E Lohena I Ka Ulu Nahele (Listening to the Forest): Developing tohu (environmental indicators) for forest monitoring in Te Wao Nui ā Tiriwa in collaboration with Te Kawerau ā Maki

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Abstract

There are numerous threats to the state of biodiversity in Aotearoa (New Zealand), including land use change, invasive plant and animal species and climate change. Environmental monitoring by government institutions and local communities is crucial to gain an understanding of forest health, and there is a growing need for more holistic solutions to mitigate future harms. The weaving of Indigenous knowledge with Western science offers an underexplored opportunity to address these challenges. Cultural health environmental monitoring frameworks have been applied in many ecosystems worldwide, with freshwater monitoring being the most common in Aotearoa. This research aimed to co-create an environmental monitoring framework and tohu (environmental indicators) for forest monitoring in Te Piringa (Upper Waitākere River catchment) in collaboration with mana whenua (Māori who have historic and territorial rights over the land) Te Kawerau ā Maki.

This was achieved through hui (gatherings) and kōrero (conversations) with representatives from Te Kawerau Iwi Tiaki Trust over three years (2021–2024). Themes arising from these hui included the prioritisation of mātauranga Māori (Māori knowledge system, including the maramataka, the Māori lunar calendar) and the need for information sharing on existing monitoring within their rohe (region, territory). Data from a number of existing environmental monitoring programmes in the study area were compiled and summarised. A literature review of kōrero tuku iho (oral traditions) surrounding people and places from Te Kawerau ā Maki history, the maramataka, and plant and animal species commonly found in the kauri podocarp broadleaf forest ecosystem informed the development of the monitoring framework. A brief review of collaborative monitoring models from Aotearoa was carried out with the research partners, and it was found that representatives of Te Kawerau Iwi Tiaki Trust preferred a bespoke environmental monitoring framework based on intuitive observations and relationships.

Observations developed as part of this framework included the five senses, as well as emotional and somatic responses in the field. The emphasis on relationships in this framework illustrates the interconnected perspective of many Indigenous people with the environment. Vegetation, bird, weather, environmental, sensory, emotional and somatic observations were collected and summarised from nine transcribed audio-recorded field visits from November 2024 to March 2025. An exploratory data analysis of bird observations in relation to the lunar phases according to the maramataka was performed. Field observations were examined for characteristics of ngā kaupeka o te tau (seasonal divisions within the maramataka). Based on

hui with Te Kawerau Iwi Tiaki Trust representatives, information accessed from published kōrero tuku iho, and analysis of field observations, a set of potential tohu for forest monitoring in the study area was proposed. These tohu are: birds and insects, flowering and fruiting plants, new growth on vegetation, weather, somatic and emotional responses and the presence of non-native plant and animal species. The observation- and relationship-based environmental monitoring framework developed as part of this thesis research, combined with the method of co-creation with Indigenous research partners, can improve understanding of environmental health and provides an avenue to strengthen relationships between research partners and institutions.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless clearly stated, and referenced), along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Sarah Kapuhealani Bishop 02/07/2025

Signature Date

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One of the greatest gifts from working on this project is that it has inspired me to pursue similar exploration of ʻike kupuna (ancestral knowledge) in the nāhele of Hawaiʻi. For that, I thank the project partners, Te Kawerau ā Maki.

E ola mau ka ʻike maoli! *Long live Indigenous knowledge!*

Positionality Statement

Kaulana nā pua aʻo Hawaiʻi	*Famous are the children of Hawaiʻi*
Kūpaʻa ma hope o ka ʻāina	*Ever loyal to the land*

As described in a well-known Hawaiian patriotic song, *Kaulana Nā Pua* (Famous are the Flowers) by Eleanor Kekoaohiwaikalani Wright Prendergrast, one of the most essential values in Kānaka Maoli (Native Hawaiian) culture is “aloha ʻāina” (love of the land). *Kaulana Nā Pua* was written to protest the overthrow of Queen Liliʻuokalani and the Hawaiian Kingdom in 1893. It describes Hawaiians' love and strong appreciation for the ʻāina (land), and its importance to Kānaka Maoli. The song goes so far as to say that Hawaiians would rather eat stones of the land than accept sums of money from the American government (this song is also known as *ʻThe Stone Eaters' Song*).

Some of my ancestors come from many places throughout Europe, and my mother’s family originates in Hawaiʻi. Due to economic hardship as a result of the illegal overthrow and continued occupation of the Hawaiian Nation by the United States, my mother’s family moved to the Continental US in the late 1950s. I am now, like the majority of Native Hawaiians, a proud member of the Hawaiian Diaspora. I moved to Aotearoa (New Zealand), and I recognise my position as Tauiwi (a non-Māori person living in Aotearoa) but also as an Indigenous person whose life has also been impacted by the effects of colonisation. I did not grow up in my ancestral lands and am constantly seeking reconnection to the knowledge of my kūpuna (ancestors). As a Kanaka Maoli student, I carry the value of aloha ʻāina into my research, and my love of the land played a significant role in my decision to pursue an MSc in Environmental Science.

I have a keen interest in forest plants, animals and ecosystems – a trait I believe I inherited from my kupuna, great Aunt Marie Emelia Leilehua McDonald, who was well-known for her ʻike kūhohonu (deep knowledge) of native Hawaiian plants and their traditional uses in weaving, lei (flower garland) and kapa (bark cloth) making. This was ʻike that she graciously shared with me and many others before her passing. I was naturally drawn to conduct my thesis research in the awe-inspiring ngahere (forest) in our backyard of Hikurangi (West Auckland) – Te Wao Nui ā Tiriwa (The Great Forest of Tiriwa). As Tauiwi, it seemed correct for me to engage with mana whenua (Māori who have historic and territorial rights over the land) as part of my research in the first instance, as the field of Environmental Science is so closely tied to the whenua (land) in Aotearoa. Rather than approaching my thesis from a traditional Western academic perspective, I wanted to prioritise an approach supporting tangata whenua

in Aotearoa, following the lead of seminal scholars such as L. T. Smith who states “Indigenous methodologies tend to approach cultural protocols, values and behaviours as an integral part of the research design…”(Smith, 1999, p. 15).

I was inspired by the (albeit brief) mention of mātauranga Māori (a dynamic system generating Māori wisdom, knowledge and understanding) and its role in Environmental Science in my Master’s coursework. I saw my MSc thesis as an opportunity to tautoko (support) the rangatiratanga (sovereignty and self-determination) of Te Kawerau ā Maki to exercise their role as kaitiaki (guardians) in a taonga tuku iho (treasured heirloom) for them – Te Wao Nui ā Tiriwa (The Great Forest of Tiriwa). Performing this role requires careful navigation, not least because “Māori history is complex. It is based around whakapapa genealogy and takes a knowledge of the Māori language and tikanga to understand properly, even over a lifetime” (Taua, 2009, p. 24). Furthermore, I am not an expert in the fields of mātauranga Māori or te reo Māori (the Māori language), and I acknowledge my role as a tauira (student) in Environmental Science and Māoritanga. My position humbles me. However, I saw my MSc research as an opportunity to utilise my time, skills and resources to produce a result that hopefully benefits Te Kawerau a Maki. As Tauiwi, it was vital for me to ensure that the aspirations of the community I was working with were prioritised at all times (Pihama, 2015) – which led to a few twists and turns along the way, as we adjusted to their needs as they became apparent. Oftentimes, Western scientific research works in isolation from Indigenous people upon whose land they are studying and ignores the rich knowledge of place. I firmly believe that working with tangata whenua provides a deeper understanding and can be of great value for the Western scientific process when carried out correctly.

I ka nānā nō a ʻike. *By observing, one learns (Hawaiian proverb).*

Intellectual Property Rights

This research was developed in collaboration with research partners: Te Kawerau ā Maki Iwi (mana whenua). Any intellectual property provided by mana whenua for the benefit of the project and its objectives remains the property of the mana whenua authority unless expressly stated otherwise in writing by duly authorised offices of Te Kawerau ā Maki. All new intellectual property is jointly owned by Te Kawerau ā Maki and myself, which includes new methods developed by the project around environmental monitoring approaches.

Ethics Approval

Ethics approval was granted by AUTEC on 17 April 2024 AUTEC application no. 23/145.

Dedication

In memory of Uncle George Hori Winikerei Taua. Moe mai rā e te rangatira.

Chapter 1 Introduction

E ho mai ka ike mai luna mai e. *Grant us knowledge from above.*
O na mea huna no'eau o na mele e. *The knowledge hidden in the chants.*
E ho mai, E ho mai, E ho mai e. *Grant us, Grant us, Grant us*
(Hawaiian oli)

He kura kainga e hokia, *The treasures of the land will persist,*
He kura tangata e kore e hokia. *Human possessions will not persist.*

There are many threats to the state of biodiversity in Aotearoa (New Zealand), and a growing need for innovative solutions to address these threats (Brown et al., 2015; Ministry for the Environment & Stats NZ, 2025; Norton et al., 2016). The country is experiencing increasing biodiversity loss in terrestrial ecosystems, and it has one of the highest proportions of threatened or at-risk indigenous terrestrial species (Ministry for the Environment & Stats NZ, 2025). A report from the Ministry for the Environment and Statistics New Zealand (2015) found that 21 percent of indigenous bird species are extinct, 18 percent of freshwater fish and vascular plants are threatened or in decline, and approximately two-thirds of the original native forests have been lost due to deforestation. The Ministry for the Environment declared that, as of 2021, 77 of 99 indigenous terrestrial bird species (78 percent) continue to be threatened with extinction or are at risk of becoming threatened (Ministry for the Environment & Stats NZ, 2025). While 21 percent of these species had increasing populations, 22 percent had decreasing populations (Ministry for the Environment & Stats NZ, 2025). Indigenous plant species are also vulnerable, with 48 percent threatened with extinction or at risk of becoming threatened (de Lange et al., 2024). Pressures on indigenous terrestrial ecosystems include land-use change from urban development, agriculture and forestry, pollution, invasive plant and animal species and climate change (Bishop, 2019; Ministry for the Environment & Stats NZ, 2025; Wardle, 1991; Williams, 1997).

There is a demand for the exploration of more holistic solutions in the field of environmental science to alleviate the harm posed to biodiversity by these threats (Brown et al., 2015; Department of Conservation, 2020). Indigenous knowledge systems offer an underexplored opportunity to develop solutions to environmental challenges (Berkes, 2009), and numerous research projects in environmental science have been co-developed and co-created with Māori (the Indigenous people of New Zealand) (McAllister et al., 2019). For example, an environmental programme using community-based survey indicators developed by Tuawhenua Māori in the Whirinaki and Ruatāhuna forests provided similar results to plot-based forest monitoring, allowing for a greater understanding of forest state for both scientists

and communities and also encouraging an opportunity for mana whenua (Māori who have historic and territorial rights over the land) to utilise their ways of knowing that have been passed down through generations (Lyver et al., 2018). Working with kaumātua (elders) from Ngāi Tahu, Tipa and Teirney (2006) developed a set of Cultural Health Index (CHI) for stream health that can be used in many locations across Aotearoa for freshwater monitoring. Despite the successful outcomes of research incorporating Indigenous knowledge, it often remains overlooked in research publications in Aotearoa (Wehi et al., 2019), or is subjected to intense scrutiny (Black & Tylianakis, 2024; Hanly, 2025).

There is justifiable mistrust by some Indigenous peoples in "the capacity, motives or methodologies of Western research to deliver any benefits to Indigenous peoples whom science has long regarded, indeed has classified, as being 'not human'" (Smith, 1999, pp. 117–118). In response to these historical injustices, this collaborative research project strives to support self-determination for mana whenua, Te Kawerau ā Maki. Linda Tuhiwai Smith discusses the more significant implications of Indigenous people's self-determination in *Decolonizing Methodologies: Research and Indigenous Peoples,* stating*:* "Self-determination in a research agenda becomes something more than a political goal. It becomes a goal of social justice which is expressed through and across a wide range of psychological, social, cultural and economic terrains"(L. T. Smith, 1999, p.116).

1.1 The purpose of this thesis

Nā tō rourou, nā taku rourou **ka ora ai te iwi.**	*With your food basket, and my food basket* *the people will thrive.*

The primary aim of this MSc thesis was the development of tohu (environmental indicators) within an environmental monitoring framework for monitoring in Te Piringa (upper Waitākere River catchment) in Tāmaki Makaurau (Auckland), Aotearoa. This thesis also aims to support the rangatiratanga (sovereignty, self-determination) of mana whenua Te Kawerau ā Maki through a process of project co-design and collaboration. This thesis research will contribute to a growing discipline in environmental science that centres on collaborative and co-created projects with Indigenous groups, to create environmental monitoring methods that are better aligned with Indigenous worldviews.

1.2 Research partners: Te Kawerau ā Maki

1.2.1 History

Kia tia Te Kawerau. *Kawerau who stand firm.*

Te Kawerau ā Maki are the mana whenua of Hikurangi (The West Auckland Region), which includes the area now referred to as the Waitākere Ranges. The iwi (tribe, kinship group) have some of the earliest historical ties to Tāmaki Makaurau, and they are genealogically connected to the Turehu, who were among Aotearoa's original inhabitants, inhabiting the land prior to the Polynesian migration (Murdoch, 1990; Royal, 2012). Te Kawerau ā Maki are a distinct iwi, but are connected to the 14th Century arrivals of the Tainui, Aotea, Tokomaru, Kahuitara and Kurahaupō waka (canoes) and Ngāti Awa, Ngā Iwi and Ngā Oho iwi who lived in the Tāmaki Makaurau area before 1600 (Murdoch, 1990; Taua, 2009; Taua-Gordon, 2017). Te Kawerau ā Maki have ancestral ties to several surrounding iwi through ancestral links and historical intermarriages (Taua, 2009).

The namesake of Te Kawerau ā Maki, Maki, was a prominent warrior who migrated from the northern Taranaki-Kawhia area through the lands of his Tainui relatives to Tāmaki Makaurau with roughly 300 of his hapū (kinship group) (Taua-Gordon, 2017). Over time, Maki's descendants occupied lands in many areas of Tāmaki Makaurau, from Hikurangi, to Whangaparaoa, the gulf islands of Aotea, to Paratutai (North Head, Manukau Harbour) (Figure 1) (Taua-Gordon, 2017). Although Te Kawerau ā Maki's area of cultural and historical interest spans a much larger area, "The heartland of Te Kawerau ā Maki was and remains Hikurangi" (Taua-Gordon, 2017, p. 9). The construction of the Waitākere Dam in 1910 had devastating effects on the people of Te Kawerau ā Maki. The dam blocked the flow of water from the Waitākere Ranges to Te Pūaha ō Waitākere (the river mouth of the Waitākere), making the river unnavigable by waka. This cut off Te Kawerau ā Maki's last remaining lands at Waiti (the name of a settlement in Te Henga, Bethells Beach) from the rest of their rohe (region, territory) (Taua, 2009). The iwi are now planning to build a new marae (courtyard in front of the meeting house, often used to include the complex of buildings around the marae) at Te Henga (Te Kawerau ā Maki, 2023).

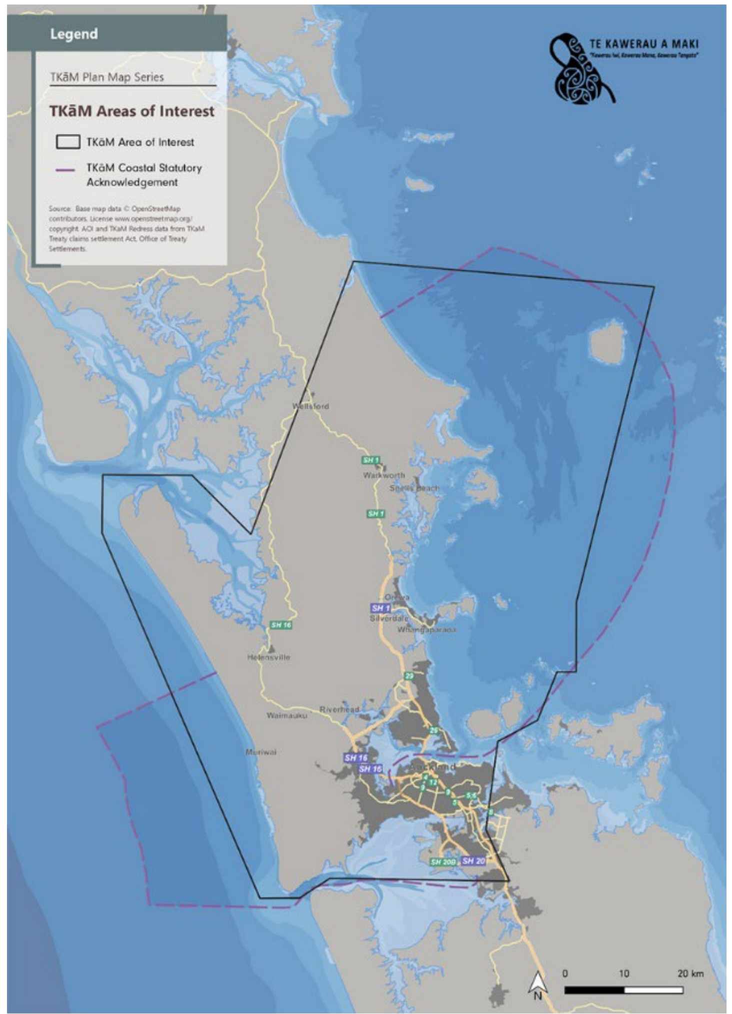


Figure 1

Map showing Te Kawerau a Maki Areas of Interest, ranging from Okaka (South Head, Kaipara) to Paratutai (North Head, Manukau Harbour) in the west, to Te Arai o Tahuhu (Te Arai Point) in the northeast, to Takapuna in the southeast, as well as the gulf islands. Map from: (Te Kawerau ā Maki, 2023a).

1.2.2 Te Kawerau ā Maki organisational structure

Te Kawerau ā Maki are represented by the post-Treaty of Waitangi settlement governance entity, Te Kawerau Iwi Settlement Trust (Figure 2), which was established to represent the iwi and administer their Treaty settlement assets. I reached out to the chair of Te Kawerau Iwi Settlement Trust in November 2021 via email to express my interest in collaborating with the iwi for my MSc research, which was followed by a kōrero (conversation) via Zoom due to COVID-19-related restrictions in Aotearoa. The purpose of this kōrero was to support whanaungatanga (familiarising ourselves with each other) and discuss potential MSc research. Following that discussion, I met with representatives from Te Kawerau Iwi Tiaki Trust, specifically the Pou Tiaki (CEO) and Kaimahi Taiao (Environmental Officer), to establish a

research partnership, finalise the scope and subject of the project and develop research methods.

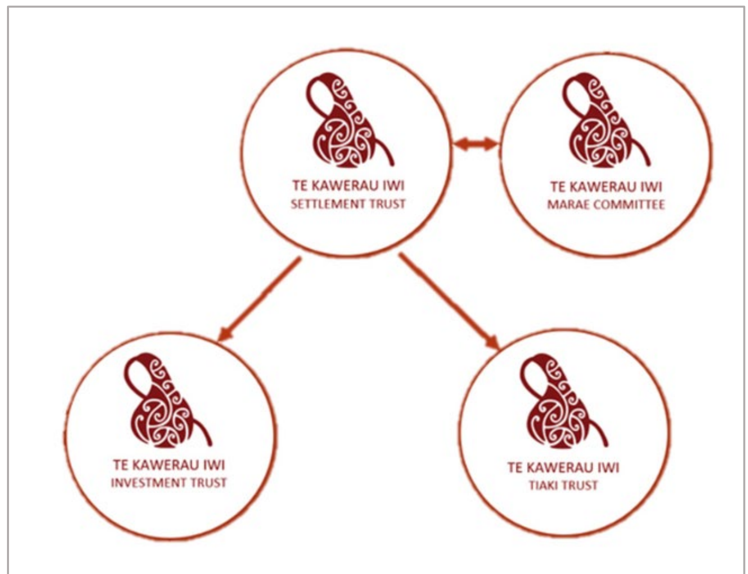


Figure 2

Te Kawerau ā Maki Iwi organisational structure. For this research, I initially contacted the Chair of Te Kawerau Iwi Settlement Trust before meeting with representatives from Te Kawerau Iwi Tiaki Trust, including Pou Tiaki (CEO) and Kaimahi Taiao (Environmental Officer), to discuss project development, design, and implementation. Graphic from (Te Kawerau ā Maki, 2023a).

1.2.3 Partnership development

E kore te tōtara e tū nua i te pārae engari I te wao nui.	*A tōtara tree does not stand alone in an open field but in the great forest.*

As an Indigenous science student, and inspired by seminal Indigenous scholars such as Linda Tuhiwai Smith and Manulani Aluli Meyer, I recognised the plethora of potential positive outcomes that can result from collaboration with Indigenous peoples, particularly in the field of environmental science. I viewed my MSc thesis not only as a research project, but also as an opportunity to support the rangatiratanga of Te Kawerau ā Maki, through collaborative methods. My initial communication was with Te Kawerau Iwi Settlement Trust's Board Chair. Following this, I developed a relationship with the representatives of Te Kawerau Iwi Tiaki Trust over a period of four years. Thesis-related consultation hui (gatherings) with Te Kawerau ā Maki included two introductory meetings with Te Kawerau ā Maki management, five hui with iwi representatives focused specifically on environmental indicator development, two introductory site visits and three observational site visits to Te Wao Nui ā Tiriwa with Te Kawerau Iwi Tiaki Trust representatives from 2021-2025 (Appendix C). This thesis research would not have been possible without this partnership established over time.

1.3 Te Wao Nui ā Tiriwa/Waitākere Ranges Heritage Area

Rarangi maunga tut e ao, tu te po;
rarangi tangata ka ngaro, ka ngaro.

A range of mountains stands day in and day out,
but a line of people is lost, is lost.

Commonly known as the Waitākere Ranges, Te Wao Nui ā Tiriwa is the original name of the area used by Te Kawerau ā Maki (T. W. Taua, 2009, p.24). Te Wao Nui ā Tiriwa is made up of a c. 17,000 ha area of steeply dissected hill country forming a high barrier along a c. 20 km section of the western coastline of Tāmaki Makaurau (Froud et al., 2022) (Figure 3). The ranges are the eroded flanks of a c. 20 Mya volcano whose summit once lay offshore (Cole et al., 2015). Despite being extremely rugged, due to the value of the timber and proximity to Tāmaki Makaurau, the Waitākere Ranges were extensively logged for kauri (*Agathis australis*) from the 1840s to the 1940s, during which time an estimated 120,000 trees comprising 700,000 cubic metres were taken (McClure, 2016). The increased human settlement of the area meant the Ranges provide a wide range of critical ecosystem services to the inhabitants of Auckland, including storm buffering, sediment trapping, catchment protection and water supply (Auckland Council Plans and Places, 2018).

The Waitākere Ranges Heritage Area Act 2008 established the Waitākere Ranges Heritage Area (WHRA) (Figure 3) in Tāmaki Makaurau, with the purpose to: “(a) recognise the national, regional, and local significance of the Waitakere Ranges heritage area; and (b) promote the protection and enhancement of its heritage features for present and future generations” (Waitakere Ranges Heritage Area Act 2008, 2008, p.4). Some of the heritage features protected by the Act include Natural Values (including indigenous terrestrial and aquatic ecosystems, habitats, and native vegetation), and fostering tangata whenua (people of the land) relationships with the land and exercise of kaitiakitanga (guardianship)(Waitākere Ranges Local Board & Auckland Council, 2013a). The WHRA is approximately 27,000 ha in area, including 21,200 ha of native vegetation (Figure 3, Auckland Council, 2018). The area encompasses the Waitākere Ranges Regional Park (WRRP), the urban areas of Titirangi and Laingholm, as well as the foothills and coastal villages. Environmental monitoring programmes in the WHRA, run by mana whenua, local and regional councils, and community groups, all work to support the protection of these heritage features as required by the Act (See Section 5.1 for a description of current monitoring programmes).

Figure 3

The boundaries of the Waitākere Ranges Heritage Area (WHRA) are shown in red. The Waitākere Ranges Regional Park primarily consists of forested areas (dark green in satellite imagery). The research study area of interest, Te Piringa (the upper Waitākere River catchment) is shown within the yellow boundary. The dark green forested areas of Te Wao Nui ā Tiriwa are visible within the extent of the WHRA. The map was created by the author in ArcGIS Pro with data obtained from Auckland Council and LINZ.

The Auckland Council is required by Section 34(1)(a), (b) and (c) of the WHRA to monitor the state of the environment and provide monitoring reports. Native species, including vegetation (both threatened and non-threatened), areas of ecological significance and fauna, are monitored by the council in a network of plots throughout the area. Threats to biodiversity in the area, such as weeds, pest animal and plant species and kauri dieback disease, are also addressed in this environmental monitoring network (Auckland Council Plans and Places, 2018). Three monitoring reports were published in 2013, 2018, and 2023 (Auckland Council

Plans and Places, 2018; C. D. Bishop et al., 2013; Griffiths et al., 2023). Additional details on current environmental monitoring in the area can be found in Section 5.1.

1.3.1 Terrestrial ecosystems of the Waitākere Ranges Heritage Area

Dominant ecosystem types

Four dominant terrestrial ecosystem types make up over 87 percent of the native ecosystems in the WHRA (Auckland Council Plans and Places, 2018). What follows is a description of commonly found flora and fauna in each ecosystem type. However, many species mix between forest types, and each ecosystem type is dependent on the other for survival.

Mānuka and kānuka scrub regenerating forest

Te paku peka tāne kaha, te iti kahikātoa.	*The strength of the small man is like the small red mānuka.*

Mānuka (*Leptospermum scoparium*) and kānuka (*Kunzea ericoides*) scrub comprise 17 percent of the native forested areas in the WHRA and 2.4 percent of the study area for this research (Table 1; Figure 11). As its name suggests, mānuka and kānuka are the primary species in the canopy of this ecosystem, playing an important role as pioneer species. They prefer bare and disturbed land, as well as high levels of sunlight, for establishment (Bergin & Kimberley, 1995; Esler & Astridge, 1974). The small seeds of mānuka and kānuka are easily dispersed via wind throughout the ngahere, making them ideal pioneer species in the forest ecosystem (Allen et al., 1992; Esler & Astridge, 1974). As the mānuka and kānuka age, it allows for the establishment of other native plants in the understory, including ferns like kiokio (*Parablechnum novae-zelandiae*), shrubs such as hangehange (*Geniostoma ligustrifolium*), trees and shrubs like the *Coprosma* spp. and sedges such as *Gahnia* spp (Esler & Astridge, 1974).

Kānuka can grow up to 18 m tall and tends to form taller, denser stands than the shorter-lived mānuka, which usually grow to a maximum height of 12 m before being replaced by kānuka in the forest canopy (Esler & Astridge, 1974). Bird and insect pollinators in search of nectar are attracted to flowers from the plant species found in this ecosystem (Anderson, 2003; Clout & Hay, 1989; Innes et al., 2022; Stephens et al., 2005). Insectivorous birds, such as the pīwakawaka (*Rhipidura fulginosa*) and riroriro (*Gerygone igata*), are supported by insects found living in tree bark and fallen debris on the forest floor (Innes et al., 2022). The variety of fruits and berries found on plants in the understory serves as a food source for species such as kererū (*Hemiphaga novaeseelandiae*) and tūī (*Prosthemadera novaeseelandiae*) (Innes et al., 2022). These birds distribute seeds throughout the ngahere in an important ecological process

that contributes to the regeneration of native forests (Clout & Hay, 1989). This ecosystem can develop into a mature kauri forest ecosystem (Singers et al., 2017). The biodiversity of the Waitākere Ranges is supported by the assortment of plant species found in this ecosystem.

Table 1

Key plant and bird species from five ecosystem types found in the Te Piringa (upper Waitākere River catchment), the study area for this thesis (from Singers et al., 2017).

Ecosystem Type	Proportion of Study Area	Key Plant Species	Key Bird Species
Kauri, podocarp and broadleaf forest	69% (1,460 ha)	- Kauri (*Agathis australis*), - Northern Rātā (*Metrosideros robusta),* - Rimu (*Dacrydium cupressinum*), - Kahikatea (*Dacrycarpus dacrydoides*)	- Kākā *(Nestor meridionalis)*, - Ruru *(Ninox novaeseelandiae)*, - Pīwakawaka *(Rhipidura fulginosa)*, - Tūī *(Prosthemadera novaeseelandiae)*
Kānuka scrub/forest (regenerating)	18% (384 ha)	-Kānuka (*Kunzea ericoides*), - Horoeka *(Pseudopanax ferox)* - Karamū *(Coprosma Robusta)* - Hangehange *(Geniostoma ligustrifolium)*	- Kererū *(Hemiphaga novaeseelandiae)* - Pīpīwharauroa *(Chrysococcyx lucidus)* - Kōtare *(Todiramphus sanctus)* - Riroriro *(Gerygone igata)*
Mānuka and kānuka scrub regenerating forest	2.4% (52 ha)	- Mānuka *(Leptospermum scoparium)*, - Kānuka (*Kunzea ericoides*), - Hangehange *(Geniostoma ligustrifolium),* - Māpou *(Myrsine australis)*	- Kererū *(Hemiphaga novaeseelandiae)*, - Pīwakawaka *(Rhipidura fulginosa)*, - Riroriro *(Gerygone igata),* - Tūī *(Prosthemadera novaeseelandiae)*
Tawa, kohekohe, rewarewa, hīnau, podocarp forest	2% (43 ha)	- Tawa *(Beilschmieda tawa),* - Kohekohe *(Dysoxylum spectabile),* - Rewarewa *(Knightia excelsa),* - Hīnau *(Elaeocarpus dentatus)*	- Kererū *(Hemiphaga novaeseelandiae),* - Tūī *(Prosthemadera novaeseelandiae),* - Miromiro *(Petroica macrocephala),* - Kōtare *(Todiramphus sanctus)*
Kauri forest	1.3% (28 ha)	- Kauri *(Agathis australis),* - Kahikatea *(Dacrycarpus dacrydoides),* - Kohekohe *(Dysoxylum spectabile),* - Miro *(Pectinopitys ferruginea)*	- Kākā *(Nestor meridionalis),* - Ruru *(Ninox novaeseelandiae),* -Pīwakawaka *(Rhipidura fulginosa),* - Kererū *(Hemiphaga novaeseelandiae)*

Over time, this ecosystem can develop into a mature kauri forest ecosystem (Singers et al., 2017). The mānuka, kānuka ecosystem type is classified as of least concern according to the IUCN Red List of Threatened Species (IUCN, 2025).

Broadleaved species scrub and forest (regenerating)

Broadleaf scrub and forest comprise 13 percent of the native forested area within the WHRA; however, they are not found within the study area for this research. This forest type can grow in many areas but is typically found on formerly forested hill slopes and sometimes in a mosaic with other forest ecosystem types, such as mānuka and kānuka scrub (see the previous section) (Singers et al., 2017). Early-successional broadleaf species such as māhoe (*Ramiflorus subsp. ramiflorus*), karamū (*Coprosma robusta*), and tree kōtukutuku (*Fuchsia excorticata*) are predominant in this ecosystem (Singers et al., 2017; Wardle, 1991). Limited areas in the Waitākere Ranges are dominated by tree and shrub species māmangi (*Corposma* arborea) and māpou (*Myrsine australis*) in the understory (Burns & Leathwick, 1996; Singers et al., 2017). This variety of plant species can provide fruits for birds like kererū (Innes et al., 2022) and mokomoko (geckos) (Whitaker, 1987). They also provide an ideal habitat for insects that serve as a food source for birds, such as pīwakawaka and riroriro (Innes et al., 2022). Nectarivorous birds like tūī and tauhou feed on the nectar of the kohekohe, and occasionally the kōtukutuku (Innes et al., 2022). As discussed in the previous section, birds and insects play an important role as pollinators and seed dispersers for these plants in this ecosystem (Anderson, 2003; Clout & Hay, 1989). This forest ecosystem type is classified as of least concern according to the IUCN Red List of Threatened Species (IUCN, 2025).

Kānuka scrub and regenerating forest

Kānuka scrub and regenerating forest comprise 12 percent of native forest cover in the WHRA and 18 percent of the study area for this research (Table 1; Figure 11). This ecosystem type is typically limited to areas with well-drained soils or those that experience summer droughts (Singers et al., 2017). Kānuka dominates the canopy layer of this ecosystem, with understory plants often comprising smaller tree and shrub species like tall mingimingi (*Leucopogon fasciculatus*), prickly mingimingi (*Leptecophylla juniperina*) and tauhinu (*Ozothamnus leptophyllus*) (R. B. Allen et al., 1992; Singers et al., 2017; Wardle, 1991). The shade provided by kānuka scrub forests create an ideal habitat for seedlings and saplings of taller forest tree species such as tānekaha (*Phyllocladus trichomanoides*), tōtara (*Podocarpus totara*) and mataī (*Prumnopitys taxifolia)*(Allen et al., 1992; Singers et al., 2017). Nectar from the flowers of these plants provides a food source for nectar and occasional fruit-eating birds like tūī and tauhou, who aid in pollination processes in this ecosystem (Anderson, 2003; Clout & Hay, 1989; Innes et al., 2022). Insectivorous birds, such as riroriro, miromiro (*Petroica macrocephala*), and

pīwakawaka, are supported by food from insects found in fallen debris (Innes et al., 2022). This forest ecosystem type is classified as of least concern according to the IUCN Red List of Threatened Species (IUCN, 2025).

Kauri, podocarp, broadleaf forest ecosystem

He aha i kiia ai ko koe hai tōtara haere wā	*Why is it said that you are a tōtara to go places*
Ko au hai kauri tū i te wao?	*While I am a kauri that stands in the forest?*

The warm forest ecosystem: kauri, podocarp, broadleaf forest makes up most of the WHRA (45 percent) and the majority of the vegetation type research study area (69 percent, Table 1; Figure 11). The emergent layer of this ecosystem includes one of the world's largest and longest-lived conifer species: the kauri, which is primarily found on ridges and hillsides (Singers et al., 2017). While the oldest recorded kauri are estimated to be over 1500 years old, the trees have an average lifespan of 600 years under favourable conditions, and can grow up to 50 m in height, with trunk diameters as large as 4.4 m (Ahmed & Ogden, 1987; Steward & Beveridge, 2010). Kauri are a "keystone species" (J. Gibson et al., 2023, p. 4) or an "ecosystem driver"(Auckland Council, 2018, p.57). This role is reflected in the tree's unique effect on soil chemistry (Beauchamp & Waipara, 2014; Ecroyd, 1982), and several plant species which depend on the presence of kauri for survival (Beauchamp & Waipara, 2014; Shortland, 2011). Kauri are also very culturally significant to Māori (Chetham & Shortland, 2013; J. Gibson et al., 2023; Hill et al., 2021; Shortland, 2011).

Lucy Cranwell describes the abundant vegetation of the kauri forest ecosystem in her book *The Botany of Auckland:*

> Within, there is a bewildering variety of strong and gleaming vegetation, usually better lit…where kauri occurs in groves… climbers and perching plants gain only an uncertain hold on its platy bark. All around, on other trees, however, there will be heavy masses of drooping asteliads, lycopods, aspleniums and networks of lianes; tree ferns, graceful nikau palms and a wide range of shrubs occur below canopy level. Trunks will be adorned with lianes, climbing ferns, tufted ferns, herbs and even shrubs. Several hundred species of vascular plants…grow in this type of forest, making for richness rarely seen outside the tropics (Cranwell, 1981, p.95).

Cavities in the currently small number of old-growth kauri in Te Wao Nui ā Tiriwa provide nesting sites for ruru (*Ninox novaeseelandiae*) (Busbridge & Stewart, 2018) and kākā (*Nestor meridionalis*) (Greene et al., 2004). The canopy layer plant species in this ecosystem include podocarp longer-lived tree species such as rimu (*Dacrydium cupressinum*) and kahikatea (*Dacrycarpus dacrydioides*), as well as broadleaf species like tawa (*Beilschmiedia tawa)* and northern rātā (*Metrosideros robusta*) (Burns & Leathwick, 1996; *Kauri-Podocarp-Broadleaved*

Forest, n.d.; Singers et al., 2017). Broadleaf tree species provide fruit for kererū, kākā and tūī, who disperse these seeds throughout the ngahere (Clout & Hay, 1989; Innes et al., 2022). Insects found in tree bark and fallen plant material in this ecosystem provide a food source for insectivorous birds like the pīpīwharauroa (*Chrysococcyx lucidus*), riroriro, miromiro and pīwakwaka (Innes et al., 2022; Singers et al., 2017).

The variation in vegetation in this ecosystem depends on altitude, with tree species such as taraire (*Beilshmiedia taraire*) and kohekohe more common at lower altitudes, and tawa more frequent at higher altitudes (Burns & Leathwick, 1996; Nicholls, 1976; Singers et al., 2017). Kererū rely on fruit to have sufficient energy for breeding (Lyver et al., 2008), and this ecosystem also supports mokomoko, kākā, and tūī, which feed on nectar during the summer months (Clout & Hay, 1989; Innes et al., 2022; Singers et al., 2017; Whitaker, 1987). This ecosystem has been classified as Endangered using the IUCN Red List of Ecosystems criteria (Singers et al., 2017).

Infrequent dominant ecosystems within the Waitākere Ranges Heritage Area (WHRA)

The following ecosystems are not listed as dominant in the WHRA; however, they are found within the research study area (Table 1; Figure 11) and Te Wao Nui ā Tiriwa and are described below.

Kauri forest

Kauri forests are perhaps some of the rarest and most treasured forest ecosystems in Aotearoa. This ecosystem type is present in small pockets of the WHRA and makes up 1.3 percent of the study area for this research (Table 1; Figure 11). Kauri forest ecosystems primarily occur on hill slopes and hill crests in predominantly warm and sub-humid to humid areas, characterised by rainfall of 1000-2500 mm/yr (Ecroyd, 1982; Singers et al., 2017). They are distinguished by their dense numbers of large conifers – kauri –which comprise the nearly complete canopy of this ecosystem. On occasion, podocarp tree species with smaller trunk diameters are present in the sub-canopy, such as tōtara, miro (*Pectinopitys ferruginea*), rimu, toatoa (*Phyllocladus toatoa*) and tānekaha, along with broadleaved trees such as rātā, tawa, taraire, hīnau (*Elaeocarpus dentatus*), rewarewa (*Rewrewa excelsa*) and kohekohe (Ecroyd, 1982; Singers et al., 2017). Understory plant species may include tree species such as toru (*Toronia toru*) and neinei (*Dracophyllum latifolium*), sedges like *Gahnia spp.* and herbs such as kauri grass (*Astelia trinervia*) (Ecroyd, 1982). The composition of these ecosystems is mainly influenced by soil fertility, altitude and location (Ecroyd, 1982; Singers et al., 2017). Kauri forests support several bird species, including ruru, who roost in the cavities of these trees

(Busbridge & Stewart, 2018), and kākā who strip kauri bark to feed on sap (Charles & Linklater, 2013), larvae and insects (Innes et al., 2022; Singers et al., 2017). Kauri forest ecosystems are classified as Endangered using the IUCN Red List classification system (IUCN, 2025).

Tawa, kohekohe, rewarewa, hīnau podocarp forest

He tawa para, he whati kau tāna. *The pulp of the tawa berry is easily crushed.*

This forest ecosystem is found in warm and subhumid to humid climates on moderately fertile soils in inland hill country, as well as on higher ground where kauri is absent (Knowles & Beveridge, 1982; Singers et al., 2017). It accounts for two percent of the research study area (Table 1; Figure 11). As the name suggests, the tree species tawa and kohekohe are the dominant canopy species in this forest ecosystem, while rimu, northern rātā, miro, and kahikatea are commonly found in the emergent layer (Nicholls, 1976; Singers et al., 2017). Other canopy tree species in this ecosystem include hīnau, rewarewa, mangeao (*Litsea calicaris*) and pukatea (*Laurelia novae-zelandiae*) (Nicholls, 1976; Singers et al., 2017). Tree species such as kāmahi (*Weinmannia racemosa*), pūriri (*Vitex lucens*) and nīkau (*Rhopalostylis sapida*) are sometimes present at lower altitudes (Nicholls, 1976; Singers et al., 2017). Kererū and tūī are important in this ecosystem for pollination and seed dispersal of many plant species (Anderson, 2003; Clout & Hay, 1989; Innes et al., 2022). Tawa, kohekohe, rewarewa, hīnau podocarp forest ecosystems are classified as Vulnerable according to the Regional IUCN (Singers et al., 2017).

1.3.2 Threats to kauri, podocarp, broadleaf ecosystems

Historic forest clearance and present-day land use change

Since the kauri, podocarp, broadleaf ecosystem makes up the majority of Te Wao Nui ā Tiriwa, the threats to this ecosystem will be examined here (although many of these threats are also applicable to the other ecosystems in this review). Land use change in this area threatens the already fragmented ecosystem of Te Wao Nui ā Tiriwa. Kauri were highly sought-after trees for the timber industry, due to their high density for milling. It is estimated that the kauri forest covered more than one million ha in Aotearoa before the arrival of Europeans. After extensive logging and burning for over 200 years, less than one percent of the original old-growth forest remains (Steward & Beveridge, 2010). The kauri forested areas of Te Wao Nui ā Tiriwa were no exception to this destruction. Logging of native timber in the area began in the late 1830s, and the land was also cleared for farming and horticulture. However, the area's rugged terrain and poor soils were not well-suited for agriculture, and much of the farmland was abandoned, replaced first by native scrub and then by regenerating kauri forest (Froud et al., 2022). The

impact of this large-scale clearance is illustrated by the habitat reduction of the pekapeka (long-tailed bat; *Chalinolobus tuberculatus*), who prefer to nest in these now scarce, mature kauri trees (~1000 years old) (Auckland Council Plans and Places, 2018).

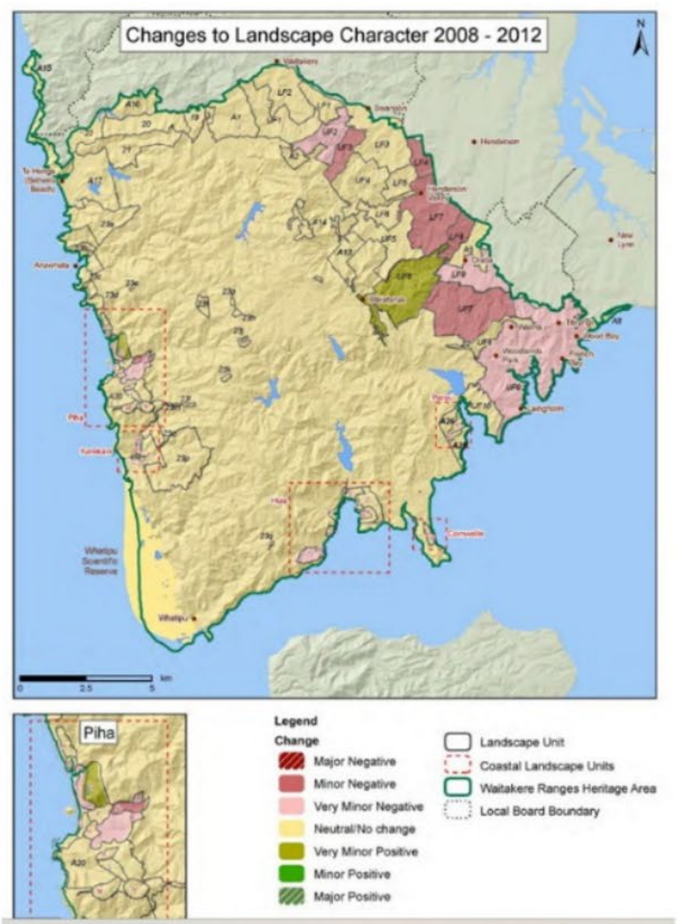
While the WHRA was established in 2008, protections in the area began much earlier. Sections of Te Wao Nui ā Tiriwa were reserved for public use beginning in 1894, and in 1940, the creation of the Centennial Memorial Park added another 6,400 ha to the protected area (McClure, 2016). Over 100 years, the Waitākere Ranges Regional Park has grown through land vesting, purchases and gifts to its current 17,000 ha of protected area (Auckland Council, 2010). However, continued small-scale clearance in the urban foothills is contributing to a "death by a thousand cuts" scenario in some locations, leading to changes in the landscape through neighbouring residential developments (Figure 4, Left; Auckland Council, 2013).

A recent study by Auckland Council utilising aerial LiDAR (Light Detection and Ranging) survey data of tree canopy (> 3 m H) changes between 2013 and 2016/2017 showed an overall canopy loss of 50 ha (two percent) within the WHRA, concentrated mainly in Rural Zones (31 ha), with additional loss in Residential Zones (9 ha). Public Open Space areas (such as Te Wao Nui ā Tiriwa) lost 8 ha of canopy cover, and General Zones saw a loss of 2ha (Figure 4, Right; Griffiths et al., 2023). The reduction of tree canopy >3 m high in Public Open Space areas and neighbouring Residential Zones within the WHRA over three years is a concern as it reduces habitat availability and ecological connectivity, undermining the area's long-term ecological resilience (Walker et al., 2021). The human settlement of the area also saw the introduction of pest plants and animals, plant pathogens and the effects of climate change (Griffiths et al., 2023). Severe drought and weather events are expected to increase with climate change (Kaplick et al., 2019; Macinnis-Ng et al., 2017). Although it is unclear how climate change will directly impact the forest ecosystems within Te Wao Nui ā Tiriwa, it is generally acknowledged that it will contribute to existing issues with invasive plants (Kean et al., 2015) and animals (Bishop & Landers, 2019, Kean et al., 2015).

Invasive plants and animals

Invasive "pest" plants and animals are a constant threat to ecosystem health for all ecosystem types within the WHRA. Invasive plant species compete with native plants for resources and can smother them, particularly younger native plants that are not yet fully established (Williams, 1997). One hundred and eighty different pest plant species from the Auckland Regional Pest Management Strategy are present in the WHRA (Auckland Council, 2007; Auckland Council Plans and Places, 2018). Pest animals such as rats *(Rattus rattus, Rattus norvegicus)*, possums *(Trichosurus vulpecula*), cats *(Felis catus*) and mustelids including ferrets

(Mustela furo), stoats *(Mustela erminea)* and weasels *(Mustela nivalis)* are threats to native animal species through predation, and also have an impact on native vegetation through browsing of seedlings and new growth (Clayton & Cowan, 2010). Deer and goats are absent from almost all of the WRHA, although DOC (Department of Conservation/Te Papa Atawhai) and Auckland Council wage a continual battle against re-invasion from forests to the north and north-east (Auckland Council Plans and Places, 2018).



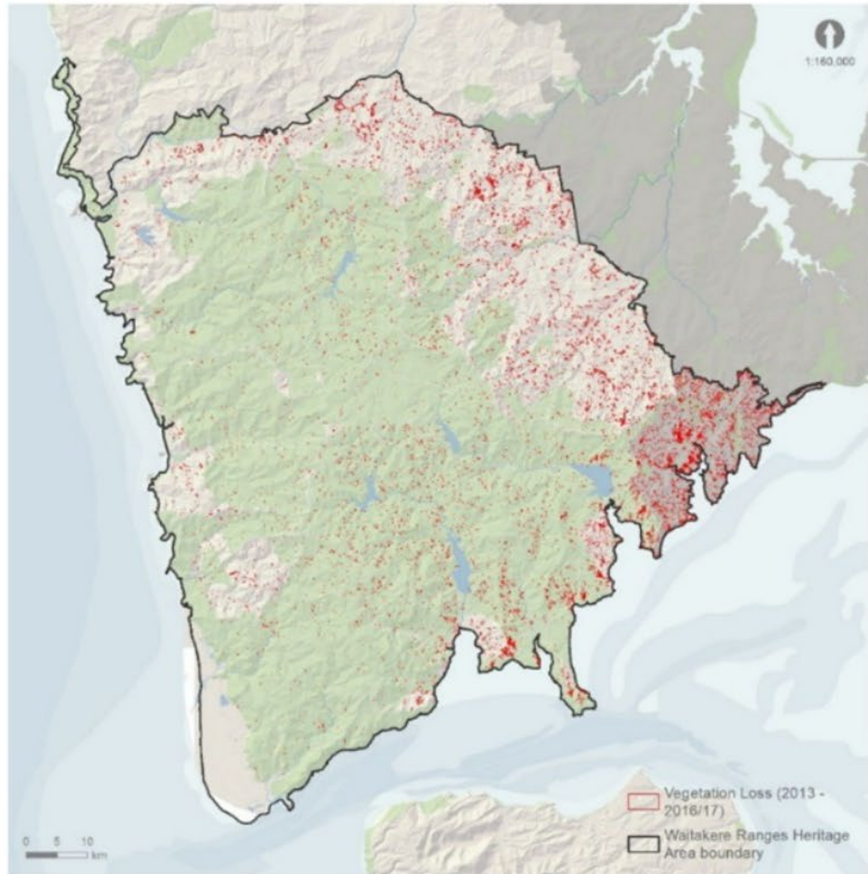


Figure 4

(Left) Changes to Landscape Character map showing "minor" and "very minor" negative changes to the mainly residential foothill areas within the Waitākere Ranges Heritage Area (WHRA) from 2008-2012. Map from (Waitākere Ranges Local Board & Auckland Council, 2013b). (Right) Spatial distribution of canopy loss (in red, > 3 m H) within the WHRA, the results of a LiDAR (Light Detection and Ranging) study of canopy cover in the WHRA done by Auckland Council. The majority of canopy loss occurred in Rural Zones (31 ha). Map from (Griffiths et al., 2023).

Kauri dieback disease

Kauri are one of the most important plant species to Māori (Lambert et al., 2018), including Te Kawerau ā Maki, who have an ancestral connection to these tūpuna (ancestors) and rangatira (leaders) of the ngahere. The health of many associated plant and animal species, as well as mana whenua Te Kawerau ā Maki, relies on the health of kauri in Te Wao Nui ā Tiriwa (Te Kawerau ā Maki, 2017). Kauri dieback is a potentially deadly disease affecting kauri trees that is spread by a microscopic, fungus-like, soil-borne plant pathogen, *Phytophthora agathidicida* (*P. agathidicida*) (Bradshaw et al., 2020). Kauri dieback is treatable, but Western scientific methods are time and labour-intensive, need to be applied at the individual tree level and often involve chemicals that are known phytotoxins at higher concentrations (Hunter et al., 2025). This disease causes collar rot, resulting in large, bleeding lesions, yellowing leaves and, in most cases, tree mortality (Beever et al., 2009; Bradshaw et al., 2020). The disease was first reported causing kauri stand decline on Aotea (Great Barrier Island) in 1972, before appearing on the mainland of Aotearoa in 2006 (Beever et al., 2009). This pathogen affects the feeder and structural roots of kauri trees of all ages (Bradshaw et al., 2020). The time between the development of the first symptoms and tree death varies greatly but generally ranges from one to ten years. Smaller trees normally succumb to the disease more quickly than their larger counterparts (Bradshaw et al., 2020). *P. agathidicida* is likely an introduced species to Aotearoa, but its origins and the duration of its presence in the country remain to be determined (Weir et al., 2015). This pathogen is spread between kauri root systems via water and soils, and humans, animals and vehicles are all possible vectors (Bradshaw et al., 2020).

Kauri dieback disease was identified as "…the most significant threat to kauri forest ecosystem[s] of the [Waitākere Ranges] Heritage Area; all kauri forest within the heritage area is now considered to be at very high risk of infection and there is currently no proven method to combat the disease or its spread" (Auckland Council, 2018, pp. 34–35). An aerial survey of kauri forests in 2015 in the Waitākere Ranges Regional Park (WRRP) revealed that 58.3 percent of kauri stands above 5 ha showed disease symptoms, a significant increase since a previous survey in 2010. In the survey, the WRRP was the most heavily infected area recorded in Aotearoa, with 58.3 percent of kauri stands above 5 ha in size showing signs of kauri dieback infection to some degree within them (Hill et al., 2021).

Human activity is a known vector of *P. agathidicida.* A study by Auckland Council in 2017 found a close relationship between kauri dieback zones and proximity to the track network in the WRRP, with 70 percent of confirmed kauri dieback zones and 56 percent of possible kauri dieback zones within 50 m of a walking track (Hill et al., 2021). However, further research is needed to investigate the transmission of kauri dieback disease through human activities. It

has also been confirmed that due to their rooting behaviours and preference for kauri forests, feral pigs may act as pathogen vectors (Bradshaw et al., 2020). Nonetheless, according to Niebuhr et al. (2024), there have been limited practical research studies in the area, and both a field surveillance study (Hill et al., 2017) and a study testing for the presence of *P. agathidicida* on culled feral pigs' hooves (Krull et al., 2013) had anecdotally collected data, small sample sizes and/or insufficient statistical analyses and were unable to provide conclusive evidence. Bassett et al. (2017) found that feral pigs can ingest and pass *P. agathidicida* through their digestive systems, providing another mode of possible transmission. Further research into the transmission of kauri dieback disease by feral pigs is necessary, and future recommendations in this area are provided by Niebuhr et al. (2024). Whatever the main vectors of kauri dieback disease, it is well known that it poses a significant threat to the already fragmented old-growth stands of kauri trees in Te Wao Nui ā Tiriwa. In December 2017, disease prevention measures were put in place by Te Kawerau ā Maki in the form of a rāhui (temporal or spatial prohibition restricting access) (Te Kawerau ā Maki, 2017) over the kauri forested areas of the WHRA, which Auckland Council now supports through their active kauri dieback management plan (Auckland Council, 2025).

1.4 Te Kawerau ā Maki: History and cultural significance

Te Kawerau ā Maki consider Te Wao Nui ā Tiriwa their heartland through over 400 years of occupation and guardianship of the area (Gibson, 2023; Taua, 2009; Taua-Gordon, 2017). The name "Waitakere" was misapplied to the region of Hikurangi, when the actual Waitakere is the name for a large rock located in a small bay north of Ihumoana Island in Te Henga (Murdoch, 1990; Taua, 2009). Te Kawerau ā Maki's ancestral ties to the area date back to the creation pūrākau (stories). In the iwi's historical accounts, Tiriwa was a Turehu tribal chief who came to the area now known as the Waitākere Ranges. The Turehu people were among the original inhabitants of Aotearoa, in contrast to those who arrived during the Polynesian migration (Taua, 2009). Tiriwa was a historical figure who carries significant importance to Te Kawerau ā Maki. He lived throughout Te Wao Nui ā Tiriwa, but preferred to live on the coastline between Piha in the north and Whatipu in the south. His home, Otiriwa, was near Pararaha, near the outlet of the Pararaha stream, which runs from its source in the Waitākere Ranges to its outlet at Whatipu. His superhuman ability to walk with great strides across vast areas of land is remembered in the traditions, songs and carvings of Te Kawerau ā Maki. Iwi pūrākau recount that Tiriwa relocated Rangitoto from its original position in Te Unuhunga-a-Rangitoto (Mercer Bay) at Karekare to its current location in the Waitematā Harbour. He is one of the most revered ancestors of the present-day members of Te Kawerau ā Maki (Littlewood & Snell, 2018; Taua, 2009).

For many generations, Te Kawerau ā Maki maintained kāinga (villages) and pā (fortified settlements) along the Waitākere River and the west coast of the WHRA. In these areas, they systematically and carefully gathered resources for kai (food), rongoā (medicine), textiles and timber according to the maramataka (Māori calendar utilised for the gathering of resources according to seasonal cycles) (Hill et al., 2021; Murdoch, 1990). They have strong genealogical connections to Te Taiao (The Natural World). For these reasons, Te Kawerau ā Maki see the survival of kauri and the health of ecosystems in Te Wao Nui ā Tiriwa as an existential matter– the state of environmental health in Te Wao Nui ā Tiriwa is a reflection of the health of Te Kawerau ā Maki (Hill et al., 2021; Littlewood & Snell, 2018; Te Kawerau ā Maki, 2017). Carved pou (posts) throughout Hikurangi and the Te Wao Nui ā Tiriwa are physical present-day reminders of Te Kawerau ā Maki's connection to the whenua (land) (Taua, 2009; Waitākere Ranges Local Board & Auckland Council, 2013a).

The kauri and kauri, podocarp, broadleaf forest ecosystems found in Te Wao Nui ā Tiriwa are of great cultural importance to Te Kawerau ā Maki. Tāne, often depicted as a kauri tree, features prominently in one creation pūrākau, which describes the transition of the world from Te Ao Pō (The World of Night) to Te Ao Mārama (The World of Light). In the beginning, Ranginui (Sky Father) and Papatūānuku (Earth Mother) lived bound to one another. Their children were born between them and lived in darkness (Te Ao Pō) (Royal, 2005b). Using the strength of his powerful legs, Tāne Mahuta separated his parents, Ranginui and Papatūānuku, which allowed light to enter the darkness (thus transitioning from Te Ao Pō to Te Ao Mārama). In this way, all beings on earth and in Te Taiao are descendants of Ranginui and Papatūānuku (Royal, 2005b). Te Kawerau ā Maki see the great kauri within Te Wao Nui ā Tiriwa as older tūpuna and rangatira of the forest, with whom they are connected through their whakapapa (genealogy) (Te Kawerau ā Maki, 2017). In December 2017, the iwi, having witnessed the devastating effects of kauri dieback disease on their tūpuna, observed growing evidence that the disease was linked to proximity to walking tracks in the area (Hill et al., 2021). In response to the bleak possible outcomes of the disease being left to spread unchecked, the iwi chose to place a rāhui over Te Wao Nui ā Tiriwa, to "enable the environment to recuperate and regenerate without the presence and impacts of humans… [the rāhui] applies to and follows all kauri ecology within and up to the boundary of the Waitākere Ranges Heritage Area" (Te Kawerau ā Maki, 2017, p. 1).

1.5 Thesis roadmap

Chapter 1: Introduction presents an overview of the purpose of this thesis research: to develop a framework and tohu for environmental monitoring in Te Wao Nui ā Tiriwa, and a history of

mana whenua research partners Te Kawerau ā Maki's connection to the area. *Chapter 2: Mātauranga Māori and Environmental Science* provides a literature review of mātauranga Māori and its application in New Zealand government policy and environmental science. *Chapter 3: Assessing Forest Health: Environmental Monitoring* discusses the literature surrounding Western-science based and Indigenous knowledge and participation in environmental monitoring in Aotearoa and worldwide. *Chapter 4: Research Methods* outlines the research approach and details of the methods used in this thesis. *Chapter 5* provides an overview of the results of this thesis research. Finally, *Chapter 6* provides a discussion on project limitations, future recommendations and the potential wider applications of this research.

As kaitiaki (customary guardians), Te Kawerau ā Maki has rightly expressed a desire to be involved in environmental monitoring decision-making in Te Wao Nui ā Tiriwa. In the 2018 State of the Waitākere Ranges Heritage Area report, Te Kawerau ā Maki and Ngāti Whātua provided a recommendation to the Auckland Council to: "Identify baseline gaps, and re-design the measures and monitoring processes to align with both western science and tikanga Māori" (Auckland Council, 2018, p.12). They also stated that there is a lack of adequate environmental measures and monitoring processes in the Waitākere Ranges Heritage Area, and a lack of involvement by the mana whenua in: "…the development of information baselines, measures, monitoring, management and governance decision-making" (Auckland Council, 2018, p. 12). Working in collaboration with mana whenua Te Kawerau ā Maki, this research addresses the need to develop environmental monitoring in the Waitākere Ranges that involves and better aligns with te ao Māori (the Māori world).

Chapter 2 Literature Review: Mātauranga Māori and Environmental Science

> It would be futile to discover the beginning of mātauranga Māori. It comes with the people, with the culture and with the language. Mātauranga Māori is and will be (Mead, 2003, p. 338).

2.1 Introduction

Mātauranga Māori is often defined as Māori "knowledge" (Mead, 2003, p. 395); however, its meaning can be much more complex. Definitions for mātauranga found in literature include: "[a] knowledge base" (Harmsworth & Awatere, 2013, p. 274), "[a] whole distinctive body of Māori knowledge in relation to society and environment," (Mercier, 2018, p. 83) and "The pursuit and application of knowledge and understanding of Te Taiao (world, Earth, natural world, environment, nature, country), following a systematic methodology based on evidence, incorporating culture, values and world view" (Hikuroa, 2017, p. 5). By these definitions, mātauranga Māori is a system that generates knowledge and is constantly changing and growing, not just knowledge itself, as it is commonly defined.

It is important to note that iwi have group-specific mātauranga based on their group's knowledge systems, so mātauraga-ā-iwi may be a more appropriate terminology than mātauranga Māori (Harmsworth & Awatere, 2013; Hikuroa, 2017; Mercier, 2018). Ocean Mercier discusses this in her article on mātauranga and science, "While mātauranga is used to talk about a global corpus of Māori knowledge, in practice, people will deal with localised knowledge. The term mātauranga-ā-iwi is used to denote knowledge related to specific iwi, hapū (subtribe), places and people" (Mercier, 2018, p. 84).

As the first settlers of Aotearoa, Māori have accumulated knowledge of the natural world through many generations (Robb et al., 2016). Ensuring that Māori in Aotearoa can adequately fulfil their role as kaitiaki in their rohe is enshrined in various government rules, acts and statutes (See Section 2.5 of this thesis). Research projects in environmental science in Aotearoa proceed with little to no involvement of tangata whenua with troubling frequency (McAllister et al., 2019; Te Reo o Te Repo = The Voice of the Wetland, 2017; Wehi et al., 2019), and a genuinely collaborative research process must create opportunities for partnerships with tangata whenua from the early stages of research planning (Harmsworth & Awatere, 2013). Because environmental science is closely tied to Te Taiao, mātauranga Māori should play a crucial role in any environmental science research project, and research should be iwi-led whenever possible. The inclusion of mātauranga Māori in this type of research should be

paramount, allowing opportunities for mana whenua to participate in decision-making regarding research design actively and to listen to and implement their desired research approaches (Hikuroa, 2017; McAllister et al., 2019; Wehi et al., 2019).

