Informing Ecosystem-Based Fisheries Management from an Indigenous Perspective:

The Mōtū Kahawai Fishery

by

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Te Whānau-a-Apanui, Te Whakatōhea, Ngāti Porou, Ngāitai, Ngāti Tūwharetoa

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Hikarukutai Unahi Kahawai!

Te kaha, te maha, me te kōtahitanga, hei tiaki i ngā taonga tuku iho.

Let us, Hikarukutai, be like the scales of the kahawai!

Strong, plentiful and united, to protect that which is most dear to us.

Kimberley Hera Maxwell, 2015

While working on the Mōtū kahawai fishery, this whakataukī was developed, and I offer it as an aspiration for Te Whānau-a-Hikarukutai/Ngāti Horomoana, which reflects our cultural identity and practice.

Abstract – Te Wairua o Te Tuhingaroa

Despite agencies striving to manage fisheries sustainably, focusing on large-scale commercial interests and ignoring target species and their wider ecosystem interactions, has depleted or collapsed fisheries globally. Indigenous community well-being, practices, knowledge, and food supplies have also diminished as a result. Fisheries managers are now developing a more combined approach to decision-making, which recognises the social and ecological relationships of fisheries. The Ecosystem Approach to Fisheries encourages fisheries scientists and managers to engage with each other, and with the wider community, and to include information on the wider social and ecological components of fisheries systems in decision-making.

This thesis explores an Indigenous fishery by demonstrating how to appropriately gather information from a wide range of sources to inform its management. We focus on a case study fishery for kahawai (*Arripis trutta*), from the perspective of Te Whānau-a-Hikarukutai/Ngāti Horomoana (TWAH/NH). This Hapū (sub-tribe) is part of the larger Te Whānau-a-Apanui Iwi (tribe) of New Zealand (NZ), who have strong cultural connections to, and a unique system for managing, the Mōtū kahawai fishery. This fishery is a small-scale, land-based, hand-line fishery for a medium-sized pelagic teleost fish based at the Mōtū river mouth, located at Maraenui in the eastern Bay of Plenty, NZ.

This research demonstrates holistic ecosystem-based fisheries research as a template for future fisheries research activities. A transdisciplinary research approach, grounded in kaupapa Māori research principles and Māori research ethics, was taken. A strategy was developed to direct engagement with Māori for fisheries research. The existing NZ fisheries management system was defined, and Independent fishery forum plans were identified as the most proactive way to inform the system. A plan can also be used to inform fisheries through other mechanisms; therefore, it is a valuable resource to create. Information on the history, background and value of the fishery was gathered and the Mōtū kahawai fishery identified as a cultural keystone species for TWAH/NH. Kahawai trophic and ecosystem interactions were described from ecology and mātauranga studies. This information was collated in a Hapū plan to inform management of the Mōtū kahawai fishery. This fishery has existed for ca. 600 years and the Hapū wish for it to thrive indefinitely. The Hapū plan will inform wider fisheries management, of Hapū values, practices, and knowledge, to be recognised by the wider community, and to support Hapū rangatiratanga (sovereignty) over the fishery.

Acknowledgements – Mihi

Tuatahi, me mihi ki te runga rawa, nāna nei ngā mea katoa.

First let me acknowledge the heavens, from whom all things emanate.

In acknowledgement of the spiritual realm, I share an old fishing chant with it's origins in the Cook Islands, as a reminder that our ancestors travelled the South Pacific bringing their knowledge and practices with them to New Zealand, and adapting them here. Such knowledge includes the activities of Maui, who fished up the North Island, known here in New Zealand as The Fish of Māui – Te-Ika-a-Maui, using his grandmother Muri-ranga-whenua's magic jawbone as a mātau (fishhook). In Māori custom, we associate the jawbone with knowledge. Therefore the fishing up of the North Island, akins fishing to the act of drawing upon the mātau-ranga (knowledge of our ancestors, such as Muri-ranga-whenua) in the pursuit of innovation and exploration. This waiata (song) expresses these sentiments felt in the act of pursuing the unknown, and that indeed our past is what we draw upon and the results satisfying.

Ka rū ka rū, Cook Islands, 1800s

Taku wairua ora e	Will my spirit stay with me
Tapu taku kino nei e?	or will my bad luck now begin?
Aue, te mataku e	Aye, I'm a bit scared.
Karekare, ka matau e	Ripples, so drop the hook
Karekare, ka matau e	Ripples, so drop the hook
Ka rū, Ka rū,	It's quivering, trembling,
Ka te hī au e	I'm pulling up the line
Ka rū, Ka rū,	It's quivering, trembling,
Ka te hī au e	I'm pulling up the line
Ka rū, Ka rū,	It's quivering, trembling,
Ka te hī au e	I'm pulling up the line.
Ka haere ki te ora mōu	Here comes something good for you
Ka haere, ka haere	They're coming, coming
Kaumātua e	the old people
Ka haere, ka haere	They're coming, coming
Kaumātua e	the old people
Ka rū, Ka rū,	It's quivering, trembling,
Ka te hī au e	I'm pulling up the line
Ka rū, Ka rū,	It's quivering, trembling,
Ka te hī au e	I'm pulling up the line
Ka rū, Ka rū,	It's quivering, trembling,
Ka te hī au e	I'm pulling up the line.
Ka haere ki te ora mōu	Here comes a treat for you.
Wairua ana rei	The spirits indeed have overcome
te mataku nei e...	the fear I had here...

From the NZ Folksong website: http://www.folksong.org.nz/ka_ru_ka_ru/index.html

Tuarua e tangi ana au ki te hunga wairua, kua whetūrangitia.

Second, I remember longingly those who have departed this mortal coil and have become heavenly beings.

While I was a PhD student, many special people in my life passed on. To my grandparents, Sally and Geoff Hope, I miss your chortles and affirmations, and I think of you every time I see a blooming flower, or I put on one of your knitted cardigans. To my sweet angel cousins, Sylvia Quant and Julia Bent, you have been my guiding lights. Sylvia, every cat and sassy perfumed blonde I see, I think of you, I am not half the student you were. Julia, every fudge slice, and confident, smiley red-haired woman I see, I think of you, I am not half the mother you were. I will be my best me because you all shine down on me with your love.

To my Grandfather's good friend, Uncle Eric Koopu, who was a staunch but quiet member of the Maraenui community. Thank you for sharing stories of my grandfather, Anaru 'Sundo' Maxwell, with me, and for letting me share in your everyday life. I can see why you two got on, because you were both no nonsense types. I picture you both contemplating what's happening down here, having a quiet beer and a laugh while something you gathered is cooking in the background.

To our whanaunga, Bryan Riesterer. Thank you for supporting me during my studies. In such a short time you connected me with the Māori fisheries world and shared your aspirations for our people. You reminded me of the greatness we can achieve as a collective and introduced me to good people and ideas relating to money and marriage. You showed me how to really stretch the resources too. Gone too soon, dear friend.

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Tuatoru, ka hoki mai ki te hunga ora e kaha nei te tiaki i o tātou taonga tuku iho.
Third, I return to the living generation, those who work hard to ensure the treasures bequeathed to us live on.

I would like to dedicate this thesis to my Nan, Daphne Tawhi Maxwell, who has been the ahi kā for our immediate family, all her life. Nan, your ability to retain knowledge, in particular whakapapa, and exercise the tikanga of our ancestors is such a taonga. That is a true tohu mātauranga Māori. I am blessed that you shared what you did with me. For your support and incredible guidance, you taught me about the coastie life. Not to get caught up in the fast and flashy, but to be humble and focus on your strengths. We have such a warm and generous extended whānau and I truly felt welcome when I was back home amongst everyone. Thank you so much for everything, relating to this thesis and beyond. I am proud to be your mokopuna.

Daphne Maxwell at the Matarau, Maraenui 2013 (K. Maxwell).

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PART I – WAHANGA TAHI
(UPOKO)

Prologue – Wahinga

In this prologue, I whakawhanaunga (relate) myself to the research topic (kaupapa). Whakawhanaungatanga is the process of establishing relationships. Despite typical marine biology theses avoiding notions of subjectivity in the research, as this thesis aims to span disciplines and knowledge systems, including social sciences and mātauranga-Māori, I deem it necessary to establish my relationship to the research topic. I identify myself in relation to my ancestors and their homelands through citing a ngeri (chant), my pepeha (tribal sayings) and whakapapa (genealogy). I then provide personal background relevant to the research topic. This version of Maruhia atu, was published in the Te Whakatōhea Agreement in Principle (https://www.govt.nz/treaty-settlement-documents/whakatohea/, *accessed 25 October 2019*).

Maruhia atu

Maruhia atu i runga o Tirohanga te tohu Whakaari, whakarērea atu te whaiwhaiā te mate tonu atu. Whakaihu Moutohora, tāpapa ana Te Rae o Kōhi, waiho ma te whakamā e patu. Ana Waimuri tō ringa te waka! Hiko te uira, haruru te rangi ngaoko te whenua, ikahuirua. Tapu te wai, tapu te tai ki te rātō Awa-te-Ātua. Eke Arawa. Whakaheke matamoe Waipiko hurihia Rūrima tūtūtara noa mua iho koe. Rukuhia te hāpuku te wheke. Tōia tō hope, Hāmatatū timu Te Koko, auē Ngā tamahine a Te Whakatōhea. Takahia te pipi tahe aku pōtiki, Pākihikura ki uta, kura ki waho. Kapakapa Hukitewai pāra takoto te one. Kōpū e oho! Kaikirikiri tuatua Waiaua te kai a te karoro koa. Koeaea e. Tītītiko e. Tapu te paru. Nukutere Te Rangi Awaawakino ngā tai nui ngā tai roa. Kōpua-Pātiki huki te pakeke. Minohia atu te wai Waiomahau. Hīa te mure Tokaroa kai waho, kai uta Parinui tātahi whatawhata kahawai, pāraharaha ika iti Ōhinemōtu, Aukati-Pāhau, Pou tū ana te ure. Tapu te awa ŌHēkopara! Tōtōia atu, tōtōia mai, Mai i Ngā Kuri a Whārei ki Tihirau. Ei te tapu o Muriwai e!

From Tirohanga I look out towards the plume of Whakaari, where the seer was left to die. Yet he mounted a whale and made landfall at Te Rae o Kōhi where he quoted, “let you die from embarrassment.” You were forsaken Muriwai for tampering with the canoe (Mātaatua). The skies lit up with lightning, roared with thunder and the earth trembled. A sign of death, your two sons had drowned at sea. Muriwai you placed a restriction on the sea and the land, no gathering of food was permitted from Tihirau in the east to the setting of the sun. Te Awa o Te Atua where Toroa performed a karakia on the beached Te Arawa canoe and exclaimed, “move Arawa.” The migration of the matamoe eel navigating the tuatara inhabited Rūrima Islands. Dive deep for groper at Te Puku o Te Wheke. At Ōhope make good with your paddle and arrive at Hāmatatū. Low tide at Ōhiwa is when the bountiful shellfish can be seen; known as “the daughters of Te Whakatōhea.” Tread upon the pipi at Waiōtahe arriving at the pool where my

pets from afar reside at Pākihikura inland and onshore. The water boils at Hikuwai with shoals of fish. The morning star Kōpū is visible, awake, frost fish are on the beach. The sand-eating tuatua are plentiful at Waiaua where the seagull feast on whitebait and tītiko. The people at Waiaua are known as "Tapu te paru." At Awaawakino is where the anchor rock Te Rangi of the Nukutere canoe can be found. The great tides and long tides of the Tainui flow at Kōpua-Pātiki (the bay at Tōrere) where Ngātoroirangi caught the tail of the whale. The water of the Waiomahau waterfall cascades down to the snapper rocks, Tokaroa, which is further out and Parinui, which is closer to shore. Upon the shore kahawai and the small pink moki (pāraharaha) are dried on the drying racks. Aukati-Pāhau intercepted the attempt on the maiden Ōhinemōtu by Poumātangatanga. A restriction was placed on the Mōtū River with the drowning of He Kōpara. Haul the canoe; from Ngā Kurī a Whārei ki Tihirau. It is the tapu of Muriwai!

Pepeha

Pepeha are tribal sayings which identify a person with their tūrangawaewae (standing place), demonstrating an individual's connection to people and places. Pepeha include a maunga (mountain), a river (awa) or sea (moana), a canoe (waka), a tribe (Iwi), a Hapū (sub-tribe), a marae (meeting house or village), a supreme chief (Ariki), or esteemed ancestor (tangata). I first share my Tainui connections, as Poumātangatanga, who you will read about later in Chapter 2 (History and background fo the Mōtū kahawai fishery), had relations on the Tainui waka that made landfall near Whangaparāoa in the eastern Bay of Plenty. The Tainui waka then travelled north settling in many places, including Maraetai. I descend from a union between Thomas Maxwell and Ngeungeu, the daughter of chief Tara-te-Irirangi, in thanks for creating peace between the Waikato and Ngāpuhi people. One son from this union married into the Ngāti Porou tribe, which is why our Ngāti Porou pepeha is shared next. From this pepeha, I acknowledge a great-uncle, Ta Apirana Ngata, who penned the whakataukī (proverbial saying):

> E tipu, e rea, mo nga ra o tou ao,
> ko to ringa ki nga rakau a te Pakeha hei ora mo te tinana,
> ko to ngakau ki nga taonga a o tipuna Māori hei tikitiki mo to mahuna,
> a ko to wairua ki to Atua, nana nei nga mea katoa.
>
> Thrive in the days destined for you,
> Your hand to the tools of the Pākehā to provide physical sustenance,
> Your heart to the treasures of your ancestors to adorn your head,
> Your soul to God to whom all things belong. Tā Apirana Ngata, 1949

This whakataukī grounds me in my daily life activities, including being a Māori marine researcher. My Ngāti Porou grandfather Anaru Maxwell, then married my grandmother, Daphne Maxwell, who was raised in Te Whānau-a-Apanui. This is why I share my Te Whānau-a-Apanui pepeha next. It is through this connection I have the right to study the Mōtū kahawai fishery. From my grandmother's ancestry, on her mother Ripeka Albert's side, I also descend from Whakatōhea chief Mokomoko. I was also raised in the Whakatōhea district, which is why I acknowledge these connections here, because they have helped form my understanding of Te Ao Māori (the Māori world). Lastly, I acknowledge my grandmother's ancestry, on her father Amokura Arapeta Pita Te Rua Albert's side, to Ngāti Tūwharetoa. Ngāti Tūwharetoa Iwi descends from Ngātoro-i-rangi of the Arawa canoe refered to in the ngeri, Maruhia atu, above.

Ko Kohukohunui te maunga
Ko Wairoa te awa
Ko Maraetai te moana
Ko Tainui te waka
Ko Ngāi Tai te Iwi
Ko Umupuia te marae
Ko Tara-te-Irirangi te Ariki ki runga

Ko Hikurangi te maunga
Ko Waiapu te awa
Ko Horouta te waka
Ko Ngāti Porou te Iwi
Ko Te Aitanga-a-mate te Hapū
Ko Rongo-i-te-kai te marae
Ko Ta Apirana Ngata te tangata

Ko Ōtūkani te maunga
Ko Mōtū te awa
Ko Te Arawa, ko Horouta, ko Tauira-mai-tawhiti ngā waka
Ko Te Whānau-a-Apanui te Iwi
Ko Te Whānau-a-Hikarukutai/Ngāti Horomoana te Hapū
Ko Maraenui te marae
Ko Apanui Ringamutu te tangata

Ko Mākeo te maunga
Ko Waiaua te awa
Ko Mataatua te waka
Ko Te Whakatōhea te Iwi
Ko Ngāti Patumoana te Hapū
Ko Waiaua te marae
Ko Mokomoko te tangata

Ko Ruapehu te maunga
Ko Waikato te awa
Ko Taupō-nui-a-Tia te moana
Ko Te Arawa te waka
Ko Ngāti Tūwharetoa te Iwi
Ko te Ngāti Rauhoto te Hapū
Ko Rauhoto te marae
Ko Te Heuheu te tangata

Tīhei mauri ora!

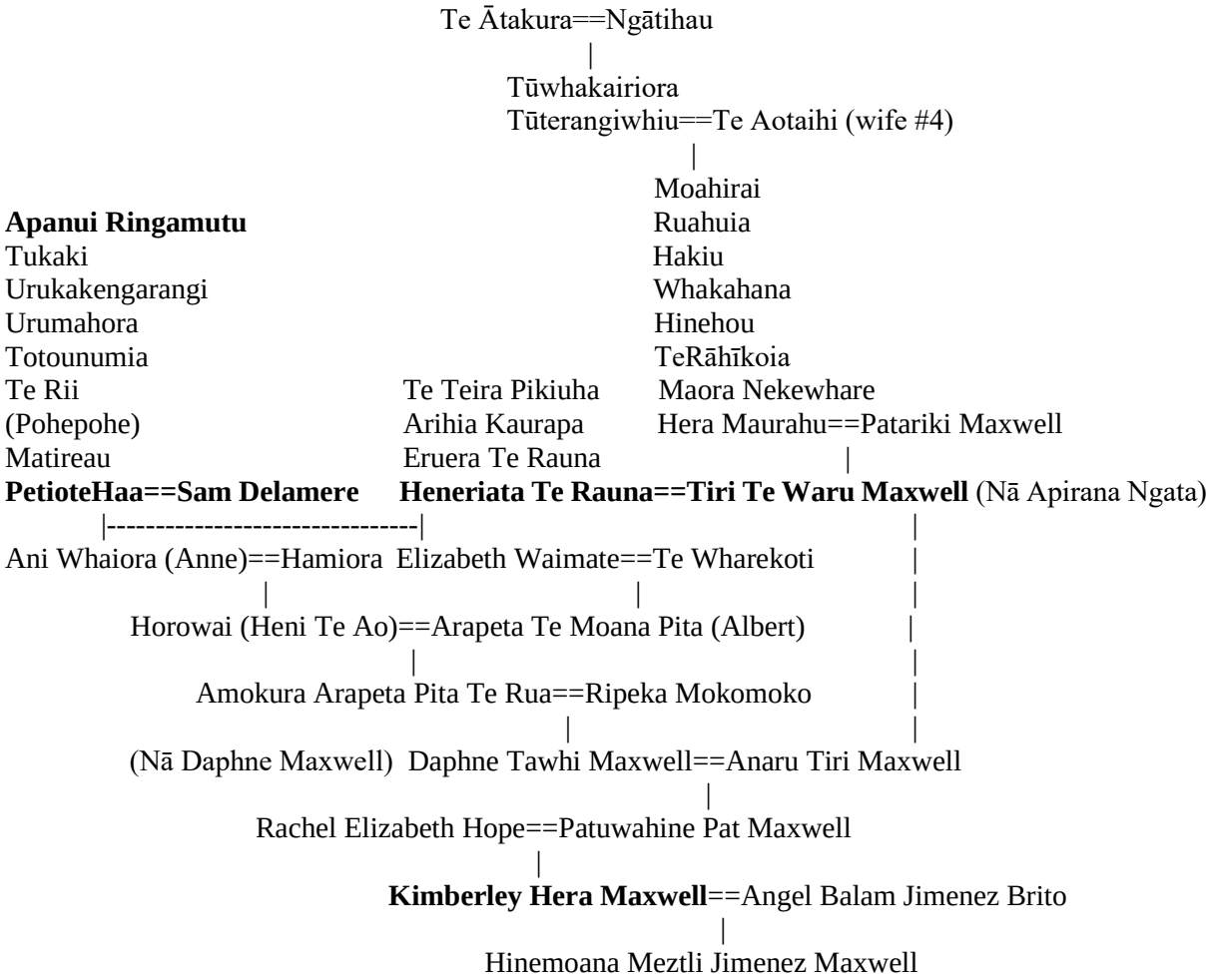
Whakapapa

Whakapapa is genealogy that also connects a person to wider society and the environment. Therefore, I present my whakapapa, demonstrating how we connect to Māui, who fished up the North Island, through to Poumātangatanga, founder of the Mōtū kahawai fishery, down through the generations. Ideally, I would like to have spent more time understanding Te Whānau-a-Apanui whakapapa to Poumātangatanga more directly, however, this did not come to light during my studies and perhaps it is not meant to be published in a thesis format, but rather in a format that is more suited as a resource for Te Whānau-a-Apanui directly. This whakapapa illustrates the connections to people and resources that have made this thesis possible, as mentioned in the acknowledgements section and the knowledge and ability to do what I have done.

Māui-tikitiki-a-Taranga
Ruatonganuku
Ruatongarangi
Tahu
Rongotope
Marunui-a-Whatu
Toikairākau (Toi-te-huataki, Toi-te-ariki)
Raurunui-a-Toi
Ngā Puna-ariki-a-Whātonga
Poutūpari
Poutiriao
Manutohikura
Tāneuarangi
Paikea
Pouheni
Tarawhakatū
Nanaia
Porourangi (Nā Tamati Muturangi Reedy)

Poumatangatanga==Ohinemōtū
|
Paimanutanga
Ruatapu
Tehau
Nanaia ==Aniwaniwa
|
Porourangi
|

Hau	Hau	Hau	Tamatekapua
Awapūruru	Rākaipō	Rākaipō	Tūhoromatakakā
|	Rākaiwetenga	Manutangirua	Īhenga
Tangihaereroa	Tapuatehaurangi	Hingāngaroa	Tuariki
Poroumāta	Tāwakeurunga	Tauā	Wāhiawa
Mate (w)	Hinekehu	Apanui-waipapa	|
|	Whāene==Poroumātā	Rongomaihuatahi==Turirangi	|
Te Aitanga-a-Mate	|	|	(Nā Roka Paora) **Apanui Ringamutu**
(Nā Rawiri Taonui)	|		
	|		


Te Ātakura==Ngātihau
Tūwhakairiora
Tūterangiwhiu==Te Aotaihi (wife #4)
Moahirai
Apanui Ringamutu
Ruahuia
Tukaki
Hakiu
Urukakengarangi
Whakahana
Urumahora
Hinehou
Totounumia
TeRāhīkoia
Te Rii
Te Teira Pikiuha
Maora Nekewhare
(Pohepohe)
Arihia Kaurapa
Hera Maurahu==Patariki Maxwell
Matireau
Eruera Te Rauna
PetioteHaa==Sam Delamere
Heneriata Te Rauna==Tiri Te Waru Maxwell (Nā Apirana Ngata)
Ani Whaiora (Anne)==Hamiora
Elizabeth Waimate==Te Wharekoti
Horowai (Heni Te Ao)==Arapeta Te Moana Pita (Albert)
Amokura Arapeta Pita Te Rua==Ripeka Mokomoko
(Nā Daphne Maxwell)
Daphne Tawhi Maxwell==Anaru Tiri Maxwell
Rachel Elizabeth Hope==Patuwahine Pat Maxwell
Kimberley Hera Maxwell==Angel Balam Jimenez Brito
Hinemoana Meztli Jimenez Maxwell

Personal background

I was born in NZ and have lived here all my life. I grew up in my tūrangawaewae, surrounded by family, on the marae (Māori meeting house), and the coast. My 'home' is the rural eastern Bay of Plenty, a low socio-economic, predominantly Māori society. Ōpōtiki township is 60% Māori, 40% Pakehā (New Zealander of European descent), and the coast is 80% Māori, 20% Pakehā. I grew up very near the Māori reservation where my ancestors were exiled to, following the unjust persecution of Te Whakatōhea leaders and confiscation of Te Whakatōhea land. Our elders raised us to recognise the maunga (mountains) and awa (rivers) of our neighbouring Hapū as our own, so that we were connected to our tūrangawaewae (place where one has rights of residence and belonging through kinship and whakapapa (ancestral lineage)), and we were connected.

I am both a NZ Māori and Pakehā woman. Plural heritage is my life. I am the intertwined threads of my ancestry. NZ Māori and Pakehā history has been rocky, therefore in order to make peace within myself, as a descendent of both colonised and colonising ancestors, I reflect on what was intended at the signing of Te Tiriti o Waitangi (the Treaty of Waitangi), and subsequent processes being made to right the wrongs of the Crown, and early NZ citizens, towards NZ Māori. I am keenly interested in understanding and respecting different people's beliefs, values, and practices, and in turn sharing my culture with others.

For school and work reasons I have lived in NZ's main urban areas all of my adult life. This is an important factor in Te Ao Māori (the Māori world). It means that I am not hau kainga (an Iwi (tribe) or Hapū (sub-tribe) member living at home), or an ahi kā (people keeping the home fires burning, acting as guardians of our homelands). Instead I am taura-here (living away from home), like the majority of Māori today. Much like wherever I live in NZ, when I go 'home' it is at the grace of our hau kainga and ahi kā. At 14, I went to school in Auckland and was immersed in a high socio-economic, predominantly Pākehā (New Zealander of European descent), multicultural environment. It was at this time that I first felt 'disconnected.' In my second to last year of high school I joined the kapa haka (Māori cultural performance group), but we weren't good like the teams back home, and it didn't help me reconnect. In my final year of high school, I stayed with family and this really helped me to reconnect again. My primary school principal, a proud Ngāti Porou woman, Mrs Paula Reid, taught us all the value of perseverance. This is the value I took with the experience of going to Auckland, that it was a fantastic opportunity to go to a very good school, and despite feeling disconnected as a result of many of my values not being reflected with my peers and their families, I persevered. The Auckland school expected all of its students to continue their education after graduating. It

wasn't a matter of if, but a matter of where. I took this opportunity to go on my 'overseas experience' to Te Wai Pounamu, The South Island, and study at Otago University. Much like our ancestral demi-god Māui I love to ask why and explore the answers and I also had a passion for animals and the ocean growing up in a rural area and heading food gathering on the weekends at the water's edge. A science degree seemed appropriate to support these passions. However, I continued to feel disconnected during my undergraduate studies as they lacked any recognition of my Māori side. My father always encouraged us not to be quitters, therefore I persevered with my studies and completed the degree and gained additional tools with which to explore, understand and care for the marine world. I also completed a SCUBA diving course that reconnected me with Tangaroa, the ocean, and helped me to steer my life direction. These two major life experiences helped me understand the disparity present in NZ society, in terms of worldviews, beliefs, and positions. While attending Hapū hui as a youth, I was conscious of the Hau kainga and Ahi kā view that Hapū members who went away to study and work, and then returned home thought they knew what was best for those who lived at home and were clear that this was not the case. There was a clear distinction of tertiary education being valued for the financial and status gains it created for the individual in wider society, but not for the knowledge that the urban experiences brought, particularly when they challenge tikanga Māori (Māori customary practices, values and protocols). This is probably because Te Ao Māori rarely featured in tertiary education. Fortunately, this is increasing changing in NZ university curriculums. But it also put me at a crossroads in terms of my own education. Firstly, I made a conscious decision not to return home to Ōpōtiki and be a burden. If I was to return home it would be with a job. Secondly, was regarding my Te Ao Māori education. My father recommends going back to my tūrangawaewae as the best place to learn about Te Ao Māori and Te Reo Māori as it relates to me. So, I have gained a degree in a field where there were no jobs available in my hometown, and I had not yet started learning more about Te Ao Māori because I had not yet returned home.

I did land a job which nurtured my career as a Māori marine researcher. I was fortunate to work for NIWA in the Māori Environmental Research team, Te Kūwaha. I wasn't a lone Māori in my field. This helped me to reconnect to my taha Māori and showed me that my skills were useful for helping Māori communities achieve their aspirations. My studies were not a waste of time. For example, my Masters research was for Hongoeka, looking at growing sea cucumbers in a pāua farm.

Through my work experience I gained research-community engagement experience. I learned that the whakapapa connection that you have with the community is more important than the

research relationship, and that both of these two things can impact on each other. For example, whakapapa connections allow you to work with the community, or do research for them. As a researcher, the research relationship remaining positive becomes doubly important because this becomes everlasting in your familial whakapapa relationship.

Being part of Te Kūwaha exposed me to Māori science leaders in the process of Te Tipu Pūtaiao – Māori growth in science. They were changing NZ science from 'token' Māori representation; to Māori having a voice, leading research teams, directing research, and raising a cohort of Māori scientists who were not as disconnected as previous Māori may have been, and were able to acknowledge their Māori side within their work. I was also able to work on customary fisheries and aquaculture projects of interest to Māori. Now Māori scientists, including myself, are creating the bridges between Māori and science. Through my personal and work experience combined, I am capable of interchanging between compartmentalising knowledge and seeing everything as interconnected.

