition. LakeSPI assessments were carried out on each lake to describe: - Pristine condition (lake plant communities in pre impacted times) - Historical condition (lake condition as described by historical data) - Present day condition (most recent data)	Assessments undertaken at Lakes Taharoa and Harihari.	NIWA Client Report: HAM2008-089 Project code: EVW08218

Year	Title	Agency	Description	Focus Area	Reference/links
2008	Zooplankton Composition and a Water Quality Assessment of Seventeen Waikato Lakes Using Rotifer Community Composition	Centre for Biodiversity and Ecology Research Prepared for Waikato Regional Council	Zooplankton species composition was documented from 17 Waikato lakes from net haul samples collected in late 2007 (summer) and early 2008 (autumn). The lakes examined were Harihari, Mangahia, Maratoto, Ngahewa, Ohinewai, Okowhao, Parangi, Rotokawau, Rotomanuka, Serpentine East, Serpentine North, Serpentine South, Taharoa, Tutaeinanga, Waahi, Waikare and Whangape.	Lake Tahaaroa	Duggan, I. C (Centre for Biodiversity and Ecology Research)
2008	Taharoa Lakes Customary eel fisheries	Ministry of Fisheries	Researchers Ben Chisnall and Ian Ruru implemented this customary research project with Kaitiaki from Tahaaroa with funding from Ministry of Fisheries.	Tuna surveys undertaken at Lakes Taharoa, Numiti, Rotoroa and Harihari.	Project EEL2006-06

Year	Title	Agency	Description	Focus Area	Reference/links
2010	Assessment of the ecological condition of lakes in the Waikato Region using LakeSPI – 2010	NIWA Prepared for Environment Waikato	NIWA was contracted by WRC to assess the condition of selected lakes within the Waikato Regional using LakeSPI; a method that uses Submerged Plan Indicators (SPI) to monitor and report on lake condition. A total of fifty-two Waikato lakes were assessed for the report using LakeSPI to describe: - Pristine condition (lake plant communities in pre impacted times) - Historical condition (lake condition as described by historical data) - Present day condition (most recent data)	Assessments undertaken at Lake Harihari, Lake Taharoa.	NIWA Client Report: HAM2010-065 Project code: EVW10211

Year	Title	Agency	Description	Focus Area	Reference/links
2011	Wainui Stream and Fish Pass October 2010 and January 2011 Fish Surveys	Tonkin & Taylor Ltd Prepared for New Zealand Steel Ltd	Reporting the results of the fish pass monitoring programme to Waikato Regional Council by 1 August each year is a condition of the resource consent. This report includes the following information as required by Condition 3 (vi) of Resource Consent number 100904: the number (average and range) and species of fish passing through the fish pass during the peak migration times for each of the species listed above (inanga, smelt, long fin eel, short fin eel and mullet). frequency of non-target fish utilising the fish pass. the effectiveness of the fish pass. frequency and timing of monitoring (which shall be at least annually).	Monitoring programme results of the Wainui Stream and Fish Pass	T&T Ref: 22861. 300

Year	Title	Agency	Description	Focus Area	Reference/links
2014	Wainui Stream and Fish Pass October 2013 and January 2014 Fish Surveys	Tonkin & Taylor Ltd Prepared for New Zealand Steel Ltd	Reporting the results of the fish pass monitoring programme to Waikato Regional Council by 1 August each year is a condition of the resource consent. This report includes the following information as required by Condition 3 (vi) of Resource Consent number 100904: the number (average and range) and species of fish passing through the fish pass during the peak migration times for each of the species listed above (inanga, smelt, long fin eel, short fin eel and mullet). Frequency of non-target fish utilising the fish pass. The effectiveness of the fish pass. frequency and timing of monitoring (which shall be at least annually).	Monitoring programme results of the Wainui Stream and Fish Pass	T&T Ref: 22861. 300
2014	Taharoa data deficient shallow lakes survey May 2014	Waikato Regional Council, NIWA and DOC	This multiagency study provides baseline physico-chemical, submerged plants and ecological information for Lakes Numiti, Rotoroa, Piopio and Rototapu. Results for each lake are discussed including potential priorities for future management of these relatively remote dune lakes.	Assessments undertaken at Lakes Numiti, Rotoroa, Rototapu and Piopio.	https://www.waikatoregion.govt.nz/assets/WRC/WRC-2019/TR201464.pdf