The following review examines aspects of mātauranga Māori that provide a foundation for applying this knowledge in the development of environmental monitoring methods within forest ecosystems, such as Te Wao Nui ā Tiriwa. *Section 2.2* will draw on a selection of key Māori environmental concepts identified by Harmsworth and Awatere (2013) and their relationship to the natural world. *Section 2.3* will examine tātāi arorangi (Māori astronomical knowledge) and maramataka, a component of tātāi arorangi, which can provide a deeper understanding of the seasonal cycles and their signs in Te Taiao. *Section 2.4* provides an overview of kōrero tuku iho (oral traditions passed down intergenerationally through pūrākau, whakataukī (proverbs) and *Ngā Mōteatea* (chants, laments, poems and songs). Finally, *Section 2.5* will review the role of mātauranga Māori in Aotearoa New Zealand government policy.

2.2 Māori concepts and the natural world

A preliminary understanding of mātauranga is incomplete without discussing some of the key environmental concepts of Māori culture (Allen et al., 2009; Harmsworth & Awatere, 2013; Harmsworth & Tipa, 2006). Harmsworth & Awatere (2013) discuss some of these concepts, "For Māori the modern use of the terms ecosystem and ecosystem services can be explained through traditional knowledge and the interwoven concepts of whakapapa, mana and kaitiakitanga, and possession of the spiritual qualities of tapu, mauri, and wairua" (p. 276). This section briefly draws on a selection of "Key Māori Environmental Concepts"(p. 275) identified by Harmsworth & Awatere that "…form the basis for Māori perspectives when seeking to assess and understand ecosystems" (Harmsworth & Awatere, 2013, p.274)

2.2.1 Whakapapa and whanaungatanga

In te ao Māori, Whakapapa is defined as "ancestral lineage" (Harmsworth & Awatere, 2013, p. 274) and "genealogy" (Mead, 2003, p. 402). It is an essential component of mātauranga, as this knowledge is transmitted from one generation to the next (Allen et al., 2009; Marsden, 1992). Whanaungatanga, the "organising principle of mātauranga Māori" (Ko Aotearoa Tenei, 2011, p. 105), is centred around building and maintaining deep and enduring relationships between people, groups of people and Te Taiao. Through this ancestral relationship, Māori are genealogically connected to the natural world and its organisms, rather than viewing themselves as separate entities (Allen et al., 2009; Marsden, 1992). As descendants of Papatūānuku, Māori must protect her wellbeing (Harmsworth & Awatere, 2013; Marsden,

1992). For example, waterways in Aotearoa are regarded as the arteries of Papatūānuku, through which she shares life-giving water (Marsden, 1992).

Relationship with Te Taiao

Whakapapa is a framework for making sense of the world, as described by Mere Roberts, “Whakapapa as a philosophical construct implies that all things have an origin (in the form of a primal ancestor from which they are descended), and that ontologically things come into being through the process of descent from an ancestor or ancestors” (Roberts, 2013, p. 93). This knowledge is often codified in pūrākau, reminding us of a single set of ancestors—Ranginui and Papatūānuku—from whom all entities ultimately descend, establishing a fundamental interconnectedness among all things (Roberts, 2013). In te ao Māori, all things in the environment fall under the domain of environmental atua (deities), these include: Tāne (associated with forests, trees, birds and insects, and in some tribal traditions, humans); Tangaroa (associated with water – fresh and salty and aquatic life, and also humans in certain genealogies); Rongomātāne (related to cultivated crops such as kūmara, taro, and yam); and Haumiatiketike (connected to uncultivated or ‘wild’ foods, such as aruhe or fernroot) (Roberts, 2013). These relationships with Te Taiao and the deities continue to the present day. Māori and other Indigenous people carry their whakapapa and ancestral wisdom with them as they move forward through time (Smith, 2020), “walking backwards towards the future” (Roberts, 2005, p. 1). Mātauranga that has been lost is currently being revitalised, facilitated through deeper connections with Te Taiao.

2.2.2 Kaitiakitanga

Kaitiakitanga or environmental guardianship (Marsden, 1992) is perhaps one of the most essential Māori values related to environmental science and conservation (McAllister et al., 2023). Kaitiakitanga is defined in the Resource Management Act (1991) as guardianship and/or stewardship, and stewardship has now become a standard definition. However, stewardship may not be an appropriate definition, as it implies taking care of someone else’s property, whereas kaitiakitanga implies a more guardianship-like role over a familial relation (Marsden, 1992). Additionally, guardianship and/or stewardship do not capture the “core spiritual dimension that animates the concept” (Ko Aotearoa Tenei, 2011, p. 105). Instead, kaitiakitanga is a “product of whanaungatanga… an intergenerational obligation that arises by virtue of the kin relationship” (Ko Aotearoa Tenei, 2011, p. 105). Kaitiakitanga is an essential concept in environmental management that aligns with te ao Māori, as Māori have a cultural obligation to care for the environment around them through a whakapapa relationship.

2.2.3 Mana

Mana means prestige, having authority, or control (Harmsworth & Awatere, 2013; Moorfield, 2011). An example from environmental science could be the authority and control over the management of natural resources. A person or group usually gains mana through prestige and recognition from others within the cultural group through whakapapa and life experience (Mead, 2003). Mana in an environmental context can determine who has rights of access to an area, who would be suitable for leadership roles, or the appropriate person or group to consult for decision-making processes (Hudson et al., 2010). Mana can also be lifted or diminished depending on the ability of people or a group to act as hosts to manuhiri (guests) in an adequate manner. "[Mana] is humanity's greatest possession"(Henare, 2001, p. 208). If the state of the environment is not well, the hosts will not be able to adequately provide for their manuhiri due to limited resources; consequently, the mana of both parties will be negatively impacted.

2.2.4 Mauri and wairua

Atua tū, manu ū, mauri ora i te ao mārama.
The generative energy of the universe is instilled and flourishes in all living things (Te Rā Moriarty)

Mauri can be defined as an "internal energy or life force derived from whakapapa, an essential essence or element sustaining all forms of life" (Harmsworth & Awatere, 2013, p. 274). Mauri can be found in all beings, including plants, animals, water and soil, as is seen in the following quote from Manuka Henaare (2001),

> For instance, a tree is first formed as a seed resplendent with the mauri… of Tane… the seed now has a being with potential to be a living, creating process that is the mana of Tane. In time, the form, the seed, is transformed into a trunk, a body, which has a wairua, a spirit and these are bound together by a mauri, which when separated from the tree, causes the tree to die (p.210).

Māori have recognised the potential for shifts in mauri due to human activities such as environmental land use changes and pollution. Negative shifts in the mauri of surrounding ecosystems can lead to a decline in the health of human populations. Wairua is the spiritual energy and dimension, and reflects Māori well-being (Harmsworth & Awatere, 2013). This spiritual dimension is essential in environmental practices and is related to mauri, which is an indicator of wairua and spiritual health. Taha wairua (the spiritual side) is "generally felt by Māori to be a significant and integral part of Māori well-being" (Harmsworth & Awatere, 2013, 278). Wairua is the spirit present in all beings, and mauri is life energy itself. Together, mauri, wairua and the physical body make up a living being (Henare, 2001). The vitality of forest

ecosystems and Te Taiao are reflections of their mana and must be protected through proper kaitiakitanga (Henare, 2001).

2.2.5 Tikanga and ritenga

Tikanga means the tika (right, correct) or correct way of doing things (Mead, 2003). Ritenga is “the area of customs, protocols and laws that regulate actions and behaviour related to the physical environment and people” (Harmsworth & Awatere, 2013, p. 276). Both are concepts that can be applied in environmental science. Tapu, a concept closely associated with ritenga, is a Māori spiritual value defined as “sacred“ (Harmsworth & Awatere, 2013, p. 281) and “set apart” (Mead, 2003, p. 299). Tapu physical areas can be placed under a rāhui, restricting access to resources and/or places for Māori cultural and customary reasons. The placement of rāhui in Te Taiao demonstrates tikanga in practice. From the point of view of mana whenua, it can represent the correct and appropriate response to uphold the balance and protection of ecosystems. Rāhui also operates within the scope of ritenga by observing customary protocols and laws. The placement of rāhui have been used in Aotearoa for environmental protection and to protect humans from the impacts of visiting sacred sites or those deemed off-limits (Maxwell & Penetito, 2007; Te Kawerau ā Maki, 2017; Whaanga & Wehi, 2017).

2.3 Tātai arorangi – Māori astronomical knowledge

Me mātau ki te whetū,	*Before you set forth on a journey,*
i mua i te kōkiri o te haere.	*be sure you know the stars.*

Tātai arorangi (Māori astronomical knowledge) is an integral part of the broader knowledge system known as kauwaerunga, which includes knowledge of the cosmos, creation myths, deities, celestial bodies, and the concept of time (Best, 1924; Harris et al., 2013). While the wider community had general knowledge of tātai arorangi, tohunga kokorangi and tohunga tātai arorangi were the teachers and specialists of Māori astronomical knowledge – only a particular set of qualified experts were entrusted to hold in-depth knowledge of these systems (Harris et al., 2013). In common with many Indigenous knowledge systems faced with the forces of colonisation, “…Māori astronomy as with other Māori knowledge became sidelined, [or] mixed with the new colonial knowledge and then was lost” (Harris et al., 2013, p. 325). Historical narratives surrounding tātai arorangi were collected by early ethnographers, including Elsdon Best (1922a, 1922b, 1996), James Cowan (1930), Edward Tregear (1891, 1904), and Herbert W. Williams (1908). However, these authors have been criticised for oversimplifying and generalising the narratives collected (Harris et al., 2013; Orchiston, 2000). The current revitalisation of tātai arorangi has uncovered much mātauranga that is not included in early writings by the authors mentioned above. For example, *Matariki – The Star of*

the Year, written by Rangi Matamua, primarily drew on the 400-page writings of the author's tipuna (ancestors), describing ancestral star lore compiled between 1898 and 1933 (Matamua, 2017). This mātauranga is held by only a few individuals today, although there is an active revitalisation movement in tātai arorangi.

The 1970s saw a growing interest in revitalising mātauranga related to Māori celestial navigation, a movement led in Aotearoa by Hector Busby and elsewhere by other Pacific navigational knowledge seekers (Harris et al., 2013; Matamua et al., 2013). In addition to the resurgence of appreciation for Māori and Pacific navigational techniques, an interest in general tātāi arorangi grew between 1970 and 2000. The late 2000s saw the formation of the Society for Māori Astronomy Research and Traditions (SMART), a "…group… of Māori knowledge experts, educators, navigators and scientists" (Harris et al., 2013, p. 326). One of the group's goals is to perform research and produce publications that are "…centred on Māori astronomical knowledge" (Harris et al., 2013, p. 326). This group is active today, supported by researchers from the University of Auckland, Te Whare Wānanga o Awanuiarangi and Victoria University of Wellington, researching and publishing papers on the subject of Māori astronomical knowledge, including commonalities in mātauranga between Māori meeting houses before European contact, exploring mātauranga related to the maramataka, and the influence of stars on te reo Māori (the Māori language) iwi-specific astronomical knowledge (Harris et al., 2013).

One of the main aspects of tātai arorangi is that "certain stars were used as markers for certain times of the year, when they just became visible again in the night sky" (Harris et al., 2013, p. 327). The most well-known example of this is the marking of the Māori new year, which occurs with the rising of the Matariki star cluster (Pleiades), or the star Puanga (Rigel), depending on geographic location (Best, 1922; Harris et al., 2013). The resurgence of Māori new year celebrations, by Māori and non-Māori alike, saw a revitalisation in the early 2000s and sparked further interest in tātai arorangi (Harris et al., 2013). I will now turn to a discussion surrounding the maramataka, the Māori lunar calendar.

2.3.1 Maramataka

Tuia ki te rangi,	*It is written in the heavens,*
Tuia ki te whenua,	*Upon the land,*
Tuia ki te moana.	*and the ocean.*
E rongo te pō, e rongo te ao.	*And balanced between night and day.*

Māori use the heliacal rising and setting of certain stars to determine the start of the new year and the time of year. Maramataka is one of the most important components of tātai arorangi, particularly in its potential applications in environmental science. The presence or absence of

flora and fauna species, whether specific plants are fruiting, flowering, or bare, along with changing weather patterns, are all reflected in the maramataka. Māori observed patterns of events in detail, noted their regularity and used this information to provide guidance surrounding particular events or activities that helped the community survive and thrive (Marsden, 1992; Mead, 2003). The concepts in maramataka are based on knowledge created using evidence and processes consistent with the scientific method (Hikuroa, 2017).

The maramataka's primary use is for marking time and scheduling essential activities, such as fishing, gathering kai moana (seafood), and planting and harvesting of food (Hikuroa, 2017). Maramataka vary from iwi to iwi; in fact, there are over 30 known calendar variations reflecting the differing climates and environments of different tribal regions (Roberts et al., 2006; Warbrick et al., 2023). Many Māori are actively revitalising maramataka, each informed by their own mātauranga and ancestral connections. Notable recent contributors include Rangi Matamua, author of *Matariki: The Star of the Year* (2017), Hinemoana Elder (*Wawata: Moon dreaming: Daily wisdom guided by Hina, the Māori moon*, 2022), Rereata Makiha and his tauira (student) Ayla Hoeta and the late Wiremu Tawhai (*Living by the Moon: Te Maramataka o Te Whanau-a-Apanui,* 2007), among others.

The mātauranga from tohunga (environmental expert) and kaumatua Rereata Makiha was selected for more in-depth analysis here, as representatives from Te Kawerau Iwi Tiaki Trust expressed a particular interest in his knowledge. Hailing from Hokianga (north of Hikurangi), Matua Rereata Makiha (Ngapuhi/Te Arawa/Rangitane) is a leading expert on maramataka. He has been immersed in mātauranga maramataka from a young age, including the traditional food planting and harvesting practices influenced by it, as well as kōrero tuku iho, which were intergenerationally passed down to him through oral history (*Waka Huia Rereata Mākiha*, 2018). These types of mātauranga were nearly eliminated after the implementation of the Tohunga Suppression Act of 1907, but tohunga like Makiha are part of the renaissance movement to revitalise and share this ancestral knowledge (*Rereata Makiha*, 2021; *Waka Huia Rereata Mākiha*, 2018). Makiha learned this mātauranga and how to apply it over many years through a series of wānanga (educational seminars or meetings), which he describes below.

> You had to wait until the sun set and then the tohunga would start reciting and you copied him, and it was a form of wānanga… to infuse memory work into a person, because remember it was all oral history, the old people never wrote anything down, it was all passed on through oral histories…(There were) different houses of learning, some of them taught the use of the stars, others taught tauparapara [recitation], others taught all those pūrākau (*Rereata Makiha*, 2021, para. 7).

Fortunately, Makiha received mātauranga related to the maramataka and ngā kaupeka o te tau (seasonal phases of the year) and has since played an vital role in transmitting this knowledge to others (Husband, 2021; *Rereata Makiha*, 2021; *Waka Huia Rereata Mākiha*, 2018). The following section provides a more in-depth discussion of seasonal indicators from mātauranga shared by Makiha.

Ngā kaupeka o te tau – Seasonal phases of the year

The location and movement of the sun's path between the two solstice points is an essential guide for ngā kaupeka o te tau, the Māori divisions of the year. Observation of flora and fauna, tide cycles, the weather and the arrival and position of stars or star clusters in the sky are also important indicators for determining the seasonal phase (Figure 5). This Indigenous seasonal system differs from the four seasons, which are based on the Gregorian calendar and occur on fixed dates each year. The maramataka comprises 13 kaupeka (seasonal divisions), consisting of seven matiti (summer) phases, three wero (cooling phases), and three takurua (cold) phases (Warbrick et al., 2023). Additional takurua phases occur in the south of Aotearoa, where the weather is colder (Warbrick et al., 2023).

Key terrestrial environmental characteristics (where available in the literature) from each kaupeka, according to mātauranga from Rereata Makiha, are listed in Figure 5. Māori used these recurring seasonal tohu to determine the phases of the year and accompanying recommended actions. However, most likely due to climate change, some of these annual divisions are now more prominent, becoming irregular, or being skipped entirely. For example, due to the extreme rain events during the matiti phases in 2023, much of Te Ika a Māui (The North Island of Aotearoa) did not see the warmer phases of matiti kaiwai or matiti raurehu (Te Karere TVNZ, 2023). The impact of these changes due to climate change is yet to be determined, but they will most certainly have ripple effects on the planning of planting, harvesting and gathering of food resources. Ayla Hoeta, a tauira of Rereata Makiha, has published a series of newspaper articles sharing mātauranga maramataka, including terrestrial tohu of ngā kaupeka o te tau, which are included in the following discussion.

Takurua a uru: The first takurua/cold phase

Takurua a uru is marked by the rising of the Matariki star cluster or the star Pūanga (depending on geographic location), and the setting of Rēhua (Antares). The rising of these stars around the end of June to the beginning of July in the Gregorian calendar marks the beginning of the Māori year, widely known as "Matariki." This marks the time to prepare for the colder winds and rainier days ahead (Hoeta, 2021). Now a national holiday in Aotearoa, Matariki is also a

time to remember loved ones who have passed away over the year and to plan for the new year ahead (Hoeta, 2021).

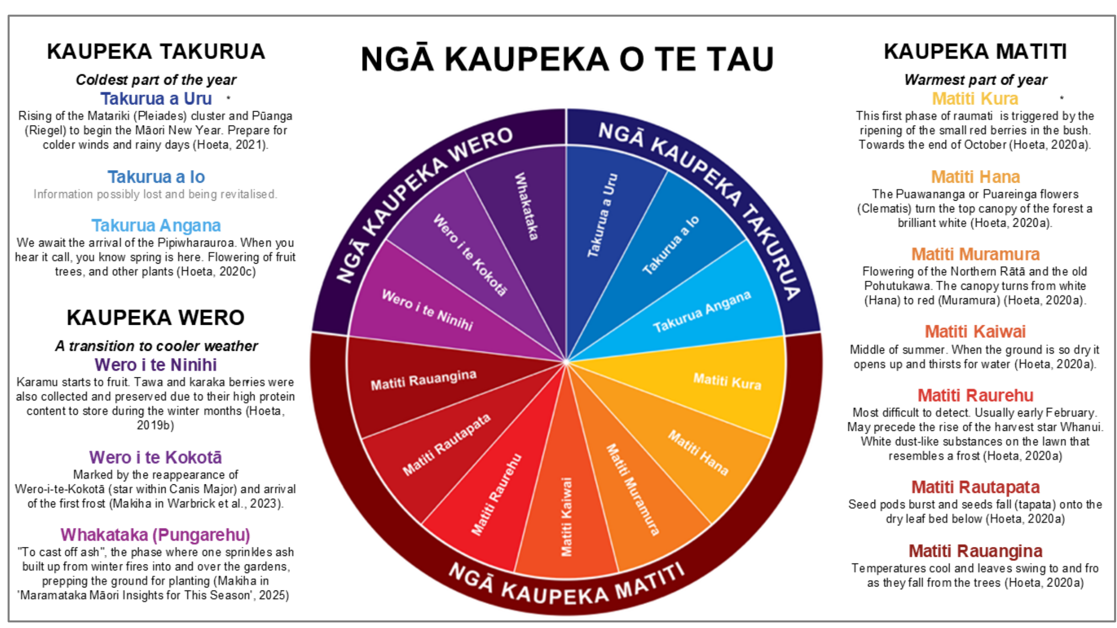


Figure 5

Ngā kaupeka o te tau- Seasonal divisions of the Māori year shows mātauranga shared by Rereata Makiha and his student Ayla Hoeta. The year is divided into three kaupeka takurua (cold phases), three kaupeka wero (cooling phases) and seven kaupeka matiti (warm phases). I found information for all but one of ngā kaupeka o te tau (takurua a io) in publications by Hoeta and Makiha (Hoeta, 2019b, 2020a, 2020c, 2021; 'Maramataka Māori Insights for This Season', 2025; Warbrick et al., 2023). It is possible that this mātauranga has been lost and is being revitalised. What is remembered are the divisions.

Takurua a io: The second takurua/cold phase

I was unable to obtain information regarding takurua a io from published sources. This information is possibly lost and currently being revitalised. What is remembered is the seasonal division.

Takurua angana: The third takurua/cold phase

Takurua angana represents the coming of spring, which usually occurs around September in the Gregorian calendar system. One of the main terrestrial tohu of Takurua angana is hearing the call of the pīpīwharauroa in the ngahere (forest). This migratory bird is present during the summer in Aotearoa. This kaupeka is a time of regrowth and renewal and a transition to the warmer months of ngā kaupeka matiti (Hoeta, 2020c).

Matiti kura: The first matiti/warming phase

A common sign of this phase is the ripening of small red berries in the ngahere (reflected in the translation of kura, “red” in te reo Māori). Matiti usually occurs around October in the Gregorian calendar. The whitebait will begin running at this time. This is a time of renewal and rebirth, marking the end of the cold phases of takurua and the beginning of the warming phases of matiti (Hoeta, 2018a, 2020a; Moorfield, 2011).

Matiti hana: The second matiti/warming phase

Matiti hana is indicated by the terrestrial tohu of the blooming of the puawānanga or puareigna flowers *(Clematis paniculata)* in the ngahere, along with other white flowers. This turns the forest canopy a bright white. Matiti hana usually occurs around the end of October in the Gregorian calendar. Whitebait season comes to an end, and kanae (mullet; *Aldrichetta forsteri, Mugil cephalus*) begin to run during this phase (Hoeta, 2020d).

Matiti muramura: The third matiti/warming phase

The flowering of the northern rātā and pōhutukawa (*Metrosideros excelsa*) in the ngahere is a tohu that the third phase of matiti muramura has begun. These tohu are reflected in te reo Māori, where the canopy turns from hana (white) to muramura (red). The presence, size and colour of the pōhutukawa flower on land can be a tohu of when kina (sea urchin; *Evechinus chloroticus*) are ready for harvesting at sea (Hoeta, 2018b).

Matiti kaiwai: The fourth matiti/warming phase

Matiti kaiwai occurs during the height of summer, a time when the whenua dries and cracks open, thirsting for water. This kaupeka is accompanied by the rising of the Rehua (Antares) star. One terrestrial tohu of matiti kaiwai is the call of the teoteo (female tūī), which may be prominent in the ngahere accompanying the hatching of their piipii (chicks)(Hoeta, 2018c).

Matiti raurehu: The fifth matiti/warming phase

Matiti raurehu, the fifth warming phase, usually occurs in the Gregorian calendar around early February and is the most difficult to determine. This phase may come before the rise of Whanui, the harvest star. During this matiti phase, a white dust-like substance resembling frost may appear on lawns and flat areas of the terrain (Hoeta, 2019a).

Matiti rautapatapa: The sixth matiti/warming phase

Terrestrial tohu of the arrival of matiti rautapatapa, the sixth matiti/warming phase, are bursting seed pods and the falling (tapata) of seeds onto the forest floor below (Hoeta, 2020a). This was typically a time for harvesting and storing food, as well as preparing for ngā kaupeka takurua (the cold phases) (Hoeta, 2019b).

Matiti rauangina: The seventh matiti/warming phase

The seventh and final phase of matiti, matiti rauangina, is when the leaves swing to and fro as they fall from the trees in the ngahere. "Te angina" translates to "free fall" in te reo Māori (Hoeta, 2020b, para. 10). This is the last warm phase of the seasonal divisions, followed by a transition into the three wero phases and three takurua phases ('Maramataka Māori Insights for This Season', 2025).

Wero i te ninihi: The first wero/cooling phase

This phase occurs around May in the Gregorian calendar. Terrestrial tohu of this kaupeka may include the fruiting of karamū. Other tohu of this phase are the tawa and karaka (*Corynocarpus laevigatus*) berries, which have a high protein content and are collected and preserved for consumption during the winter phases when food supplies are low (Hoeta, 2019c). As the weather gets colder, the wero and takurua phases are traditionally when people would store food such as the peruperu (Māori sweet potato) and kumara to support and help the marae ('Maramataka Māori Insights for This Season', 2025).

Wero i te kokotā: The second wero/cooling phase

One of the tohu of the arrival of wero i te kokotā, the second wero/cooling phase, is the appearance of a star by the same name within the Kāhui Takurua (Canis Major constellation). The arrival of the first frost is a terrestrial tohu of wero i te kokotā (Warbrick et al., 2023).

Whakataka (pungarehu): The third wero/cooling phase

This phase translates to "to cast off ash". It relates to the cooler wero phase where people might sprinkle ash built up from the fires into and over the gardens, preparing the ground for planting ('Maramataka Māori Insights for This Season', 2025).

Ngā mata o te marama – Lunar phases

The maramataka from Rereata Makiha's mātauranga draws on observations of ngā mata o te marama (the phases of the moon) (Figure 6). In te ao Māori, certain moon phases are associated with distinct energy flows, which can impact the environment and people, as humans and Te Taiao are interconnected through whakapapa. Energy levels are at their highest around the time of Rākaunui (the full moon). This is often a good time for social and physical activities, and there may also be more activity in Te Taiao. Remembering this is important when carrying out environmental monitoring that is aligned with te ao Māori.

Following the Rākaunui phases, the waning Korekore moons are associated with lower, reflective energy. Additional lower energy moon phases include: Takirau, Omauri and Mawharu. However, these phases also exhibit transitional characteristics. For example, Takirau

and Omauri are phases of energy reduction, while Mawharu is a phase of energy surge. During these times, the environment may be less active. Korekore moon phases are a good time to stay close to home and rest, and they are not good days to plant (Hoeta, 2020a). As the moon wanes, the Tangaroa moon phases are a time of abundant energy and high productivity. There may be increased activity in Te Taiao, making it an ideal time to be near the water or tackle larger projects (Hoeta, 2019d).

Figure 6

A contemporary maramataka dial by Ayla Hoeta displays ngā mata o te marama (moon phases) in the Māori lunar cycle and corresponding energy flows. In this maramataka, the highest energy days are those leading up to and immediately following Rākaunui (the full moon). The waning Korekore moon phases are a time of lower, reflective energy. Tangaroa moons (waning periods following the half-moon) are days of abundant and productive energy. Tamatea moons (the waxing phases after Whiro, the new moon) can be unpredictable. This maramataka dial was designed and developed by Ayla Hoeta with mātauranga from Rereata Makiha. Recognising patterns of energy, activity and rest in Te Taiao supports more sustainable and respectful interactions with the environment and can be used to inform environmental monitoring methods that better align with te ao Māori. From (Hoeta, A. in (Warbrick et al., 2023).

High-energy Tangaroa moon phases may be a preferable time for environmental fieldwork. In contrast, Tamatea moon phases can be unpredictable (Hoeta, 2019d); these may not be ideal phases for hui and/or fieldwork, as results may be arbitrary.

While the maramataka was initially developed through generations of observations to guide the timing of subsistence activities, such as fishing, planting, and harvesting (Warbrick et al., 2023), mātauranga maramataka has the potential to provide foundational knowledge for planning environmental monitoring activities that align with the seasonal and monthly cycles of Te Taiao. Ngā kaupeka o te tau and ngā mata o te marama in particular are under-explored components of mātauranga Māori that may prove helpful in informing environmental monitoring methods that better align with te ao Māori.

2.4 Kōrero tuku iho – Oral traditions

Ko te reo te mauri o te mana Māori. *The language is the force of the Māori authority.*
- Sir James Hēnare

Taonga tuku iho includes taonga (treasured physical items), wahi tapu (sacred places), and also kōrero tuku iho – oral traditions handed down–transmitted by the tūpuna to future generations through pūrākau, whakataukī and waiata (songs)(Wehi et al., 2009). Johnson (2024) describes the multiple functions of kōrero tuku iho, their origins and ability to transcend time:

> These oral traditions are not mere subjects found in books; kōrero tuku iho transcend mere textual subjects. They embody narratives directly witnessed and heard from living and deceased individuals, as well as the woven universe of more-than-human ancestors, making their presence tangible and familiar (p. 2).

These kōrero tuku iho are for the most part unexplored by Western scientists as sources of environmental knowledge, partly because they were originally written in te reo Māori, and also because many do not realise the “link between biological and cultural diversity” (Wehi et al., 2009, p. 201). Furthermore, these kōrero tuku iho are often codified according to a Māori worldview (Hikuroa, 2017) and hence written using imagery rather than expressing concepts and ideas directly, making their interpretations challenging for some (Wehi et al., 2009). This research provides a review of pūrākau, whakataukī and waiata that could be valuable to the field of cultural environmental monitoring in Te Wao Nui ā Tiriwa (See Section 5.2). A brief description of each type of kōrero tuku iho used in this research as foundational knowledge for field observations follows.

2.4.1 Pūrākau

As some pūrākau describe the origins and interactions between the beings and elements of Te Taiao, a foundational knowledge of these stories can be useful in developing an environmental monitoring method that aligns with te ao Māori. According to Hikuroa (2017), the concepts of pūrākau and maramataka are central to the definition of mātauranga. Pūrākau are a traditional form of Māori narrative that contain philosophies, worldviews, cultural codes and constructs (Hikuroa, 2017; J. Lee, 2009; Mead, 2003). Pūrākau can be defined as Māori myth, ancient legend and stories (Moorfield, 2011). However, they are not seen as imaginary or fictional by many (Ihimaera & Hereaka, 2019a; Lee, 2009), but rather as "a traditional form of Māori narrative, [that] contains philosophical thought, epistemological constructs, cultural codes, and worldviews that are fundamental to our identity as Māori" (Lee, 2009, p. 1). Ihimaera & Hereaka (2019) expand on this view:

> Nor is there any separation of the 'fanciful' stories of our origin, i.e. mythology and folklore, from the believable or factual, the real from the imagined, rational from the irrational, or what can be believed in and what cannot. Māori do not make distinctions. It's all history, fluid, holistic, inclusive – not necessarily linear… (Ihimaera & Hereaka, 2019, p. 13).

These descriptions illustrate the importance of pūrākau as a written history for Māori in Aotearoa.

It is not known how many pūrākau remain in difficult-to-access, unpublished manuscript form, while others are hard to retrieve as they are in Māori language newspapers (Lee, 2009; Reedy, 1993). Despite this, pūrākau recorded and translated by Māori themselves are occasionally available in older translated manuscripts (Reedy, 1993) and more contemporary works (Ihimaera, 2020). These include both versions based on stories collected by early ethnographers, as well as the authors' own mātauranga (Ihimaera, 2020; Jones, 2004). Modern-day retellings offer contemporary perspectives on traditional stories (Ihimaera & Hereaka, 2019b). Pūrākau have been shared as part of Native Land Court proceedings; however, while traditional pūrākau were centred on relationships, Māori narrators in these court cases often reframed these histories with a particular emphasis on whānau (family), hapū or iwi genealogical connections to the land (Lee, 2009; Parsonson, 2001), so there may be fewer aspects of these pūrākau that are connected to Te Taiao.

While some turn to pūrākau recorded by early anthropologists such as Elsdon Best (1942), Alfred Grace (1907) and Alexander Wyclif Reed (1946), these accounts are not without issues. It is almost certain that they distorted tribal histories by combining versions from various iwi, producing composite or hybrid narratives that likely do not accurately represent any single

tribal tradition (Calman, 2004; Lee, 2009). These pūrākau, collected by early ethnographers, have also been critiqued for their generalisation of specific iwi narratives to create stories more easily understood and palatable by Pākehā (New Zealanders of European descent) (Bishop & Glynn, 1999; Lee, 2009). Because of this, it is important to view these historical narratives with a critical lens.

2.4.2 Whakataukī

Kia mau ki te kupu ā tōu matua. *Hold fast to the words of your parent.*

Whakataukī can be loosely translated as proverbs, but Hirini Moko Mead, co-author of *Ngā Pēpeha a Ngā Tīpuna* (a collection of over 2,500 whakataukī from across Aotearoa), argues that this definition is too "restrictive"(Mead & Grove, 2001, p. 9). Mead states that whakataukī are not just proverbs; they are also historical writings and a method of communicating with the ancestors:

> Through the medium of words it is possible to discover how they thought about life and its problems. Their advice is as valuable today as before. Their use of metaphor and their economy of words become a beautiful legacy to pass on to generations yet unborn (Mead & Grove, 2001, p. 9)

Indeed, whakataukī provide a glimpse into historical daily life, and are a rich source of Māori ancestral wisdom that have been carefully preserved through oral transmission and, in some cases, published works. However, these proverbs are often imbued with idiom and iwi-specific language, and often require contextual analysis and lived experience to fully interpret their deeper meanings (Wehi et al., 2009). This is a process that does not come quickly or naturally to some. For the literature review of whakataukī (Section 5.2.2), I primarily reviewed *Ngā Pepeha a Ngā Tīpuna* (Mead & Grove, 2001) and another highly regarded source, *The Raupō Book of Māori Proverbs: Te Kohikohinga Whakataukī a Raupō* (Brougham & Reed, 1963).

2.4.3 Ngā Mōteatea

Ngā Mōteatea is a four-volume set of books that includes nearly 500 chants, laments, poems and waiata collected by Sir Apirana Ngata over a period of 40 years (Ngata, 2004-2007). The *Journal of the Polynesian Society* published the first volume in 1928. It is the most extensive collection of mōteatea to be published (*Ngā Mōteatea*, 2025). Pei Te Hurinui Jones carried on the work of collecting and translating these works for this collection after Ngata's death in 1950 (Ngata, 2004b). *Ngā Mōteatea* were classified into four basic categories: *(i) Lullabies, (ii) Laments, (iii) Pātere (Abusive Songs about Kaioraora, Songs of Defiance), and (iv) Love Songs* (Ngata, 2004a). The compositions contained in *Ngā Mōteatea* often employ imagery to

describe Te Taiao, occasionally referencing the various plants and animal species found in forest ecosystems. The results of a literature review of *Ngā Mōteatea* related to Te Taiao are presented in Section 5.2.3.

2.5 Mātauranga in Aotearoa-New Zealand government policy

2.5.1 Te Tiriti o Waitangi (1840)

As part of Te Tiriti o Waitangi, Māori are granted tino rangatiratanga or sovereignty over their local environmental systems under Article 2 which states: “The Queen of England agrees to protect the chiefs, the subtribes and all the people of New Zealand in the unqualified exercise of their chieftainship over their lands, villages and all their treasures” (Wilson, 2016). These provisions enable the development of governmental initiatives that support the inclusion of mātauranga Māori in various aspects of society, including environmental science. Mātauranga Māori is an all-encompassing, dynamic knowledge system firmly embedded in the natural world, making it applicable in environmental science (Hikuroa, 2017; Mercier, 2018). The following sections will examine the inclusion and role of mātauranga Māori in Aotearoa New Zealand government policy and legislation.

2.5.2 The Resource Management Act (RMA) (1991) and new planning laws

The Resource Management Act 1991 (RMA) was proposed under the Labour Government and passed by the National Government in 1991 to address growing environmental concerns through the use of an up-to-date planning framework (Ministry for the Environment, 2023). The focus of the RMA was on effects-based regulation, meaning that regulations were based on levels of environmental effects or management of the effects of development (Counsell, 2023). The RMA had many positive impacts as it streamlined more than 50 environmental laws concerning land, water, air and coastlines into a single system and enabled local councils to manage environmental resources according to local needs (Ministry for the Environment, 2023). However, it was called into question when it came to supporting the principles of Te Tiriti o Waitangi (Jacobson et al., 2016). For example, the RMA required minimal legal obligations of decision-makers to uphold Te Tiriti o Waitangi, requiring them only to “take into account” (Resource Management Act 1991, Section 8) Treaty principles. Additionally, the RMA did not require Māori to hold decision-making roles in environmental initiatives (Waitangi Tribunal, 2011).

In 1991, six iwi/hapū from throughout Aotearoa (Ngāti Wai, Ngāti Kūrī, Te Rarawa, Ngāti Porou, Ngāti Kahungunu and Ngāti Koata) made the Wai262 claim to the Waitangi Tribunal (Waitangi Tribunal, 2011). This claim called into question who owns or has control over three

things: mātauranga Māori, the “tangible products of mātauranga Māori” (Waitangi Tribunal, 2011, p. 17), (i.e., medicinal knowledge, traditional artistic and cultural expressions or “taonga works” etc.) (Waitangi Tribunal, 2011, p. 17). Factors that contribute to mātauranga Māori were also included, such as the “unique characteristics of flora and fauna” (Waitangi Tribunal, 2011, p. 17) and Te Taiao as a whole. Taonga species are defined in the claim as: “species of flora and fauna for which iwi, hapū, or whānau says it has kaitiaki responsibilities” (Waitangi Tribunal, 2011, p. 65). The Wai262 report called on the Crown to protect the obligations of kaitiaki concerning the environment, stating that this responsibility could not be delegated to regional and local governments. A further recommendation from the report suggested that Māori decision-making capabilities needed to be determined with the value of kaitiakitanga in mind (Waitangi Tribunal, 2011).

The Resource Legislation Amendment Act (RLA Act, 2017), introduced by the National Party and supported by Te Pāti Māori, was an amendment to the RMA created partially in response to the Waitangi Tribunal’s Wai262 Report (2011). Through the RLA Act, councils were required to provide draft regional and district plans to tangata whenua and allow sufficient time for their review before sharing with the public (Ministry for the Environment, 2017). Local councils were also required to “consult iwi authorities about whether it is appropriate to appoint a commissioner who understands tikanga Māori, and the perspectives of local iwi and hapū” (Ministry for the Environment, 2017, p. 2). If this was deemed appropriate, then the appointment of at least one commissioner with an understanding of tikanga Māori and tangata whenua perspectives was required (Ministry for the Environment, 2017). The Act contained several other provisions that incorporated Māori viewpoints and perspectives into resource management practices, including the requirement of Mana Whakahono a Rohe: Iwi Participation Agreements (Ministry for the Environment, 2017, 2025). These agreements provided iwi with a more structured and consistent role in planning decision-making when working with local councils (Ministry for the Environment, 2025).

The RMA (1991) has continued to be highly debated, with many changes by the central government in recent years. The 2017 – 2023 Labour Government introduced legislation (the Natural and Built Environment Act (NBEA) and Spatial Planning Act (SPA)) in 2023 that replaced the RMA, which aimed to strengthen Māori involvement in environmental planning decision-making (Ministry for the Environment, 2022). This new legislation introduced Te Oranga o Te Taiao, a concept from te ao Māori, that “speaks to the health and wellbeing of the natural environment, and the essential relationship between a healthy environment and its capacity to sustain all life” (Ministry for the Environment, 2022, p. 1). The NBEA and SPA required

decisions to “give effect to the principles of Te Tiriti o Waitangi” (Natural and Built Environment Act, 2023, Section 69(2)), rather than just acknowledging it as in the RMA.

The current National-NZ First-Act Coalition Government, whose term commenced in 2023, has repealed the Labour Party's introduced Acts and introduced the Regulatory Standards Bill (2025)(RSB) to replace the RMA (1991) with a different framework for resource management. The RSB would introduce a new set of principles that future laws must align with. These new principles would include property rights, individual freedoms and business certainty as a few priorities (Ministry for Regulation, 2025). However, the proposed RSB leaves out the principles of Te Tiriti o Waitangi, the founding document of the government in Aotearoa, and has been criticised for the lack of consultation with Māori in its development (Hapai Te Hauora - Māori Public Health, 2025). In fact, there were over 20,000 public submissions (88 percent) from various environmental groups, iwi/hapū and individuals opposing the bill, with only 76 submissions (0.33 percent) in support of the bill (Ministry for Regulation-Te Manatū Waeture, 2025). Although New Zealand government legislation over the years has provided opportunities for better environmental outcomes, in reality, as discussed at the start of this thesis, the environment is not in a healthy state, and in particular, biodiversity is imperilled.

2.5.3 Vision Mātauranga (2007)

Vision Mātauranga is a government policy framework developed in 2007 by the Ministry of Research, Science and Technology in Aotearoa, whose goal is to support research “that unlocks the innovation potential of Māori knowledge, resources and people” (Vision Mātauranga, 2007, p. 18). It is a guiding document for Aotearoa’s educational institutions in science. Te Ara Tika (2010) is a document stemming from the Vision Mātauranga framework to address Māori ethical issues within the health and university systems. This document provides a guide for the “ethical dimensions of tikanga as they relate to particular research proposals,” (Hudson et al., 2010, p. 2) and created a Māori ethical framework with four tikanga-based principles: whakapapa, tika (research design), manaakitanga (cultural and social responsibility), and mana (justice and equity) (Hudson et al., 2010). This framework can be a “critical point of engagement for researchers” (Mercier, 2018, p. 83) within their institutions when working with mātauranga Māori.

2.6 Mātauranga Māori in ecology and environmental science

As demonstrated through government policy and requirements in Aotearoa, which attempt to uphold the principles of Te Tiriti o Waitangi, the inclusion of mātauranga Māori has been a requirement for government funding of many scientific research projects in the country

(Broughton & McBreen, 2015). However, mātauranga Māori faces criticism and is considered incompatible with science by some academics (Clements et al., 2021) and, more recently, politicians in Aotearoa (Hanly, 2025). According to Hikuroa (2017), these individuals fail to understand that knowledge gained through intergenerationally transmitted sources, such as kōrero tuku iho and maramataka, is "generated using the scientific method, explained according to a Māori worldview" (p. 6). Mātauranga Māori has been developed through centuries of hypotheses, observations and conclusions. While many aspects of mātauranga Māori are derived using processes from the Western scientific method (Hikuroa, 2017; Mercier, 2018), Wehi et al. (2019) found that only three papers from 1953 to 2018 in the New Zealand Journal of Ecology featured partnerships with Māori or made meaningful acknowledgements of mātauranga. The authors found that while studies involving mātauranga Māori were not frequently published in this journal, they have been published in other journals in Aotearoa and internationally (Harmsworth et al., 2016; Lyver et al., 2015; Moller et al., 2004; O'Connell-Milne & Hepburn, 2015; Timoti et al., 2017). With the growing interest in the interweaving of mātauranga Māori with environmental science, one would hope these figures have improved since this article was published in 2019.

2.6.1 Challenges

Numerous challenges may arise when weaving mātauranga Māori and the Western scientific process. McAllister et al. (2019) Discuss the importance of incorporating the Māori value of manaakitanga (generosity, care, and reciprocity) in relationships between scientists and Māori. Some Māori can view the knowledge sharing in Western science of all information as the sharing of sacred knowledge with the tutuaa, "the common herd" (Marsden, 1992, p. 4) – that is, some knowledge should be reserved for members of society who after a long apprenticeship and testing were deemed fit to hold and retain such knowledge (Marsden, 1992). Additionally, the foundational concepts of kaitiakitanga (see Section 2.2.2) in te ao Māori often differ from those of Western science-based environmental conservation efforts. Kaitiakitanga emphasises a holistic approach to caring for the ecosystem, from the mountains to the sea (Wehi et al., 2019). In contrast, Western conservation tends to compartmentalise or separate elements of Te Taiao into smaller fragments, focusing on the management and analysis of individual species or ecosystem levels (McAllister et al., 2019; Noss, 1990). Other challenges include racism in research institutions in Aotearoa and the lack of support and understanding for research initiatives that align with te ao Māori (McAllister, 2022).

2.6.2 Interconnectedness versus detachment & “Two-Eyed Seeing”

While Western science tends to analyse one component of an ecosystem at a time, “Māori seek to understand the total system and not just parts of it”(Harmsworth & Awatere, 2013, p. 274). This stems from the whakapapa-based nature of mātauranga. Māori, like many Indigenous peoples, view themselves as closely connected to the world around them through whakapapa and genealogical relationships (Harmsworth & Tipa, 2006; Robb et al., 2016). McAllister et al. (2020) discuss how “Two-Eyed Seeing”[1] can be a helpful method in combining mātauranga Māori with Western-based knowledge systems to generate new knowledge or strategies for environmental protection. One example of new strategies resulting from “Two-Eyed Seeing” in Aotearoa is the assigning of legal personhood status (and accompanying legal protections) to natural ecosystems, as in the cases of the Whanganui River (Brierley et al., 2019; Te Awa Tupua (Whanganui River Claims Settlement Act) 2017, n.d.) and Te Urewera National Park (Te Urewera Act, 2014). Mātauranga Māori may also be incorporated in ecological research on traditional harvesting and agriculture (McAllister et al., 2019). Wehi et al. (2020) utilised Indigenous knowledge gathered from various te reo Māori names for the forest tree putaputawētā (*Carpodetus serratus*) in comparison with scientific data through a process of “Two-Eyed Seeing”. Tapping into both mātauranga Māori, handed down through millennia of observation and interconnection with Te Taiao, alongside Western science-based processes and data, can enrich our understanding of the environment.

2.6.3 Performance-Based Research Funding (PBRF) and funding challenges

A challenge raised regarding scientific collaborative projects with iwi/hapū in Aotearoa concerns the now decommissioned Performance-Based Research Funding (PBRF) model (Roa et al., 2009; Smith et al., 2016). The PRBF was implemented in 2002 as a method to “increase quality of research through peer assessment and performance indicators” (Ministry of Education, 2002, p. 55). Under this model, funding could be secured if research projects achieved specific performance indicators. However, these indicators often hindered collaborative research projects with tangata whenua, as they were problematic and biased towards more Western-based methodologies (Roa et al., 2009; Smith et al., 2016). Roa et al. (2019) discussed fourteen problems that arose from the PBRF process. One included not allowing for long-term research, which is often necessary to build relationships with iwi/hapū in collaborative projects (Roa et al., 2009). PBRF expected researchers to publish more than

[1] “Two-Eyed Seeing” is a “the gift of multiple perspective treasured by many aboriginal peoples… learning to see from one eye with the *strengths* of Indigenous knowledges and ways of knowing, and from the other eye with the *strengths* of Western knowledges and ways of knowing, and to use both these eyes together, for the benefit of all” (Bartlett et al., 2012, p. 335). This concept was first presented in 2004 by Elder Albert Marshall of the Moose Clan of the Mi’kmaw Elders (Bartlett et al. 2012).

four papers on the international excellence standard in six years. This amount of time restricted researchers from forming long-term relationships with their collaborators. This six-year plan also made it challenging to transfer research control to tangata whenua collaborators, as it focused on predictable outcomes that may not have been achievable in collaborative research. Roa et al. suggested determining project success based more on the *quality of the research process* rather than end-products, and recommended improvements to this funding scheme. This included taking a more pluralistic approach to judging the quality of research (Roa et al., 2009). Although the PBRF is no longer in use in Aotearoa, funding strategies such as this create unachievable expectations for projects working in collaboration with tangata whenua.

2.6.4 Mātauranga Māori and appropriation issues

Under Article Five of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP):

> Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies, and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of flora and fauna... They also have the right to maintain, control, protect and develop their intellectual property over such cultural heritage, traditional knowledge, and traditional cultural expressions (United Nations Declaration on the Rights of Indigenous Peoples, 2007, p. 9).

As described in the UNDRIP, there are valid concerns surrounding the protection and ownership of Indigenous knowledge. The extractive nature of Western science is a concern when considering collaborative initiatives that attempt to weave mātauranga Māori with Western science. Some mātauranga scholars view traditional science as exploitive of the Māori knowledge system, using it for its gain, while failing to support mātauranga outside of these purposes (Broughton & McBreen, 2015; McAllister et al., 2019; Smith et al., 2016). It is essential for Western science academics who have received many benefits from this extractive nature to reflect on how they may reciprocate and support mātauranga after decades of appropriation (McAllister et al., 2019).

2.6.5 “Moving over” and the transfer of authority

“In the absence of Indigenous governance of Indigenous knowledge gathering and creation, knowledge co-production processes reproduce the extractive approach to traditional ecological knowledge (TEK) that is well documented in critical policy and scientific scholarship” (Latulippe & Klenk, 2020, pp. 7–8). As described by Latulippe and Klenk (2020), it is essential

when doing collaborative research with tangata whenua to shift the power balance of Western science and empower Indigenous collaborators through the transfer of resources and authority (Moller et al., 2009). “Moving over is about the wholesale transfer of research resources and authority to Indigenous-led knowledge gathering, generation, and mobilisation” (Latulippe & Klenk, 2020, p. 10). This type of knowledge sovereignty can be realised by collaborating with tangata whenua from the early stages of research projects and supporting research partners in having control over processes from start to finish. An example of where this has primarily happened is the Te Mana o Rangitāhua MBIE Endeavour project, a five-year collaborative project led by Ngāti Kuri in partnership with the Auckland War Memorial Museum (Tāmaki Paenga Hira) and supported by several research institutions including Manaaki Whenua, Massey University, The University of Auckland and NIWA (Ngāti Kuri et al., 2020).

Chapter 3 Literature Review: Assessing Forest Health: Environmental Monitoring

3.1 Introduction

Biodiversity and environmental monitoring provide critical information for the appropriate and sustainable management of natural resources (Hurst et al., 2022). Society demands it, so every three years, the Ministry for the Environment and StatsNZ produce a *State of the Environment* report (Ministry for the Environment & StatsNZ, 2022, 2025). As a signatory to the United Nations Convention on Biological Diversity, Aotearoa is obligated to report on the health of indigenous ecosystems and biodiversity (Secretariat of the Convention on Biological Diversity, 2011). Western-science based environmental and biodiversity monitoring is defined as the collection of environmental data (air, land, water, and biodiversity). This data is used to inform conservation practices and gain a better understanding of the natural world (Lee et al., 2005). This is one tool that can be used in reporting on biodiversity health..

There has been a substantial increase in the systematic reporting of biodiversity values at the landscape scale within Aotearoa over the last 20 years. The initiative has been undertaken by both central and local governments and aligns with international norms for biodiversity reporting among OECD nations (Leonelli, 2013; Ondei et al., 2018). In 2005, a Natural Heritage Management System was implemented by DOC, which provided the impetus for a national-scale monitoring system for biodiversity (McGlone & Dalley, 2015; Wright et al., 2020). Several wealthier (in terms of ratepayer base) and more urbanised Regional Authorities have also commenced regional-scale monitoring. This includes biodiversity, which integrates with DOC's national system in sampling and experimental design, as well as initiatives by the Auckland Council (Auckland Council, 2012), Greater Wellington Regional Council (Greater Wellington Regional Council, 2016) and Waikato Regional Council (Waikato Regional Council, 2025).

The native forests of Aotearoa have been a priority for environmental monitoring. Indigenous forests cover over six million ha, or 26 percent of its land surface, 30 percent when including kānuka and mānuka (Cieraad et al., 2015; Hurst et al., 2022). Legislation such as the Forests Act 1949, the Conservation Act 1987, and the Resource Management Act 1991 has emphasised the importance of effective forest management, including the protection of native forests. New Zealand is legally obligated to conduct environmental monitoring and assessment as a signatory to the Convention on Biological Diversity (1992). Environmental monitoring,

including that of forests, is also required under the Environmental Reporting Act 2015 (Hurst et al., 2022; Lee et al., 2005).

3.2 Western-based environmental monitoring for forest health in Aotearoa

In response to the adverse effects of land-use change and the introduction of invasive plant and animal species, systemic, quantitative and purpose-driven environmental monitoring began in Aotearoa in the 1920s. These early monitoring initiatives mainly consisted of on-the-spot anecdotal observations rather than those collected systematically. These initial monitoring efforts were primarily motivated by the potential economic impact of declining natural resources (Lee et al., 2005; McKelvey, 1995). More quantitative and protocol-based monitoring techniques were developed after the establishment of the New Zealand State Forest Service in 1920, followed by the National Forest Inventory (1920-1930). The 1960s and 1970s saw the growing awareness of environmental issues beyond the environment's economic value, including the preservation of forested areas. In the late 1980s, the Ministry for the Environment and DOC were established in response to growing environmental concerns, with a distinct purpose to protect the well-being of the environment (Lee et al., 2005).

DOC now carries out most biodiversity monitoring in Aotearoa (Lee et al., 2005). However, the Auckland Council carries out the majority of monitoring within the Waitākere Ranges Heritage Area (Griffiths et al., 2023). Monitoring efforts by DOC emphasise managing biodiversity assets, with a strong focus on vegetation communities and threatened plants and birds. Standard monitoring techniques vary depending on the data collection type, but the most commonly used methods identified in a study by Lee et al. (2005) are found in Table 2.

Table 2

Broad groupings of monitoring techniques most often used by Department of Conservation teams or contractors. From (Lee et al., 2005).

Monitoring Technique	Description (From Lee et al., 2005)
Standard forest plot and grassland survey	Line transects, cover estimates in fixed areas, photo points and use of exclosure plots to provide information on changes in stand structure and vegetation composition in the presence of herbivorous pests.
Protocols for indexing vertebrate/invertebrate abundance	(e.g.) residual trap catch and wax blocks for possums; tracking tunnels for rodents and mustelids; kill trapping; spotlight counts for rabbits; chalk boards for cats; animal sign (e.g. faecal-pellet line surveys for ungulates); kiwi call counts; 5-minute bird counts; netting; trapping; spotlighting; electric fishing; acoustics; pitfall traps; weta boxes; malaise traps; pheromone traps; artificial covers; bat boxes) in areas under management to provide information on success of interventions.
Browsing surveys to document impacts on vegetation	(e.g. foliar browse index on indicator species to determine the success of possum control operations; seedling ratio index for ungulates) to determine when management intervention is required / to determine if improvement in biodiversity asset status has occurred.
Methods for estimating seasonal fluctuations in flowering and fruiting	(e.g. seed collected in seed traps quarterly) to anticipate predator irruptions/breeding in acutely threatened taxa.
Nest inspections; banding; radio telemetry;	(e.g. territory mapping; roost/colony counts, photos of individuals; burrow density; mark-recapture, distance sampling, aerial surveys for terrestrial and marine mammals; intensive searches using grids/transects; marking and mapping of individuals).
Methods to provide information on population trends in abundance	Video cameras, to provide data on demographic parameters such as productivity, mortality, sex ratio, dispersal, and survival

The primary goal of biodiversity monitoring carried out by DOC is to gain a better understanding of dynamic environmental processes and to adjust environmental management accordingly (Lee et al., 2005). Data collected and analysed from long-term environmental monitoring of forest ecosystems can provide a greater understanding of vegetation dynamics (Hurst et al., 2022). However, these Western-science-based monitoring efforts are not without problems; they are often "…uncoordinated, ambiguous, intermittent and irregularly reported" (Lyver et al., 2018, p. 1909). Lee et al. (2005) found several issues with monitoring carried out by DOC (Table 3). Incorporating Indigenous Knowledge into existing environmental monitoring methods provides an opportunity to help strengthen these efforts (Berkes, 2009; Lyver et al., 2018).

Table 3

Observations from the monitoring history in New Zealand (Lee et al., 2005) show common issues arising in Western-science-based environmental monitoring programmes in Aotearoa.

Observations From The History of Monitoring in New Zealand (From Lee et al., 2005)	
1. Little monitoring has been initiated or continued simply to provide baseline biodiversity data.	5. Monitoring schemes, or the data archived from them, often end by addressing different issues additional to or replacing those for which they were originally designed.
2. Monitoring has a tendency to perpetuate itself regardless of changes in policy.	6. Monitoring information is often not used or poorly employed in making management or policy decisions.
3. Much monitoring appears to be done, in part, because it was relatively easy to do.	7. Changes in institutional structures pose great risk regarding loss of expertise, continuity of monitoring and preservation of data.
4. Physical collection of monitoring data has a tendency to run far ahead of the ability of the system to archive and analyse.	8. The increasing demand for non-intensive, reliable, rapid assessment monitoring methods is leading to experimentation with non-comparable tools of low rigour.

3.3 Environmental monitoring for forest cultural health in Aotearoa

Cultural environmental health monitoring is a method of assessing the environment using cultural health indicators, usually selected by tangata whenua based on spiritual, historical, and harvesting practices, to determine environmental health (Bishop, 2019; Shortland, 2011). Māori have developed extensive knowledge of and intimate relationships with Te Taiao through whakapapa and intergenerational transmission of mātauranga. This can be used to inform historically Western science-based environmental monitoring practices. Many models and assessment frameworks have been developed over the past 20 years, and cultural health monitoring is of growing interest in environmental conservation (Harmsworth & Tipa, 2006; Lambert et al., 2018; W. Lee et al., 2005; Lyver et al., 2018). Tadaki et al. (2022) discuss the aim of "cultural monitoring":

> …'cultural monitoring' is distinguished by Indigenous people, Indigenous knowledge and Indigenous objectives driving the monitoring exercise… cultural monitoring is about local Indigenous people making and interpreting environmental observations within an Indigenous worldview… Cultural monitoring often emphasises accumulation of cultural knowledge but sometimes also includes translating knowledge into a format that can be wielded effectively in environmental decision-making (Tadaki et al., 2022, p.38).

It was not long ago that mainstream environmental monitoring began weaving mātauranga Māori into its systems. According to Robb et al. (2016): "Until recently, little consideration has been given to identifying and building biodiversity indicators that are relevant to mana whenua" (p. 5). Although the development and use of cultural indicators in environmental monitoring is relatively underdeveloped in Aotearoa, a few studies have utilised this approach. Cultural health monitoring frameworks in Aotearoa have been implemented in terrestrial, wildlife, marine, and freshwater monitoring, with the latter being the most frequent application. This emphasis on cultural health monitoring in freshwater ecosystems is reflected in the creation of a Cultural Health Index (CHI) freshwater monitoring framework (Tipa & Teirney, 2006), which is now referenced by the Ministry for the Environment (2006) for nationwide use.

There is a limited number of published collaborative initiatives for forest environmental monitoring in Aotearoa (Chetham & Shortland, 2013; Lyver et al., 2017; Reihana et al., 2023; Robb et al., 2016; Shortland, 2011; D. P. Walker, 2019). Prior to studies like these, Western-science-based forest monitoring methods were the norm used for decades (Allen et al., 2003a). This section will examine some of these forest-based cultural health studies from Aotearoa.

3.3.1 Kia Toitu He Kauri (2011-2013)

Kia Toitu He Kauri is a framework and set of cultural indicators for kauri ngahere, first developed in 2011 by Shortland and Repo Consultancy Ltd. (Shortland, 2011). This framework was commissioned by the Tāngata Whenua Roopū of the Joint Agency Response team, a group of iwi affected by Kauri dieback. This assessment framework was informed by values determined by kaumātua and other experts in kauri ngahere. The identified values included intellectual property, whakapapa, ngahere, whāngaia (nourishing) te mauri/hau (vitality) o te kauri, species capability indicators and whanaungatanga. A four-step process was used to select species and indicators for this framework. The first step was to include species known to be living on kauri. Step two involved the inclusion of species known to inhabit the vicinity of kauri. The third step included species that were ecologically susceptible and/or threatened (e.g. frogs). Finally, the fourth step examined the cultural health value of species identified in steps 1-3.

Future recommendations for a monitoring programme focusing on the maramataka were made as part of the framework. The authors consider the maramataka to be "the most effective tool to monitor cultural health due to the numerous indicators and their range and rates of change" (Shortland, 2011, p. 43). Environmental indicators related to the maramataka

may include the fruiting and flowering of plants, as well as the presence or absence of key plant and animal species. The authors described the maramataka as providing the "ideal timetable for site monitoring" (Chetham & Shortland, 2013, p. 13); however, the exact manner in which maramataka would be incorporated into monitoring frameworks was still to be finalised. They recommended monthly monitoring during the first year of fieldwork, followed by seasonal data collection thereafter. This would help prevent the further spread of kauri dieback by reducing human presence in the kauri forest. The authors addressed the limitations of the study, particularly that it was developed in a short timeframe, and the need to adapt for iwi/hapū values. The researchers omitted Te Kawerau ā Maki (research partners for this MSc thesis) in their working group, which was an unfortunate oversight, considering the extensive kauri ngahere within their rohe (Gibson et al., 2023). While the study was limited to its short development timeframe, it was grounded in consultation and collaboration with Indigenous elders and experts in the kauri ngahere. The study can provide a solid foundation for forest health assessment and has been considered for use in other studies (Robb et al., 2016).

3.3.2 Tūhoe Tuawhenua forest health assessment framework (2004-2017)

Lyver et al. (2017) developed a forest health assessment framework in collaboration with the Tūhoe Tuawhenua in central Te Ika a Māui. In the study, the authors established a long-term relationship with tangata whenua through interviews conducted with 55 individuals between 2004 and 2014 (Lyver et al., 2017). The research also included recording information and mātauranga surrounding kererū from interviewees to help inform monitoring methodologies (Lyver et al., 2008). Through these interviews and a prioritisation process, the authors were able to select forest health indicators important to the iwi. Indicators identified included resource availability, water, land, and forest characteristics, as well as human wellbeing. Twenty-five priority indicators were selected for potential use in a forest health survey (Lyver et al., 2017). In 2017, these community-based indicators were combined with a Western scientific plot-based survey by the authors and iwi kaumātua surveyors as part of a cross-cultural forest monitoring and reporting system (Lyver et al., 2018). The framework for forest health has its strengths in that it was developed by building a long-term relationship with the iwi. However, the attempt to combine quantitative analysis with qualitative responses from kaumātua was sometimes unclear and depended on the individual perspective of each respondent (Lyver et al., 2018).