A valuable experience that helped me to complete my Master of Science was being a member of MAI ki Pōneke, the Māori and Indigenous post-graduate student support group. MAI ki Pōneke is part of the larger MAI te Kūpenga network that operates across NZ universities and whare wānanga (places of higher learning) under Ngā Pae o Te Māramatanga, NZ's Māori Centre of Research Excellence. There are very few Māori students in the sciences at post-graduate level and being able to come together regularly with other Māori and Indigenous post-graduates to discuss our research and experiences helps to stay connected to our Māori side. MAI ki Pōneke members are my on-campus whanau (family). I knew that with their support I could complete a PhD.

When choosing a PhD topic, I reflected on the points shared by Dr Charlotte Severne: "Work at home and work on something you can eat." When I finished working on the Master of Science project, I decided that I must work on something that I felt connected to, if I was to pursue PhD study. A PhD would give me more control over the research questions I addressed so that they better reflected Māori interests, more control over research-community engagement because I wanted these processes to whakamana (empower) the community, and more control over the research methods applied, and the research outcomes sought, or community input into the research outcomes sought.

When considering a PhD topic, the first person I spoke to was my Nan, Daphne Maxwell. She immediately suggested that I study the kahawai and find out where they spawn. I was keen but on returning to work at NIWA I couldn't find a way to connect the PhD research dream with supervisors, funding, and a tertiary institution. I pursued a myriad of other options for seven

years and had almost committed to working on sea cucumbers again, when it all fell through. This was a blessing because no sooner had that pathway disappeared, an opportunity to study the kahawai appeared. I am thankful to everyone who supported me to pursue a PhD and created this pathway for me.

Historically, fishing for kahawai at the Mōtū and Waiapu river mouths was an activity carried out by men. With the World Wars taking many adult Māori men away, no doubt women needed to fish to support themselves and their families. Especially in isolated areas. Women are certainly participants in the fishery now. As a Māori woman myself, I respect that there is likely a strong preference for passing on particular knowledge of the fishery from man to man. In fact, I was particularly interested in learning about the post-harvest practices of the fishery, such as bleeding, gutting and cooking kahawai which is a role that I often saw my Nan take, although my male relatives did too and were completely capable of the whole process.

I grew up with my Grandad, father and uncles all fishing makamaka style (using handlines) for kahawai, little did I know they might be the last generation to makamaka. What does concern me is that it all may be lost. The Mōtū kahawai fishery is located in a rural setting that is becoming more accessible to urban society through improved roads and vehicles. This is part of the reason why there has been a shift in perspectives of the people fishing at the Mōtū. I take pride in seeing my male cousins participating in the Mōtū kahawai fishery and providing for the family. I know I can catch a fish if I need to, but I think it is nice for whānau to have reasons to call upon each other.

Here I have identified not just who I am, but who I am in relation to the Mōtū kahawai fishery and this PhD. I have done this through three traditional Māori knowledge forms, waiata, pepeha and whakapapa; and a positionality statement. This is an important part of bringing mātauranga-Māori (Māori-knowledge) and science research together in this thesis. I believe that by respectfully bringing knowledge across the cultural divides, more people of different cultures have an opportunity to come together and respect each others' knowledge, beliefs, and practices. There becomes less opportunity for ignorance, and more potential for Te Tiriti (the Treaty) to be honoured, and for NZ to be great.

Chapter 1 General Introduction

I'm at the Mōtū. The air is salty, and you can taste it. The heat rising from the hot stones makes your body hairs rise, and your skin cells sweat, in an effort to keep you cool. A gentle warm breeze caresses your skin, drying your sweat and leaving your skin salty too. Your ears are welcomed by the rhythmic crunch of the stones moving under your feet, and the powerful dump-hiss-rattle of the waves, crashing onto the beach, throwing sea spray into the air, and then sucking back out through the stones again. The seagulls cry at the sight of you, then gently lift off the beach, and hover momentarily, testing their wings in case you prove too dangerous, and they need to fly off.

Everyone is busy, and yet there is time for everything. Fishers greet one another and set up along the parade. They cast out their lines, and reel them in, finding their own beat to add to nature's orchestra. Shhhhhuuuuur, plonk! Ziz-ziz-ziz-ziz. Shhhhhuuuuur, plonk! Ziz-ziz-ziz-ziz. And the fish! Black figures surfing along the waves, tails breaking the surface, seemingly determined as they approach the swift river mouth. A wrist flicks! A line tightens, a kahawai has struck at the paua fishing lure sparkling in the sunlight. Back and forth along the beach he swims, leaping and bounding, doing his best to regain freedom.

The kahawai is landed, dabbled blue-grey-green hues above, and solid white below. A large yellow eye stares upward, and gills rapidly rise and fall. The kahawai flicks and bounces back towards the sea. Bounty received, the kahawai's black red blood spills and splashes in a gory act necessary to swiftly end this child's life. Thank you Tangaroa, ātua of the sea. Through you we continue to exist.

In this place, there are smiles and satisfaction. My bloodlines connect me to many families and special places. This thesis is my Te Whānau-a-Hikarukutai/Ngāti Horomoana story, about a fish that connects our Mōtū whānau to Ranginui, skyfather, and Papatūānuku, earth mother. A story about a fishery for the Mōtū kahawai, and how we have looked after each other, before, now, and in to the future.

1.1 Context

1.1.1 Indigenous perspectives

This thesis aims to give an Indigenous perspective. Indigenous peoples are those people, inhabiting, or existing in, a land from the earliest times, or from before the arrival of colonists (FAO, 1997). There are 370 million Indigenous people in the world, spread across 90 countries with 5,000 different Indigenous cultures (International Year of Indigenous Language website, https://en.iyil2019.org/, *accessed 30 October 2019*). In the 13th Century, Māori ancestors arrived to NZ from the Pacific (Hogg et al., 2003). NZ Māori is the collective term for the

Indigenous members of the 100 known Iwi (tribes), and >800 known Hapū (sub-tribes) of NZ (Te Kāhui Māngai website, http://www.tkm.govt.nz/ *accessed 15 November 2018*). "Indigenous" is a descriptor used by most Māori and Pasifika scholars to position themselves within the postcolonial era (Smith et al., 2016).

So, what is an Indigenous perspective? The foundation of many Indigenous worldviews is that everything is connected (Berkes, 2012). Indigenous philosophy incorporates all aspects of interactions of body, mind, soul, and spirit, with all aspects of nature (Cajete, 2000). So too, the Māori worldview recognises the interrelationships of all things, their dependency on each other, and seeking to understand the total system not just its parts (Harmsworth & Awatere, 2013). Māori values are the foundation of the Māori worldview and can be defined as, 'instruments through which Māori make sense of, experience and interpret their environment' (Harmsworth & Awatere, 2013; Harmsworth & Warmenhoven, 2003). These values and perspectives are essential to Māori and ground tangata whenua (local Indigenous people) thinking in modern times, including ecosystems management (Harmsworth & Awatere, 2013). Indigenous management is based on the Indigenous worldview. Māori environmental management is often referred to as kaitiakitanga (the reciprocal act of guardianship) which focuses on looking after the mauri of a resource (Harmsworth & Awatere, 2013). Mauri is the internal energy or essence that binds the spiritual and the physical together (Barlow, 1991; Mead, 2003). Everything has a mauri which is important for tangata whenua to protect from degradation and damage (Mead, 2003; Morgan, 2006). Activities may have either a positive, negative or neutral impact on mauri (Morgan, 2004). Those that diminish mauri can be synonymous with negative issues, so the aim of environmental management from a Māori perspective is to address activities that diminish mauri and encourage activities that maintain or enhance the mauri of an ecosystem.

It is important to provide an Indigenous perspective because Indigenous people have a long history of being violated, excluded, discriminated against, and disempowered by society, and often through legislation in colonised countries (e.g. Briskman, 2015; Buxton-Namisnyk, 2014). The United Nations (UN) Declaration on Rights of Indigenous Peoples (UNDRIP), developed in the 2000s, calls for UN countries to better recognise Indigenous peoples rights (Anaya, 2009; Bruce & Gilio-Whitaker, 2014; Davis, 2010; Obama, 2011). However, there is still a long way to go. For example in Mexico, Ecuador, and Australia, governments continue to value external industries extracting resources from Indigenous peoples' territories, more than Indigenous peoples' rights; and governments have silenced or ignored Indigenous peoples' protests (e.g. Hammer, 2012; Santamaria, 2013). Providing for Indigenous rights calls for

Indigenous people to be freed from human injustices and to be present at the highest levels of political decision-making, as a matter of protecting their health and well-being (Hammer, 2012; Magallanes, 2011).

Australian Aboriginal and Torres Strait Islander men from Woolloongabba suggested that reconnecting to their country and culture would help them regain their pride as Indigenous men, as a means of caring for their health (Adams, 2002). For NZ Māori, self-identification (tribal affiliation and ethnic affiliation), easy access to the Māori language, tikanga Māori (Māori customs, practices, and protocols) knowledge and skills, and active participation in marae (Māori pā) communities, as well as access to Māori physical resources (Māori land, fisheries, wāhi tapu (sacred places) and tribal estates) is necessary for gaining a secure sense of identity, which is linked to positive Māori mental health (Durie, 2001). As demonstrated by the pepeha in the Prologue, Māori identify with key natural features, such as mountains, rivers, and seas. Therefore, the health of these features reflects a Māori person's ability as a kaitiaki (guardian). This is also true for fisheries, which is further explored in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery).

Realising that Indigenous worldviews are fundamental to Indigenous peoples' health and well-being, has motivated Indigenous peoples to voice their need to express their culture, own their territory, and exercise their institutions (Debelo, 2011). There is a call for more cultural appropriateness generally, and more culturally appropriate spaces and curricula for Indigenous students specifically, as well as supporting the use of Indigenous methods, such as story-telling, for archiving knowledge, teaching, healing, and reconnecting to cultural identity (Genovese, 2016; Kuokkanen, 2005; Macfarlane et al., 2007; Mcgregor, 2005; Morgan & Slade, 1998; Sherwood, 2005; Somerville et al., 2010; Voght, 2017).

Resilience theory assumes individuals accept some responsibility for being disadvantaged and focuses on adjusting to the status quo, i.e. being reactionary. Whereas, resistance advocates for making deliberate efforts to opposing negative influences and exposing the inequitable distribution of power, i.e. being proactive. Smith et al. (2016) indicate a real concern that Indigenous research methodology has become "institutionalised away from its Indigenous communities and contexts, where it began, and where it still informs identities, ways of living and being." To decolonise dominant Western practices, an essential requirement is that Indigenous researchers purposefully and actively align research outcomes to the cultural survival of Indigenous peoples (Smith, 1999; Thaman, 2003). Māori academics in NZ, for example, have provided models for disruption through the use of approaches aligned to Kaupapa Māori (Bishop, 2003; Kerr et al., 2010; Smith, 1997; Walker et al., 2006). Being open

about the challenges and complexities for Indigenous researchers is a necessary, crucial part of doctoral research (Webber, 2009). This is certainly the case for this thesis.

Indigenous experiences internationally, have also been experienced here in NZ. During the late 1700s to early 1900s, European explorers, whalers, sealers and missionaries settled in NZ and they desired a government. In 1840, over 500 Māori leaders signed Te Tiriti o Waitangi (the Treaty of Waitangi, or the Treaty) with British Crown representatives, who went on to form the NZ government. The Treaty principles and history are fundamental to understanding Māori rights and the relationships between Māori and the NZ Crown (Māori Policy Unit, 2011).

The Treaty was written in two languages, English and Te Reo Māori (the Māori language). While the Te Reo Māori version reassured Māori that they would retain rangatiratanga (sovereignty) over land, forests, fisheries, and prized possessions, the English version said Māori would cede sovereignty to the Crown. The key Treaty principles are partnership/ equality, reciprocity/ mutual benefit, autonomy, and protection. The Crown subsequently breached the Treaty principles numerous times, causing multiple rights and sovereignty disputes, and resulting in Māori having significant social, cultural, institutional and economic losses and gaining a deep-seated distrust in the Crown.

Māori have fought long and hard to have past injustices redressed and to reinstate their rights. NZ is now in an era of apology and grievance settlement and attempting to build trust. Treaty principles are being increasingly recognised throughout government policy and legislation, including new legislation resulting from Treaty grievance settlements (Treaty settlements; Hepi et al., 2018, Parliamentary Counsel Office, 2017). Many Iwi Māori (Māori tribes) and Māori collectively, have settled Treaty grievances with the Crown. As part of this process a Deed of Settlement (DoS) is enacted. Māori have regained more political and economic influence, and more direct engagement with senior government officials and Ministers through these Treaty settlements. This is above the influence which should have been afforded all Māori via the Treaty of Waitangi alone. This has created some discrepancies in the treatment of the ‘settled’ versus the ‘unsettled’ tribes.

Twenty-seven million coastal Indigenous people across 87 countries consume an estimated 2.1 million (1.5 million-2.8 million) metric tonnes of seafood per year (Cisneros-Montemayor et al., 2016). On average, consumption per capita, is 15 times higher than non-Indigenous country populations (Cisneros-Montemayor et al., 2016). Indigenous fisheries are the fisheries of Indigenous people who share vital links to marine ecosystems that conserve their cultural heritage and underpin food sovereignty (the right to define and access healthy and culturally appropriate food) (Cisneros-Montemayor et al., 2016). For example, fishing contributes to

traditions, religious observances and recreation for Mayan communities in Quintana Roo, Mexico (Arce Ibarra, 2007). Indigenous fisheries may also have communal rather than capitalist perspectives and aspirations (Plagányi et al., 2013).

One key area where Treaty settlements have made a significant change for Māori is in fisheries. The Māori Fisheries Settlement (Sealord Deal) 1992, and subsequent Treaty of Waitangi (Fisheries Claims) Settlement Act 1992, was a major game changer regarding all Iwi Māori interests in commercial and customary fishing. Māori received either 10% of quota shares for all species in the Quota Management System (QMS), or the cash equivalent where this was not possible. Quota shares are a property right that represents the quota owner's share of a fishery. The QMS regulates total commercial catch of all New Zealand's main fish stocks. Under the QMS, commercial fishers were allocated the right to fish for a quota share of a species, based on their commercial fishing history. These are called Individual Transferable Quotas (ITQs). Māori were resourced to collectively buy 50% of Sealord, a major owner of NZ fisheries quota shares (right to fish for a proportion of catch) and one of NZ's largest fishing companies at the time. Māori are given 20% of all commercial fishing quota shares for new species introduced to the QMS.

Indigenous rights are being increasingly recognised through fisheries co-governance and co-management policies in colonised countries such as Australia, Canada, Norway, the US and New Zealand (Memon & Kirk, 2011; Richmond, 2013; Sheppard et al., 2008; Søreng, 2013; van Putten et al., 2013). This extends to collaborative research partnerships to inform monitoring and management, resulting in training and employment opportunities for Indigenous people in remote areas (Dobbs et al., 2016; Saunders & Xuereb, 2016). The importance of context and culture when developing these management frameworks is emphasised, which naturally favours an ecosystem-based approach (Søreng, 2013). Gutiérrez (2011) highlighted leadership, social cohesion, and incentives (catch shares and conservation benefits) to be the key attributes of a successful community co-management fisheries plan.

Not only have Māori regained rights to participate in fisheries, they have also retained the right to exercise authority in fisheries management. Māori can make regulations for self-management of Māori customary fishing. Māori are to be appointed on all statutory fisheries bodies. In addition to the pan-Iwi Fisheries Treaty Settlement, individual Iwi have Treaty settlements that provide further influence in their territorial fisheries see Chapter 5 (Māori participation in NZ fisheries management).

1.1.2 Fisheries management

Since the late 1990's, single-species, or Target Resource Oriented Management (TROM) of modern fisheries has been evolving to become more ecosystem-based. TROM is supported by single species stock assessment models which are used to predict how a fish stock has responded to fisheries management measures, e.g. an annual Total Allowable Catch (TAC), and then predict what effect these outcomes would have on the future stock status and fishery yield. The models feed into the management process, including setting of targets, limits, and associated rules. Developed fisheries have largely been managed based on these types of single-species assessments, however these models lack the ability to recognise the impacts of the additional ecological and social interactions at play.

As TROM treats each fishery in isolation, a number of collapsed and fully exploited fisheries has resulted (Botsford et al., 1997; Pauly, 1995). For example, as at December 2018 the NZ SNA1 snapper (tāmure, *Pagrus auratus*) stocks of the north-eastern North Island of NZ are <10% likely to be at, or above, target levels, are potentially below the soft limit, and are 60% likely to overfished (Ministry for Primary Industries, 2018). These outcomes occur partly due to a lack of understanding of ecosystem processes and inclusion of this information in decision-making, or unreliable and biased assessments of stock and ecosystem performance, and/ or insufficient involvement of local communities in management, conservation and enforcement measures (Espinoza-Tenorio et al., 2013).

To addresses these issues, countries worldwide are adopting ecosystem approaches to fisheries management. The Ecosystem Approach to Fisheries (EAF) expands the principles of sustainable fisheries management to the whole ecosystem, recognising that fishing pressure acts in combination with a number of other pressures. The EAF aims to balance diverse societal objectives, consider knowledge and uncertainties about socio-ecological systems and their interactions, and apply an integrated approach to fisheries within ecologically meaningful boundaries (FAO, 2003). By accounting for the interactions between the wider ecosystem and the fishery, and by recognising humans as part of the system, EAF is viewed as being more holistic. Summarised broadly, the Ecosystem-based Fisheries Management (EBFM) principles are: timely and transparent integrated decision-making processes based on precaution and best scientific evidence available (incl. traditional knowledge), in order to maintain the natural structure and function of diverse ecosystems, while meeting human needs, including alleviating poverty and food shortages, and minimising adverse impacts on communities, and supporting responsible and sustainable conditions and practices in the industry (Anonymous, 1995; Garcia et al., 2003; Ward et al., 2002).

The Ecosystem approach fisheries management (EAFM) and Ecosystem-based management (EBM) are similar concepts towards management in that they both consider the bigger picture. However, they have alternative approaches to being implemented. EAFM builds on existing institutions and practices, while incrementally changing the system's policies and techniques in order to address ecosystem factors, as fast as the science can provide the evidence (Cowan et al., 2012). EBM on the other hand, gathers all the information available regarding ecosystem structure and function, and determines the ecosystems capacity for accommodating human activities before reaching a tipping point. Then the legislation and regulatory roles of agencies, even the agencies themselves, are revolutionised to reflect this (Cowan et al., 2012).

A decade ago, the key challenges to implementing EAFM were including the increased information complexity into the management process, along with determining appropriate scales, priorities and incentives for driving the change (Cowan et al., 2012; Essington & Punt, 2011; Grafton et al., 2006; Rice, 2011). Today, communicating information across the science-management divide in ways that are useful and don't limit the types of information which decisions are based on, while maintaining the independence of the research and societal trust in the process, are the key challenges (Juan-Jordá et al., 2018; Koen-Alonso et al., 2019; Porobic et al., 2018; Soomai, 2017). Another challenge is changing governance structures to better receive this information, i.e. based on ecosystems rather than single species, in a timely manner, with minimal disruption, and assisting staff to understand how their role and responsibilities fit into achieving the organisational vision (Koen-Alonso et al., 2019; Porobic et al., 2018). Early assessments (EAs) on the progress of governance transformations to new regimes can help to identify any issues preventing success (Gelcich et al., 2019).

Fisheries experts see bycatch in the tuna fisheries and climate change, habitat destruction, overfishing and lack of politic will as the main challenges for achieving sustainable fisheries, challenges that could be overcome by applying existing fisheries management approaches and focusing on closures, gear restrictions, improved compliance, monitoring and control, and use of individual transferable quotas (ITQs) (Juan-Jordá et al., 2018; Nilsson et al., 2019). Existing management tools can address the issues but need adjusting from target stock management to suit the EAFM regime. For example, more appropriate reference points and indicators, particularly for human dimensions (socio-cultural, institutional and less so, economic as there are plenty). Using the Gulf of Mexico large marine ecosystem as a case study, Kilborn et al., (2018) successfully demonstrated the use of the Ecosystem-Level, Management-Indicator Selection Tool (EL-MIST) to identify appropriate ecosystem-level fishery management indicators, describe historical changes of ecosystem organization quantitatively, recognise key

system regimes and driver variability, and communicate findings beyond a scientific audience. However, political priorities will continue to be challenging, as developing and implementing EAFM is a long-term process, which will experience waves of political support from various parties in power (Koen-Alonso et al., 2019).

Hilborn (2007) argued that strong, well-funded single agencies, e.g. Fisheries NZ, are able to achieve biological sustainability and economic success when the race to fish is eliminated and the agencies are given mandate to manage the fisheries on behalf of the nation. At present in NZ, fishery management objectives are based on the values a society places on a fishery. These are currently grouped as environmental and use objectives. The use objective for a stock is to maximise the overall social, economic, and cultural benefit obtained (Ministry of Fisheries, 2011). However much of the NZ fisheries science focus is currently ecological and economic dimensions, rather than a balance of all the human dimensions.

1.1.3 Informing fisheries management

A precautionary, proactive approach to decision-making, based on the best information available is recommended (FAO, 2009). In an EAF context, this means being able to assess the impacts of the wider socio-ecological system on fisheries, as well as fisheries impacts on their wider socio-ecological systems. Single stock assessments are still important in the EAF, but to balance diverse societal objectives and ecological interactions requires further information (FAO, 2009). With increasing technological advances and computer processing power, an array of ecosystem models has become available, allowing single-species information to be incorporated into models that are able to assess the broader spatial and temporal interactions. For example, ecosystem modelling has been used to demonstrate that NZ lobster fisheries are presently fished at higher exploitation levels than predicted to achieve maximum sustainable yield from single-species perspectives, and reducing current lobster fisheries exploitation levels could improve fisheries catches and also reduce ecosystem impacts (Eddy et al., 2017). Although the large majority of these tools have primarily had an ecological focus, significant gains have been made in investigating the human dimensions (socio-cultural, economic and institutional). A workable EAF requires information from a range of research disciplines (Alexander et al., 2019).

Hilborn (2007) suggests understanding human behaviour and incentives will be the key to success in all fisheries, from industrial fisheries in well-developed countries to small-scale fisheries, and industrial fisheries in developing countries. Non-economist social scientists as disciplinary experts for robustly applying their methods, i.e. maps, models and networks, have a critical role in gathering local knowledge and perspectives on priorities, goals, and objectives

to help managers determine risk points on the human dimensions of fisheries (Hall-Arber et al., 2009). More recent papers applying these methods have focused on three key research areas. Firstly, identifying contextual socio-cultural values of fish and fisheries. For example, Chesapeake Bay oysters are a popular menu item, an important habitat for other fish species, and a cultural touchstone (Freitag et al., 2018). Coral reef lagoon features assist Western Solomon Island communities in navigating, defining property rights and embodying tribal identity and ideology (Aswani, 2014). Further understanding of the socio-cultural value of fish and fisheries to society can increase transparency in the definition of the common good, e.g. Baltic salmon fish and fisheries, so it can be agreed upon by all involved in decision-making (Ignatius & Haapasaari, 2018).

Without this understanding, fisheries management can have negative impacts on fishing practices that are not apparent. Take for example early salmon opening days in Cook Inlet/Kenai Peninsula region, Alaska. At these times, the salmon are less abundant but the days are viewed as important opportunities for fishers to test their gear, train their crew, and renew important social connections with other fishers, as well as an important rite of passage for seasonal fishers who view salmon fishing as their primary occupation and identity (Loring & Harrison, 2013). Directed opening days, focused on maximising catch, are contributing to the ageing of the fishery and fishing community (Loring & Harrison, 2013). Fishery management systems which limit fishers access to a range of resources in favour of selective catches, also narrow the scope of fishers associated ecological knowledge (Farr et al., 2018).

Including human dimensions (governance, scenarios, indicators, participatory processes) in fisheries management is occurring, but needs to be more deliberate (Link et al., 2017). Fisheries managers need human dimension information for planning (values, beliefs, attitudes, and behaviours of users, direct and indirect economic values of fisheries, and contributions of fisheries to ecosystem services), decision-making (addressing management issues), and evaluation of management (to demonstrate achievement of management goal; Heck et al., 2016). Subsequently, fisheries social scientists are also helping to develop more ecosystem-based management systems. Such as collaborative management plans like the multispecies coastal shelf recovery plan for New England groundfish, which manages smaller interconnected fishery units within existing administration and regulations (Ames, 2010), and Espinoza-Tenorio et al. (2013) developed transdisciplinary models to improve holistic management of Huave and Zapotec fisheries of the Huave Lagoon system of Southern Mexico. Hornborg et al. (2019) reviewed EAFM human dimension indicators and found that there are very few in use relative to ecological indicators, and they are primarily concerned with fisheries

economy profitability. More institutional and socio-cultural indicators need to be developed and/or applied to be true EAFM, with existing indicators, such as human well-being, being included in current models a good starting point (Breslow et al., 2016). Others include the 8 indicators developed to identify oyster areas of priority for Chesapeake Bay management (Freitag et al., 2018).

Lastly, fisheries management assessments are being improved to determine how well systems are addressing multiple objectives and navigating trade-offs, such as, the trade-off between efficiency versus participation and democracy in decision-making (Hersoug, 2014). Plagányi et al. (2013) measured management strategy success for traditional Indigenous and commercial fishers, and found that market-based management options, which score well in a capitalist society, have negative repercussions on community connectedness and equity, in societies with a strong communal ethic. Finding that some trade-offs experienced at smaller scales, such as food production, employment and well-being of marginalised stakeholders (women) are being overlooked in favour of win-wins between conservation and profitability at the large scale (Daw et al., 2015). This has led to new approaches for resolving resource conflicts. For example, the value- and ecosystem-based management approach (VEBMA) to facilitate ethical governance, used in the Pacific herring *Clupea pallasii* fishery in British Columbia, Canada to address conflict between local and Indigenous communities, and the fishing industry, over the management of herring, a forage fish with significant ecological, socioeconomic, and cultural value (Lam et al., 2019).

De Young et al. (2008) and the Food and Agriculture Organisation (FAO; 1999) recognise the need and potential in using information from different knowledge systems that is not included in standard reporting, such as Indigenous, local, and scientific knowledge. Indigenous knowledge holders retell carefully constructed stories to the younger generations, conveying their ancestors' lessons learned through observing natural processes; adapting to survive; and acquiring natural resources for food, tools and implements, in specific places (Cajete, 2000; Kawagley, 2006). For example, Indigenous ecological knowledge (IEK) and sea tenure was used to inform bumphead parrotfish (*Bolbometopon muricatum*) management in the Roviana Lagoon, Solomon Islands (Aswani & Hamilton, 2004). IEK verified the urgent need to protect bumphead parrotfish, explained how different habitats structured the size distribution of bumphead parrotfish, and identified sensitive locations and habitats in need of protection. Sea tenure information helped to identify the best locations for management programmes with greater likelihood of local participation and success, leading to two marine protected areas being established in the region. The value of Indigenous knowledge for fisheries management

includes localised knowledge of the fishery and wider systems, and in some cases over long time periods.

A well-known example of local ecological knowledge being used in fisheries management is in the pirarucú (*Arapaima* spp.) fishery of the Jarauá area in Mamirauá Reserve, Brazilian Amazonia. Initially, fishers and researchers collaborated to develop a method for counting pirarucú fishes. Fishers very experienced in harpooning, had developed skills to differentiate between surfacing individual fish based on subtle visual and acoustic cues (Castello, 2004). The method was standardised, shown to be consistent with mark-recapture methods, and then experienced fishers were able to train other fishers in the counting method. The method is very cost effective, being ~200 times faster and less expensive than the mark-recapture method, and is used to recommend catch quotas (Fischer et al., 2015).

Campos-Silva & Peres (2016) demonstrated how community management provided sustainable resources and poverty alleviation by analysing eight years of *Arapaima gigas* stock assessment data to compare protected areas, community-based management, landscape and limnological variables across 83 oxbow lakes monitored along ~500 km of the Juruá River in Brazilian Amazonia. Community management explained 71.8% of the variation in arapaima population size, with protected lakes on average containing 304.8 (±332.5) arapaimas, compared to only 9.2 (±9.8) in open-access lakes. Protected lakes are likened to high-interest savings accounts, ensuring an average annual revenue of US$10,601 per community and US$1046.6 per household. This highlights the need to include local stakeholders in conservation planning of Amazonian floodplains.