Year	Title	Agency	Description	Focus Area	Reference/links
2014	Waikato region shallow lakes management plan: Volume 2	Waikato Regional Council	This document is the second part of Waikato Regional Council's Shallow Lake Management Plan. It has been developed as a resource statement (to accompany Volume I) that summarises available information and knowledge about the condition of shallow lakes in the Waikato region and identifies specific management recommendations for individual lakes.	Lake Tahaaroa mapped priority 1 for stock exclusion areas in the regional plan maps and Lake Harihari is priority 2. Financial assistance and advice has been provided to fence, plant and extend riparian margins at priority lakes.	Dean-Spiers, T., Neilson, K., Reeves, P., Kelly, J.
2019	Our lakes' health: past, present, future (Lakes380)	GNS Science and Cawthron Institute	Lakes380 was a five-year MBIE funded programme. The programme was jointly led by GNS Science and the Cawthron Institute and involved seven other national and many international organisations where sediment cores were collected from approximately 10% of New Zealand's 3,800 lakes (>1 ha). This was used to explore how and why lake health has changed. Changes in lake health were reconstructed using environmental DNA, paleoecology and high-resolution scanning at selected lakes. Due to budget and resourcing constraints not all sediment cores were analysed as is the case for Lakes Tahaaroa and Harihari.	Core sediments taken from Lakes Tahaaroa and Harihari.	https://lakes380.com/lakes/lake-taharoa-waikato/

Year	Title	Agency	Description	Focus Area	Reference/links
2019	Use of West Coast Waikato estuaries by Canada geese and black swans	Tonkin & Taylor Prepared for Waikato Regional Council	This report discusses concerns that Canada goose and black swan numbers are increasing in west coast Waikato estuaries, specifically Aotea Harbour, Whaingaroa (Raglan) Harbour1 and Kawhia Harbour. These birds may be having negative ecological impacts, particularly on seagrass, which is a key biogenic habitat (Anderson et al., 2019) that has been declining over the last 50 years and is now At Risk – Declining.	Tahaaroa lakes	Briar Taylor Smith (Tonkin & Taylor Ltd)
2019	Sites of importance to shorebirds and seabirds in the Waikato region	Waikato Regional Council	Site inventories are provided for 51 sites, 11 on the west coast and 40 on the east coast. The inventories summarise the main avian values of each site, note threats to those values, and identify information gaps. Based on threat status and numbers of birds, sites have been assigned to one of three broad priority categories, reflecting each site's importance to shorebirds or seabirds. Threatened and At Risk taxa are common around much of the coast and on offshore islands in the region, and almost all sites qualify as significant habitat of indigenous fauna under Waikato Regional Council guidelines. There are 15 Priority 1 sites on the east coast and four on the west coast.	CMA related - Taharoa is a priority 1 site	Dowding, J.E. 2019. Sites of importance to shorebirds and seabirds in the Waikato Region. DM Consultants contract report number 291. DM Consultants, Christchurch.

Year	Title	Agency	Description	Focus Area	Reference/links
2020	Conservation Action Plan for the Taharoa Lakes	Nicholas Singers Ecological Solutions Innovation in Conservation Prepared for Waikato Regional Council	This report is an update of the 2016 version which includes a revision of the invasive weed management section and associated appendix. Sections covering fencing and vegetation restoration were not updated.	Assessments undertaken at Lake Taharoa, Lake Numiti, Lake Rotoroa, Lake Piopio, Lake Rototapu, Lake Harihari.	NES Ltd report 6:2016/17 Updated August 2020
2020	Sites and habitats of significance within the Waikato Region's coastal marine area		The analysis involved a desktop data collation and assessment exercise, drawing upon existing data, to identify significant sites and habitats within the CMA of the Waikato region, out to the 12 nautical mile (nm) limit. No field site visits or fieldwork were undertaken. Significance was assigned to sites and habitats on the basis of meeting one or more of 11 criteria identified in the WRC's (2016) existing Regional Policy Statement (RPS).	CMA related – Tahaaroa	D.R Thompson, C.J. Lundquist, W.A. Nelson, S. Nodder, M.P. Francis, K. Hupman, S. Watson, and S. Woelz (National Institute of Water & Atmospheric Research Ltd)