3.3.3 Ketewhaihua toolkit for assessing forest health (2008-2019)

The Ketewhaihua cultural health assessment toolkit was developed as part of a PhD thesis by Walker (2019). The toolkit was created in collaboration with Te Ātiawa, Ngāti Tama, Ngāti Kuia,

and four mandated kaumātua in the Whakatū (Nelson) region. A Kaupapa Māori research approach (Bishop & Glynn, 1999) was used, including eight essential principles, examples include: "Taonga tuku iho – The cultural aspirations principle," (Walker, 2019, p. 55) and "Te Tiriti o Waitangi – The principle of the Treaty of Waitangi" (Walker, 2019, p. 59). The research used an Action Research approach, which included planning and action followed by periods of reflection and adjustment (Walker, 2019). The author followed recommendations from Harmsworth et al. (2006) that Māori cultural health environmental indicators should be "simple, robust, meaningful, and defensible, and be able to be monitored at a reasonable cost" (Walker, 2019, p. 91). The project began with a community hui in 2008, during which the research plan was presented to local iwi. The study employed an Atua framework, based on Māori cosmogony, which enabled iwi to select culturally relevant health indicators. For example, the Tāwhirimātea (deity of winds and storms) domain might include wind-related forest species or those particularly vulnerable to the effects of climate change. Potential environmental health indicators under Tāwhirimātea included "smell of the forest" and "species on the edge" (Walker, 2019, p.93). In 2013, the toolkit was tested at six forest sites in the Motueka and Riwaka River catchments over four seasons (Walker, 2019), before being used to assess three forest ecosystems. The Ketewhaihua is a robust and easily adaptable framework that effectively interweaves mātauranga Māori with Western methodologies. Its strengths lie in the long-term relationship with iwi research partners and the seamless combination of quantitative scientific measuring techniques with qualitative cultural indicators.

3.3.4 He Kete Hauora Taiao (2020)

Belcher created an environmental assessment framework entitled *He Kete Hauora Taiao* as part of an MSc thesis (Belcher, 2020). The framework uses the concept of ariā (Māori ecological perspectives, indicators or concepts) within the "Driver – Pressure – State/Condition – Indicator – Response" framework developed by Hughey et al. (2004). Mauri, whakapapa, tapu, wairua and mahinga kai are examples of ariā included in the framework and are linked to environmental processes and indicators of environmental health. The indicators developed in the study can then be assessed using qualitative scientific tools and targets.

He Kete Hauora Taiao enables the viewing of quantitative ecological data from a Māori perspective. For example, in the study, the ariā mauri is defined as "the life-force and the special nature of organisms"(Belcher, 2020, p. 163). The author states that indicators of mauri could be: "...the occupancy, connectivity, heterogeneity, representativeness, rarity and structure of ecological habitats"(Belcher, 2020, p. 163). To assess the mauri ariā in a terrestrial

landscape, the author recommends quantitative methods such as FORMAK assessments, mapping the distribution of rare plant and/or bird species, mapping habitat fragments and any threatened or rare habitats, and analysing habitat variability and land use to determine habitat representativeness and heterogeneity. The Kete Hauora Taiao could be a practical framework, as quantitative ecological data is clearly integrated with the ariā concepts.

3.3.5 Me ora te ngāhere (2023)

In the study by Reihana et al. (2023), the authors employed a mixed-methodology approach, working with Ngāti Rangi in central Te Ika a Māui, to develop an environmental monitoring method for use within the iwi's rohe. The main methodology involved a series of noho taiao (community workshops) and interviews with 54 Ngāti Rangi kaumātua and pāhake (older adults) to identify values aligned with Ngāti Rangi's worldview. These kaumātua were identified by Ngā Pou Taiao (Ngāti Rangi's Environmental Resource Managers) as knowledgeable about the local forests. "Biocultural Vision" posters were created by an illustrator who attended these noho taiao, where five key cultural themes were identified based on mātauranga shared by Ngāti Rangi elders. These themes included: rongoā (medicinal resources), manu (birds), ahua o te ngāhere (nature of the forest), wai (water) and tāngata (people) (Reihana et al., 2023).

Forest indicators were identified that fell under each of the five cultural themes described above within a community monitoring framework. Information from kaumātua and pāhake was used to create observation criteria for each indicator. For example, an indicator for the "Ahua o te ngahere" theme was "Is the Ngahere floor flourishing?" (Reihana et al., 2023, p. 7). The directive for determining the score for this indicator was: "Look around, what can you see?" (Reihana et al., 2023, p. 7). Based on observation, ordinal scores were then assigned on a scale of 0-4 in Māori and English. An ordinal score Māori of "0-Aue" would be "Not great" in English, with the description of this in the forest being "The ngahere floor is severely limited with leaf litter and debris, no sign of ferns or juvenile trees. It is dry and feels impoverished" (Reihana et al., 2023, p.7). In comparison, the environmental description of a high ordinal score Māori of "4-Nui" ("Abundant" ordinal score in English) for this indicator is: "The ngahere floor is covered in dense leaf litter and debris, ferns, fungi and moss are abundant, the small shrubs and seedlings are diverse and abundant" (Reihana et al., 2023, p. 7). Cultural indicators in the study could also be scored with "1-Āna" ("Yes" in English ordinal score) or "0-Kaore" ("No"). For example, under the cultural theme of Rongoā, the Āna/Yes or Kaore/No indicators were: "Is this a known site for rongoā?" and "Are there weeds present?" (Reihana et al., 2023, p. 7). The framework was trialled at three sites within their rohe by a select group of seven

Ngāti Rangi ngā tāngata tiaki (environmental guardians) over three years. Selection criteria for the group included "…those who grew up using the forest for cultural purposes, or held cultural knowledge about practices that had been passed down to them, or who had worked within the forests" (Reihana et al., 2023, p. 4). These participants also completed the field data collection for the project.

Additionally, the researchers conducted a retrospective analysis, wherein nine kaumātua and ngā tāngata tiaki were interviewed using the same indicators and ordinal scores to evaluate forest health across the tribal rohe by decade, from 1930 to 2010. Interviewees were asked to identify their earliest memory of an indicator and assign a score. This allowed for kaumātua who could not participate in field environmental monitoring to provide data for the study and assess changes in the environment over time.

The five themes and indicators in the Me ora te ngāhere study reflect the interconnected nature of Te Taiao, encompassing the observation of several aspects of the environment as a whole, and importantly, the state of tangata, rather than only looking at vegetation, birds, or water monitoring separately, as often occurs in Western science-based environmental monitoring. The strengths of Reihana et al.'s environmental monitoring framework lie in its development, which involved working closely with members of Ngāti Rangi kaumātua and ngā tāngata tiaki, reflecting a strong relationship developed over time.

3.4 International Indigenous knowledge and participation in environmental monitoring for forest health

3.4.1 International studies up to 2020 (a review by Thompson et al., 2020)

The call for Indigenous people's involvement in environmental monitoring for forest health is not restricted to Aotearoa. Academic publications concerning Indigenous knowledge or Indigenous peoples' involvement in environmental monitoring have increased in number since the 1990s, which likely reflects an increase in monitoring projects of this kind (Thompson et al., 2020). A literature review by Thompson et al. (2020) examined international peer-reviewed publications of environmental monitoring projects that incorporated Indigenous knowledge or participation up to the end of 2019. The following section will provide a brief overview of the most successful and unsuccessful environmental monitoring initiatives included in the review. The authors identified 77 case studies of environmental monitoring initiatives that involved at least 82 unique Indigenous groups from more than 35 countries worldwide.

Most articles reviewed by Thompson et al. (2020) were from Arctic ecosystems (n = 37). Twenty-five reviewed studies were from freshwater ecosystems, 19 from coastal or marine ecosystems, 15 from grassland ecosystems, and two from desert ecosystems. Twelve articles focused on temperate forests and 12 on tropical forests. Three temperate forest articles in the review by Thompson et al. were from Aotearoa (Lyver et al., 2008, 2017, 2018) and will not be included in this international discussion. One article (Garcia & Lescuyer, 2008) was a review and was not ranked by Thompson et al. Of the 21 remaining temperate and tropical forest articles reviewed in the study, five were from South America (Bellfield et al., 2015; Constantino et al., 2008; Olivero et al., 2016; Oviedo & Bursztyn, 2017; Parry & Peres, 2015), five from North America (McKay & Johnson, 2017; Noss, 1990; Pacheco-Cobos et al., 2015; Parlee et al., 2010; Torres et al., 2014), three from Oceania (Brammer et al., 2016; Sheil et al., 2015; Ziembicki et al., 2013), one from Central and South America (Paneque-Gálvez et al., 2017), one from Asia (Setty et al., 2008), and two were comparative studies between cultural environmental monitoring initiatives in South America and Africa (Constantino et al., 2012; Cummings et al., 2017).

Thompson et al. (2020) assigned “weighted participation” scores (p. 3) to each study based on the “governance weight” (p. 3) attributed to Indigenous groups during each phase of monitoring activities. For example, if Indigenous participants were involved in independently making management decisions, the study would have a significantly higher weighted participation score than a study where an external advisory group led the project. The review provided an overview of the general trends of studies of this kind up to 2019. I was interested in how these studies supported or failed to support the Indigenous participants. Because an exhaustive review of all forest ecosystem initiatives reviewed by Thompson et al. (2020) would fall outside the scope of this thesis, I examined the highest and lowest-scoring studies in more detail below.

LEK (Local Ecological Knowledge) and tropical forest wildlife monitoring in the Amazona State, Brazil (Parry & Peres, 2015)

A study by Parry & Peres (2015) examined the monitoring of hunted tropical-forest wildlife over large areas in Amazonas state, Brazil, focusing on human population density, landform, and physical accessibility. The study received the lowest weighted participation score (24) by Thompson et al. (2020) and the lowest category of participation score (IP1) of forest ecosystem monitoring initiatives reviewed. The main objective of environmental monitoring in the study was identified as “biodiversity conservation” (Thompson et al., 2020, p. 10), rather than the more highly scored objectives seen in other studies, such as “enacting Indigenous

governance", "revitalising Indigenous knowledge", or "enhancing use of Indigenous knowledge in management"(Thompson et al., 2020, p. 10).

An IP1 category of participation score indicates that the participation of Indigenous groups in a study was low, being "Externally driven with Indigenous people as data collectors" (Thompson et al., 2020, p. 10). Indeed, the researchers interviewed Amazonian hunters (without identifying their specific tribal identities) located in 161 settlements along the Amazon River. The researchers conducted surveys lasting 10 to 21 days by boat with a "locally assembled crew" (Parry & Peres, 2015, p. 15), who had familiarity with the local people and the locations of human settlements along the river. The primary information gathering method was rapid interviews with rural hunters, rather than building and maintaining long-term relationships with Indigenous project participants, as is reflected in the following excerpt: "By asking Amazonian hunters to identify the nearest location in which they had directly or indirectly encountered a particular species, we were drawing on their LEK [local ecological knowledge], defined as the knowledge and insights acquired through extensive observation of an area or species" (Parry & Peres, 2015, p.15). The researchers asked the hunter participants to identify the location of the nearest place where species had been detected. These observations were compared with the distance to human settlements, using secondary data, to identify areas of species depletion. The researchers then used data analysis to determine the species with the most significant and the least minor areas of depletion within the Amazona state. The involvement of Indigenous people in the study seemed to be limited to interviews, which some may view as extractive.

It was unlikely that the researchers developed the methodology with input from the Indigenous people in the study area, as this process was not described in the article. The authors also did not specify whether the project's aims, methodology, or results were shared with the Indigenous participants throughout the different phases of the initiative. There was considerable discussion about the value of the study's results for informing conservation targets. However, there was limited discussion of its value to the Indigenous people from whom they obtained this knowledge. The authors suggested that these results could inform community-based monitoring programmes to raise awareness of overhunting in these areas. They briefly discussed the importance of "local stakeholders [being] active and equal participants in decision-making processes, rather than just agents of data collection" (Parry & Peres, 2015; p. 15); however, this was included in the discussion section and suggested as a recommended future action. Overall, the research by Parry & Peres (2015) missed opportunities to support the needs, desires, and empowerment of the Indigenous people from the Amazonas state.

Local environmental monitoring and control in Papua (Indonesian New Guinea) (Sheil et al., 2015)

In contrast, a study by Sheil et al. (2015), which reviewed environmental monitoring activities in three villages in the Mamberano-Foja region of Papua New Guinea, was the highest-scoring forest ecosystem study in the review by Thompson et al. (2020). The study was given a weighted participation score of 81 and a category of participation score of IP4. The IP4 score was given to studies where the Indigenous participants performed "Autonomous monitoring… with some external support" (Thompson et al., 2020, p. 10). The primary objective of the study by Sheil et al. (2015) was to assess the existing autonomous environmental monitoring systems employed by three Indigenous communities (Kay, Metaweja and Yoke) in the Mamberamo-Foja watershed. The authors highlighted the lack of studies in autonomous environmental monitoring by Indigenous people and the limited attention from Western-science-based researchers in the Mamberamo-Foja region, despite its high biodiversity values.

Over the course of several years, the authors collaborated with three Indigenous groups, building relationships through various environmental activities. These activities included the mapping of local and customary needs, perceptions, and practices, as well as examining resilience to and variability of climate change. The research team developed strong relationships with the Indigenous community over time and held collaborative information meetings with Indigenous community members, during which they described their research approach and objectives. They also asked for permission for their planned activities and asked participants to help inform their research. The researchers gathered information through interviews, participatory exercises (such as mapping the frequency of visits by hunters), discussions and field visits. Information was drafted and reviewed by community members and then printed and shared with the community after being gathered. The research team clearly communicated that the information would be disseminated more widely, and any information that was not to be shared would remain confidential.

Through their collaborative, transparent and empowering methodology, Sheil et al. were able to provide a review of existing autonomous environmental monitoring by the Kay, Metaweja and Yoke groups. They found that the Kay group has a system of patrilineal hereditary guardians, known as "Ijabait," at nine locations in their territory, whose primary role is to protect areas of river access to resource-rich areas by controlling local access for the clan. There were no known incidents of intruders passing into the territory unnoticed by the Ijabait, and those who were caught would be punished, usually through fines. Members of the Kay community kept stock of the resources available and adjusted their harvesting accordingly. The protection of territory was a shared responsibility among the Metaweja community members,

with particular emphasis on territorial boundaries. Intruder hunters from neighbouring territories' identities were shared with village leaders, and fines were demanded. This identification acted as a deterrent for future similar intrusions. Much like in the Kay community, members of the Metaweja knew when their resources were being depleted and would adjust their collecting practices until that species recovered. Fish is a valuable resource for the Yoke community, and most fishing areas are visible from the village. When commercial fishing companies were seen fishing in the Yoke territory, their boats were intercepted, and they were asked to leave. Members of the community stated that there were no shortages of resources, so adjusting harvesting or collecting practices was not necessary.

By establishing long-term relationships with Indigenous project participants to gather information on their autonomous environmental monitoring practices, Sheil et al. (2015) confirmed that these communities could autonomously and effectively protect their territories and natural resources through proven cultural practices. It was evident that empowering Indigenous project participants through active engagement was one of the primary research objectives. The study by Sheil et al. (2015) illustrates the efficacy of existing environmental monitoring practices among Indigenous peoples in their customary territories, which are often overlooked or downplayed in Western science-based monitoring.

3.4.2 International studies post-2020

I conducted a literature review using the Scopus database for articles using the search terms employed by Thompson et al. (2020): "Indigenous environmental monitoring", and "Indigenous resource monitoring", then ["environmental monitoring" OR "ecological monitoring" OR "biological monitoring" OR "resource monitoring"] AND ["Indigenous Knowledge" OR "Traditional Ecological Knowledge" OR "Aboriginal Knowledge"] for papers from January 2021 to May 2025. Next, I examined the results of this search for peer-reviewed articles related to forest ecosystems. I found a total of five relevant publications from 2021 to May 2025 from various parts of the world, including Brazil (Quaresma et al., 2025; Schmidt et al., 2021), Kenya (Kenrick et al., 2023), Indonesia (Susanto et al., 2024), and Asia and New Guinea (Crowe et al., 2023). Based on exploratory questions from the literature review from Thompson et al. (2020), I examined the level and nature of involvement by Indigenous community members during different phases of these studies. What follows is a summary of these findings.

Research objectives

Two of the five studies' (Kenrick et al., 2023; Quaresma et al., 2025) main research objectives seemed to be based firmly on the needs of the Indigenous people they worked with. A study

on land mapping of the Ogiek Indigenous people in Kenya, Africa, by Kenrick et al. (2023), was a direct result of the Ogiek participants' desire to map their lands for their use in response to environmental impacts from external forces and humanitarian rights violations, including the confiscation of Ogiek territorial lands. Rather than the project researchers declaring the primary research objective based on their own needs or desires, the research objective directly supported the needs of the Indigenous project partners.

The primary research objective of an environmental monitoring study by Quaresma et al. (2025) was also grounded in the needs of the Indigenous community with which the researchers worked. The initiative stemmed from a lack of trust in environmental monitoring reports supplied by the private commercial operators of a nearby hydropower plant. The Indigenous Juruna Yujá people sought to assess the environmental impact of constructing a dam that blocked the formerly seasonally flooded forest ecosystems within their tribal territory. The primary source of data analysed in the Quaresma et al. (2005) study was environmental monitoring data collected by the Indigenous community, rather than data collected by the researchers. By prioritising the use of this data, the authors demonstrated a strong foundation in supporting autonomous environmental monitoring programmes by the Juruna Yujá. Additionally, three of the study's lead authors are members of the Indigenous community, which most likely indicates their involvement in the development of research objectives.

In contrast, in their study on the distribution of Javanese edelweiss (*Anaphalis javanica*) in Indonesia, Susanto et al. (2023) made no mention of the involvement of Indigenous community members in developing research objectives. Crowe et al. (2023) collaborated at a higher level with partners and non-governmental organisations, rather than directly with Indigenous community members, to develop their research objectives for their study monitoring forest health in four locations across Asia and Papua New Guinea.

Project design, development and relationship building with Indigenous communities

Again, the level of participation by Indigenous community members was high in the studies by Kenrick et al. (2023) and Quaresma et al. (2025). In the Quaresma et al. (2025) study, the mapping project design and development prioritised data collected by Indigenous-led initiatives, which was the primary information source. Although the methods of relationship building were not explicitly stated in the paper by Quaresma et al. (2025), given that three of the paper's authors are Indigenous community members, one might expect that a relationship with the Indigenous community had already been established prior to the project's commencement.

The lead author of the study by Kenrick et al. (2025) is an anthropologist who has worked with the Ogiek Indigenous community for over ten years, and another author is a community leader, highlighting a well-established relationship with Indigenous community members. Relationship-building in the study took place over many years, in the form of "…reciprocal visits and joint facilitation of the community engagement processes and monitoring, such as community meetings, in-depth interviews and participatory mapping conducted by the Ogeik community" (Kenrick et al., 2023, p. 301). The project design and development were highly participatory; the data structure was developed in response to community needs, and the authors sought feedback from community members throughout all phases of the project.

A study from Brazil by Schmidt et al. (2021) examining forest management techniques based on Indigenous knowledge in areas impacted by shifting cultivation also demonstrated high levels of Indigenous participation in project design and development, as well as relationship building. The authors clearly described how they obtained consent from Indigenous leaders and community members for all activities. The project was co-constructed and adapted to meet the needs of the Indigenous community through workshops at Indigenous schools, community meetings and presentation of previous results to Indigenous community members.

In comparison, the environmental monitoring initiative by Susanto et al. (2023) did not describe any involvement of Indigenous communities in project design and development, and it was unclear whether and how relationships with the Indigenous community were established. However, it was stated that written informed consent was obtained from community members prior to participation. Project design and development in the Crowe et al. (2023) study primarily occurred at a higher level, between project researchers and project partners/NGOs, who determined the environmental monitoring frameworks. Similarly, the relationship with the Indigenous participants in the study was primarily managed by the NGO project partners, rather than the lead researchers.

Environmental monitoring and data analysis methods

All studies except one (Susanto et al., 2024) reported moderate to high levels of participation by Indigenous participants in environmental data collection and/or analysis. For example, in the study by Kenrick et al. (2023), Ogiek community members mapped resources and potential threats to the forest ecosystem using a digital mapping application. In an iterative process, community meetings were held to gather feedback on and tailor the mapping application to meet the needs of Indigenous community members based on this feedback. Participants in the study were also trained to synchronise and visualise data using the mapping application,

ensuring high Indigenous participation in data collection and analysis throughout all project phases.

Susanto et al. (2024) used data collected from 641 individual interviews in seven Tengger villages in Indonesia, along with questionnaires, as their primary source of information for identifying the threatened Javanese edelweiss. There was no apparent input from Indigenous community members regarding the questions asked in interviews and questionnaires, nor was there any input on how the data obtained was analysed. This illustrates the contrast between potential high and low levels of Indigenous participation in environmental monitoring initiatives that work with Indigenous communities.

Benefits of research outcomes to Indigenous participants

I found that the studies by Kenrick et al. (2023), Crowe et al. (2023), Quaresma et al. (2025), and Schmidt et al. (2021) yielded moderate to high benefits from these environmental monitoring initiatives. All three studies demonstrated the importance and value of Indigenous participation in environmental monitoring, based on the intergenerational knowledge held within these communities. For example, the study by Schmidt et al. (2021) supported the Indigenous view of the interconnectedness of forest ecosystems during regeneration following cyclical agricultural practices. The results of Crowe et al. (2023) demonstrate the value of over 14 years of existing monitoring data from Indigenous-organised and led monitoring groups of the endangered Hornbill species, which supports the argument for increased funding for Indigenous monitoring initiatives. Quaresma et al. (2025) identified inaccuracies in the environmental monitoring being carried out by private companies in the territory of the Indigenous participants in their research, as well as the impact of a hydroelectric power plant on formerly flooded forests. In contrast, the benefits of the research outcomes described by Susanto et al. (2023) were limited to those that the Western-science-based scientific conservation community could gain, rather than the potential benefits to the Indigenous community members themselves.

Environmental monitoring initiatives that aim to interweave Indigenous knowledge with Western scientific methods are growing internationally. It is essential to ensure that collaborative projects are based on existing Indigenous knowledge, with project aims driven by the needs and aspirations of Indigenous project partners, rather than those of Western-science-based researchers. Ideally, relationships with Indigenous community members should be built over extended periods, through an iterative process where project design and development are adjusted in response to revitalised knowledge, changing needs and/or newly expressed aspirations. The outcomes of these collaborative environmental monitoring

initiatives should also benefit Indigenous project partners, rather than just the researchers themselves. In this way, collaborative environmental monitoring initiatives can better support the self-determination and empowerment of Indigenous participants in the project, while developing more holistic environmental monitoring methodologies.

Chapter 4 Research Methods

4.1 Research objectives

Working in collaboration with Te Kawerau ā Maki Iwi Tiaki Trust representatives, the objectives of this research are as follows:

1. Investigate potential approaches to cultural health monitoring of Te Wao Nui ā Tiriwa using methods that support the mana and worldview of mana whenua, Te Kawerau ā Maki.
2. Compile environmental monitoring data from Auckland Council and Ark in the Park from within the research study area, specifically Te Piringa (the upper Waitākere River catchment) and create a summary and synthesis of this data.
3. Complete a review of publicly available literature of kōrero tuku iho (pūrākau, whakataukī and waiata) that are relevant to the forest ecosystem of Te Wao Nui ā Tiriwa.
4. Identify the priority values and environmental concerns of Te Kawerau ā Maki for the forest ecosystem of Te Wao Nui ā Tiriwa.
5. Develop and perform preliminary field tests in the study area, specifically Te Piringa (the upper Waitākere River catchment), of culturally appropriate and mana-uplifting environmental monitoring methods suitable for potential future assessment of forest health in Te Wao Nui ā Tiriwa.

4.2 Environmental framework co-creation process

The whanaungatanga, kōrero, hui, and research that formed the foundation for the environmental monitoring framework and tohu developed as part of this thesis were part of a process that occurred over several years (November 2021 to March 2025). An outline of the research process is detailed below:

1. Whakawhanaungatanga (establish, build and maintain relationships) early on and throughout the research process to discuss potential collaboration and seek permission to carry out this MSc thesis research in Te Wao Nui ā Tiriwa through initial kōrero with Te Kawerau Iwi Settlement Trust's Board Chair.
2. Identify project scope and objectives (the development of tohu-environmental indicators for forest health in Te Piringa/upper Waitākere River catchment) through hui in collaboration with appropriate Te Kawerau ā Maki Iwi Tiaki Trust representatives (Pou Tiaki and Kaimahi Taiao).

3. Working with Te Kawerau Iwi Tiaki Trust's Pou Tiaki, clarify and define the environmental and biodiversity priorities and values of Te Kawerau ā Maki for the forest ecosystem of Te Wao Nui ā Tiriwa.
4. Based on the desires of Te Kawerau Iwi Tiaki Trust representatives, provide a brief review and synthesis of current environmental monitoring programmes being carried out by Auckland Council and the Ark in the Park within the research study area.
5. Working with Te Kawerau Iwi Tiaki Trust Pou Tiaki and Kaimahi Taiao, discuss and briefly evaluate existing approaches to cultural environmental monitoring. If existing approaches are not suitable, develop a bespoke environmental monitoring framework aligned with Te Kawerau ā Maki's values, priorities and aspirations.
6. Acting upon the advice of Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao, complete a literature review and create a preliminary index of publicly available kōrero tuku iho (pūrākau, whakataukī, and waiata) that are relevant to the forest ecosystem of Te Wao Nui ā Tiriwa. These will inform the development of an environmental monitoring framework that supports the worldview of Te Kawerau ā Maki.
7. Create an observation and relationship-based framework for environmental forest monitoring in Te Piringa for potential future wider use in Te Wao Nui ā Tiriwa.
8. Perform preliminary data analysis and synthesis of collected field observation data.
9. Based on these results, propose a set of tohu (environmental indicators) for potential use in long-term environmental monitoring of forest health in Te Wao Nui ā Tiriwa.

4.3 Research study area: Te Piringa/upper Waitākere River catchment

A study encompassing the entirety of Te Wao Nui ā Tiriwa was beyond the scope of an MSc thesis. Therefore, in collaboration with representatives from Te Kawerau Iwi Tiaki Trust's Pou Tiaki, Te Piringa (the upper catchment of the Waitākere River) was selected as the geographic focus area (Figure 3, in yellow). The study area comprises a 2,130 ha area of steep terrain from 15 m (Hayward, 2009) to 409 m above sea level. The dominant landcover is indigenous forest and scrub (c. 92% of total area) with smaller areas of exotic pasture (6.3%), water reservoir (1%) and a retired quarry (0.7%) (Figure 11). A 9.43 km reach of the Waitākere River flows through the centre of the study area, and three significant tributaries join it along this reach (Cascade, Maioha, and Waitupu streams) (Figure 7). The catchments of the four waterways that comprise the study area cover approximately one-third of the c. 6,600 ha Waitākere River catchment. The Waitākere River has been known to Te Kawerau ā Maki by this name for generations (Murdoch, 1990). However, it was previously known as Te Awa Kōtuku, or the "River of the white heron's (*Ardea alba modesta*) plume" (Murdoch, 1990, p. 21), because of the resemblance of the nearby waterfall to that of the white heron.

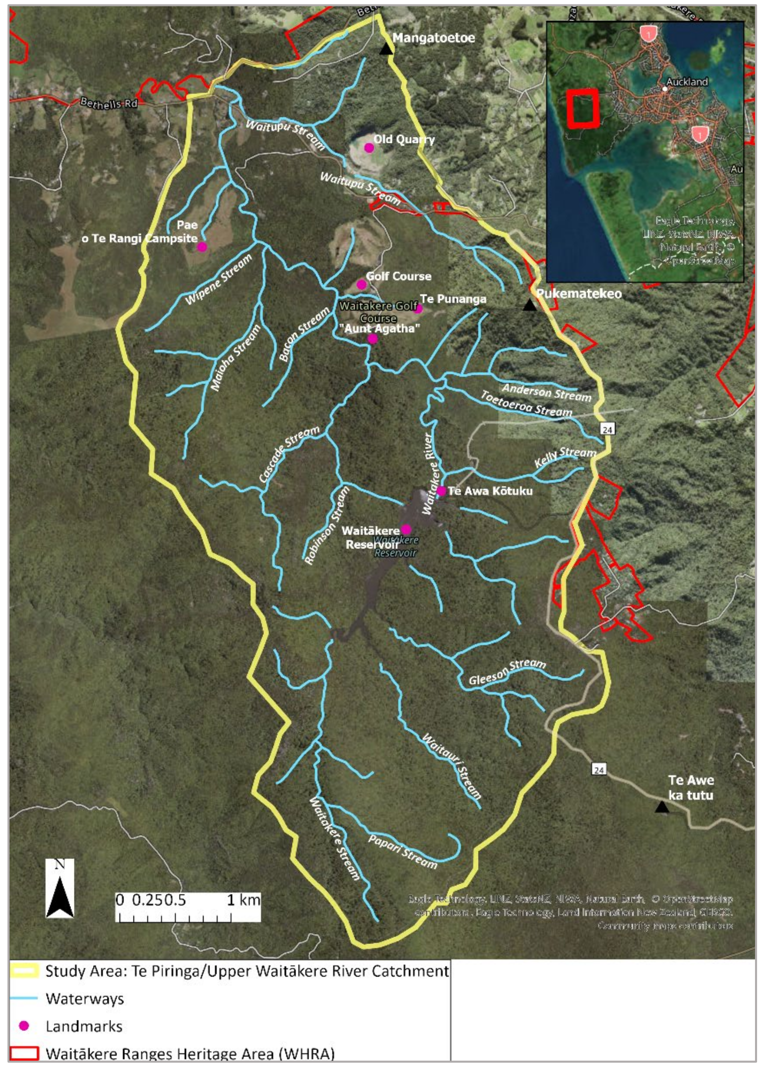


Figure 7

Waterways within the research study area: Te Piringa/the Upper Waitākere River catchment is shown highlighted with a yellow boundary. Map created in ArcGIS Pro by the author with data obtained from Auckland Council and LINZ.

The research study area is home to Te Piringa/Cascade Kauri Regional Park. The park covers approximately 92 percent of the entire study area. A c.200 ha patch of private land, with multiple (n > 30) private owners, lies in the northern tip of the catchment, near the junction of Bethells and Te Henga Roads. An extensive network of historical walking tracks criss-crosses the study area (Figure 8). However, use of many of these tracks has ceased in recent times due to: (1) the identification of kauri dieback within in Te Wao Nui ā Tiriwa in 2006 (Beever et al., 2009) and subsequent spread of the disease which led to a rāhui being placed on all public use of walking tracks; and (2) erosion and other track damage associated with the severe storms in early 2023 (Auckland Council, 2024). Several walking tracks were reopened in 2024 (Prasad, 2024, Figure 8) after the rāhui, implemented in 2017, was lifted to prevent the spread of kauri

dieback disease (Te Kawerau ā Maki, 2018). Pukematekeo, “the hill at the end of the range” (Manatū Taonga – Ministry for Culture and Heritage, 2024), is the highest point at the head of the Waitākere River valley (Murdoch, 1990).

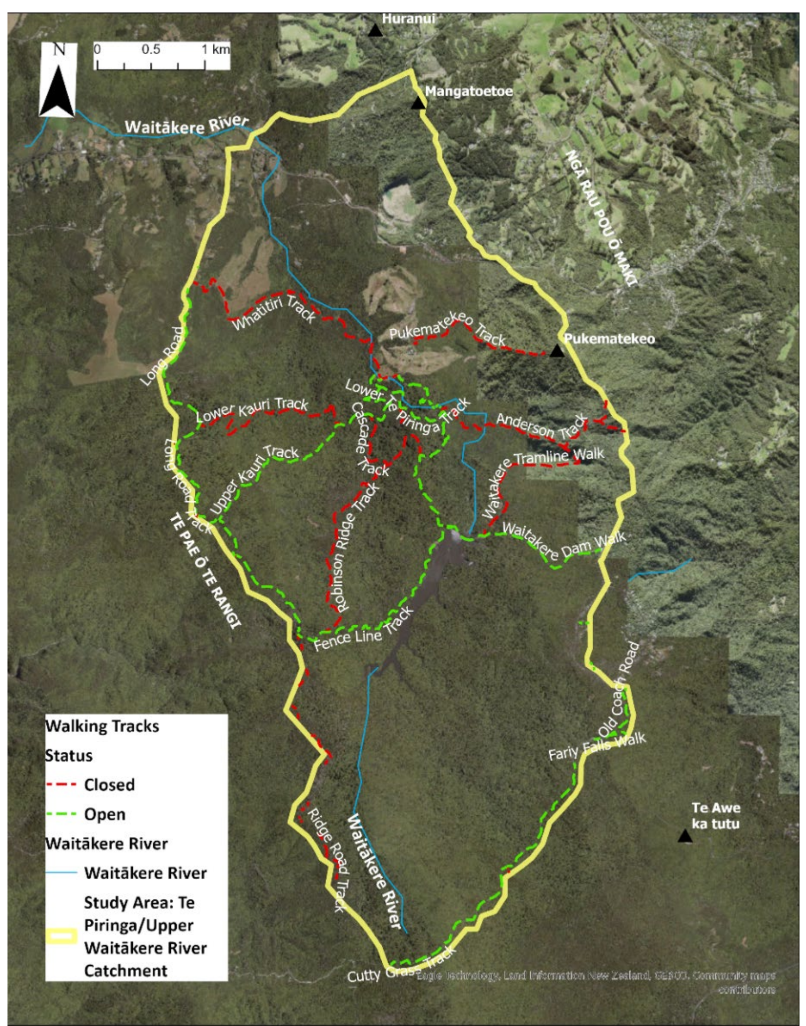


Figure 8

Map showing open and closed walking tracks (due to kauri dieback disease and storm damage) within the research study area of interest. Map created by the author in ArcGIS Pro Software using data provided by Auckland Council.

Almost the entire study area (c. 89%) lies within the boundary of Ark in the Park (ARK). ARK is a conservation project in the Waitākere Ranges, a partnership between Forest & Bird and Auckland Council, supported by Te Kawerau ā Maki. It includes intensive predator control, with rat, stoat, and weasel traps, alongside a network of bait stations. ARK has been in operation since 1999 (Ark in the Park, n.d.-a).

4.4 Iwi engagement: The Māori Engagement Process

I consulted the Māori Engagement Process (Figure 9) developed by Repia, Smith & Perrott from AUT's Research Innovation Office in 2018 as a general guide when working with representatives of mana whenua, Te Kawerau ā Maki. This project was co-designed and developed in collaboration with representatives from Te Kawerau Iwi Tiaki Trust through a series of hui (gatherings) and kōrero – a methodology that aligns with Māori Ethical Principles, such as Te Ara Tika (Hudson et al., 2010).

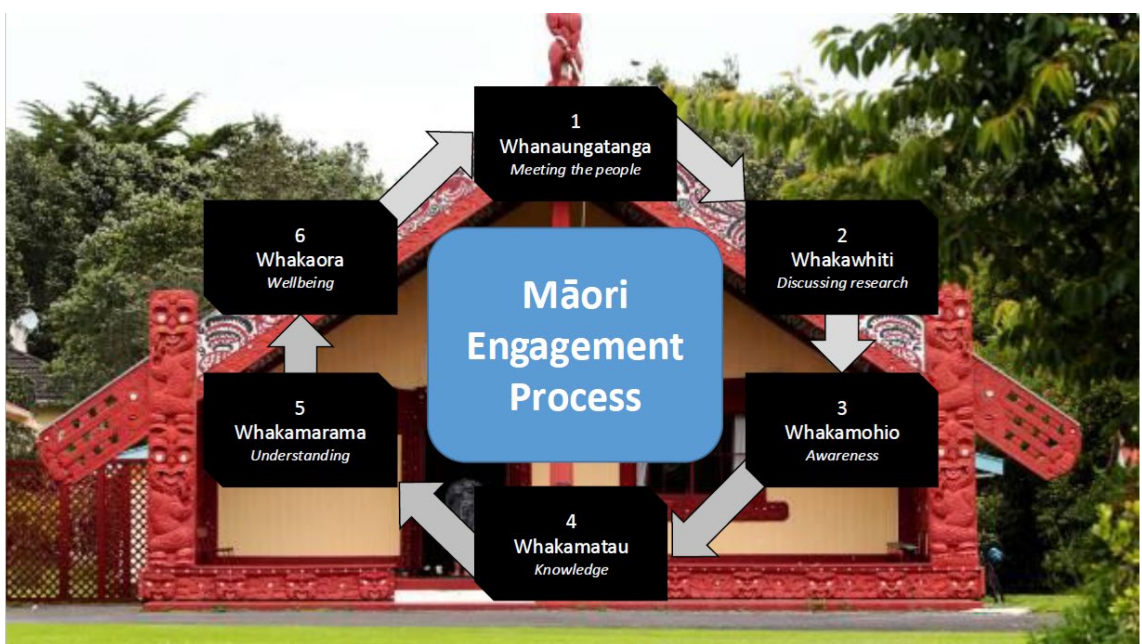


Figure 9

The Māori Engagement Process was developed by Repia, Smith and Perrot from AUT's Research Innovation Office in 2018. This diagram illustrates the six steps of effective Māori Engagement, as outlined in this process: 1. Whanaungatanga: Meeting the people; 2. Whakawhiti: Discussing research; 3. Whakamohio: Awareness; 4. Whakamatau: Knowledge; 5. Whakamarama: Understanding; 6. Whakaora: Wellbeing. This model was designed to be deeply rooted in Māori methodologies that align with Māori ethical principles.

4.4.1 Whanaungatanga: Meeting the People

Whanaungatanga describes the relationship, kinship and interconnectedness of all things (Moorfield, 2011), which is reflected in whakapapa (Mead, 2003; Royal, 1998). To do this research, developing a strong relationship through whanaungatanga with representatives from Te Kawerau Iwi Tiaki Trust was imperative. It was essential for the research partners to know who I am: not just as an Environmental Science student at AUT, but also as a mother with genealogical connections to Moana Nui a Kiwa and Tauiwi – a non-Māori guest on Māori land. I

knew that whanaungatanga was a process that could not be rushed, so I first contacted representatives from Te Kawerau ā Maki early in my research in November 2021. Our relationship was further strengthened through a series of hui whanaungatanga held from November 2021 to February 2024 (See Appendix C for a list of hui and hīkoi – walks during this research), which served as the primary method of collaboration, co-creation and knowledge sharing for this project. During these hui, Te Kawerau Iwi Tiaki Trust representatives had the opportunity to get to know me better and meet my research supervision team, and I was able to do the same. I also familiarised myself with Te Wao Nui ā Tiriwa and its non-human inhabitants who reside there through field visits with the ngahere.

4.4.2 Whakawhiti: Discussing Research

Definitions of whakawhiti include transferring, crossing over, or conveying (Moorfield, 2011). Following the preliminary whanaungatanga phase, and after developing a relationship with Te Kawerau Iwi Tiaki Trust Pou Tiaki and Kaimai Taiao, more details of the planned collaborative research were discussed through a series of hui from February to June 2024 (Appendix C). These hui focused on kōrero surrounding Te Kawerau ā Maki's values, aspirations, preferences, and concerns, which were used to inform the development of an environmental monitoring framework within Te Piringa. We also discussed potential participants with knowledge of the forest ecosystems of Te Wao Nui ā Tiriwa, as well as the project design and methods. The hui format was chosen as the preferred method for collaborative information gathering with Te Kawerau Iwi Tiaki Trust representatives, myself, and project supervisors. Hui Information Sheets were distributed along with Hui Consent Forms (Appendix B) for signature during this phase of engagement with Te Kawerau Iwi Tiaki Trust representatives.

4.4.3 Whakamohio: Awareness

Whakamohio means "to inform, notify, acquaint, teach, inform" (Moorfield, 2011, p. 249). Good communication was maintained with Te Kawerau Iwi Tiaki Trust representatives to keep them updated as the research progressed. When audio recordings of the hui were transcribed and thematically analysed, summaries were shared with those present at the hui so that all would understand the knowledge developed after the hui. Several environmental monitoring activities are currently underway in the research study area by organisations such as Auckland Council and Ark in the Park. Te Kawerau Iwi Tiaki Trust representatives expressed they would like to see and understand the data collected in their rohe. I made it one of the project's goals to clarify current environmental monitoring activities within the geographic area of interest and to share this information with Te Kawerau ā Maki.

4.4.4 Whakamatau: Knowledge

Whakamatau means to test, examine, or try (Moorfield, 2011). At hui from April 2023 to June 2024 (Appendix C) with Te Kawerau Iwi Tiaki Trust representatives, we reviewed frameworks, methodologies and concepts from previous studies on cultural indicators in environmental monitoring in Aotearoa (Section 4.7.3) to determine if any of the existing frameworks might serve as a suitable starting point for developing tohu for Te Kawerau ā Maki. Before choosing an environmental monitoring framework and data collection method, we visited the ngahere with two Kaimahi Taiao from Te Kawerau Iwi Tiaki Trust for two preliminary site visits in March and April 2024. During these preliminary visits, we visited Aunt Agatha, a rākau tupuna (ancestor tree) who has succumbed to kauri dieback disease and walked a portion of the Upper Kauri Track to familiarise ourselves with the plant and animal species present in Te Wao Nui ā Tiriwa and with one another.

4.4.5 Whakamarama: Understanding

Whakamarama means to explain, clarify, or illuminate (Moorfield, 2011). Upon completion of this thesis, a summary of research findings will be provided to Te Kawerau ā Maki along with the thesis in its entirety. Additionally, I will present my findings in person to Te Kawerau ā Maki Iwi Tiaki Trust representatives and other interested parties (kaumātua, iwi members, etc.) in the interest of knowledge sharing. A draft of this thesis was provided to participants, who were given the opportunity to provide feedback before submission. Some cultural indicators identified through this research may be considered sensitive and will remain confidential. They will be provided in a confidential document to be shared in a way the iwi deems appropriate. General indicators and information to be shared with larger audiences will be included in the final version of this thesis and are subject to iwi approval.

4.4.6 Whakaora: Wellbeing

Whakaora means to restore, heal, or save (Moorfield, 2011). At the heart of this research is the primary purpose of supporting and strengthening the relationship between the members of Te Kawerau ā Maki and Te Wao Nui ā Tiriwa. Numerous studies have shown the benefits of people's connections to the ngahere (Grilli & Sacchelli, 2020; Roberts et al., 2015). The displacement of Te Kawerau ā Maki iwi members from their ancestral lands was raised as a significant concern by the Pou Tiaki during the hui for this project. There is potential for iwi members to reconnect with Te Wao Nui ā Tiriwa through the creation of an environmental monitoring framework and method that aligns with their worldview, values and aspirations. Reconnecting members of Te Kawerau ā Maki to the ngahere after generations of

disconnection and resettlement due to colonisation can be a vital tool in supporting the health and wellbeing of iwi members.

4.5 Whanaungatanga and whakapapa centred research method

The research methods for this project have been relationship-driven, and relationships lie at the heart of whanaungatanga (Gillies et al., 2007). The primary information-gathering method for this thesis has been through a series of hui and kōrero with representatives from Te Kawerau Iwi Tiaki Trust, my supervisors, and myself. Later, during the data collection portion of this project, through hīkoi in the field (Table 6 and Appendix C), this whanaungatanga continued as the research team (comprising field assistants, project supervisors, and myself) built stronger relationships with the non-human inhabitants of Te Wao Nui ā Tiriwa.

A significant aspect of relationships is whakapapa, which was a substantial component of this research. “As interdependent and complementary components woven together in the natural world, whakapapa is the sacred thread that connects humans deeply amongst all other species, including time, space and the spiritual and cosmic realms” (Johnson, 2024, p. 1). Being aware of the whakapapa of the research team, Te Kawerau Iwi Tiaki representatives, other project participants, and Te Taiao was an important element in whanaungatanga. Project partners needed to be aware of the backgrounds of our research team to ensure their safety and that of our team. Our first project design hui was held kanohi ki kanohi (face to face) so that Te Kawerau ā Maki Representatives could understand who the research team was, including where we came from and our experiences. During the field-based data collection portion of this project, I needed to familiarise myself with the whakapapa of Te Wao Nui ā Tiriwa – understanding the genealogical connections of the ngahere and its current and past inhabitants. Although I do not whakapapa to Te Wao Nui ā Tiriwa, I made my ancestral connections to Te Moana Nui a Kiwa (The Great Ocean of Kiwa; Pacific Ocean) known to the ngahere through oli (chant) in ʻōlelo Hawaiʻi (Hawaiian language). The research methods described below were based on whanaungatanga as a foundational element.

4.6 Identification of current environmental monitoring programmes within Te Wao Nui ā Tiriwa

Existing monitoring within the project study area was first discussed at a hui in June 2023 (Appendix C). Although monitoring initiatives have been led in the area by organisations like Auckland Council and Ark in the Park, data and details from these projects have not been actively shared with Te Kawerau ā Maki. Representatives from Te Kawerau ā Maki expressed a desire to have increased awareness of monitoring occurring within the study area. In response

to this need, I compiled data from existing monitoring being carried out by Auckland Council and Ark in the Park within the study area as part of this thesis research. To date, a synthesis and spatial evaluation of environmental monitoring data from different groups in Te Wao Nui ā Tiriwa have not been compiled, so this fills a research need for Te Kawerau ā Maki.

4.6.1 Compilation of current environmental monitoring data within study area

The data analysed for this thesis is only a small portion of what is available. Environmental monitoring is being carried out by several organisations in the Waitākere Ranges Heritage area. However, due to the constraints of an MSc thesis, two of the most extensive monitoring programmes will be the focus of this research.

Auckland Council monitoring plots

In May 2023, I obtained environmental monitoring data from Auckland Council through email and online information requests in the form of Excel spreadsheets (See Appendix D for location and other metadata). I entered the GPS coordinates of Council monitoring plots (vegetation and soil monitoring) into ArcGIS Pro Software (*ArcGIS Pro*, 2021), then clipped these points to the area of interest for this research (Te Piringa/upper Waitākere River catchment) to create a geospatial map of Auckland Council monitoring plot locations. I analysed the data in ArcGIS to determine when vegetation monitoring last occurred and created a geospatial map representing this.

Vegetation basal area and species abundance analysis

Tree stem diameter measures from Auckland Council 20m x 20m forest monitoring plots within Ark in the Park were analysed in Excel to provide a general picture of forest composition across the study area, including the relative dominance of canopy trees and understorey plants. This data included the diameter at 1.35 m above the ground (diameter at breast height, DBH) of all woody species within each 20 m x 20 m plot and sapling counts for the same plots. Saplings were assigned an indicative DBH of 1.25 cm for combining with the tree stems. Total basal area was summed by species to evaluate the relative biomass (basal area, m^2 / ha) of different plant species within the research study area (See Appendix E for a sample page from this dataset). This dataset was used to describe the general vegetation pattern and, combined with phenology information, to examine changes in flower and fruit resources throughout the year.

The Ark in the Park predator control programmes

Ark in the Park traplines

In May 2023, I obtained the Ark in the Park trapline GPS coordinates through email in the form of Excel spreadsheets (See Appendix F for a sample from this dataset). I entered these coordinates into ArcGIS Pro Software (ArcGIS Pro, 2021), then I clipped the points to the research study area to create a geospatial map of the Ark in the Park monitoring plot locations. I downloaded trap count data from CatchIT! (*CatchIT*, 2023) and used this data to create a summary of the trapping history, including the total number of catches by species, from 2021 to 2024 in RStudio (RStudio Team, 2020).

Ark in the Park bait stations

Rats and mice are controlled using poison through a network of bait stations, set up on a 50 m x 100 m grid across the study area. Bait is set at least twice annually, depending on bait uptake levels and rat monitoring data. Bait uptake is recorded by Ark in the Park volunteers, and the type of poison used, as well as the locations where the poison is placed during the next round of baiting, is modified based on this information (Ark in the Park, n.d.-b). Ark in the Park provided bait take data from January 2020 to November 2024–just under five years (See Appendix G for a sample page from this dataset). Bait take was recorded by station from the approximately 4,800 stations within the intensive control area, although the exact number of stations varied across the study period. Stations were grouped into blocks by the Ark in the Park staff based on their physical location. Bait take was recorded as an index from 1 (no bait take) to 8 (all bait taken). This was done on the basis of at least two observations of bait take, scored according to the system seen in Table 4. These raw data were analysed to assess any changes in bait take over the 2020-2024 period. A total of nine different measurement periods were available for analysis.

Table 4

Bait take index used by the Ark in the Park in network of bait stations throughout Te Wao Nui ā Tiriwa (including the research study area). Scores range from 1 (no bait taken) to 8 (all bait taken). The columns indicate bait uptake upon first observation, and the rows indicate bait uptake upon second observation, and a socre assigned based on this index.

Bait Condition	Untouched	Nibbled	<1/2 gone	> ½ gone	All gone
Untouched	1	2	3	4	5
Nibbled	2	3	3	5	5
<1/2 gone	3	3	4	5	6
>1/2 gone	4	4	5	6	7
All gone	5	5	6	7	8

4.6.2 Phenological analysis

Flowering and fruiting times for vascular plants within the study area

A full vascular plant species list for the area was obtained by combining the list of plant species from Auckland Council 20 m x 20 m forest plots within the Waitākere River catchment with a species list from a plant survey undertaken by the Ark in the Park staff and volunteers. The flowering and fruiting times of these plants were sourced from the NZPCN (New Zealand Plant Conservation Network) website. Where this data was not available, flowering and fruiting times were sourced from the NZ Plants online database. If neither of these sources provided phenology information, flowering and fruiting times were obtained from Regional Council technical reports and restoration guides. Each species was assigned a number according to the month of the Gregorian calendar (1 – 12) in which flowering and fruiting occurred (See Appendix H for a sample page from this dataset). These data were summarised to determine which times of the year had the highest diversity of flowering and 'fruiting' plants. Fruiting included the production of berries and smaller, wind-dispersed seeds. Basal area data from 20 m x 20 m plots was also used to quantify which plant species were most dominant in the vegetation, and this information was cross-referenced with the flowering and fruiting times of these dominant species to provide a general picture of the changes in fruit and flower production throughout the year.

4.7 Development of monitoring framework

4.7.1 Hui with Te Kawerau Iwi Tiaki representatives

This process began with a smaller project design hui (April 2023) with Te Kawerau Iwi Tiaki representatives before opening up to a larger group hui, which also included Riki Bennett, the Auckland Council Park Ranger responsible for Te Piringa/Cascade Kauri Regional Park (June 2023) (Appendix C). Project planning hui continued through a hui in February 2024, before our first site visit to Te Wao Nui ā Tiriwa in March 2024. During these hui, we discussed what type of framework Te Kawerau Iwi Tiaki Trust representatives would prefer for their monitoring methodology. Two frameworks previously used by the Te Kawerau Iwi Tiaki's Pou Tiaki for non-environmental projects were shared as potential ways to set some ideas in motion. These included a Māori Cultural Heritage Asset Monitoring framework for Māori heritage sites developed by the Pou Tiaki in a former role with Auckland Council, and a thematic framework developed for an infrastructure project within the iwi's area of interest in North Auckland.

These two documents, along with insights shared during hui, provided a good foundational understanding of potential underlying themes and frameworks that might be useful for developing an environmental monitoring framework for forest health in Te Wao Nui ā Tiriwa.

4.7.2 Identification of Te Kawerau ā Maki key values concepts & priority environmental and biodiversity concerns

According to Harmsworth and Tipa (2006), tangata whenua values form the basis of sustainable resource management, decision-making, and the development of monitoring tools. Based on this recommendation and as shown in similar studies (Rewi, 2022; Robb, 2014; Walker, 2019), I collaborated with Te Kawerau ā Maki to identify values specific to their iwi, which helped inform potential monitoring frameworks. Due to time constraints, it was agreed that I review existing iwi literature to identify these values, which the Pou Tiaki of Te Kawerau Iwi Tiaki Trust subsequently confirmed (Te Kawerau Iwi Tiaki Trust Pou Tiaki, personal communication, 28 March 2024). I also examined existing iwi documents to identify priority environmental concerns, which were reviewed and confirmed by Te Kawerau Iwi Tiaki Trust's Pou Tiaki in March of 2024.

4.7.3 Evaluation of previous studies

After a literature review, I found that although there is a well-developed recent history of collaboration with tangata whenua in freshwater environmental monitoring in Aotearoa, most terrestrial environmental monitoring programmes are rarely developed in collaboration with mana whenua. However, I did come across a few previous studies focused on evaluating forest health in collaboration with tangata whenua that might have provided a jumping off point for creating Te Kawerau Iwi-specific cultural indicators for environmental monitoring in Te Wao Nui ā Tiriwa (Table 5). Based on comments from Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao surrounding the importance of all species as an interconnected family in the kauri forest ecosystem, a framework focusing on a single "taonga species", like the one developed by Lyver et al. (2008), did not seem appropriate for this thesis research. Some frameworks and indicators from previous studies (Robb et al., 2016; Walker, 2019), and literature surrounding Māori environmental monitoring and collaboration methods (Harmsworth, 2001; Jefferies & Kennedy, 2009) were briefly explored during a hui in June 2024 with Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao and Riki Bennett, Auckland Council Ranger for Te Piringa. A potential framework and study by Reihana et al. (2023) (See Section 3.3.5 of this thesis) was not discussed, as it had not been published by the time we were well into our series of hui.

Table 5

Examples of cultural indicators for forest health developed in previous studies throughout Aotearoa were derived from a literature review on the subject.

Example Indicator(s)	Research Method	Reference	Relevance to This Research
The timing and number of audible cues from kererū (*Hemiphaga novaeseelandiae*) in the forest canopy signify the timing of the harvest season and population abundance.	One of the earlier studies used cultural indicators in Aotearoa to determine the presence of the taonga species kererū in Te Urewera Forest. Single-species study.	(Lyver et al., 2008)	Could potentially focus on 1-2 taonga species within Te Wao Nui ā Tiriwa.
Tinana oranga: Are there signs of Kauri (*Agathis Australis*) Dieback (Basal lesions, defoliation)? **Whanaungatanga***:* Are there seeds, fruit, seedlings?	Building on (Shortland, 2011), this research provides a more detailed view of cultural health indicators included in the 2011 report.	(Chetham & Shortland, 2013)	As Kauri Dieback is a significant issue within Te Wao Nui ā Tiriwa, this approach may be utilised (in whole or part) by Te Kawerau ā Maki.
See (Shortland, 2011) and (Chetham & Shortland, 2013)	Suggested monitoring tools developed in (Shortland, 2011) for potential future use as part of a larger Te Uri o Hau biodiversity monitoring framework in the kauri forest of Pukeareinga maunga, Ōtamatea Marae in Kaipara. However, these were not implemented because of rāhui to prevent the spread of kauri dieback disease.	(Robb et al., 2016)	Identified for potential use in the kauri forest ecosystem as found in Te Wao Nui ā Tiriwa.
The abundance of medicinal plants (rongoā) in the forest. Amount of possum signs (possum dung, bite marks and scratchings on trees) in the forest.	80 interviews with 55 forest users within the Tuawhenua tribal group to identify forest health indicators in Te Urewera.	(Lyver et al., 2017	Adjustments may be needed to the metrics for assessing indicators to obtain objective and quantitative data.
Tangaroa: Water quality **Tāne:** Emergent trees **Tāwhirimātea:** Smell of forest **Tū:** Manaakitanga (ability to provide for guests) **Rongo:** Rongoa/medicinal plants **Haumie:** Mahinga kai levels **Ruaūmoku:** Erosion **Mauri-Wairua:** Feeling in the puku (overall feeling of the mauri and wairua of the forest)	In this PhD thesis, the author worked with mana whenua in Nelson and Motueka to develop a set of cultural indicators within an Atua framework. Kaitiaki rate each tohu ngahere (forest indicator) from -2 to +2, with unique metrics based on tohu. This framework continues to be used by kaitiaki in environmental monitoring.	(Walker, 2019)	The study could be of interest to Te Kawerau ā Maki. The Tū theme, including indicators of rangatiratanga, kaitiakitanga, and manaakitanga, is unique to the study and complementary in supporting tino rangatiratanga of mana whenua.

4.7.4 Thematic analysis of hui audio recordings

Due to the qualitative nature and large amount of information gathered during hui with Te Kawerau Iwi Tiaki Trust representatives, I found that thematic analysis (Gibson & Brown, 2009) would be an appropriate method for identifying recurring themes from these hui. According to Gibson & Brown (2009), the three aims of thematic analysis include examining commonality, differences and relationships between different points that arise. It is essential to address the limitations of thematic analysis – one being that through the analysis of transcriptions and coding according to general themes, this may omit “the particularities of the cases being examined” (p. 128) or the specific experiences of individuals. However, the benefits of analysing themes arising from data in this way can add value to research, by “creating new readings and renderings of that data” (p. 129). Additionally, thematic analysis is a robust method for identifying overall themes from large amounts of qualitative data, such as those gathered during these hui. Meeting notes and audio recordings from hui (where available) were transcribed, coded and thematically analysed. Sample pages of hui thematic analysis coding sheets for both audio and non-audio recorded hui can be found in Appendix I and Appendix J.

4.7.5 Identification of relevant kōrero tuku iho

Kōrero tuku iho was identified by Te Kawerau Iwi Tiaki Trust’s Kaimahi Taiao as a preferred literature review source to inform the creation of tohu for environmental monitoring at a hui in June 2024. As Wehi et al. (2009) argue, properly analysing ancestral knowledge found in kōrero tuku iho requires: “Specialist knowledge of context, including for example, knowledge of the characters and biases of the ethnographers, [to assist in the] interpretation of TEK, and other linguistic and cultural expertise helps clarify these (at times) subtle issues” (p. 202). Regrettably, I was unable to secure this type of assistance in interpreting kōrero tuku iho for this thesis. I am not fluent in te reo Māori, so texts that had not yet been translated into English were not accessible to me. For these reasons, it is highly likely that many meanings of the kōrero tuku iho included in this literature review were lost in translation.

Recognising these limitations, I searched published sources of kōrero tuku iho (including pūrākau, waiata, and whakataukī) for terms related to Te Taiao and the history of Te Kawerau ā Maki. Search terms included the names of notable people and places in Te Kawerau ā Maki iwi history (Appendix K), maramataka-related terms (Appendix L), and plant and animal species associated with kauri, podocarp, broadleaved forest ecosystems (Appendix M and Appendix N). The knowledge held in kōrero tuku iho is vast, and a comprehensive review of kōrero tuku iho concerning tribal history, places, genealogies and maramataka would have been beyond

the scope of this project. Thus, I conducted a general review of the above subjects, with a more in-depth review focusing on the flora and fauna species found in Te Wao Nui ā Tiriwa. I entered the collected kōrero tuku iho into an Excel spreadsheet database for reference by Te Kawerau ā Maki. While not a comprehensive literature review of all related subjects, it serves as a good starting point for preparing for environmental monitoring fieldwork. A more detailed discussion of the kōrero tuku iho literature review performed for this research is summarised in the following sections.

Pūrākau

The primary resources I referred to for pūrākau were written by members of Te Kawerau ā Maki themselves (i.e. *He kohikohi korero mo Hikurangi*: *A collection of stories about Hikurangi*[2]) (Taua, 2009)), or by trusted kaumātua and experts in the history of the iwi (i.e. *Ngā tohu o Waitakere* (*The signs/symbols of Waitākere*) (Murdoch, 1990)). I also searched for relevant pūrākau in *Nga iwi o Tainui* (Jones, 2004), due to Te Kawerau ā Maki Iwi's ancestral ties to the Tainui waka. Pei Te Hurinui Jones's writings were recommended by a guest at a June 2024 hui with Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao and Riki Bennett, Auckland Council Park Ranger. Another resource I used for pūrākau was the short book: *The Māori history and legends of the Waitakere Ranges* (Diamond & Hayward, 1979). The Diamond and Hayward book was based on pūrākau collected by George Graham, an early ethnographer in the area. Other pūrākau collected by early ethnographers that might be related to forest ecosystems and/or the tribal history of Te Kawerau ā Maki include works by Best and Reed (Best, 1942; Reed, 1946). Search terms included the names of notable people and places in Te Kawerau ā Maki iwi history (Appendix K), maramataka-related terminology (Appendix L), as well as plant and animal species related to kauri, podocarp, broadleaved forest ecosystems (Appendix M and Appendix N). I reviewed these with a critical lens due to issues with pūrākau collected during the early days of colonisation (See Section 2.4.1 of this thesis). Due to time constraints, I conducted a brief literature review of pūrākau. Relevant pūrākau from this literature review were referenced and entered into an Excel-based database to add to mātauranga-Te Kawerau ā Maki. This database may be built upon in the future.

Whakataukī

"[Whakataukī] are not mere subjects found in books; kōrero tuku iho transcend mere textual subjects. They embody narratives directly witnessed and heard from living and deceased individuals, as well as the woven universe of more-than-human ancestors, making their presence tangible and familiar" (Johnson, 2024, p. 2). I searched for relevant whakataukī for

[2] Translation is author's own.

this literature review in two primary sources: *Ngā Pēpeha a Ngā Tīpuna* (Mead & Grove, 2001) and *The Raupō Book of Māori Proverbs: Te Kohikohinga Whakataukī* (Brougham & Reed, 1963). These sources were recommended at the June 2024 hui with Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao and are considered well-respected sources of whakataukī in Aotearoa. Like the Literature Review surrounding pūrākau, I conducted a more general search for names of notable people and places in Te Kawerau ā Maki iwi history (Appendix K), as well as terminology related to the maramataka (Appendix L). I conducted a more detailed review of plant and animal species related to kauri, podocarp, and broadleaved forest ecosystems (Appendix M and Appendix N). Relevant whakataukī from this literature review were referenced and entered into an Excel-based database to add to mātauranga-Te Kawerau ā Maki.