Indigenous management is adaptive management, based on Indigenous ecological knowledge (IEK) and holistic ecosystems thinking (Berkes et al., 2000). Indigenous groups and management bodies must find ways to accommodate Indigenous values, knowledge, management practices, and cultural uses, and consider fisheries resource allocation models that represent Indigenous needs and interests (Capistrano & Charles, 2012). In Australia's Great Barrier Reef Marine Park multispecies sea cucumber fisheries, Plagányi et al. (2015) found an increased need to use rotational harvesting, an ancient management strategy, as a low-information, low-cost, co-management approach. Rotational harvesting reduced the risk of localised depletion and provided higher long-term yields and economic performance in sessile species (Plagányi et al., 2015). This demonstrates traditional fisheries management practices as successful options for meeting a broader set of management objectives.

Also in Australia, Stewart et al. (2011) provided a comprehensive report on Australian *Arripis trutta* (same species as kahawai only the Australian population), to support fisheries

management. *Arripis trutta* was found to be of cultural importance to the local Yuin people of Australia's southern NSW coast, who have a long connection to *A. trutta*, including as a commercial fishery, as a staple cultural food, and of totemic significance (Waddell, 2010). Future management considerations identified in this case study included (page 248):

- *A. trutta* bringing commercial value as an important economic resource for Indigenous beach-haul fishers (Edmunds, 2008),
- Many Indigenous fishers practice subsistence harvest and resource sharing regime which, if limited can severely impact on standard of living and quality of life;
- Further commercialisation of this resource will negatively affect Indigenous use and values;
- Resource allocation and fisheries use planning of salmon [*A. trutta*] and other marine resources must consider a range of needs, uses and values within Indigenous communities;
- Spiritual and belief values, such as totem significance of the fish are a significant value to be considered by managers; and
- Traditional Ecological Knowledge should be employed in achieving ecologically sustainable use of marine resources.

Waddell (2010) gives some insight into totemic identity and how it relates to Indigenous fishing practice. In some Indigenous Australian cultures, totem systems play an important role in social order, for regulating marriage systems and taboos on certain species, which continue to be maintained, and should be recognised and respected in management conversations (Waddell, 2010). The importance of non-commercial fisheries for Indigenous communities can also be impacted by socio-economic factors such as job type and social security payment use when there are also commercial fisheries for the same resource (Busilacchi et al., 2013). These are valuable human dimensions to include in EAFM.

1.2 Thesis research aim and questions

NZ Minister of Fisheries Hon. Stuart Nash announced last year that by mid-2020 NZ will adopt the Ecosystem Approach to Fisheries Management (Nash, 2018). Meanwhile, NZ has also made a significant scientific research investment to support the implementation of EBM of NZ's marine ecosystems through to 2024 (Sustainable Seas Challenge, 2015). Hopefully the two will dovetail and the EAF initiatives are not thrown out at the implementation of EBM.

In NZ, more co-management of fisheries is required to honour the Treaty principle of partnership. Developing the EAF in a co-governance/co-management context also provides a need for research that spans disciplines and cultures such as cross-cultural or transdisciplinary

research. To achieve this, engagement and understandings between Indigenous peoples, researchers, fisheries managers, and society will need to increase, particularly as public interests drive EAF, and necessary management measures will ultimately result in social and economic consequences (Cowan et al., 2012).

Therefore, this thesis looks at informing the Ecosystem Approach to Fisheries Management from an Indigenous perspective. This supports NZ's goal of adopting the EAF approach. It does so in a manner which empowers Māori by recognising their rights to participate and manage fisheries and empowers Māori knowledge systems as a matter of enhancing health and well-being.

The overall aim of this thesis is to give an Indigenous perspective on informing ecosystem-based marine fisheries management. There are seven research questions addressed within this overall aim. Each question is addressed in its own chapter (shown in brackets). The chapters are described further below in section 1.4 (Thesis layout).

Question 1: What do we already know about the fishery? (Chapter 2)

Question 2: What should fisheries researchers consider when engaging with Māori for fisheries research? (Chapter 4)

Question 3: How can Māori inform NZ fisheries management? (Chapter 5)

Question 4: How does a Māori community value a fishery? (Chapter 6)

Question 5: What is the ecological relationship underpinning the fishery? (Chapter 7)

Question 6: What knowledge does the Māori community hold regarding the fishery? (Chapter 8)

Question 7: What are the key components of the fishery from a Māori perspective? (Chapter 9)

To answer these questions, a case study was investigated. A case study assists the understanding of a complex social phenomenon where it is difficult to untangle the phenomenon from the context in which it is embedded (Bernard, 1988). Case studies are regularly used to study fisheries (Chuenpagdee & Jentoft, 2019) and are also appropriate for this research because Indigenous perspectives are contextual.

The NZ Mōtū kahawai fishery is a case study from a post-colonial nation and therefore the results may not reflect what is experienced in decolonised countries, e.g. Indonesia, or countries that have not been colonised, e.g. Fiji. The Mōtū kahawai fishery consists of the Mōtū River which is in the eastern Bay of Plenty, in the North Island of NZ, approximately 100km east of Whakatāne. The river mouth is within the territory of Te Whānau-a-Hikarukutai/Ngāti Horomoana, a Hapū who have a strong connection to the fishery and their own local fishery

management system (Richards & Paora, 1992). The fishery is small-scale and land-based, using handlines to catch kahawai (*A. trutta*), a medium-sized pelagic teleost fish. More information on the history and background of the Mōtū kahawai fishery is provided in Chapter 2 (History and background of the Mōtū kahawai fishery).

The Mōtū kahawai fishery is a good case study for EAF research because kahawai are valued highly by the non-commercial fishing sectors (customary and recreational), who have expressed concern over the status of kahawai in the eastern Bay of Plenty since the 1970s (Ministry for Primary Industries, 2017). A management plan has not been developed for kahawai, but has been for other nationally important species, such as blue cod. In 1991, the local community wrote a submission to the Ministry responsible for NZ fisheries at the time, requesting that habitat and associated species be considered in the management of kahawai. This highlights that local fishers and community desired an ecosystem approach for managing the Mōtū kahawai fishery decades ago and raised this with national fisheries managers as early as 1991. This thesis is an opportunity to address that request.

1.3 Thesis layout

He aha te kai a te rangatira? He kōrero, he kōrero, he kōrero. What is the food of the leader? It is knowledge, it is communication. This thesis is a form of knowledge and communication and therefore can be likened to the food of a leader or decision-maker. As kahawai, the focus of this thesis, is the prized food of Te Whānau-a-Hikarukutai/Ngāti Horomoana, this thesis is presented in three parts, each representing parts of the kahawai, as in the partaking of a meal. Part I – Wahinga Tahi is the Ūpoko or Head. The fish head is the most prized meal and is eaten first. The knowledge contained in Part I sets the direction of the thesis, much like the head of the kahawai sets the fish's swimming direction. Part I includes the prologue and four introductory chapters. Chapter 1 (General Introduction), introduces fisheries management and Indigenous perspectives on fisheries, and provides the research aim and questions, a brief description of the case study fishery, and the layout of the thesis. Chapter 2 (History and background of the Mōtū kahawai fishery), defines the Mōtū kahawai fishery management unit and the broader KAH1 fishery management area of which the Mōtū kahawai fishery is a part of. Chapter 3 (Taking a transdisciplinary research approach), discusses the methodology of this thesis, namely taking the transdisciplinary approach, and applying Māori research principles and ethics. Lastly, Chapter 4 (Māori engagement for fisheries research), defines engagement, describes considerations when engaging with Māori for fisheries research, and outlines the engagement process followed in this project.

Part II – Wahinga Rua is the Tinana or Body. Part II contains the original contributions of the thesis, much like the body of the kahawai is the real sustenance of the fish, providing one with at least four hearty meals. Part II includes Chapters 5-8. Chapter 5 (Māori participation in NZ fisheries management), explores how Māori can best inform NZ's national fisheries management decision-making, and the instruments available to support Māori customary fishing interests. Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery), describes the cultural values of the Mōtū kahawai fishery for the local Hapū and determines if kahawai is their cultural keystone species (CKS). Chapter 7 (Ecological relationship between kahawai and the Mōtū), investigates four hypotheses to explain the ecological relationship underpinning the Mōtū kahawai fishery. Lastly, Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery), describes the Hapū ecological knowledge regarding the Mōtū kahawai fishery.

Part III – Wahinga Toru is the Hiku or Tail. After all the flesh or knowledge has been consumed, the tail is what you are left with. Part III brings together the information from the previous chapters as a Hapū plan in Chapter 9 (Holistic management of the Mōtū kahawai fishery), which reflects the future direction the tail is propelling the fish towards; a summary of the findings in Chapter 10 (Conclusion), which reflects the tail itself, and an Epilogue, containing concluding remarks on the researcher's journey in preparing this thesis, as a meal for the reader. This is followed by Definitions of Māori words in English, and Definitions of scientific terms and abbreviations, to ease with reading the thesis.

1.4 Language use in the thesis

This thesis is written mostly in English with Te Reo Māori where appropriate. Presently less than 4% of NZ's population can speak Te Reo Māori. Although Te Whānau-a-Hikarukutai/ Ngāti Horomoana people are strong Te Reo Māori speakers, Te Reo Māori is my second language, and I would not have done it justice here as my fluency is not poetic and flowing yet. The English medium allows this thesis to reach a very wide audience, particularly Te Whānau-a-Hikarukutai/Ngāti Horomoana hapū members, and the Mōtū kahawai fishery community, but also fishers, fisheries researchers, and fisheries managers broadly. Definitions of Māori words in English at the end of the thesis.

1.5 Conclusion

This chapter has provided context for the research, including Indigenous and Māori perspectives and rights, the NZ context, developments in fisheries management, and the subsequent changes in providing information to support the new fisheries management regime. The EAF is more aligned with Indigenous fisheries management and allows for Indigenous knowledge systems to be exercised. The key is to appropriately bring this information together in a way which empowers Indigenous people. This is the aim of this thesis. The chapter finished by describing the specific research questions, a brief description of the Mōtū kahawai fishery case study, the thesis layout, and a language use statement. The next chapter describes the Mōtū kahawai fishery case study in more detail.

Chapter 2 History and background of the Mōtū kahawai fishery

Here we discuss fisheries management units (FMUs) which are the focal points of fishery management systems. This chapter provides historical and background information on the Mōtū kahawai FMU, in other words, about the place, the people, the fish, and their connections to one another. The connections referred to here are the metaphysical relationships between the kahawai and the Hapū, the history of the fishery, local Mōtū kahawai fishery management practices or tikanga, and the national KAH1 fishery management system, which the Mōtū kahawai fishery is managed within. This gives an overview of the fishery and a baseline on the extent to which the fishery is managed through an EAF approach. This chapter demonstrates the need for this type of research to be carried out.

2.1 Introduction

The task of assessing marine resources starts with defining the management unit. A fishery management unit (FMU) is a fishery or portion of a fishery identified in a fishery management plan (FMP) relevant to the FMP's objectives. The choice of stocks or species in an FMU depends on the focus of FMP objectives, and may be organised around biological, geographical, economic, technical, social, or ecological perspectives (NOAA Fisheries Glossary, https://definedterm.com/a/document/11111, *accessed 11 January 2019*). FMU profiles capture the broad range of interests and dimensions to the fishery. This information then acts as a baseline for assessing change over time and monitoring management strategy performance.

Staples et al. (2014) gives a note of caution that having good stewardship of coastal resources that are then exploited by larger vessels from other localities is counter-productive and inevitably leads to a breakdown in the system. This is likely the case for the Mōtū kahawai fishery. The Mōtū kahawai fishery is the FMU of focus here, but because the Mōtū kahawai fishery is managed nationally as part of the KAH1 fisheries management area, background information for both of the fisheries are provided. This highlights the importance of spatial scale when managing fisheries.

2.2 Mōtū kahawai fishery background

This section describes the Mōtū and eastern Bay of Plenty area; metaphysical information including whakapapa (genealogy), and pūrākau; how the fishery is managed locally, the history of the fishery, and management at the national level.

2.2.1 The place – Mōtu kahawai fishery area

The Mōtū kahawai fishery operates at the Mōtū river mouth. At times, there is more than one mouth. The Mōtū river mouth is located at Maraenui in the eastern Bay of Plenty (BOP), North

Island, New Zealand (37°53.7′S and 177°32.7′E, Figure 2-1). The Mōtū river estuary covers 0.29km^2 and ~3.1km of shoreline (Park, 1991). The Mōtū is a large river with a steep, primarily forested catchment, and a small shingle estuary near Maraenui village (Rowe, 1981). The river discharges at an average rate of 82m^3·s^{-1} into the eastern end of the beach, which has a very steep beach face with coarse pebbly sediments and deep water offshore (Penlington, 1988). The freshwater plume has been measured travelling out into the bay at 2.20m·s^{-1} declining to 0.09m·s^{-1} at 750m out to sea, the detectable limit of the river at full tide (Penlington, 1988). At this point, which is roughly in line with the nearest headland, the freshwater layer is 5cm deep (Penlington, 1988).

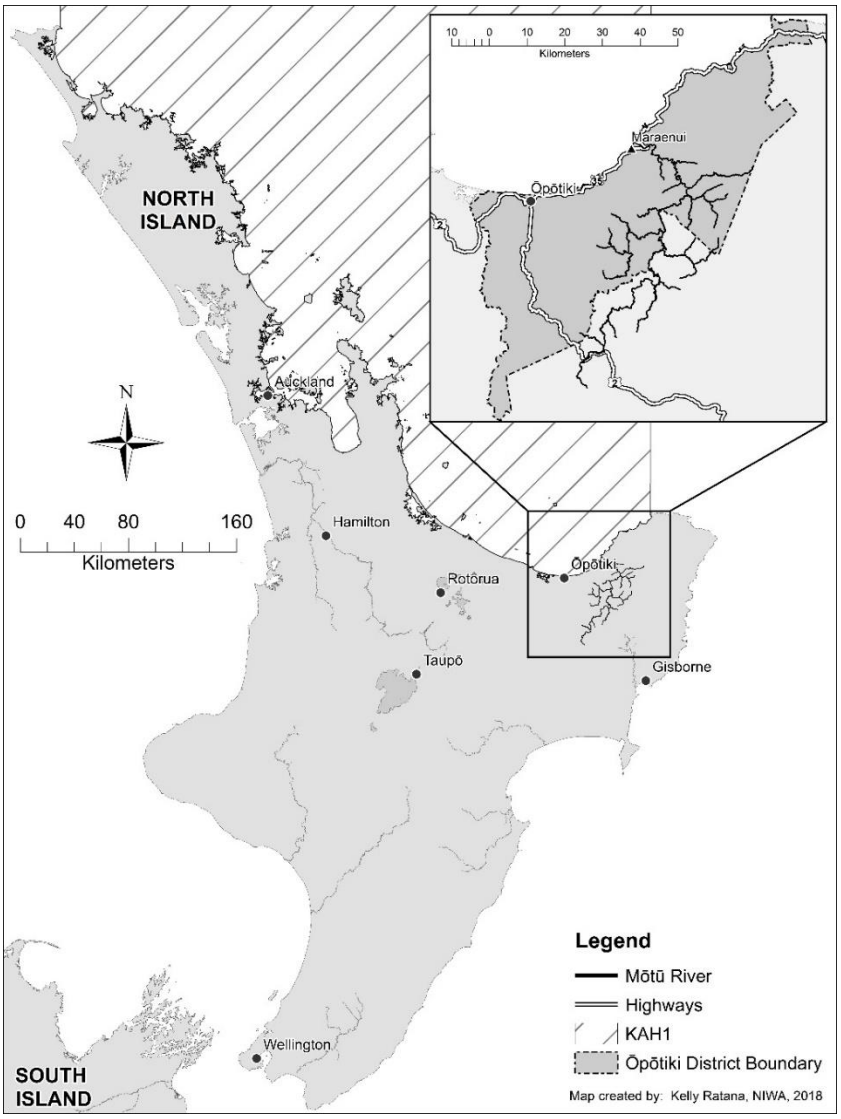


Figure 2-1 Mōtū River mouth, Maraenui Bay in the eastern Bay of Plenty, North Island, New Zealand.

Figure 2-2 shows a band of gravel/sand sediments north of the Mōtū river mouth, and a band of volcanic sediments to the west. Otherwise the sea bottom is largely muddy (Marine Environment Classification (MEC) Bottom Sediment Type, (Snelder et al., 2004). The area

also has a high (5°C) annual amplitude sea surface temperature (MEC Physical Variable: Sea Surface Temperature Annual Amplitude, NIWA, 2002). The East Auckland Current (EAUC), a continuation of the East Australian Current (EAC), flows south-east along the north-eastern coast of the North Island and across the Bay of Plenty inshore, travelling at speeds of up to 0.5m·s^{-1} (Stanton et al., 1997; Stevens & Chiswell, 2006).

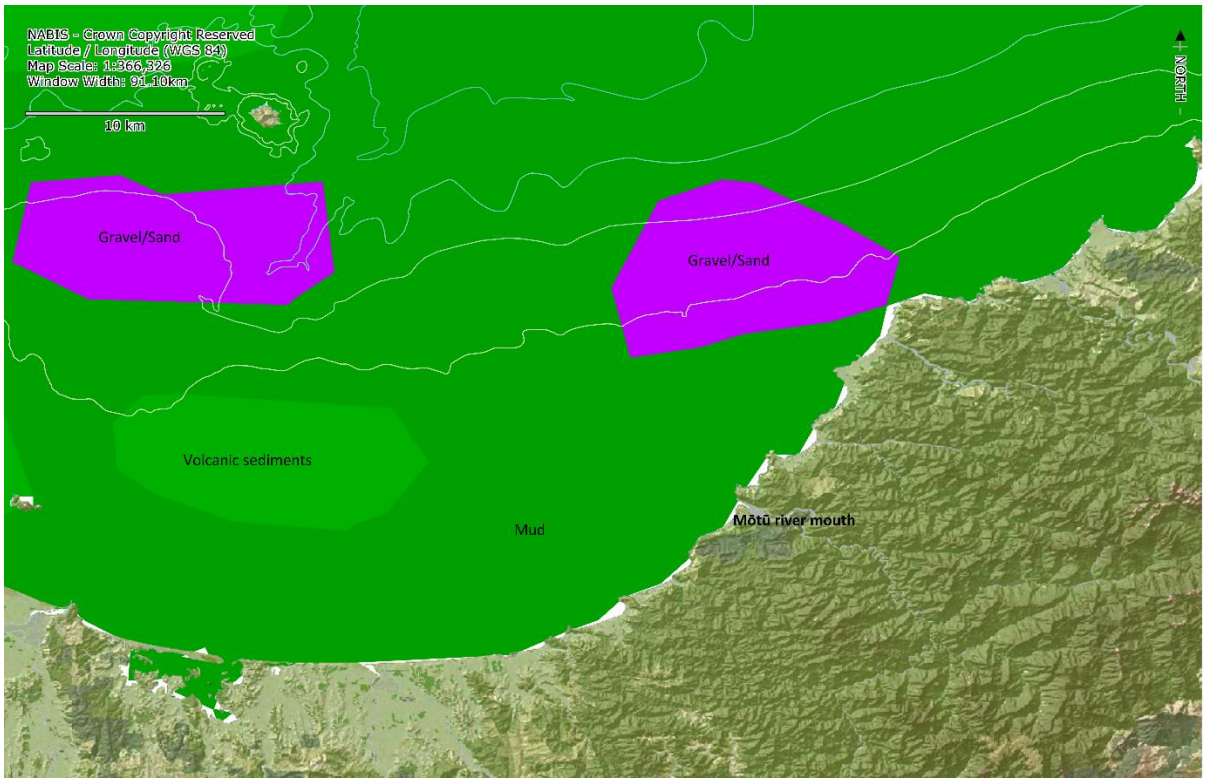


Figure 2-2 Bottom sediments in the Bay of Plenty (Marine Environment Classification MEC Physical Variable: Bottom Sediment Type). Source: Ministry for Primary Industries and licensed by MPI for re-use under the Creative Commons Attribution 4.0 International licence .

2.2.2 The people – Te Whānau-a-Hikarukutai/Ngāti Horomoana

The Mōtū river mouth area is under the mana (authority) of Te Whānau-a-Hikarukutai/Ngāti Horomoana (TWAH/NH or the Hapū). They are a Hapū of the 13,000 strong Te Whānau-a-Apanui Iwi (tribe) that make up 1.9% of the NZ Māori population (Statistics New Zealand, 2013; Richards & Paora, 1992). There are no official statistics on the Hapū population or their geography, however, 59.1% of the whole Te Whānau-a-Apanui Iwi live in urban areas, and 33.5% live in the Bay of Plenty (Statistics New Zealand, 2013). Approximately 9,000 people live in the Ōpōtiki District encompassing the Mōtū river mouth (also shown in Figure 2-1), and 50.8% are NZ Māori (City population website, www.citypopulation.de, *accessed 30 August 2018*). Indicative Hapū coastal boundaries are from Parinui to Tokatā.

2.2.3 The fish – kahawai biology and ecology

Kahawai (*A. trutta*, Bloch and Schneider 1801), shown in Figure 2-3, is from the Class: Actinopterygii, Order: Perciformes, and Family: Arripidae (Paulin, 1993). Kahawai are also known as sea trout and Australian salmon, but are not true trout or salmon (Paul, 2000). There are 4 Arripidae species, *Arripis xylabion*, *Arripis georgianus*, *A. trutta* and *Arripis truttaceus*. *Arripis georgianus* and *A. truttaceus* are only found in Australia. Kermadec kahawai (*A. xylabion*) is only found in northern NZ waters.

Kahawai is found throughout NZ and along Australia's coasts, south of Perth and the Gold Coast. MacDonald (1983) found that Eastern Australian salmon and New Zealand kahawai are the same genetically. The pattern of kahawai movement around NZ is poorly understood and there are regional differences in age structure and abundance that are consistent with limited mixing between regions (Ministry for Primary Industries, 2017). Kahawai swim in age-class schools with adults found in pelagic waters within 20km of the coast, corralling baitfish or krill into balls which seabirds and marine predators also feed on (Baker, 1971; Hughes et al., 2013; Robertson, 1992). These feeding episodes or 'work-ups' 10-200t large were previous characters of NZ coastlines, seldom seen today (Hartill & Walsh, 2005).

Figure 2-3 A Kahawai A. trutta (December 2014, K. Maxwell).

Kahawai are 'medium-lived' species with a maximum age of 26 years and a moderate growth rate, reaching 15cm after one year, and sexual maturity at 35-40cm after 3-5 years (Bradford, 1999; Paul, 2000).

2.2.4 Metaphysical connections

Here we present the whakapapa of the kahawai (Figure 2-4). Ranginui is the skyfather and Papatūānuku is the earth mother. Tāne-mahuta is their son and atua (deity) of the forests, birds and mankind. He breathed life into Hineahuone (ancestress of the first humans, the female

element that comes from the soil), and they created Hinetītama (the dawn maid). From a union between Tāne-mahuta and Hinetītama come all of mankind. Tangaroa is the brother of Tane-mahuta and atua (deity) of the sea and waterways. He wed Te Anu-mātao (the chilling wind), and they produced Punga. From Punga came Ikatere who is the ancestor for all the fishes, including the kahawai.

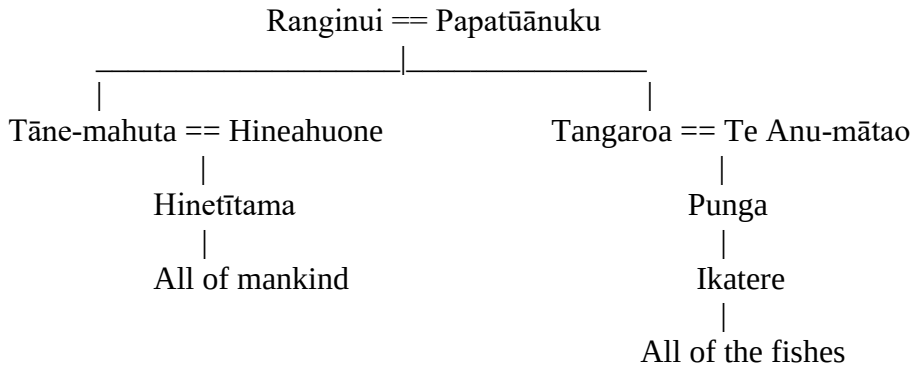


Figure 2-4 Whakapapa of the kahawai.

2.2.4.1 He Kōpara pūrākau

There are multiple accounts of the pūrākau, He Kōpara. This one has already been reported by Penlington (1988) and makes reference to Bill Tāwhai, of Te Whānau-a-Apanui:

> Historically, legend has it that the kahawai were gifted to the people of Maraenui, adjacent to the Mōtū, by Tangaroa, the god of the sea, after the Māori people arrived from Hawaii. When Maraenui was first settled, one of the residents was Pou-ma-tangatanga, who had a wife Ōhinemōtū, and a son, He Kōpara. When He Kōpara went missing, Pou-ma-tangatanga searched for him until he was told to consult Tangaroa. Tangaroa admitted that he had taken He Kōpara for his own purposes. On seeing Pou-ma-tangatanga's grief, Tangaroa gave a gift to Pou-ma-tangatanga and his people. Tangaroa told Pou-ma-tangatanga that when the dust of the bracken flew, and the berry of the karaka turned golden, a gift would be sent to the mouth of the Mōtū River. Pou-ma-tangatanga and his people could take as much as they wished until the kōwhai [tree, *Sophora microphylla*] floods came to wash the river clean. (Kōwhai floods occur in late March, when it rains in the headwaters, but is still fine on the coast (B. Tawhai *pers. comm.*)). The gift would return each year to commemorate the loss of He Kōpara.

Other records include that of Rimini (1901), individual accounts given orally, and an account written in Te Reo Māori provided by E. Koopu that includes the whakapapa to Poumatangatanga. The Te Reo Māori account is referred to at times in this thesis, however it

has not been translated, because the information could be considered sensitive intellectual property belonging to the Hapū and is therefore not included here.

2.2.4.2 Tapuikakahu pūrākau

Rimini (1891) also provides an account of the Tapuikakahu pūrākau which was published in the Journal of the Polynesian Society by George Davies with translations by Margaret Orbell:

> Once upon a time there was a man named Tapuikakahu who lived at his home in the bush at Waiaua, inland from Opotiki. One day he wanted some fish to eat, so he took his greenstone fish-hook inlaid with paua, paddled out to sea, and threw the hook into the water. While it was still above the water, the kahawai rose to take it. Then when he had as many as ten fish, and was highly delighted, a big kahawai suddenly carried off the fish-hook! Our hero was very upset at this, for the hook was an ancestral heirloom. He went back to the shore and put on his dogs'-tail cloak. Then he started following the shoal of kahawai. They swam along out at sea and he ran along the shore, reciting incantations as he went. He thought that the shoal must be making for the Mōtū River, for that is the source of all the kahawai in the land. He also thought to himself that Te Whānau-a-Apanui would probably net the kahawai, and that the one that had carried off his fish-hook would very likely be among all the fish they caught. At last he came to Maraenui, on the Mōtū River. When he arrived he found that Te Whānau-a-Apanui had caught the shoal of kahawai in their net, just as he had thought they would. The leaders of Te Whānau-a-Apanui asked him, 'Why are you here?' But our hero didn't say a word; he kept gazing at all the women gutting the fish. Very soon, one of them found the fish-hook! It was still in the mouth of the rascally kahawai that had carried it off. The woman cried, 'Why, here's a paua fish-hook—I've got a paua fish-hook of greenstone, here in the mouth of this fish!' She held up the fish, and everyone crowded round to look at it. Then our hero stood up in the midst of all those people. At last he spoke; he called to the woman, there among that multitude, 'My friend that is why I am here. I came after my paua fish-hook, which was carried off at Tirohanga by that rascally kahawai there.' The woman gave the paua fish-hook to our hero, and he, Tapui-kakahu, took off his dogs'-tail cloak and presented it to her. After this he returned to his home at Waiaua, for he was well satisfied. But he was very hungry indeed, for he had not eaten since morning and it was now near sundown. They said to him, 'Stay for a meal, and go back after you have eaten.' His answer was, 'But there is also food at Waiaua!' This reply became a proverb

among his descendants, and they still use it today. This is how they do so. If someone who is going home, and is anxious to get there, is pressed to have a meal, he will continue on his way saying, 'But there is also food at Waiaua!'