Year	Title	Agency	Description	Focus Area	Reference/links
2022	Taharoa Ironsands Mine – Fish Passage Assessment in Response to Further Information Request	4Sight Consulting | Part of SLR Prepared for Tahaaroa Ironsands Limited	Taharoa Ironsands Ltd (TIL) are seeking a renewal of their resource consents to undertake ironsand mining operations within the Taharoa C block. Subsequent to lodging the application, Waikato Regional Council (WRC) filed a Section 92 request for further information, including a number of requests on the effectiveness of the fish pass within the site.	Fyke nets deployed in Lake Taharoa and electric fishing of tributaries within the wider catchment undertaken. eDNA samples taken from Wainui Stream below and above dam, Mangatangi Stream, Lake Numiti and Lake Taharoa. Wilderlab website shows taxan results of eDNA samples from Lakes Numiti, Rotoroa and Harihari.	eDNA Sample Reports https://s3.ap-southeast-2.amazonaws.com/wilderlab.openwaters/reports/eb31f6533f863842.html https://s3.ap-southeast-2.amazonaws.com/wilderlab.openwaters/reports/cf1c577e7c4b0f7f.html https://s3.ap-southeast-2.amazonaws.com/wilderlab.openwaters/reports/d3a319357c8c5ca4.html

Year	Title	Agency	Description	Focus Area	Reference/links
2022	Taharoa Ironsands Mine - Fish Passage Assessment in Response to Further Informaiton Request	Prepared for Taharoa Ironsands Limited by 4sight consulting (Part of SLR)	Taharoa Ironsands Ltd (TIL) are seeking a renewal of their resource consents to undertake ironsand mining operations within the Taharoa C block. Subsequent to lodging the application, Waikato Regional Council (WRC) filed a Section 92 request for further information, including a number of requests on the effectiveness of the fish pass within the site.	Fyke nets deployed in Lake Taharoa and electric fishing of tributaries within the wider catchment undertaken. eDNA samples taken from Wainui Stream below and above dam, Mangatangi Stream, Lake Numiti and Lake Taharoa.	—
2023	State of the environment monitoring Waikato Lake water quality	Waikato Regional Council	The present report describes the current and past state of water quality, and its trends, within the Waikato Regional Council State of the Environment (SOE) lakes monitoring network. The Waikato regions shallow lakes are under pressure from a combination of factors, including nutrient loads above critical loading, impacts of pest fish, lake level fluctuations, climate change and in many lakes hysteresis and negative feedback loops derived from alternative turbid stable states.	Tahaaroa Lakes	Allan, M., Baptista, M

Year	Title	Agency	Description	Focus Area	Reference/links
2023	Marine biosecurity risks arising from activities/stressors within the Waikato coastal marine area	Prepared for Waikato Regional Council	This report provides an overview of marine biosecurity issues relevant to a range of coastal activities and stressors in New Zealand at the time of writing, with specific appraisal of risks to WRC's Coastal Marine Area	Wainui Stream	Cawthron Institute

Appendix C Example of Health and Safety Plan

Health and Safety Procedures
Ngaa taonga tuku iho o ngaa roto o Tahaaroa

Description	Tahaaroa Lake Monitoring
Date	

Key contacts		**In the field**	**At the Paa**
Ngahuia Herangi	021 067 2374	✓	
Keith Kana	027 233 8425	✓	
			✓

Briefing

- In the operation of any field project the wellbeing of whaanau/kaitiaki is the highest priority.
- At the start of each day (and at every new site) we will take some time as a team to discuss the range of potential hazards and the actions we could take to help reduce any risks.
- Being proactive about safety and looking after each other will keep the whole team safe.
- Connectivity is limited, take a satellite phone if available in the case of an emergency.
- Remind whaanau that there are no whareiti onsite.

What to bring?

- Sturdy shoes, waders and/or gumboots must be worn during fieldwork.
- Hats and sunscreen should be worn during fieldwork.
- Please bring a safety/high vis vest if you have one.
- Please bring a towel, raincoat, and a spare set of clothes in case you get wet or cold.
- Please bring your own water bottles and snacks.

Health and Safety – Virus risk management and pre-existing medical conditions

- If you are feeling unwell or have been around a whaanau member that has been feeling unwell, please stay home.
- Wash hands regularly with soap and water for at least 20 seconds, or clean with hand sanitiser which is available in NIWA vehicles.
- If you have a medical condition (e.g., bee allergy) and/or are on medication, please let Ngahuia Herangi know and your contact persons in case of an emergency.
- A first aid kit, sunblock and hand sanitiser will be available in NIWA vehicles.

Driving to fieldwork sites

- Please help to keep our vehicles and field gear tidy and clear of roads and access points.
- 4WD vehicles only.

Access

- [Insert name] manages access to Lake Tahaaroa via Taharoa Ironsand Ltd through email and phone prior to all monitoring events. An initial email will be sent 4-weeks or more in advance with a follow up to be sent a week before fieldwork to be held and the day before as a reminder.