Ngā Mōteatea

I examined the four volumes of *Ngā Mōteatea* (Ngata, 2004a, 2005, 2006, 2007) for relevant chants, laments, poems and waiata for this literature review. Again, I did a more generalised search of *Ngā Mōteatea* for notable people and places in Te Kawerau ā Maki's history (See Appendix K for a list of search terms), and terminology related to the maramataka (See Appendix L for search terms). I conducted a more in-depth review of plant and animal species associated with kauri, podocarp, and broadleaved forest ecosystems, such as those found in Te Wao Nui ā Tiriwa (See Appendix M and Appendix N for a list of search terms). As the nearly 500 compositions contained in *Ngā Mōteatea* are organised broadly by type and group, rather than geographic region or content, I used *A name and word index to Ngā Mōteatea* to search for terms in te reo Māori (Harlow & Thornton, 1986). Relevant compositions from this literature review were referenced and entered into an Excel-based database to add to mātauranga-Te Kawerau ā Maki.

4.7.6 Finalisation of monitoring approach

I developed an environmental monitoring framework informed by collaboration with representatives from Te Kawerau Iwi Tiaki Trust, which involved five hui and two initial site visits to Te Wao Nui ā Tiriwa (Appendix C). After months of discussion, the June 2024 hui yielded many specific insights that significantly influenced the development of the framework. Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao agreed with comments shared by an anonymous participant that existing collaborative environmental monitoring frameworks we reviewed would likely be insufficient as a foundation for this research. As a result of this discussion, I prioritised the development of a bespoke, iwi-specific framework that was co-created through a relationship and direct communication with Te Wao Nui ā Tiriwa and with a foundation in

kōrero tuku iho. I felt that this tailored approach to framework development better supported the aspirations and concerns of Te Kawerau Iwi Tiaki Trust representatives and felt more appropriate.

Insights shared by an anonymous participant during the June 2024 hui also influenced the timing of field observations as part of this monitoring framework. I was advised to enter the ngahere during the pre-dawn and early morning hours, when Te Taiao was transitioning from Te Ao Pō to Te Ao Mārama. After doing this, the forest would tell me what it wanted me to know. The special nature of the dawn hours is described in the following excerpt from Manuka Henare (2001):

> The dawn, whei ao, refers to the unfolding of the world of light, whereas daylight, ao mārama, refers to the world of light itself, which is a way of referring to a state of enlightenment. Whei ao is a transitional or liminal state between darkness and the world of light… (p. 201).

In te ao Māori, the time around sunrise can be a powerful transitional time, where understanding and knowledge can be revealed, and was presumably the reason why this was the recommended time for me to visit the ngahere and make observations.

4.8 Development of tohu

E kore e taea e te kupu	There are no words
te whakapuaki	to express
i te mahana o te rā,	the warmth of the sun,
te mākuku o te ua,	the drizzle of the rain,
me toe marietanga o te hau.	the peaceful wind.
Mā te kite,	With sight,
mā te rongo,	with sound,
mā te whakaaro	with thoughts,
ka tau te kupu.	Words appear.

I used the observational approach recommended to me by research partners to communicate directly *with* the ngahere, rather than *about* it. I was advised to enter the ngahere (guided by my ancestors and grounded in knowledge from kōrero tuku iho) and introduce myself, particularly as Kanaka Maoli, in so doing, honouring deep ancestral connections from Moana Nui a Kiwa. Once there, I would hīkoi and make any observations of what I might hear, smell, feel and intuitively sense as I walked through the ngahere. By building a deeper connection with Te Wao Nui ā Tiriwa, grounded in mātauranga from my literature review of kōrero tuku iho, the forest would reveal to me what I needed to know, and I would be better able to assess the state of health of the ngahere. This communication with Te Taiao method is similar to one used by Johnson (2024) in their "Te Awa Tupua" framework:

> Considering Te Awa Tupua as the primary ancestor of Whanganui Iwi, the methodology devised for this whakapapa-based research is ‘led by the Awa’ through conversations with it…Four whakataukī are operationalised as a methodology, a flexible research strategy that can be viewed more as a philosophical guide than a rigid methodological tool, underpinned by a variety of Whanganui worldviews, knowledge and traditions (Johnson, 2024, p. 9).

The methods used to develop Te Kawerau ā Maki-specific tohu for forest health monitoring were based on whakapapa. This view of people being related to the environment is common in Indigenous cultures (Mahuika & Kukutai, 2021). Although Indigenous peoples have a genealogical connection to the environment, I did not find previous studies from the field of environmental science that specifically identified this method of self-identification upon entering the forest. It shares similarities with the Mauri Monitoring Model (Morgan, 2006a), which has been utilised in a few environmental monitoring projects in Aotearoa (Faaui et al., 2017; Hikuroa et al., 2011; Morgan, 2006b). Like the Mauri Model, the research conducted for this thesis is based on mana whenua's aspirations, needs and perspectives. It explores the state of mauri through the observation of potential impacts on environmental indicators. This research also emphasises the importance of relationships between people, the environment and resources, which is a key aspect of the Mauri Model. This research differs from the Mauri Model, however, in that it potentially may not be used as a decision-making tool to evaluate trends in sustainability over time, instead focusing on changes in biodiversity. The tohu developed in this research are localised to a specific geographic region and based on field observations. In contrast, those in the Mauri Model reflect broader mauri impacts across larger geographic areas. The development of tohu through visits with Te Wao Nui ā Tiriwa and analysis of collected data is detailed below.

4.8.1 Field visits with the ngahere

Tikanga: Karakia and oli (incantations)

Noho ana ke akua	*The god resides*
i ka nāhelehele,	*in the thick forest,*
I alae ia i ke kiʻohuʻohu	*that was hidden by the clinging mist*
e ka ua koko.	*by the low-lying rainbow.*
E nā kino malu,	*O beings sheltered in the heavens,*
malu i ka lani,	
malu e hoe.	*sheltered continually.*
E hoʻoulu mai ana ʻo Laka	*Laka will confer growth*
i kona mau kahu.	*on her caretakers.*
O mākou, o mākou nō, a!	*Tis we, ʻtis we indeed, ah!*

Poʻe hula (hula practitioners- literally “hula people”; *ʻōlelo Hawaiʻi*) often recite *Noho Ana,* an oli pale (chant, incantation of protection; *ʻōlelo Hawaiʻi*) upon entering the nāhele (forest,

ʻōlelo Hawaiʻi). This chant describes the divine nature of the forest as the home of the akua (deity, *ʻōlelo Hawaiʻi*) of hula–Laka–and the role of the mea hula (singular form of hula practitioner, *ʻōlelo Hawaiʻi*) as kahu (caretaker, *ʻōlelo Hawaiʻi*) of the forest (Blair-Stahn, 2014). I recited this oli, or Hawaiian chant, upon entering the ngahere during our field visits, as I have done anytime I enter the forest "with a purpose" (for research in this instance, in Hawaiʻi, this would be to gather lei-making materials) since I began my hula journey in 2018. I recite this oli before gathering materials for making hula adornments; sometimes I recite it before entering a stage or a hālau hula (hula school or place of learning).

By reciting this oli, I made myself known to the forest and shared my whakapapa as Kanaka Maoli with Te Wao Nui ā Tiriwa and the non-human inhabitants who live or have lived there. We also recited karakia before entering and upon leaving the ngahere. I encouraged those joining me to mihi (greet) the inhabitants of Te Wao Nui ā Tiriwa in their own way upon entering the forest. This adherence to tikanga prepared the group for entrance into the forest. It provided a form of cultural safety, as we were entering Te Wao Nui ā Tiriwa, which is considered to be a very sacred place. This was described by George Hori Winikerei Taua, a kaumatua of Te Kawerau ā Maki, "To the Māori people, the forest is very sacred. This was not only because in the early days this was where you got your food from, but you also got your medicine. It was the way we lived, because the forest was very, very important" (G. Taua in Littlewood & Snell, 2018). Adherence to tikanga was also important as we were entering the forest during a time of tapu (Te Ao Pō) (Marsden, 2003). The presence of kauri dieback disease within the ngahere was another form of tapu, and required the spiritual protection provided by the incantation of karakia.

Dawn visits

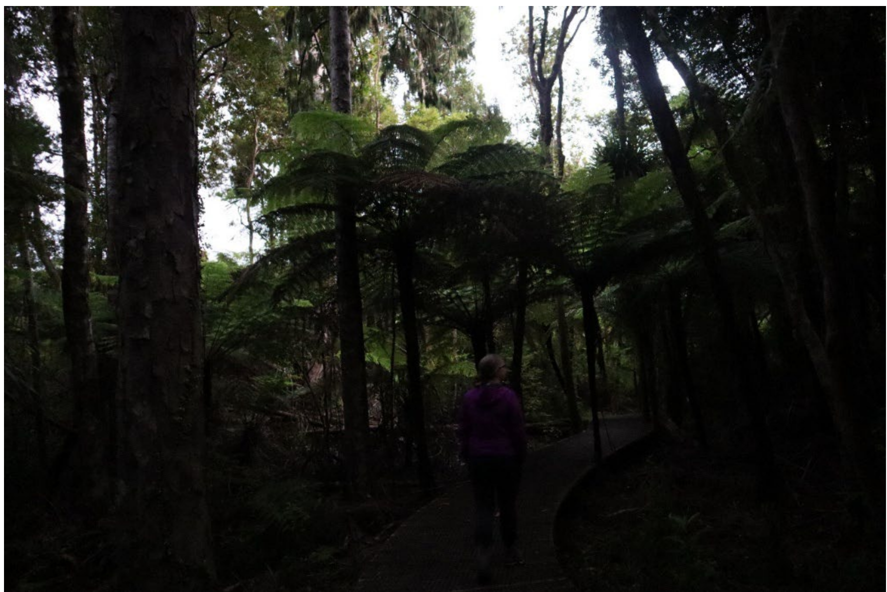


Figure 10

Te Wao Nui ā Tiriwa just after dawn. Photo: Author's own.

Whāia ngā pae o te māramatanga,	*Pursue the horizons of understanding,*
Ko te pai tawhiti, whāi kia tata;	*Bring the distant horizon closer,*
Ko te pae tata, whakamaua kia tina;	*Secure the nearby horizon firmly,*
E puta ai ki te whaiao, ki te ao Mārama.	*So that you may emerge into daylight, into the world of light.*[3]

As recommended to me, I made myself known to Te Wao Nui ā Tiriwa at the time just before dawn, when Te Taiao is moving from darkness into light, from tapu to noa (the absence of tapu, ordinary). In the Māori belief system, the time before dawn is a period of great spiritual energy, when Te Ao Pō transitions into Te Ao Mārama (Marsden, 2003; Mead, 2003). This spiritual nature of Te Ao Pō is also reflected in the Kānaka Maoli worldview: "There is a sea of time, so vast man cannot know its boundaries, so fathomless man cannot plumb its depths….For this is the measureless expanse of all space. This is the timelessness of all time. This is eternity, This is *Pō*. In *Pō* there dwell our ancestors, transfigured into gods" (Pukui, 1979, p. 35). After making myself known to the ngahere, the ngahere would tell me what it wanted me to know. While environmental science is underpinned by methods of observation that often focus on objectivity, impartiality and lack of bias, this monitoring method is based on a different kind of observation —one that emphasises intuition, subjectivity and the influence of lived experiences of the observer and the connections between the human and non-human elements of Te Taiao.

[3] Translation is author's own.

Observations

Mūmū ana te kūkū,	*The wood pigeon is silent,*
ketekete ana te kākā.	*but the parrot chatters.*

Silent observation was necessary during the field data collection portion of my research, and on many occasions in the ngahere, we felt compelled to pause and silently observe. This was noted in the thematic analysis of recordings. Participants wore two lapel microphones to record observations they might have had while in the ngahere, which allowed us to be unencumbered from writing notes in a notebook. Recordings from these visits were later analysed for bird calls, which were documented in an Excel spreadsheet along with the date of collection (See Appendix Q for a sample page from this spreadsheet). While visiting the ngahere, we frequently observed plant species that were in fruit or flower (See Appendix P and Appendix Z). We observed fallen trees, birdsong, leaf fall, and non-native species, along with several other notable observations. In the Kanaka Māoli worldview, any elements of nature may be taken as a hōʻailona (mystic portent, *ʻōlelo Hawaiʻi*) (Pukui, 1979, p. 54) or sign. According to Kānaka Maoli scholar Mary Kawena Pukui:

> These may be a chill wind, whirlwind, sudden mist, rainbow, the flight pattern or cry of birds, cloud formations, unexpected ocean waves, strange behaviour of fish or animals. Without mystic overtones, any natural manifestation may be a sign. For example, a dark cloud may be a hōʻailona of rain (1979, p.54).

Hōʻailona also include bodily sensations and manifestations, including: “smelling flowers or other scents out of their normal setting, sudden chilling, goosebumps… and various skin sensations” (Pukui, 1979, p. 54). I prioritised observations of signs through the lens of my inherent Kānaka Maoli worldview, being open to observations of hōʻailona during my field visits with Te Wao Nui ā Tiriwa.

Locations

Field visits primarily took place on the open trails towards the centre and northern region of the research study area (Table 6, Figure 11). On one occasion, accompanied by Te Kawerau Iwi Tiaki Trust’s Kaimahi Taiao, we walked a short portion of the closed Tramline Track. I encouraged those accompanying me for the first time to the research area to introduce themselves to Aunt Agatha, a great rākau tupuna who has succumbed to kauri dieback disease, located shortly upon entering the Upper Te Piringa Track (Figure 11). This was the first place I was taken to by Te Kawerau Iwi Tiaki’s Kaimahi Taiao on our first hīkoi together to Te Wao Nui ā Tiriwa in March 2024. I felt that to best honour the tūpuna of Te Wao Nui ā Tiriwa,

newcomers to the ngahere and this project research should introduce themselves to Aunt Agatha before proceeding with further data collection.

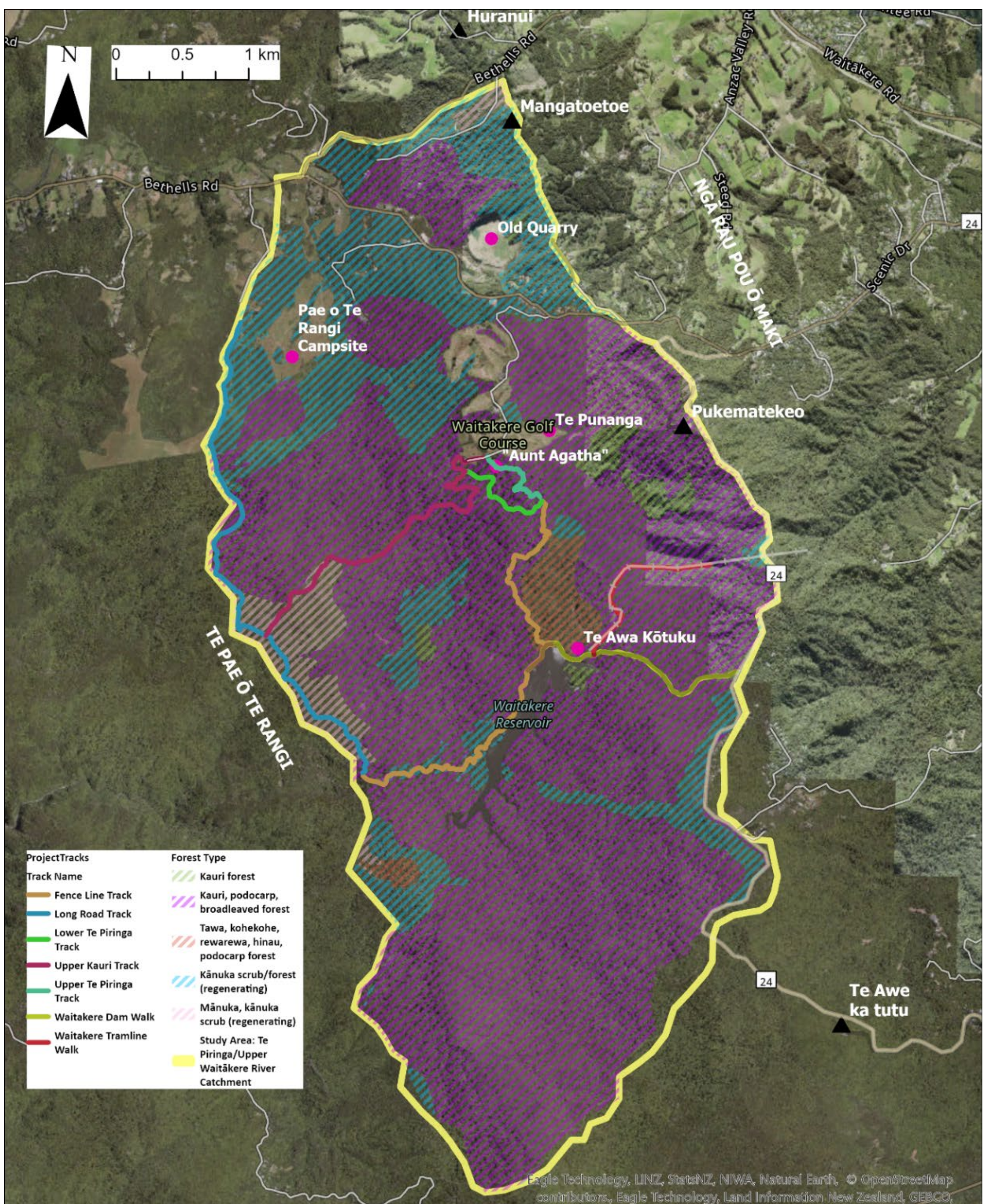


Figure 11

Map showing vegetation cover and locations of walking tracks visited during this research within the upper catchment of the Waitākere River. These walking tracks lie within Te Piringa/Cascade Kauri Regional Park. Map created in ArcGIS Pro with data obtained from Auckland Council.

As described earlier, if the support person was accompanying me for the first time in this project, we would walk the Upper Te Piringa Track to recite karakia, to mihi those in the forest

and to recite an oli from myself. I extended the opportunity to the support person to introduce themselves to Aunt Agatha in a manner that makes them feel comfortable. For the most part, all participants took part in some form of mihi to Aunt Agatha and the non-human beings present in Te Wao Nui ā Tiriwa.

Maramataka Māori lunar calendar

During the visits to the ngahere, the lunar phase of the maramataka based on mātauranga from Rereata Makiha and his student, Ayla Hoeta, was taken into consideration and recorded (See Table 6). This reflects the whakapapa-centred nature of this research, acknowledging that the presence of environmental tohu is a product of the *relationship* between the origins of these phenomena (Royal, 1998). I endeavoured to perform field visits during higher energy moon phases, such as Tangaroa (Tangaroa ā mua, Tangaroa ā roto, Tangaroa ā kiokio), and around Rākaunui or the full moon. I avoided going in the field during lower energy Korekore moon phases (Korekore te whiwhia, Korekore te rawea, Korekore piri nga Tangaroa), and unpredictable energy moon phases (Tamatea a ngana, Tamatea a hotu, Tamatea āio, Tamatea kai airiki). This was not only due to the energy levels of the elements of Te Taiao, but also to protect the safety of support people and myself. However, due to the scheduling of field support personnel, it was sometimes necessary to go out on lower or unpredictable energy moon phases.

Table 6

Nine site visits were performed as part of this thesis research from November 2024 to March 2025. These visits occurred in various locations within Te Wao Nui ā Tiriwa during different kaupeka matiti (summer seasons) and lunar phases recorded according to mātauranga from Rereata Makiha and his student, Ayla Hoeta.

Visit No.	Date	Track Name	Kaupeka	Mata o te Marama; Energy
1	19 Whiringa-ā-rangi (November) 2024	Upper Te Piringa	Matiti Muramura	Takirau; Lowering energy flow
2	25 Whiringa-ā-rangi (November) 2024	Lower Te Piringa; Fenceline; Long Road; Upper Kauri	Matiti Muramura	Tangaroa ā roto; Abundant/Productive energy flow
3	15 Hakihea (December) 2024	Upper Te Piringa	Matiti Kaiwai	Ōturu; Highest energy flow
4	16 Hakihea (December) 2024	Waitākere Dam/Fenceline	Matiti Kaiwai	Rākaunui; Highest energy flow
5	22 Hakihea (December) 2024	Waitākere Dam/Fenceline	Matiti Kaiwai	Korekore Piri Nga Tangaroa; Reflective energy flow
6	23 Kohitātea (January) 2025	Pukematekeo	Matiti Raurehu	Tangaroa ā Roto; Abundant/Productive energy flow
7	18 Huitanguru (February) 2025	Fenceline	Matiti Rautapata	Korekore Te Whiwhia; Reflective energy flow
8	23 Huitanguru (February) 2025	Pae o Te Rangi/Long Road	Matiti Rautapata	Tangaroa ā Kiokio; Abundant/Productive energy flow
9	10 Poutūterangi (March) 2025	Tramline*	Matiti Rauangina	Mawharu; Low/Surging energy flow

*Closed track due to kauri dieback. Was accompanied by Te Kawerau Tiaki Trust Kaimahi.

Weather

He moana kē tā matawhāiti, **he moana kē matuaaua.**	*The sea of the prudent person,* *and that of the rash one*

The weather was observed and recorded during our hīkoi in Te Wao Nui ā Tiriwa (See Appendix R for a sample page from these observations). As all elements of nature are interconnected in a whakapapa-based worldview, the weather may affect the behaviour of animals and plants. We also avoided going out during hazardous conditions (such as heavy rain or wind), as this poses risks of landsliding or flooding (Harmsworth & Raynor, 2005). This led to a few days in the field being cancelled. However, we took this extra safety measure to ensure the field team's safety and that our observations were made safely.

4.8.2 Analysis of field audio recordings

All field visits were recorded on two BOYA BY-M1V lapel microphones (BOYA, n.d.). As with analysing themes arising from hui with project participants, I transcribed audio from our field visits to identify recurring themes, observations, birdsong, and emotional or sensory responses that occurred during these visits.

Thematic analysis

After transcription, I performed thematic analysis (Braun & Clarke, 2006; Gibson & Brown, 2009; Vaismoradi et al., 2013) on a small subset of these recordings to identify the overall themes that arose from field visits to Te Wao Nui ā Tiriwa. I analysed a subset of transcripts (I randomly selected four of 34 transcripts > 10 minutes in length) from pre-dawn/dawn field trips, as well as those that included representatives from Te Kawerau Iwi Tiaki Trust for this thematic analysis. Sample pages from the thematic coding of these field audio recording transcripts can be found in Appendix O.

Vegetation analysis

I searched all field visit transcriptions and photographs to identify any mention or images of plants that were fruiting, flowering, regenerating, thriving, in decline or otherwise notable plant species and entered these into an Excel spreadsheet. (A sample page from this spreadsheet can be found in Appendix P). The total number of observations of different plant species was analysed in RStudio (RStudio Team, 2020), and a bar graph was created using the ggplot2 package (Wickham, 2016).

Birdsong analysis

> ***Kei ngā manu te tikanga.*** *When the birds go to sleep we do, when the birds wake up, we do.* – Rereata Makiha (Hoeta, 2021)

Birdsong was present in the background of these audio recordings. Sometimes, these birdsongs were not mentioned in our observations, or we were unable to identify a birdsong while in the field. I revisited these recordings after each visit and noted the presence of birdsong, identifying the species where possible. These observations were entered into an Excel spreadsheet, noting the species and the number of times the birdsong was heard. (A sample page from this spreadsheet can be found in Appendix Q). Total birdsong observations for each species were analysed in RStudio (RStudio Team, 2020), and a bar graph was created using the ggplot2 package (Wickham, 2016). While the collection of bird song recordings was not necessarily systematic, the inclusion of the presence or absence and activity of bird species contributed to the identification of tohu for environmental monitoring.

Weather and environmental observations

Environmental observations also came up in the audio transcriptions of field visits. This included weather observations (i.e., feeling hot or cold, noticing a mist or light rain, or wind), as well as times when the light was changing (i.e., commenting on the moonlight or the increase in light levels as the sun rose). A complete analysis of all audio recordings for weather and environmental observations lies beyond the scope of this MSc research. However, I analysed a small subset of audio transcripts (I randomly selected four of the 34 transcripts >10 minutes in length) for these observations. Each transcript was searched for the terms and common derivatives related to the weather and environment (i.e. windy, rainy, light etc.) (Table 7). These search terms were selected as they were commonly found in audio transcript observations. If no search terms were found in any of the randomly selected recordings, they were omitted from the dataset. Weather and environmental observations from this subset of audio transcripts were entered into an Excel spreadsheet. (A sample page from this spreadsheet can be found in Appendix R).

Table 7

Weather and environmental search terms for a subsection of audio transcripts collected throughout this project (November 2024-March 2025).

Weather and Environmental Search Terms for Audio Transcripts	
Temperature	Chill, cold, cool, freezing, heat, hot, warm
Wind and Air	Breeze, calm, gust, still, wind, windy, weather
Rain	Damp, downpour, drizzle, humid, moisture, rain, rainy, shower, ua (rain)
Clouds	Cloud, fog, haze, hazy, mist, overcast
Sun and Light	Bright, clear, dawn, early, glare, light, rā (sun), shade, shadow, sky, sun
Darkness and Night	Dark, late, marama, meteor, moon, night, pō (night)

Somatic and emotional response analysis

Mā te rongo ka mōhio *Through sensing comes awareness*
Mā te mōhio ka mārama *Through awareness comes understanding*
Mā te mārama ka mātau *Through understanding comes knowledge*
Mā te mātau ka ora *Through knowledge comes well-being.*

Somatic and emotional responses were one of the more challenging aspects to record and analyse. However, I believe they are an important component of the observational research methods employed in this study. I also noticed “gut feelings” – emotional, bodily and/or intuitive responses that arose while in the ngahere. These types of observations are similar to the concept of somatic markers described by Damasio (1996), which refer to physical bodily

sensations in response to emotions. Both somatic and emotional responses were recorded alongside other environmental indicators. Sometimes these emotions or sensations arose as a result of events in the environment (i.e., a change in light, weather, or a sound). At other times, these responses seemed to arise with seemingly no apparent trigger (i.e., a "gut feeling"). These "gut feelings" are known as naʻau ʻoiaiʻo in the Kānaka Maoli worldview, as described by Pukui: "ʻOiaiʻo is truth in the feeling sense. You *feel* whether what you are saying is ʻoiaiʻo or not. Hawaiians believed the intellect and emotions both come from the naʻau (gut, *ʻōlelo Hawaiʻi*). Real truth–real sincerity–comes from the naʻau ʻoiaiʻo. From ʻtruthful gutsʼ"(1979, p. 73). ʻIli ʻōuli (skin signs, *ʻōlelo Hawaiʻi*) are "disturbed skin sensations interpreted as signs or portents," (Pukui, 1979, p. 92), and include "goose bumps". These are known as ʻōkala or ʻōkakala in ʻōlelo Hawaiʻi are "often interpreted as a warning or given mystic significance" in the Hawaiian way of being (Pukui, 1979, p. 174), and are another example of a somatic response observation in the field. Based on my inherent worldview as Kanaka Maoli, I placed great importance on listening to ʻoiaiʻo naʻau and ʻili ōuli in the field, which were interpreted as somatic and emotional response observations.

A complete analysis of all audio recordings for somatic and emotional response observations lies beyond the scope of this MSc research. However, I analysed a small subset of audio transcripts (I randomly selected four of the 34 transcripts > 10 minutes in length) for these observations (different from the subset from the previous section analysed for weather and environmental observations). Each transcript was searched for standard terms (i.e., sad, peace, etc.) and their derivatives (i.e. sadness, peaceful, etc.) listed in Table 8 and entered into an Excel spreadsheet. (See Appendix S for a sample page from this spreadsheet). These search terms were selected as they represent common emotions and physical sensations we could potentially feel in the ngahere. If no search terms were found in a randomly selected recording, the recording was omitted from the dataset. Recording these somatic markers can be a method to discover tohu that are noticed through intuitive or sensory awareness, which might have been otherwise overlooked.

Table 8

Somatic and emotional search terms for a subset of audio transcripts collected throughout this research (November 2024-March 2025).

Somatic and Emotional Search Terms for Audio Transcripts	
Calm/Peaceful States	Alright, calm, content, happy, observation, pause, peace, relaxed, silent, still
High Energy/Activation	Alert, awake, aware, heightened
Anxiety/Unease	Anxious, funny, freaked (out), nervous, scared, strange, uncomfortable, uneasy, weird, worried
Low Energy/ Sadness/Grief	Depressing, lonely, sad, tired
Physical Somatic Sensations	Chicken skin, chills, feel, goosebumps, sense, shiver, tingle, tingling, vibe, warm

4.8.3 Contextual analysis of observations

Data analysis: Bird activity & ngā mata o te marama

It is essential to note that bird observation data for this study were neither collected through a standardised plot system nor via regimented, repeated visits to predetermined locations in the ngahere. However, the data may provide preliminary insights that can inform more structured data collection methods in the future. As an exploratory data analysis exercise, I attempted to analyse birdsong data collected during this research (Appendix Q) in relation to the energy levels of ngā mata o te marama (phases of the moon, see Section 2.3.1; Figure 6 and Table 6). I applied statistical analysis using RStudio (RStudio Team, 2020) to bird observations collected during nine site visits (Table 6) from November 2024 to March 2025. I used the readxl package (Wickham & Bryan, 2025) to read the Excel spreadsheet in RStudio. Next, I used the dplyr (Wickham et al., 2023) package to select only relevant data from the dataset: “Mata o te Marama” (the moon phase) and “Birds Per minute” (the average number of birdcalls seen or heard during our recorded field visits). Using the clean_data function in the dplyr package, I grouped Ngā Mata o te Marama into four groups according to mātauranga maramataka from Hoeta and Makiha (See Figure 6). These groupings included “Low Energy” phases (Mawharu, Takirau), “Reflective Energy” phases (Korekore Piri Nga Tangaroa, Korekore te Whiwhia), “Abundant” phases (Tangaroa ā roto, Tangaroa ā Kiokio), and “High Energy Phases” (Ōturu, Rākaunui). Next, I performed a Kruskal-Wallis test (a non-parametric ANOVA used for comparing abnormally distributed data from three or more sets) from the RStudio FSA package (Ogle et al., 2025) to determine if perceived bird activity differed significantly across the four

energy groups. I then created a box plot of these results using the ggplot2 package (Wickham, 2016)

Analysis: Vegetation & ngā kaupeka o te tau

After researching the characteristics of the various matiti (summer) phases of the maramataka, and performing an analysis of field audio transcriptions, notes and photographs, I examined vegetation (Appendix P) and weather observations (Appendix R) from field visits (Table 6) with the known characteristics of the matiti phases according to mātauranga from Rereata Makiha and his student Ayla Hoeta (See Section 2.3.1). As these field visits took place between November 2024 and March 2025, I focused my research on the characteristics of ngā kaupeka that typically occur around this time in the Gregorian calendar (matiti muramura, matiti kaiwai, matiti raurehu, matiti rautapata and matiti rauangina). After this, I examined the collected audio recordings and photographs for characteristics of these seasonal phases and provided a summary of my main findings based on this analysis.

4.8.4 Finalisation of tohu

Through a combination of a foundation in kōrero tuku iho, established whanaungatanga with Te Wao Nui ā Tiriwa and the analysis of environmental monitoring data gathered across several field visits from November 2024 to March 2025 (Table 6), I developed a small set of potential tohu (environmental indicators) (detailed in Section 5.3.8) to be considered for use in long-term environmental monitoring in Te Wao Nui ā Tiriwa. The main factors that led to an observation being selected as a tohu included whether it was: 1) prevalent in kōrero tuku iho, 2) appeared to be particularly striking or unusual in its form or behaviour, 3) showed recurring patterns, or 4) was related to a plant or animal species that was abundant in the same area. These decision criteria supported the development of tohu that are ecologically relevant and grounded in mātauranga Māori.

Chapter 5 Results

5.1 Current environmental monitoring in Te Wao Nui ā Tiriwa

5.1.1 Auckland Council Environmental Monitoring

According to the 2018 *State of the Waitākere Ranges Heritage Area Report* by Auckland Council: "Environmental indicators are used to: measure the state of the natural environment of the heritage area; determine the threats and changes to the environment; [and] provide an overview of the environmental management activities undertaken by the local community and the council" (Auckland Council, 2018, p. 35). Various community organisations and Auckland Council departments are performing environmental and forest monitoring within Te Wao Nui ā Tiriwa, all for different purposes and in different locations. These include Auckland Council's Biosecurity Team, Biodiversity Team, Parks Department, Watercare and Auckland Transport. While the five-yearly *State of the Waitākere Heritage Area* reports provide an element of synthesis of the monitoring being performed by Auckland Council (Auckland Council Plans and Places, 2018; Waitākere Ranges Local Board & Auckland Council, 2013b, 2013a), to date, a comprehensive summary, synthesis and spatial evaluation of all the Auckland Council's and Council Controlled Organisation's environmental and biodiversity data have not been completed.

Auckland Council vegetation plots in the wider Waitākere Ranges Heritage Area

In the wider area, monitoring is carried out by Auckland Council within a series of 20m x 20m forest plots distributed throughout the Te Wao Nui ā Tiriwa. Fifty-two Auckland Council forest, scrub, and shrubland vegetation plots are shown in Figure 12, located from Bethells Road in the North to Whatipu in the South. Auckland Council's sampling methodology used for forest plots closely follows the 'standard' 20 m x 20 m Permanent Plot forest monitoring methodology used throughout Aotearoa since the 1950s (Allen, 1993; Hurst et al., 2022). In these permanent plots, all trees present are recorded, counted and stem diameter measured at 1.35 m above the ground. Saplings and seedlings are counted in twenty-four 0.75 m^2 sub-plots. Epiphytes, climbers, weeds and any additional species are also noted in sub-plots. Three bird counts are also undertaken at each plot as part of the vegetation sampling. Pest animal monitoring using chew-cards was initially included as part of the vegetation sampling methodology. However, this was discontinued in the early 2010s due to budget constraints.

Figure 12

Overview map showing the location of 52 environmental monitoring plots from Auckland Council monitoring the Waitākere Ranges Heritage Area, created using environmental monitoring data obtained in February 2023. (Map created by the author in ArcGIS Pro Software by the author using plot data provided by Auckland Council in February 2023).

Auckland Council vegetation plots within Te Piringa (research study area)

Nineteen of the Auckland Council Vegetation Plots lie within the study area for this thesis: Te Piringa (the upper Waitākere River catchment) (Figure 13). Data obtained from the Auckland Council shows vegetation plot data dating back to 2009. As the forest plot dataset was obtained in 2023, 14 of the 19 plots only had baseline vegetation monitoring data collected between 2009 and 2013. Four plots had baseline data collected in 2010 and remeasured in 2014; one plot had baseline data collected in 2010 and remeasured in 2015 (Figure 13). See Appendix E for a sample of Auckland Council vegetation plot data collected in their monitoring programme. Most of these plots (n = 15) are in the kauri, podocarp, and broadleaf forest ecosystem type. Two plots are within the broadleaf scrub and forest ecosystem, and two plots lie in the mānuka, kanuka scrub ecosystem type (Figure 13). The plot locations are relatively evenly spaced throughout the study area, providing a broadly representative sample for most of the catchment. There is a gap in coverage in the northern part of the study area. This area lies outside the Ark in the Park boundary and has a high proportion of private land. Therefore, locating 20 m x 20 m plots was not a priority in the past, but it should be given more attention in any future expansion of the plot network. The existing Auckland Council plot locations were selected using a grid. The starting point of the grid was chosen randomly, rather than individual plots being randomly located (Craig Bishop, pers. comm., 2025).

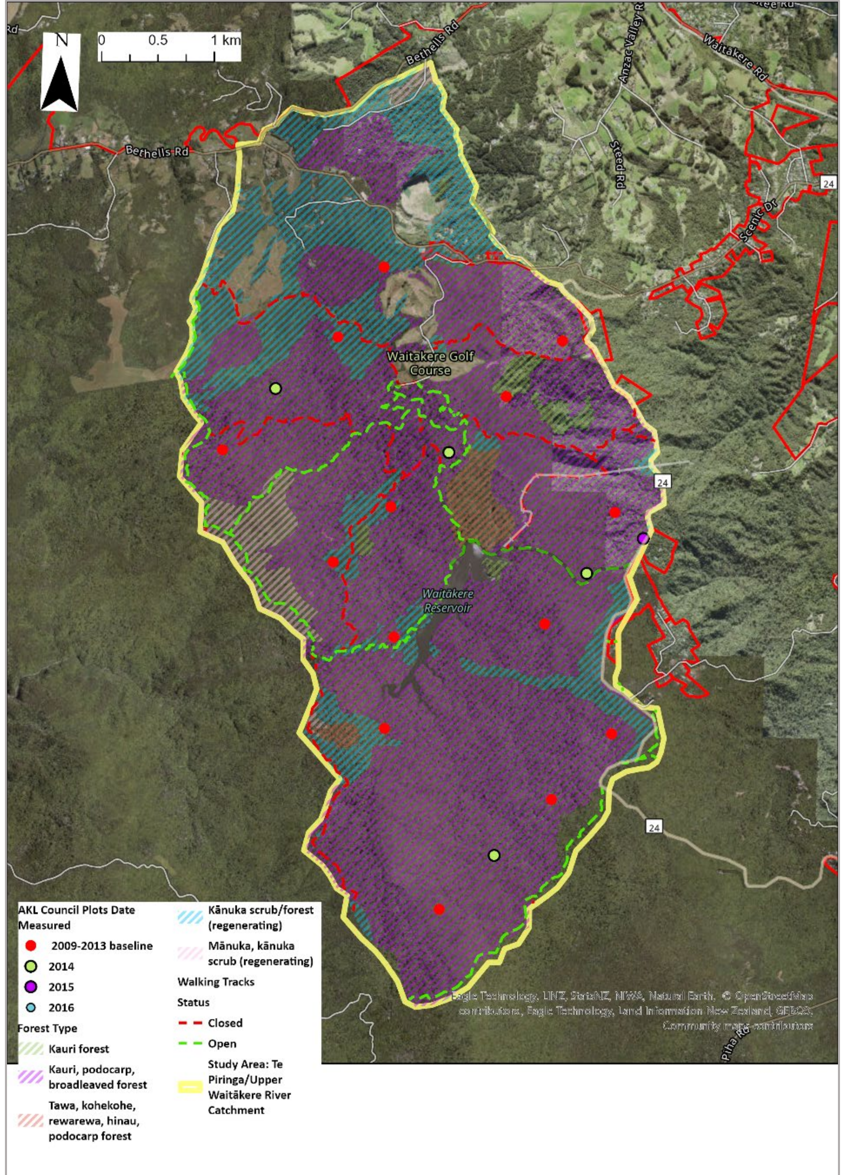


Figure 13

Map showing the location of Auckland Council vegetation monitoring plots within Te Piringa/upper Waitākere River catchment (the geographic area of interest for this study). The coloured circles represent the last year the data was measured as of February 2023. Different-coloured hatched areas represent the forest types. Closed and open walking tracks are symbolised with red and green dashed lines. Map created in ArcGIS Pro Software by the author using plot data from Auckland Council in February 2023.

Ten-minute bird counts (a derivative of five-minute bird counts) occurred from 2009 to 2018, and showed no significant changes in bird populations over that period (Auckland Council Plans and Places, 2018). Ten-minute bird counts were undertaken at the centre of each vegetation plot (three samples before 1 pm on the same day as vegetation measurement). Pest plant monitoring is also included in this research. This is based on the presence and

abundance of pest plants within the vegetation plot network. However, as outlined in the 2013 report from Auckland Council, pest plants in the WRHA are under-monitored, and the program needs to be expanded to include monitoring along walkways and road corridors (Waitākere Ranges Local Board & Auckland Council, 2013a).

Basal area and vegetation species abundance in the study area

The relative basal area of tree stems > 2 cm DBH (diameter at breast height) and saplings recorded in 22 Auckland Council 20 m x 20 m forest plots within the study area were analysed as a part of this research (Figure 14). The plots are a representative sample and therefore provide a good indication of the relative dominance of woody plant species within the study area. Plant species with a basal area per ha of > 0.3 m^2 are shown in Figure 14, including 25 species with the highest basal area per m^2 , and an "other" category comprised of 142 additional unique species.

The 'inverse exponential curve' of relative dominance, with most of the biomass concentrated in a few key dominants, is typical of plant communities worldwide. Kauri was the most dominant species in terms of basal area, with a value of 18.5 m^2 per ha. Ponga (*Cyathea dealbata*) had the second-highest basal area (9.4 m^2 per ha), followed by rimu (4.6 m^2 per ha). Eighteen of the 25 most dominant woody plant species produce berries or nectar that are an important source of food for indigenous birds and reptiles. The top 25 species include a diverse range of podocarp species, kauri (a cone plant), tree ferns, and berry- and seed-producing hardwood trees. This would provide a wide range of resources for indigenous fauna (Clout & Hay, 1989; Innes et al., 2022). Kānuka is a disturbance adapted plant (Allen et al., 1992), and the relatively high dominance of kānuka (4th ranked species, 3.7 m^2 / ha), and lower importance of mature coastal forest trees such as tawa, pūriri and karaka, highlight the importance of disturbance in the recent history of this area.

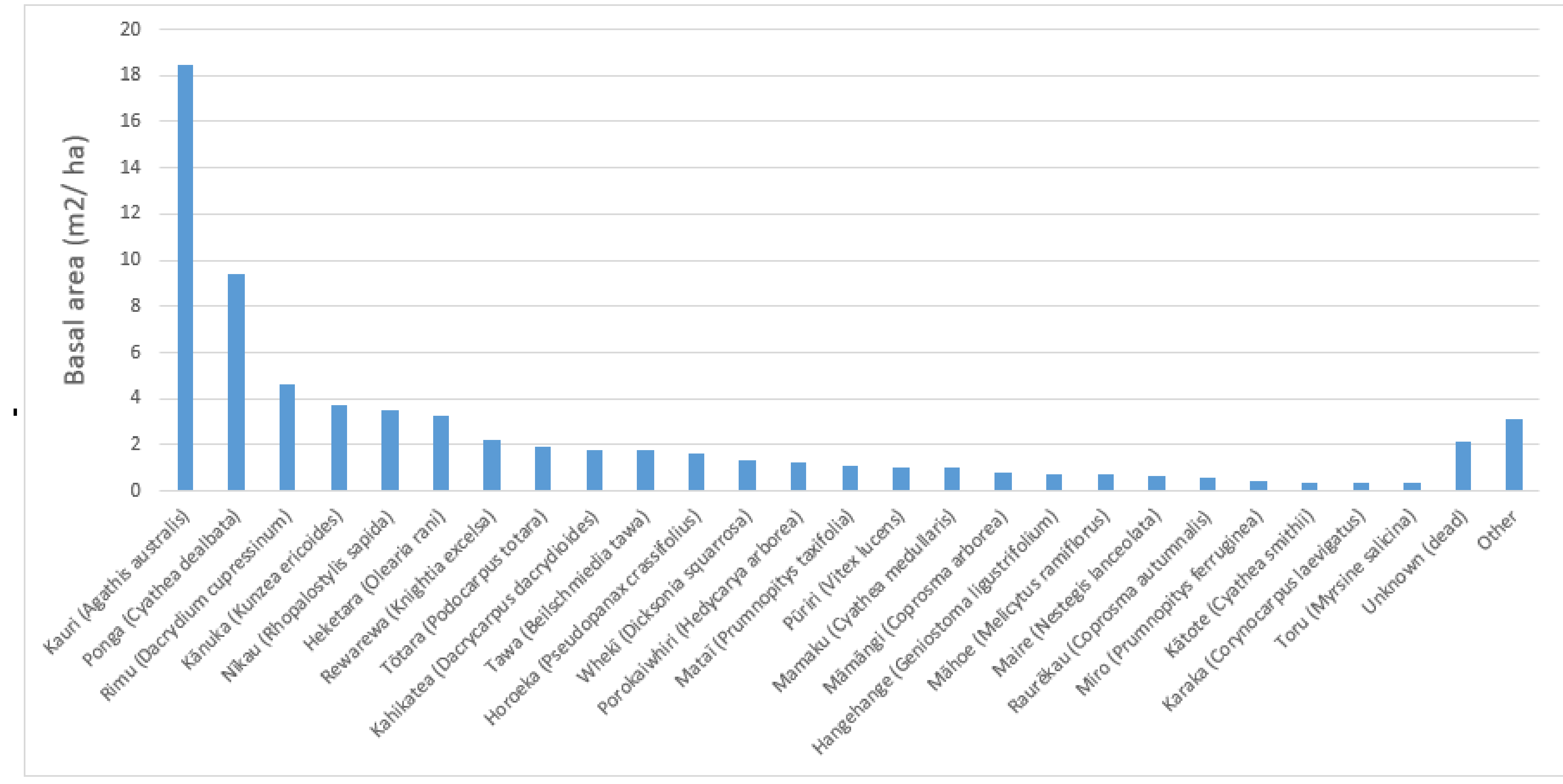


Figure 14

Relative basal area of tree stems > 2 cm DBH and saplings from 22 Auckland Council 20m x 20 m forest plots within the study area. The graph includes all stems with a basal area / ha of > 0.3. The other category comprises an additional 142 species.

5.1.2 Ark in the Park

The Ark in the Park is a collaborative project between Forest & Bird and Auckland Council, supported by Te Kawerau ā Maki. The Ark in the Park is a 2,270 ha area of land within the Waitākere Ranges (much of which falls within this research study area), where Ark staff and volunteers undertake a significant amount of predator control. This is mainly independently organised and carried out by Forest and Bird. The project is primarily run on the efforts of volunteers, and one of the desired outcomes by the group is to complete a monitoring programme of pest populations via tracking tunnels, analysis of bait uptake and trap catch data (The Ark in the Park: Five Year Plan 2016-2021, 2016). The project also conducts bird counts of all species, monitors geckos, performs occasional invertebrate surveys and implements weed control measures. No systematic monitoring of weedy plants is undertaken by Ark in the Park. However, they do undertake weed surveys around existing control locations and control weeds as new infestations are detected. Weed control work is primarily focused on disturbed, high-light environments associated with human activity (Ark in Park Staff, pers. comm., May 2025). Native vegetation monitoring was listed in the group's five-year plan. Ark in the Park trapline and bait station data are summarised in the following sections.

Ark in the Park traplines

As of April 2025, Ark in the Park had 326 predator control trapping points within the research study area (Figure 15). These run through different ecosystem types, with a large portion within the kauri, podocarp, and broadleaved forest in Te Wao Nui ā Tiriwa. In April 2025, I obtained and analysed trap data collected through CatchIT! online predator control trapping database to determine the species and number of pests caught via these traplines from 1 January 2021 to 31 December 2024 (Figure 16).

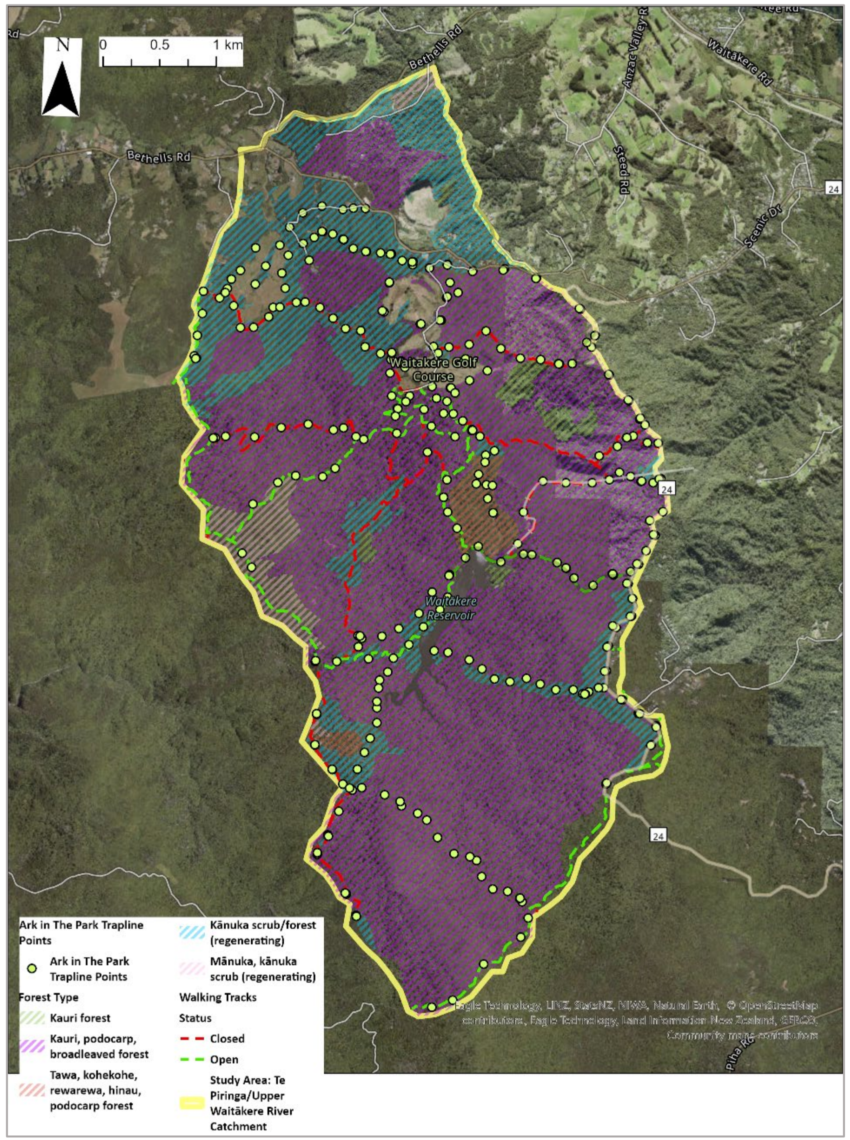


Figure 15

Location of the Ark in the Park trapline points within Te Piringa (upper Waitākere River catchment) (research area of interest). Created by the author in ArcGIS Pro, 2020, with data provided by Ark in the Park.

Rats were overwhelmingly the most frequently trapped pest mammal species within the research study area (n = 636) in 2024. The following largest species caught in 2024 was mice (n = 102), an increase from 42 mice caught in 2023. The number of stoats caught from 2023 to 2024 decreased from 119 to 49. As shown in Figure 16, the total number of mammalian pests caught through the Ark in the Park programme has steadily increased since 2021.

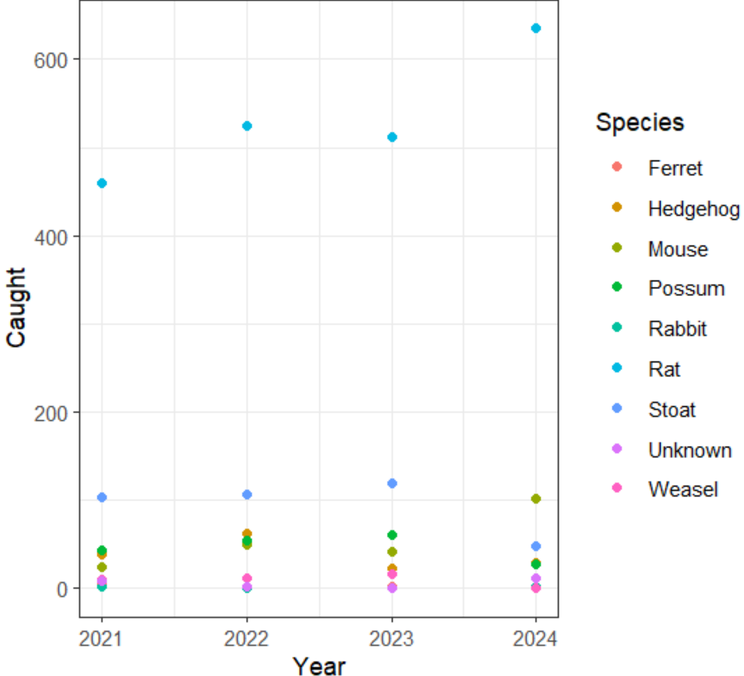


Figure 16

Plot showing the total number of catches from 2021-2024 by Ark in the Park for predator species within the Te Piringa (upper Waitākere River catchment) (Created by author in RStudio, 2020, with data retrieved from CatchIT! online database).

Ark in the Park bait stations

Ark in the Park provided bait take information for their rat bait station network (Figure 17) that covered the period from November 2020 to November 2024. Table 9 shows the average bait take index for the c. 4,800 poison stations maintained by Ark staff and volunteers, presented by block. Around two-thirds (n = 15, or 68%) of the 22 blocks recorded a significant improvement (i.e., a decrease) in bait take from 2020 to 2024. Some of these changes were quite large. For example, a drop of three points in the bait take index represents a change from bait > half gone (4) to nibbled bait only (2). Four blocks had no significant change in average bait index, which was relatively lower (index < 2) in all cases. Just three blocks showed a significant increase in bait take across the study period, and one of these was a block with only a small number of stations deployed (17 in Block K, Figure 17). Figure 18 provides another picture of the dramatic decrease in bait take from 2020 to 2024. Approximately 40 percent of the stations in 2020 had low bait take (index value of 1), whereas this had shifted to more than 70 percent by 2024.

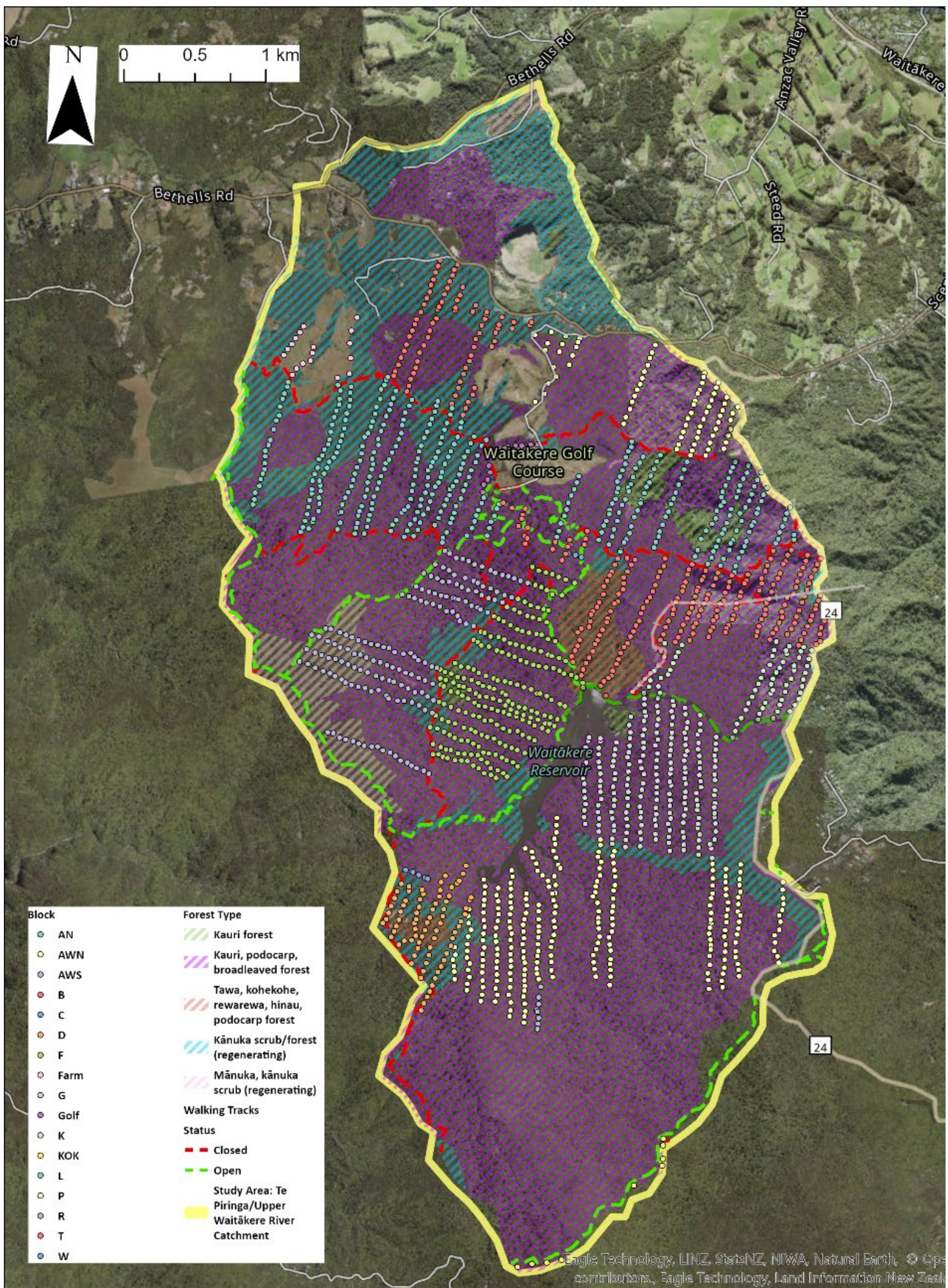


Figure 17

Locations of Ark in the Park Bait Stations within Te Piringa (upper Waitākere River catchment), the study area for this research. Also shown are the different forest types in the study area (coloured, hatched areas), as well as open and closed walking tracks (green and red dotted lines). Map created in ArcGIS Pro by the author with data obtained from Ark in the Park and Auckland Council. See Table 9 for a list of block abbreviations.

Table 9

Average bait take index for stations within Ark in the Park over the period of January 2020 to November 2024. Columns show the average bait take index for the preceding time period. Bait index ranges from 1 (=good, no bait taken) to 8 (=bad, all bait taken).

Block	**# Of Stations In Block**	**Δ from Nov 20-Nov 24 (4 years)**	**S = Significant Change**	**Nov 24**	**May 23**	**May 22**	**Nov 20 (Bait Deployed Jan 2020)**
Anderson(AN)	264	-4.26	S	2	2.21	3.71	6.27
AW	234	-3.88	S	1.79	4.24	5.67	0
Gleeson (G)	283	-3.68	S	1.47	2.1	2.26	5.15
Golf	11	-3.18	S	1	3	2.33	4.18
B	148	-3.14	S	2.4	2.07	3.16	5.54
Pukematekeo (P)	208	-2.94	S	3.02	2.75	4.18	5.96
Upper Kauri (U)	164	-2.86	S	1.98	2.71	3.27	4.84
Fenceline (F)	258	-2.83	S	1.38	2.19	2.37	4.21
Toetoeroa/ Tramline (T)	313	-2.78	S	2.22	3.15	4.32	5
Waitākere (W)	99	-2.64	S	1.68	3.23	2.82	4.32
Dam (D)	98	-2.3	S	1.81	3.4	3.42	4.11
Lower Kauri (L)	413	-2.22	S	1.88	3.05	3.78	4.1
Robinson (R)	334	-2.2	S	1.94	2.22	2.62	4.14
AWN	498	-2.13	S	1.47	2.3	4.34	3.6
Kelly (K)	132	-1.94	S	2.02	3.23	4.44	3.96
Cutty Grass S (CGS)	177	n/a	N	1.6	3.58	3.1	1.88
Cutty Grass N (CGN)	287	n/a	N	2.7	4.96	4.46	2.84
Kōkako (KOK)	389	0.41	N	1.93	3.93	3.43	1.52
Farm	18	0.5	N	1.5	2.11	1.17	1
Ian Wells (IW)	186	0.81	S	2.7	4.29	4.64	1.9
Nihotupu (N)	150	1.04	S	3.11	4.08	3.67	2.06
Cascades (C)	17	2.47	S	4.59	1.71	2.33	2.12

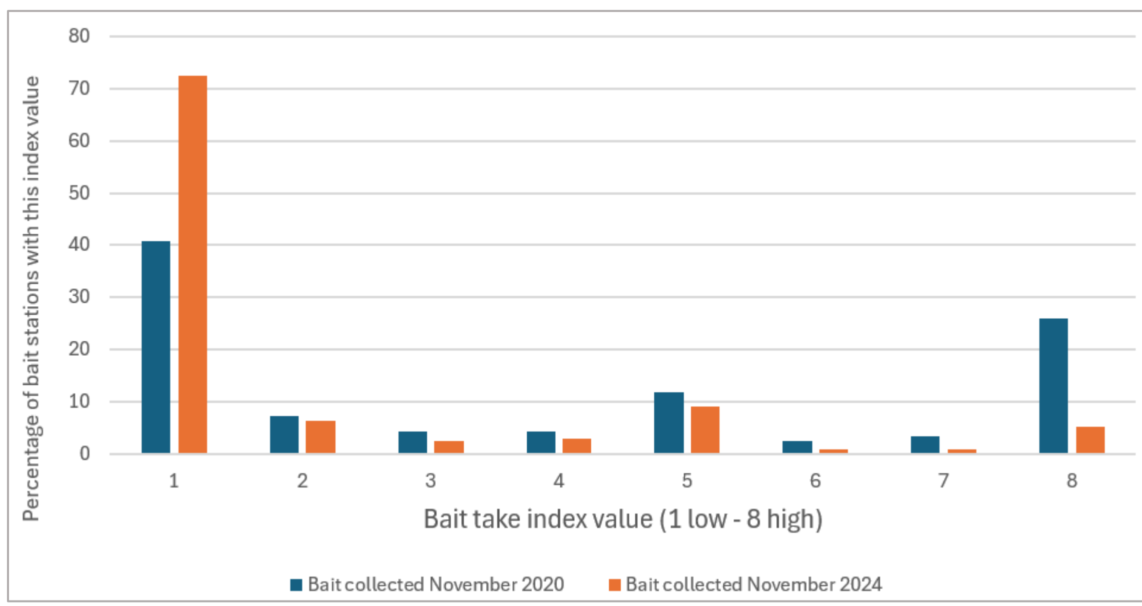


Figure 18

Change in the relative proportions of bait take index value for the Ark in the Park bait stations. This figure shows the difference between the first record in November 2020 (covering the 11 months prior to this) and most recent data available in November 2024 (covering the 9 months prior to this).