2.2.4.3 Te Whatukura-a-Tangaroa pūrākau

There are multiple accounts of the history of Te Whatukura-a-Tangaroa. This account was provided in the children's story written by Te Whānau-a-Apanui author Tamati Waaka (Waaka, 2013):

> Named after the stone Tāne obtained from the wānanga (places of knowledge) and given to Tangaroa and Kiwa (deities of the ocean) to enable them to keep the sea in place so that it should not overflow the land. Te Whatukura-a-Tangaroa was fashioned by Rua-te-pūpuke, grandson of Tangaroa, so that his son Manurūhī may catch fish for the insatiable hunger of his son Rua-te-pūkenga, for seafood. Rua-te-pūpuke cautioned his son Manurūhī not to disrespect Tangaroa and to only take what he needed. But the fishhook was so powerful, Manuruhi did not listen and fished to excess, angering Tangaroa, who dragged him into the depths to become the tekoteko (carved figure on the gable of a meeting house) atop his whare (house), Hui-te-ana-nui (House of Tangaroa).

There are also other records about Te Whatukura-a-Tangaroa by Cowan (1930) and Gudgeon (1906).

2.2.5 Mōtū kahawai fishery history

Kahawai migrate to the Mōtū river mouth every austral summer when in reproductive condition (Penlington, 1988). This phenomenon is the basis of the Mōtū kahawai fishery (Ritchie et al., 1982). Initially this fishery would have been 100% Māori fishers.

2.2.5.1 1400s

The Mōtū kahawai fishery likely began within 50 years of the Tauira-mai-tawhiti waka (canoe) arriving to New Zealand some 600 years ago (Law, 2008). Initially this was a net and hand-line fishery. In the pūrākau (narrative) of He Kōpara (son of Poumātangatanga), Titipā obtained nets from the tūrehu (fairies) to catch kahawai (Rimini, 1901). This suggests that nets were the first gear used in the fishery. A longer net called a 'kupenga koko kahawai,' was used to catch kahawai on the east coast at the Waiapu River, by scooping up the shoals as they swam into the river mouth, see Figure 2-5a (Hiroa, 1869). Additional nets used at Maraenui were described by Takataka Koopu and are provided in Table 2-1. This includes the pou-a-hao-kai used for catching large volumes of kahawai for feasts.

2.2.5.2 1600s

Hand-lines were used with a trolling hook known locally as paua, as they were previously inlaid with the shell of pāua (*Haliotis iris*, black-foot abalone), or more widely known as a pā kahawai (kahawai fishing lures), as shown in Figure 2-5b (Hiroa, 1869). Tapuikakahu is an ancestor of Te Whakatōhea people who lived around 1600 AD (Lyall, 1979). The Tapuikakahu pūrākau tells of Tapuikakahu fishing with a handline and paua-pounamu (abalone-greenstone) lure, when a kahawai carried off the lure. He followed the kahawai to the Mōtū, where as he suspected Te Whānau-a-Apanui were fishing for kahawai with a net (Rimini, 1901).

Table 2-1 Nets used at Maraenui described by Takataka Koopu.

Kupenga mo te awa/ Nets for the river	*Kaupapa*	*Use*
Kupenga kaharoa	Ma te waka e hoe	For use on the row boat
Kupenga koko	Kotahi te tangata ki tana, ka haere mai te ngaru ka kokona atu te kupenga	For individual use, when the waves come, scoop up the net
Kupenga Pou-a-hao-kai	E wha kumi (rua tekau mita) te roa, toko wha rima ranei nga tangata hei mau te kupenga ki te moana	Four fathoms (20 m) long, requiring 4 or 5 people to carry the net to the sea
Kupenga whakau	E wha kumi (rua tekau mita) te roa, e rua tangata ki te kupenga kotahi	Four fathoms (20 m) long, two people to the one net
Kupenga auparu	Kia pari te tai ka whakatu tonu ki te awa, kia timu te tai kua mau nga tamariki a Tangaroa ko te ika tera	When the tide is in set the net in the river, when the tide goes out you've caught the children of Tangaroa (deity of the sea) that's the fish
Kupenga mo te paripari/ Nets for the bluff	*Kaupapa*	*Use*
Kupenga matarau	Mo runga waka	For boats
Kupenga whiu	Mo runga toka	For rocks
Kupenga koko	Mo runga toka	For rocks
Kupenga hinaki	Ara mo te awa tenei	This is for the river
Kupenga pouraka	Mo runga toka tenei	This is for rocks

2.2.5.3 1900s

Rimini (1901) described the Mōtū kahawai fishery at the turn of the nineteenth century, "when daylight appears if you look out towards the mouth of the Mōtū, you will see the place covered with crowds of people, and the fishing lines thrown out on one side of the river and the other are as close as the telephone wires in Wellington. … So closely the men and women stand on both sides of the river that all spaces are filled up. The river here is a chain and a half (about 30m) wide." This suggests that at the time, the fishery was mainly handlines. Rimini (1901) also describes the catch: …the ovens are prepared; there are four or five sub-tribes (Hapū) to

one oven. Each oven is about three or four chains long and four feet wide (60-80m long and 1.5m wide). There are about twenty or thirty thousand fish in one oven." However, it is not clear how many ovens there were. This is approximately 36-54t per oven, based on the average weight of a fish caught in the current study (1.8kg).

a) b)

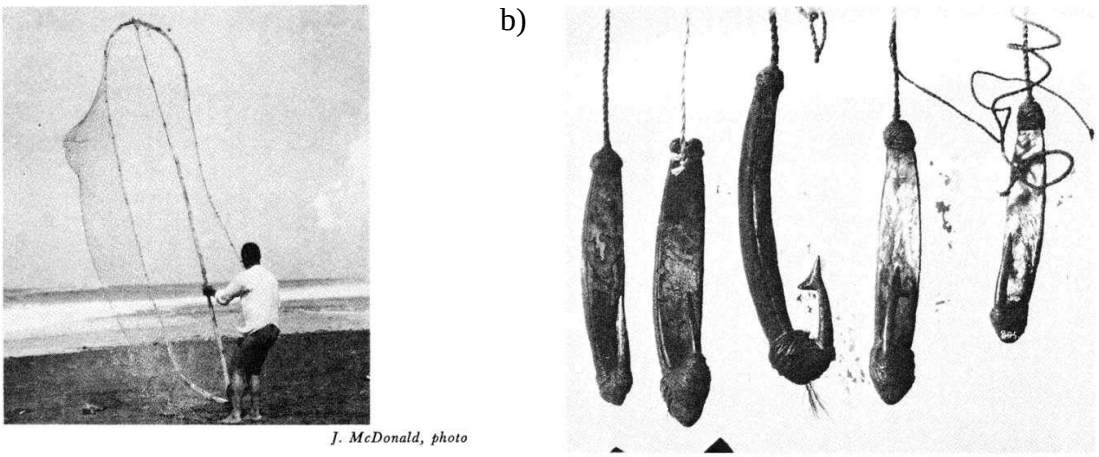


Figure 2-5 a) Net used in taking kahawai at Waiapu (Hiroa, 1869); b) Trolling hooks known as paua or pā kahawai (Hiroa, 1869).

2.2.5.4 1980s

The Mōtū kahawai fishery is in a low socio-economic area. Rowe (1981) observed 2,178 people fishing at the Mōtū river mouth between Christmas 1981 and Easter 1982 and suggested this was a mostly local fishery with 66% of the fishers lived within a day's drive of the mouth. Members of neighbouring Te Whānau-a-Apanui Hapū, and Iwi (Ngāitai, Te Whakatōhea, Tūhoe and Ngāti Awa) travel to the Mōtū river mouth to fish for kahawai. Rowe (1981) characterised the 1980 fishery as mostly for local consumption and important for tourism in the region. Ritchie etal., (1982) further defined the fishers as 19.3% local, i.e. living between Ōpōtiki and Cape Runaway, 33% from Ōpōtiki, the closest town to the river, 33.7% as away from home, and 85% of these came from the area bounded by Tauranga, Hamilton, Taupō and Gisborne (Penlington, 1988). The number of fishes caught per person per day ranged from 0 to 60 and the total weekly catch ranged from 10 to 1408. Local people spent an average of 2.08h fishing and caught an average of 4.17 fish per hour, while people from outside the survey area spent 2.65h fishing and caught 2.24 fish per hour (Ritchie, 1982). Fishers averaged a catch of 6.5 fish (11.7kg) and either gave away part of their catch, or stored it for future consumption by smoking, bottling or freezing it (Ritchie et al. 1982). The current status of the Mōtū kahawai fisher population is unknown.

2.2.6 Mōtū kahawai fishery management - tikanga and the Ringatū faith

TWAH/NH operate a local Indigenous fisheries management system for the Mōtū kahawai fishery. The system is reviewed annually by the Hapū and tikanga (Maori customs, values, and protocols) are visible on signs at access points to the river mouth. The Ringatū faith have included components of the Mōtū kahawai fishery tikanga into their religious practices. This may have helped the tikanga to endure the prohibiting of Māori tohunga practices through the Tohunga Suppression Act 1907.

The Ringatū faith was founded on May 12 1868 by Te Kooti Arikirangi Te Turuki (Te Kooti), who was raised in the Christian faith by missionaries (Binney, 2012). He later developed his own version of the faith that was better suited to his Māori followers, i.e. without reference to consuming the body and blood of Christ, a reference that linked to cannibalism. He was also a tohunga Māori because he prophesised particular events through whakataukī (proverbial sayings), and he was revered for his ability to unite people and for recording his experiences through waiata (Binney, 2012). The waiata 'E pa tō reo…' which is always sung by TWAH/NH at Māraenui marae, was composed by Te Kooti in praise for Paora Ngamoki, Te Kohi Delamare, and the Whānau-a-Apanui people, when Te Kooti was invited to a rā (Ringatū church service) at Maraenui on 1 July 1887 (Binney & Chaplin, 1996).

Thus, the Ringatū church came to Te Whānau-a-Apanui. The chiefs of Maraenui were Paora Ngamoki, followed by Te Kohi Delamare, Koopu Erueti, and Paora Delamare (Binney & Chaplin, 1996). Te Kohi Delamare converted to the faith after the 1868-72 wars. His son Paora Delamare became a poutikanga (leader) of the Ringatū faith. During this time Paora and his daughter, Maaka Jones, created the first published text of the Ringatu faith, and together with the Te Whānau-a-Apanui families, built a Ringatū whare karakia (church) at Maraenui marae. He also evolved the faith, towards an acceptance of Christ.

The Ringatū church largely follows the Christian Old Testament but also incorporates tikanga, providing an additional means for tikanga to be taught and exercised in modern times (Ringatū Church, 2005).

Here are some examples of the intertwined nature of both the tikanga and the faith. In 1879, Te Kooti added the first of July and November as two of the four pillar days of the church (T. K. Maxwell, n.d.). At Whitianga, on the other side of the Mōtū River, Te Kooti had set up the Firsts, the 'huamata' on the first of June and the 'pure' on the first of November. One day for planting and one day for harvesting the first fruits from the special garden.

On the first of June, some of the sacred seeds were planted in the sacred garden, and some were taken down to the sea and thrown to the four corners of the earth, asking for God to produce

fish. On the first of November the men harvest from the garden and catch kahawai for the First hākari (special feast). These days signal the opening and closing of the kahawai fishing season and special ceremonies are performed to open and close the fishery.

The seasonal regeneration of the plants and the return of the kahawai were described as resembling the resurrection of Christ. While the mara tapu (sacred gardens) are not practiced as intensely as they were originally, the opening of the kahawai season on the First of November is. To this day, one of the largest followings of the Ringatū faith is in the eastern Bay of Plenty (Binney, 2012).

Rāhui, a prohibition mechanism utilised in tikanga-based resource management, are observed on church service days meaning there is no kahawai fishing at the Mōtū river mouth on these days. This reflects the tapu (sacredness) of the kahawai.

A rāhui whakamahara (remembrance closure), also a prohibition mechanism however utilised for remembrance, is observed on Saturdays. This commemorates the major tragedy where 16 children and 2 adults that were crossing the flooded river to attend school on the other side at Ōmaiō drowned at the river mouth on the 5th of August 1900. After the drowning, a rāhui was placed on the sea from Maraenui to Ōmaiō in the east for five years (Maxwell & Penetito, 2007). Imposing a rāhui is standard practice to avoid coming into contact with the drowned persons as they cycle through the ecosystem.

This was a time of momentous grief for the community. Subsequently families changed their names, and the hapū changed their names. Te Whānau-a-Hikarukutai became Ngāti Horomoana (taken by the sea), the hapū at Whitianga became Ngāti Paeakau (cast ashore on the beach), the hapū at Ōmaiō became Ngāti Horowai (the flowing waters), and the hapū at Ōtūwhare became Ngāti Terewai (the fast waters). For over one hundred years, the Hapū of Maraenui has used this name, and the remembrance name is yet to be lifted, which is why both of the names are used here (Richards & Paora, 1992). The wharenui at Maraenui is named Te Iwarau. This is to commemorate the family members who were lost in the year 1900 (kotahi mano, e iwa rau), and there is a memorial stone on the marae grounds.

The Saturday rāhui simultaneously relieve fishing pressure at the Mōtū. These rāhui are commonly referred to as ‘hāpati’ (Sabbath), as they fall on the Ringatū Sabbath (Poihipi, 2014). They are adhered to particularly well by locals, Ringatū followers, and the majority of the wider public. This may be as respect for the event, however understanding what took place and what this meant for the local community needs to be known in order for people to respect it for this reason.

Additional tikanga are taking only what you need and not wasting the kahawai, i.e. consuming the whole fish not just the fillets. Also taking care with the fish once you have caught it, bleeding it straight away and keeping it cool to avoid it cooking in the hot sun. With an increase in the number of people with freezers in the 1980s and '90s, a series of overfishing incidents started occurring. The tikanga were adapted to reduce the 'abuse' of the fishery by strongly discouraging netting and fishing at night (between dusk and dawn). Fishers are encouraged to troll for kahawai using lures rather than using baited lines. Fishers are also encouraged to stay out of the water, lest they be swept away in the fast-flowing current. Everyone is encouraged to distribute their catch with those who are less fortunate on the day. Local fishers love having a go at catching fish for other people if required. The Maraenui community also ask for fishers to drive safely on the paper road down to the river mouth and not to leave any rubbish.

The management of this fishery is carried out by the local community in their capacity as kaitiaki. Management decisions are informed by the history of the fishery, ethics, i.e. based on respect and minimising waste, and local observations.

2.2.7 Mōtū kahawai fishery management at national level

The Mōtū kahawai fishery is managed nationally via the NZ Quota Management System (QMS) as part of the KAH1 Quota Management Area (QMA) stock (Ministry for Primary Industries, 2017). The recreational fishing regulations allow a catch of 20 mixed fish (kahawai, trevally, mullet or flounder) per person per day, year-round, with no size limits. If using nets, a minimum mesh size of 90mm is required (Ministry for Primary Industries, 2014).

Customary fishers can catch kahawai for hui (gatherings), and tangi (Māori funeral ceremonies), with an authorisation from a kaumātua (elder) or member of a Māori authority (Rūnanga or Trust Board). Customary fishers apply to catch a given number of fishes for the event and then carry the authorisation while they fish and return to the authoriser to report the actual catch taken.

Mōtū kahawai fishery practices were provided for through general fishing regulations rather than customary regulations as they were not available when the restrictions were put in place. Regulation 17 of the Fisheries (Auckland and Kermadecs) Commercial Fishing Regulations 1986 prohibit commercial fishing within a 6 nautical mile radius (11.11km) from the Okatoa rocks, at 37°53.7′S and 177°32.7′E, in the mouth of the Mōtū. There are also restricted areas where particular fishing methods are banned or catch/bag limits for particular species are different. Regulation 73 of The Fisheries (Amateur Fishing) Regulations 2013 prohibits any amateur fishing except by hand line, i.e. no set nets or set lines from the 1st December to 31st March at Okatoa Rock, near the Mōtū River mouth.

In 2005, the Mōtū River along with the Mōhaka, much of the Whanganui River catchments and a number of smaller areas elsewhere, were designated as customary eel fisheries and were closed to commercial eel fishing. This was primarily to provide for spawning eel escapement but it also means that no other commercial fishing can take place in the Mōtū River above Mean High Water Springs (Graynoth et al., 2008).

In 2014, there were nine MPI staff responsible for animal welfare, forestry, emissions trading scheme, food safety and fisheries compliance in the area from Ōtamarakau-Matatā in the central Bay of Plenty, across to Paritū, Gisborne, and encompassing Kaingaroa, Te Urewera, Te Wairoa and Te Minginui forests.

2.2.8 How national and local management interacts

Monitoring and policing is central to current traditional management practices. This consists of the designated kaitiaki, or in fact any Hapū member, voluntarily educating fishers on the local tikanga, and encouraging everyone to adhere to the tikanga. There are voluntary Te Whānau-a-Apanui customary fisheries officers operating at the Mōtū who were finding it hard to police the Mōtū kahawai fishery in the 2012/13 season. During this season, groups of fishers were catching large volumes of kahawai under the recreational regulations (i.e. 20 per person per day) and were returning to the river on multiple consecutive days to repeatedly catch this number of fish. These fish were then seen being wasted, for example, baking in the sun on the back of trailers, being dumped in rubbish bins in the local township or on the side of the road, or sold illegally on Facebook or in Rotorua markets (P. Koopu, *pers. comm.*, 2013). These activities are not compliant with the local tikanga, particularly, take only what you need, and are therefore acts of disrespect towards the kahawai and subsequently the hapū. This ultimately has a negative impact on the hapū. Where possible, the Hapū will try to educate the perpetrators directly, but have experienced threats and abuse as a result, therefore it becomes a matter of safety. When warnings have been ignored, the Hapū have resorted to slashing the perpetrators car tyres and/or naming them for their crimes publicly on Facebook for the local community to witness. It is unknown how much of a deterrent these repercussions are.

Under a co-management arrangement, the intent would be that the customary fishery officers are better supported, with fishing bylaws in place which align with tikanga so all fish caught are not wasted, and tikanga are recognised and respected by all Mōtū kahawai fishers. Additionally, MPI staff would then work with the Hapū to police the fishery, particularly when fish go out of the local area and are sold.

2.3 KAH1 fishery background

This section describes the KAH1 fishery management area; the customary, recreational, and commercial fisheries, the history of the commercial fishery, and how it is managed.

2.3.1 KAH1 fishery management area

The KAH1 fishery management area (KAH1) is also shown in Figure 2-1 and runs eastward from the North Cape to the East Cape of the North Island, and then due north at these points to the limit of the NZ Exclusive Economic Zone (EEZ). The FMA1 fishery management area has the same boundaries as the KAH1 fishery management area. The fishery management areas are divided into smaller management areas called statistical areas. The Bay of Plenty coincides with statistical areas 008, 009, and 010 see Figure 2-6. The Mōtū kahawai fishery is in statistical area 010. For recreational catch estimates, KAH1 is divided further into three sub-areas, East Northland (EN), Hauraki Gulf (HG), and the Bay of Plenty (BOP).

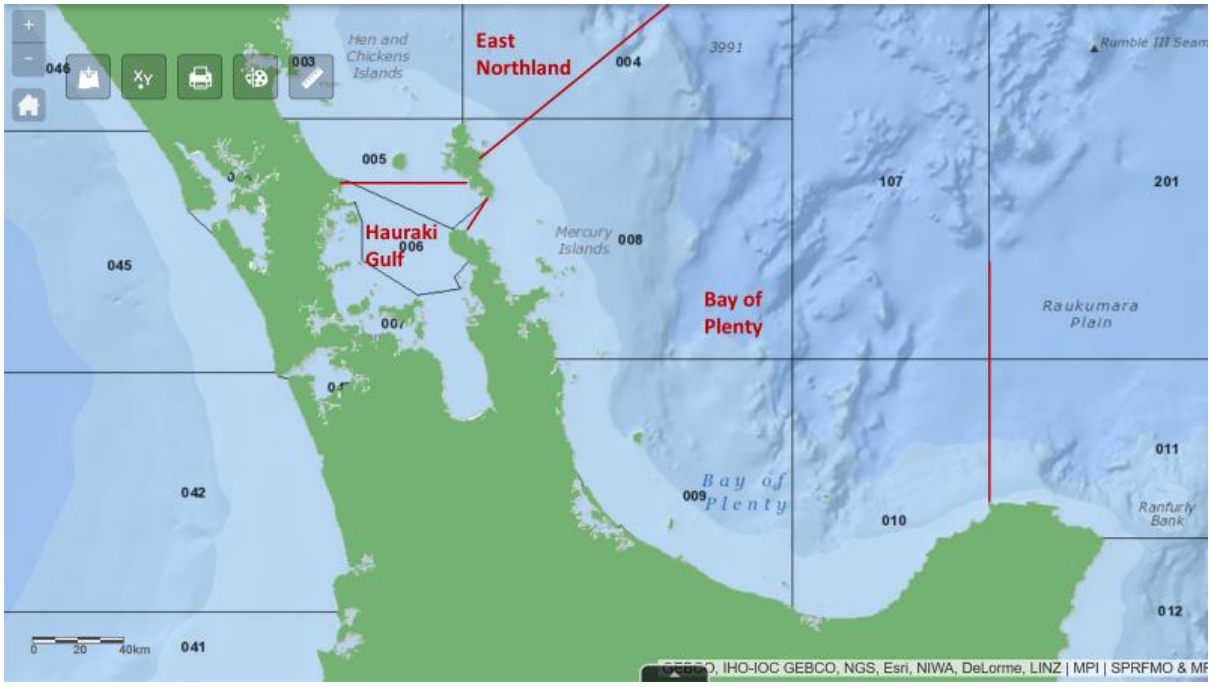


Figure 2-6 Statistical areas (outlined in black) and recreational catch estimate areas (outlined in red). Created using NABIS. This work is based on/includes MPI data which is licensed by Ministry for Primary Industries (MPI) for re-use under the Creative Commons Attribution 4.0 International licence.

2.3.2 KAH1 fisheries

2.3.2.1 Customary non-commercial KAH1 fishery

Kahawai is recognised as an important traditional and customary food fish for Māori. Other than the details provided above for the Mōtū kahawai fishery, customary non-commercial catch information is unknown (Ministry for Primary Industries, 2018). Some Māori have expressed concern over the state of their traditional fisheries for kahawai, especially around the river mouths in the eastern Bay of Plenty.

2.3.2.2 Recreational KAH1 fishery

Kahawai is the second most important recreational species in FMA1, after snapper (*Pagrus auratus*; Ministry for Primary Industries, 2017). Recreational fishers' benefits vary from use as food, to enjoyment, competitive fishing for prize money, fishing for bait for other larger fish species, and for pet food. The Ministry for Primary Industries plenary (2017) explicitly state that recreational groups continue to express concern about the state of kahawai stocks in some areas. Shore and boat-based fishing methods are used to catch kahawai. The 2011–12 national panel survey showed that kahawai were mainly caught by rod or line (93.7%), with over half of the landed catch taken from trailer boats (54.4%), and a third taken from shore (Wynne-Jones et al., 2014). Historical recreational catches are poorly known. Kahawai are caught commercially, although only fetching a low price as bait, pet food, or canned fish offshore; or as a fresh, smoked, or value-added product domestically (Ministry for Primary Industries, 2014). The Tauranga purse-seine fleet catch the majority of kahawai, during the skipjack tuna (*Katsuwonus pelamis*) off season, from June to November (Ministry for Primary Industries, 2018). Kahawai are often caught as bycatch of mackerels, as kahawai, blue mackerel-tawatawa (tawatawa, *Scomber australasicus*), trevally (araara, *Pseudocaranx dentex*) and jack mackerels (haature, *Trachurus* spp.), school together.

As shown in Figure 2-7, the commercial fishery was small up until the 1970s when snapper were depleted and a market started to open up for non-white flesh fish (Collier, 1996). A voluntary moratorium was placed on targeting kahawai by purse-seine in the Bay of Plenty from 1 December 1990 to 31 March 1991, which was extended from 1 December to the Tuesday after Easter in subsequent years (Ministry for Primary Industries, 2017). Landings in KAH1 increased in 1991-1992, and in 1993–94 the competitive catch limit for purse-seining in KAH1 was reduced from 1,666t to 1,200t. Purse-seine catch limits were reached in KAH1 between 1998–99 and 2000–01, and in 2003–04. Before the 2002–03 fishing year, a high proportion of the purse-seine kahawai catch was targeted, but in recent years approximately half of the landed catch has been reported as a bycatch while targeting other species with purse-seine gear.

Kahawai are found using a spotter plane, with an experienced pilot (35+years), who can accurately estimate school size and species mix, prior to the purse-seine boat launching their nets. The purse-seine fleet need to catch kahawai to keep the boats operating in the skip-jack tuna off-season. Mixed schools of kahawai and jack mackerels are avoided to conserve kahawai quota, particularly at the beginning of the fishing year. When mixing of the two species is

prevalent, low kahawai annual total allowable commercial catch (TACC) can result in the targeting of jack mackerel being inhibited.

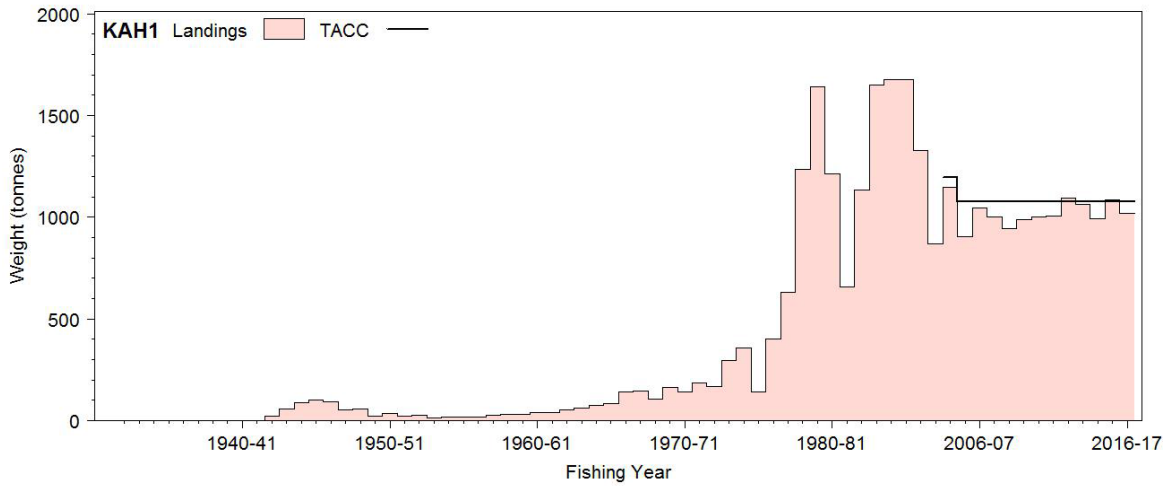


Figure 2-7 Total commercial landings and Total allowable commercial catch (TACC) for the KAH1 (Auckland-East) stock. Ministry for Primary Industries, 2018, p 631). Source: Ministry for Primary Industries and licensed by MPI for re-use under the Creative Commons Attribution 4.0 International licence. © Crown Copyright May 2018 – Ministry for Primary Industries.

There are also a small number of seasonal set net fishers operating in the Hauraki Gulf, and kahawai are caught as bycatch in long-line and trawl fisheries. Tourist fishing operators also catch smaller kahawai as live baits for big-game fishing and as a secondary recreational target species to snapper (Ministry for Primary Industries, 2017).

2.3.3 KAH1 fishery management

KAH1 is managed as a Group 1 Finfish fishery by the Northern Inshore team of Fisheries New Zealand, the national fisheries management agency. Kahawai and Kermadec kahawai are managed together in KAH1. Except its distribution, no information about the Kermadec kahawai is available. Kahawai are managed as six different stocks around NZ, and KAH1 is assumed to be one single biological stock for the purposes of stock assessment. Kahawai were introduced to the Quota Management System (QMS) in 2004. Since its introduction to the Quota Management System (QMS) the government's management decisions regarding kahawai commercial quota allocation have caused public outrage (Feldman, 2010, *accessed 20 October 2014*). The Kahawai Legal Challenge group formed to represent recreational fisher's interests in a five-year legal battle against the Fisheries Minister, and Kahawai commercial fishers, in an attempt to appeal the Minister's quota allocation decision. The lobby group were clear that what they wanted was more fish in the sea (Feldman, 2010, *accessed 20 October 2014*).