Potential Hazards

Task/Hazard	**Possible harm** (what could happen)	**Is the hazard significant?** (i.e., could it cause serious harm?) **Y/N**	**Risk of harm** Very high, High, Medium or Low	**Controls** (including Personal Protective Equipment) (Actions required to eliminate, isolate or minimise the hazard)	**Residual risk** Very high, High, Medium or Low
At each site we will: • Check mobile phone connectivity locations. • Assign H&S person to each team (if we split up into groups) • Talk through the following list of potential hazards that the team may be exposed to at each site and add any new ones that we identify					
Contracting a virus	Loss of life. Prolonged sickness. Anxiety and depression. Isolation and prejudice	Y	Very high	If you feel unwell, and/or have been in close contact with someone who is unwell or has been feeling unwell (e.g., tamariki, partner, whanau, friend, work colleagues), please stay home. Keep numbers of people in a team to the minimum needed. Wash hands with sanitizer regularly. Cough or sneeze into a tissue or your elbow, throw used tissues into rubbish bags provided, and then sanitise hands. Each team member to bring their own water bottle (please don't share water bottles). Clean surfaces people touch regularly.	Medium
Administration and project management	Stress and fatigue	N	Low-medium	Check with project team every month, be proactive and quick to address problems (before they become big and unmanageable). Seek advice and assistance from senior staff and project directors when necessary. Discuss issues arising at regular project and monthly Te Kūwaha group hui	Low

Task/Hazard	**Possible harm** (what could happen)	**Is the hazard significant?** (i.e., could it cause serious harm?) **Y/N**	**Risk of harm** Very high, High, Medium or Low	**Controls** (including Personal Protective Equipment) (Actions required to eliminate, isolate or minimise the hazard)	**Residual risk** Very high, High, Medium or Low
Driving/ poor road and weather conditions	Loss of control of vehicle / accident causing injuries or death. Getting stranded. Vehicle damage.	Y	High to very high	Licensed drivers; Warranted vehicles; Driver experienced with particular vehicles and road conditions; Vehicle suitable for driving conditions; Check the weather forecast; Change route if necessary; Defer travel if tired; Take a tow rope; Travelling with more than one vehicle, together and on planned route so we know where different vehicles are.	Low-medium
Other vehicles when stop on side of road	Getting hit by other vehicles	Y	High	Ensure vehicle parked well off road and visible to oncoming traffic; Passengers to exit vehicle from side of vehicle away from the road and to avoid road; Children to be supervised; Briefing around this hazard to occur before reach a site of risk.	Medium
Slips, trips and falls	Strains, sprains, fractures.	Y	Medium	Keep field gear tidy and clear of walkways and main access points; Point out any trip hazards (e.g., broken fences); Change route if necessary; Wear sturdy shoes or gumboots during fieldwork; Give team mates enough room to work (e.g., when processing tuna)	Low
Climbing fences	Electric shock, falls, joint or muscle injuries	Y	Medium	Check if the fence is electric before climbing over; Ensure fences are climbed in a sturdy location utilising	Low

Task/Hazard	**Possible harm** (what could happen)	**Is the hazard significant?** (i.e., could it cause serious harm?) **Y/N**	**Risk of harm** Very high, High, Medium or Low	**Controls** (including Personal Protective Equipment) (Actions required to eliminate, isolate or minimise the hazard)	**Residual risk** Very high, High, Medium or Low
				posts for support and avoid touching live wires.	
Dogs	Dog bites	Y	High	Do not enter private property if there are unchained dogs and no one to control them.	Low
Roaming animals/stock	Interacting with roaming stock could cause risks to personal safety	Y	Medium	Check gates to make sure they are closed; Identify walkways and access points away from stock; Walk calmly around stock where unavoidable; Don't yell or chase stock	Low-Medium
Tamariki	Personal security issues	Y	High	Please supervise children, especially near the water. Clear communication with the kids and the rest of the team, e.g., when people split off and do different activities. Give kids enough time and room to help (e.g., processing the tuna). No throwing stones near another person. Keep kids fed and hydrated	Medium-High
Field work (mud/sand). Streams, Lakes and Rivers	Personal security issues, sprains and strains, stuck in mud/sand, drowning, exposure	Y	High	Use of appropriate field gear/clothing, i.e., waders, raincoat, sunhat, lifejacket; Don't wander off without telling another team member where you are going; All team members wearing hazard vests; Bankside H&S observer in charge of keeping a head count	Low
Sunstroke/sunburn	Loss of control, injuries, headaches	Y	Low-Medium	Wear hats, apply sunblock and work under the gazebo if very sunny, and	Low-Medium