5.1.3 Phenological analysis

Flowering plants in the study area

Flowering times data obtained from the New Zealand Plant Conservation Network (NZPCN) were analysed according to plant species from both the Auckland Council and the Ark in the Park species lists. A total of 219 different vascular plant species were present in Auckland Council monitoring plots or on the Ark Plant List. Fifty-three of these were ferns, leaving a remaining 166 species of flowering plants, and podocarps (including kauri). Literature-sourced flowering times of these 166 species are presented, by months of the Gregorian calendar in Figure 19. Overall, November is the month with the highest number of flowering plants, featuring over 100 unique species. October and December also see a relative abundance of flowers, with over 80 species in flower. The number of unique flowering species begins to decrease in December, with the number of species in flower at its lowest during the period from April to July. The sparsest month for flowering is June, with around a quarter of the number of flowering species (29 species) compared to the most abundant month.

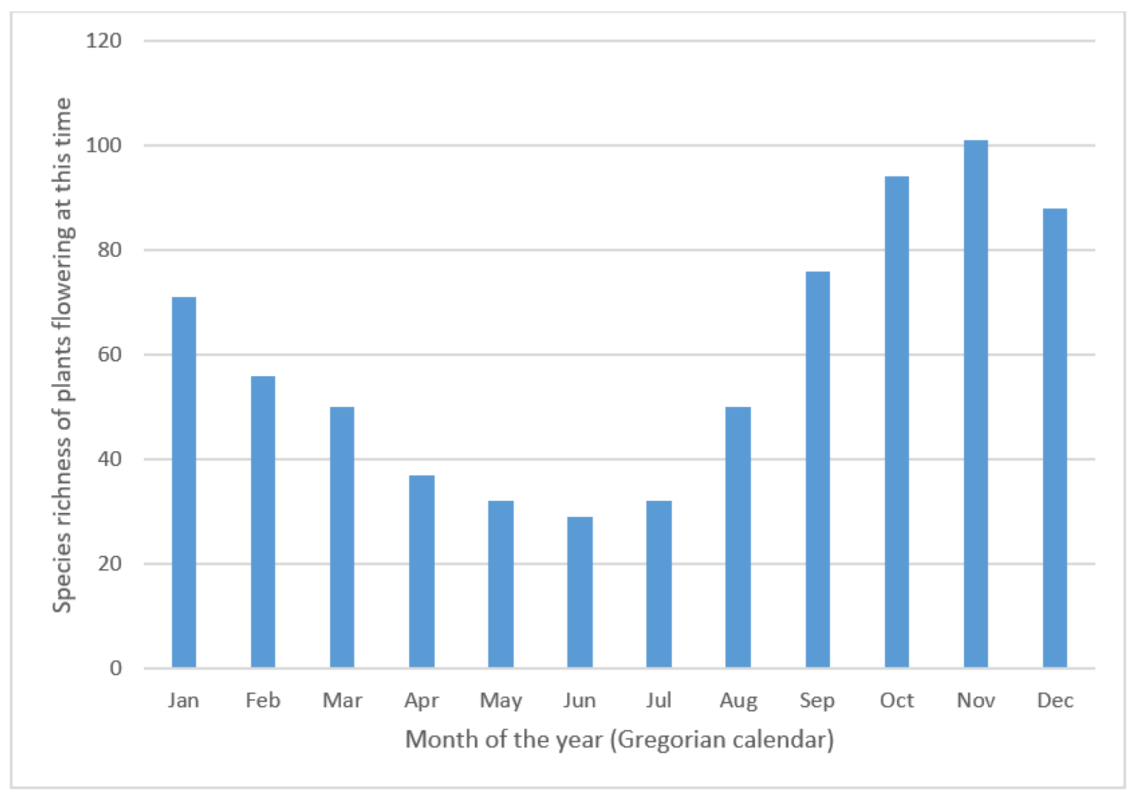


Figure 19

Number of flowering plant species by month within Te Piringa (upper Waitākere River catchment) based on full plant species lists from Auckland Council and Ark in the Park. Phenology data gathered from New Zealand Plant Conservation Network.

Fruiting plants in the study area

Annual fruiting patterns

In a similar manner to the analysis performed for flowering data, the timing of fruiting of plant species was also analysed. Phenology data is mainly from the NZPCN, with some additional records from the NZ Plants database. "Fruiting" includes the production of fleshy fruits (i.e., Coprosma berries, podocarp berries, pigeonwood, etc.), sticky seeds (e.g. Pittosporum) and small wind-dispersed seeds (e.g. mānuka, kānuka, daisy and rātā species). The peak months for fruiting plant species occur from January to April in the Gregorian calendar. All these months have around 100 or more vascular plant species in fruit, peaking in February and March with 109 species in both those months. The "low period" of fruit production occurs from June to September, with 48 – 50 fruiting species in each of these months (Figure 20). Note the slightly offset peaks of flower (October –December) vs. fruit (January – April) resources (Figure 19 & Figure 20). There is also an offset "trough" in resources of April – July (flowers) vs. June – September (fruit).

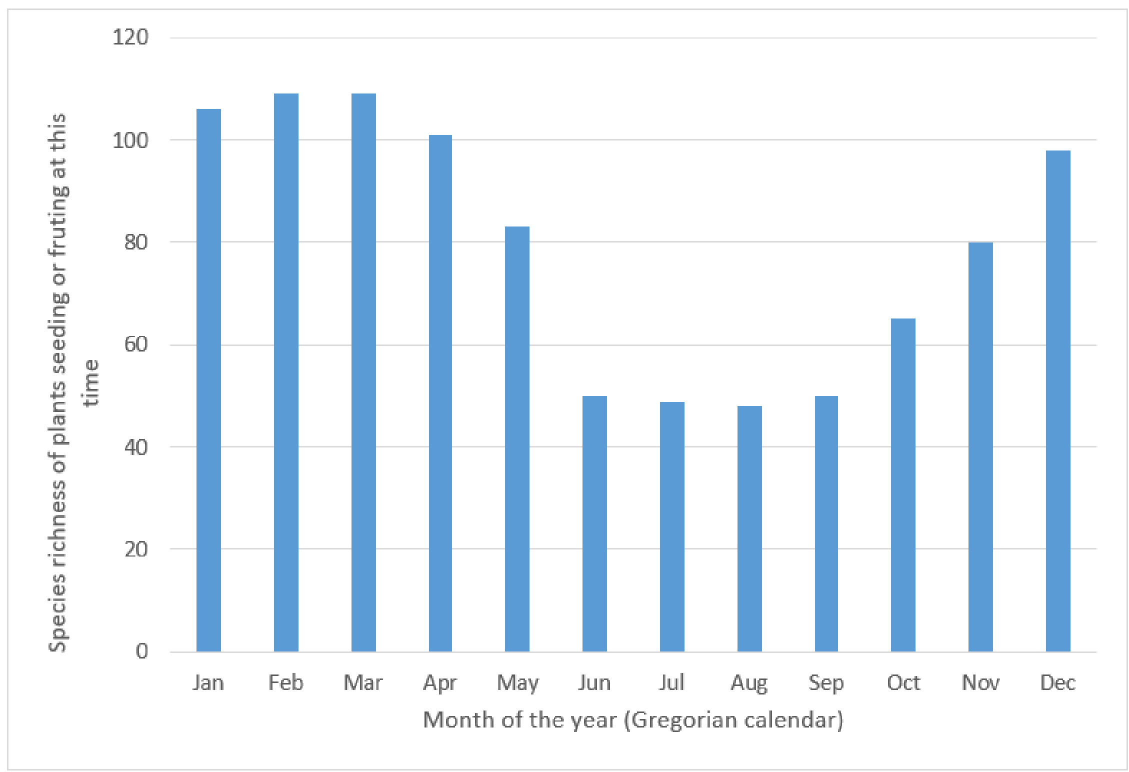


Figure 20

Number of seed plant species with ripe seeds or fruit by month within the research study area, based on plant species lists compiled from data from Auckland Council and Ark in the Park. Phenology data gathered from New Zealand Plant Conservation Network (NZPCN).

Relative fruit production by species

The data presented in the previous two sections is based on species only and takes no account of the relative abundance of different plant species. Relative fruit production by species and month was determined by cross-referencing the abundance of different vascular plant species with fruiting times in the Gregorian calendar (See Figure 21). Abundance was based on the density of individual species within Auckland Council 20 m x 20 m forest monitoring plots. Using this approach, the annual pattern of fruit production was almost identical to that presented in Figure 20. With "peak months" (January – March) comprising >12 percent of production and "trough months" (June - September) making up < 6 percent. Based on stem density, nīkau was the most abundant fruiting species (12 percent of total fruit production), followed by kanono (*Coprosma autumnalis*) (10 percent) and kiekie (*Freycinetia banksii*) (7 percent). These three species are all forest understorey plants.

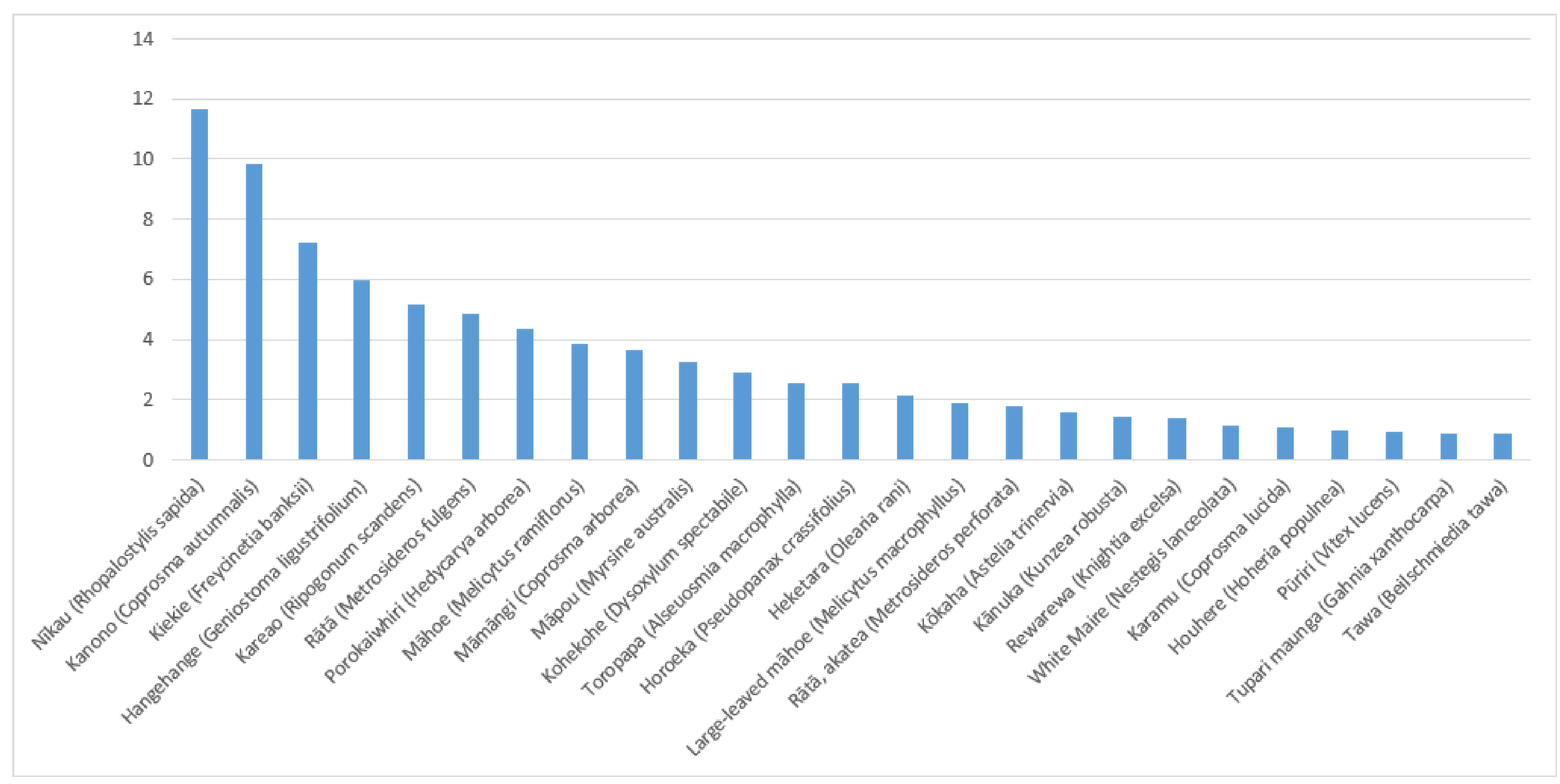


Figure 21

Relative fruit production (by frequency) in the research study area. Species not shown here account for a further 16 percent of potential fruit production. Based on plant species lists compiled from data from Auckland Council and Ark in the Park. Phenology data gathered from New Zealand Plant Conservation Network (NZPCN).

5.2 Relevant kōrero tuku iho

Kia heke iho rā i ngā tūpuna, kātahi ka tika.	*If handed down by the ancestors, then it would be correct.*

5.2.1 Pūrākau

As preferred by Te Kawerau Iwi Tiaki Trust representatives, I performed a literature review of publicly available printed sources of kōrero tuku iho. A general review of pūrākau provided helpful background on how Te Taiao is understood and remembered within Te Wao Nui ā Tiriwa. A small selection of pūrākau follows, reflecting key relationships between people, places and Te Taiao that I encountered during this literature review. While the selected pūrākau are by no means an exhaustive collection of all possibly relevant stories, familiarising myself with these and other pūrākau better prepared me for my fieldwork in Te Wao Nui ā Tiriwa.

How Tāne brought light to the world

The creation story (described in more detail in Section 1.4) illustrates the separation of Ranginui and Papatūānuku by Tāne Mahuta, one of their children, and the transition of the world from Te Ao Pō to Te Ao Mārama (Diamond & Hayward, 1979; Royal, 1998; Taonui, 2006). This pūrākau holds great importance as it provides a foundational understanding of the interrelated nature of the elements of Te Taiao. It underscores the importance of understanding all elements of Te Taiao as genealogically connected, rather than as separate entities (Roberts, 2013). This pūrākau is especially relevant to forest ecosystems, where the inhabitants of the ngahere are considered to be children of Tāne (Royal, 2005a). The ngahere remains in the domain of Tāne to this day and can be seen with the dawn chorus of birds as they greet Tāne-te-Waiora at dawn.

Hinetītama – The Dawn Maiden

Hinetītama was the daughter of Tāne and Hineahuone (the first woman, made of clay by Tāne, a son of Papatatūānuku), who later became the wife of Tāne. When she discovered that her father was also her husband, she fled to Rarohenga (the underworld) as she was so ashamed by this revelation. She became Hine-nui-te-pō (the goddess of death and night) who rules over Rarohenga. She is the custodian of the threshold between night and day, Te Ao Pō and Te Ao Mārama. She is seen with the setting of the sun at night and with the rising dawn (hence her name, “The Dawn Maiden”) (Mead, 2003; Royal, 2005a). Familiarity with this pūrākau strengthened my knowledge of who is present in the ngahere at dawn and how this might impact Te Taiao.

Tiriwa

Tiriwa was a revered Te Kawerau ā Maki ancestor, whose domain is Te Wao Nui ā Tiriwa. He was a chief of the Turehu people, the earliest inhabitants of the land. The Turehu were the earliest ancestors of the Kawerau people, and contributed to the naming of many places in the present-day landscape of Te Wao Nui ā Tiriwa. This great ancestral chief of Te Kawerau ā Maki lived throughout the vast ngahere in the Waitākere Ranges and also lived along the western coastline of Hikurangi. Te Unuhanga o Rangitoto is the pūrākau that describes the shifting of Rangitoto Island from its former location in Te Unuhanga-a-Rangitoto at Karekare to its current position in the Waitematā Harbour. The place names, waiata, oral traditions, and carvings of Te Kawerau ā Maki continue to honour this revered ancestor (Murdoch, 1990; Taua, 2009).

Te Mokoroa

Te Mokoroa was a taniwha kaitiaki of the northern Waitākere Ranges and the Waitākere River valley. After the taniwha continuously raided the eel traps of Te Wao Nui ā Tiriwa inhabitants, the people decided Te Mokoroa was a menace and needed to be killed. Te Kawerau ā Maki ancestor Taiaoroa killed the taniwha by ensnaring him in a net he placed outside Te Mokoroa's lair. Once he came out for the evening, he became trapped in the net, and Taiaoroa killed him with his spear (Diamond & Hayward, 1979). The placename Te Rua o Te Mokoroa (The Mokoroa Falls) in Te Wao Nui ā Tiriwa depicts this ancestral historical narrative (Taua, 2009).

5.2.2 Whakataukī

Whakataukī Te Kawerau ā Maki

Due to time constraints, I conducted a partial literature review of whakataukī related to people and places associated with Te Kawerau ā Maki. All relevant whakataukī I came across were entered into an Excel spreadsheet (in te reo Māori and English where available; I came across approximately 35 kōrero tuku iho related to Te Kawerau ā Maki), along with references for future use by Te Kawerau ā Maki. (See Appendix T for a sample page from this database). A few notable examples of whakataukī related to Te Kawerau ā Maki compiled as part of this literature review are presented below.

Ko Te Au o te Whenua te tangata. *Te Au o te Whenua is the chief.*
Ko Te Kawerau-a-Maki te iwi. *Te Kawerau-a-Maki is the tribe.*

This whakataukī is from a mihi from Te Kawerau ā Maki describing Te Au o te Whenua – a prominent chief of theirs in the 1700s. Te Au o te Whenua translates to "The Current of the Land" (Murdoch, 1990, p. 14). The whakataukī above resonates with the well-known proverb: "Ko au te whenua, ko te whenua ko au," I am the land, and the land is me. Te Au o te

Whenua's name reflects a deep connection to the land and illustrates the close connection between identity and the whenua in te ao Māori.

Te ipukura o Maki. *The red calabash of Maki.*

This whakataukī describes the red calabash, also known as the red bowl of Maki, who was another famous ancestor of Te Kawerau ā Maki. He had residences at Manurewa and Rarotonga (Mount Smart). This saying describes the red-earthed crater at Rarotonga, "Te ipukura o Maki". This whakataukī holds great importance for the descendants of Maki, as evident in the name that has been passed down through generations (Taua, 2009).

I found a few other whakataukī in the literature relating to the ancestral waka of Te Kawerau ā Maki (Tainui, Aotea, Tokomaru, Kauitara and Kurahaupō), their renowned navigators, notable people, and places in the iwi's history. I listed these in an Excel spreadsheet for reference by Te Kawerau ā Maki, and to possibly build upon in the future.

Whakataukī maramataka

There are numerous whakataukī relating to the maramataka. I searched for the names of the months and ngā kaupeka o te tau as a starting point for this literature review. All relevant whakataukī I came across (approximately 100 kōrero tuku iho related to maramataka) were entered into an Excel spreadsheet (in te reo Māori and English where available), along with references for reference by Te Kawerau ā Maki, and to possibly build upon in the future. See Appendix U for sample pages from this database. Two notable whakataukī surrounding the maramataka are presented below.

Matariki ahunga nui. *Matariki with many mounds heaped up.*

This whakataukī describes the heaped-up mounds of kumara tubers, which are prepared for the planting season. According to Mead & Grove (2001), the Matariki season, which falls during winter, is a time for preparing for the planting season. Food would be on the mind of the tangata as this is a season of food scarcity (Brougham & Reed, 1963).

He puanga kākaho, ka rere it te waru. *The blooms of the toeote fly in the eighth month.*

This is a whakataukī describing what tohu may be present during Kohitātea (December/January) in Te Taiao. It describes how the lightweight seeds of the toetoe fly in the sky in the summer. It is one of many whakataukī related to "te waru" or Kohitātea (the eighth month in the maramataka).

Whakataukī surrounding plant species

I conducted a more in-depth literature review of whakataukī related to plants found in the ecosystems of Te Wao Nui ā Tiriwa. I used the species list from Springer (2017) as search terms for whakataukī, and I also included plant species that I came across in the literature. I found a total of 142 whakataukī relating to Te Wao Nui ā Tiriwa plant species. All relevant whakataukī were entered into an Excel spreadsheet (in te reo Māori and English where available), along with references for future reference by Te Kawerau ā Maki. See Appendix V for sample pages from this database. A summary of concepts derived from kōrero tuku iho related to key plant species found in Te Wao Nui ā Tiriwa is provided in Table 10. A description of overall themes and examples of compiled whakataukī related to plant species found during this literature review is provided below.

Some whakataukī related to plant species found in Te Wao Nui ā Tiriwa reflect the strength of particular plant species, inspiring similar qualities in humans. This is reflected in the following whakataukī about mānuka: **Te paku peka tāne kaha, te iti kahikatoa.** *The strength of the small man is like the small red mānuka;* and mangemange: **Kia pēnei te mārōrō o te kākāhu me te mangemange.** *The strength of your clothing should be like the mangemange.* Conversely, some whakataukī reflect the fragility that can come from division, as seen in the following: **He tōtara wāhi rua he kai nā te toki.** *A tōtara tree split in two is food for the adze.*

Other whakataukī describe the interrelated nature of plants and animals in the ecosystem, such as **Ka mahi koe i te whare o te tīeki.** *You are making a saddleback's nest.* According to Mead & Grove's (2001) interpretation, this whakataukī refers to one making a cloak out of kiekie, a plant species in which the tīeki (syn. tīeke) or saddleback (*Philesturnus rufusater*) is known to build its nests. Finally, some whakataukī related to plant species that I came across in the literature warned the listener of the harmful effects of certain plants, as follows: **Ki te inumia weratia te tutu, ka rore.** *If the juice of the tutu is drunk while it is hot, it is intoxicating.* This whakataukī describes the poisonous seeds (if prepared incorrectly) of the tutu (*Coriaria arborea var. arborea*) tree and shrub species (Mead & Grove, 2001).

Whakataukī surrounding animal species

Similarly to the whakataukī related to plant species found in Te Wao Nui ā Tiriwa, I conducted a more in-depth literature review of proverbs related to commonly found animal species. I came across approximately 80 whakataukī related to these species. All relevant whakataukī I were entered into an Excel spreadsheet (in te reo Māori and English where available), along with references for future reference by Te Kawerau ā Maki. See Appendix W for sample pages from this database. A summary of concepts derived from kōrero tuku iho related to key animal

species found in Te Wao Nui ā Tiriwa is provided in Table 11. A selection of notable whakataukī included in the database provided to Te Kawerau ā Maki is presented below.

Whakatauakī relating to animal species often depict human behaviours through the actions of animals – a busy or talkative person might be compared to a noisy kākā. In contrast, a calm person's behaviour may be reflected in the characteristics of the kererū, as illustrated in the following whakataukī: **Kai ana ngā kākā, noho ana ngā kererū.** *The kākā are eating while the woodpigeon is sitting quietly.* Alternatively, the opportunistic nature of a person may be likened to the behaviour of the kōtare (*Halcyon sancta*), known for its self-serving actions, as reflected in the whakataukī: **He peo, he pitoto koe, he pinono koe, he pirinoa koe, he kotare koe.** *You are slippery, you beg, you are a parasite, a true kingfisher.* Whakataukī also provide awareness into the temporal behaviour of specific animal species. The seasonal and daily behaviour of animals was observed over many generations by ancestors and then orally transmitted through kōrero tuku iho to future generations. A distinctive tohu of the arrival of springtime in Te Wao Nui ā Tirwa is the call of the pīpīwharauroa. The following whakataukī describes their seasonal migratory patterns: **Ka tangi te pīpīwharauroa, ko te karere a Mahuru.** *When the cuckoo cries, that is the herald of spring.* Mahuru, referenced in the above whakataukī, occurs around September in the Gregorian calendar. It is the fourth month in the Māori calendar, coinciding with the first phase of summer in the maramataka (matiti kura) and the beginning of spring in the Gregorian calendar. Finally, whakataukī about animals present in Te Wao Nui ā Tiriwa might describe them as a potential source of food or sustenance – this whakataukī simultaneously reflecting the undesirable human trait of gluttony: **Ko te kūkū (kererū) horo tāepa.** *The pigeon eats until it falls down.*

5.2.3 Ngā Mōteatea

I limited my literature review of *Ngā Mōteatea* to focus on plants and animals commonly found in Te Wao Nui ā Tiriwa. Excerpts from these compositions were compiled into an Excel spreadsheet database for reference by Te Kawerau-ā-Maki. The name of the plant or kirehe was noted, along with the relevant excerpt from the waiata (in te reo Māori and English where available), with references including iwi association and author if known. Due to time constraints, this literature review was not exhaustive; however, the database can hopefully be expanded upon in the future.

Ngā mōteatea surrounding plant species

All relevant compositions I came across were entered into an Excel spreadsheet (in te reo Māori and English where available), along with references for future use by Te Kawerau ā Maki. See Appendix X for sample pages from this database. (See Table 10 for a summary table

of concepts derived from kōrero tuku iho surrounding key plant species from Te Wao Nui ā Tiriwa).

Often, the compositions I came across used the depiction of plants as reflections of people for whom the composer felt a strong admiration, as part of a lament. This is evident in the following excerpt, where the composer compares their loved one to a towering rātā tree: **Mā te hau takaha e turaki taku rata tiketike, Taku whakaruru tōtara e tū ki Poutama rā.** *It was, indeed a raging tempest which o'erwhelmed my sturdy towering rātā tree, My sheltering tōtara tree that once stood at Poutama yonder* (Te Maropounamu, 2005). This example illustrates how the depiction of plants in compositions found in *Ngā Mōteatea* may be associated with death, mourning, or lament.

Plants were often mentioned in waiata tangi (laments), perhaps discussing a waka of a loved one or symbolically describing the coffin of one who has departed. **Nā i eke atu i te waka pukatea, I te waka kohekohe.** *You would go aboard a pukatea canoe, or one made from the kohekohe tree yonder. A handsome one indeed.* Composers of waiata sometimes used the characteristics of plants to describe their emotional state, as is shown in the following excerpt: **Me he wai wharawhara te tūturu i āku kamo.** *Like the dripping wharawhara leaves are my tear-dimmed eyes* (Te Wharepouri, 2004).

Ngā mōteatea surrounding animal species

All relevant compositions I came across that were related to animal species found in Te Wao Nui ā Tiriwa were entered into an Excel spreadsheet (in te reo Māori and English where available), along with references for future use by Te Kawerau ā Maki (See Table 11 for a summary table of concepts derived from kōrero tuku iho surrounding key animal species from Te Wao Nui ā Tiriwa, and Appendix Y for a sample page from this database).

Similarly to the whakataukī concerning animal species, the presence of animals in *Ngā Mōteatea* was often used to describe their role as indicators of seasonal change, as can be seen in this excerpt, which describes the pīpīwharauroa: **"Pīpīwharauroa! Kawekaweā! Te tangi iho nei, karere o Mahuru, Whiti mai! Whiti mai!** *Shining cuckoo! Long-tailed cuckoo! Singing from above, the message of spring. Shine forth! Shine forth!* (Ngāpuhi & Hongi, 2007). Mahuru occurs around the time of September and springtime in the Gregorian calendar, and is during the first summer phase of matiti kura in the maramataka. The arrival of the pīpīwharauroa is one tohu that matiti kura has arrived. The behaviour of kīrehe may also help illustrate expressions of sorrow, as in the case of the kihikihi (cicada) in this excerpt: **E tangi rā koe e te kihikihi; Tēnei koe ka rite mai ki ahau.** *Sing your song, oh cicada; You are in like case*

with me (Tangikuku, 2004). The composer may also liken the beauty of a departed loved one to a member of the animal world: **Tāku kākā haetara ki te iwi rā ia Wātea kau ana ko te tūranga kau o Rehua.** *My bright-plumaged bird, admired by the tribes, has flown; and the star Rehua shines down on a desolate land* (Te Heuheu (II) Tukino, 2004).

5.2.4 Summary

By conducting a literature review of kōrero tuku iho surrounding historical people and places in Te Kawerau ā Maki's history, as well as the maramataka and plant and animal species found in Te Wao Nui ā Tiriwa, I was better prepared for environmental monitoring fieldwork. I am grateful that this literature review was suggested by Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao, as it highlighted an existing knowledge gap for me. Through familiarising myself with this ancestral knowledge, I was better able to connect with the non-human inhabitants of the ngahere and to know who to look out for and when. Key concepts that I derived from a literature review of kōrero tuku iho surrounding key plant and animal species commonly found in Te Wao Nui ā Tiriwa are summarised in Table 10 and Table 11.

Table 10

Concepts derived from a literature review of kōrero tuku iho (pūrākau, whakataukī and waiata) related to key plant species in Te Wao Nui ā Tiriwa were used to inform field observations.

Key plant species	Concepts derived from kōrero tuku iho
Kahikatea (*Dacrycarpus dacrydioides*)	The small leaves of the grand stature of the kahikatea are described. Koroī (kahikatea berries) are also depicted as an important food source, with sometimes inconsistent annual fruiting amounts (Mead & Grove, 2001; Ngata, 2004b).
Karaka (*Corynocarpus laevigatus*)	The karaka is lauded for its kōpī (orange fruit) it bears, providing sustenance for the people and food for guests (Mead & Grove, 2001).
Kauri (*Agathis australis)*	Kauri, while valued less by Māori for their carving, remain steadfast, slow-growing inhabitants of the ngahere, valued for their resin, which is used as chewing gum and kauri soot used in tattooing. These trees are viewed as ancestors, which is reflected in the whakataukī recited when they pass away through disease or are cut down (Mead & Grove, 2001). Kauri also represents the chiefly status of individuals (Mead & Grove, 2001; Ngata, 2004b).
Kiekie (*Freycinetia banksia*)	Kiekie leaves are described for their use in the weaving of cloaks, and the flower bracts serve as an important food source for people and also as a habitat for nesting tīeke (*Philesturnus rufusater*) (Mead & Grove, 2001; Ngata, 2004b).
Kohekohe (*Dysoxylum spectabile*); Pukatea (*Laurelia novae-zelandiae*)	Along with pukatea (*Laurelia novae*-zelandiae), it is described as having softer wood and being prone to becoming waterlogged. Kohekohe and pukatea were not suitable wood for canoe construction (Mead & Grove, 2001; Ngata, 2004b).
Kōtukutuku (*Fuchsia excorticata*)	The kotukutuku sheds its leaves in autumn, marking the beginning of harvest time. The leaves of this tree changing colour indicate the halfway mark between the cold of winter and springtime, a season of food scarcity (Mead & Grove, 2001).
Maire (*Nestegis cunninghamii*)	The hardwood of the maire tree is described as being able to be felled only with an adze. Additionally, adzes made of the strong hardwood of the maire could fell large trees, and weapons made from maire were known for their strength (Mead & Grove, 2001; Ngata, 2004b).
Mamaku (*Spaeropteris medullaris*)	The value of the mamaku tree-fern root as a form of sustenance was described in waiata, as well as the drooping growth patterns of its fronds (Ngata, 2004b).
Mānuka (*Leptospermum scoparium)*	The strength of the small mānuka tree's hardwood and its usefulness in adzes, weapons and tools are featured prominently in whakataukī (Mead & Grove, 2001).
Miro (*Prumnopitys ferruginea*)	The fruits of the miro tree were described as a food source for kererū and other bird species (Mead & Grove, 2001; Ngata, 2004b).
Rātā (*Metrosideros robusta*)	The blooming of rātā flowers during the eighth month of the maramataka (Mahuru) is described in whakataukī, as well as the reference to the rātā leaves as "Te maro o Tāne", "The loin-mat of Tāne" (H. Mead & Grove, 2001, p. 377) by Ngāti Awa, believed to be tapu and used in ceremonies.
Tawa (*Beilschmiedia tawa*)	The fruits of the tawa tree are described in whakataukī and waita, particularly being roasted over the fire (Mead & Grove, 2001; Ngata, 2004b).
Tōtara (*Podocarpus totara)*	The strength of the tōtara's hardwood is described as ideal for canoe construction and smooth inner bark for carving. The tōtara's chiefly status is described in many whakataukī and waiata (Mead & Grove, 2001; Ngata, 2004b).

Table 11

Concepts derived from a literature review of kōrero tuku iho (pūrākau, whakataukī and waiata) related to key plant species in Te Wao Nui ā Tiriwa were used to inform field observations.

Key animal species	Concepts derived from kōrero tuku iho
Kākā (*Nestor meridionalis*)	The kākā's lively disposition, calls at dawn, red plumage used in the creation of cloaks and preference for nectar from rātā trees are described in whakataukī and waiata (Mead & Grove, 2001; Ngata, 2004b).
Kererū (*Hemiphaga novaeseelandiae*)	The silent nature of the kererū and its propensity for eating large amounts of fruits and berries are described in whakataukī (Mead & Grove, 2001). The use of kererū as an important food source for humans is described in both whakataukī and waiata (Mead & Grove, 2001; Ngata, 2004b).
Kihikihi (*Amphipsalta zelandica, Kikihi muta*)	The call of the kihikihi is illustrated in whakataukī, often as a sign of summer, in the eighth month of the Māori year (Mead & Grove, 2001).
Miromiro (*Petroica macrocephala*)	Whakataukī describe the sharp eyesight of the miromiro, which it uses to feed on small insects as its primary food source (Mead & Grove, 2001).
Mokoroa *(Aenetus virescens)*	Although small in size, the significant impact of the mokoroa on the ecosystem is described in whakataukī, where it is illustrated felling large trees through infestation (Mead & Grove, 2001).
Pīpīwharauroa (*Chrysococcyx lucidus*)	The seasonal pattern of movement of the pīpīwharauroa is described in whakataukī and waiata, with the call of this bird being a sign of spring (Mead & Grove, 2001; Ngata, 2004b).
Pīwakawaka (*Rhipidura fuliginosa*)	The restless, erratic nature of the flight of the pīwakawaka is used to describe the behaviour of people in whakataukī. Its characteristic fan-shaped tail is also described (Mead & Grove, 2001).
Riroriro (*Gerygone igata*)	The characteristic song of the riroriro and its distinctive nest are referenced in waiata (Ngata, 2004b).
Tūī (*Prosthemadera novaeseelandiae*)	The tūī is praised in whakataukī for its beautiful singing, and its role as a food source for humans is also described in whakataukī (Mead & Grove, 2001).
Tuna (*Anguilla dieffenbachia*)	Whakataukī describe the tuna as an important food source for humans and the presence of eels after a night of rain (Mead & Grove, 2001).

5.3 Observational-relational monitoring framework

5.3.1 Hui outcomes

Thematic analysis

Hui meeting notes (April 2023, June 2023, February 2024) and audio transcriptions (May 2024, June 2024) were first coded, analysed and grouped into recurring themes (See Appendix C for a complete list of hui, see Appendix I and Appendix J for sample pages from thematic analysis coding sheets). The following overall themes were identified through this thematic analysis.

Theme 1: Prioritisation of mātauranga Māori

Mātauranga Māori, particularly in relation to Te Taiao, was a recurring theme in hui with project participants. Aspects of mātauranga Māori, particularly seasonal tohu and maramataka, were frequently discussed during hui. Potential seasonal tohu based on the maramataka for ngahere monitoring mentioned at these hui included the migration of the piharau/kanakana (lamprey eel, *Geotria australis*) during the time of the rising of Matariki or Pūanga; the presence of pīpīwharauroa during springtime and the flowering of certain plants (i.e., rātā, puawānanga and kohurangi, *Brachyglottis kirkii var. kirkii*). There was an emphasis on the presence or absence of species in the ngahere. Who/what should be there? Who/what should not be there? For example, the toru tree (*Toronia toru*) was mentioned as a positive tohu of environmental health in the ngahere because of its association with kauri. In contrast, pests and invasive plants were mentioned as negative tohu, indicating a possible decline in ecosystem health.

Through hui with Te Kawerau Iwi Tiaki Trust representatives, one overall theme also related to mātauranga Māori was that the monitoring framework developed in this study should resonate with the maramataka. There was a general interest in phenological patterns of plants (fruiting and flowering) as tohu of shifting seasons and potentially consulting kōrero tuku iho to revitalise this mātauranga. Concerns were raised on several occasions about the impact of climate change on usually reliable seasonal tohu and how participants have heard or witnessed that these indicators no longer align with the maramataka. Project participants had noticed or heard about plants flowering early and were interested in knowing more about the effects of climate change on these seasonal indicators.

Theme 2: Te Kawerau ā Maki Values

Te Kawerau ā Maki values of whakapapa and kaitiakitanga were recurring themes in the hui. The whakapapa of the ngahere was commonly discussed, particularly who was there and

when. The interrelationship between different plant species was mentioned; for example, the coastal pōhutukawa and rātā, although located in different ecosystems and areas of the whenua, would bloom at the same time during the maramataka (See Appendix H and Appendix Z for data on the flowering times of common species). Another example of this interrelatedness between species mentioned during the hui is the pepe tuna (literally "eel moth", *Aenetus virescens*), which pupates around the same time as the tuna (*Anguilla dieffenbachii*). When the pepe tuna die, they fall into the water and become food for the eels. In this sense, the whakapapa and the relationship between species were emphasised as something to be observed during this research. In later hui where field methodology was discussed, the value of whakapapa was emphasised, specifically the relationship between myself (the researcher) and Te Wao Nui ā Tiriwa was important. Project participants did not seem to take an interest in a single-species monitoring approach, as seen in previous studies (Lyver et al., 2008). Some disagreed with the notion of "taonga species", arguing that all species are interrelated and rely on each other to survive and thrive. Focusing on the monitoring of a single taonga species would overlook this important relationship between species in Te Wao Nui ā Tiriwa.

Kaitiakitanga was another value discussed, concerning the protection and sustainable harvesting of native species for use as rongoā, craft and kai. The ability of Te Kawerau ā Maki to fulfil their obligation as kaitiaki of their environment was an important value voiced by project participants. There was an emphasis on the value of historical texts and kōrero tuku iho to inform the development of tohu and the environmental monitoring framework. There was also an emphasis on having access to existing monitoring data from within their rohe to contribute to Te Kawerau ā Maki's ability to act as kaitiaki in the area appropriately.

This research highlighted the concern of protecting cultural knowledge and safety at hui. We agreed that not all mātauranga-a-Te Kawerau ā Maki is meant to be widely shared (i.e. wahi tapu, certain kōrero, etc.); however, it could still be of value and importance to the iwi to fulfil their responsibilities as kaitiaki in Te Wao Nui ā Tiriwa. We agreed that certain mātauranga should remain confidential yet be prepared for the iwi for their personal use. We also agreed that any mātauranga shared by project participants would remain their intellectual property, and that any new mātauranga developed as part of this research would be shared IP between the researcher and Te Kawerau ā Maki.

Theme 3: Environmental monitoring and frameworks

The importance of knowledge sharing regarding current monitoring activities by organisations such as Auckland Council and Ark in the Park was another theme during the hui with

representatives from Te Kawerau Iwi Tiaki Trust. They expressed concerns that the data from current monitoring by different organisations within their rohe was not being shared with Te Kawerau ā Maki. Another recurring discussion concerned the creation of an iwi-specific environmental monitoring framework rather than using an existing framework. Previous similar studies in cultural environmental monitoring were briefly discussed (Robb et al., 2016; Walker, 2019); however, a tailored approach was preferred, involving the development of a monitoring framework and method specific to Te Kawerau ā Maki. The presence or absence of species was frequently discussed. As part of the monitoring strategy developed through this research, it was essential to consider which species were present and which were not. Early on in our hui, the observational use of all senses (sound, sight, smell, taste and intuition) and all aspects of the interconnected environment was recommended. This holistic evaluation of environmental conditions reflects a te ao Māori worldview (Tadaki et al., 2022). The later hui informed a monitoring framework for this research grounded in whakapapa and whanaungatanga.

Review of existing studies and frameworks

Previous frameworks from similar studies were discussed with representatives from Te Kawerau Iwi Tiaki Trust (Harmsworth, 2017; Lyver et al., 2017; Rangiwai, 2018; Robb, 2014; Te Reo o Te Repo = The Voice of the Wetland, 2017; Walker, 2019). However, after reviewing these existing frameworks, we determined that a Te Kawerau Iwi-specific framework would be preferable.

At a hui in June 2024, I was recommended to enter the ngahere and make myself known, preferably before and during dawn. It was through this process that tohu would become present for observation — that the forest would reveal to me what it wanted me to know. This approach to fieldwork falls under a whakapapa-based framework (see Section 2.3.1 of this thesis). An emphasis is placed on the *relationship* between the researcher and Te Taiao. In this instance, the relationship between me and those present or absent in Te Wao Nui ā Tiriwa was paramount.

5.3.2 Te Kawerau ā Maki key values

As discussed in Section 2.3, Te Kawerau ā Maki values are essential considerations when making decisions regarding environmental monitoring. An important component of mātauranga-a-Te Kawerau ā Maki, iwi values should serve as the basis for creating environmental monitoring frameworks and tohu (Harmsworth & Tipa, 2006). It would be unsuitable and mana diminishing if the environmental monitoring framework and tohu created in this project did not agree with Te Kawerau ā Maki's key values. Acting on the advice of the

Pou Tiaki, I created an initial list and description of values I found in publicly available iwi planning and policy documents (Kawerau a Maki Trust, 1995; Te Kawerau Iwi Tiaki Trust, 2021). The five values described below (and one concept, whakapapa) were confirmed and refined with the addition of thoughts from Te Kawerau Iwi Tiaki Trust's Pou Tiaki (Te Kawerau Iwi Tiaki Trust Pou Tiaki, personal communication, 28 March 2024).

Rangatiratanga

Rangatiratanga has multiple definitions, but it can be understood to mean sovereignty, self-determination and self-management (Moorfield, 2011). Rangatiratanga is related to leadership and the ability to unite (ranga) groups (tira) together (Royal, 1998). Within the context of environmental monitoring, rangatiratanga for Te Kawerau ā Maki can mean that the iwi have the right to self-determination and sovereignty over monitoring in their rohe (as provided for under the Te Tiriti o Waitangi), including their heartland – Te Wao Nui ā Tiriwa. The environmental monitoring framework and tohu resulting from this thesis should be created in a way that supports the rangatiratanga of mana whenua, Te Kawerau ā Maki. This is achieved by ensuring that the monitoring framework developed through this research aligns with their desired outcomes and values.

Whakapapa

The whakapapa (See Section 2.2.1) of flora and fauna within Te Taiao via atua (ancestral deities) is an important concept, rather than a value to keep in mind in the development of an environmental monitoring framework in Te Wao Nui ā Tiriwa (Te Kawerau Iwi Tiaki Trust Pou Tiaki, personal communication, 28 March 2024). It is essential to recognise the ancestral connections of all elements of Te Taiao, as well as the researchers, mana whenua, and other human visitors to Te Wao Nui ā Tiriwa. When the state of forest health in Te Wao Nui ā Tiriwa is poor, it affects the health of Te Kawerau ā Maki members through this interrelatedness. Acknowledging the concept of ancestral connections and interrelatedness of Te Taiao was essential in developing a cultural environmental monitoring framework and tohu for Te Kawerau ā Maki.

Whanaungatanga

Whanaungatanga (See Section 2.2.1) is a value that describes the interconnectedness of all things. This interconnectedness is reflected in whakapapa (Royal, 1998). Te Kawerau ā Maki documents highlight the importance of whanaungatanga for the iwi (Te Kawerau Iwi Tiaki Trust, 2021), emphasising the kinship and reciprocal connections through shared whakapapa. Whanaungatanga is supported in environmental monitoring by and for Te Kawerau ā Maki through the development of monitoring methods, a monitoring framework and tohu that

emphasise the connection and relationships between all things–the researcher, mana whenua and Te Taiao.

Wairuatanga

In te ao Māori, wairua is defined as “the soul” or “spirit”, something that is in every being before birth, and carries on after their death (Section 2.2.4, Marsden, 2003; Mead, 2003). It is connected to overall wellbeing, identity and a core concept in the Māori worldview. Wairua is “…the source of existent being and life” (Marsden, 2003, p. 47). Wairuatanga is an essential concept from te ao Māori that holds great importance to Te Kawerau ā Maki. The state of wairua has an a cascading impact on other values and state of health and well-being for the iwi, as illustrated in this statement from Te Kawerau Iwi Tiaki Trust’s Pou Tiaki: “If the wairua (including tapu) and mauri of a place is depleted, then kaitiakitanga has failed and we also then cannot provide for ourselves or our guests, which undermines our rangatiratanga, which undermines our mana and wellbeing as a people” (Te Kawerau Iwi Tiaki Trust Pou Tiaki, personal communication, 28 March 2024). If performed correctly, environmental cultural health monitoring in Te Wao Nui ā Tiriwa has the potential to monitor and sustain the state of wairua in the area, which, as described above, plays a vital role in the mana and health of Te Kawerau ā Maki.

Manaakitanga

Manaakitanga (Section 2.2.3) describes the mutual increase of mana in a scenario where groups encounter one another (Royal, 1998). According to Mead (2003), “All tikanga are underpinned by the high value placed upon manaakitanga–nurturing relationships, looking after people, and being very careful about how others are treated” (Mead, 2003, p. 33). Mana is increased on both sides, showing the guests hospitality and care. The hosts' mana is also increased by their ability to provide for their manuhiri. Environmental cultural health monitoring in Te Wao Nui ā Tiriwa can provide a greater understanding of the health of the ngahere and the ability of Te Kawerau ā Maki to manaaki their guests. Te Kawerau ā Maki cannot properly host their manuhiri if the ngahere is in a poor state of health and resources are depleted.

Kaitiakitanga

As discussed in Section 2.2.2, kaitiakitanga, or guardianship, is one of the most relevant Māori values relating to environmental conservation. Te Kawerau ā Maki can gain a better understanding of the health of Te Wao Nui ā Tiriwa through the creation of an environmental monitoring framework that is aligned with te ao Māori, thereby increasing their ability to act as guardians over the land. Additionally, increasing awareness of existing monitoring within

their rohe (by Auckland Council, Ark in the Park, etc.) can support mātauranga-a-Te Kawerau ā Maki. It is essential to maintain Te Kawerau ā Maki's ability to fulfil their obligations as kaitiaki as a central focus during the development of an environmental monitoring framework and tohu for monitoring in Te Wao Nui ā Tiriwa, the heartland of their rohe.

5.3.3 Te Kawerau ā Maki priority environmental and biodiversity concerns

The framework developed through this research also needed to align with Te Kawerau ā Maki's key environmental and biodiversity concerns within Te Wao Nui ā Tiriwa and wider rohe. Again, after reviewing publicly available iwi documentation (Kawerau a Maki Trust, 1995) and consulting with Te Kawerau Iwi Tiaki Trust's Pou Tiaki, the main environmental concerns for Te Kawerau ā Maki were identified (Table 12) and confirmed with the iwi's Pou Tiaki (personal communication, 28 March 2024). The first area of environmental concern for the iwi is the mauri of waterways, encompassing concerns about wastewater, including domestic and industrial waste, as well as farm effluent. They are concerned about contaminated stormwater runoff, which is likely to become an increasing concern with the rise of extreme weather events due to climate change. Waterways are sources of kai for Te Kawerau ā Maki, who desired that the awa (waterways) in their rohe were in a state to be able to harvest traditional food species (Kawerau a Maki Trust, 1995). While acknowledging Te Kawerau ā Maki's environmental concerns regarding the waterways within their rohe, the time constraints of an MSc thesis necessitated a focus on the scope of this research to forest ecosystems. The iwi's concerns regarding terrestrial and forest ecosystem types are described below.

Te Kawerau ā Maki has concerns regarding the flora and fauna within their heartland, Te Wao Nui ā Tiriwa and their wider rohe. The iwi wishes to have access to a thriving terrestrial ecosystem for gathering, harvesting, craft, medicine and food. They support programmes that work to eradicate pest plants and animals that pose a threat to native ecosystems and wish to be involved in all decision-making regarding the introduction of non-native plant species to Aotearoa (Table 12) (Kawerau a Maki Trust, 1995). It was vital to consider Te Kawerau ā Maki's environmental concerns regarding water, flora, and fauna, as well as their key values, and to use these to help inform the development of a cultural environmental monitoring framework and tohu during this research.

Table 12

Te Kawerau ā Maki Key Environmental Concerns (Water, Flora & Fauna) from (Kawerau a Maki Trust, 1995).

Area	Concerns
Water	• Protect the mauri of all natural waterways. • Protect and enhance the food-producing capacity of natural waterways. • Protect and enhance the life-supporting capacity of natural waterways. • Promote water conservation and efficient water use.
Flora and Fauna	• Have access to flora and fauna for harvesting and craft. • Ensure the protection and enhancement of native flora and fauna and their ecosystems • Support the eradication of exotic plants and animals that are damaging, destroying, or competing with native species or their ecosystems. • Participate in decisions regarding the introduction of exotic flora and fauna into NZ. • Ensure that property rights are not ascribed to native species in breach of our Treaty rights.

5.3.4 Field audio recordings: thematic analysis

There were 57 audio transcripts created from 23 hours of audio recordings from nine site visits in various parts of Te Wao Nui ā Tiriwa (See Table 6 for a list of hīkoi and Figure 11 for a map of walking track locations). These transcripts varied in length and contained field observations collected over four months (November 2024 – March 2025). Thematic analysis (For methods, see Section 4.8.2) of all audio transcripts was outside the scope of this research, so I analysed a subset of transcripts (I randomly selected four of 34 transcripts > 10 minutes in length) from pre-dawn/dawn field trips and those including Te Kawerau Iwi Tiaki Trust representatives for this analysis (See Appendix O for a sample page from thematic analysis coding sheets of field audio transcripts). The following five themes emerged after coding and categorising audio transcripts from site visits to the ngahere.

Tikanga and kaitiakitanga

This theme surrounds the foundational values, responsibilities and practices of caring for Te Taiao. Content surrounding tikanga included discussions and practices related to spiritual protocols (i.e., karakia upon entering and leaving the forest, oli and incantations where appropriate, and being mindful of tapu spaces). I encouraged those accompanying me to Te Wao Nui ā Tiriwa to introduce themselves to the ngahere mindfully through mihi or greeting, whether spoken aloud or expressed silently to themselves. Spiritual cleansing was performed

through the incantation of karakia and through cleansing with water when available upon entering and exiting the ngahere. The practice of withholding mātauranga that is not to be widely shared was reflected in a field transcript of Te Kawerau Iwi Tiaki Trust's Kaimahi Taiao concerning pūrākau tapu (sacred stories), where they described stories of the tūpuna that they were unable to share widely. This preservation of privileged information is also a form of tikanga, a set of protocols in place to protect and respect these valuable knowledge sources.

Being respectful of the human visitors to the ngahere and non-human inhabitants was another recurring theme. The old rākau tūpuna were often addressed directly and respectfully, with "Tēnā koe". If these rākau were mauiui (sick, unwell) with kauri dieback disease, we would often acknowledge them with words of support such as "Kia kaha", or thanking them for their presence and mauri, which lifts the mana of those in the forest, ourselves included.

Katiakitanga, or the proper guardianship of the ngahere, was also a central theme of these observations and is closely tied to tikanga. There were frequent discussions about kauri dieback disease, and arriving with clean boots and further disinfection at cleaning stations was a common practice as a preventative measure. Another aspect of kaitiakitanga was limiting my time in the ngahere. Although the tracks we visited were opened after the rāhui was partially lifted in 2024 (apart from one visit to a closed track in March 2025), the ngahere is still considered a wahi tapu due to the presence of kauri dieback disease, and because of the great spiritual and ancestral value Te Wao Nui ā Tiriwa holds for Te Kawerau ā Maki (Littlewood & Snell, 2018). We were also visiting the ngahere during the predawn hours, which some consider a tapu time of great spiritual significance. I commented that I felt it was important to visit the ngahere when I "have a purpose", and only to visit the ngahere when my field assistants and I were feeling well, which sometimes led to delays in field data collection progress. While it was important to spend time in Te Wao Nui ā Tiriwa to get to know the ngahere and let it know us, it was also important to act as good kaitiaki by observing proper protocols. These preventative acts and awareness of kaitiakitanga supported our aspirations to act as respectful guardians of Te Wao Nui ā Tiriwa.

Sensory awareness

Observation using this environmental monitoring method was often centred around perceiving subtle shifts within the observer and in the environment through sight, sound, smell, intuition and somatic feelings. Visually, members of the research team, including myself, might notice seedlings on the forest floor, a plant with new growth, a plant in decline or birds in the trees. Some examples of these observations made by field assistant Lynda Burnside (Tainui, Ngāti Maniapoto), who accompanied me on many site visits, reflects this visual sensory awareness,

“There’s two small birds on her branches,” “There’s a pīwakawaka just in here, and then up here is a baby tūī, or a juvenile tūī who hasn’t quite learned its call yet.” We would often take note of the clouds in the sky and the stars.

Another recurring theme was auditory observations. Birdsong was noted on several occasions, notably the distinct sound of the pīpīwharauroa, tūī, pīwakawaka and ruru. The sound of the awa (water) often caught our attention, and we would frequently try to gauge our proximity to it. Olfactory observations were also noted in field audio recording transcripts, such as the smell of something rotten or a sweet scent. This would motivate us to look around the area, where we might see a rotting animal or a flowering plant nearby. Physical observations through the sense of touch were another aspect of these observations, as noted in field transcriptions, where we would make remarks about feeling hot or cold, or feeling a light or heavy breeze on our skin.

Somatic and intuitive feelings were prevalent, yet are some of the more challenging to describe here. This involves reacting to a “gut-feeling” while in the ngahere. For example, upon approaching a rākau tūpuna, I described a somatic response as is illustrated in this field transcript excerpt, “When we were approaching, my heart started racing–I hadn’t seen the tree at all yet–and then when we came upon it, Oh! OK, I definitely felt something in my naʻau – in my gut.” A familiar somatic feeling we would experience in the ngahere would be a physical reaction to sadness or hopelessness upon encountering a dead or dying rākau tūpuna as a result of kauri dieback disease. At times, I would respond to these through pule (prayer, *ʻōlelo Hawaiʻi*) or karakia. I often recited an oli aloha (chant of love, *ʻōlelo Hawaiʻi*), sending love to these trees in response. Sitting or standing in silent reverence for these tūpuna at other times seemed like the most appropriate response. As described above, being open and receptive to our senses and perceiving appropriate responses was essential to our environmental observation methods.

Whakapapa and whanaungatanga

Another recurring theme from field transcripts was the relationship between Te Wao Nui ā Tiriwa's non-human inhabitants and the research team. First, it was of great importance that myself and those accompanying me in the field share our whakapapa with the inhabitants of the ngahere where possible. I recited oli to share my whakapapa as Kanaka Maoli to Te Wao Nui ā Tiriwa. Others who joined me in the forest might give a silent mihi to share their background or ancestral connections. The theme of whanaungatanga was reflected in the many instances where the research team members would directly address the forest's inhabitants, just as one would address a person. Often, we expressed gratitude to the non-

human elements of Te Taiao, acknowledging their mana-uplifting energies. “Thank you, Marama, for guiding us,” Lynda declared as we walked through the pre-dawn hours in the ngahere on Ōturu, where the moon was nearly full. We frequently thanked the rākau tūpuna in Te Wao Nui ā Tiriwa for sharing their life and powers with us while in the ngahere. A further example of acknowledging the importance of whakapapa and whanaungatanga was a discussion surrounding the whakapapa and relationships of the forest's non-human inhabitants. Te Kawerau Iwi Tiaki Trust’s Kaimahi Taiao shared this whakaaro (thought) on the whakapapa of the birds who call Te Wao Nui ā Tiriwa home: “I always think of the reason the birds call early in the morning is because first light is Tāne te Waiora. So [they are] greeting him… That’s why they’re so busy first thing in the morning.” Another example of the whakapapa of the forest is insects, who are also children of Tāne. Whanaungatanga– relationships, and whakapapa – genealogy of the forest inhabitants and the research team were important themes that arose during audio recordings during field observations.

Environmental tohu

Tohu, or “signs” in the environment, were another recurring theme throughout the audio transcripts. These were differentiated from general plant and animal observations, as they were more likely to grab our attention. Tohu might include certain plants, the presence of bird droppings containing seeds of native plants, plants that are fruiting, flowering, or grazed by insects, as well as those that are thriving or in decline. We took particular notice of koru — the spiral-shaped new growth of ponga and mamaku (*Cyathea medullaris*) tree ferns —and commented on their symbolism of new life, especially in the context of a ngahere affected by kauri dieback disease. Fallen trees on the path were tohu that the ngahere had recently experienced a storm. One of the more obvious tohu was encountering a dead bird in the middle of the path (we happened to be on a closed track, “Tramline Track” at that time, see Table 6, Figure 11), indicating that it was unsafe for us to proceed and prompting us to quickly change our location.

We occasionally observed meteors and shooting stars during the pre-dawn hours. According to Rāwiri Taonui, “Bright meteors were taken as a good omen, indicating future action. Duller ones were bad omens. Meteors also augured the death of great leaders and the rise of new ones” (Taonui, 2006, p. 5). Sometimes tohu were auditory, such as a bird's song that captured our interest. Occasionally, a bird would respond after I shared an oli to introduce myself to the ngahere. Certain birds might be present, seem very close to us, or seem to follow us along the track. Sometimes birds would be more active and audible, which we interpreted as a sign of high energy in the forest. The sound of the pīpīwharauroa was a sign of the beginning of matiti kura, the first phase of summer in the maramataka, that coincides with the arrival of spring in

the Gregorian calendar around September. The absence of the pīpīwharauroa was a tohu that this migratory bird had left Aotearoa, and a shift into matiti rauangina (the final phase of summer in the maramataka, autumn, occurring around March in the Gregorian calendar), or kaupeka wero (the first of three cooling phases in the maramataka, occurring around April in the Gregorian calendar). As reflected in whakataukī, the sound of kihikihi (Cicadas; *Amphipsalta zelandica; Kikihia muta*) and the other manu o Rehua (birds of summer) was a sign that the matiti seasonal phases had well and truly arrived.

Maramataka and temporal awareness

During our field visits, the maramataka and the observation of time and seasons were common themes. For example, we might notice the moonlight in the ngahere as it shed light upon different plants or elements of the environment. There were frequent comments on the sunrise phases, as Te Taiao transitioned from Te Ao Pō into Te Ao Mārama. This observation method was centred around the sunrise, which was often the subject of discussion. Did we enter the forest too early? Too late? What time should we arrive the following day? At sunrise, I would sometimes recite the karakia *'Whakataka te hau',* as its words describe the bright sunrise and morning frost. The themes arising from the fieldwork observation transcriptions did not exist in isolation from one another. There was often an interaction between them. For example, the darkness of Te Ao Pō (Theme: temporal awareness) often evoked a feeling of unease in me (Theme: somatic awareness), which I responded to with karakia, pule, or oli to provide another level of safety (Theme: tikanga). Another example of the fluid nature between themes is the discussion surrounding Hinetītama–the Dawn Maiden (Figure 22)– who is a symbol of the rising sun (Theme: temporal awareness) with a genealogical connection to Tāne (Theme: whakapapa and whanaungatanga). Additionally, the dawn chorus of manu (Themes: temporal awareness, sensory awareness) reflected the identity of the birds as children of Tāne (Theme: whakapapa and whanaungatanga). These predominant themes were recurring throughout our visits to the ngahere and were important in shaping our research methods and observations.

Figure 22

The view of Hinetītama/Tāne-te-waiora (the sunrise) over Ngā Rau Pou ā Maki as seen from Fenceline Track (Montana Heritage Trail). Photo: Author's own.

5.3.5 Field observations

Figure 23

The author observes the epiphytic winika (Dendrobium cunninghamii) *orchid in bloom during dawn monitoring in Te Wao Nui ā Tiriwa. Photo: Aaron Blackbourn.*

Using the methods recommended to me, I carried out nine site visits on various track locations within Te Piringa (the upper Waitākere River catchment) from November 2024 to March 2025 (See Figure 11 and Table 6). This method differs from a Western science approach to environmental monitoring, which employs standard quantitative methods, such as plots, counts, and individual species surveys. The data collection method used in this research was a preliminary effort to trial an observation- and relationship-based environmental monitoring method over a four-month period. While the data collected from this research was not necessarily a result of a structured or formalised methodology, it can provide a preliminary understanding that can potentially be used to inform an environmental monitoring framework. What follows are the results of these site visits.

Flora in te Wao Nui ā Tiriwa

We took note of plants that caught our attention during our field visits, and these were recorded in field observation transcripts. Some plants seemed to be thriving, while others appeared to be in decline or on the verge of death. Occasionally, we noticed seedlings and noted their species, and we also noted new plant growth where possible. This was not an exhaustive, traditional, plot-based vegetation monitoring method, but one that aligned with the observational method of environmental monitoring created as part of this research. Overall, 197 native plants from 54 different species were observed as part of this research (Figure 24). Some were noted for particular characteristics (e.g., flowering, fruiting, in decline, etc.) and are described in the following sections. The most frequently observed plant species were the kauri, which could have been due to their dominance in Te Wao Nui ā Tiriwa and large size. These observations are in agreement with the data analysis of basal area and species abundance carried out as part of this thesis (See Figure 14), which found that kauri were by far the dominant species within the study area in terms of basal area (m^2 per ha). We also frequently mentioned kauri that were affected by kauri dieback disease, which evoked feelings of sadness at times. Rewarewa caught our eye, often because of their epiphytic growth patterns and deep red flowers. The nīkau were often observed with noticeable and plentiful bright red fruit, which is consistent with the phenological analysis carried out as part of this research (See Figure 21). Hangehange was often mentioned in field audio recordings because of its flourishing growth patterns.