In 2010, the recreational and non-commercial customary quota allocations for KAH1 were reduced to 54% and 40% of the 2005 allocations, while the commercial allocation remained unchanged (Table 2-2, Ministry for Primary Industries, 2017).

Table 2-2 Quota allocations for Kahawai in KAH1 (green weight tonnes) in 2017. TACC – Total Allowable Commercial Catch, other mortality – bycatch in commercial fisheries, TAC – Total Allowable Catch.

Sector allocation	*KAH1 (t)*	*KAH1 (%)*
TACC (Commercial)	1,075	48.42
Other mortality	45	2.03
Recreational	900	40.54
Non-commercial customary	200	9.01
TAC	2,220	

Despite kahawai having low-value commercially, the commercial sector are allocated the highest proportion of KAH1 quota (48% total allowable commercial catch and 2% other mortality, which represents bycatch) (Ministry for Primary Industries, 2017). In contrast, kahawai is the second highest valued fish recreational fish in the region, the first being snapper, however, this sector is only allocated 41% of the KAH1 quota. The customary sector who also value kahawai highly, are only allocated 9% of the quota (Ministry for Primary Industries, 2017). These quota allocations suggest that the commercial and non-commercial sectors value kahawai equally, as they have been allocated equal proportions of the quota.

2.3.3.1 Stock assessment

CASAL (C++ Algorithmic Stock Assessment Laboratory) is an advanced software package developed by NIWA for fish stock assessment. The software implements a generalised age- or length-structured fish stock assessment model that allows a great deal of choice in specifying the population dynamics, parameter estimation, and model outputs. The KAH1 stock assessment uses an age-structured, single stock integrated stock assessment model using CASAL (Ministry for Primary Industries, 2017). The model assumes a single annual time step within which ageing, recruitment, maturation, growth, natural and fishing mortality take place. Quantitative stock assessments have estimated that the KAH1 stock was gradually fished down until the late 1970s, followed by a steeper decline that coincided with the development of the purse-seine fishery (Figure 2-8). The stock has generally been rebuilding since the early 2000s (Hartill et al., 2013). In 2010, the Minister of Fisheries set a target reference point of 52% of virgin biomass (B_0) for the KAH1 stock, with a soft limit of 20%B_0, and a hard limit of 10%B_0 (Plenary, 2018). This is based on a virgin biomass of 50 000t in 1930. In the most recent assessment, the KAH1 kahawai stock had a 94.5% probability of being above the target reference point (Ministry for Primary Industries, 2017).

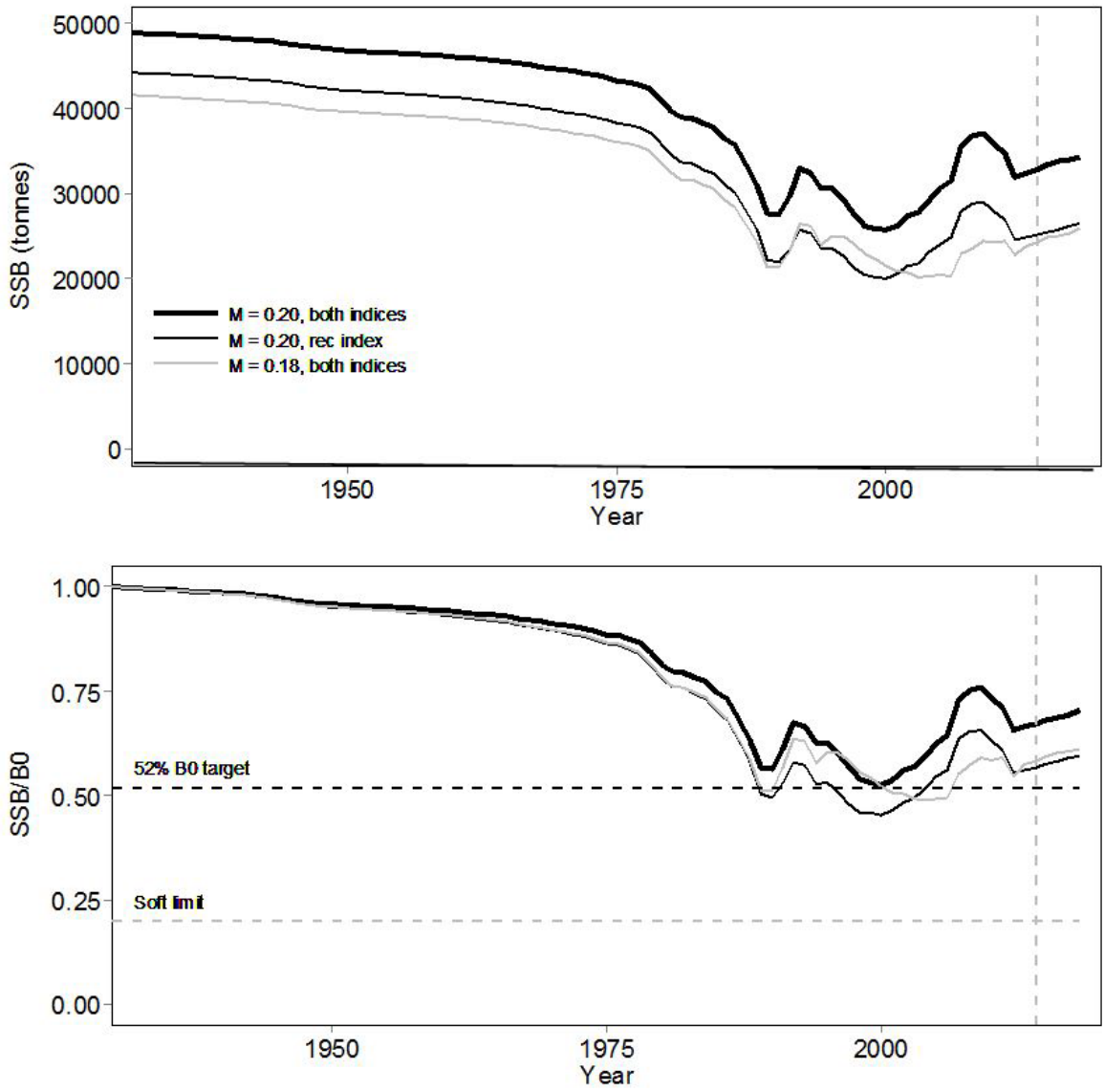


Figure 2-8 Comparison of spawning stock biomass (upper panel) and stock status trajectories (lower panel) for the base case (where M – natural mortality rate was assumed to be 0.20 and both the recreational catch per unit effort (CPUE) and sightings per unit effort (SPUE) indices were fitted in the model) and for two other calculations of M, B_0=Virgin biomass, rec=recreational. The vertical dashed line denotes first year of the projection period (2014). Source: Ministry for Primary Industries and licensed by MPI for re-use under the Creative Commons Attribution 4.0 International licence. (Ministry for Primary Industries, 2018, p 644). © Crown Copyright May 2018 – Ministry for Primary Industries.

2.3.3.2 Wider KAH1 ecosystem considerations

Fishery interactions identified for kahawai are with jack mackerel, blue mackerel, and trevally, in the purse-seine fishery. There has been no seabird or other endangered, threatened or protected (ETP) species risk assessments for kahawai fisheries. No other considerations such as: the kahawai role in the ecosystem; trophic interactions; other indicators that describe stock status; kahawai as bycatch, and fish and invertebrate bycatch of the kahawai fishery; interactions and incidental captures of ETP species (marine mammals, seabirds and sea turtles); benthic interactions; and spawning disruption; genetic effects; and habitat of particular significance to fisheries management (HPSFM), are included in kahawai management.

2.4 Discussion

In this chapter, we provided an overview of the Mōtū kahawai fishery management unit and its national counterpart KAH1. Not only are the two vastly different in temporal and spatial scale but also in how they operate. The Mōtū fishery is 100% non-commercial and kahawai are caught with handlines during summer months only, whereas the KAH1 fishery includes commercial fishing and kahawai are caught during the winter months using nets. The local fishery is managed based on ethic the ethic of respect and minimising waste, whereas the KAH1 fishery is managed based on maximising use and results in bycatch, fish caught in sub-optimal condition, or to excess in the case of the recreational regulations. There are instances where Mōtū kahawai fishery tikanga are supported by national regulations, such as the river being non-commercial and banning netting around Okatoa Rock. There appear to be no ecological ecosystem considerations in the management of the KAH1 fishery. Determining whether the commercial inshore and local land-based fisheries are targeting the same kahawai populations would help us understand the interactions between the sectors and determine the most appropriate management scale.

This chapter shared existing knowledge about the fishery that was sourced from multiple disciplines and knowledge systems, outside of standard fisheries research (life history and fish stock status). Of note, are the metaphysical considerations associated with the fishery. For many FMUs worldwide, metaphysical considerations and/or cultural institutions may not exist to the extent that they do for this fishery, or they may not have been thought about before in the context of FMUs. This information may have a strong influence on how the fishery operates and is managed locally and can inform the best spatial scale with which to manage the fishery. Therefore, we recommend including cultural information, i.e. metaphysical and spiritual considerations of the fishery, in EAFM plans if it exists, particularly in countries like NZ, with Indigenous rights and cultural interests in fisheries to support.

A report on the NSW *A. trutta* (kahawai) fishery includes a section on the cultural value of the fishery for a sub-section of Yuin people (Waddell, 2010). This is only one Aboriginal tribe, and there could potentially be a lot more cultural information for tribes in other areas of the kahawai distribution. For example, while working on the Mōtū kahawai fishery, comments and information on the cultural importance of kahawai was found for the following areas and Indigenous people: Marokopa River (Waikato-Tainui), Thames (Hauraki Māori Trust Board), Kaituna/ Maketū (Te Arawa), Rangitaiki river mouth, Thornton (Ngāti Awa), Hikuwai Beach (Te Whakatōhea), Te Kereū River (Te Whānau-a-Te Ehutu), Waiapu River (Ngāti Porou), Mōhaka (Ngāti Pahauwera), Waipāoa River (Rongowhakaata), Wairoa River (Ngāti

Kahungunu). A number of localised FMUs may be associated with each of these places mentioned above, with associated management practices and Indigenous ecological knowledge and fishing history information.

The information provided also demonstrated how kahawai fisheries are important to recreational and customary fishers in NZ, however there is very little information reported on historical catch of the recreational and customary kahawai fisheries. Removing the customary permits would remove the administration bias which currently favours fishing under the recreational regulations, however we would be left with even less data than we have now, despite this data being biased. Two other solutions could be to impose permits for all fishers, recreational and customary; or to review both sectors and redefine how they are managed collectively. Further investigation into the administration costs and the value of the information gained would help to inform such as change.

The national management strategy estimates the virgin biomass as it was at 1930. Here we describe the fishery as 600 years old, suggesting it would be more sensible to estimate the virgin biomass at a much earlier epoch. Combining the catch estimates for KAH1 based on our understanding of where the historical fisheries were located, historical NZ population sizes, and methods used in the Taking Stock project (collating archaeological data, oral histories, historical records, and catch data), would help to recreate an accurate historical record on NZ kahawai fisheries (Maxwell & MacDiarmid, 2016).

Based on this demonstration, we make the case to explore information gathering and analysis from other disciplines and knowledge systems further, to support the NZ kahawai fishery management system transitioning from the single species approach to an ecosystem-based approach and more aligned with local Indigenous fisheries management practices. In this thesis we go on to do just that. With respect to the human component of the Mōtū kahawai fishery, we look at the cultural value of the fishery to the Te Whānau-a-Hikarukutai/Ngāti Horomoana community, the Indigenous ecological knowledge associated with the fishery, and how this can inform management at the local and national levels. With respect to the ecological component of the Mōtū kahawai fishery, we further explore kahawai trophic interactions, the relationship of kahawai to ETP species (marine mammals, seabirds and sharks), and habitats of particular significance to fisheries management (HPSFM). We also look at approaches to working with Māori communities to gather and share information. In the next chapter we discuss the transdisciplinary research approach as a way to formally gather and share information in a Māori fisheries case study context.

Chapter 3 Taking a transdisciplinary research approach

This chapter outlines the research methodology adopted for this project. Research methodologies are not usually described for fisheries science so this may seem unusual, however in social science disciplines, providing a research methodology is standard. Transdisciplinary research is relatively new to fisheries research. Therefore, some effort has gone into defining this approach, among other combined research approaches. The transdisciplinary research principles are also presented as they provide good guidance for applying the transdisciplinary approach.

Here we explore the transdisciplinary research approach for its suitability in gathering and analysing information from across multiple disciplines, and knowledge systems, to support ecosystem-based fisheries co-management in a NZ context. Given that this project is being carried out by a Māori researcher and the aim is to present an Indigenous perspective on informing fisheries management, Māori research ethics and kaupapa Māori research principles also guided this research.

In the second part of this chapter, the research methodology is further defined. The kaupapa Māori research principles are presented and Te Ara Tika is provided as a Māori research ethics framework. The disciplinary methods applied to address each research question are presented and we outline how the transdisciplinary research principles were addressed.

3.1 Defining transdisciplinary research approaches

In this section combined research approaches, the principles of transdisciplinary research, and the risks of transdisciplinary research are described. Then we explain why a transdisciplinary approach was suitable for this project.

3.1.1 Defining combined research approaches

Figure 3-1 shows the defining characteristics of the most commonly used combined research approaches, i.e. multidisciplinary, interdisciplinary, and transdisciplinary (Stock & Burton, 2011). Multidisciplinary approaches apply methods from different disciplines, but these can be carried out simultaneously and independently, i.e. the research does not have to be integrated. 'Integrated' means that the various parts are harmoniously linked together. Interdisciplinary approaches are more complex in that the research process is integrated, crosses epistemological boundaries, and the research is iterative.

Transdisciplinary approaches go a step further, by sharing knowledge across multiple disciplines to address real world problems, crossing philosophical boundaries, involving non-academics in the research process, creating new disciplines and theory, and in some cases, implementing the results as part of the research process (Lang et al., 2012; Stock & Burton,

2011). The definitive features of the transdisciplinary approach, particularly crossing philosophical boundaries and involving non-academics in the research, suggest that this is the best of the three types of combined approaches to take. However, as there really are no formal boundaries for disciplines, which are constantly adopting or dropping methods, and for holism boundaries are non-existent, all combined research approaches are somewhat flexible in definition, and could be made to suit this type of research project (Stock & Burton, 2011). Based on its characteristics a transdisciplinary research is certainly the most complex approach to adopt.

	Thematically based	Involves multiple disciplines	Knowledge sharing between disciplines	Problem solving focus	Follows pluralist /more than one methodology	Iterative research process	Research integrated	Cross epistemological boundaries	Involves stakeholders in research process	Create new disciplines and theory	Implements results as part of process
Multidisciplinary	■	■	■	◪	■						
Interdisciplinary	■	■	■	■	◪	■	■	■	◪		
Transdisciplinary	■	■	■	■	■	■	■	■	■	■	◪

Figure 3-1 Defining features of combined research approaches. Filled boxes = generally includes this component, empty boxes = generally does not include this component and diagonal in boxes = may or may not include this component (Reproduced from Stock & Burton, 2011).

Nonetheless, providing clear definitions of the research activities helps simplify the research process, and make it easier to achieve the project goals, though only multidisciplinary research can develop a rigid methodological framework prior to starting (Stock & Burton, 2011). Project managers and team members need to include developing the research method into the preliminary stages of the research, and to have broad objectives that are more well-defined after the research starts, if non-academics are to be fully involved. Gaining funding to support research without a clear plan can be challenging. However, pilot studies, and prior engagement with communities to identify problems, and appropriate research methods, can overcome this challenge.

There are more challenges associated with taking a transdisciplinary research approach. With additional complexity comes additional costs, risks and competition with disciplinary inquiry for time, funds, and available expertise (Stock & Burton, 2011). Additional costs are needed for developing the societal infrastructure to support teamwork and involvement (Hogan et al., 2018). This includes providing for multiple perspectives, equal access, and distribution of benefits, and dedicated trust building to overcome conflicts (Jarre et al., 2018; Masterson et al., 2018). Although it is not always possible to overcome all existing conflicts (Trimble &

Plummer, 2018). Table 3-1 provides examples of actual challenges experienced in transdisciplinary research and coping strategies that have been previously used.

3.1.2 Transdisciplinary research principles

Lang et al. (2012) described design principles for transdisciplinary research (Table 3-1). These principles, as well as guiding questions, potential challenges, and examples of coping strategies, are provided as a guide for researchers wishing to follow a transdisciplinary research approach. The research process is broken into three phases. In Phase A, the preparation phase, the research team, objectives, and methodology are defined as part of the research process. In Phase B, the research proper, the research team is assigned work, and the research carried out. In Phase C, the research is delivered, by integrating the research, creating products, and evaluating the research impact. Across the project's lifetime, evaluation, conflict mitigation, and enhancing participation activities are carried out, providing feedback and momentum across the whole research project.

Table 3-1 Adapted from Table 2 of Lang et al., 2012 Design principles for transdisciplinary research in sustainable science and related guiding questions and Table 3 of Lang et al., 2012 Empirically derived challenges of transdisciplinary research in sustainability science including examples of coping strategies.

Design principle	*Guiding question*	*Challenges*	*Coping strategy examples*
Phase A			
Build a collaborative research team	Does (did/ will) the project team include all relevant expertise, experience, and other relevant "stakes" needed to tackle the sustainability problem in a way that provides solution options and contributes to the related scientific body of knowledge?	Insufficient legitimacy of the team or actors involved	Stakeholder mapping (expertise and interest); creating structures that enable participation
Create joint understanding and definition of the sustainability problem to be addressed	Does the project team reach a common understanding of the sustainability problem to be addressed and does the team accept a joint definition of the problem?	Lack of problem awareness or insufficient problem framing	Conduct primary study to build problem awareness
Collaboratively define the boundary/research object, research objectives as well as specific research questions, and success criteria.	Is a common research object or guiding question, with subsequent specified research object and questions, formulated, and do the partners	Unbalanced problem ownership	Joint leadership

Design principle	*Guiding question*	*Challenges*	*Coping strategy examples*
	agree on common success criteria?		
Design a methodological framework for collaborative knowledge production and integration	Does the project team agree upon a jointly developed methodological framework that defines how the research target will be pursued in Phase B and what transdisciplinary settings will be employed?	Conflicting methodological standards	Systematic comparison of methods; use demonstration projects
Phase B			
Assign and support appropriate roles for practitioners and researchers	Are the tasks and roles of the actors from science and practice involved in the research process clearly defined?	Discontinuous participation	Design projects with low thresholds for and appropriate levels of participation
Apply and adjust integrative research methods and transdisciplinary settings for knowledge generation and integration	Does the research team employ or develop methods suitable to generate solution options for the problem addressed? Does the team employ or develop suitable settings for inter- and transdisciplinary cooperation and knowledge generation?	Lack of integration Vagueness and ambiguity of the results	Application of structured and formative knowledge integration methods Specification and explicit conflict reconciliation
Phase C			
Realise two-dimensional integration (both directions)	Are the project results implemented to resolve or mitigate the problem addressed? Are the results integrated into the existing scientific body of knowledge for transfer and scaling up efforts?	Limited, case-specific solution options Lack of legitimacy of transdisciplinary outcomes	Comparative studies to derive generalisable results Consider existing socio-political context in the design
Generate targeted products for both parties	Does the research team provide practice partners and scientists with products, publications, services etc. in an appropriate form and language?	Capitalisation on distorted research results	Establish ongoing collaborative and reflexive discourse

Design principle	*Guiding question*	*Challenges*	*Coping strategy examples*
Evaluate scientific and societal impact	Are the goals being achieved? What additional (unanticipated) positive effects are being accomplished?	Tracking scientific and societal impacts	Employ advanced evaluation methodologies
General design principles (cutting across the three phases)			
Facilitate continuous formative evaluation	Is a formative evaluation being conducted involving relevant experts related to the topical field and transdisciplinary research (throughout the project)?		
Mitigate conflict constellations	Do the researchers/ practitioners prepare for/ anticipate conflict at the outset, and are procedures/ processes being adopted for managing conflict as and when it arises?		
Enhance capabilities for and interest in participation	Is adequate attention being paid to the (material and intellectual) capabilities that are required for effective and sustained participation in the project over time?	Fear to fail – pressure leads to retreat to pre-packaged solutions, knowledge-first trap blocks solution-oriented progress	Initialise actions first to stimulate researching/ learning-by-doing
The precise formulation of the design/evaluative guiding questions depends on the specific type of evaluation, e.g. ex-ante assessment, formative evaluation during the research process, or ex-post evaluation (internal or external).			

The principles are designed to help overcome the complexity of the approach by breaking the research into smaller manageable stages that guide the research towards completion. As simple as they may seem however, the nature of each research project will be entirely unique and as complex as necessary. Describing the project methodology is therefore essential to help the reader understand how the research components fit together and to determine if the approach taken is fit for purpose. Therefore, we are not only looking to describe the research methodology here, but also to assess the suitability of the research approach taken and also to provide an example for future Māori fisheries research projects.

3.2 Suitability of a transdisciplinary approach for this project

A transdisciplinary approach was chosen for this research because transdisciplinarity is open to new forms of scientific and place-based knowledge (Arroyo et al., 2019). However, in previous marine transdisciplinary research, projects have primarily focused on environmental rather than socio-economic components, and science currently dominates local knowledge (Benson et al., 2018). Knowledge systems need to be sourced equitably as socio-cultural dimensions were most frequently discussed in projects that involved the community (Arroyo et al., 2019; Martinez-Harms et al., 2018; Quintas-Soriano et al., 2018).

This emphasis on pluralism and intellectual equality between disciplines is also an appeal of the approach (Martinez-Harms et al., 2018). This means the knowledge of the community directly related to the issue can be included in the research in an empowering way. Incorporating participatory methods is also paramount to the approach, as well as a strong focus on building trust, relationships, and joint understandings. This component is further outlined in Chapter 4 (Māori engagement for fisheries research).

Another positive aspect of this approach is that the research outcomes can be very practical and have the potential to bridge the research-management-action divide (Stock & Burton, 2011; Trimble & Plummer, 2018). This is because communication around shared issues softens boundaries between stereotyped stakeholders, contributes to a shared knowledge base, and extends the toolkit for management (Jarre et al., 2018). Examples of successful research outcomes include: council operational agreements, public policy revisions, bylaw changes, the launches of several parliamentary interventions and publications with higher than average citations (Burkhardt-Holm & Zehnder, 2018; Trimble & Plummer, 2018).

Transdisciplinary research is well suited to this project as Indigenous perspectives and the EAF are derived from different knowledge systems, and a transdisciplinary approach can accommodate this. Ogilvie et al. (2018) took a transdisciplinary approach to create innovative technologies in the NZ scampi industry by applying methods from both Māori (mātauranga) and Western (science) knowledge systems. As fisheries are systems that have both human and environmental elements, integrating natural and social science research to find solutions to issues is logical. Chuenpagdee & Jentoft (2019) make a strong case for transdisciplinary approaches to both research and action to assure that fisheries, the humans that rely on them, and their communities, survive.

3.3 Mōtū kahawai fishery project methodology

In this section, we present the Mōtū kahawai fishery project methodology including the Māori research principles and research ethics, how the transdisciplinary research principles in Table 3-1 are addressed in the research, and which disciplinary methods are applied.

3.3.1 Māori research principles and research ethics

In this section we describe how the Māori worldview guides the research by applying Māori research principles and ethics frameworks. The kaupapa Māori research principles (Smith, 2012) were adopted to provide a culturally safe, respectful, and thorough way to rediscover and collate tangata whenua values, goals and perspectives. Kaupapa Māori research is research conceived, developed, and carried out by Māori, in some cases using Māori research techniques, with the end outcome being of benefit to Māori, including enhancing the rangatiratanga (self-determination) of Māori people (Walker et al., 2006). From an Indigenous perspective, this type of work is best conducted by kin insiders with the support of the Indigenous community who will benefit from the information (Cristancho & Vining, 2004). The kaupapa Māori research principles are described in Box 3.1.

Box 3.1 The kaupapa Māori research principles (Rangahau website, www.rangahau.co.nz/research-idea/27/, accessed 30 October 2019).

Tino Rangatiratanga (Self-determination) – Tino Rangatiratanga relates to sovereignty, autonomy, control, self-determination and independence. The notion of Tino Rangatiratanga asserts and reinforces the goal of Kaupapa Māori initiatives: allowing Māori to control their own culture, aspirations and destiny.

Taonga Tuku Iho (Cultural aspiration) – This principle asserts the centrality and legitimacy of Te Reo Māori, Tīkanga and Mātauranga Māori. Within a Kaupapa Māori paradigm, these Māori ways of knowing, doing and understanding the world are considered valid in their own right. In acknowledging their validity and relevance it also allows spiritual and cultural awareness and other considerations to be taken into account.

Ako Māori (Culturally preferred pedagogy) – This principle acknowledges teaching and learning practices that are inherent and unique to Māori, as well as practices that may not be traditionally derived but are preferred by Māori.

Kia piki ake i ngā raruraru o te kainga (Socio-economic mediation) – This principle asserts the need to mediate and assist in the alleviation of negative pressures and disadvantages experienced by Māori communities. This principle asserts a need for Kaupapa Māori research to be of positive benefit to Māori communities. It also acknowledges the relevance and success that Māori derived initiatives have as intervention systems for addressing socio-economic issues that currently exist.

Whānau (Extended family structure) – Whānau sits at the core of Kaupapa Māori. It acknowledges the relationships that Māori have to one another and to the world around them. Whānau, and the process of whakawhanaungatanga are key elements of Māori society and culture. This principle acknowledges the responsibility and obligations of the researcher to nurture and care for these relationships and also the intrinsic connection between the researcher, the researched and the research.

Kaupapa (Collective Philosophy) – The 'Kaupapa' refers to the collective vision, aspiration and purpose of Māori communities. Larger than the topic of the research alone, the kaupapa refers to the aspirations of the community. The research topic or intervention systems therefore are considered to be an incremental and vital contribution to the overall 'kaupapa'.
Te Tiriti o Waitangi (the Treaty of Waitangi) – Te Tiriti o Waitangi (1840) is a crucial document which defines the relationship between Māori and the Crown in New Zealand. It affirms both the tangata whenua status of whānau, hapū and iwi in New Zealand, and their rights of citizenship. The Tiriti therefore provides a basis through which Māori may critically analyse relationships, challenge the status-quo, and affirm the Māori rights.
Ata (Growing Respectful Relationships) - Āta was developed primarily as a transformative approach within the area of social services. This principle relates specifically to the building and nurturing of relationships. It acts as a guide to the understanding of relationships and wellbeing when engaging with Māori.

Te Ara Tika: Guidelines for Māori research ethics, is a framework drawing on tikanga Māori (Māori protocols and practices) for researchers, ethics committee members, those who engage in consultation or advice about Māori ethical issues from a local, regional, national or international perspective. This code of ethics is one of a range of Māori research ethics models, which has been born out of the experiences of Māori critiquing research practices and advocating for tikanga Māori to be included formally in ethical decision-making processes in research (Hudson et al., 2010). Te Ara Tika provides strategic questions to determine how a project is addressing Māori research ethics. Below we provide each question and the response for this PhD project.

1. He aha te whakapapa o tēnei kaupapa? (What are the origins of this research?)

The initial problem raised by hapū kuia (elderly woman), Daphne Maxwell, was to investigate why the kahawai came to the Mōtū River and if it was to spawn. The whakapapa is described further below in section 3.3.2 (Addressing transdisciplinary principles in the current study).

2. Me pēhea e tika ai tēnei kaupapa? (How will the project proceed correctly?)

This project follows the transdisciplinary research principles and kaupapa Māori research principles, where possible, as described above.

3. Mā wai e manaaki tēnei kaupapa? (Who will ensure respect is maintained?)

Maintaining respect is my responsibility as the PhD student, as described further below in the following chapter, Chapter 4 (Māori engagement in fisheries research), section 4.3 (Mōtū kahawai fishery engagement process).