Task/Hazard	**Possible harm** (what could happen)	**Is the hazard significant?** (i.e., could it cause serious harm?) **Y/N**	**Risk of harm** Very high, High, Medium or Low	**Controls** (including Personal Protective Equipment) (Actions required to eliminate, isolate or minimise the hazard)	**Residual risk** Very high, High, Medium or Low
				drink water/keep hydrated. Provide shade during lunch breaks	
Waterbourne disease	Illness	Y	High-Medium	Hand sanitizer to be used after handling water/animals and to be used before eating. Adhering to any water health signs and using protective hand coverings when conducting E.coli tests.	Low
Lifting	Back/shoulder injuries	N	Low-Medium	Use correct lifting techniques; Get help to lift heavy weight; Take regular breaks; Don't fill buckets with too much water; Team to help carry field gear	Low

Please list any hazards we have missed below

Appendix D Example of Attendance Register

ATTENDANCE REGISTER – [Enter date]

Full Name (including tamariki)	**Please ✓ if you have**		**[Month, Year]**		
	Read and understood the Health and Safety Plan	Given consent to the project team taking photos of me for reporting and promotional purposes	**Friday**	**Saturday**	**Sunday**
1.					
2.					
3.					
4.					
5.					
6.					

Appendix E Examples of parasite and pathogen infestations observed in shortfin during Lake Tahaaroa customary tuna survey in February 2025

Most images are of tuna caught in Lake Tahaaroa with the exception of the nematode example, sourced from a 2008 observation in the Kaikou River (Williams et al. 2017).

Table E-1: Examples of parasite and pathogen infestations observed in shortfin during Lake Tahaaroa customay tuna survey in February 2025.

Description	Photos
Pathogen/parasite Shagworm, *Eustrongylides* sp. **Site of infection** Stomach, intestine Shagworm were prevalent in the shortfin caught in Lake Tahaaroa. The intermediate stage of this worm is typically found in the body cavity and flesh of fish, reaching maturity in predatory birds (Williams et al 2017). The immature worms are red in colour and can grow up to about 60 mm in length. Shagworms are typically coiled in cysts attached to various organs within the fish's body cavity, most commonly on the outer surface of the stomach (Stokell, 1936). It also appeared that shagworms were encysts deep within the stomach wall of some eels.	 
Pathogen/parasite Nematode, *Anguillicola spp.* **Site of infection** Swim bladder Nematodes were observed in the swim bladder of two shortfin assessed. Nematodes are ingested by tuna and move from the digestive tract to the swim bladder. A severe infestation of nematodes may result in symptoms such as bleeding lesions and swim bladder collapse. As it affects its swim bladder, it can also hamper a tuna's ability to swim and reach its spawning grounds. (Source: Wikipedia).	 Nematode in the swim bladder of a longfin found in Kaikou River in 2008. Photo credit: Erica Williams, Jacques Boubée. (Williams et al. 2017).

Description	Photos
Pathogen/parasite Unidentified/putative trematode **Site of infection** Stomach, intestine Unidentified parasite. White worm-like structure encysted in the stomach/intestine of shortfin. It is likely a digenean trematode due to its location within the eel and description. Further assessments required for accurate identification.	
Pathogen/parasite Unidentified **Site of infection** Stomach wall/Body cavity Unidentified black markings were observed along the body cavity and the stomach wall of shortfin. Potential pathogen. These markings have also been observed in other eels (Williams et al 2017).	

Appendix F List of equipment

Table F-1: List of tools and equipment for monitoring and field work.

Equipment	Qty
Course mesh fyke net*	2
Weights	2
Stakes	4
Gee minnow fish trap*	2
Gee minnow clips	2
Gee minnow rope*	2
Fish bin with lid	2
Bucket	2
Tuna catch/holding bag*	4
Tuna measuring board*	1
First aid kit	1
Table/workbench	1
Pens/pencils	1
Stopwatch/phone	1
Clipboard	1
Bleach	1
Hand sanitiser	1
Bathyscope	1
Hoe (Leaf Rake)	1
Scales	1
Dissection kit	1
Vernier calipers	1
Stanley knife	1
Clarity tube magnet (NIWA)	1

Equipment	Qty
Short handle sledgehammer	1
Phillips head screwdriver	1
White invertebrate tray	4
GPS unit	1
Tape measure	1
Meter ruler	1
Rubbish bags	
Torch or headlamp	
Batteries	
Aqui-S (NIWA)	
Envelopes	
Vivid	
Scissors	
Ice pack	
Aluminium foil	
Tweezers**	
Resealable bags^	
ID guides:	
- Fish	
- Macroinvertebrate	
- Macrophyte	
- Erosion percentage	
- Freshwater mussels	

* Wash and hang out to dry after each monitoring event

** Sterilise after processing

^ Items that will need to be replenished