Flowering plant species

Ka kai te kākā i te wai kaihua,	*When the parrot partakes of the rātā nectar*
Ka kiia he rārangi tahi.	*it is called a single line.*

A total of 20 flowering plant observations across 12 unique species were included in field observations in Te Wao Nui ā Tiriwa, either mentioned in audio recordings or photographed (Appendix Z). The species with the most flowering plants observed was māhoe (n=6), followed by rewarewa (n = 4) (Figure 25). The rewarewa's large, bright red flowers caught our eye, and the scent of the māhoe flowers sometimes made us take pause and make a note of their flowering. Some plants had senescent flowers, meaning their flowers had previously bloomed, and their aged flowers remained on the plant (Figure 26). These were recorded as separate observations and not included in the number of flowering plants (Appendix Z).

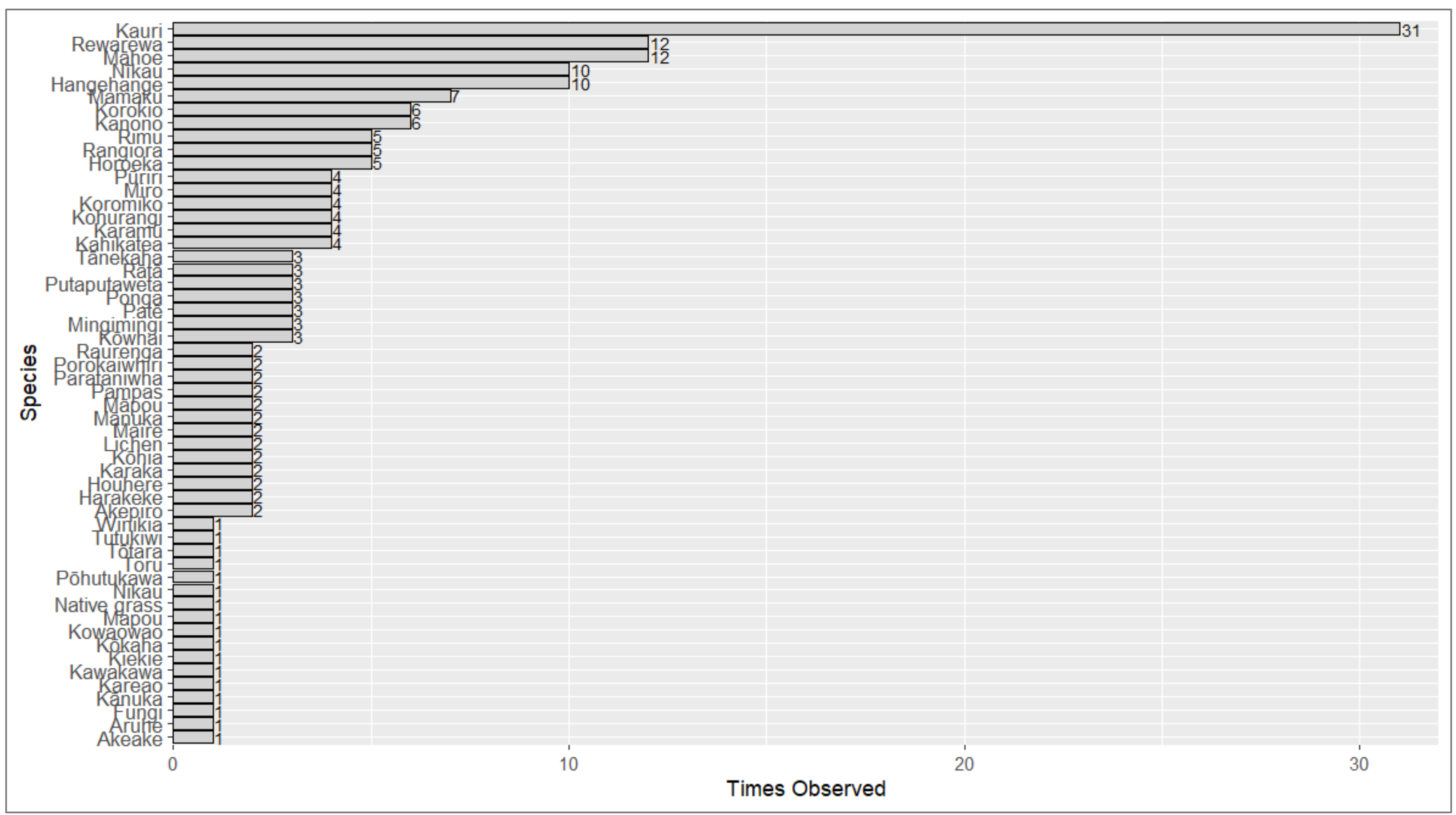


Figure 24

This bar graph shows 54 unique plant species observed and noted during nine site visits to Te Wao Nui ā Tiriwa from November 2024 to March 2025. This is not a population estimate; for example, one mamaku observed could represent the mention of a grove containing many mamaku in audio transcripts.

Figure 25

Photos showing observed flowering on a rātā (Metrosideros robusta) *and māhoe* (Melicytus ramiflorus subsp. ramiflorus)*. Photos: Author's own.*

Figure 26

Senescent flowers observed on an akepiro (Olearia furfuracea; Left) *and kōkaha* (Astelia trinervia) *during field visits from November 2024 to March 2025. Photos: Author's own.*

Fruiting plant species

He kōkō kai kohe. A tūī eating kohe berries.

Fruit dispersal by native birds contributes to plant population abundance (Clout & Hay, 1989; Innes et al., 2022); therefore, these fruiting plant species can be useful indicators of a healthy

ecosystem in Te Wao Nui ā Tiriwa. A total of 30 fruiting observations of 14 unique plant species were observed in their fruiting stages during the monitoring period from November 2024 to March 2025 (Appendix Z). The most frequently observed fruiting species was the nīkau, with its larger distinctive red fruit, which is a frequent food choice of native bird species like the kererū. Kanono produces orange berries and is also an important food source for many birds. Other species observed to be fruiting include the miro and hangehange (Figure 27, left and right). Several plants were observed post-fruiting, with aged and/or dried and seedless fruiting bodies attached (Figure 28, Left). These were not included in the total number of fruiting plants.

Figure 27

*Fruiting observed on a miro (*Pectinopitys ferruginea*) tree (left) and hangehange (*Geniostoma ligustrifolium var. ligustrifolium*). Photos: Author's own.*

Insect herbivory

Figure 28

*Koromiko (*Veronica salificfolia*) is post-fruiting, with no seeds present (left). Rangiora (*Brachyglottis repanda*) showing signs of insect herbivory. Photos: Author's own.*

A total of five observations of signs of insect herbivory on four different species were noted during these visits to the ngahere (Appendix Z). Māhoe with signs of herbivory was noted twice, followed by rangiora (*Brachyglottis repanda)*, houhere *(Houheria populnea)* and harakeke *(Phormium tenax)*. Māhoe, rangiora and houhere were observed with holes in their leaves, which is characteristic evidence of herbivory by insects. The harakeke observed with herbivory was likely grazed by birds, rather than insects, as evidenced by the presence of seedpods from this plant on the forest floor.

Plant species in decline

Kua hinga te kauri o Te Wao Nui ā Tiriwa.	*The kauri of the great forest of Tiriwa has fallen.*

Seven dead trees were noted during our visits with Te Wao Nui ā Tiriwa. The majority being kauri (Figure 29, n = 5), but also including a single porokaiwhiri *(Hedycarya arborea*, n=1) and ponga (n = 1). Eleven other plants were noted as "in decline", meaning they were visibly deteriorating (i.e. wilting and/or less vigorous growth, etc.). Many of these were rākau kauri, which had been affected by kauri dieback disease.

Figure 29

*A kauri (*Agathis australis*) in Te Wao Nui ā Tiriwa showing signs of decline as observed by their thinning canopy. Photo: Author's own.*

New growth

New foliage growth on plants was another common observation of vegetation. We observed fresh, young leaves on several plant species during our site visits, and we mentioned a selection of these in our audio recordings and photos. New foliage growth in plant species suggests low levels of browsing by pests, such as possums (Sweetapple et al., 2016; Windley et al., 2016), indicating that the plants are healthy and successfully growing under their current environmental conditions. Eleven observations from eight unique species were observed with some form of new growth (Appendix Z). While in the ngahere, we noted the numerous koru – striking, coil-shaped new growth forms – on mamaku and other fern species (Figure 30, top right). This was reflected in the mamaku, the most frequently observed plant with new growth. Tānekaha patē *(Schefflera digitata)* and kawakawa *(Macropiper excelsum)* were among the other plant species observed with new growth (Figure 30).

Figure 30

*(Top left) New growth observed on a patē (*Schefflera digitata*. (Top right) A koru on a mamaku (*Sphaeropteris medullaris*, top right). (Bottom left) New growth observed on a miro (*Pectinopitys ferruginea*, bottom left). (Bottom right) Rangiora exhibiting signs of new growth* (Brachyglottis repanda). *Photos: Author's own.*

Regeneration

When we encountered native plant species seedlings or saplings on our hīkoi in the ngahere, we occasionally noted them on the audio recording or through photographs (Figure 31 and Figure 32). Nineteen observations across six unique species were described as seedlings or saplings during audio recordings or were present in field photographs (Appendix Z). On some occasions, these seedlings were a part of a mixed species presentation (as seen in Figure 31, Left). Native regeneration indicates high levels of frugivory and dispersal of seeds by native bird species (Clout & Hay, 1989; Innes et al., 2022), as well as low levels of browsing by pest mammals (Allen et al., 2003b), and can be an important indicator of forest health, demonstrating the vitality of the next generation of plants.

Figure 31

(Left) Kahikatea (Dacrycarpus dacrydioides) *and hangehange* (Geniostoma ligustrifolium var. ligustrifolium) *seedlings grow on the forest floor. (Right) Putaputaweta* (Carpodetus serratus) *seedlings observed. Both photos show a healthy amount of the invasive* Selanginella sp. *(clubmoss), commonly found along forest tracks, which can block native seedling regeneration. These were observed during field visits to Te Wao Nui ā Tiriwa from November 2024 to March 2025.*

Thriving plants

Figure 32

*Lynda Burnside, field assistant, observes new growth on a māhoe (*Melicytus ramiflorus subsp. ramiflorus*, foreground). "Thriving" hangehange (*Geniostoma ligustrifolium*) with vigorous growth patterns can be seen in the mid and background. Photo: Author's own.*

Six observances of six unique plant species were noted as "thriving", meaning they appeared to be in very healthy condition or exhibiting healthy growth forms (Appendix Z). Hangehange (Figure 32), is a shrub that grows up to four meters tall and thrives in many habitats. It is the most widely distributed woody plant in the Auckland Region within Council 20m x 20m forest plots (Craig Bishop, personal communication, June 2025), and is an important source of nectar and fruit for native birds in Te Wao Nui ā Tiriwa (Innes et al., 2022). This plant species was prevalent throughout the forest floor, thriving in both shaded environments and along forest margins. Parataniwha *(Etatostema rugosum)* is another forest floor plant species we observed "thriving" during field visits. Nīkau were observed to exhibit vigorous growth patterns, with some specimens growing exceptionally tall or forming large groups. A few glades of healthy rimu trees were also observed (Figure 33).

Figure 33

*(Left) A very tall nīkau (*Rhopalostylis sapida*) and (Right) a glade of numerous young rimu (*Dacrydium cupressinum*) noted as "thriving" during field observations in Te Wao Nui ā Tiriwa. Photos: Author's own.*

Notable species

Kauri (*Agathis australis*)

Ko te kauri ko au, ko te au ko kauri *I am the kauri, the kauri is me.*

Kauri are the most prominent rākau within Te Wao Nui ā Tiriwa and are known for their large, straight trunks and dense, wide canopies when in healthy condition (Cranwell, 1981; Ecroyd, 1982). As previously discussed, they are of great importance to Te Kawerau ā Maki, for they are their tūpuna and offer a physical connection to the ancestral world through whakapapa. Their size, abundance and state of health due to the effects of kauri dieback disease were certainly attention-grabbing for our research team, and they were the most frequently mentioned plant species in audio transcriptions Figure 24.

Rātā (*Metrosideros robusta*)

The northern rātā is a tree that is prevalent throughout Te Wao Nui ā Tirwia. Rātā starts as an epiphyte, growing in the canopy of larger trees before growing roots that form a trunk around the host tree (de Lange, 2004). We encountered many rātā during our field observations, some in surprising places. The impressive epiphytic growth form of the rātā, its abundance in Te Wao Nui ā Tiriwa, and its significance as a tohu for the beginning of matiti muramura in the maramataka make this species particularly notable.

Tutukiwi (*Pterostylis banksii*)

The tutukiwi *(Pterostylis banksii*) (Figure 34, left) is a forest orchid native to Aotearoa, notable for its rare occurrence and distinctive large green hood (de Lange, 2007b). The tutukiwi's distribution is limited to kauri forests, so the loss of kauri due to kauri dieback would have a potentially devastating effect on this species. We found two of these species growing next to each other on the forest floor, where they are commonly found. Their rarity during field observations, as well as their distinctive growth form, captured the interest of the field team.

Figure 34

*(Left) Tutukiwi (*Pterostylis banksia*) and (Right) winika (*Dendrobium cunninghamii*) orchids were observed in Te Wao Nui ā Tiriwa during field observations from November 2024 to March 2025.*

Winika (*Dendrobium cunninghamii*)

Winika (Figure 23 and Figure 34, right) is a small epiphytic orchid that grows in forests in Aotearoa, often found in shaded environments (de Lange, 2007a). This orchid was striking and a memorable observation during our field visits with Te Wao Nui ā Tiriwa. We observed two large clumps of winika along with other epiphytic plants growing on a mamaku (Figure 23 and Figure 34, right). Winika is said to have derived its name from the war canoe Te Winika of the Tainui people. This may have special significance considering Te Kawerau ā Maki's ancestral ties to the Tainui iwi (St George, 2007).

Birds and insects in Te Wao Nui ā Tiriwa

Figure 35

*A kererū (*Hemiphaga novaeseelandiae*) observed in a kānuka (*Kunzea ericoides*) tree in Te Piringa, Te Wao Nui ā Tiriwa. Photo: Author's own.*

Bird observations were recorded during field visits with Te Wao Nui ā Tiriwa (Figure 36). These were verbally mentioned on audio recordings or, more frequently, heard in the background audio and then transcribed. I entered the birdsong observations into an Excel spreadsheet for tabulation (See Appendix Q for a sample page from this dataset). Much like in vegetation observation-based monitoring, this data was not collected using a standard methodology (such as the 5-Minute Bird Count), so it does not represent an exact calculation of the number of unique birds heard throughout our time spent in the ngahere. However, this data can provide a general idea of which bird species were more noticeable and active in the research study area during our field visits.

E koekoe te tūī, e ketekete te kākā, e kūkū te kererū. *The tūī chatters, the parrot gobbles, the wood pigeon coos.* This whakataukī is reflected in the results of bird observations during this study. Tūī were by far the most commonly heard bird species in recordings, where 610 observations were recorded (Figure 36). Pīwakawaka was the following most frequently heard bird species (n = 315), followed by the riroriro (n = 190). The distinctive calls of the kākā and pīpīwharauroa were also heard during this observation-based monitoring.

Figure 36

Total bird observations recorded during field visits to Te Wao Nui ā Tiriwa from November 2024 to March 2025.

As children of Tāne, kihikihi (*Amphipsalta zelandica, Kikihi muta*), pēpē (moths, unknown sp.) and kapowai (dragonflies, unknown sp.) like birds, contribute to the health of Te Wao Nui ā Tiriwa (Anderson, 2003). Kihikihi were present in the first recording on 19 November 2024; however, their sound was very faint. Starting with the visit on 16 December 2024, their sound grew in intensity and became more consistent as summer progressed. Kihikihi were audible in the background of the remaining audio recordings until the final site visit for this study on 10 March 2025. This observation is in line with the mātauranga passed down through the whakataukī: **Me te terakihi e papaā ana i te waru.** *Like the cicada in the eighth month.* Kohitātea, the eighth month in the Māori year, occurs around December to January, so hearing the kihikihi's strident buzzing during this time aligns with these ancestral observations. Pēpē were often observed in the pre-dawn hours, sometimes attracted to the torches carried by the research team. A kapowai was present for much of our visit to the ngahere on 22 December 2024 on the Fenceline Track, making their presence known by buzzing around our heads.

Weather and environmental observations

Figure 37

Hinepūkohurangi (the Mist Maiden) settles over the ngahere near Te Awa Kōtuku. Photo: Author's own.

Commentary on the weather and light levels was frequently included in audio transcript observations. Audio transcriptions were examined for these observations and entered on an Excel spreadsheet. (See Appendix R for a sample page from this dataset). Because of the nature of dawn monitoring, with the sun rising, there were frequent comments about the light in the ngahere. Shifting light levels, shadows created by the rising sun, moonlight coming through the forest canopy and lighting our way through the ngahere during pre-dawn hours were frequently mentioned. Weather observations were also regularly made. There were times when the interaction between weather and light conditions was also commented on. While trying to determine if the sunrise had passed, Lynda Burnside, the field assistant, spoke about the effect of cloud cover on lighting conditions in the ngahere, "If it wasn't so cloudy, it would be a lot lighter – if you look over there." Later that same morning, she commented on the shadows and moonlight in the ngahere, and how the moon appeared to light our way and illuminate the parataniwha plants alongside the trail.

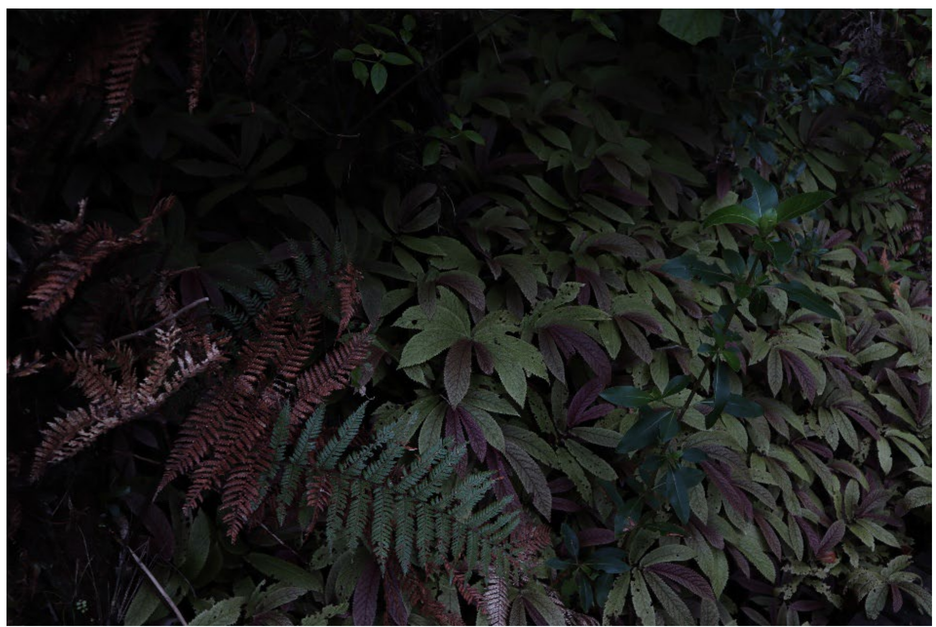


Figure 38

Parataniwha (Elatostema rugosum) in the early morning light in Te Wao Nui ā Tiriwa. Photo: Author's own.

Emotions and somatic markers

Figure 39

Lynda Burnside in Te Piringa, Te Wao Nui ā Tiriwa, in the early morning. Photo: Author's own.

As previously discussed, the great kauri of Te Wao Nui ā Tiriwa have seen the destructive effects of kauri dieback disease, and many of these rākau tūpuna have succumbed to the disease. It is not surprising that being in a forest environment that is mauiui can have an

impact on the emotional well-being of visitors to the ngahere. Audio transcriptions were examined for these observations and entered on an Excel spreadsheet. (See Appendix S for a sample page from this dataset). Feelings of sadness were frequently recorded in field notes, as evident in this conversation between Lynda Burnside and myself. I described a kauri tree's current state of health: "Oh he's very sick." Lynda replied, "I think that one's slowly going too. You're going to lose all of these trees that are a couple hundred years old–well, 500, 600, 800 years old. It's so sad." Another excerpt illustrates this emotional reaction to seeing tūpuna kauri in decline. Lynda stated, "It makes me sad, it's like the tree's crying. It's bleeding." At other times, there were comments about fears for the kauri forest's future, especially after the reopening of some tracks in the Waitākere Ranges in 2021. Lynda describes observed affected kauri she has seen, "Oh there's two there and there's one back there… This one that's just got a few little leaves hanging on there." I replied, "It's…scary. I really hope the land stays protected long enough for the small ones to get this amount of mana." Sometimes, this sadness was mixed with feelings of hope as displayed in the following transcript excerpt where Lynda says, "It's sad, but it's regenerating…There's so many rewarewa seedlings. Just over the whole day, I don't think I've ever seen so many."

As previously discussed, in the Māori worldview, Te Ao (light) is often associated with peace and understanding. In contrast, Te Pō (darkness) is not merely a state of darkness, but a realm of potential and spiritual activity (Marsden, 2003). On some occasions, I would feel uneasy, nervous, or even fearful being in Te Wao Nui ā Tiriwa during the pre-dawn hours. Sometimes, I would experience somatic responses, such as a racing heart or feelings of tension. During occasions when I was very uneasy, I would recite additional pule (prayers, incantations; *ʻōlelo Hawaiʻi*) to ask for protection and strength for our travelling party during this tapu time. Sometimes I would get the feeling that we were not alone in the ngahere, and from a te ao Māori and Indigenous people's perspective, indeed, we were not. We were in the presence of the inhabitants of the realm of Te Ao Pō, awaiting the transition to Te Ao Mārama– from darkness to light–with the hopes that accompanying it would come greater knowledge and understanding.

The emotions experienced during our time in Te Wao Nui ā Tiriwa were not all negative ones. As Lynda described, we felt at peace in many ways while sitting quietly in the ngahere during the sunrise, "It's very peaceful and calming." We also experienced feelings of excitement as we were joined by ngā tamariki o Tāne–the birds, "Sarah, Sarah! –Kererū, up there!", and upon hearing a kākā early in the morning. This observation-based monitoring allowed us to build a deeper connection with the forest. When our field-based research was complete, we felt at home in Te Wao Nui ā Tiriwa and with the non-human beings we encountered there.

5.3.6 Contextual analysis of observations

Te Kawerau Iwi Tiaki Trust representatives sought to ground this project in ancestral wisdom, guided by respect for tikanga and cultural protocols through observation-based monitoring, a literature review of kōrero tuku iho, and prioritisation of maramataka. I attempted two sets of data analysis using observation-based birdsong (See Appendix Q for a sample page from this data), vegetation observation data (Appendix P), and weather and environmental observation data (Appendix R) to investigate the potential correlation between ngā mata o te marama (lunar phases) and ngā kaupeka o te tau (the seasonal phases of the Māori year).

Temporal analysis of birdsong observations

Figure 40

*A kauri (*Agathis australis*) and moon during mata o te marama (moon phase) Tangaroa ā Roto. Photo: Author's own.*

It is essential to note that, due to time constraints and the exploratory nature of this environmental monitoring method, the data were neither collected through a standardised plot system (i.e., 5-minute bird count, repeat visits to the same plot points) nor regimented, repeated visits to the ngahere. As a result, the following data analysis is primarily an exploratory exercise. Frequent, regular visits to Te Wao Nui ā Tiriwa are crucial to getting to know Te Wao Nui ā Tiriwa, and letting it know the visitor. This would enable a more accurate assessment of forest health. I attempted to analyse birdsong data collected during this research in relation to the energy levels of ngā mata o te marama (phases of the moon; see Figure 6 and Table 6) according to mātauranga from Rereata Makiha and his tauira, Ayla Hoeta

(See Section 2.3.1). The results of data analysis indicate that bird activity (average bird calls observed per minute) during "Reflective" energy (Korekore) moon phases was significantly different when compared to the other energy groups ($p < 0.001$) (See Figure 41). Bird activity during the two Korekore moon phases was significantly lower than the other energy groups. There was no significant difference in average bird calls per minute found between the "Abundant" (Tangaroa moon phases), "High" (Ōturu, Rākaunui moon phases) and "Low" (Mawharu, Takirau) energy groupings.

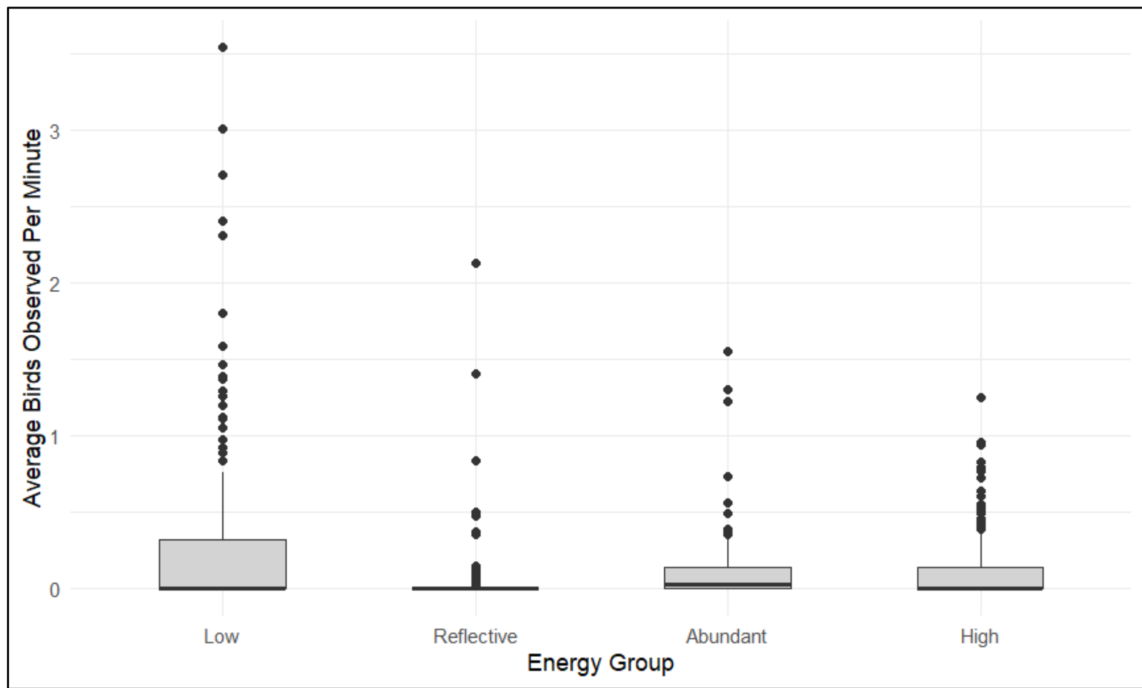


Figure 41

Average bird activity (per minute) was observed during this research according to the Maramataka Energy Phase. Bird observations were grouped according to ngā mata o te marama (the phases of the moon) according to mātauranga from Rereata Makiha and his tauira, Ayla Hoeta (Hoeta, 2020c)"Low" energy moon phases during this study include Mawharu and Takirau. "Reflective" energy phases from this study are Korekore Piri Nga Tangaroa and Korekore Te Whiwhia. "Abundant" energy phases are Tangaroa Kiokio and Tangaroa ā Roto. "High" energy phases are Ōturu and Rākaunui. This analysis found significantly fewer average bird song observations per minute during "Reflective" (Korekore) moon phases than during all other moon phase energy types.

The weather may have influenced these results, as it was raining during one field visit that took place on a Korekore moon phase. Te Kawerau ā Maki's Kaimahi Taiao noted that the lower number of tūī observed on that day may have been due to the rain. The time of day that the data was collected and whether the data was collected on an open or closed track are other potential factors that could have led to this significant difference. Although this was merely an

exploratory data analysis exercise, the findings may provide a good starting point for future, more structured monitoring and data analysis of activity levels in Te Taiao in relation to ngā mata o te marama.

Vegetation in Te Wao Nui ā Tiriwa and ngā kaupeka o te tau (seasons of the year)

Due to the time constraints of an MSc Thesis, field observations were limited to ngā kaupeka matiti (the seven phases of summer, Figure 5, Section 2.3.1). According to mātauranga from Rereata Makiha and his student Ayla Hoeta, the Gregorian calendar months of November to March typically correspond to the kaupeka (seasonal phases) matiti muramura, matiti maiwai, matiti maurehu, and matiti rautapata. Utilising field observations from this research, I attempted to determine if any of the indicators from ngā kaupeka were present during our field data collection. These usually reliable and precise indicators are changing, perhaps due to climate change (Te Karere TVNZ, 2023). While in the field, I tried to be aware of the characteristics of the matiti phases to see if these indicators were present in Te Taiao.

Two of the kaupeka matiti tohu include the flowering of particular species of plants in terrestrial ecosystems. As discussed in Section 2.3.1, matiti hana, the second phase of matiti, is denoted by the flowering of the puawānanga, and usually occurs around Whiringa-ā-nuku (October in the Gregorian calendar) (Hoeta, 2020d). Matiti muramura occurs around Whiringa-ā-rangi (November in the Gregorian calendar) and is signified by the flowering of the northern rātā and pōhutukawa. The bright red flowers of these trees in bloom change the forest canopy from the white of hana (to shine, glow, etc.) to red (muramura).

Matiti muramura

The flowering of the northern rātā and pōhutukawa characterises the matiti muramura seasonal phase. Based on our observations, I suspect field observations took place towards the end of this summer phase. During our nine visits to Te Wao Nui ā Tiriwa, we observed one rātā tree in bloom on 22 December 2024 (Figure 42) and did not see any others either in the month preceding this observation or until the fieldwork was completed in March 2025. It is possible that the rātā were at the end of their blooming phase by the end of December, and Te Taiao would be moving into the next seasonal phase, matiti kaiwai. Other possibilities are that the rātā bloomed much later than usual, or this was a poor flowering year for this species.

Figure 42

*(Left) A rātā (*Metrosideros robusta*) in bloom indicates matiti muramura, the third summer phase, according to mātauranga from Rereata Makiha and his student Ayla Hoeta surrounding Māori ngā kaupeka o te tau (seasonal phases of the year). (Right) The wilting and falling leaves of the māhoe (*Melycitus ramiflorus*) may have been an indicator of matiti rauangina, the final phase of summer, where leaves swing to and fro as they fall from the trees. Photo: Author's own.*

Matiti kaiwai

Matiti kaiwai is the middle of summer, where the ground is parched and cracks may be present as it thirsts for water. Participants described the hot weather in transcripts of audio recordings from the 16 December 2024 field observations with phrases like: "It's warm." "Last night it was so hot I couldn't go to sleep." "It's warm now, eh?" and "It's really hot." The mention of these weather observations in field recordings may indicate that Te Taiao was in the kaupeka matiti kaiwai at that time. This analysis could be improved through a more focused study by collecting and analysing real-time weather conditions.

Matiti raurehu

Matiti raurehu usually occurs around early February in the Gregorian calendar and is the most challenging summer phase to detect (Hoeta, 2019a). This phase may come before the rise of Whanui, the harvest star. Hoeta describes white dust-like substances that may appear on lawns during this time, resembling frost. However, our audio field observations made no mention of the observation of such substances.

Matiti rautapata

Matiti rautapata is determined when seed pods burst and seeds fall (tapata) onto the dry leaf bed below. We noticed seeds on the ground during our site visit on 19 November 2024, but determined that these were most likely evidence of bird droppings. During the 19 March 2024 field visit to Te Wao Nui ā Tiriwa, we observed a koromiko (*Veronica salificolia*) with seed pods that had already burst, leaving no seeds inside (Figure 28). This is highly likely to be a tohu that matiti rautapata had already passed as of March 2024.

Matiti rauangina

An indicator of the matiti rauangina summer phase is the leaves swinging to and fro as they fall from the trees. Leaf fall was observed twice during field visits to Te Wao Nui ā Tiriwa (19 November 2024 and 10 March 2025). However, during the 10 March 2025 field visit, we noticed that the leaves of many of the māhoe trees were very dry and drooping (Figure 42, *Right*), suggesting that Te Taiao may have been in the matiti rauangina phase at this time.

Based on the above environmental indicators, the period for field visits was between the summer phases of matiti muramura and matiti rauangina. However, these observations could have been improved in a more targeted study, perhaps focusing solely on the tohu of ngā kaupeka.

5.3.7 Proposed environmental monitoring framework

Mātauranga Māori and environmental observation domains

Through a culmination of information gathered from hui and kōrero with Te Kawerau Iwi Tiaki Trust representatives, a literature review of kōrero tuku iho and nine site visits to the research study area, I developed a conceptual diagram illustrating the observation and relationship-based environmental monitoring framework developed as a part of this thesis research (Figure 43). Four prominent components from mātauranga Māori– Whakapapa, Tikanga, Kōrero Tuku Iho and Maramataka (Figure 43, in blue)– lie at the heart of this framework. The environmental observation domains (Flora, Fauna, Weather and Environment, and Emotional and Somatic Markers) comprise the green outer ring in Figure 43. Tohu from each domain are also listed in the conceptual diagram. The reciprocal relationship, interaction and influence of mātauranga Māori and the environmental monitoring domains are illustrated by the grey arrows between them (Figure 43).

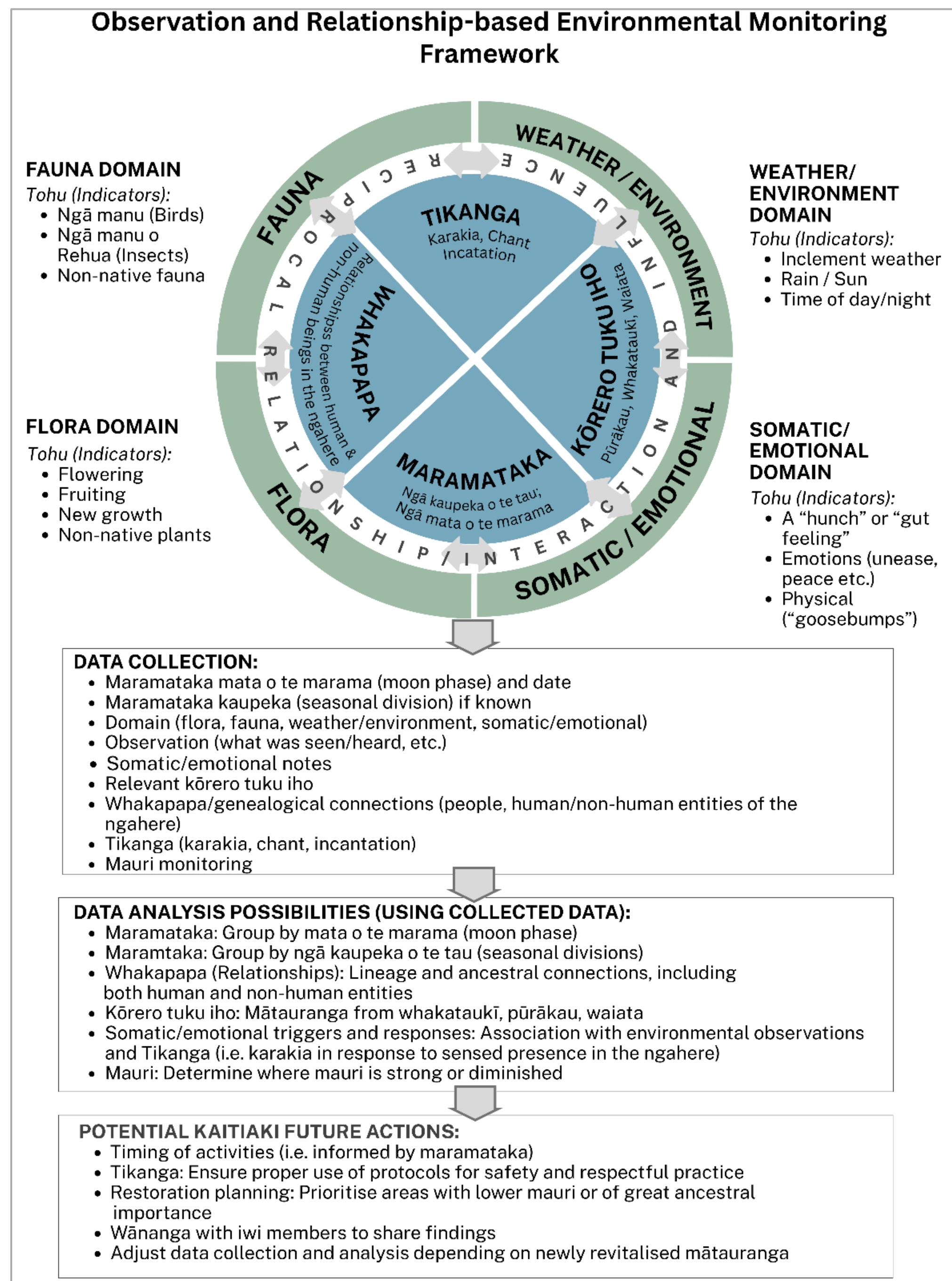


Figure 43

An observation and relationship-based environmental monitoring framework conceptual diagram was developed as part of this study. The proposed tohu are divided into four domains: Fauna, Flora, Weather/Environment and Somatic/Emotional, represented in the green outer circle segments. Four components of mātauranga Māori —Tikanga, Kōrero Tuku Iho, Maramataka, and Whakapapa—are represented in the blue central core, highlighting the foundational nature of mātauranga in this framework. The reciprocal influence between mātauranga Māori and the environmental monitoring domains is reflected in the white central circle. Potential Data Collection, Analysis and Kaitiaki Future Actions are described.

Reciprocal relationship, interaction and influence

The reciprocal relationship, interaction and influence between the environmental domains and tohu, and components of mātauranga Māori, are illustrated in Figure 43. Fieldwork methods in this framework are influenced by tikanga, utilising karakia, chant, and incantation to draw upon spiritual strength and protection upon entering and leaving the forest. Reciprocally, the observations of different flora and fauna (i.e., witnessing a rākau tūpuna affected by kauri dieback disease), or environmental observations like the time of day, may influence the observer to recite a karakia or chant for protection or to offer a formal greeting to an elder, influencing the application of cultural protocols. The basis in kōrero tuku iho, particularly pūrākau, whakataukī and waiata, has an influence in that it provides the observer with a foundation in ancestral knowledge. In return, as mātauranga Māori is a dynamic, growing knowledge system, the observation of tohu may inspire the creation of future kōrero tuku iho by mana whenua or others. In this monitoring framework, components of the maramataka, including ngā kaupeka o te tau and ngā manu o te marama, may influence the timing of field visits or the interpretation of results (i.e., conducting fieldwork during “high energy” lunar phases). Reciprocally, data collected through this environmental monitoring framework may also inform the maramataka, as changes to tohu (i.e., weather conditions and the flowering and fruiting times of plants) could indicate that the seasonal divisions of the maramataka are shifting due to influences such as climate change.

Finally, whakapapa can influence environmental observations in this framework, as the assessment of the health of Te Wao Nui ā Tiriwa will likely deepen as the relationship between the observer and the human and non-human inhabitants of the ngahere grows over time and with repeated visits. Conversely, field observations may influence the relationship between the observer and Te Wao Nui ā Tiriwa (i.e., if the observer experiences a somatic response to a specific area of the forest or a particular plant or animal, it may indicate a deeper connection with that area or species). As described above, the observation and relationship-based monitoring framework developed as part of this thesis reflects the reciprocal relationship, influence and interactions between components of mātauranga Māori and environmental observation methods for use in Te Wao Nui ā Tiriwa, which were also developed as part of this thesis research.

Data collection

Potential categories for data collection are described at the bottom of Figure 43. These include the mata o te marama (moon phase) and date, maramataka kaupeka (if known), the observation domain (Flora, Fauna, Weather/Environment, Somatic/Emotional), along with observations of what was seen, heard, etc. In addition to these data, somatic and emotional

notes should also be recorded if applicable, as well as any whakapapa or genealogical connections between the observers, including human and non-human entities of Te Wao Nui ā Tiriwa. If any aspects of tikanga were employed (i.e. karakia, or chant), these could be recorded (if culturally appropriate), as well as a general assessment of the level of mauri in the forest area. All these observations are dependent on the relationship of the observer to Te Taiao, particularly the strength of this relationship. As some observers may be unable to complete all sections of the data collection, these recommendations are provided as guidance.

Data analysis possibilities

Data analysis possibilities are also described in Figure 43. The collected data could be grouped according to the mata o te marama or kaupeka. Lineage and ancestral connections may be explored between the observers and non-human entities in the ngahere. Deeper meanings and understanding may be gained by further exploration of kōrero tuku iho surrounding these observations as part of the analysis. Somatic and emotional triggers and responses can be analysed, along with the use of tikanga within the data, to identify any potential patterns. Finally, the strength or weakness of the mauri in the ngahere may be analysed, perhaps over time.

Potential kaitiaki future actions

Potential future actions for kaitiaki in Te Wao Nui ā Tiriwa, resulting from the observation and relationship-based environmental monitoring framework, are detailed at the bottom of Figure 43. The timing of activities in the ngahere may be informed by the maramataka (ngā mata o te marama and ngā kaupeka), depending on desired outcomes. The use of tikanga in monitoring activities can increase observer safety and promote respectful monitoring methods. Analysis of mauri levels can assist with restoration planning, as areas with lower mauri levels may be suitable candidates for restoration projects. Wānanga could be used as a method to share results from environmental monitoring with iwi members as a potential future action. Finally, this is an adaptive monitoring method. This means that future environmental observations (including domains), mātauranga selected to support the monitoring framework, and data collection and analysis may be adjusted in an iterative process based on newly revitalised mātauranga and changing needs and aspirations of mana whenua.

5.3.8 Proposed tohu (environmental indicators)

The primary purpose of this research was to develop tohu (environmental indicators) for environmental monitoring in Te Wao Nui ā Tiriwa that support and align with the values, aspirations and worldview of Te Kawerau ā Maki. This was achieved through field visits, observation, and communication with Te Wao Nui ā Tiriwa as the primary method of field

monitoring. The most important aspect of this method was to develop and maintain a relationship with Te Wao Nui ā Tiriwa and mana whenua Te Kawerau ā Maki, and to develop these tohu in a way that supported the needs and aspirations of mana whenua. Through a process of whanaungatanga with human and non-human beings within the research study area and respectful communication with and observation of the ngahere, I suggest the following potential tohu for use in long-term environmental monitoring of forest health in Te Wao Nui ā Tiriwa.

Ngā manu and ngā manu o Rehua: proximity, behaviour and presence

The birds and insects of Te Wao Nui ā Tiriwa are children of Tāne. They act as guardians over visitors to the ngahere as we made our way through the forest for this study. The behaviour, importance and beauty of birds and insects in Te Taiao are reflected in numerous kōrero tuku iho, which were a factor in identifying these as potential tohu for use in environmental monitoring within Te Wao Nui ā Tiriwa. During our field visits, birds were often very active. There were times when the birds of the forest seemed to be quite close, or very vocal. Sometimes, the birds seemed to follow us on our journey through the ngahere, moving from tree to tree nearby. Some manu like the pīpīwharauroa, the harbinger of spring as described in kōrero tuku iho, act as seasonal indicators with their presence in the ngahere. The presence of other birds, such as the kererū, may be a sign that vegetation in the ecosystem is fruiting and ecosystem processes, such as seed dispersal, are functioning well. I believe it is essential that people conduct this environmental monitoring after they have become familiar with Te Wao Nui ā Tiriwa and its inhabitants for a considerable period. As people become more familiar with the ngahere, they will be familiar with the language of the birds.

Flowering & fruiting plants

The flowering and fruiting of plants are often indicators of the changing seasons from a te ao Māori perspective, as reflected in the maramataka and numerous kōrero tuku iho. For example, the puawānanga is a tohu of moving into matiti hana, the first warming phase of the year. However, other known flowering plants can also serve as indicators of ngā kaupeka, such as the rātā. The fruiting of plants is also a seasonal indicator, as reflected in whakataukī: **He te tau koroi rā anō.** *Put off until the berries of the white pine appear.* According to Mead & Grove (2001), the hidden meaning of this whakatauāki is reflected in the irregular fruiting of the kahikatea, meaning the listener should delay a task indefinitely. Because of the strong importance of maramataka to Te Kawerau ā Maki, observing the timing and nature of flowering and fruiting of plants is recommended as a potential tohu in an environmental monitoring programme that aligns with a te ao Māori worldview in Te Wao Nui ā Tiriwa.

New growth

Seasonal new growth of native plant species can indicate a healthy forest ecosystem, and I have identified this as another potential tohu for environmental monitoring in Te Wao Nui ā Tiriwa. The presence of seedlings, fresh shoots and young leaves often caught our attention during this observation-based monitoring, and again, these growth forms are mentioned in kōrero tuku iho. Therefore, seasonal new growth can potentially be used as an indicator of a healthy, flourishing ngahere and be incorporated into a more formal monitoring framework. It should also be noted that this tohu might not be appropriate for kauri. Kauri affected by kauri dieback disease can show signs of new growth, particularly as their canopy thins and is replaced by new leaves (Te Kawerau Iwi Settlement Trust Kaimahi Taiao, Field Transcription, 10 March 2025). This response may be misinterpreted if other indicators (such as the presence of kauri dieback disease) are not considered.

Weather

Mate wareware te uri o Kaitoa,	*Thoughtlessly died the offspring of Reckless,*
Takoto ana te paki ki tua.	*but fine weather soon followed*

The preceding whakataukī illustrates the dangers of disregarding bad weather conditions and venturing out to sea, and highlights the benefits of waiting until the weather conditions are safe. The weather can be an important tohu in an observation-based environmental monitoring programme, and weather is often mentioned in kōrero tuku iho. Extreme or inclement weather can be a reason to refrain from entering the ngahere that day for safety reasons, as depicted in the above whakataukī. Weather also appeared to affect the elements of Te Taiao, particularly the behaviour of the birds, whose activities seemed to be more subdued during times of rain. Weather conditions should be considered during this type of monitoring and can be an important tohu to consider for use in environmental monitoring in Te Wao Nui ā Tiriwa.

Somatic and emotional responses

My field research assistants and I experienced a wide range of emotions and physical sensations during our site visits to Te Piringa in Te Wao Nui ā Tiriwa that were worth noting. Often, these emotions arose unexpectedly and seemed to hold meaning beyond what was immediately visible in our surroundings. At times, we would get a “hunch” or feel instinctively drawn to a particular location, prompting us to stop for silent observation in the ngahere. These did not feel like random moments, but rather like indicators based on intuition, which drew our attention to notable elements in Te Taiao. While Western-science based environmental monitoring methodologies typically omit the emotions and physical

experiences of field-based researchers, I believe these should be considered within an environmental monitoring framework that aligns with Indigenous worldviews, such as the method developed through this research.

Presence of non-native plant and animal species

While not systematically recorded as part of this research, the presence of non-native and/or invasive plant and animal species in Te Wao Nui ā Tiriwa could be another potential tohu of environmental health or decline in a forest ecosystem. This tohu was raised during a hui with Te Kawerau Iwi Tiaki Trust representatives and through discussions with Riki Bennett, an experienced Auckland Council Park Ranger. Non-native plants and animal species might indicate that the health of the ngahere is under stress or in decline (Kawerau a Maki Trust, 1995; Williams, 1997). As described above, although data related to the presence and absence of non-native plant and animal species in Te Wao Nui ā Tiriwa were not systematically collected as a part of this research, they may still be an important potential tohu for environmental monitoring in this ecologically and culturally significant place.

Chapter 6 Discussion

6.1 Revisiting research objectives, findings and future recommendations

One of the main objectives of this research was to develop tohu (environmental indicators) for forest health monitoring in Te Piringa (upper Waitākere River catchment) for potential wider use in Te Wao Nui ā Tiriwa (the great forest of Tiriwa), in collaboration with mana whenua, Te Kawerau ā Maki. The research objectives revisited below all contributed to the creation of tohu for forest monitoring.

6.1.1 Investigating potential approaches to cultural health monitoring

Existing collaborative environmental monitoring frameworks for forest ecosystems were briefly discussed during hui with representatives from Te Kawerau Iwi Tiaki Trust. This was achieved through a series of kōrero and hui, as well as a review of existing studies. While some frameworks have already been developed for forest health monitoring from a te ao Māori perspective in Aotearoa, it is essential to recognise that these are not "one-size-fits-all" solutions. In this case, an appropriate framework needed to be developed specifically in response to the needs of Te Kawerau ā Maki. There were slight concerns raised regarding the Atua framework utilised in some cultural forest monitoring initiatives (Chetham & Shortland, 2013; Walker, 2019), particularly surrounding the potential for this framework to oversimplify the complex and interconnected nature of Te Wao Nui ā Tiriwa's ecosystem. Moreover, while the forest health indicators developed by Lyver et al. (2019) were also briefly discussed, it was suggested by the project partners from Te Kawerau ā Maki that I speak *with* the ngahere, rather than *about* it, which became the foundational method for developing the observation and relationship-based framework for this research.

The concept of speaking *with* rather than *about* Te Taiao has been explored in literature outside environmental science (Apiti et al., 2024; Johnson, 2024). Several international studies have highlighted the significance of the relationships between Indigenous people and the non-human inhabitants of their environments (Country et al., 2016; Cruikshank, 2001; McGregor & Dhillon, 2022; Wooltorton & Poelina, 2022). Some environmental monitoring initiatives in Aotearoa have employed an emphasis on "listening to the forest" as part of their monitoring methodology, the importance of which was described by a research project participant in a forest monitoring initiative by Lyver et al. (2017):

> *When we journeyed into the forest with our father… I remember one…time he says 'Listen! Listen to what is going on in the forest. Can*

> *you hear the birds?' He would add, 'You aren't listening to the language of the tree and the birds.'… The language of the trees can be heard if you listen carefully* (p. 3196).

The forest monitoring indicators were developed by Lyver et al. (2017) through a series of interviews with mana whenua project participants. The set of tohu resulting from these interviews explored the use of the sounds of the forest and water, as well as sensing the presence of energy flow and life essence in the forest, as indicators of environmental health in their collaborative forest monitoring method. However, these indicators were among many others that were based on more commonly seen indicators for forest health, such as vegetation canopy and ground cover. While the indicators developed by Lyver et al. (2017) involved using the senses and listening to the forest, the development of these tohu occurred through interviews (talking about the forest), rather than engaging with the forest directly, as in this research.

Some environmental monitoring frameworks utilise the Mauri Model (Faaui et al., 2017; Hikuroa et al., 2011, 2018), which encourages the use of senses, intuition and direct experience of a place, as well as scientific data to assess the overall health of the environment (Morgan, 2006a). While similar sensorial observation methods are used in the Mauri Model, communicating directly with the forest, the primary research method developed for this framework remains underutilised in forest monitoring initiatives in Aotearoa.

An environmental monitoring framework tailored to the needs of Te Kawerau ā Maki was developed as a part of this thesis research. This observation and relationship-based framework represents an exploratory and foundational approach. It is recommended that this framework be further developed and enhanced over time, including the following tasks:

1. Further investigate supportive literature that was unexplored during this thesis due to time constraints, including the Rongomātau, "sensing the knowledge" framework by Dell (2021). The framework examines how the researcher's own "imprinted sensed experiences" (p. 1) interact with both the external world and higher/spiritual consciousness, thereby contributing to a more holistic approach to knowing. Research methods from a recent study on the mauri of kauri, conducted in collaboration with tangata whenua in Te Tai Tokerau by psychology researchers Pomare et al. (2023), may also be examined for similarities to the framework developed in this thesis for future development.

2. The inclusion of these full sensory methodologies in the construction of an environmental monitoring framework can better support an observation and relationship-based approach, such as the one developed in this thesis.

6.1.2 Compilation of existing environmental monitoring data in the study area

Knowledge from existing environmental monitoring programmes being carried out in Te Wao Nui ā Tiriwa can help Te Kawerau ā Maki gain a greater understanding of the state of environmental health within their rohe, as well as identify potential research gaps in environmental monitoring. Ongoing monitoring work is carried out by Watercare, the Regional Parks, Biosecurity and Biodiversity teams within Auckland Council, Landcare Research, and Forest & Bird. Te Wao Nui ā Tiriwa is also the setting for specific research activity by students from a range of tertiary institutions. While the various users are usually happy to share this information when requested, most likely due to capacity limitations, it is rarely compiled and shared with other users. One of the frustrations expressed by Te Kawerau ā Maki during hui as part of this research has been the lack of information sharing of the results and sometimes the methods of environmental monitoring programmes occurring within their rohe.

The findings from my review of existing knowledge indicate that while the network of established plots laid out for vegetation monitoring in the upper Waitākere River catchment by Auckland Council is satisfactory in terms of geographic scope, these plots require remeasurement to keep this valuable information up to date. The phenological analysis of flowering and fruiting plant species provided in this study will also hopefully contribute to the knowledge Te Kawerau ā Maki have regarding these ecological processes within their rohe. Flowering and fruiting data can be used to enhance knowledge about the maramataka and its relationship to the phenological processes of plant species.

The number of pest animal species caught through this programme appears to be increasing slightly over time, with rats being the most frequently trapped. However, data obtained from the Ark in the Park show a decrease in bait uptake in the area over the same time period, indicating a potential decrease in the effectiveness of the bait station programme. This is a potential issue that underscores the importance of ongoing, timely collection and sharing of pest monitoring data.

A significant amount of environmental data is collected within the research study area (Te Piringa) and Te Wao Nui ā Tiriwa, and a more in-depth analysis of environmental monitoring data obtained from Auckland Council and the Ark in the Park fell outside the scope of this MSc thesis research. I recommend that the following actions be taken to better integrate current

data collection with Te Kawerau ā Maki's aspirations for better-informed kaitiakitanga of Te Wao Nui ā Tiriwa.

1. The health of waterways within Te Kawerau ā Maki's rohe was identified as an environmental concern for the iwi, but fell outside the scope of this thesis. Obtain and analyse data from water monitoring carried out by Auckland Council or others to add to mātauranga-a-Te Kawerau ā Maki.
2. A more in-depth analysis of the fruiting and flowering times of plant species can be compared with the characteristics of ngā kaupeka (Māori seasonal phases) to gain a better understanding of seasonal cycles.
3. A detailed analysis of the Ark in the Park bait station uptake data is recommended to analyse the success of this programme or to identify where possible improvements can be made.
4. Obtain and analyse all available pest monitoring data from Auckland Council and the Ark in the Park on an annual basis. Analysis of pest animal tracking tunnel data in relation to bait station uptake data from Ark in the Park Data could provide additional useful information for Te Kawerau ā Maki.
5. Perform an annual inventory of permits that have been issued for environmental research within Te Wao Nui ā Tiriwa. Copies of any academic theses or environmental reports resulting from this research can be provided to Te Kawerau ā Maki to enhance their knowledge of research activities undertaken within their rohe.
6. Share annual environmental monitoring information through annual wānanga with Auckland Council and the Ark in the Park, and/or through Environmental Monitoring reports requested from these organisations. Kōrero during these wānanga and/or reports could include the research undertaken in the previous year and who collected the data. This should include not only a summary of the reports but an inventory of what was undertaken, to add to mātauranga-a-Te Kawerau ā Maki, while strengthening relationships between the iwi and those carrying out research and environmental monitoring within their wāhi taonga (treasured places).

6.1.3 Literature review of kōrero tuku iho (pūrākau, whakataukī and *Ngā Mōteatea*)

A review of publicly available literature of kōrero tuku iho (including pūrākau, whakataukī and *Ngā Mōteatea*) carried out as part of this thesis research found several relevant results that were compiled into a database for reference by Te Kawerau ā Maki. While this review included important people and places related to Te Kawerau ā Maki, as well as search terms related to

the maramataka, it was primarily focused on plant and animal species commonly found in the research study area. It is recommended that this database be expanded in the future through the following actions:

1. Complete a more in-depth literature review of key historical figures and locations of significance for Te Kawerau ā Maki to enhance this database.
2. Kōrero tuku iho surrounding weather events were briefly explored but not collected as part of this research, and this database may be expanded.

6.1.4 Te Kawerau ā Maki key values & priority environmental concerns

Te Kawerau ā Maki's priority environmental concerns and biodiversity values were identified using publicly available iwi documents and confirmed by Te Kawerau Iwi Tiaki Trust's Pou Tiaki. Key values for the iwi include rangatiratanga, whanaungatanga, wairuatanga, manaakitanga and kaitiakitanga. Key environmental concerns included the protection of mauri in both water and forest ecosystems, especially regarding food, harvesting, and crafts, as well as the involvement of iwi in environmental decision-making. Te Kawerau ā Maki's values and priority environmental concerns are interrelated, for example, the protection of food resources from water and terrestrial ecosystems contributes to the values of manaakitanga (as a healthy ecosystem will provide resources to host guests properly), and kaitiakitanga (enabling Te Kawerau ā Maki to successfully act as guardians over ecosystems in their rohe). The collaborative nature of this research, working with research partners, Te Kawerau ā Maki, supports their key value of rangatiratanga, allowing for the project to be led by the interests of the iwi. My future recommendations surrounding Te Kawerau ā Maki values and priority conservation concerns are as follows:

1. Te Kawerau ā Maki's environmental concerns regarding waterways within their rohe were identified but not addressed in this thesis, which focused on terrestrial and forest ecosystems. Explore the use of similar environmental monitoring frameworks for freshwater ecosystems within the rohe.
2. Environmental priorities for Te Kawerau ā Maki may change over time, particularly in response to the potential impacts of climate change and land-use change within their rohe. As priorities evolve, new environmental concerns for the iwi should be considered in the development of future environmental monitoring frameworks.
3. To uphold the value of rangatiratanga, future environmental monitoring methodologies within their rohe should be developed in collaboration with Te Kawerau ā Maki. Strengthening partnerships with Auckland Council, Ark in the Park and the Department of Conservation can also support this value by providing

opportunities for iwi to actively participate in the environmental decision-making process.

4. The values of wairuatanga and whanaungatanga can be supported through the future involvement of iwi members, especially younger generations, through participation in environmental monitoring activities, to support the intergenerational transmission of knowledge and connection to whenua.

6.1.5 Preliminary environmental monitoring framework development and field testing

This thesis developed an observation and relationship-based environmental monitoring framework for forest health, with foundations in kōrero tuku iho and priority environmental and biodiversity values for Te Kawerau ā Maki (Figure 43). This differs from previous models in that it prioritises communication with the forest and emphasises the relationships between people and Te Taiao. During field testing from November 2024 to March 2025, I entered the forest at dawn (moving from Te Ao Pō to Te Ao Mārama), following protocol (karakia, oli, mihi) for protection and identification. Plants that were fruiting, flowering, regenerating, declining, or thriving were recorded in field audio transcriptions. Preliminary data analysis included characteristic weather and flowering patterns from ngā kaupeka, bird songs from audio recordings, and bird observations related to ngā mata o te marama (phases of the moon). Weather, emotional, and somatic observations were also collected and analysed.

This culturally appropriate, mana-uplifting monitoring at Te Piringa used methods suitable for future forest health assessments in Te Wao Nui ā Tiriwa. The proposed tohu included birds, insects, flowering and fruiting plants, new growth, weather events, somatic and emotional responses, and the presence of non-native species. Described below are my future recommendations for further development of this environmental monitoring framework:

1. Further develop the sensory awareness aspect of the monitoring framework, drawing on existing literature (Apiti et al., 2024; Dell, 2021; Pink, 2003).
2. Expand on tohu categories; for example, bird observations could be monitored according to species presence, abundance, seasonal movements or changes in bird song or activity.
3. Further integration of aspects of maramataka (the Māori lunar calendar) into monitoring tohu and method.
4. Work with Te Kawerau ā Maki to expand on the list of proposed tohu developed in this thesis, and the further development of sub-categories of tohu.
5. Develop a defined set of metrics for tohu assessment.

6. Develop data sheets for data collection using the monitoring framework, including observational domains and tohu/subcategories of tohu and metrics developed in recommendations 5 and 6.
7. With newly developed field data sheets, perform field testing with representatives and/or interested members of Te Kawerau ā Maki.

6.2 Project limitations

One of the main limitations of this research stems from the forces of colonisation. As with many Indigenous knowledge systems, much mātauranga-a-Te Kawerau ā Maki has been lost, and there is an active movement to revitalise this knowledge. Prior to the arrival of Europeans in Aotearoa, Māori had developed extensive knowledge systems surrounding Te Taiao for over 600 years, which were subsequently undermined and ignored through New Zealand's governmental policy and legislation, as well as the effective ban on te reo Māori in schools, while privileging Western knowledge (Broughton & McBreen, 2015). In addition, problematic research and publication practices of early ethnographers in Aotearoa, such as Elsdon Best and A.W. Reed, were believed to have produced sometimes distorted and inaccurate accounts of mātauranga Māori. The historical depletion of mātauranga Māori posed challenges to this research, and my resources were limited to a select number of sources.