4. Kei a wai te mana mo tēnei kaupapa? (Who has control over the study?)

This was an exercise of Hapū rangatiratanga (self-autonomy as a Hapū) as Hapū members determined the research questions, and the research was led and conducted by a Hapū member.

3.3.2 Addressing transdisciplinary principles in the current study

In this section we outline how the transdisciplinary principles noted above in Figure 3-1 were addressed for the current study.

3.3.2.1 Phase A – Defining the research

Rather than this project being the work of a collaborative research team, this study was a PhD project, i.e. one student's research. A collaborative supervisory/mentor team was created to support the PhD project (Figure 3-2). In the centre is the PhD student who started the PhD with skills in Māori community engagement and marine ecology. From left to right in the semi-circle around the PhD student are the Hapū knowledge system (mātauranga-a-Hapū) and research disciplines (kaupapa Māori, social sciences, fisheries ecology, and statistics). In the outer boxes, are the names of the supervisors/mentors and their respective expert disciplines. The PhD supervisors are experts in fisheries science, ecology and statistics. Delwyn Goodrick provided formal training on social science methodologies and methods. The rest of the relationships were mentorships. There were three mentors in fisheries management, one mentor in social science methods, and there were at least four informal mentors in kaupapa Māori research methodologies and plural epistemology research who helped occasionally.

The Hapū steering committee and Patu Maxwell advised the student on mātauranga-a-Hapū but none were obligated to be part of the research team. Erica Williams is skilled in all of the aforementioned disciplines, including working with mātauranga Māori (Māori knowledge) and was a close mentor throughout the entire research project. Other relevant stakeholders, i.e. commercial kahawai fishers, and fisheries compliance officers, were also involved in the research, but did not become part of the mentoring team.

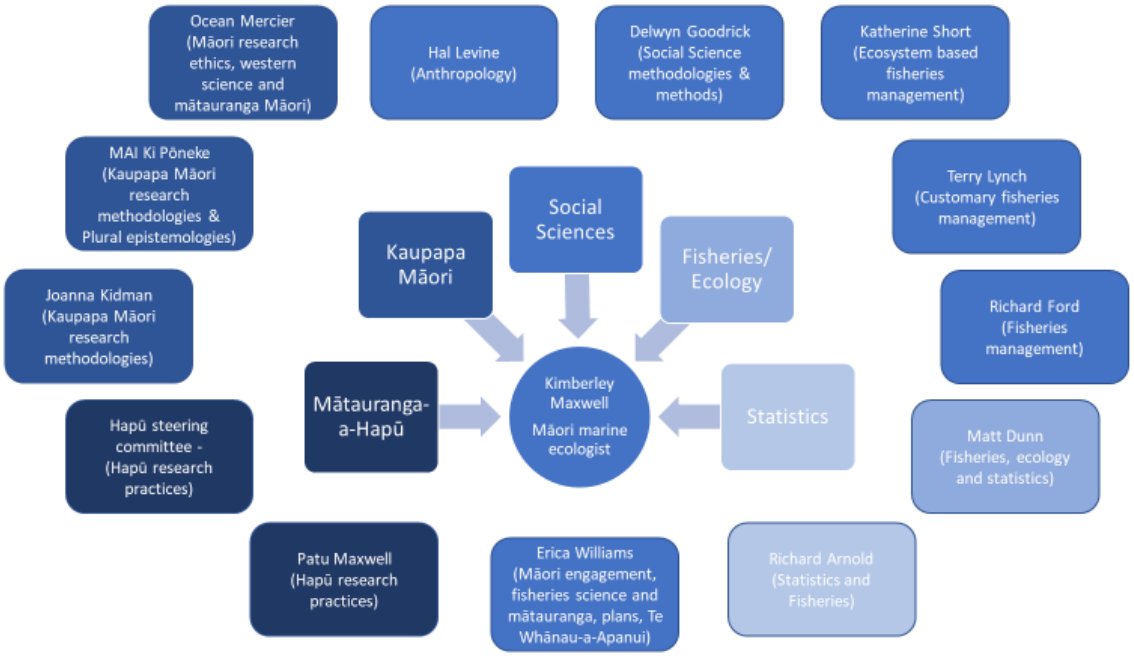


Figure 3-2 Collaborative supervisory/ mentor team (including expertise areas).

One hapū mentor has always stipulated to go home and learn about the Māori world, from my own Hapū and Iwi, through their knowledge systems, and I stand by that. For example, experiencing the Māori oral tradition, the passing down of knowledge from one to another, first-hand accounts of events the informant has participated in. The approach to this thesis was an act of this principle. This is why seeking mātauranga-a-Hapū mentorship took precedence over finding kaupapa Māori research mentorship in the first instance.

As this was the research project of a PhD student, the rest of the Phase A research principles (create joint understanding and definition of the sustainability problem to be addressed; collaboratively define the boundary/research object, research objectives as well as specific research questions, and success criteria; and design a methodological framework for collaborative knowledge production and integration) were addressed during formal supervisor meetings which were approved by the hapū, at the outset of the PhD, in order to gain Human Ethics Approval and entry into PhD candidature.

Given the number of information gaps in the Mōtū kahawai fishery, narrowing the scope of this project was necessary. The research case study started as the Bay of Plenty kahawai fishery and was narrowed down to the Mōtū kahawai fishery.

The research objectives were defined successively for each phase of the research. This was sensible as the initial problem was to investigate why the kahawai came to the Mōtū River and if it was to spawn. This is addressed in Chapter 7 (Ecological relationship between kahawai and the Mōtū) and Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery).

NIWA supported the research to provide information on Māori engagement for fisheries research methods, of which this project is a case study. This is addressed in Chapter 4 (Māori engagement for fisheries research). The original scope of the project was also to identify the key components of the Mōtū kahawai fishery to create a model of intermediate complexity of the Mōtū kahawai fishery system, based on supervisor discussions. The first part of this objective is addressed in Chapter 9 (Holistic Mōtū kahawai fishery management). Defining the fishery management unit is the first objective of developing an EAF management plan. This is the focus of Chapter 2 (History and background of the Mōtū kahawai fishery). The second objective of developing a fisheries management plan is to understand the importance of the fishery. This is addressed in Chapter 6 (Cultural values of the Mōtū kahawai fishery). During the formal social statistics training it was suggested to map the NZ fisheries management system to help understand how it can complement the Indigenous fisheries management system. This is addressed in Chapter 5 (Māori participation in NZ fisheries management).
I iteratively developed the methodological framework, with input from different members of the supervisory/mentor team on a case by case basis.

3.3.2.2 Phase B – Carrying out the research

In terms of the first principle of Phase B (assign and support appropriate roles for practitioners and researchers) only the supervisors and I had defined roles, and the hapū steering committee were asked to advise me and communicate research updates to the wider hapū at hapū meetings and any feedback back to me. The practitioners, including the hapū steering committee, participated as they saw fit. The second principle of Phase B (apply and adjust integrative research methods and transdisciplinary settings for knowledge generation and integration) was limited to applying my existing skills and what I could learn during the PhD timeframe.

3.3.2.3 Phase C – Integrating the research

Principle 1 and 2 of Phase C (realise two-dimensional integration (both directions); and generate targeted products for both parties) has seen Chapter 4 (Māori engagement for fisheries research) presented to fisheries modellers at a Sustainable Seas National Science Challenge workshop on NZ fisheries modelling held on 4 June 2019. NZ fisheries manager Richard Ford has asked that Figure 5-2 in Chapter 5 (Māori participation in NZ fisheries management) be made available for use by the Fisheries NZ organisation. Chapter 6 (Cultural values of the Mōtū kahawai fishery) has been integrated into the existing scientific body of knowledge as a Ministry for Primary Industries Aquatic Environment and Biodiversity report, and as a journal article in the NZ Journal of Marine and Freshwater Research. Research outcomes in Chapter 7 (Ecological relationship between kahawai and the Mōtū) were presented at the NZ Marine

Sciences Society Conference in 2017. Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery) and Chapter 9 (Holistic Mōtū kahawai fishery management) were presented at the MAI ki te Ao Doctoral Gathering in 2019.

The future aims are to publish Chapter 7 and 8 together in a peer reviewed journal article, to present the entire thesis in an exhibition at Maraenui and Wellington, and to mandate the Hapū plan. For more details on the plan see Chapter 9 (Holistic Mōtū kahawai fishery management).

A goal of this research is to provide clearer insights into how different sources of knowledge and practice could be synthesised at the national and local fishery management levels. The Hapū plan is the demonstrative outcome if this. During the research I became an information bridge between local and national fishery management, but the goal would be to bring the national management team and the local team together, to create a community of practice, which was not realised in this project.

During the examination process, the Te Whānau-a-Apanui examiner proposed a Mōtū kahawai fishery wānanga (place of learning), an online platform, and education resources, as products for sharing the research findings, including the Hapū plan, with interested parties. Due to the constraints of the PhD, these products are yet to be realised. Prior to, and following on from, these products being developed, the impact of the research can be evaluated in order to address the impact the products had on Phase C, Principle 3 (evaluate scientific and societal impact).

3.3.2.4 General design principles – evaluating the research

Expert driven approaches, traditionally followed in fisheries science, have been shown as barriers to collaborative cross-sectoral governance (Walsh, 2019). Most expert driven approaches are aimed at providing information as text. This is likely to be a barrier for Māori, given that Māori are apprehensive about, critical of, and disinterested in books as repositories and prefer education through the ear (McRae, 2000). Without voice, performative gesture and an emotional and informed kinship with the speaker, an oral text loses the ‘evocative resonance’ of the information. Hence the range of information provided in the prologue of this thesis and the thesis proper starting with a piece of creating writing.

Increasingly, Māori scholars are publishing books as a commitment to secure and revitalise their tribal language and traditions (McRae, 2000). With the migration of Māori away from their traditional homelands, this is meet with support of wide readership of kin who are unable to attain the information in the traditional sense (McRae, 2000; Statistics New Zealand, 2013). This gives this thesis purpose but suggests that it is not the best format to convey the information to a Māori-Crown co-governance or independent Māori governance group. Therefore, face-to-face presentations of the research findings, rather than reviews of the thesis

text, were used as a means of evaluating the research from a Hapū perspective. How the general design principles (facilitate continuous formative evaluation, mitigate conflict constellations, and enhance capabilities for and participation in the research) were addressed, is discussed in the next chapter, Chapter 4 (Māori engagement for fisheries research), section 4.3 (Mōtū kahawai fishery engagement process), and presented in Table 4-2Table 4-2 Timeline of engagement activities carried out.

3.3.3 Disciplinary methods applied in the Mōtū kahawai fishery study

A mix of qualitative and quantitative research methods from mātauranga-a-Hapū, social science, fisheries ecology, and statistics, were applied in this research project (Bickman & Rog, 2009). The specific methods used for each sub-component of the research will be further outlined in the relevant chapter as follows in Table 3-2.

Table 3-2 Chapters, aims of each chapter and the disciplines of the research methods applied in that Chapter.

Chapter	*Aim*	*Research methods*
Chapter 4: Māori engagement for fisheries research	Present a Māori engagement strategy for fisheries research	Qualitative social science (Participatory methods) Mātauranga-a-Hapū (Hui)
Chapter 5: Māori participation in NZ fisheries management	Describe how Māori can participate in NZ fisheries management	Qualitative social science (Network analysis)
Chapter 6: Hapū cultural values of the Mōtū kahawai fishery	Identify Māori cultural values for a fishery	Qualitative social science (Participatory observations, semi-structured interviews, document analysis, and thematic analysis) Mātauranga-a-Hapū (Hīkoi, wānanga, hui)
Chapter 7: Ecological relationship between kahawai and the Mōtū	Investigate the ecological relationship underpinning the fishery	Qualitative and quantitative ecology and statistics (observational study and statistical modelling)
Chapter 8: Indigenous ecological knowledge of the Mōtū kahawai fishery	Investigate the Māori knowledge of the fishery	Qualitative social science (Oral histories, thematic analysis) Mātauranga-a-Hapū (Photos)
Chapter 9: Holistic Mōtū kahawai fishery management	Identify the key components of the fishery from a Māori perspective	Qualitative social science (Oral histories and visual mapping)

The qualitative social science research methods described here include oral histories. An oral history is the collection and study of historical information using tape recordings of interviews with people having personal knowledge of past events. The NZ Department of Conservation demonstrated how recording oral histories and oral traditions can be a major asset to support

site management and build good relationships with Māori for the Ruapekapeka Pā site (Clayworth, 2010). But rather than recreate Māori oral histories within this thesis, I have drawn on Māori oral histories to identify useful information to inform local and national kahawai fisheries management. The challenge was to accurately interpret the information, which was in Te Reo Māori. Bartlett et al. (2012) points out that knowledge at its core cannot be translated out of its original language and is therefore protected.

An additional social science method applied was network analysis to track flow of information through the NZ fisheries management system. A visual of this type proved most beneficial for implementing the Northwest Atlantic Fisheries Organization (NAFO) Roadmap framework (Koen-Alonso et al., 2019). For fishing communities, social network analysis can help build human, social, and organizational capital, leading to greater resilience and sustainability (Hall-Arber et al., 2009). These types of maps can also be beneficial for presenting the flow of information through transdisciplinary research projects (Espinoza-Tenorio et al., 2013).

3.4 Conclusion

This project is guided by kaupapa Māori research principles and Te Ara Tika – the Māori research ethics framework. Within this overall worldview, a transdisciplinary research approach is taken, whereby methods from mātauranga-a-Hapū, social sciences, fisheries ecology and statistics are applied to address each research aim. We have provided a template to help guide similar types of NZ fisheries research.

As this is a PhD project, we set up a disciplinary expert supervisor/mentor support group, rather than have a collaborative expert team. This approach is useful for future student research but is unlikely to be necessary for all transdisciplinary research projects. Due to time and finance constraints, completing all of the desired project products, i.e. digital strategy, and evaluation of the scientific and social impact of these products, will need to occur beyond the life of the PhD.

We noticed that when addressing the transdisciplinary research principles for the current study, the first three questions of Te Ara Tika were also addressed. For example, the whakapapa of the research is provided in Phase A, the project will proceed correctly by following the transdisciplinary research approach, and respect is maintained by the lead researchers as demonstrated in Chapter 4 (Māori engagement for fisheries research). The fourth question, however, is particular to exercising the Indigenous right of self-determination which may be why it is not addressed in the transdisciplinary research questions.

By adding this additional question, the transdisciplinary approach lends itself well to guiding fisheries researchers who are respectful of Indigenous communities and Indigenous researchers

themselves. The approach is new to NZ and is necessary, or some form of it, to allow for multiple knowledge systems to come together to support the co-management of NZ fisheries with respect to the Treaty of Waitangi. This then supports the sustainability of the fishery, while simultaneously sustaining the use of the Indigenous knowledge system to inform the fishery management system. As this project involved tangata whenua and additional interested parties, i.e. managers and industry, engagement is the focus of the next chapter.

Chapter 4 Māori engagement for fisheries research

As described in the previous chapter, community participation is a key aspect of transdisciplinary research. Particularly when the research aims to address real-world problems within the community by drawing on their observations and experiences. Therefore we have dedicated an entire chapter to discussing Māori engagement for fisheries research. This chapter introduces engagement, and the engagement setting in NZ between Māori, government, the Hapū of Te Whānau-a-Apanui, and researchers. This chapter describes considerations when conducting Māori research engagement, how these considerations were addressed in this project, and the Mōtū kahawai fishery research engagement process followed here.

4.1 Introduction

This section defines engagement, engagement in fisheries research, and why it is sensible to engage with Māori for fisheries research. Examples of engagement guidelines for decision-making processes, the importance of Māori-Crown engagement, and examples for government engagement with Māori, are provided. We describe Te Whānau-a-Apanui governance and engagement experiences with the Crown at national and local levels. We identify Iwi management plans as useful tools for engagement preparation, and the current Māori-Researcher engagement setting.

Engagement describes a range of methods and activities used to interact with people, essentially relationships (Māori Policy Unit, 2011). The principles of good relationships are trust, respect, honesty and openness (Māori Policy Unit, 2011). These all take time to develop and require ongoing investment (Staples et al., 2014). It is important to develop and maintain good relationships when working with communities. NZ resource managers liken relationships to bank accounts, as shown in Figure 4-1. Positive experiences, trust, and confidence create deposits into relationship accounts; whereas negative experiences, or distrust, create withdrawals from relationship accounts. NZ resource managers aim to keep Māori community relationship accounts in credit to ensure public confidence in their work (Māori Policy Unit, 2011).

Fisheries research has previously focused on engaging with economically dominant stakeholders, essentially the fishing industry. They often have the resources, e.g. money, to engage with fisheries researchers, and are motivated to do so because their investments in fisheries, and livelihoods, can be impacted by the research outcomes. Effective involvement is more difficult for groups with limited resources and/or differing worldviews, with the whole process sometimes viewed as a means to an end, for gaining community support of a pre-determined plan by government and/or other large stakeholders (Dale & Lane, 1994).

Inadequate engagement with the broader community in the past has led to failure, lack of acceptance, and disengagement of the communities in the processes and plans put in place, and actual outcomes not reflecting the intended (Rockloff & Lockie, 2006; Rockloff & Lockie, 2004).

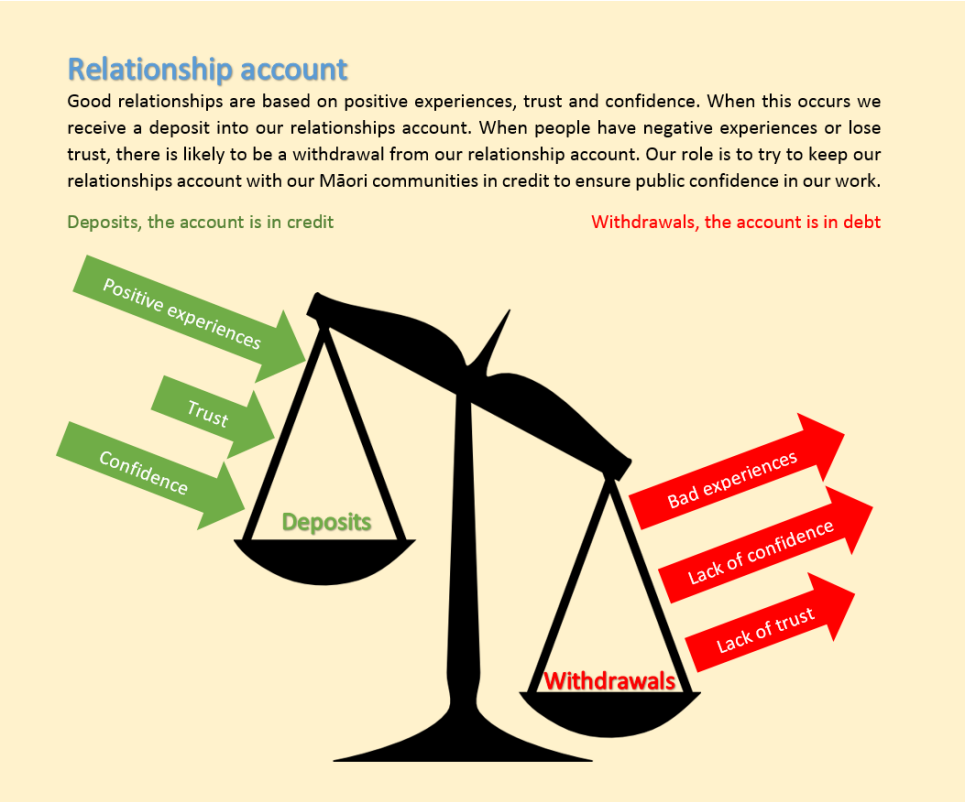


Figure 4-1 Relationship account (adapted from Figure on page 8, Māori Policy Unit, 2011). © 2018 Bay of Plenty Regional Council.

It is important to recognise the experiences and worldviews of the wider community, for example managers, policy makers, local communities, Indigenous communities, as well as industry and researchers. It is difficult to see where Indigenous communities are represented in the widely recognised EAF stakeholders diagram shown in Figure 4-2 (Staples et al., 2014). Perhaps they are not included because Indigenous communities and stakeholders differ in their rights and interests. Indigenous communities have place-based Indigenous rights, described in Chapter 1 (General Introduction), where stakeholders do not.

However, Indigenous communities may also have further interests in fisheries, or the wider environment, over and above Indigenous rights, that are similar to those interests of stakeholders. For example, Māori have become major participants in all aspects of NZ fisheries, such as commercial, customary, recreational, management and compliance, through Treaty mechanisms. As Māori are represented in all fisheries sectors and also have additional

rights as Indigenous people and Treaty partners, their involvement in fisheries research would seem paramount. Hence the focus on the Mōtū kahawai fishery, a non-commercial fishery under the authority of a Hapū, that has limited resources to manage the fishery.

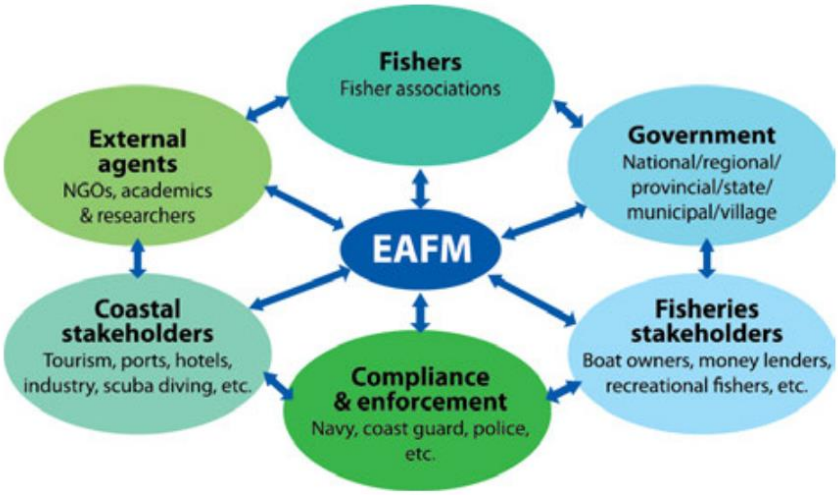


Figure 4-2 Examples of stakeholder groups (Staples et al., 2014, © FAO 2014).

Best practice guidelines have been developed to support improved community participation in decision-making processes (Dale & Lane, 1994; Dick et al., 2012; Espinoza-Tenorio et al., 2013; Michaelidou et al., 2002; Rockloff & Lockie, 2006; Rockloff & Lockie, 2004; Smith, 2012; Yandle, 2003). These guidelines can be applied in research engagement, but rather than with stakeholders, with Iwi and Hapū. For example, the EAF management-stakeholder engagement steps are (Staples et al., 2014):

1. Invite stakeholders to an initial meeting to establish a group of key stakeholders and determine the legal basis (which supports co-management with the right people).
2. Identify a champion to drive the process and motivate others, with the outcomes being excellent participation and facilitation of stakeholder workshops.
3. On-going engagement with the stakeholder group.
4. It is important to acknowledge when significant milestones have been achieved as a result of engagement.

Treaty-related policy and legislation changes are increasing the need for Māori-Crown engagement. Therefore, democratic participation and dialogue of Māori community representatives is essential to NZ fisheries management (De Young et al., 2008; FAO, 2009; Haapasaari et al., 2012). Fisheries New Zealand outline the engagement process they followed for developing the National Blue Cod Strategy 2018 shown in Figure 4-3 (Fisheries New Zealand, 2018). This figure suggests that the development of the strategy was expert led, with

wider engagement. However, it is unclear how the specific rights of Māori were recognised in this engagement process. This suggests there is room for more transparency in demonstrating how Māori engagement takes place. The processes with which Māori are engaging in NZ fisheries management are further discussed in Chapter 5 (Māori participation in NZ fisheries management).

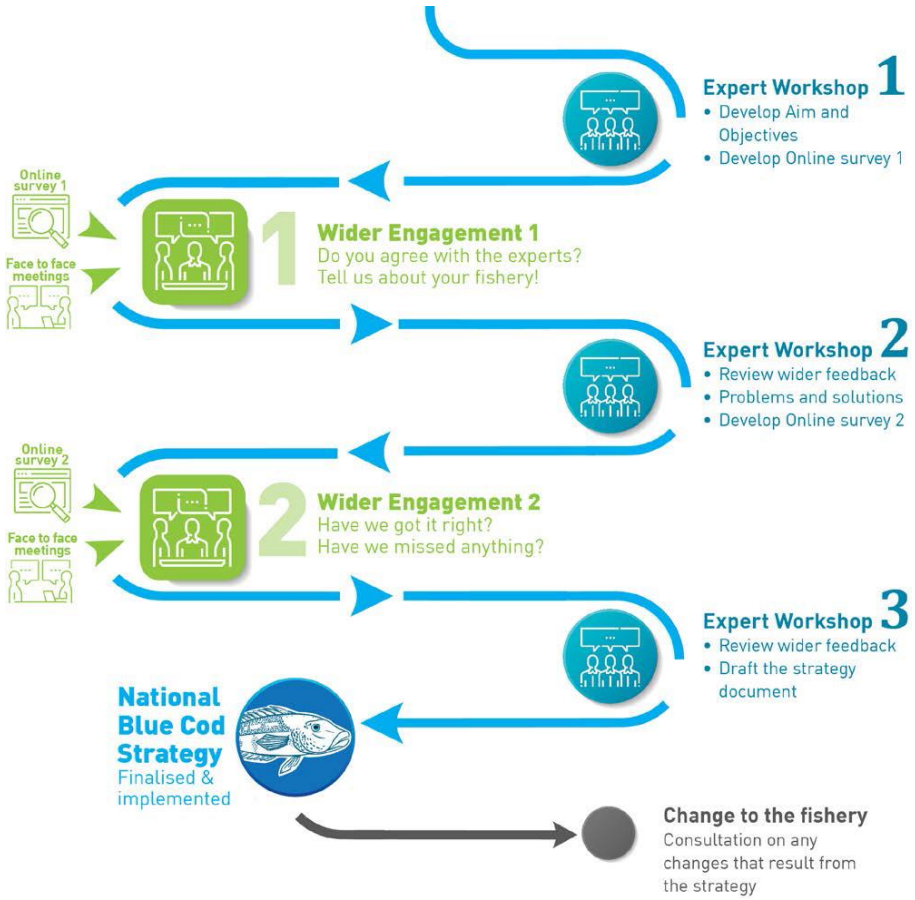


Figure 4-3 The Fisheries New Zealand National Blue Cod Strategy Engagement Timeline (Fisheries New Zealand, 2018). Source: Ministry for Primary Industries and licensed by MPI for re-use under the Creative Commons Attribution 4.0 International licence .

NZ's local government, i.e. councils, have a responsibility to foster healthy relationships with Māori (Māori Policy Unit, 2011). The majority of councils (two-thirds) provide internal training on statutory obligations, the Treaty of Waitangi, the Māori language and culture, and marae-based protocols (Local Government NZ, 2004). Council policies and practices for maintaining relationships with Māori include co-management of sites and activities; relationship agreements; consultation policies and practices; Iwi management plans (IMPs); projects, and funding. Council resources, training, and relationship monitoring includes Iwi liaison and Māori policy units; internal staff and councillor training; monitoring of relationships; and hearing commissioners.

Governance within Te Whānau-a-Apanui is at the Hapū level, with each Hapū typically having at least a marae or Hapū committee. Eleven of the 13 Te Whānau-a-Apanui hapū, including Te Whānau-a-Hikarukutai/Ngāti Horomoana, also have representation through the Iwi authority organisation, Te Rūnanga o Te Whānau. Each Hapū elects a Hapū delegate to represent them on Te Rūnanga o Te Whānau's board of trustees, and a proxy who represents the Hapū when the Hapū delegate is not available. The Hapū delegates are responsible for communicating between Te Rūnanga o Te Whānau, and their respective hapū. Te Rūnanga o Te Whānau hold monthly Hapū delegate meetings where matters addressed by Te Rūnanga o Te Whānau are discussed.