Another limitation of this project surrounds the development of tohu for this project. The definition of tohu has most likely changed over time. Tohu can be either active or passive (non-reactive), and verbal or non-verbal, and there is evidence that in precolonial times, tohu were mainly non-verbal (Smith, 2010). As a tangata moana, Indigenous and Tauiwi science student, I bring my own worldview, biases and knowledge with me. My perceptions of tohu may differ from those of members of Te Kawerau ā Maki, ahi kā (those who keep the home fires alive), te reo Māori speakers, or those with long-term associations with Te Wao Nui ā Tiriwa. Observation and relationship-based environmental monitoring methods, such as those employed in this research, would likely benefit from being carried out by individuals with genealogical ties to Te Wao Nui ā Tiriwa or those with a prolonged association with the area.

Working within the time constraints of an MSc thesis was another challenge I faced throughout this research. The interconnected nature of the elements of Te Taiao (plants, animals, weather, wairua, mauri, maramataka, etc.) meant it was difficult to narrow down the scope of this research. As a novel approach was developed and applied in this research, it perhaps would have benefited from focusing solely on the development of the monitoring framework and method, with field testing recommended for the future. Many aspects of this thesis (i.e., the literature review of kōrero tuku iho surrounding Te Taiao and the compilation

of existing environmental monitoring programmes in the research study area) could have been examined in greater detail if they were the primary focus of the research. As a result of these time constraints, much remains to be explored, including (but not limited to) a more in-depth analysis of the plant and animal species of Te Wao Nui ā Tiriwa, a more complete literature review of kōrero tuku iho, and the potential for better integration of the maramataka into environmental monitoring methods.

There were limitations in working within the University system to conduct this research. First, we were unable to properly uplift the mana of Te Kawerau ā Maki at AUT because of strained relationships between the University and the iwi, and it was not viewed as a safe space to host them during the early stages of my research. In addition, I found that the University (particularly the AUT Ethics Committee) wanted very detailed plans and methods before the project began. This posed a significant challenge to collaborative research projects like mine, where the research plan and methods are often developed in collaboration with Indigenous research partners well after the project has commenced.

I found the weaving of mātauranga Māori and the Western scientific process during this project to be largely unproblematic; however, I did encounter challenges with data analysis. Due to the observational and at times ad hoc nature of the data collected using the observational monitoring method employed in this research, I did not find suitable methods to analyse it. Data analysis for this type of environmental monitoring could perhaps be improved with the development of metrics for measuring tohu. The data collection and analysis I carried out for this thesis research were exploratory and highlighted the need to develop metrics for tohu measurement. Despite these challenges and limitations, my primary research aim of developing an environmental monitoring framework that aligns with the values and aspirations of Te Kawerau ā Maki remained my primary motivation for this research.

6.3 Potential wider applications

The environmental monitoring framework and method developed in this thesis were specifically designed in collaboration with Te Kawerau ā Maki within the research study area Te Piringa (the upper Waitākere River catchment). However, this environmental monitoring method can potentially be trialled at different locations within Te Wao Nui ā Tiriwa. Other iwi or hapū interested in observation and relationship-based environmental monitoring methods may find this research helpful as a foundation for creating a similar framework for monitoring in their rohe. The kōrero tuku iho gathered as part of this research, surrounding plant and animal species commonly found in kauri forest ecosystems, may be helpful to other iwi with these forest types within their rohe. Indigenous people outside of Aotearoa may turn to their

own intergenerationally transmitted oral histories for knowledge and insights regarding the natural world.

This thesis research also highlights the potential and necessity of creating iwi-specific environmental monitoring frameworks when existing methods may not adequately meet the needs of iwi in Aotearoa and other Indigenous groups. Observation-based monitoring, which involves not only the use of the five senses but also the recognition of emotions and intuitive somatic responses in field participants, may be a valuable method for Indigenous groups outside of Aotearoa, whose connection with the environment often lies in a realm different from the purely physical observation techniques traditionally used in Western science monitoring. Similarly, the use of a relationship-based environmental monitoring framework honours the interrelatedness of various aspects of nature (both human and non-human), including the field participants, which is a common viewpoint of Indigenous peoples worldwide.

6.4 Conclusion

Collaboration with research partners, Te Kawerau ā Maki, from the early stages of project design and development through to field testing of this environmental monitoring framework had many benefits. Environmental monitoring initiatives can help support Indigenous sovereignty and empowerment in their ancestral lands by prioritising Indigenous participants in decision-making processes. Through the prioritisation of the inclusion of intergenerationally transmitted Indigenous ancestral knowledge, such as mātauranga Māori, the cultural identity and ability of Indigenous peoples to properly care for their environmental guardianship can be strengthened. Relationships between scientific researchers and Indigenous community members can also be strengthened through collaborative research initiatives. This research was specifically designed for forest ecosystems within Te Wao Nui ā Tiriwa. This place-specific framework can enable a better understanding by Te Kawerau ā Maki and its members of geographically specific ecological processes and their ability to respond more rapidly and adapt to changes in Te Taiao. Indigenous groups can utilise location-specific environmental monitoring frameworks to gain increased insights into the environmental health of key areas within their territories.

An observation-based framework encourages a deeper connection between Te Kawerau ā Maki and other Indigenous peoples to the land, as well as to the human and non-human elements within their territories, through direct communication with the environment. The emphasis on relationships in this environmental monitoring frameworks recognises the importance of connections between Indigenous people, environmental observers and the

land. The use of environmental monitoring frameworks that are better aligned with te ao Māori and other indigenous worldviews can provide a monitoring methodology that Indigenous groups are more comfortable using — one that resonates with ancestral wisdom and their worldview. This sentiment is expressed by Solomon Islands scholar, David Welchman Gegeo: "…the deconstruction process must be undertaken through the lenses of our own Pacific Islander ways of knowing – in other words, our own epistemologies… We get ourselves into an intellectual bind when we try to work on such issues using only the frameworks of the powers who colonised us in the first place" (Gegeo, 2001, p. 503). The development and implementation of environmental monitoring methods that better align with Indigenous worldviews will hopefully encourage the participation of younger generations to reconnect with Te Taiao after generations of separation due to the deleterious effects of colonisation.

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Glossary

ahikā	home fires, and those who keep them alive
ʻāina	land *(ʻōlelo Hawaiʻi)*
akua	deity *(ʻōlelo Hawaiʻi)*
aloha ʻāina	love of the land *(ʻōlelo Hawaiʻi)*
Aotea	Great Barrier Island
Aotearoa	New Zealand
ariā	ecological perspectives, indicators or concepts
atua	ancestor with continuing influence, deity
awa	waterway
hālau hula	hula school or place of learning *(ʻōlelo Hawaiʻi)*
hapū	kinship group
hīkoi	walk
Hikurangi	name applied to all of the central and western Waitākere Ranges from the Waitākere River south to Manukau
hōʻailona	mystic portent (ʻōlelo Hawaiʻi)
hui	gathering
ʻike	knowledge *(ʻōlelo Hawaiʻi)*
ʻike kūhohonu	deep knowledge *(ʻōlelo Hawaiʻi)*
ʻili ʻōuli	skin signs *(ʻōlelo Hawaiʻi)*
iwi	tribe, extended kinship group
Kāhui Takurua	Canis Major star constellation
kai	food
kai moana	seafood
Kaimahi Taiao	Environmental Officer
kainga	homestead
kaitiaki	guardian(s)
kaitiakitanga	guardianship
Kānaka Maoli	Native Hawaiians *(ʻōlelo Hawaiʻi)*
kanohi ki kanohi	face to face
kapa	bark cloth *(ʻōlelo Hawaiʻi)*
kaumatua/kaumātua	elder/elders
kaupapa	topic, purpose, plan
kauwaerunga	broader knowledge system which included insights into the cosmos, creation myths, deities, celestial bodies, and the concept of time
kīrehe	animals
kokorangi	celestial observation/astronomy
kōrero	discussion
kōrero tuku iho	oral traditions handed down
kōpī	orange fruit of the karaka (*Corynocarpus laevigatus*)

kūpuna	ancestors *(ʻōlelo Hawaiʻi)*
lei	flower garland *(ʻōlelo Hawaiʻi)*
mahinga kai	cultivated food
mana	authority and prestige
manaakitanga	generosity, care and reciprocity
mana whenua	Māori who have historic and territorial rights over the land
Mangatoetoe	high point named after the stream "Mangatoetoe" or "the stream of the toetoe", which flows from it to the east
manuhiri	guest
Māori	the Indigenous people of New Zealand
mara	cultivation site
marae	courtyard, open area in front of meeting house, often used to include the complex of buildings around the marae
maramataka	Māori calendar utilised for the gathering of resources according to seasonal cycles
Matariki	Pleiades star cluster
mātauranga	a dynamic system generating wisdom, knowledge and understanding
mātauranga-a-iwi	iwi-specific mātauranga based on their group's knowledge systems
mauiui	sick, unwell
maunga	mountain
mauri	life force, vital essence, energy
mihi	greeting or acknowledgement
nāhele	forest *(ʻōlelo Hawaiʻi)*
naʻau	gut *(ʻōlelo Hawaiʻi)*
ngahere	forest
ngā kaupeka o te tau	Māori seasonal phases of the year
ngā kaupeka matiti	warmest seasonal phases of the year
ngā kaupeka takurua	coldest seasonal phases of the year
ngā kaupeka wero	seasonal phases of the year when cooling occurs
ngā mata o te mārama	phases of the moon
Ngā Mōteatea	a collection of four books of chants, laments, poems and waiata (songs) published in Māori and English
Ngā Rau Pou a Maki	the northern foothills of the Waitakere Ranges; "the many posts of Maki"
noa	the absence of tapu, ordinary
noho taiao	community workshops (Reihana et al., 2023)
ʻoiaiʻo naʻau	truthful guts *(ʻōlelo Hawaiʻi)*
ʻōkala, ʻōkakala	goosebumps *(ʻōlelo Hawaiʻi)*
ʻōlelo Hawaiʻi	Hawaiian language *(ʻōlelo Hawaiʻi)*
oli	chant, incantation *(ʻōlelo Hawaiʻi)*
oli aloha	chant of love , (*ʻōlelo Hawai'i*)
oli pale	chant of protection *(ʻōlelo Hawaiʻi)*

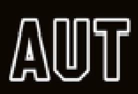
pā	fortified settlements and outposts
Pākehā	New Zealanders of European descent
papakāinga	original home, home base, village
Papatūānuku	Earth Mother
Paratutai	North Head, Manukau Harbour
peruperu	Māori sweet potato
piipii	chicks
poʻe hula	hula people *(ʻōlelo Hawaiʻi)*
pou	posts
Pou Tiaki	CEO
Pūanga	Riegel (star)
Pukematekeo	the highest point at the head of the Waitākere River valley; the "hill at the end of the range"
pule	incantation, prayer *(ʻōlelo Hawaiʻi)*
pūrākau	stories
rāhui	temporal or spatial prohibition restricting access
rākau	tree
Rākaunui	full moon
rangatira	leader, person of high rank
rangatiratanga	sovereignty, self-determination
Ranginui	Sky Father
Rēhua	Antares (star)
ritenga	custom, customary practice, the normal way of doing things
rohe	region, territory
rongoā	medicine
taha wairua	the spiritual side
taiao	natural world, environment
Tāmaki Makaurau	Auckland
tangata whenua	people of the land
taonga tuku iho	treasured heirloom, something handed down, cultural property
tapu	sacred, prohibited, restricted, set apart, forbidden, under *atua* protection
tātai arorangi	Māori astronomical knowledge
tauira	student
Tauiwi	non-Māori people residing in Aotearoa
tauparapara	recitations
tautoko	to support
Tāwhirimātea	deity of winds and storms
te ao Māori	the Māori world
Te Ao Mārama	The world of light, daytime
Te Ao Pō	The world of darkness, night
Te Arai o Tahuhu	Te Arai Point

Te Awa Kōtuku	traditional name of the Waitākere River and Waitākere Falls near Waitākere Dam; "the river of the white heron's plume"
Te Henga	Bethells Beach
Te Ika a Māui	The North Island
Te Ipu Kura a Maki	the Tāmaki Isthmus
Te Kawerau ā Maki	tangata whenua of the Waitākere area; "the carrying strap of Maki"
Te Kore	nothingness
Te Moana nui a Kiwa	The great ocean of Kiwa (Pacific Ocean)
teoteo	female tūī *(Prosthemadera novaeseelandiae)*
Te Pae ō Te Rangi	The high country immediately to the south of the Waitākere River; "the platform of the sky"
Te Papa Atawhai	Department of Conservation (DOC)
Te Pūaha ō Waitākere	the river mouth of the Waitākere
Te Punanga	kainga and mara (cultivation site) located on what is now Waitākere Golf Course; "the hidden place"
te reo Māori	the Māori language
Te Taiao	world, Earth, natural world, environment, nature, country
Te Unuhanga-a-Rangitoto	Mercer Bay
Te Wao Nui ā Tiriwa	The Great Forest of Tiriwa – the Waitākere Ranges
tika	right, correct
tikanga	right, correct or best cultural practice or customs
tino rangatiratanga	Māori sovereignty and self-determination
tipu	plants
tipuna	ancestor (eastern dialect variation)
tohu	instructions, guides and targets (environmental indicators in this thesis)
tohunga	environmental expert
tohunga kokorangi	teachers and specialists of Māori astronomical knowledge
tohunga tātai arorangi	teachers and specialists of Māori astronomical knowledge
tupuna	ancestor
tupuna rākau	ancestor tree
tūpuna	ancestors
wāhi taonga	treasured place(s)
wāhi tapu	sacred place(s)
waiata	songs
wairua	spiritual energy and dimension
wairuatanga	related to wairua, spirituality
Waitākere	the name of a large flat rock in the small bay near Te Ihumoana Island, Te Henga; now used as a name for the surrounding area
Waiti	the name of a settlement in Te Henga (Bethells Beach)
waka	canoe(s)

wānanga	educational seminars or meetings
whakaaro	thought
whakamarama	explain, clarify, or illuminate
whakamatau	to test, examine, or try
whakamōhio	to inform, notify, acquaint, teach, inform
whakaora	to restore, heal, or save
whakapapa	genealogies
whakataukī	proverbs
Whakatū	Nelson Region, New Zealand
whakawhanaungatanga	to establish, build and maintain relationships
whakawhiti	to transfer, cross over, or convey
whānau	family
whanaungatanga	relationship, kinship and interconnectedness of all things; to become familiar with one another
whāngaia	nourishing
wharenui	meeting house, large house, main building of a marae where guests are accommodated
whenua	land
Whiro	new moon

Appendices

Appendix A *Ethics approval*



Auckland University of Technology Ethics Committee (AUTEC)

17 April 2024

Craig Bishop
Faculty of Health and Environmental Sciences

Dear Craig

Ethics Application: **23/145 Collaboratively developing cultural indicators for environmental monitoring in Te Wao Nui ā Tiriwa**

Thank you for submitting your responses to AUTEC's conditions which has been approved subject to:

1. Please develop the protocol for determining whether information provided during hui is so sensitive as to exclude it from the thesis. Who decides and how? If the information was offered by one person during the group discussion, who has the authority to remove it from the data included in the publication?

Please provide a response to the conditions in a memo and attach any altered documents, such as the Information Sheet, Consent Forms, Survey.

A revised EA1 is not required unless specifically requested in the conditions.

Please reference the application number and study title in all correspondence.

The Committee is always willing to discuss with applicants the points that have been made. There may be information that has not been made available to the Committee, or aspects of the research may not have been fully understood.

When the conditions have been met, you will be notified of the full approval of your ethics application. Full approval is not effective until all the conditions have been met. Data collection may not commence until full approval has been confirmed. If these conditions are not met within six months, your application may be closed, and a new application will be required if you wish to continue with this research.

If you have any enquiries about this application, please contact us at ethics@aut.ac.nz.

(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: wnp2416@autuni.ac.nz; John Perrott

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Appendix B *Tools include a) Hui Information Sheet provided to project participants and b) Hui Consent form*

Hui Information Sheet

Date Information Sheet Produced:

14 August 2023

Project Title

Collaboratively developing an environmental monitoring plan for Te Piringa/Cascades within Te Wao Nui ā Tiriwa (Waitakere Ranges Heritage Area – WHRA).

He tautoko / An Invitation

'Onaona i ka hala me ka lehua	Fragrant with hala and lehua
He hale lehua nō 'ia na ka noe	A house of lehua for the mist
'O ka'u nō ia e 'ano'ī nei	It is mine to cherish
E li'a nei ho'i o ka hiki mai	Longing for your arrival
A hiki mai no mākou	For when we come
A hiki pū nō mei kei aloha	Love comes with us.
Aloha ē	

Ko Hamilton te maunga. Ko Thompson te awa. Ko Moana Nui a Kiwa te moana. Ko Sarah Kapuhealani Bishop oku ingoa. I am a MSc student in Environmental Science at Te Wānanga Aronui o Tāmaki Makau Rau - AUT. I am Kanaka Maoli, USA European, Tauiwi, born in California. I moved to Tāmaki Makaurau in 2015 to join my partner and start our small family. I am a proud tangata moana and active in my Kanaka Maoli heritage in the small Hawaiian community here in Tāmaki Makaurau.

I tautoko the tino rangatiratanga of the mana whenua of Te Wao Nui ā Tiriwa (Waitākere Ranges Heritage Area) – Te Kawerau ā Maki. I also acknowledge the kaitiaki obligation of Te Kawerau ā Maki and those working in Te Wao Nui ā Tiriwa to protect this wahi tapu and secure it for future generations. The research team invites you to participate in the collaborative development of cultural indicators within a monitoring framework for environmental health in forest ecosystems in Te Piringa/Cascades area in Te Wao Nui ā Tiriwa.

What is the purpose of this research?

The development of cultural indicators for environmental health monitoring will help to address issues of importance to Te Kawerau ā Maki including inter-generational loss of knowledge, the lack of embedded te ao Māori into western paradigms of environmental management, and ultimately developing tools to help better manage the area.

This research will help strengthen and support the tino rangatiratanga of the mana whenua of Te Piringa and Te Wao nui ā Tiriwa, as they will have the opportunity to play an active role in decision making through the entirety of the project. Additionally, this research will potentially strengthen the ability of Te Kawerau ā Maki to fulfil their role as kaitiaki in Te Piringa by providing a set of indicators within a monitoring framework to provide a clearer picture of the state environmental health in the area.

The improvement of environmental health and awareness in Te Piringa allows for increased potential for cultural harvesting for kai, rongoā, and toi for present and future generations of mana whenua. The creation of a set of indicators for this specific geographic area may also be used by the iwi to inform future projects, and as an educational document to empower Te Kawerau ā Maki to act as kaitiaki in their rohe.

I am working under the supervision of Dr. Craig Bishop, Lecturer in Environmental Science at AUT and Dr. Dan Hikuroa, Senior Lecturer in Māori Studies, Te Wānanaga o Waipapa, at the University of Auckland. This research will form a component of my MSc Thesis in Environmental Science from AUT. The findings of this research may be used for academic publications and presentations. The project is not anticipated to generate intellectual property which has commercialisation potential.

How were we identified and why am I being invited to participate in this research?

You were identified by Te Kawerau ā Maki iwi representatives as a person knowledgeable in the research area of environmental monitoring in Te Wao Nui ā Tiriwa. I am inviting Te Kawerau ā Maki members, kaumatua, and/or trusted whanaunga to participate in this research as they are and most knowledgeable in environmental concerns in the area. Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time.

How do we agree to participate in this research?

Please contact me directly through email [redacted] or phone my Co-Supervisor (Admin) Craig Bishop [redacted] to notify me of your agreement to participate in this research. I have also included a Hui Consent Form. You may sign this form on the day of the Hui or sign and return to me via email ahead of time.

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

Where and when?

This research is part of a MSc Thesis in Environmental Science at AUT, on a full time basis (40hours/week) from with hui commencing in February 2024 to thesis submission in November 2024. I anticipate there will be and 6 in-person hui to gather information for this project (see next section for anticipated project timeline and hui themes). In-person hui will most likely occur at the Te Kawerau ā Maki offices in Henderson, with potential for field visits at a site within Te Piringa. You may attend as many hui as allows for your schedule, or attend via Zoom if you prefer. Information from these hui will be collected by me and my primary supervisor Craig Bishop from AUT. Dan Hikuroa, my secondary thesis supervisor from University of Auckland, and John Perrott, advisor from AUT may also be present at these hui.

What will happen in this research?

Literature and Data Review (March 2023 – December 2023): During the preliminary phases of the project, I will perform a literature review of similar studies of existing cultural indicators and monitoring frameworks for environmental health in forest ecosystems in Aotearoa and abroad. I will review existing iwi documents that may contain relevant information for the development of cultural indicators for forest health. I will examine the extent of current forest monitoring occurring in the geographic focus region. I will synthesise this information and use this to inform hui with participants.

Project Design (March 2023 – August 2023): This time will also be spent meeting with Te Kawerau ā Maki iwi representatives, including the CEO and Heritage and Environment Officer, to identify potential participants with environmental knowledge of forest ecosystems of Te Wao Nui ā Tiriwa. During this time the research team will reach out to potential participants to prepare them for hui. Project design and methodology will also be discussed during this time. The series of hui format was chosen as the preferred method for information gathering collaboratively with Te Kawerau ā Maki representatives and the research team.

Sarah will perform a literature review of existing cultural indicators and monitoring frameworks for environmental health in forest ecosystems Te Kawerau ā Maki representatives. Based on the existing literature, Sarah will work with Te Kawerau ā Maki through a series of hui (the number of hui will be increased as needed) to select the most relevant and useful cultural indicators for the iwi, and the most effective framework to be used.

Feedback from participants is encouraged throughout the project and research approaches will be adjusted as needed.

Thesis writeup will be performed mainly by Sarah, but Te Kawerau ā Maki is invited to participate in this if Te Kawerau ā Maki wishes to be involved in this process. Working documents and drafts will be provided to Te Kawerau ā Maki for feedback through the duration of the project until project completion and final submission.

Hui with participants (March 2024-August 2024): The number of hui is yet to be determined and will be based on the needs of Te Kawerau a Maki and the pace of the project and kōrero. Hui with participants will be audio recorded so as not to miss any information shared. Based on the existing literature, mātauranga-a-iwi, and site visits, the research team will work with Te Kawerau ā Maki through a series of hui to select the most relevant and useful cultural indicators for the iwi, and the most effective framework to be used. The AUT Research Team may ask guiding questions during these kōrero to gather information to be used in the development of cultural indicators. Similar research projects as well as existing iwi documentation can be examined and potentially used as a jumping off point for the development of these themes and indicators. However, the creation of cultural

indicators using a blank slate may be desired. The themes for discussion at each hui are subject to change based on the desires of Te Kawerau ā Maki. Possible discussion themes include: current environmental monitoring networks (i.e. Auckland Council, Ark in the Park), and geographic gaps addressed. There will likely be an onsite visit to Te Piringa (if accessible) – the geographic focus for this study, which will provide on-site context for this research.

Thesis writeup (August– November 2024): Thesis writeup will be performed mainly by myself, project participants are invited to participate in this if they wish to be involved in this process. Working documents and drafts will be provided to Te Kawerau ā Maki for feedback through the duration of the project until project completion and final submission.

What are the discomforts and risks?

As I am neither mana whenua nor Māori, there may be some discomfort in my undertaking research in the area of cultural indicators for environmental health in Te Wao Nui ā Tiriwa. There may be some mātauranga that the iwi wishes to remain confidential, or may be concerned about sharing during the course of this project. I am a member of and have support from AUT's School of Science MaiSci Team (a rōpū of Māori and indigenous science researchers). Furthermore, I am grateful that AUT's Te Ara Poutama (Māori advancement School) is available to provide cultural advice and support throughout the project. While I will do my best to create an atmosphere of support and aroha, it is understandable that Te Kawerau ā Maki may feel discomfort when asked questions, advice and/or for participation in this research.

How will these discomforts and risks be alleviated?

I will do my best to foster an environment of safety and security. Cultural safety provisions included in this project include (but are not limited to): Te Kawerau ā Maki members will be given the opportunity to perform karakia at the beginning and end of all hui. Mātauranga that the iwi wishes to remain confidential will be safeguarded while still collected and provided in a confidential document to be used by authorised members of Te Kawerau ā Maki only. The values of whakawhanaunatanga (relationship-building), kaitiakitanga (the process of exercising guardianship, care and wise management of tribal taonga including taonga plant and animal species) will be supported and respected. The privacy of iwi members will be respected during consultation, and hui during this project. Permission will be sought when collecting data from Māori land or surrounding taonga species. You and members of Te Kawerau ā Maki have all rights to decline to answer any questions or requests for information that make you feel uncomfortable or put you at risk.

What are the benefits?

This project is responsive to the needs and aspirations of Te Kawerau ā Maki and the main justification of this project, to develop measures and environmental monitoring processes that are better aligned both western science and tikanga Māori. The creation of cultural indicators can also increase the relevance of science and research to address issues that are particularly important to Te Kawerau ā Maki, including inter-generational loss of knowledge, the lack of embedded te Ao Māori into western paradigms of environmental management, and ultimately developing tools to help better manage the area. The development of these indicators within an environmental monitoring framework would support Te Kawerau ā Maki to fulfil their obligation as kaitiaki of Te Wao Nui ā Tiriwa, by providing a more complete picture of the state of environmental health of the area.

The development of cultural indicators will hopefully increase environmental awareness and connection by Te Kawerau ā Maki members in kōrero surrounding environmental monitoring. Additionally, the cultural indicators developed through this research will potentially be used in future iwi-led environmental monitoring programmes to reconnect younger generations with the whenua. This research will hopefully lead to the increased sharing of scientific information with Te Kawerau ā Maki, which is one concern raised in initial hui with the iwi. The improvement of environmental health and awareness in Te Wao Nui ā Tiriwa also allows for increased potential for cultural harvesting for kai, rongoā, and toi for present and future generations of mana whenua.

This research will provide a much-needed increase in cultural perspectives in science and research. The development of cultural health indicators for the area will address the need for improved forest management as described in the Conservation Act 1987, Resource Management Act 1991, The Environmental Monitoring Act 2015, and the Ko Aotearoa Tēnei: Wai 262 Report 2011.

How will my privacy be protected?

All notes and audio recordings from hui with Te Kawerau ā Maki will be kept confidential. Direct quotes or paraphrasing of information from hui with Te Kawerau ā Maki to be included in the thesis will be shared with iwi representatives for approval before submission. Consent forms and hui notes will be accessed by the research team only in a secure location. At the end of the project, data and consent forms will be securely stored on AUT premises for a period of 6 years, and then destroyed. Participants will not be able to be identified in any reports or publication unless there is a desire to have their name(s) included. Some information gathered in this project

may be culturally sensitive in nature and will not be shared in the published thesis. Documents containing culturally sensitive information will be given to Te Kawerau ā Maki for internal use only, or as deemed appropriate by the iwi. If there is a breach of this privacy agreement, Sarah Kapuhealani Bishop, the researcher, and Dr. Craig Bishop, her research supervisor will be responsible.

What are the costs of participating in this research?

The costs of participating in this research for Te Kawerau ā Maki is your time. As this is a student research project, unfortunately we are unable to reimburse you for this time. We hope that the indicators developed through this research will be of benefit to Te Kawerau ā Maki in lieu of payment for consultation.

What opportunity do I have to consider this invitation?

A period of 2-4 weeks will be given to potential participants to consider this invitation. The research team is open to any recommendations or alterations of the research plan and will consider any concerns brought forward by Te Kawerau ā Maki.

Will we receive feedback on the results of this research?

A 1-2 page summary of research findings will be provided to Te Kawerau ā Maki along with full MSc Thesis drafts and final report. This research will be included as part of a MSc (Research) in Environmental Science. The results of this research will be included in a written MSc Thesis and may be presented at conferences in Aotearoa and beyond pending approval by authorised iwi representatives. Iwi members are welcome to present on their learnings and experience alongside the researcher at these conferences if they desire.

It is to be determined whether this thesis will result in a formal publication in scientific journals, but approval from Te Kawerau ā Maki will be sought before pursuing this. Members of the iwi or trusted whanaunga are again invited to co-author papers surrounding this research with Sarah and the research team.

What do we do if we have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Dr. Craig Bishop, [redacted] Ethical concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Liz Binns, [redacted]

Researcher Contact Details: Sarah Kapuhealani Bishop, MSc (Research) Student, AUT Ph: [redacted] Email: [redacted] *Co-Supervisor (Admin) Contact Details:* Dr. Craig Bishop Lecturer, Department of Environmental Sciences, AUT Ph: [redacted] Email: [redacted]	*Co-Supervisor Contact Details:* Dr. Dan Hikuroa Associate Professor, Māori Studies Waipapa Taumata Rau – University of Auckland Ph [redacted] Email: [redacted] *Advisor Contact Details:* Dr. John Perrott Associate Head of School Māori Advancement School of Sciences, AUT Ph: [redacted] Email: [redacted]

References

Auckland Council. (2018). *State of the Waitākere Ranges heritage area 2018*.

Approved by the Auckland University of Technology Ethics Committee on 14 August 2023, AUTEC Reference number 23/145.

Hui Consent Form

Project title: Collaboratively developing cultural indicators for environmental monitoring in Te Wao Nui ā Tiriwa

Project Supervisors: Craig Bishop, Dan Hikuroa

Project Advisor: John Perrott

Researcher: Sarah Kapuhealani Bishop, MSc (Research) Student

- ○ I have read and understood the information provided about this research project in the Information Sheet provided ________________________ (date).
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the hui and that they may also be audio-taped and transcribed.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I understand that data and consent forms will be kept in a secure location on AUT premises for a period of 6 years, after which they will be destroyed.
- ○ I wish to receive a summary of the research findings (please tick one): Yes ○ No ○

Participants signature: ....

Participants name: ....

Participants Contact Details (if appropriate):

....

....

....

....

Date: ....

Appendix C *List of hui and hīkoi with Te Kawerau ā Maki representatives carried out as part of this thesis research from November 2021 to March 2025.*

Date	Type	Purpose	Attendees	Location	Outcome(s)	Audio Recorded?	Notes/ Transcribed
26-Nov-2021	Hui	Whanaungatanga; Discuss MSc Collaboration	Sarah Bishop, Te Kawerau ā Maki Iwi Tiaki Trust Chair	Zoom	Welcoming collaboration	No	Notes
8-Dec-2021	Hui	Whanaungatanga; Thesis koorero to dsicuss monitoring opportunities at Whatipu (previous project concept)	Sarah Bishop, Craig Bishop (Supervisor), Te Kawerau Iwi Tiaki Trust CEO	MS Teams	Welcoming collaboration; Kōrero surrounding Whatipu (previous project concept)	No	Notes
6-Apr-2023	Hui	Project planning: Updated Research proposal discussion	Sarah Bishop, Te Kawerau Iwi Tiaki Trust CEO	MS Teams	Changed research subject to environmental monitoring in Waitākere Ranges	No	Notes
9-Jun-2023	Hui	Project planning: Hui to Discuss cultural indicators in Te Wao Nui a Tiriwa	Sarah Bishop, Craig Bishop (Supervisor), Te Kawerau Iwi Tiaki Trust CEO, Guest of Te Kawerau Iwi Tiaki Trust	Te Kawerau ā Maki Offices, Henderson, Auckland	Narrowed the geographic focus of study area to Upper Waitākere River Catchment Area	No	Notes
20-Feb-2024	Hui	Whanaungatanga, project planning: AUT MSc research - Collaboratively developing cultural indicators for forest health	Sarah Bishop, Craig Bishop (Supervisor), Dan Hikuroa (Supervisor), Te Kawerau Iwi Tiaki Trust CEO, Te Kawerau Iwi Tiaki Trust Officers (2), AUT representative	Te Kawerau ā Maki Offices, Henderson, Auckland	Whanaungatanga to meet wider research team and new supervisor, Dan Hikuroa; Discussed importance of sensory awareness, indicator species	No	Notes
14-Mar-2024	Hīkoi	Whanaungatanga; Preliminary site visit to Te Wao Nui ā Tiriwa	Sarah Bishop, Craig Bishop (Supervisor), Te Kawerau ā Maki Iwi Tiaki Trust Environmental Officers (2)	Te Piringa/Cascade Kauri Regional Park	Whanaungatanga - walk in Te Wao Nui ā Tiriwa to meet the ngahere	No	Notes
11-Apr-2024	Hīkoi	Whanaungatanga; Preliminary site visit to Te Wao Nui ā Tiriwa	Sarah Bishop, Craig Bishop (Supervisor), Te Kawerau ā Maki Iwi Tiaki Trust Environmental Officer	Te Piringa/Cascade Kauri Regional Park	Whanaungatanga - walk in Te Wao Nui ā Tiriwa to meet the ngahere	No	Notes

Date	Type	Purpose	Attendees	Location	Outcome(s)	Audio Recorded?	Notes/ Transcribed
24-May-2024	Hui	MSc Research Kōrero - Tohu development	Sarah Bishop, Te Kawerau ā Maki Iwi Tiaki Trust Environmental Officer, Auckland Council Park Ranger	Te Piringa/Cascade Kauri Ranger Office	Themes: effect of climate change on tohu; seasonal presence of species; definition of tohu; species-specific tohu; maramataka; kōrero tuku iho; need for information sharing in the rohe	Yes	Transcription
25-Jun-2024	Hui	MSc Thesis Kōrero - Tohu development	Sarah Bishop, Te Kawerau ā Maki Iwi Tiaki Trust Environmental Officer, Auckland Council Park Ranger, Guest of Te Kawerau ā Maki	Swanson Cafe	Themes: Marmataka; seasonal presence of species; kōrero tuku iho. Determined dawn monitoring, observation-based, whanaungatanga-based method; Kōrero tuku iho-based literature review recommended	Yes	Transcription
19-Nov-2025	Hīkoi	Site visit: Whanungatanga, Observations	Sarah Bishop, Lynda Burnside	Te Piringa/Cascade Kauri Regional Park	Whanaungatanga: Upper Te Piringa Track; Observations: Upper Te Piringa Track; Upper Kauri Track (Montana Heritage Trail)	Yes	Transcription
25-Nov-2025	Hīkoi	Site visit: Observations	Sarah Bishop, Lynda Burnside	Te Piringa/Cascade Kauri Regional Park	Observations: Upper Te Piringa Track; Lower Te Piringa Track, Fencelline Track, Long Road Track, Upper Kauri Track (Montana Heritage Trail)	Yes	Transcription

Date	Type	Purpose	Attendees	Location	Outcome(s)	Audio Recorded?	Notes/ Transcribed
15-Dec-2025	Hīkoi	Site visit: Whanungatanga, Observations	Sarah Bishop, Aaron Blackbourn	Te Piringa/Cascade Kauri Regional Park	Whanaungatanga: Upper Te Piringa Track; Observations: Upper Te Piringa Track	Yes	Transcription
16-Dec-2025	Hīkoi	Site visit: Observations	Sarah Bishop, Lynda Burnside	Te Piringa/Cascade Kauri Regional Park	Observations: Waitākere Dam Walk, Fencline Track	Yes	Transcription
22-Dec-2024	Hīkoi	Site visit: Observations	Sarah Bishop, Aaron Blackbourn	Te Piringa/Cascade Kauri Regional Park	Observations: Waitākere Dam Walk, Fencline Track	Yes	Transcription
23-Jan-2025	Hīkoi	Site visit: Observations	Sarah Bishop, Te Kawerau ā Maki Iwi Tiaki Trust Environmental Officer	Pukematekeo	Observations: Scenic Drive, Pukematekeo	Yes	Transcription
18-Feb-2025	Hīkoi	Site visit: Observations	Sarah Bishop, Te Kawerau ā Maki Iwi Tiaki Trust Environmental Officer, Te Kawerau ā Maki Officer, Auckland Council Park Ranger	Te Piringa/Cascade Kauri Regional Park	Observations: Fencline Track	Yes	Transcription
23-Feb-2025	Hīkoi	Site visit: Observations	Sarah Bishop, Aaron Blackbourn	Te Piringa/Cascade Kauri Regional Park	Observations: Pae o Te Rangi Farm Summit Track	Yes	Transcription
10-Mar-2025	Hīkoi	Site visit: Observations	Sarah Bishop, Te Kawerau ā Maki Iwi Tiaki Trust Environmental Officer, Te Kawerau ā Maki Officer	Te Piringa/Cascade Kauri Regional Park	Observations: Tramline Track	Yes	Transcription

Appendix D *Vegetation plot location and other metadata obtained from Auckland Council in May 2023 within the study area: Te Piringa (upper Waitākere River catchment).*

STATC	TENURE	BASELINE	REMEASURE	DATE_	MEASU	RECOR	GPS_E	GPS_N	GPSPC	GPS_A	ALTIT	SLOPE	ASPEC	PHYSI	DRAIN
CF39A	PUBLIC	2009	2014	01/12/09	KD	HB	1730730	5921897		10	54	20	110	FACE	GOOD
CF39D	PRIVATE	2012		09/11/12	SA	KD	1733616	5919358	P	5	124	20	200	FACE	GOOD
CF39DD16	PUBLIC	2012		14/12/12	SG	SW	1735270	5917708	P	7	104	11	220	TERRACE	MODERATE
CF40AA	PUBLIC	2009	2014	07/12/09	VM	VM	1728438	5916496		8	28	30	280	FACE	GOOD
CF40AD	PUBLIC	2013	2016	17/12/13	WH	ML	1730602	5914396	P	8	184	20	25	FACE	GOOD
CF40BA	PUBLIC	2012	2016	14/12/12	JR	CB	1732586	5916252	P	8	193	28	125	FACE	GOOD
CF40BB16	PUBLIC	2013		19/12/13	SA	SA	1735376	5915579	P	5	142	10	260	FACE	GOOD
CF40BB2	PUBLIC	2012		14/12/12	SA	KD	1734874	5917077	P	3	72	10	30	FACE	MODERATE
CF40BB6	PUBLIC	2009	2014	30/11/09	JM	JM	1734330	5916608		13	145	17	120	FACE	GOOD
CF40BB9	PUBLIC	2013		22/11/13	SA	SA	1733872	5916053	P	5	242	10	10	FACE	GOOD
CF40BD16	PUBLIC	2013		26/11/13	SG	SG	1735360	5913608	P	0	212	15	262	FACE	MODERATE
CF40BD3	PUBLIC	2010		18/11/10	SG	SG	1734876	5915079		6	206	20	212	FACE	GOOD
CF40BD8	PUBLIC	2011		04/11/11	CB	CB	1735426	5914423	P	7	0	35	130	FACE	MODERATE
CF40D	PUBLIC	2009	2014	30/11/09	RB	KD	1733640	5911516		10	252	30	280	FACE	GOOD
CF40DA	PUBLIC	2010	2015	01/12/10	SG	SG	1732648	5912358		6	271	17	320	RIDGE	GOOD
CF40DB16	PUBLIC	2010		16/11/10	SG	SG	1735397	5911584		12	336	4	338	FACE	GOOD
CF40DC	PUBLIC	2016		06/12/16	ML	AK	1730571	5912297	P	4	162	0			GOOD
CF40DD	PUBLIC	2009	2014	08/12/09	VM	VM	1734701	5910295		8	288	43	265	FACE	GOOD
CF41A	PUBLIC	2011	2016	14/11/11	SG	SG	1730765	5907304	P	16	0	0	X	FACE	GOOD
CF41BD	PUBLIC	2012	2016	17/12/12	SG	SW	1734762	5906338	P	7	352	37	78	FACE	GOOD
CF41D	PUBLIC	2009	2014	30/11/09	VM	VM	1733266	5903640		14	237	40	150	GULLY	GOOD
CF41DA	PUBLIC	2009	2014	30/11/09	FW	FW	1732600	5904312		12	243	20	242	FACE	MODERATE
CF41DD	PUBLIC	2010	2015	07/12/10	CK	CK	1734651	5902336		8	226	30	50	FACE	GOOD
CF42BA	PUBLIC	2010	2015	29/11/10	CK	CK	1733336	5900512		5	221	10	120	FACE	MODERATE
CG40	PUBLIC	2010	2015	13/12/10	KP	KP	1737621	5915345		11	343	0	X	TERRACE	POOR
CG40AA16	PUBLIC	2010		16/11/10	SG	SG	1737364	5915572		11	303	22	160	FACE	MODERATE
CG40AA3	PUBLIC	2012		13/12/12	SG	SW	1736868	5917084	P	6	268	20	296	FACE	GOOD

S_SOI	S_BED	S_ROC	S_RSZ	G_VEG	G_MOS	G_LIT	G_ROC	G_BAR	CNP_H	HISTO	CNP_C	C_FIR	C_LOG	C_CLE	C_MIN	C_TRA	C_OTH
									7	SECONDARY	65						
95	0	5	NONE	20	0	95	2	3	9	MODIFIED	70	N	N	N	N	N	
100	0	0	NONE	60	1	40	0	1	8	SECONDARY	50	Y	Y	Y	N	N	
									10	MODIFIED	75						
100	0	0	NONE	75	0	25	0	0	10	SECONDARY	70	Y	Y	Y	N	Y	
99	0	1	>30CM	85	5	70	0	5	8	MODIFIED	90	N	Y	N	N	N	
100	0	0	NONE	60	5	95	0	0	18	MODIFIED	60	N	Y	N	Y	N	
100	0	0	NONE	30	1	80	0	20	8	MODIFIED	70	N	N	N	N	Y	
									15	PRIMARY	70						
98	0	2	<30CM	65	0	90	2	3	15	PRIMARY	90	N	N	N	N	N	
100	0	0	NONE	10	0	80	0	10	7	SECONDARY	70	Y	Y	Y	N	Y	ark bait lines
									28	SECONDARY	70						
100	100	0	NONE	40	10	50	0	0	10	MODIFIED	70	N	Y	N	N	N	N
									7	SECONDARY	60						
									7	SECONDARY	30						
									8	MODIFIED	24						
98	0	2	NONE	80	2	70	0	5	6	SECONDARY	50	N	N	Y	N	N	
									8	SECONDARY	60						
95	90	5	NONE	40	5	25	0	10	3	SECONDARY	40	Y	Y	Y	N	Y	N
80	0	20	<30CM	70	1	10	0	5	8	SECONDARY	60	Y	Y	Y	N	N	
									20	MODIFIED	80						
									8	SECONDARY	55						
									6	SECONDARY	75						
									3	SECONDARY	25						
									7	SECONDARY	75						
									7	MODIFIED	60						
85	0	15	<30CM	40	15	20	0	2	11	SECONDARY	60	Y	Y	Y	N	Y	bait lines

Appendix E *Sample page of plant species biomass data obtained from Auckland Council vegetation monitoring plot data for analysis carried out for this thesis of the relative basal area of different plant species within the study area.*

Sampling area name	Date	Event Number	Sub-plot	Type of observation	Scientific name	Condition	Count	DBH measure	Species 'basal area' (cm2)
CF40BD3	18/11/2010	Baseline	SubPlotF	DBH Measure	Coprosma autumnalis	Alive	1	2	3.14159
CG40AC3	16/12/2014	Revisit 1	SubPlotI	DBH Measure	Coprosma autumnalis	Alive	1	2	3.14159
CG40AA9	17/11/2009	Baseline	SubPlotA	DBH Measure	Dysoxylum spectabile	Alive	1	2.1	3.463602975
CF40BA	31/10/2022	Revisit 2	SubPlot F	DBH Measure	Coprosma autumnalis	Dead	1	2.4	4.5238896
CG40CD	10/11/2016	Revisit 1	SubPlotM	DBH Measure	Geniostoma ligustrifolium	Alive	1	2.4	4.5238896
CG40AC3	16/12/2014	Revisit 1	SubPlotO	DBH Measure	Unknown	Dead	1	2.4	4.5238896
CF40BA	14/12/2012	Baseline	SubPlotP	DBH Measure	Hoheria populnea	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotJ	DBH Measure	Geniostoma ligustrifolium	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotH	DBH Measure	Geniostoma ligustrifolium	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotD	DBH Measure	Beilschmiedia tarairi	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotD	DBH Measure	Hedycarya arborea	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotD	DBH Measure	Hoheria populnea	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotD	DBH Measure	Unknown	Dead	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotB	DBH Measure	Coprosma autumnalis	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotB	DBH Measure	Dysoxylum spectabile	Alive	1	2.5	4.908734375
CF40BA	14/12/2012	Baseline	SubPlotB	DBH Measure	Dysoxylum spectabile	Alive	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotP	DBH Measure	Geniostoma ligustrifolium	Invalid	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotN	DBH Measure	Unknown	Dead	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotH	DBH Measure	Geniostoma ligustrifolium	Alive	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotG	DBH Measure	Coprosma autumnalis	Alive	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotG	DBH Measure	Coprosma lucida	Alive	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotF	DBH Measure	Coprosma autumnalis	Alive	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotF	DBH Measure	Melicytus ramiflorus	Alive	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotC	DBH Measure	Dysoxylum spectabile	Alive	1	2.5	4.908734375
CF40BA	17/11/2016	Revisit 1	SubPlotC	DBH Measure	Geniostoma ligustrifolium	Alive	1	2.5	4.908734375
CF40BA	31/10/2022	Revisit 2	SubPlot F	DBH Measure	Coprosma autumnalis	Dead	1	2.5	4.908734375
CF40BA	31/10/2022	Revisit 2	SubPlot F	DBH Measure	Coprosma autumnalis	Dead	1	2.5	4.908734375
CF40BA	31/10/2022	Revisit 2	SubPlot B	DBH Measure	Dysoxylum spectabile	Alive	1	2.5	4.908734375
CG40AD	8/12/2009	Baseline	SubPlotP	DBH Measure	Geniostoma ligustrifolium	Alive	1	2.5	4.908734375

Appendix F *Sample page of Ark in the Park trapline GPS coordinates data obtained in May 2023 for analysis in this research.*

ident	y_proj	x_proj	mline	tpe_tunnel	
mAW21	5913496	1737396	AWdiag	B	
mAW22	5913522	1737367	AWdiag	B	
mAW23	5913534	1737312	AWdiag	B	
mAW24	5913556	1737283	AWdiag	B	
mAW25	5913585	1737261	AWdiag	B	
mAW26	5913634	1737252	AWdiag	B	
mAW27	5913658	1737203	AWdiag	B	
mAW28	5913681	1737181	AWdiag	B	
mAW29	5913700	1737142	AWdiag	B	
mAW30	5913732	1737110	AWdiag	B	
CGM1	5912130	1736266	CG	B	
CGM10	5912131	1735808	CG	B	
CGM2	5912162	1736221	CG	B	
CGM3	5912160	1736167	CG	B	
CGM4	5912148	1736120	CG	B	
CGM5	5912150	1736069	CG	B	
CGM6	5912166	1736012	CG	B	
CGM7	5912156	1735971	CG	B	
CGM8	5912151	1735916	CG	B	
CGM9	5912136	1735874	CG	B	
mKOKb11	5910958	1736004	KOK	B	
mKOKb12	5910986	1735962	KOK	B	
mKOKb13	5910992	1735907	KOK	B	
mKOKb14	5911029	1735870	KOK	B	
mKOKb15	5911067	1735822	KOK	B	
mKOKb16	5911089	1735778	KOK	B	
mKOKb17	5911117	1735729	KOK	B	
mKOKb18	5911149	1735682	KOK	B	
mKOKb19	5911211	1735679	KOK	B	
mKOKb20	5911214	1735598	KOK	B	
mZoo-1	5916335	1737231	Zoo	W	
mZoo-2	5916375	1737199	Zoo	W	
mZoo-3	5916414	1737172	Zoo	W	
mZoo-4	5916456	1737169	Zoo	W	
mZoo-5	5916506	1737133	Zoo	W	
mFew-10	5914149	1735304	Fenceline	W	
mFew-2	5914495	1735517	Fenceline	W	
mFew-3	5914447	1735493	Fenceline	W	
mFew-4	5914403	1735477	Fenceline	W	
mFew-5	5914358	1735451	Fenceline	W	
mFew-6	5914321	1735420	Fenceline	W	
mFew-7	5914285	1735389	Fenceline	W	
mFew-8	5914223	1735381	Fenceline	W	

Appendix G *Sample page from Ark in the Park baitstation dataset obtained for analysis as part of this thesis research.*

index	ident	y_proj	x_proj	block	Avg	2024Spring	2024Autumn	2023/4Summer	2023Autumn	2022Spring	2022Autumn	2021Summer	2021Autumn	2020Spring
0.1						Data collected 2024Spring	Data collected 2024Autumn	Data collected 2023/4Summer	Data collected 2023Autumn	Data collected 2022Spring	Data collected 2022Autumn	Data collected 2021Summer	Data collected 2021Autumn	Data collected 2020Spring
0.2						Bait placed 2024Autumn	Bait placed 2023/4Summer	Bait placed 2023Autumn	Bait placed 2022Spring	Bait placed 2022Autumn	Bait placed 2021Summer & 2021Autumn	Bait placed 2021Autumn	Bait placed 2020Spring	Bait placed 2020Summer
1	AN0-1	5916356	1737510	AN	4.0	1.0	8	4	1	1	5		4	8
2	AN0-2	5916387	1737509	AN	4.4	5.0	5	8	1	1	2		4	9
3	AN1-1	5916324	1737383	AN	6.0	8.0	8	8	5	5	5		1	8
4	AN1-2	5916355	1737401	AN	5.6	5.0	8	4	5	5	5		5	8
5	AN1-3	5916402	1737409	AN	4.1	2.0	7	1	3	5	5		2	8
6	AN1-4	5916446	1737429	AN	5.8	8.0	8	5	5	5	5		3	7
7	AN1-5	5916497	1737444	AN	4.9	1.0	7	8	3	5	5		5	5
8	AN1-6	5916539	1737457	AN	5.0	4.0	8	5	5	1	4		5	8
9	AN1-7	5916579	1737478	AN	3.9	1.0	7	1	4	5	5		5	3
10	AN2-0	5916647	1737391	AN	4.6	5.0	1	2	4	5	8		5	7
11	AN2-1	5916599	1737371	AN	4.3	1.0	1	9	1	5	8		4	5
12	AN2-2	5916553	1737359	AN	5.0	3.0	1	8	5	5	8		5	5
13	AN2-3	5916518	1737345	AN	4.8	8.0	1	1	5	5	8		2	8
14	AN2-4	5916469	1737329	AN	5.0	3.0	8	5	2	5	5		5	7
15	AN2-5	5916418	1737311	AN	5.4	5.0	4	8	4	5	8		1	8
16	AN2-6	5916369	1737302	AN	4.3	1.0	4	5	5	5	8		1	5
17	AN2-7	5916333	1737280	AN	3.0	1.0	2	7	2	5	5		1	1
18	AN2-8	5916294	1737263	AN	6.3	8.0	8	8	5		5		3	7
19	AN2-9	5916243	1737255	AN	5.6	5.0	8	8	1	5	5		5	8
20	10	5916195	1737241	AN	5.9	4.0	8	8	5	5	5		4	8
21	11	5916156	1737217	AN	3.9	1.0	4	8	6	5	5		1	1
22	AN3-1	5916714	1737313	AN	5.5	8.0	8	8	1	9	4		5	1
23	AN3-2	5916664	1737291	AN	6.1	1.0	8	8	5	9	5		5	8
24	AN3-3	5916621	1737275	AN	5.9	3.0	8	8	5	5	5		5	8
25	AN3-4	5916567	1737252	AN	3.4	1.0	1	1	5	5	1		5	8
26	AN3-5	5916532	1737244	AN	3.8	1.0	1	5	5	4	1		5	8
27	AN3-6	5916469	1737225	AN	3.9	1.0	2	8	1	4	2		5	8
28	AN3-7	5916445	1737211	AN	3.8	1.0	1	4	1	4	5		5	9
29	AN3-8	5916401	1737194	AN	2.5	1.0	1	5	1	1	1		5	5

Appendix H *Sample page of flowering and fruiting data obtained from the New Zealand Plant Conservation Network (NZPCN) of species lists from Auckland Council and the Ark in the Park from the research study area. This data was used in the phenological analysis (fruiting and flowering times) of plants carried out as a part of this research.*

SPECIES LIST COMPRISES ALL PLANTS FROM ARK PLANT SURVEY AND AUCKLAND COUNCIL MONITORING PLOTS				
Taxa	**Common names**	**Flowering MONTH**	**Fruiting - MONTH**	**Authority**
Abrodictyum elongatum	Trichomanes elongatum, Bristle fern	n/a	n/a	NZPCN
Acacia mearnsii	black wattle	7 - 9	7 - 11	other
Acianthus sinclairii	heart-leaved orchid, pixie cap	I - 10	4 - 12	NZPCN
Adiantum cunninghamii	Common maidenhair, puhinui	n/a	n/a	NZPCN
Agathis australis	Kauri	n/a	Female cones 11 - 12, male cones 9 - 1 (1 - 12)	NZPCN
Alectryon excelsus subsp. excelsus	Titoki, NZ Ash	10 - 12 (6 - 12)	11 - 8	NZPCN
Alseuosmia macrophylla	Toropapa, Karapapa, Perfume of the Grove	8 - 12	9 - 1	other
Asplenium bulbiferum	Mauku, Pikopiko, Hen & chickens fern	n/a	n/a	NZPCN
Asplenium flaccidum	Makawe, Hanging spleenwort	n/a	n/a	NZPCN
Asplenium oblongifolium	Huruhuru whenua, Shining spleenwort	n/a	n/a	NZPCN
Asplenium polyodon	Petako, Sickle spleenwort	n/a	n/a	NZPCN
Astelia banksii	TBD	4 (3 - 6)	1 - 12	other
Astelia fragrans	TBD	10 - 11	12 - 5	other
Astelia solandri	Kowharawhara, Kaiwharawhara	10 - 6	1 - 12	other
Astelia trinervia	Kauri grass	3 - 6	7 - 5	other
Beilschmiedia taraire	Taraire	11 (9 - 12)	3 - 11	NZPCN
Beilschmiedia tawa	Tawa	1 (10 - 5)	1 (12 - 3)	NZPCN
Blechnum chambersii	Rereti/Nini	n/a	n/a	NZPCN
Blechnum discolor	Piupiu, Crown fern	n/a	n/a	NZPCN
Blechnum filiforme	Paanako, Thread fern	n/a	n/a	NZPCN
Blechnum fluviatile	kiwikiwi, kiwakiwa, creek fern	n/a	n/a	NZPCN
Blechnum fraseri	Maukurangi, Miniature tree fern	n/a	n/a	NZPCN
Blechnum membranaceum	(blank)	n/a	n/a	NZPCN
Blechnum minus	swamp kiokio	n/a	n/a	NZPCN
Blechnum novae-zelandiae	Kiokio	n/a	n/a	NZPCN
Blechnum parrisiae	Doodia australis, rasp fern, pukupuku,	n/a	n/a	NZPCN
Brachyglottis kirkii var angustior	Kohurangi, Kirk's tree daisy	3 - 6 (1 - 6)	4 - 8 (2 - 8)	NZPCN

Appendix I *Sample coding sheet used for thematic analysis from (non-audio recorded) hui with Te Kawerau ā Maki representatives, speaker names, if noted, were retained in original data sheets and hidden here to maintain privacy.*

Hui Date	Quote From Transcription or Excerpt from from meeting Notes	Theme	Notes
20-Feb-24	Mauri monitoring; regenerate and recapture matauranga	Mātauranga Māori	
20-Feb-24	Bigger picture use mātauranga and presence	Mātauranga Māori	
20-Feb-24	10x10 area	Environmental Monitoring and Frameworks	
20-Feb-24	Quantitative/qualitative - statistically will always be narrative type along with statistical	Environmental Monitoring & Frameworks	
20-Feb-24	Kauri, pekapeka, manu	Values(Te Kawerau ā Maki)	whakapapa
20-Feb-24	Rāhui	Values(Te Kawerau ā Maki)	
20-Feb-24	Healthy whenua	Values(Te Kawerau ā Maki)	kaitiaki, manaakitanga
20-Feb-24	Ngahere succession	Environmental Monitoring & Frameworks	
20-Feb-24	Whole whānau	Values(Te Kawerau ā Maki)	whakapapa
20-Feb-24	Awa	Environmental Monitoring and Frameworks	tohu
20-Feb-24	Birdsong	Environmental Monitoring and Frameworks	tohu
20-Feb-24	Rongoā	Mātauranga Māori	
20-Feb-24	flowering	Environmental Monitoring and Frameworks	Seasonal tohu
20-Feb-24	pests	Environmental Monitoring and Frameworks	non-native tohu
20-Feb-24	Sound/sight/smell/taste	Environmental Monitoring and Frameworks	
20-Feb-24	Tohu	Environmental Monitoring & Frameworks	
20-Feb-24	Upper Cascades track - toru trees - positive indicator	Environmental Monitoring and Frameworks	tohu

Appendix J *Sample coding sheet used for thematic analysis from (audio recorded) hui with project participants speaker names if noted were retained in original data sheets and hidden here to maintain privacy.*

Hui Date	Quote From Transcription or Excerpt from from meeting Notes	Theme	Notes
24-May-24	So they reckon...they're saying that climate change has a lot to do with the... the out of sequence flowering of the plants now.	Mātauranga Māori	change; maramataka
24-May-24	..cos you our weather patterns have changed so much – and that's worldwide. and that's not only here, but in other countries as well, they're having the same experiences as well, with a lot of their, um, environmental indicators, as such, yeah.	Mātauranga Māori	
24-May-24	Well here, you know, the term, you got the Nga manu o Rehua, which is the summer insects- and at the moment you can't hear them, cos they've gone to ground. And um, you've got the um uh what's the name of the... cicadas, which you can normally hear.	Mātauranga Māori	maramataka
24-May-24	But I mean environmental indicators doesn't only indicate what's here, but it's also what's not here.	Environmental Monitoring and Frameworks	Tohu
24-May-24	You know, because it's seasonal, you know? So you get that tātarakihi, means the cicada. But [with the drought?] comes matuakiki, as a baby? You know, I mean, they're one of the indicators. And you have pepetunga as well, which is the moth, or the Puriri, Puriri moth? And it's baby is mokoroa. And they live inside of the um, the putuputuweta tree and the um the puriri. So they're all kinds of things as well. So when [the seasons?] come round - So pepetunga means um, eel moth. And when they pupate exactly around the same time as the eels are migrating. And so they, they fall into the water,	Mātauranga Māori	maramataka
24-May-24	Yes. Have you heard about the matiti phase? or phases? which is the summer phases?	Mātauranga Māori	maramataka
24-May-24	Matiti [?], Matiti [hunga?] and all that? Which is the sequence of different flowers, flowering plants, based on their their colours? Matiti kauwai [kaiwai?], which is when the ground opens up, you know because of the hot sun. They [were?] also the seven phases of summer. So um, based around sequence again of plants flowering. But again, that sort of gets all thrown over the place as well with what's happening at the moment, you know?	Mātauranga Māori	maramataka

Appendix K *Search terms (including synonyms) and references for kōrero tuku iho (stories of the past, traditions, oral histories including pūrākau, waiata and whakataukī) literature review of kōrero tuku iho related to Te Kawerau ā Maki history, places and events. Not all of these search terms were used during this research, but may be useful for future research.*

Kupu (synonyms in ())	Notes	Reference	Kupu (synonyms in ())	Notes	Reference
Aotea	One of 5 ancestral canoes of Te Kawerau ā Maki.	(Taua, 2009)	Ruarangiharere		(Taua, 2009)
Anawhata	Our tūpuna sometimes visited our Te Kawerau relatives at Awataha on the North Shore, at Mahurangi and in eastern Kaipara. The also regularly visited and married our Te Waiohua relatives living at Ihumatao near Mangere and Pukaki near Papatoetoe.'	(Taua, 2009), p. 42	Tahinganui	descendent of Tahuhunui, should not be confused with the Tainui ancestor Tahinga, whose descendants occupy the Te Akau area today.	(Taua, 2009)
Erangi	Ngaoho tūpuna of Te Kawerau ā Maki	(Taua, 2009)	Tahurangi	one of the preferred Te Kawerau a Maki names (aka Tutumaiao, Ngarukehu)more secretive forest-dwelling people, around time of the Turehu	(Taua, 2009)
Hakawau	Te Kawerau a maki ancestor, killed Kaiwhare - kahui tipua (guardian taniwha) at Te Rua o Kaiwhare (the Blowhole at Piha)	(Taua, 2009)	Tahuhunui	Commander of the Moekakara canoe which originally landed at Wakatuwhenua (Goat Island Marine Reserve, Leigh). Some of the crew of this canoe and their descendants migrated overland to the Waitakere River catchment area where they settled. Their occupation of the land is remembered in placenames north of Te Henga (Bethell's Beach) like Tuwhenua and Pu o Tahinga	(Taua, 2009)
Hape (Rakataura)	Bestowed many names including Titirangi, Hikurangi, Waiokahu (Piha Stream), Tirikohua and Te One Rangatira (Muriwai Beach).	(Taua, 2009)	Taiaoroa	ancestor who killed Te Mokoroa at Te Rua o te Mokoroa (The Mokoroa Falls)	(Taua, 2009)
Haumia	grandfather of Maki; Ngaiwi; had settled earlier before Maki in the Tāmaki area between Mangere and Maungakiekie where they became dominant figues.	(Taua, 2009)	Tainui	Through our ancestor Maki we can claim descent from five other ancestral waka, however the canoe that predominates in our anestry is the famous Tainui canoe which arrived in the Auckland region in the mid-fourteenth century. Our Tainui ancestrall associations that pre-date the arrival of our ancestor Maki in the district endure to this day and are remembred in numerous placenames, traditions and waiata.	(Taua, 2009)
Hikurangi	West Auckland; name bestowed by Hape/Rakataura	(Taua, 2009)	Tāmaki		
Hoturoa	Crew of Tainui who settled permanently in the district and married into earlier local people; Leader of Tainui canoe	(Taua, 2009)	Tāne		
Ihumoana	island in Te Henga	(Taua, 2009)	Tawhiakiterangi (Te Watarauhi Tawhia)	(AKA Te Kawerau a Maki); early 19th Century rangatira; Son of Maki & Rotu	(Taua, 2009)
Kahuitara	one of 5 ancestral canoes	(Taua, 2009)	Te Ao Kohatu	the age of stone	(Taua, 2009)
Kahui tipua	the many guardian taniwha who came from an earlier age, seen by tūpuna as being both kindly and malevolent, associated with the land and the sea.	(Taua, 2009)	Te Ao Marama	The age of light	(Taua, 2009)
Kaiwhare	particularly powerful and troublesome kahui tipua (guardian taniwha) to all iwi occupying the shores of the western coastline and the Manukau Harbour. Caused sudden modifications of the coastline, taking fishermen's catches and even killing people. He was, according to Te Kawerau a Maki tradition, trapped in his lair Te Rua o Kaiwhare (the Blowhole at Piha) and killed by an ancestor known as Hakawau.	(Taua, 2009)	Te Awa Kotuku	Cascade Kauri park	(Taua, 2009)
Karanga a Hape	exploits of Hape/Rakataura himself	(Taua, 2009)	Te Henga		(Taua, 2009)
Kau waha ia/Kauwahaia	traditional story of Erangi (see Purakau)	(Taua, 2009)	Te Hoe a Kupe	Placename: the paddle(?) of Kupe?	(Taua, 2009)