During the extended field visit in 2014, I attended a Hapū delegate meeting and learned first-hand how the council engages with Te Whānau-a-Apanui. For example, a letter had been sent to Te Rūnanga o Te Whānau from Bay of Plenty Regional Council (EBOP) regarding the Mōtū River. During a Hapū delegate meeting, the letter was read out and it asked for Te Rūnanga o Te Whānau to respond with their perspective by a particular date, which from memory was prior to the next scheduled Hapū delegate meeting. The Hapū delegates discussed the letter, stating something to the effect that they were disappointed that: the council had contacted the Iwi authority rather than the relevant Hapū committees in the first instance; that the council had not come in person; and that the council wished to receive a response in a time that was too short for Hapū delegates to raise the request at the respective Hapū or marae committee hui (meetings), have the request addressed and response motioned by the Hapū at a subsequent Hapū or marae committee hui, before bringing the mandated response back to the following Te Rūnanga o Te Whānau Hapū delegate meeting for discussion. Therefore, the letter was dismissed.

These types of government engagement practices exacerbated the Petrobras Oil Exploration protests. Petrobras was awarded a petroleum exploration permit for the Raukumara Basin, off the East Cape, in 2010. The surveying activities were met with a series of protests led by Te Whānau-a-Apanui, and environmental group, Greenpeace. Dayle Takitimu, Te Whānau-a-Apanui lawyer, stated that New Zealanders had not given the NZ government mandate to allow oil drilling. Therefore, Te Whānau-a-Apanui were lodging a complaint with the United Nations regarding the NZ government awarding the oil exploration permit prior to consulting with them. The protests resulted in a Te Rūnanga o Te Whānau skipper being arrested and boat taken off the water, as well as lawyer defence costs and downtime losses to the Rūnanga, even though the skipper's charges were later dismissed. Te Whānau-a-Apanui's view is that, 'deep sea oil exploration and drilling is a threat to one of the greatest resources that we have all

inherited and must pass on to the next generation in better condition than we found it. Te Whānau-a-Apanui will, now and forever, stand up against government recklessness if it threatens that environment, and the livelihood of future generations.' This case did not represent the NZ government working in partnership with Treaty partner, the Hapū of Te Whānau-a-Apanui, at a loss to all involved.

Māori are becoming more directly involved in local councils, particularly in Ōpōtiki District where the newly elected mayor and two new councillors are Māori. There is Māori or Iwi representation on council committees with specific rights to make recommendations, or in an advisory capacity. Some Māori organisations have formed their own committees and have established regular meetings with councillors and staff to discuss issues or concerns. EBOP have relationships based on Treaty Settlements (e.g. Kaituna River, Rangitaiki River and Te Arawa Lakes), and in accordance with the Local Government Act; three Māori seats on the Council established in 2004; a Māori committee of seven councillors established in 2006 supported by Tauranga District Council; Western BOP District Council and EBOP; a Tauranga Moana Tangata Whenua collective; support for land trusts with biodiversity projects; and a Māori commissioner on resource consent and plan review hearings; and funding to support Iwi/Hapū plan development which must be taken into account under the Resource Management Act 1991 (Local Government NZ, 2015).

EBOP appears to still have very little engagement with Te Whānau-a-Apanui governance bodies. A group applying for a resource consent to fix a culvert on State Highway 35 engaged with Te Whānau-a-Hikarukutai/Ngāti Horomoana Hapū committee regarding their planned activities and impacts of those activities to the Hapū, however no such correspondence has been reported for council activities. At this point it looks like Te Whānau-a-Apanui will have to initiate contact with councils or re-emphasise the need for the councils to have a relationship with the Hapū of Te Whānau-a-Apanui through their Treaty Settlement, which is currently in progress.

Within these processes, is a substantial amount of information available to assist fisheries researchers. Iwi/Hapū management plans (IMPs) are planning documents developed by tribal representative organisations and lodged with local authorities to support Iwi/Hapū environmental and resource management aspirations. IMPs provide useful background information for researchers planning to engage with the respective Māori entity and Iwi/Hapū responsible for the plan. Some plans include preferred means of contact, consultation and engagement, including contact details, and level of engagement sought. Alternatively, Māori engagement processes may be flexible and developed on a case-by-case basis. Māori entities

may have a website with useful background information too. However, the reading of these plans and websites should not be considered engagement with Māori by government agencies or researchers, merely background information to help prepare for engagement (D. Hikuroa, *pers. comm.*, 2018).

The Vision mātauranga (Māori knowledge) or VM policy 2005 provides strategic direction on how Māori people, resources and knowledge can help to create a healthier, more vibrant and sustainable NZ through government-funded research (Ministry of Science, Research and Technology, 2005). This includes investing in Māori-relevant research, developing Māori research capability, fostering connections between Māori, government, the science system and industry; and supporting Māori community-led research and development strategies. Since 2015, VM has been integrated across the government's science investments, which has also motivated many researchers to improve their engagement with Māori communities.

However, through personal observations, not all of these activities have been genuine, and there are researchers who engage with Māori communities in order to receive funding, rather than genuinely wanting to work together. These bad experiences can increase the distrust Māori communities already have towards scientists who come from the coloniser society, as mentioned in Chapter 1 (General Introduction), section 1.1.1 Indigenous perspectives). This further separates Māori communities from being involved in, accessing, or applying information gained from research.

This has resulted in a need for people who are able to bridge the gap between Māori communities and researchers, to overcome this distrust, not to mention the language and culture barriers. Researchers who are comfortable in both settings and are able to bridge across are stretched to capacity at present and require scientists to walk further across the bridge instead of relying on mediators to facilitate research engagement. Scientists may improve their research relationships with Māori greatly by learning from, and adapting, or engaging in the Māori-Crown engagement developments mentioned above and being genuine in their intentions.

We aim to describe a suitable way for engaging with a Māori community for fisheries research. Considerations for guiding Māori engagement for fisheries research, and the novel engagement framework followed in this research project are outlined. We argue that building and maintaining positive research relationships is an important part of fisheries research, and fisheries management, which is increasingly called for in NZ government policy to recognise the Treaty principle of partnership.

4.2 Māori engagement considerations

This section describes the key considerations when engaging with Māori: (1) identifying the appropriate people to work with; (2) agreeing on an engagement level, (3) Māori cultural competency within the research team; (4) compensation for Māori engagement; and (5) culturally appropriate research methods (Robb et al., 2015).

4.2.1 Māori entities

Firstly, it is important to uncover the complexities of Māori that are defined by this 'umbrella' term. For the purposes of census, people of Māori descent are of Māori race or a descendent of such a person. A Māori person may affiliate to a Māori whānau (family), Hapū (sub-tribe) or Iwi (tribe). Hau kāinga and tangata whenua are Māori people who affiliate to a tribal area through whakapapa, and also live there. Whereas, taura-here are Māori people who affiliate to a tribal area through whakapapa, but do not live there. Mātāwaka is a termed used to describe Māori people not affiliated to the place where they live long-term, and rāwaho are non-local people, not necessarily Māori. Each has different rights.

With that being said, it is important to engage with the correct group or individual for the respective region and level of representation. There is a wide range of Māori entities and individuals to engage with as shown in Table 4-1. Māori have multiple interests in fisheries accompanied by unique rights for engagement and recognition in fisheries management. Often, practical matters influence who agencies engage with, i.e. who is the most influential and best able to help deliver the results or objectives of the agency. However, this does not always align with the correct group.

Working with existing structures and processes is beneficial. For example, when developing the Ōhiwa Harbour Management Strategy, co-operation between Iwi (Ūpokorehe, Te Whakatōhea, Ngāti Awa, and Tūhoe) was an important step (Bay of Plenty Regional Council et al., 2015). Iwi and Hapū had their own structures in place for managing the harbour, therefore the engagement model was designed based around these existing Iwi structures. Initial scoping involved consulting with interested groups including government agencies, Iwi and Hapū and interaction between Iwi and local government preceded the initiation of the strategy. However, while these arrangements are acceptable for a management process, they may not be acceptable for a legally binding process that renders authority to one Māori entity over another. This should not be a concern in a purely research setting but should be something to consider if the research aims to support governance in the long run.

Table 4-1 Descriptions of Māori entities (Robson et al., 2001)

Māori Entity	*Description*
Iwi	Iwi or tribal entity/representatives.
Hapū	Hapū or sub-tribal entity/ representatives.
Whānau	Māori family/families.
Tangata whenua	Local Indigenous people from a particular area.
Individuals	Influential and/or powerful Māori individuals.
Marae	People representing Marae.
Māori landowners	Māori landowners or representatives of Māori landowners.
Trusts and incorporations	Trust and incorporations that represent Māori people and administer and govern their interests (e.g. trusts and incorporations that represented Māori land and landowners).
Rūnanga	The governing council or administrative group of an Iwi or Hapū.
Māori claimant group(s)	The entity representing a Māori group(s) in a Treaty settlement negotiation.
Post-settlement governance entities (PSGEs)	The entity formed to receive and administer settlement assets on behalf of a Māori claimant group.
Asset holding companies	Refers to the entity formed to hold and manage a Māori claimant group's commercial asset (obtained before and through the settlement).
Mandated Iwi organisations (MIOs)	Refers to an organisation that has met the governance criteria set out in the Māori Fisheries Act 2004, which receives fisheries assets as the mandated Iwi organisation for that Iwi.
Iwi aquaculture organisations (IAOs)	Under the Māori Commercial Aquaculture Claims Settlement Act 2004 an Iwi aquaculture organisation is also a mandated Iwi organisation under the Māori Fisheries Act 2004, authorised to act on behalf of its Iwi in relation to aquaculture claims and aquaculture settlement assets.
Iwi Chairs Forum	The Iwi Chairs Forum is a collection of Iwi chairpersons and leaders that meet quarterly to discuss Māori aspirations in the spheres of cultural, social, economic, environmental and political development. The Forum regularly invites Crown representatives, Members of Parliament and stakeholder and community groups to present at hui on projects and issues that concern Iwi. All Iwi chairpersons have an open invitation to participate in, and contribute to, this group.
Iwi Leaders Group(s)	Iwi Leaders Groups are established through the Iwi Chairs Forum on particular kaupapa (topic) to engage directly with Iwi, Hapū and Government. Their meeting schedules and agenda depend on the nature of the kaupapa. Iwi Leaders Groups host regional hui as required, and report to the Iwi Chairs Forum at their quarterly hui.
Māori representatives on advisory boards	Māori representatives that are placed on advisory boards to represent Māori interests and/or specific Iwi/Hapū interests.
Māori sector groups	Māori entities that represent specific sectors and interests (for example the Federation of Māori Authorities, Māori Tourism).
Māori authorities	Some agencies mentioned urban Māori authorities as an important stakeholder, particularly around their role in representing urban Māori populations and interests. Although none of our interviewees stated that they engaged with urban Māori authorities, they did note that they are an important Māori entity for engagement.

Māori are changing how they organise themselves with more amalgamation and collaboration. Māori groups and interests are consolidated within Māori business and Māori economy settings because of the benefits. For example, the Iwi Collective Partnership (ICP), Moana NZ, and Wakatū Incorporation are all Māori fisheries and aquaculture businesses recognising the interests of multiple Iwi. This way Māori entities share costs, resources, expertise, capacity and capability to reduce the administrative burden and pressure to perform while also creating sufficient scale to ensure competitiveness. This can also put them in a better position to engage in research. At present, Te Rūnanga o Te Whānau manage their own subsidiary fishing company and have their own administration team supporting their subisdiaries. They are yet to access all of Te Whānau-a-Apanui quota share revenue from Te Ohu Kaimoana, but doing so will free up significant Te Whānau-a-Apanui assets.

4.2.2 Engagement levels

Short of community control, which is often difficult to obtain, partnership arrangements such as co-governance and co-management are highly sought after by Māori, in order to recognise their self-determination (Robb et al., 2015). Particularly as Māori and other Indigenous peoples are also looking to gain more autonomy and control over how their knowledge is accessed, applied in answering the research question, and retained for the future. This power-sharing is difficult to balance if the research contract is with the research organisation and not the Māori entity. The level of community involvement, power-sharing and formality can also vary in research relationships. It is important for the researcher/s and the community to agree on a suitable level of engagement for the project.

There are multiple levels of engagement as shown in Figure 4-4, with increasing levels of community involvement, power-sharing, and formality. Lower levels of engagement are either: informative, where the community is informed of decisions the government has already made; consultative, where the government consult but then make all of the decisions; co-operative, with community input into management; and communicative, involving two-way information exchange (Staples et al., 2014). While at higher levels of engagement there are community advisory committees, management boards and partnerships with joint decision-making; or community control with the government being advised of decisions (Local Government NZ, 2007, 2011; Māori Policy Unit, 2011; Staples et al., 2014). Some forms of engagement are structured and specific, while others are open and flexible.

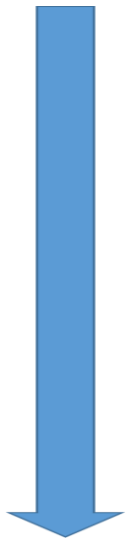
 Increasing levels of Māori community involvement, power-sharing and formality in resource management	Whakamōhio – Inform	Informing	Community is informed about decisions already made
	Whakauiuia – Consult	Consultation	Start face-to-face contact, community input heard but not necessarily heeded
	Whakaura – Involve	Co-operation	Community starts to have input into management: e.g. use of local knowledge, research assistants
	Mahi ngātahi – Collaborate	Communication	Start of two-way information exchange, local concerns begin to enter management plans
		Advisory committees	Partnership in decision-making starts, join action or common objectives
	Whakamanahia – Empower	Management boards	Community is given opportunity to participate in developing and implementing management plans
		Partnership/ Community control	Partnership of equal, joint decision-making institutionalised, power delegated to community where feasible

Figure 4-4 Increasing levels of Māori community involvement, empowerment and formality in resource management. Adapted from Local Government NZ, 2007 and Māori Policy Unit, 2011. © 2018 Bay of Plenty Regional Council.

4.2.3 Māori cultural competence

Cultural competence is being able to interact effectively with people of different cultures, by being aware of one's own culture and attitude towards cultural difference, knowledge and sensitivity of different cultural practices and the ability to use cross-cultural skills (Waitemata District Health Board (WDHB) - Asian Health Support Services, 2010). Researchers who have an understanding and appreciation of the Māori worldview, values, and ethics regarding mātauranga Māori (Māori knowledge) are better placed to develop positive research relationships with Māori. Those with Te Reo Māori skills are even better placed still. Often Te Reo Māori and Tikanga Māori are taught together.

Rata (2012) developed the Waka hourua (double-hulled canoe) research framework for researcher-community engagement. The waka components, and wider environmental elements used to navigate the waka, all represent engagement components required for success, such as

experts, values and respect. Rata (2012) stresses that the whole waka, i.e. all components, are required for success, not just picking some. Within the crown research sector there are accounts of researchers and Māori successfully navigating ethics and intellectual property on a routine basis with good-will and mutual benefits being made (Waitangi Tribunal, 2011).

4.2.4 Compensation and koha

Limited investigation has been carried out on compensation for participation in research. However, in health research there have been a few studies which found that busy physicians are more likely to complete a study when they receive monetary compensation, compared with those who are offered school credits, suggesting that monetary compensation is vital particularly in intense research programs where projects are ambitious, and require significant time commitments (Young et al., 2011). In addition, for vulnerable populations, such as drug-using or HIV-positive populations, compensation can often be critical in determining an individual's participation and experience with research (Collins et al., 2017). However, compensating people for participation in research is contentious, due to concerns regarding its impact on incentivising participation, particularly for vulnerable populations with financial motivations, such as drug-users. Therefore, restrictions around compensation for research have been implemented, in order to 'protect' these vulnerable people.

Voluntary participation, i.e. free from manipulation, coercion, inducement or any other undue influence, is a key aspect of consent (Ministry of Health, 2002). Coercion, inducement or intimidation takes many forms and may occur directly or indirectly through financial or other rewards (such as promises of treatment), exploiting the vulnerability of individuals, or the influence and status of the researcher. Reasonably reimbursing individuals for participation costs is acceptable, so long as these reimbursements don't induce participation, thus compromising the voluntary nature of participating.

Collins et al. (2017) argued that research compensation practices needed to be evaluated to ensure they were equitable. For example, despite having identical clinical trial protocols, standards for compensation varied substantially across 69 Independent Review Board approved Informed Participation and Consent Forms (Kimberly et al., 2006). Of the 48 trials offering compensation, monetary compensation was offered by 33 as reimbursement for travel, parking or food expenses, whereas monetary or material compensation was offered by 22 for subject inconvenience, and by 13 for subject time (Kimberly et al., 2006). The value also varied widely, between US$180-$1425 for study 1, US$0-$500 for study 2, and US$0-$100 for study 3 (Kimberly et al., 2006). Therefore, in the interests of both ethics and statistical inference,

further investigation into research compensation, to support standardisation and transparency in the compensation of participants in clinical trials, is warranted (Swanson & Betensky, 2015). In addition to the international debate on the acceptability of compensation for research participation, is the acceptability of koha in research engagement. The University of Waikato Te Manu Tāiko Human Research Ethics Committee, Te Pua Wānanga ki te Ao – Faculty of Māori and Indigenous Studies, and Te Kotahi Research Institute Application for Human Research Ethics Committee Approval Form 2017, asks applicants if participants will receive material benefits from the research, such as payment of any kind for taking part, or reimbursement of expenses. The form notes that researchers in the Faculty of Māori and Indigenous Studies are encouraged to consider giving 'koha' in the form of kai (food), to participants. This form is based on Te Ara Tika, guidelines for Māori research ethics, however koha is not discussed at length in this document. Rather it refers to the NZ Ministry of Health Operational Standard for Ethics Committees (Ministry of Health, 2002), where koha are described as a traditional acknowledgement of the knowledge and/or hospitality extended by tangata whenua to manuhiri (guests).

Traditionally, food certainly was the most well-known form of koha for all instances, and even today when visiting whanau (family), food is typically exchanged as a form of koha. But during my lifetime, money has replaced food in more formal settings. The money is collected by a quick whip around the manuhiri (visiting group) and placed in an envelope, to be presented to the hosts as part of a pōwhiri (welcoming ceremony) onto a marae, or other venue. In keeping with this practice, the Ministry of Health (2002) indicate that koha may be offered in line with the cultural norms of the researchers and/or participants in research. The guidelines go on to state that koha should not be confused with payments to participants. The NZ Inland Revenue Department, which manages NZ taxation, has also developed the Payments and Gifts in the Māori Community guidelines, which address the treatment of koha as a non-payment. Therefore, including koha in research participation processes where it is culturally normal, is provided for in NZ's research ethics and taxation practices.

Again, these guidelines are largely centred on health research, and certainly require more investigation in the environmental research space. Groups in more remote areas, or with less infrastructure and capacity, may be highly in need of the benefits of the research and may therefore provide in-depth knowledge that can help improve the research impact, but are too expensive to engage with compared with groups situated in close proximity to the research organisations or in urban areas. A consistent compensation practice which also accounts for

these factors, would potentially prevent further marginalisation of remote community groups, and biases which community groups are continually participating.

Based on my previous 10 years of environmental research experience working in NIWA's Māori environmental research group, Te Kūwaha, every community we engaged with felt that there was an imbalance of funding that was received by the research organisation conducting the research, and the community who participated in the research. The community who typically volunteered their time and knowledge, despite the research being impossible to conduct without them. Māori entities will often coordinate, host and facilitate events and provide valuable information. Reimbursement for these activities is considered appropriate.

Engagement is rarely included research proposals and reimbursing people for their contributions is often overlooked when developing research budgets. Therefore, efforts were increasingly made to have community reimbursement for engagement included in research proposal budgets as standard practice. Asking the Māori entity what they consider to be appropriate reimbursement would improve this aspect of research engagement. If working with a predetermined research budget, then often what can be afforded is a good guide. If similar activities are held throughout the research, then those budgets can be used as a guide too.

4.2.5 Māori research methods

It is important to stay open to adapting the research methods to suit both the researcher/s and the community. Discussing research methods with the community prior to starting the research ensures the most suitable methods are selected and that those methods are compatible with the communities' values and ethics. For example, the kanohi-kitea (seen face) principle of the kaupapa Māori research framework acknowledges that kanohi-ki-te-kanohi (face-to-face) meetings are preferred in Māori society, over other means of contact (Smith, 1999). The community may also have their own research methods they wish to use. For example, hīkoi (travelling, walking/talking workshops) were used in the Manaaki Taha Moana Horowhenua research project to facilitate relationship-building and networking between researchers, local communities and Iwi (Hardy et al., 2015).

4.3 Mōtū kahawai fishery engagement process

In this section, we describe how Māori engagement considerations were addressed in the current project. Then we detail the engagement process which was applied in the current research project.

4.3.1 Addressing Māori engagement considerations

In this research, a three-person Hapū steering group was formed and the members provided cultural input and feedback on the research process. For example, the steering group members

encouraged the principle of 'Kaua e whakamā – don't be shy,' when conducting the research. Compensating the Hapū and research participants for their contributions and facilitation of the research was factored into the budget of this project prior to the research being funded and conducted.

The research methods were often guided by the Hapū, in terms of including hīkoi as a method, and setting up a lab at the beach, and at the marae. The Hapū were heavily involved in information sharing, and kahawai sampling. Opportunities to train and work with research assistants and engage with kōhanga reo (Māori language preschool), primary schools/kura, wharekura (Māori language secondary school), and whare wānanga (place of higher learning) activities relating to the kahawai were particularly beneficial for involving younger generations in the research.

4.3.2 Engagement process

The engagement process followed in this project is outlined in Figure 4-5. There were six engagement objectives: relationship building, information sharing, reviewing midway results, ecology field sampling, management process, and reviewing final results. As I was based in Wellington and needed to travel to the Mōtū River area to carry out engagement, there were short or extended field visits associated with each objective, with specific activities carried out for achieving each objective. The Hapū were involved in all the research engagement activities in blue, and the national fisheries managers were involved in the management process activities in green.

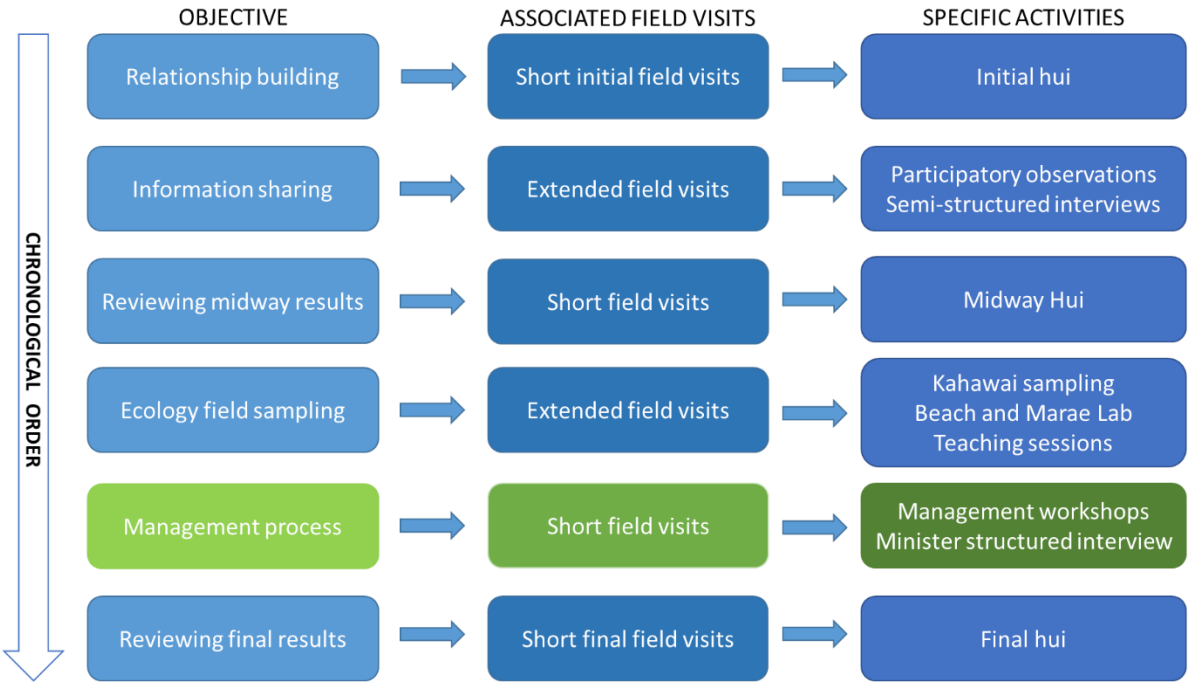


Figure 4-5 Engagement process for the research.

4.3.2.1 Relationship building

In this project, a research relationship with TWAH/NH already existed through a prior research project, surveying the Mōtū River eel populations. When developing the Mōtū River eel study that was carried out in 2009, Rikirangi Gage, the chairperson of Te Rūnanga o Te Whānau, the governance entity acting on behalf of 11 Te Whānau-a-Apanui Hapū, confirmed that the TWAH/NH Hapū committee was indeed the appropriate representative group to approach in the first instance, from the Te Whānau-a-Apanui perspective. The Mōtū River is in their rohe (territorial area), and the Hapū is the main operational level of mana (authority) for Te Whānau-a-Apanui. Therefore, when it came to identify and engage with the appropriate Māori entity at the outset of the Mōtū kahawai fishery research it was straightforward because of the existing relationship.

The overall timeline of engagement activities is shown in Table 4-2. The research relationship with the Hapū for this specific project was further developed over six initial field visits, between September 2013 and March 2014. Over this time, the research methods, budget, and resources were discussed and approved by the Hapū (recorded in hui minutes, 30 March 2014). The research was introduced to the wider community, who were interested in the Mōtū kahawai fishery, at two Mōtū kahawai fishery management hui, and as an article in the local newspaper (Thatcher, 2014). In between field visits, progress updates were made with the Hapū steering group via phone and email and with the interview participants via phone, email, and mail. The steering group members also communicated progress to Hapū members throughout the project (Dale & Lane, 1994; Rojas-Nazar, 2013).

4.3.2.2 Information sharing

Regarding transdisciplinary general research principle 3 (enhance capabilities for and participation in the research), the majority of the research was carried out in the Mōtū River area where the Hapū are located. The information sharing engagement relating to a particular chapter are further described in that respective chapter. Participatory observations and semi-structured interviews are described in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery). This extended field visit at Maraenui allowed time for the participants to share in their own ways. For example, by inviting me to participate in school fishing trips. This was a unique experience that was Hapū led. Ecology field sampling activities are described in Chapter 7 (Ecological relationship between kahawai and the Mōtū), section 7.2 (Methods). During these field trips, a lab was set up at the beach and marae. This allowed fishers to offer their kahawai catch as samples for the study, and to help with the sample processing. During these times, interested people were able to query us about the research first-hand, and offer their own

perspectives on the Mōtū kahawai fishery. The management process activities were carried out with fisheries researchers and managers as described in Chapter 5 (Māori participation in NZ fisheries management), section 5.2 (Methods). This took place at times and locations convenient to the managers to ease their participation.

4.3.2.3 Reviewing midway results

To address the transdisciplinary research approach general design principle 1 (facilitate continuous formative evaluation), the research was evaluated through research presentation and review throughout the project. Feedback on midway results was sought from the Hapū and the Bay of Plenty Iwi Fisheries Forum (Table 4-2). The Ministry for Primary Industries (MPI) financially supported this research through the MPI Customary Fund. Therefore, the Aquatic Environment Working Group (AEWG) members formally assessed and approved the research methods and results of Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery). Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery) was then developed into a New Zealand Aquatic Environment Biodiversity Report and a New Zealand of Marine and Freshwater Research journal article. The report and manuscript were reviewed by members of the Hapū, prior to the report being reviewed by MPI staff as part of their review process, and the journal article was reviewed by the journal reviewers as part of their quality assurance practices. This research was also assessed and approved by PhD examination committee in written and presentation form on 2 September 2019.

4.3.2.4 Reviewing final results

The reviewing final results activities are outlined in Table 4-2 below, and are further described in Chapter 9 (Holistic Mōtū kahawai fishery management), Section 9.2 (Methods). There was still interest in the research at the end of the project with 24 people planning to attend the final hui, 16 attended (Table 4-2). This hui was conducted prior to submitting this thesis for examination and created a community call to take the findings further.

General research principle 2 (resolve conflict constellations) was avoided as I engaged with the national fisheries management collaborators and the hapū collaborators independently of each other. This was for practical reasons, i.e. the hapū are located in Maraenui and the managers located in Wellington, but also meant that there were no conflicts to mitigate during the research.

Table 4-2 Timeline of engagement activities carried out.