Kupu (synonyms in ())	Notes	Reference	Kupu (synonyms in ())	Notes	Reference
Kawau	cormorant, kaitiaki of all Te Kawerau a Maki's ancestral domain, both in Waitakere City and beyod.	(Taua, 2009)	Te Ika Roa a Māui	the long fish of maui	(Taua, 2009)
Kupe	famous Māori ancestor and navigator Kupe mai tawhiti visited the Waitakere coastline.	(Taua, 2009)	Te Ipu Kura a Maki	the Tāmaki isthmus	(Taua, 2009)
Kurahaupo	one of the 5 ancestral canoes	(Taua, 2009)	Te Kā a Maki	(Jackie's Peak, Huia)	(Taua, 2009)
Maki	epynomous ancestor; led Ngāti Awa group from Kawhia to Auckland region along with his younger brother Matāhu. Acoompanied by two of his wives, Rotu and Paretutanganui, their children Manuhiri, Ngawhetu, and Maraeariki and approximately 300 followers. After successive arguments with his relatives, Maki had decided to lead his people northward in the search for a new and more peaceful home. He and his followers settled temporarily near the Waikato River mouth, and then at Manurewa.	(Taua, 2009)	Te Kawerau a Maki		(Taua, 2009)
Manuhiri	Child of Maki	(Taua, 2009)	Te Kawerau moko torea	more recent ancestors	(Taua, 2009)
Maruiwi		Graham, 1922	Te Kura	wife of Matāhu (younger brother of Maki), high born Ngaoho woman from Whangaparaoa.	(Taua, 2009)
Matāhu	younger brother of Maki, led Ngāti Awa group from Kawhia to Auckland region along with Maki.	(Taua, 2009)	Te Mokoroa	malevolent taniwha guardian of the northern ranges and the Waitakere River valley, killed by Kawerau ancestor Taiaroa at Te Rua o Te Mokoroa (the Mokoroa Falls)	(Taua, 2009)
Mokai o Kahu	taniwha watches over the Waitemata Harbour form his lair known as Orua a mokai.	(Taua, 2009)	Te One Rangatira	(Muriwai Beach); Name bestowed by Hape/Rakataura	(Taua, 2009)
Moekakara	Moekakara canoe which was commanded by Tahuhunui and originally landed at Wakatuwhenua (Goat Island Marine Reserve, Leigh). Voyaged from Hawaiki, or the Pacific homeland.	(Taua, 2009)	Te Pae Kākā	One of the Tohu ō Waitākere from Murdoch, 1990	Murdoch, 1990
Ngai Riukiuta	tribal names developed by descendants of Tainui	(Taua, 2009)	Te Rauotehuia	(Huia Bay)	(Taua, 2009)
Ngaiwi	subtribal grouping of Ngāti Awa iwi, Ngaiwi was the great grandfather of Maki	(Taua, 2009)	Te Rawharu	Kawerau chief; intermarried with sister of Kawharu of Ngati Whatua; home was at Waiherunga (South Kaipara Heads)	Graham, 1925
Ngaoho/Ngā oho mata kamokamo	original collective tribal name of the Tainui people/ known in west Auckland as Ngā oho Kamokamo, being so named after Oho Matakamokamo, a great grandson of Rakataura	(Taua, 2009)	Te Rua o Kaiwhare	The Blowhole at Piha; lair of kahui tipua/taniwha Kaiwhare by ancestor known as Hakawau.	(Taua, 2009)
Ngaoho moko koha	ancestors of Te Kawerau a Maki on account of their distinctive method of tattooing.	(Taua, 2009)	Te Rua o Te Mokoroa	Mokoroa Falls, where taniwha Mokoroa was killed by ancestor Taiaoroa	(Taua, 2009)
Ngā Rau Pou a Maki	The many posts of Maki. The many peaks extending down the Waitakere Ranges from Muriwai to the Manukau Harbour entrance	(Taua, 2009)	Te Toka Matua	The Watchman, Karekare	(Taua, 2009)
Ngā Tai a Rakataura	(Waters of Manukau Harbour) the tidal currents of Rakataura/Hape	(Taua, 2009)	Te Tokapaoke	Paratahi Island	(Taua, 2009)
Ngā tai whakatu a Kupe	the name for the ocean off the Waitakere coastline; the upraised seas of Kupe. Resulted from the karakia made by Kupe to throw off people who were pursuing him.	(Taua, 2009)	Te Tokapiri		(Taua, 2009)
Ngāti Awa		(Taua, 2009)	Te Toka Tapu a Kupe	The sacred rock of Kupe? (The Ninepin)	(Taua, 2009)
Ngāti Poutukeka	tribal names developed by descendants of Tainui	(Taua, 2009)	Te Unuhanga o Rangitoto	Te Kawerau a Maki tradition - wherein Tiriwa shifts Rangitoto from Mercer Bay at Karekare to entrance to Waitemata Harbour	(Taua, 2009)

Kupu (synonyms in ())	Notes	Reference	Kupu (synonyms in ())	Notes	Reference
Ngāti Taihua	tribal names developed by descendants of Tainui	(Taua, 2009)	Te Uru Karaka	A magnificent 'Karaka grove' at Kawaupaku	Murdoch, 1990
Ngaurukehu	(aka Patupaiarehe, Tahurangi, Tutumaiao); more secretive forest - dwelling people; during the time of the Turehu; one of the preferred Te Kawerau a Maki names	(Taua, 2009)	Te Uru Tapu	the sacred grove', located in what is now Matuku Reserve; There are other names that related to specific trees, and especially to groves of trees that were used in ritual, to gather fruit, or to snare birds.	Murdoch, 1990
Ngā toka e toru	the tree rocks	(Taua, 2009)	Te Utika	chief of Te Kawerau	(Taua, 2009)
Ngawhetu	Child of Maki	(Taua, 2009)	Te Wao Nui a Tiriwa	The great forest of Tiriwa	(Taua, 2009)
Nihotupu	One of the remaining Turehu people who occupied the forested interior of 'Te Wao nui a Tiriwa'	Murdoch, 1990	Tini o Maruiwi	ancestors of Te Kawerau a Maki; undertook the first of several major migrations from Taranaki into the Auckland region. Some of these people settled in the Waitakere Ranges where they conqured and absorbed the Turehu. This is an early tradition of Te Kawerau a Maki and is known as Te Awe ka tutu, and placenames such as Nihotupu, Rourouhue, Waiopare, Parekura, and Opanuku (Henderson Valley), commemorate this period in our history and ancestors associated with it.	(Taua, 2009)
Oho Matakamokamo	Great grandson of Rakatataura/Hape	(Taua, 2009)	Tirikohua	Name bestowed by Hape/Rakataura	(Taua, 2009)
Ōkaurirahi	(Ceramco Park);"the place of huge kauri"; Kaurilands; In pre-European times this area was distinguished by its mature kauri forest.	(Taua, 2009)	Tiriwa	Turehu chieftan, ancestor of Te Kawerau a Maki	(Taua, 2009)
Opareira	(Upper Henderson valley); name comes from Pareira, niece of Toitehuatahi	(Taua, 2009)	Titahi	famous Ngāti Awa ancestor associated with early migrations of Ngāti Awa from the Mokau-Kawhia area; associated with the construction of fortifications as far apart as Maungakiekie and Te Korekore, and Te Tuara a Titahi at Muriwai.	(Taua, 2009)
Orua a mokai	very special place in the upper Waitemata Harbour - lair of taniwha Mokai o Kahu, guardian of the Waitemata Harbour	(Taua, 2009)	Titrangi	Name bestowed by Hape/Rakataura	(Taua, 2009)
Paepae ki Rarotonga	Waka of Toitehuatahi, a famous ancestor who visited the Waitakere district with niece Pareira.	(Taua, 2009)	Toitehuatahi	Another famous early ancestor from early period who visited the Waitakere district in his waka Paepae ki Rarotonga. Ventured into the Upper Waitemata Harbour where some of his people settled.	(Taua, 2009)
Paikea	a taniwha guardian of the Waitakere coastline and Manukau Harbour entrance.	(Taua, 2009)	Tokomaru	one of 5 ancestral canoes	(Taua, 2009)
Pareira	Niece of Toitehuatahi, from whom comes the placenames Wai o pareira (Henderson Creek), and Opareira (upper Henderson Valley)	(Taua, 2009)	Tūrapa	One of the Tohu ō Waitākere from Murdoch, 1990	Murdoch, 1990
Parekura	One of the illustrious women 'tupuna' -- Parekura and her husband Panuku often lived in the Waitakere area, where they had a home at Wainamu.	Murdoch, 1990	Turehu	early inhabitants of Aotearoa, of the land, did not migrate	(Taua, 2009)
Paretutanganui	wife of Maki	(Taua, 2009)	Tutumaiao (aka Patupaiarehe, Tahurangi, Ngaurukehu)	one of the preferred Te Kawerau a Maki names (aka Tutumaiao, Ngarukehu)more secretive forest-dwelling people, around time of the Turehu	(Taua, 2009)

Kupu (synonyms in ())	Notes	Reference	Kupu (synonyms in ())	Notes	Reference
Patupaiarehe (Tahurangi, Tutumaiao, Ngaurukehu)	more secretive forest-dwelling people	(Taua, 2009)	Tuwhenua	Moekakara waka descendants occupation of this land is remembered in placenames noth of Te Henga (Bethell's Beach) like Tuwhena and Pu o Tahinga.	(Taua, 2009)
Pohatu	great uncle of Maki; Ngaiwi; had settled earlier before Maki in the Tāmaki area between Mangere and Maungakiekie where they became dominant figues.	(Taua, 2009)	Waihuna	(Pararaha Valley)	(Taua, 2009)
Pokopoko	uttered a kanga (curse) against Ngati Whatua Kawharu after sister married Te Rawharu, Kawerau chief	Graham, 1925	Wainamu	Where Parekura and Panuku maintained a cutvation known as Mara o Parekura'.	Murdoch, 1990
Potueka	Crew of Tainui who settled permanently in the district and married into earlier local people	(Taua, 2009)	Wai o Kahu	(Piha Stream);Name bestowed by Hape/Rakataura	(Taua, 2009)
Pu o Tahinga	Moekakara waka descendants occupation of this land is remembered in placenames noth of Te Henga (Bethell's Beach) like Tuwhena and Pu o Tahinga.	(Taua, 2009)	Wai o Pareira	(Henderson Creek); name comes from Pareira, niece of Toitehuatahi	(Taua, 2009)
Rotu	wife of Maki	(Taua, 2009)	Waitahurangi	name remembers the Tahurangi people (aka. Patupaiarehe, Tahurangi, Ngaurukehu) stream which flows from the Titirangi ridge in a NE direction to the head of the Whau River at New Lynn	(Taua, 2009)
Rakataura (aka Hape)	Tohunga (spiritual leader) from Tainui waka. Explored and named places on the Tāmaki isthmus and northward to Mahurangi. And up the west coast from Whatipu to Ouenuhu, near Kaipara harbour entrance. AKA Hape.	(Taua, 2009)	Waitakere	very significant rock located in the small bay just north of Ihumoana Island Te Hegna; so named because of the seas that sweep relentlessly over it	(Taua, 2009)
Rua o te whenua/Te Awe ka tutu/the feather down that summoned help.	home of Nihotupu, one of the few remaining Turehu people who occupied Te Wao Nui a Tiriwa	Murdoch, 1990	Waitetura	(North Piha)	(Taua, 2009)
Ruarangi	grandson of Rakataura/Hape	(Taua, 2009)	Whakapu	From Kupe came the name for the bay just south of Te Henga	(Taua, 2009)
			Whatipu		(Taua, 2009)

Appendix L *Search terms (including synonyms) for a literature review of kōrero tuku iho related to maramataka (Māori lunar calendar) developed during the course of this research. Not all of these search terms were used during this research, but may be useful for future research.*

Ingoa Māori (synonyms/search terms in ())	**Ingoa Māori (synonyms/search terms in ())**
Aponga (Here-turi-kōkā) (July-August)	Ōhua
Ariroa	Oike
Atua	Okoro
Autahi	Omauri
Hakihea (November-December)	Ōrongonui
Haratua (April-May)	Ōtāne
Hōngongoi (June-July)	Oturu
Hotu	Paenga-whā-whā (March-April)
Huitanguru (January-February)	Pipiri (May-June)
Huna	Poutūterangi (February-March) (Ngahuru)
Kohitātea (December-January)	Rākau ma tohi
Korekore piri ki ngā tangaroa	Rākaunui
Korekore tē rawea	Takirau
Korekore tē whiwhia	Takurua
Mahuru (August-September)	Takurua Angana
Matiti (raumati)	Tamatea a hotu
Matiti Hana	Tamatea a ngana
Matiti Kaiwai	tamatea āio
Matiti Kura	Tamatea ariki
Matiti Muramura	Tangaroa a mua
Matiti Rauangina	Tangaroa a roto
Matiti Raurehu	Tangaroa kiokio
Matiti Rautapata	Tirea
Mawharu	Wero (ngahuru)
Mutuwhenua	Whiringa-ā-nuku (Septepmber-October)
Ōenuku	Whiringa-ā-rangi (October-November)
Ohoata	Whiro

Appendix M *Search terms (including synonyms) for a literature review of kōrero tuku iho related to plant species found in Te Wao Nui ā Tiriwa developed during this research.*

Ingoa Māori (synonyms/search terms in ())		
Akatea	Korohikoc[Koromiko?]	Pūriri
Hangehange (pāhengahenga, pāpāhenga, whangewhange, pāpā, hengahenga)	Koromiko (koromuka, kōkōmuka)	Putaputawētā (kaiwētā, piripiriwhata, punawētā, putawētā)
Hīnau	Kōhūhū (kohukohu, kōwhiwhi, rautāhiri, rautāwhiri, tawhiwhi, pōhiri, tāhiri, pōwhiri, tāwhiri)	Rangiora (kōuaha, whārangi, pukapuka, raurēkau, raurākau)
Horoeka (hoheka, koeka, kokoeka, ohoeka)	Kōtukutuku	Rātā (akatea, akatoki, aka, whakapiopio, torotoro, akatorotoro, koro)
Houhere (houi, houhi, ongaonga)	Kōwhai (kōhai)	Rengarenga (kōrengarenga)
Houpara	Kūmarahou	Rewarewa (rewa)
Kahakaha (kōkaha, pūwharawhara, pūwherowhero, tākaha)	Māhoe (moeahu, hinahina)	Rimu (puaka)
Kahikatea (katea, kaikatea, koroī, kōaka, kahika)	Maire (maire raunui, maire rauriki)	Taraire
Kahikātoa (see Mānuka)	Māmangi	Taramea
Kāmahi	Mamaku	Tarata
Kanono (manono, raurekau, kawariki)	Mangemange (mounga, makamaka, mākaka)	Tātarāmoa (rōia, akatātārāmoa, taramoa, taraheke, tātaraheke)
Kānuka (kōpuka, mānuka rauriki, mārū)	Mānuka (kahikātoa, kātoa, pata, rauiri, rauwiri)	Tauhinu (taihinu, whatitiri)
Karaka (kōpī)	Māpou (mataira, takapou, tīpau, tāpau, matipou, māpau)	Taupata
Karamū (karangū, patutiketike, kāramuramu)	Mataī (māī, kākāī, kāī)	Tawa
Kareao	Matuku	Tawhiri karo (wharewhareatua)
Karo (kairako, kīhihi)	Mingimingi (hukihukiraho, inangapōriro, miki, mikimiki, mingi, ngohungohu, pārōtara, taumingi, tūmingi)	Tānekaha (tāwaiwai, nīko, ahotea)
Kauri	Miro (toromiro)	Toetoe
Kawakawa (ōramarama, puhikawa, horopito, ramarama)	Neinei (taritari āwhā)	Titoki
Kiekie (pēia)	Nīkau (kaihuia, munga, miko)	Tōtara
Kohekohe (māota, kohe)	Pātē (kōtētē, patete, patatē)	Tutu
Kohia (pōhue, kūpapap, kohe, kāhia, kaimanu, akakaikū, akatororaro, akakūkū, akakaikūkū, akakaimanu)	Ponga (kaponga)	Wharangi (whārangi, tākaka, houkūmara)
Kohurangi	Pukatea (akakopuka, akapuka, puka)	Whauwhaupaku (whaupaku, tauparapara, houhou, puahou)

Appendix N *Search terms (including synonyms) for a literature review of kōrero tuku iho related to animal species found in Te Wao Nui ā Tiriwa developed during this research.*

Ingoa Māori (synonyms/search terms in ())
Kākā
Kererū
Kihikihi/tarahiki
Koekoeā
Korimako
Kōkako
Kōpara
Kōtare
Kūkūpa
Mātātā
Mātāta
Matuku
Miromiro (kikitori, kōmiromiro, māuipōtiki, pipitore, pipitori, pīmiromiro, pīngirungiru, pīmirumiru, pīrangirangi, toitoi, hōmiromiro)
Mokomoko
Mokoroa
Pekapeka
Pīpīwharauroa
Pīwakawaka
Pōpokotea
Riroriro
Ruru
Tauhou
Tūī
Tuna

Appendix O *Sample coding sheets used for thematic analysis from (audio recorded) field visits to Te Wao Nui ā Tiriwa.*

Date	Location	Recording #	Recording Length	Timestamp	Speaker Initials	Transcript Excerpt	Theme	Subtheme / Notes
19-Nov-24	Upper Te Piringa track	5	0:07:55	:02		[stoping to pause, silent observation]	2. Sensory Awareness	silent observation
19-Nov-24	Upper Te Piringa track	5	0:07:55	0:01	LB	[noticing temperature] "The temperature's definitely dropped, I can see your breath when you're standing..."	2. Sensory Awareness	temperature
19-Nov-24	Upper Te Piringa track	5	0:07:55	2:05	SB	[notices porokaiwhiri is doing well]	4. Environmental tohu	health
19-Nov-24	Upper Te Piringa track	5	0:07:55	2:38	LB	"That mahoe is in flower"	4. Environmental tohu	flowering, māhoe
19-Nov-24	Upper Te Piringa track	5	0:07:55	2:45	LB	"Fruiting in there"	4. Environmental tohu	fruiting
19-Nov-24	Upper Te Piringa track	5	0:07:55	3:25	LB	[notices skat]	4. Environmental tohu	scat
19-Nov-24	Upper Te Piringa track	5	0:07:55	3:33	SB	hears pipipwharauroa	2. Sensory Awareness	birdsong
19-Nov-24	Upper Te Piringa track	5	0:07:55	6:00	SB	"Who's that flying around there? There's some little tiny black bird flying past Aunt Agatha."	2. Sensory Awareness	bird
19-Nov-24	Upper Te Piringa track	5	0:07:55	6:44	LB	"There's two small birds on her branches."	2. Sensory Awareness	bird

Date	Location	Recording #	Recording Length	Timestamp	Speaker Initials	Transcript Excerpt	Theme	Subtheme / Notes
19-Nov-24	Upper Te Piringa track	5	0:07:55	7:02	LB	[addressing birds directly]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	addressing birds directly
19-Nov-24	Upper Te Piringa track	5	0:07:55	7:41	LB	"We've got you, kōtare"	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	addressing birds directly
19-Nov-24	Upper Te Piringa track	6	0:04:46	0:18	LB	"There's a piwakawaka just in here, and then up here is a baby tui, or a juvenile tui that hasn't quite learnt it's call yet."	2. Sensory Awareness	bird
19-Nov-24	Upper Te Piringa track	6	0:04:46	0:34:00	SB	"So he's visiting his ancestor, you know?"	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	bird, tree, interrelated
19-Nov-24	Upper Te Piringa track	6	0:04:46	1:43	SB	"E noho ra, e hui hou."	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	addressing taiao directly, identifying myself
19-Nov-24	Upper Te Piringa track	6	0:04:46	2:49	SB	[wonders if rata vine will grow on top of Aunt Agatha]	2. Sensory Awareness	
19-Nov-24	Upper Te Piringa track	6	0:04:46	2:58	LB	"I was jus tthinking it's so shiny and smooth - cos you've got one- a couple of little epiphtes, but-- [growing on Aunt Agatha]"	2. Sensory Awareness	regrowth, epiphytes

Date	Location	Recording #	Recording Length	Timestamp	Speaker Initials	Transcript Excerpt	Theme	Subtheme / Notes
19-Nov-24	Upper Te Piringa track	6	0:04:46	3:25	SB	[noticing small birds]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	small piwakawaka on Aunt Agatha
19-Nov-24	Upper Te Piringa track	6	0:04:46	4:25	LB	[notices 6 or 7 distinct plant species in small area]	2. Sensory Awareness	
19-Nov-24	Upper Te Piringa track	6	0:04:46	4:38	SB	"It's almost colder now."	2. Sensory Awareness	weather, cold, change
19-Nov-24	Upper Te Piringa track	6	0:04:46	4:41	LB	"Yah because the cloud cover's gone.	2. Sensory Awareness	weather, cloud cover
25-Nov-24	Lower Te Piringa Track	1	0:44:36	0:48	SB	"5:01am at the entrance"; "Oh gosh, it's dark"	5. Maramataka & Temporal Awarenes	time, light
25-Nov-24	Lower Te Piringa Track	1	0:44:36	1:14	SB	[felt uneasy] "hmm it's a little spooky"	2. Sensory Awareness	somatic marker
25-Nov-24	Lower Te Piringa Track	1	0:44:36	1:35	SB	[pule in 'olelo hawai'i]	2. Sensory Awareness	somatic marker, prayer
25-Nov-24	Lower Te Piringa Track	1	0:44:36	1:41	SB	[both greet Tiriwa statue - tēnā koe, kia ora]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	
25-Nov-24	Lower Te Piringa Track	1	0:44:36	2:35	LB, SB	[lynda wants to turn off light to see with moonlinght only]	2. Sensory Awareness	moonlight

Date	Location	Recording #	Recording Length	Timestamp	Speaker Initials	Transcript Excerpt	Theme	Subtheme / Notes
25-Nov-24	Lower Te Piringa Track	1	0:44:36	2:42	SB	[felt uneasy near Tiriwa carving]	2. Sensory Awareness	somatic marker, nervous
25-Nov-24	Lower Te Piringa Track	1	0:44:36	3:37	SB	[needs more light to see]	2. Sensory Awareness	darker for SB than LB
25-Nov-24	Lower Te Piringa Track	1	0:44:36	4:02	LB, SB	[both greet ruru nearby]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	greeting non-human beings
25-Nov-24	Lower Te Piringa Track	1	0:44:36	4:57	SB	[pule He Ola i mua... in 'olelo hawai'i]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	identifying as hawaiian; relationship with others
25-Nov-24	Lower Te Piringa Track	1	0:44:36	6:29	LB,SB	[connection of Lehua to Rehua]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	tangata moana connection
25-Nov-24	Lower Te Piringa Track	1	0:44:36	6:50	LB	"It does look like pohutukawa.'	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	whakapapa of Rehua constellation to pohutukawa
25-Nov-24	Lower Te Piringa Track	1	0:44:36	7:58	LB, SB	[marama is moon]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	identification of ingoa māori name for moon
25-Nov-24	Lower Te Piringa Track	1	0:44:36	8:08	LB	"Thank you, Marama for guiding us. This light" [somatic marker, LB felt compelled to express gratitude]	3. Whakapapa (genealogy) & Whanaungatanga (relationships)	connecting with element of nature

Appendix P *Sample page from Excel spreadsheet of vegetation observations from nine field visits to Te Wao Nui ā Tiriwa from November 2024 – March 2025 as part of this thesis research.*

Recording_ Date	Moon Phase	Location	Recording #	Timestamp	Plant Species	Plant Status	Observation Type	Tohu Noted	Notes/Quotes
19-Nov-24	Takirau	Upper Kauri Track (Montana Heritage Trail)	1	0:38:17	Lichen	Present	Visual		Orange lichens on the kauri
19-Nov-24	Takirau	Upper Te Piringa Track	4	0:26:00	Lichens	Present	Visual		Catch SBs eye -- on Nīkau
19-Nov-24	Takirau	Upper Te Piringa Track	4	00:04:32	Mahoe	Flowering	Visual; Olfactory	Yes	S: The mahoe is - flowering? L: Yes. L: To me they smell like frangipani
19-Nov-24	Takirau	Upper Te Piringa Track	4	00:04:32	Mahoe	Present			
19-Nov-24	Takirau	Upper Te Piringa Track	4	0:35:33	Mahoe	Flowering	Visual		
19-Nov-24	Takirau	Upper Te Piringa Track	4	0:35:33	Mahoe	Present			
19-Nov-24	Takirau	Upper Te Piringa Track	5	0:02:45	Mahoe	Flowering	Visual		
19-Nov-24	Takirau	Upper Te Piringa Track	5	0:02:45	Mahoe	Present			
19-Nov-24	Takirau	Upper Kauri Track (Montana Heritage Trail)	1	0:55:28	Māhoe	Insect Herbivory	Visual		
19-Nov-24	Takirau	Upper Kauri Track (Montana Heritage Trail)	1	0:55:28	Māhoe	Present			
19-Nov-24	Takirau	Upper Kauri Track (Montana Heritage Trail)	1	0:10:04	Māhoe	Senescent Leaves	Visual		yellow leaf fall
19-Nov-24	Takirau	Upper Kauri Track (Montana Heritage Trail)	1	0:10:04	Māhoe	Present			

Appendix Q *Sample page from Excel spreadsheet of bird observations from nine field visits to Te Wao Nui ā Tiriwa from November 2024 – March 2025 as part of this thesis research.*

Date	Location	Recording	Approx Time	Mata o te marama	Species	Number Observed	Minutes Recorded	Avg. Birds Per Minute
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Kihikihi	0	10.93	0.00
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Kōtare	0	10.93	0.00
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Miromiro	0	10.93	0.00
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Myna	0	10.93	0.00
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Pīpīwharauroa	0	10.93	0.00
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Piwakawaka	0	10.93	0.00
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Riroriro	8	10.93	0.73
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Rosella	2	10.93	0.18
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Ruru	0	10.93	0.00
25-Nov-24	Fenceline Track to Waitakere Dam (Montana Heritage Trail)	3	AM	Tangaroa ā roto	Sparrow	1	10.93	0.09

Appendix R *Sample page from Excel spreadsheet of weather and environmental observations from nine field visits to Te Wao Nui ā Tiriwa from November 2024 – March 2025 as part of this thesis research.*

Recording_Date	Location	Length	Recording number	Timestamp	Environmental Observation	Transcription excerpt
2024-12-16 00:00:00	Waitakere Dam	0:13:54	3	0:00:00	Clear	S: On a clear day.
2024-12-16 00:00:00	Waitakere Dam	0:13:54	3	0:00:02	Clear	L: Clear day, and earlier.
2024-12-16 00:00:00	Waitakere Dam	0:13:54	3	0:00:07	Light	L: It's light now, so technically dawn has broken.
2024-12-16 00:00:00	Waitakere Dam	0:13:54	3	0:03:05	Light	S: We could just sit here, since it's light.
2024-12-16 00:00:00	Waitakere Dam	0:13:54	3	0:00:02	Early	L: Clear day, and earlier.
2024-12-16 00:00:00	Waitakere Dam	0:13:54	3	0:00:07	Dawn	L: It's light now, so technically dawn has broken.
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:01:22	Breeze	S: Light breeze - moderate breeze, walking over the dam.
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:43:06	Breeze	S: The water and the earth and the trees are all working together, so with the breeze. it's all connected and we're connected as well. We learn that in hawaiian belief system - that the wind is - the ancestors are present?
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:26:10	Wind	S: [inaudible] The wind's picking up.
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:34:54	Wind	[background noise, wind?, microphone interference?]
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:43:06	Wind	S: [inaudible] The water and the earth and the trees are all working together, so with the breeze. it's all connected and we're connected as well. We learn that in hawaiian belief system - that the wind is - the ancestors are present?
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:32:06	Rain	S: Couldve been like one raindrop.
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:20:21	Mist	S: The moonlight on this looks like a mist over the plants. You know what I mean.
2024-12-22 00:00:00	Waitakere dam	0:56:58	3	0:15:24	Bright	S: It's cool the moon shining off of the different plants. It's very bright!

Appendix S *Sample page from Excel spreadsheet of somatic and emotional response observations from nine field visits to Te Wao Nui ā Tiriwa from November 2024 – March 2025 as part of this thesis research.*

Recording_Date	Location	Recording Length	Recording number	Timestamp	Somatic Marker	Transcription excerpt/Notes
2024-11-19 00:00:00	Upper Te Piringa Track	0:51:15	2	00:08:37	Silent	Aunt Agatha, dead, silent observation
2024-11-19 00:00:00	Upper Te Piringa Track	0:51:15	2	00:34:20	Happy	L: Oh yah. Remember happy place -- this is my home.
2024-11-19 00:00:00	Upper Te Piringa Track	0:51:15	2	00:33:46	Sadness	L: Like how long has it been here? It's mind boggling. I just think it's so sad that there's very few of them.
2024-11-19 00:00:00	Upper Te Piringa Track	0:51:15	2	0:30:42	Uneasy	S: I feel like I've seen - I've been over there twice now - but I don't know, it's weird.
2024-11-19 00:00:00	Upper Te Piringa Track	0:51:15	2	0:31:06	Scared	S: Are you ok? I Just got freaked out for a minute.
2024-11-19 00:00:00	Upper Te Piringa Track	0:51:15	2	0:34:39	Sad	L: When you look at the kauri, and you're just like - how long has it been here? Like how many years old is that tree? It's mind boggling. I just think it's so sad that there's very few of them.
2024-12-15 00:00:00	Upper Te Piringa Track	0:13:46	1	0:00:47	Calm	S: It is 4:21 in the morning, it is clear, nearly full moon. It is very clear and still.
2024-12-15 00:00:00	Upper Te Piringa Track	0:13:46	1	0:06:34	Sad	A: That's pretty sad, isn't it?
2024-12-15 00:00:00	Upper Te Piringa Track	0:13:46	1	0:11:49	Alright	S: How are you feeling? A: Alright. [tui birdsong]

Appendix T *Sample page from a database of whakataukī related to Te Kawerau ā Maki gathered during a literature review of kōrero tuku iho as part of this research.*

Kupu Māori	Whakataukī	English Translation	Meaning [from 'Reference' listed in Column E)	Reference	no., page no.
Moekakara	*Not referenced in Mead & Grove, 2001*				
Ngai Riukiuta	*Not referenced in Mead & Grove, 2001*				
Ngaiwi	Need to look in Mead & Grove 2001				
Ngaoho (Ngā oho mata kamokamo)	Ngā Oho manawa rererua.	Ngā Oho whose hearts are wrapped up double-fold.	Ngā Oho of Te Arawa were said to be people who spoke in words of double meaning. The pēpeha is said of people whose words might mean anything.	Graham, n.d. In Mead & Grove, 2001	2030, p. 327
Ngaoho (Ngā oho mata kamokamo)	Ngā tamariki hikuroa a Rākeiora.	The long-tailed children of Rākeiora.	This refers to the numerous descendants of Rākeiora's sons, Ruarangi and Oho-mata-kamokamo. They fought many bloody battles with each other until finally Oho was victorious. Ngā Oho trace their ancestry to him.	Graham, 1916 in Mead & Grove, 2001	2048, p. 330
Ngaoho (Ngā oho mata kamokamo)	Te pokuru nui a Ruarangi, me ngā namunamu o Hurihuri.	The great stopped-up flow of Ruarangi, even as the sandflies of Hurihuri.	This described the long struggles of the descendats of Rākei, Ruarangi and Oho-mata-kamokamo. Eventually Oho's force prevailed and the opposing groups moved to Waitakere. The people of Tāmaki were then called Ngā Oho, although with intermarriages it became hard to distinguish between Tainui, Ngāti Whatua, Waiōhua, and Oho.	Graham, 1919 in Mead & Grove, 2001	2400, p. 385
Ngaoho (Ngā oho mata kamokamo)	Ngā Oho moko koha.	Ngā Oho tattooed with straight cuts into the skin.	This left gashes unlike the result of piercing in later times.	Graham, n.d. In Mead & Grove, 2001	2030, p. 385

Appendix U *Sample pages from a database of whakataukī related to the maramataka (the Māori lunar calendar) gathered during a literature review as part of this research.*

Kupu Māori (synonyms/ search terms in ())	Whakataukī/Waiata	English Translation	Meaning	Reference	Citation
5. Whiringa-ā-nuku (Septepmber-October)	Ka hua te kūmarahou, ka whakatō kūmara tupu.	When the kūmarahou flowers the kūmara sprouts are planted out.	The kūmarahou or golden Tainui (*Pomaderris elliptica)* is sometimes called gumdiggers soap' The shrub has showy yellow flowers blooming in September and october, the season during which kūmara sprouts are planted. Knowledge of the environment and the seasons is embraced in this proverb, providing information for those who will plant the sweet potato.	Source unknown in Mead & Grove, 2001	949, p. 156
6. Whiringa-ā-rangi (October-November)			This is the first phase and is triggered by the ripening of the small red berries in the bush. The timeframe is toward the end of October.	Matata-Sipu, Q. 2018	
6. Whiringa-ā-rangi (October-November)		It has now become summer, and the sun has acquired strength.		Best, E, 1946 in Meredith, P., 2006	
6. Whiringa-ā-rangi (October-November)	Ngā uaua o te whitu rāua ko te ono.	The strenuous times of the sixth and seventh.	At the time of the sixth month (November) and the seventh (December) gales and bad weather usually start.	Brougham, 1975; Grey, 1857; Williams, 1908 in Mead & Grove, 2001	2080, p. 335
7. Hakihea (November-December)		Birds are now sitting on their nests		Best, E, 1946 in Meredith, P., 2006	
7. Hakihea (November-December)	Ngā uaua o te whitu rāua ko te ono.	The strenuous times of the sixth and seventh.	At the time of the sixth month (November) and the seventh (December) gales and bad weather usually start.	Brougham, 1975; Grey, 1857; Williams, 1908 in Mead & Grove, 2001	2080, p. 335

Kupu Māori (synonyms/ search terms in ())	Whakataukī/Waiata	English Translation	Meaning	Reference	Citation
8. Kohitātea (December-January)	Me te kihikihi kei te waru.	LIke cicada in the summer.	This describes a noisy gathering. See also *Me te tātarakihi...*	Taylor 1870:644 in Mead & Grove, 2001	1814, p. 293
8. Kohitātea (December-January)	Me te tarakihi e papā ana i te waru.	Like the cicada chirping in the eighth month.	In the eighth month of the Māori year, or summer, the constant chirping of many cicada (*Cicado cinulata*) provides an apt comparison for the animated conversations of people.	Brougham 1975:114; Taylor 1855:134, Williams 1908:28; 1971:244 in Mead & Grove, 2001	1904, p. 306
8. Kohitātea (December-January)	Ko ngā rā ēnei o te tātua o Rangitauheke, he waru ki runga he rare ki raro.	These are the days of Rangitauheke's girdle, the eighth above and lack of activity below.	In the eighth month, January, food supplies grow scarce and the new crops are not yet ripe. The girdle slips lower (*tauheke*) because of the reduced diet and there is little to do until harvest time.	Williams, 1971 in Mead & Grove, 2001	1450, p. 238
8. Kohitātea (December-January)	He puanga kākaho, ka rere i te waru.	The blooms of the toetoe fly in the eighth month.	The eighth month, usually taken as January, refers to summer. The saying, therefore, means that summer has well and truly arrived. See also *He kihikihi* ...	Grey, 1857; Williams, 1971 in Mead & Grove, 2001	656, p. 112
8. Kohitātea (December-January)	Ka mahana ngā rā o te Hiringa.	The days of Hiringa are warm.	Hiringa is short of Hiringa-a-Nuku or Hiringa-a-Rangi, the eighth month, which is January.. The significance is that life is more enjoyable in that season. See also *He puanga...*	Williams, 1971 in Mead & Grove, 2001	995, p. 164
8. Kohitātea (December-January)	Te waru pōkai kete, te waru o kai tahi.	The eighth month, when baskets are left rolled-up, a time of scarcity and only one meal a day.	This saying refers to summer, a period before the harvest when food supplies are at their lowest level. A similar thought is found in 'Ko waru pōkai kete,' the eighth month, the season of the rolled up basket.'	Mead & Grove, 2001	2490, p. 398

Appendix V *Sample pages from a database of whakataukī related to plant species in Te Wao Nui ā Tiriwa gathered during a literature review as part of this research.*

Ingoa Māori (synonyms/search terms in ())	Whakataukī	English Translation	Meaning [from 'Reference' listed in Column E)	Reference	no., page no.	Note
Karaka (kōpī)	Ko te kaha, ko te toki; to te uaua, ko te pakake; to te pakari, ko te karaka; mō te tangata kaha ēnei whakataukī.	For strength, the adze; for resolution, the whale,; for sturdiness, the karaka nut; for the able man are these sayings.	These items – the adze, whale and karaka – were, according to Best, supposed to illustrate a number of qualitiessuch as strength, endurance, strenuousness, maturity, etc.	Best 1977b:48 in Mead & Grove, 2001	1546, p. 252	
Karaka (kōpī)	Tamatea-o-rua, nāna Te Aopaka, e Kura te aha, e Kura te aha, tē mate tētahi mahi, ka hua ai tētahi mahi.	Tamatea-o-rua, father of Aopaka, would call out to his slave, Kura to this, Kura do that, and before that job was finished another job would be designated.'	One day while Kura was up in a karaka tree hurrying to finish some assigned work, and constantly being urged on, he fell from the tree and was badly injured. The lesson from this proverb is similar to 'haste makes waste'.	Grey 1857:83 in Mead & Grove, 2001	2212, p. 358	
Karaka (kōpī)	Te anga karaka, te anga kōura, koi kitea ki te marae.	Karaka husks and crayfish shells should not be seen on the marae.	The purpose of this rule is to avoid raising false hopes in the minds of guests that a fine feast is to be served.	Brougham 1975:55; Kōhere 1951:40; Williams 1908:14; 1971:10 in Mead & Grove, 201	2267, p. 366	
Karamū (karangū, patutiketike, kāramuramu)	*Not referenced in Mead & Grove, 2001*					
Kareao	He arero kareao ka whati, engari te arero wahine kāore e whati haere tonu ana.	A toungue of supplejack will crack but not a woman's tongue, it goes on and on and on.	This unflattering saying might be amended to apply equally to some men.	Anderson 1924:689; 1934:927 in Mead & Grove, 2001	355, p. 65	

Ingoa Māori (synonyms/search terms in ())	Whakataukī	English Translation	Meaning [from 'Reference' listed in Column E)	Reference	no., page no.	Note
Houhere (houi, houhi, ongaonga)	Ngā taero o Kupe, e, ngā rōrī o te whare o Uenuku.	The obstruction which Kupe found were the knots Uenuku used to fasten his door.	The obstructions referred to were supplejacks. When knotted by Uenuku they served to protect his house from thieves. Thus an obstruction to one person is put to a practical use by another .Today when the first phrase is quoted alone it is understood to refer to the supplejacks (kareao), brambles or bush lawyer (tātarāmoa), spear grass (tūmatakuru), and stinging nettles (ongaonga)[probably *Hoheria sexstylosa*, with serrated leaves like stinging nettle -S. Bishop, April 2025] which made overland travel so difficult when Kupe arrived. They are now understood to symbolise mental difficulties and obstructions.	Grey 1853:105; 1857:77; Williams 1971:347,356 in Mead & Groves, 2001	2043, p. 329	
Houpara	*Not referenced in Mead & Grove, 2001*					
Kahakaha (kōkaha, pūwharawhara, pūwherowhero, tākaha)	E kakapa ana me he kahakaha.	Fluttering like the [leaves of] the kahakaha.	The kahakaha is a plant often growing on other plants but not parasitic on them. According to Williams (1971:82), it can be used to make snow sandals. The expression is used to describe the quivering of the hands or weapon in a haka.	Ngata, 1972; Williams, 1971 in Mead &Groves, 2001	119, p. 28	
Kahikatea (katea, kaikatea, koroī, kōaka, kahika)	He tārū kahika.	The shaking of a kahikatea.	This figure of speech provides a metaphor for a light summer rain, no more than one would get by shaking the kahikatea, or white pine.	Williams, 1971 in Mead & Grove, 2001	744, p. 124	
Kahikatea (katea, kaikatea, koroī, kōaka, kahika)	He te tau koroī rā anō.	Put off until the berries of the white pine appear.	The fruit of a particular tree might not regularly appear every year. The saying means, therefore, something was postponed indefinitely.	Colenso, 1879; Grey, 1857; Williams, 1971 in Mead & Grove, 2991	414, p. 75	

Appendix W *Sample pages from a database of whakataukī related to animal species in Te Wao Nui ā Tiriwa gathered during a literature review as part of this research.*

Ingoa Māori (synonyms/search terms in ())	Whakataukī	English Translation	Meaning	Reference	Citation
Moko (kumukumu, mokomoko, mokopeke)	He moko kākāriki.	A green lizard.	The green gecko was often thought to be an evil omen. This was related to concept that illness was caused by such a lizard entering through the mouth to consume the inside of a person. If no countermeasures were taken, the person would die. On the other hand the koeau, a lizard said to be of reddish colour, was also at times though to be the forerunner of evil and death.	Best 1982:4601f; Williams 1908:35 in Mead & Grove, 2001	580, p. 100
Mokoroa	Hei iti hoki te mokoroa, nāna i kākati te kahikatea.	Although the mokoroa is small it attacks the white pine.	The mokoroa is a large grub that eats into the tall tree. The meaning of the saying is one should not feel contempt for a weak enemy for he or she may be able to cause one much difficulty.	Grey, 1857; Taylor, 1974; Williams, 1972 in Mead & Grove, 2001	418, p. 75
Mokoroa	He iti mokoroa e hinga te pūriri.	Although the mokoroa is small, the pūriri falls.	The mokoroa is a large grub that attacks trees. The saying means one should not ignore weak opposition for it may grow to forestall success of an enterprise.	Stowell, n.d.b in Mead & Grove, 2001	423, p. 76
Mokoroa	Otirā, he iti te mokoroa, e hinga te koroī.	Although the grub is small the tree will fall.	This refers to the kahikatea or white pine and the large grub which may infest it. The lesson is that weak opposition, if allowed to grow, may forestall success of a project.	Williams 1971:144, 208 in Mead & Grove, 2001	2111, p. 340

Ingoa Māori (synonyms/search terms in ())	Whakataukī	English Translation	Meaning	Reference	Citation
Riroriro	I hea koe i te tangihanga o te riroriro?	Where were you when the grey warbler was singing.	This is yet another version with the same theme as the preceding proverbs; those who do not work should not share in the fruits of labour. Hōrirerire is sometimes used also for the grey warbler.	Brougham, 1975; Colenso, 1855; Williams, 1971 in Mead & Gove, 2001	880, p. 145
Ruru (peho, koukou)	*Not referenced in Mead & Grove, 2001*				
Tauhou	*Not referenced in Mead & Grove, 2001*				
Tūī	E koekoe te tūī, e ketekete te kākā, e kūkū te kererū.	The tūī chatters, the parrot gabbles, the wood pigeon coos.	Its popular meaning is, "It takes all kind of people..."	Brougham, 1975; Kōhere, 1951; Williams, 1908; in Mead & Grove, 2001	131, p. 30
Tūī	He kōkō kai kohe.	A tūī eating kohe berries.	The tūī grows far on the fruit of this member of the passionfruit family and the saying is a metaphor for a fat person.	Best, 1909; 1924; Brougham, 1975 in Mead & Grove, 2001	489, p. 85
Tūī	He kōkō tatakī.	A witty tūī.	This is a proverbial expression for one who gives a witty speech which sometimes borders on impropriety.	Williams, 1908; 1971; in Mead & Grove, 2001.	493, p. 86
Tūī	He kōkō whakamoe, ka mate te tangata.	When like a benumbed tūī, men die.	This served as a warning to the sentry. When the tūī is numb from the cold it may be caught by hand. The saying might equally be applied to a person who is lethargic and sleepy-headed.	Best, 1909; Brougham, 1975 in Mead & Grove, 2001	494, p. 86
Tūī	He korokoro tūī.	A throat of a tūī.	This describes a speaker of versatility and wit.	Williams, 1908 in Mead & Grove, 2001	506, p. 88

Appendix X *Sample pages from a database of waiata related to plant species in Te Wao Nui ā Tiriwa gathered during a literature review as part of this research.*

Ingoa Māori (synonyms/search terms in ())	Waiata	English Translation	Reference	Citation
Hangehange (pāhengahenga, pāpāhenga, whangewhange, pāpā, hengahenga)	*Not referenced in A name and word index to Ngā Mōteatea (Harlow & Thornton, 1986)*			
Hīnau	*Not referenced in A name and word index to Ngā Mōteatea (Harlow & Thornton, 1986)*			
Horoeka (hoheka, koeka, kokoeka, ohoeka)	*Not referenced in A name and word index to Ngā Mōteatea (Harlow & Thornton, 1986)*			
Houhere (houi, houhi, ongaonga)	"...Ka kaite rā koe te pōkai ongaonga; i ahu mai i tawhiti, te motu o Whakatu;"	"...Who lies, as you now see, upong a heap of nettles, Brought here from arar, from the land of Whakatu;	From *He Waiata Aroha/A Love Song.* (Ngati Te Kanawa, Ngati Maniapoto), Revised by Te Taite Te Tomo	68:7-8, p. 304-305, *Ngā Mōteatea,* 2006.
Houpara	*Not referenced in A name and word index to Ngā Mōteatea (Harlow & Thornton, 1986)*			
Kahakaha (kōkaha, pūwharawhara, pūwherowhero, tākaha)	"Ā e rua ia rā āku ringaringa, Ki te whakakopa mai tāku manawa, E kapapa ana me ha rau kahkaha, ē,ī."	"My two hands are needed to clutch and support my heart, Which quivers like a blade of kahakaha."	From *He Waiata Aroha/A Love Song.* (Ngati Pikiao, Te Arawa), Te Hiwi	09:08-10, p. 46-47, *Ngā Mōteatea,* 2006.
Kahakaha (kōkaha, pūwharawhara, pūwherowhero, tākaha)	Ā, e rua i ara aku ringaringa Ki te whakakopa mai i taku manawa, E kakapa ana me he rau kahakaha!	Verily both these hands of mine are needed To clutch and hold my heart within, As it flutters wildly like the kahakaha leaf.	From *He Waiata Whakamomori* (Ngati Tuwharetoa) By Rangiaho, Explanations by Pei Te Hurinui	62A:8-10, p. 274-275 *Nga Mōteatea,* Ngata, 2006.
Kahikatea (katea, kaikatea, koroī, kōaka, kahika)	...E tuia ana koe e te pua i te kahika, ē, E te ora iti rā, nāhau e Kahutore.	For you are drawn where the kahika berries abound, To the rare viands of you, Kahutore.	From *He Waiata Wawata Mō Te Kaniatakirau/A Wishful Song for Te Kaniatakirua*. (Ngati Porou), Uknown composer, supplied by Paratene Ngata	16:7-8, p. 73-74, *Ngā Mōteatea,* Ngata, 2006

Ingoa Māori (synonyms/search terms in ())	Waiata	English Translation	Reference	Citation
Mamaku	E tama mā, ē! E ahu ki uta rā, Ki ngā kai a Toi' I mahue i muri rā, Te aruhe, te mamaku, te pou o te tangata, ē.	O ye sons all! Go ye inland To the food of Toi' Which he left behind; The fern-root, the tree-fern, As sustenance for mankind.	From *He Tangi Mō Te Matenga o Ngā Kai* (Ngati Porou) By Horomona Hapai (Te Karu) Te Text of the song and explanations are by Ani Tarewa.	170:20-25, p. 318-319, *Ngā Mōteatea,* Ngata, 2006
Mamaku	Etia nei au, e tama mā, Ko te Aitanga-a-Tane' E tuohu i utu rā, E piko nei me te mamaku Ki āku tamariki.	I am like, O son's, The Progeny o fTane' That bend over upon the shore, And droop there like the mamaku Because of my children...	From *He Tangi/A Lament* (Ngati Ruanui) By Te Ikaherengutu	181:4-8, p. 366-367, Ngā Mōteatea, Ngata, 2006
Mamaku	Ka kai ki te tponga, Ka kai ki te mamaku, Ka kai ki te ngārara whakapae, Ka kai ki te pananehu, E tama, ē!	Let it rest upon the ponga, Let it rest upon the mamaku, Let it rest upon the prostrate insects, Let it rest upon the pananehu, O son of mine!	From *Pinepine te Kura/Little Tiny Kura* A Lullaby for Te Umu-Rangi (Ngati Kahungunu of Hawke's Bay)	215A:69-73, p. 84-85, Ngā Mōteatea, Ngata, 2006
Mangemange (mounga, makamaka, mākaka)	*Not referenced in A name and word index to Ngā Mōteatea (Harlow & Thornton, 1986)*			
Mānuka (kahikātoa, kātoa, pata, rauiri, rauwiri)	He ao uru pea, e takahi rawa Pūia mānuka ki te hoko tirange Marutata rawa 'hau Te wa ki Nukupori,	Tis perhaps, the heavy mist that comes From the tī tree bower where my people gather And to which I am soon to return Following the pathway to Nukupori,	From *He Waiata nā Parearohi/A Song by Parearohi* (Nga Puhi) As dictated by Ngakuru Pene Haare	37:3-6, p. 162-163, *Ngā Mōteatea,* Ngata, 2006
Mānuka (kahikātoa, kātoa, pata, rauiri, rauwiri)	Nāu rā te kikini, He mānuka i ahau.	Twas you, my beloved, who quietly pinched me, Thus to warn me in sadness.	From *He Waiata Aroha na Te Rangihiroa/A Song of Luve by Te Rangihiroa* (Ngati Toa) Explanations by TE Roore Erueti	79:12-13, p. 352-353, Ngā Mōteatea, Ngata, 2006
Mānuka (kahikātoa, kātoa, pata, rauiri, rauwiri)	Nau mai, e tama, ki te taiao nei, Ki whakangungua koe ki te kahikātoa, Ki te tūmatakuru, ki te taraongaonga;	Welcome, O son, welcome to this world of life, You are to be ritually strengthened with the kahikātoa, With the tūmatakuru	From *Pinepine te Kura/Little Tiny Kura* A Lullaby for Te Umu-Rangi (Ngati Kahungunu of Hawke's Bay)	215:7-9, p. 76-77, Ngā Mōteatea, 2006

Appendix Y *Sample page from a database of waiata related to animal species in Te Wao Nui ā Tiriwa gathered during a literature review as part of this research.*

Ingoa Māori (synonyms/ search terms in ())	Waiata	English Translation	Reference	Citation
Kākā	Hei kākā tauaki, ka hāpairangi au He hori nā te tangata ki te makiori...	You are as the chatering parrot, elvated heavenwards am I, And thus quite pointless for him to bandy words...	From 'He Waia Tohu/A Prophetic Song', (Ngati Parekawa, Ngati Tuwharetoa) Text and explanations are by Te Taite Te Tomo.	126, p. 124, *Ngā Mōteatea,* Ngata, 2006
Kākā	ka rite mai ki ahau. Me he hūroto au kei rō repo, Me he kākā, e whakarāoa ana.	case with me. For I am as the bittern in the swamp, or the parrot, making its choking sound.	From 'He Tangi Nā Te Tūroro (Te Whanau-A-Ruataupare, Ngati Porou) Nā Harata Tangikuku	20, p. 88, *Ngā Mōteatea,* Ngata, 2006
Kākā	Tāku kākā haetara ki te iwi rā ia Wātea kau ana ko te tūranga kau o Rehua.	My bright-plumaged bird, admired by the tribes, has flown; and the star Rehua shines down on a desolate land.	From 'He Tangi Mō Te Heuheu (I) Tukino Araā Te Heuheu Herea/A Lament for Te Heuheu (I) Tukino Otherwise Te Heuheu Herea	61, p. 262, *Ngā Mōteatea,* Ngata, 2006
Kererū (karoro tangi harau, rupe, kūkū)	Kia whāngaia koe ki te tauaro kūkū Nō Te Ranga-a-whakairihau, e tama ē!	Where you will be fed with the fat portion of the pigeon From Te Ranga-a-whakairihau, O son!	From 'He Tangi mō Te Matapihi-o-Rehua/A Lament for Te Matapihi-o-Rehua (Te Arawa) Nā Te Hinu	128:30-31, p. 138, *Ngā Mōteatea,* Ngata, 2006
Kihikihi/tarahiki	ka rite mai ki ahau. Me he hūroto au kei rō repo, Me he kākā, e whakarāoa ana.	case with me. For I am as the bittern in the swamp, or the parrot, making its choking sound.	From 'He Tangi Nā Te Tūroro (Te Whanau-A-Ruataupare, Ngati Porou) Nā Harata Tangikuku	20, p. 88, *Ngā Mōteatea,* Ngata, 2006
Pīpīwharauroa	Kotahi te manu o te tau, He Pipi-wharau-roa, 'Kūi, kūī, whititwhtiti ora!"	There was the well-known bird of the year, It was Te Pipi-wharau-roa, With its all of, 'Kūī, kūī, whitiwhiti-ora!	Mangatoa/Song for the Battle at Mangstoa' (Ngati Pamoana, Whanganui) By 'An Elderly Lady, the Text and Explanations are by T.W. Dowens	295, p. 568, Ngā Mōteatea, Ngata, 2006

Appendix Z *Plant species observed and date observed in different states during nine field visits to Te Wao Nui ā Tiriwa from November 2024 – March 2025 as part of this thesis research (flowering, with senescent flowers/leaves, fruiting, post fruiting, signs of herbivory, new growth, regeneration, “thriving”, “In decline” and dead).*

Plant species	Flowering (n=19)	Senescent Flowers/Leaves (n=5)	Fruiting (n=30)	Post Fruiting (n=3)	Herbivory (n=5)	New Growth (n=11)	Regeneration (n=6)	Thriving (n=6)	In Decline (n=11)	Dead (n=9)
Akeake *(Dondonaea viscosa)*	X	X	1 (10MAR25)	X	X	X	X	X	X	X
Akepiro *(Olearia furfuracea)*	1 (10MAR25)	1 (10MAR25)	X	X	X	X	X	X	X	X
Hangehange *(Geniostoma ligustrifolium)*	X	X	2 (25NOV24); 1 (22DEC24)	X	X	X	1 (25NOV24); 1 (16DEC24)	1 (25NOV24)	1 (25NOV24)	X
Harakeke *(Phormium tenax)*	X	X	2 (22DEC24); 1 (10MAR25)	X	1 (10MAR25)	X	X	X	X	X
Horoeka *(Pseudopanax crassifolius)*	X	X	X	X	X	X	1 (16DEC24)	X	X	X
Houhere *(Hoheria populnea)*	X	X	X	X	1 (15DEC24)	X	X	X	X	X
Kahikatea *(Dacrycarpus dacrydoides)*	X	X	X	X	X	X	1 (25NOV24); 1 (16DEC24)	X		X
Kanono *(Hoheria*	1 (10MAR25)	X	1 (25NOV24); 1 (15DEC24); 1 (22DEC24); 1 (10MAR25)	X	X	1 (25NOV24)	X	X	X	X
Kānuka*(Kunzea ericoides)*	1 (16DEC24)	X	X	X	X	X	X	X	X	X
Karamū *(Coprosma Robusta)*	X	X	2 (22DEC24)	X	X	X	X	X	X	X
Kareao *(Ripogonum scandens)*	X	X	1 (25NOV24)	X	X	X	X	X	X	X
Kauri *(Agathis australis)*	X	X	1 (19NOV24)	X	X	1 (10MAR25)	2 (19NOV24)	X	5 (19NOV24); 3 (25NOV24)	4 (19NOV24); 1 (25NOV24); 1 (16DEC24)
Kawakawa *(Macropiper excelsum)*	X	X	X	X	x	1 (10MAR25)	X	X	X	X
Kiekie *(Freycinetia banksii)*	X	X	1 (19NOV24)	X	X	X	X	X	X	X
Kōhia *(Passiflora tetranda)*	X	X	1 (19NOV24)	X	X	X	X	X	X	X
Kōkaha *(Collospermum hastatum)*	X	1 (19NOV24)	X	X	X	X	X	X	X	X
Korokio *(Corokia buddleioides)*	X	X	3 (19NOV24)	X	X	X	X	X	X	X
Koromiko *(Veronica salicifolia)*	1 (10MAR25)	1 (10MAR25)	X	1 (10MAR25)	X	X	X	X	X	X
Kōwhai *(Sophora microphylla)*	X	X	X	X	X	X	1 (25NOV24)	X	X	X
Māhoe *(Melicytus ramiflores)*	3 (19NOV24); 1 (25NOV24); 1 (10MAR25)	1 (19NOV24)	1 (22DEC24)	X	1 (19NOV24); 1 (15DEC24)	1 (25NOV24)	X	X	X	X
Mamaku *(Sphaeropteris medullaris)*	X	X	X	X	x	3 (19NOV24); 1 (15DEC24)	X	1 (19NOV24)	1 (25NOV24)	X
Mānuka *(Leptospermum scoparium)*	1 (25NOV24)	X	X	X	X	X	X	X	X	X
Māpou *(Myrsine australis)*	X	X	X	X	X	X	1 (19NOV24)	X	X	X
Mingimingi *(Leucopogon fasciculatus)*	X	X	1 (19NOV24); 1 (10MAR25)	X	X	X	X	X	X	X
Miro *(Pectinopitys ferruginea)*	X	X	1 (19NOV24); 1 (10MAR25)	X	X	X	1 (10MAR24)	X	X	X
Nīkau *(Rhopalostylis sapida)*	X	X	4 (19NOV24); 1 (25NOV24); 1 (15DEC24)	1 (15DEC24); 1 (18 FEB25)	X	X	1 (15DEC24)	1 (15DEC24)	X	X

Plant species	Flowering (n=19)	Senescent Flowers/Leaves (n=5)	Fruiting (n=30)	Post Fruiting (n=3)	Herbivory (n=5)	New Growth (n=11)	Regeneration (n=6)	Thriving (n=6)	In Decline (n=11)	Dead (n=9)
Paratanìwha *(Etatostema rugosum)*	X	X	X	X	X	X	X	1 (25NOV24)	X	X
Patē *(Schefflera digitata)*	X	1 (10MAR25)	X	X	X	1 (15DEC24)	X	X	X	X
Ponga *(Cyathea dealbata)*	X	X	X	X	X	1 (19NOV24)	X	X	X	1 (19NOV24)
Porokaiwhiri *(Hedycarya arborea)*	X	X	X	X	X	X	X	X	X	1 (19NOV24)
Pūriri *(Vitex lucens)*	1 (15DEC24)	X	X	X	X	X	1 (16DEC24)	X	1 (15DEC24)	X
Putaputaweta *(Carpodetus serratus)*	1 (19NOV24)	X	X	X	X	X	1 (23FEB25)	X	X	X
Rangiora *(Brachyglottis repanda)*	X	X	X	X	1 (16DEC24)	X	X	1 (19NOV24)	X	X
Rātā *(Metrosideros robusta)*	1 (22DEC24)	X	1 (22DEC24)	X	X	X	X	X	X	X
Rewarewa *(Kngitia excelsa)*	3 (19NOV24); 1 (25NOV24)	X	X	X	X	X	2 (19NOV24); 1 (25NOV24); 1 (16DEC24)	X	X	X
Rimu *(Dacrydium cupressinum)*	X	X	X	X	X	X	1 (19NOV24); 1 (10MAR25)	1 (19NOV24)		
Tānekaha *(Phyllocladus trichomanoides)*	X	X	X	X	X	1 (25NOV24)	X	X	X	X
Toru *(Toronia toru)*	1 (19NOV24)	X	X	X	X	X	X	X	X	X
Tutukiwi *(Pterostylis banksii)*	1 (25NOV24)	X	X	X	X	X	X	X	X	X
Winika *(Dendrobium cunninghamii)*	1 (22DEC24)	X	X	X	X	X	X	X	X	X