Date	*Activity*
1 September 2013	Short initial visits with Te Whānau-a-Hikarukutai/Ngāti Horomoana Hapū start for Mōtū kahawai fishery research relationship building.
1 October 2013	NIWA Engagement formalised as a contract (Erica Williams, Alistair Dunn, Julie Hall).
1 April 2014	Information sharing with Te Whānau-a-Hikarukutai/Ngāti Horomoana, Maraenui community and Mōtū kahawai fishers starts for Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery).
1 December 2014	Ecology field sampling starts for Chapter 7 (Ecological relationship between kahawai and the Mōtū).
18 December 2014	Commercial sector engagement starts with Iceman, Gibbos, Sanford, and Moana New Zealand) for Chapter 7 (Ecological relationship between kahawai and the Mōtū).
31 July 2015	Hapū hui to review midway results, Maraenui Marae.
3 August 2015	BOP Iwi Fisheries Forum meeting to review midway results.
14 October 2015	Aquatic Environment Working Group meeting to review midway results.
15 December 2015	Report based on Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery), reviewed by Richard Ford (MPI). Maxwell, K. H. and Te Whānau-a-Hikarukutai/Ngāti Horomoana (2015) Tangata whenua values and perspectives of the Kahawai fishery in the eastern Bay of Plenty. New Zealand Aquatic Environment and Biodiversity Report No. 2973 Ministry for Primary Industries, Wellington New Zealand.
9 May 2018	NIWA Fisheries management workshop 1 (3 people).
23 May 2018	NIWA Fisheries management workshop 2 (2 people).
1 June 2018	Manuscript (i.e. Chapter 6 Hapū cultural values of the Mōtū kahawai fishery) reviewed by Chris Hepburn (New Zealand Journal of Marine and Freshwater Research).
12 June 2018	NIWA Fisheries management workshop 3 (3 people).
17 June 2018	Qualitative model workshop 1 (2 people).
19 June 2018	NIWA Fisheries management workshop 4 (4 people).
22 June 2018	Qualitative model workshop 2 (2 people).
29 July 2018	Hapū reviewing final results hui, Maraenui marae (16 people).
1 August 2018	MPI Fisheries management workshop review meeting with Richard Ford, MPI Office Wellington
13 August 2018	MPI Fisheries management workshop review meeting with Richard Ford and Terry Lynch, MPI Office, Wellington
19 October 2018	Chapter 5 (Māori participation in NZ Fisheries management) and Chapter 9 (Holistic Mōtū kahawai fisheries management) reviewed by Richard Ford and Terry Lynch (MPI)
29 November 2018	Interview with Minister of Fisheries, Hon. Stuart Nash.
1 April 2019	PhD under examination (3 examiners)
2 September 2019	PhD oral examination (3 examiners)

4.4 Discussion

Engagement is about developing and maintaining positive relationships from the beginning of the research through to the end. In this chapter we identified considerations for working with Māori in fisheries research. These considerations are working with the correct Māori entities with the authority in an area, agreeing on an appropriate engagement level, increasing Māori cultural competence of the research team, compensating people for their contributions to the research, and considering applying Māori research methods, of whom the respective Hapū are the experts.

Next, we described how these considerations were addressed in the current study. Then we demonstrated how engagement with TWAH/NH Hapū members, and NZ fisheries managers was achieved through relationship building, information sharing, and reviewing results. Hapū members, fisheries managers, and fisheries researchers all initiated their respective research components, approved and guided the respective research activities, participated in the research, and evaluated the research findings. By working with these groups independent of each other conflicts were avoided, and I became a bridge between the science, management, and community. However, an opportunity was missed to create a community of practice. This can be developed further, beyond the PhD. This addresses the transdisciplinary research approach general design principles 1 (facilitate continuous formative evaluation), 2 (mitigate conflict constellations), and 3 (enhance capabilities for and participation in the research).

It is important to get engagement with Indigenous communities in fisheries research right, because of Indigenous people's rights, particularly in NZ. Treaty-related policies and legislation require increased Māori-Crown and Māori-Researcher engagement. Developments in Māori-Crown engagement can provide important lessons for researchers. The research will benefit from the research team understanding the Māori culture and language, identifying the correct entities to work with, discussing and agreeing on appropriate levels of community involvement, power-sharing, and formality, on compensation for engagement, and culturally appropriate research methods, at the outset.

The information sharing activities of this research project probably started a lot earlier than what would happen in a typical research project, with no prior relationship, because of the existing personal and professional relationships between the researcher, the TWAH/NH Hapū committee, and the Hapū. Developing research relationships can be a costly and time-consuming part of a research process especially if there is no relationship prior. Therefore, if a relationship is developed, its maintenance should be supported, in between, as well as during research programmes. This highlights the benefit of building on existing relationships for

research. The engagement considerations and process followed in this project are provided as a guide for fisheries researchers intending to work with Māori communities in the future.

This is the end of Part I (Upoko), setting the scene. Next, we move on to Part II (Tinana), the original thesis contributions. In Chapter 5 (Māori participation in NZ fisheries management) we look at how information flows through the NZ fisheries management system, and we discuss the different tools available for Māori to inform the system, and exercise self-determination through fisheries management. Then in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery) we identify why the Mōtū kahawai fishery is culturally important to the Hapū and apply an international assessment tool to determine that the kahawai is a CKS for Te Whānau-a-Hikarukutai/Ngāti Horomoana. In Chapter 7 (Ecological relationship between kahawai and the Mōtū), we investigate why kahawai migrate to the Mōtū River mouth in austral summers. Lastly, in Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery), we look back at the information collected in the previous two chapters to demonstrate that where CKS are concerned, Indigenous communities hold in-depth ecological knowledge which is consistent with the findings of time-consuming ecological field studies, and should be considered in lieu of such studies, if the principle of decision-making based on best information available is to be followed.

PART II – WAHANGA RUA

TINANA

Chapter 5 Māori participation in NZ fisheries management

In this chapter there are four sections, first providing context on informing fisheries management decision-making, second the methods followed to understand the flow of information through the NZ fisheries management system, and the tools available to support Māori customary fisheries and wider ecosystem management. Third, what we found about the flow of information and Māori management tools, and lastly a discussion of the findings.

5.1 Introduction

There are multiple ways for Māori to inform decision-making in the NZ fisheries management system, reflecting the multiple interests Māori have in fisheries. On a global level, this appears to be a great advancement in government support of Indigenous rights. However, for Iwi and Hapū to effectively participate in all avenues that are, in principle, available to them, would be an arduous task. Therefore, Māori need to find the most affordable and time-efficient means of informing decision-making, that will best address their needs.

There is also the question of whether the NZ fisheries management system is operating holistically. An 'ideal' inter-agency co-operation and consultation framework for EAF is shown here in Figure 5-1 (Staples et. Al, 2014). In this framework, the EAF fisheries agency is at the centre, disconnecting fisheries stakeholders, small-scale fisheries, and large-scale fisheries, from the environmental agency, and other coastal and offshore interest groups, who do have direct engagement with the environmental agency. Under this framework, the engagement is unbalanced, with the environmental agency working directly with coastal and offshore interest groups with fisheries groups being one step removed from direct engagement. This framework contrasts to the equal power-sharing and decentralised management objectives that EAF literature calls for (FAO, 2003). Staples et al. (2014) framework also lacks a position for Indigenous communities. This sparks the question: How are Indigenous communities involved in fisheries management?

There are examples of how the Australian and Canadian government facilitates Indigenous community involvement in fisheries management. For example, in Australia, government agencies are learning more about Indigenous fisheries so they can support the development of policy and management initiatives to meet the needs of Indigenous fishers and other stakeholders (Schnierer & Egan, 2016). Also to empower Indigenous communities to provide input into fisheries decision-making processes about management of cultural fisheries (Schnierer, 2011). The Northern Territory government aims to support sustainable, culturally appropriate, business and employment opportunities for Aboriginal communities in fisheries

management, research, development, training, industry participation and resource protection (Northern Territory Government, 2012).

In 1990, the Supreme Court of Canada issued a landmark ruling in the Sparrow decision, finding that where an Aboriginal group has a right to fish for food, social and ceremonial purposes, it takes priority, after conservation, over other uses of the resource (National Indigenous Fisheries Institute, 2018). The Supreme Court also indicated the importance of consulting with Aboriginal groups when their fishing rights might be affected. In response, an Aboriginal Fisheries Strategy was launched in 1992, reviewed in 2002, and a review of all Fisheries and Ocean Canada's Indigenous programs began in 2017. To date the review has found growth of Indigenous capacity and identified steps to improve and grow the programs. These improvements included shifting to a shared capacity model with Indigenous groups and continuing to build co-management capacity by investing in Indigenous knowledge systems, and using aquatic resource and oceans management group science, data, and knowledge (National Indigenous Fisheries Institute, 2018).

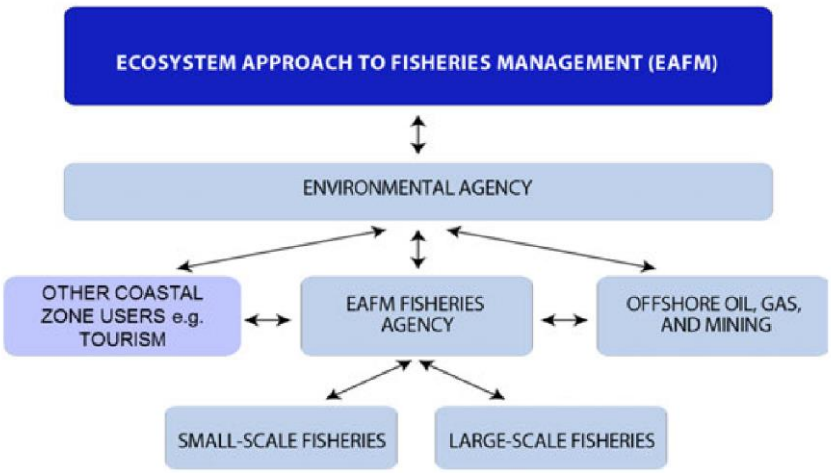


Figure 5-1 An 'ideal' inter-agency cooperation and consultation EAF framework (Staples et al., 2014). © FAO 2014

The aim of this chapter is to understand how Māori can best inform NZ's national fisheries management decision-making and utilise the instruments available to them to support Māori customary fishing interests. In this chapter we describe the NZ fisheries management system, the instruments available to support customary fishing interests, and how Te Whānau-a-Apanui Iwi and Hapū are informing decision-making and utilising the instruments.

We argue that participating in NZ fisheries management can help the Hapū to influence and inform decision-making that impacts their fisheries interests, therefore exercising rangatiratanga (sovereignty). One of the issues facing the Hapū is that the fishery is difficult to

police, people are increasingly following recreational regulations, and are challenging the whānau who are trying to maintain the tikanga which presently varies from those regulations. These activities have led to cases of overfishing, illegal selling of Mōtū kahawai in nearby cities and online, and Facebook shaming (Te Whānau-a-Apanui Facebook group webpage, https://www.facebook.com/groups/tewhanauaapanui/ *accessed 13 February 2018*). The Hapū can utilise mechanisms that support Māori fishing interests and management practices to influence the wider NZ public who do not readily comply with tikanga (customary practices) by creating recreational fishing bylaws for their territory which are more aligned to the tikanga Participating can also increase capacity to enforce Māori fisheries management practices. What is key for the Hapū is retaining rangatiratanga over the fishery, while partnering with the government.

5.2 Methods

To develop a map of the flow of information and influence through the NZ national fisheries management decision-making process we held four workshops with fisheries modellers knowledgeable on the flow of information through the NZ fisheries management system based on their involved in the system as fisheries researchers. They were Andy McKenzie (NIWA Fisheries modeller), Matt Dunn (NIWA Principal Scientist – Fisheries), and Richard Arnold (VUW Data Science Programme Leader). The dates of the meetings are shown in Table 4-2. During the meetings, attendees identified how information flows through the management system, and through whom, by drawing lines between post-it notes on a white board. Photos were taken of the whiteboard and the system was reproduced as a diagram using yEd Graph Editor (*Version 3.18.02*). We also held two qualitative modelling workshops with Alberto Rovellini, VUW regarding how to carry out qualitative modelling. The qualitative model was not pursued further in this project. The diagram was then reviewed independently by two highly experienced NZ fisheries managers during two meetings. Richard Ford (MPI Manager Fisheries Science), and Terry Lynch (MPI Principal Analyst – Customary Fisheries) who provided additional information on the map, during the meetings and via two online reviews.

To understand the instruments available to support Māori customary fishing interests, I reviewed the Fisheries NZ webpages on Māori customary fishing (Fisheries NZ website, https://www.fisheries.govt.nz/law-and-policy/Māori-customary-fishing/, *accessed 25 January 2018*), and customary fisheries management tools (Fisheries NZ website, https://www.fisheries.govt.nz/law-and-policy/Māori-customary-fishing/managing-customary-fisheries/, *accessed 1 May 2018*), and the associated legislation on the NZ Legislation website

(http://www.legislation.govt.nz/, *accessed 15 March 2018*) to find information on instruments to support customary fisheries management.

5.3 Findings

In this section we first present the NZ fisheries management system, the entities which inform NZ fisheries management on Māori interests, and the key parts of the fisheries management system, i.e. the entry points for information, and how it flows through the system to inform decision-making. Then we describe the different instruments available to Māori for supporting Māori customary fishing interests, and wider marine ecosystem management (Table 5-1). Lastly, how Te-Whānau-a-Apanui Hapū and Iwi have participated in the NZ fisheries management system is described.

Table 5-1 Entities, management structure, and instruments to support Māori fishing interests identified from the literature review and meetings.

Regional customary fishery forum
Regional recreational forum
Māori commercial fishing companies
Regional sector representative entity
Working group meetings
Submissions and Lobbying
Final Advice Paper
Temporary closures and restrictions
Taiāpure
Customary fishing authorisations
Rohe moana tangata kaitiaki/tiaki
Honorary fisheries officers
Mātaitai (seafood gathering) reserve areas
Individual Iwi settlements
Customary marine title
Resource Management Act

5.3.1 NZ Fisheries management system

A schematic diagram of the NZ fisheries management system is presented in Figure 5-2, specifically as it relates to the kahawai fishery. The NZ fisheries management system components are described in Table 5-2.

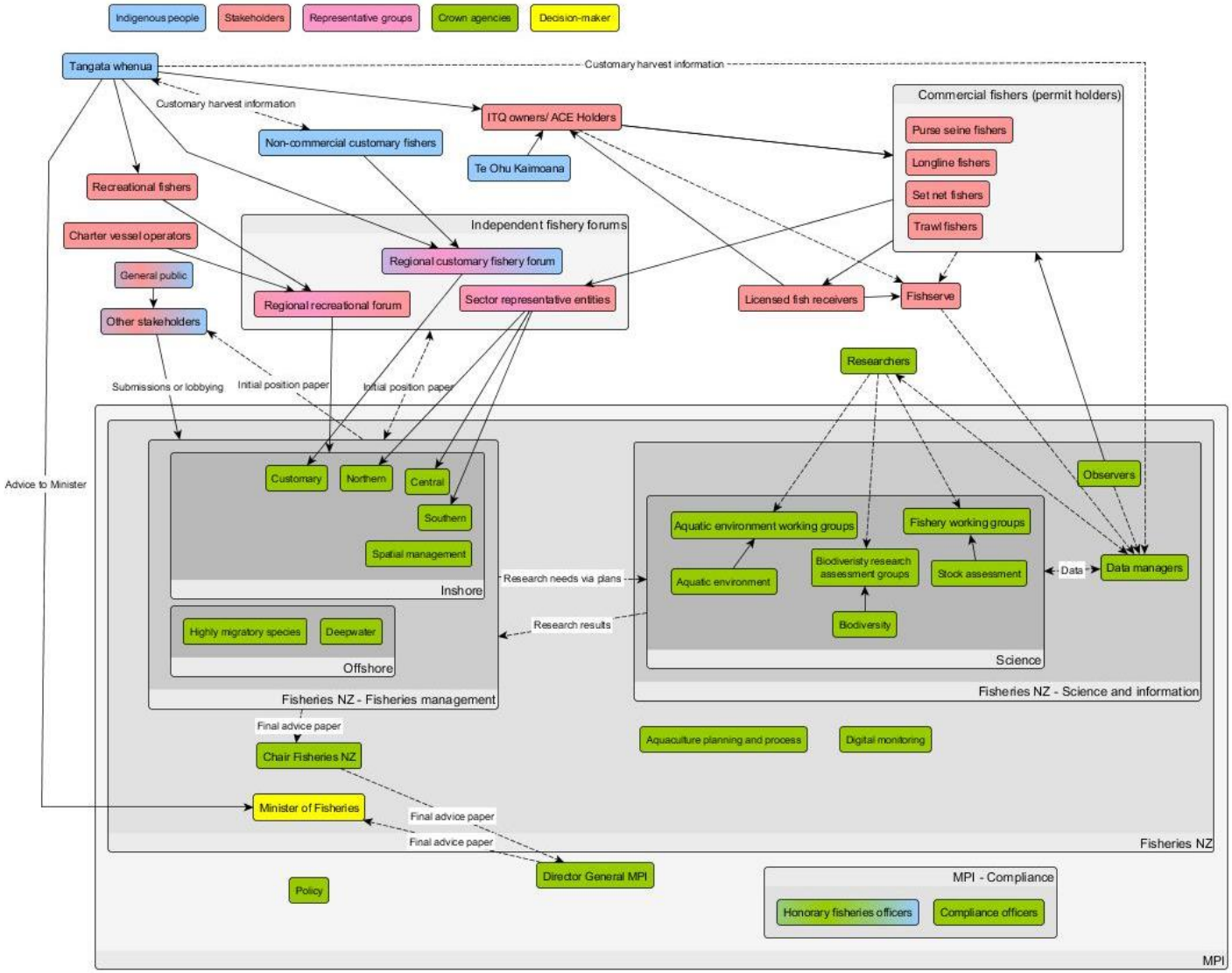


Figure 5-2 Informing decision-making in the NZ fisheries management system. Indigenous people (tangata whenua Māori) are indicated in blue, stakeholders in red, representative groups in pink, crown agencies in green, and the decision-maker in yellow. Bold lines represent information and dashed lines influence.

Table 5-2 Key personnel and entities associated with influencing and informing NZ fisheries management.

Parties	*Description of group*
Indigenous people	People with Indigenous rights.
Tangata whenua	Iwi and Hapū groups that have Indigenous rights in a particular area.
Non-commercial customary fishers	Non-commercial customary fishers who fish under a Fisheries (Kaimoana Customary Fishing) Regulations 1998 customary authorisation.
Recreational fishers	All fishers who fish under Fisheries (Amateur Fishing) Regulations 1986.
Charter vessel operators	Anyone operating a charter vessel and charters recreational fishers.
General public	Other stakeholders who have an interest.
Stakeholders	Groups that have vested interests in fisheries (not fisheries managers or researchers).
Individual Transferable Quota (ITQ) Holders	All groups holding an annual catch entitlement (ACE) for fish. ITQ/ACE holders influence who is able to catch fish commercially. Some ITQ/ACE holders may also be commercial fishers.
Commercial fishers (permit holders)	Commercial fishers who catch fish under TACC quota.
Purse-seine fishers (Commercial fishers)	Commercial fishers using purse-seine nets.
Longline fishers (Commercial fishers)	Commercial fishers using long lines.
Set net fishers (Commercial fishers)	Commercial fishers using set nets.
Trawl fishers (Commercial fishers)	Commercial fishers using trawl nets.
Licensed fish receivers	Only licensed fish receivers (LFRs) are allowed to receive fish for sale. They can also trade fish with other LFRs. They must then report who sold those fish, the species of fish they received, and the weight of each fish species received.
Fishserve	Fishserve provides commercial fisheries services, i.e. ACE and catch transfers and current balances; monthly harvest returns and licenced fish receiver returns; finances: account balances and statements; vessel permits, high seas permits and licenced fish receiver licences; quota holdings and transfer history; customisable reports from the ACE and quota registers. Fishserve provides information from ITQ/ACE holders, commercial fishers and LFRs to Fisheries New Zealand data managers.
Independent fishery forums	These are customary, recreational, and commercial representative groups facilitated by Fisheries NZ who seek their input and feedback.
Customary fishery forums	Customary fishery forums primarily represent non-commercial Iwi fisheries interests.
Recreational fishery forums	Recreational fishery forums represent recreational fisher interests. They allow recreational fishers to present information on how fisheries are performing, identify priority issues and have a say on what Fisheries New Zealand should focus on in the coming year.

Parties	*Description of group*
Sector representative entities	Commercial fishing interests and multi-sector interests are represented through sector representative entities.
Customary (Inshore Fisheries Management team)	Seeks feedback from Independent fishery forums on customary fisheries management research needs.
Northern (Inshore Fisheries Management team)	Seeks feedback from Independent fishery forums on northern inshore fisheries management research needs.
Central (Inshore Fisheries Management team)	Seeks feedback from Independent fishery forums on central inshore fisheries management research needs.
Southern (Inshore Fisheries Management team)	Seeks feedback from Independent fishery forums on southern inshore fisheries management research needs.
Spatial Management (Inshore Fisheries Management team)	Manage special permits for educational or science purposes, and special management areas such as mātaitai (customary fishing areas).
Highly Migratory Species (Offshore Fisheries Management team)	Seeks feedback from Independent fishery forums on highly migratory species fisheries management research needs.
Deepwater (Offshore Fisheries Management team)	Seeks feedback from Independent fishery forums on deepwater fisheries management research needs.
Researchers	Researchers, including fishery modellers, are commissioned by Fisheries New Zealand to conduct fisheries research. Fishery modellers provide stock assessments based on a fishery model. Scientists also provide biodiversity and aquatic environment research.
Data managers (Fisheries NZ – Science and information and NIWA)	Data managers include the people who regulate access, enter data into databases and manage data storage. They provide information to researchers and researchers provide information to them. They then provide this information to the Science team. NIWA does some of this work for Fisheries New Zealand.
Crown agencies	People who work at government ministries and represent the crown.
Fisheries New Zealand	National government agency responsible for managing New Zealand fisheries.
Observers (Fisheries NZ – Science and information)	Groups that enforce and collect information on compliance with fisheries regulations for Fisheries New Zealand as part of the Science and information directorate, observer team.
Science (Fisheries NZ – Science and Information)	The science team commission and assess fisheries research. They are influenced by the fisheries management team and provide information to the fisheries management team in response to their influence. The science team influence the researchers.
Fisheries Assessment working groups (FAWG)	Fisheries Assessment working groups assess all of the available information on a fishery to determine its quality and provide an annual stock assessment.
Biodiversity Research Advisory Group (BRAG)	This group reviews biodiversity research primarily on bycatch and seabirds.
Aquatic Environment Working Group (AEWG)	This group reviews research regarding fisheries impacts on benthic environments research and other miscellaneous research.
Minister of Fisheries	The New Zealand Minister of Fisheries makes final decisions on fishery management.
Final Advice Paper (FAP)	Advice provided to the Minister of Fisheries to inform fisheries management decision-making.

Parties	*Description of group*
Submissions	Formal process for influencing how laws are passed in New Zealand, in this case submissions would be made to New Zealand Fisheries, regarding an initial position paper (IPP). Submissions or lobbying to the Director General (DG) or Minister of Fisheries can also occur.
Lobby groups	Advocacy intent on influencing decisions made by the government by individuals or lobby groups, e.g. Greenpeace, World Wildlife Fund (WWF), Pew Charitable Trust, LegaSea, in this case to the Minister of Fisheries, regarding fisheries management IPPs.
MPI Compliance	Patrol and educate non-commercial fishers.
Compliance officers (Compliance)	Compliance officers monitor non-commercial customary and recreational fishers for any illegal activities and they also have an education role regarding regulations.
Honorary fisheries officers (Compliance)	Honorary fishery officers (HFO) are volunteer warranted officers who patrol NZ's coastline to help preserve our fisheries.
Aquaculture planning and process	Develops and manages aquaculture legislation, regulation and policy and implements the Māori aquaculture settlement.
Digital monitoring	Tracking, reporting, and monitoring of commercial fishing.

5.3.2 Independent fishery forums

Collective representative entities are sector based and include regional customary fishery forums, regional recreational forums, and sector representative entities – that represent Māori commercial fishing interests.

5.3.2.1 Regional customary fishery forums

Pan-Iwi customary fishing interests are represented at Regional customary fisheries forums. At present, there are five customary fisheries forums. Te-Hiku-o-Te-Ika, representing Northland Iwi; Mai-i-Nga-Kuri-a-Whārei, representing Bay of Plenty Iwi; Te-Tai-Hauāuru, representing the Taranaki Iwi; Te-Waka-a-Māui, representing the South Island Iwi including Te Tau Ihu Iwi; and Pā Tangaroa, representing Chatham Island Iwi. There are 52 Iwi who affiliate to the fishery management area FMA1, from North Cape to East Cape. For KAH1 which overlaps with FMA1, the representative forums are Te-Hiku-o-Te-Ika, and Mai-i-Nga-Kuri-a-Whārei. Each Iwi can have up to two mandated representatives (one for commercial, and one for customary purposes) on the Mai-i-Nga-Kuri-a-Whārei Forum, depending on the governance arrangements of the Iwi entity's commercial and non-commercial portfolios.

For the Hauraki Gulf region, a Marine Park has been developed that is administered by the Hauraki Gulf Forum (Hauraki Gulf Marine Park Act 2000). The Hauraki Gulf Forum members are representatives of the Conservation, Fisheries and Māori Affairs Ministers, elected representatives of the six affiliated local councils, and representatives of the tangata whenua of the Hauraki Gulf and its islands (Hauraki Gulf Marine Park Act 2000).

5.3.2.2 Regional recreational forums

Māori also fish under the recreational regulations. Māori meet cultural needs not provided for under the customary regulations, such as for personal well-being, under the recreational regulations. Māori may choose to fulfil cultural needs that are provided for under customary regulations, e.g. providing seafood for hui or tangi, under the recreational regulations. If they do not go above the catch limits this is administratively simpler than using the customary regulations since no specific permit is required under the recreational regulations. Recreational fisher interests are represented through regional recreational fisheries forums. For KAH1 these are Fishery Management Area 1 and 9 forums. Charter vessel operators can also influence the appropriate Regional recreational forum.

5.3.2.3 Māori commercial fishing companies

In the commercial sector, Māori influence is a two-step process. First, Māori can influence their respective Individual Transferable Quota (ITQ) and Annual Catch Entitlement (ACE) holding companies, and fishing companies if they have these. During shareholder meetings, Māori can influence how fishing companies operate. The ITQ and ACE holding companies then direct how Commercial fishers, who catch their quota, operate, e.g., when to target particular fish species.

In these cases, Māori influences are considered with external influences. For example, the Marine Stewardship Council certifies sustainable seafood and commercial fishing companies adjust their practices in order to achieve this certification. Licensed fish receivers can also influence ITQ and ACE holders as they buy the fish from the Commercial fishers (they represent the demand for fish). The Commercial fishers inform Fishserve how much fish they have caught, and the Licensed fish receivers inform Fishserve of how much fish they have received. This is an entry point for commercial catch information into the NZ fisheries management system. Fishserve then provide this information to Data managers in the Science and Information team.

5.3.2.4 Sector representative entities

Māori commercial interests are then collectively represented through sector representative entities such as Fisheries Inshore New Zealand (FINZ), and Te Ohu Kaimoana (TOKM). FINZ provides a national perspective on policy and operational issues in NZ's inshore fisheries, stock management of highly migratory species, stocks formally managed by Area 2 Inshore Finfish Management Company Ltd, and oversight of research and management of all bluenose stocks and jack mackerel in QMA1. Te Ohu Kaimoana (the Māori Fisheries Trust) is the

representative organisation for the customary and commercial interests in fisheries and the marine environment for 58 mandated Iwi.

5.3.3 Management entities and information flow

Here we describe the management entities of Fisheries NZ and how information flows through to decision-making.

5.3.3.1 Fisheries NZ

Within Fisheries NZ there are four directorates, Aquaculture planning and process, and Digital monitoring, that will not be discussed in detail here as they are relatively new and are not directly related to kahawai fisheries management decision-making at present. The two key directorates for fisheries management are: Fisheries Management, and Science & Information. Science & Information includes three groups: Observers, Science, and Data management. Observers include on-board observers, who observe and report fishing activities with respect to regulations.

Fisheries management is comprised of the Spatial management group, an Offshore group, and an Inshore group. Spatial management manage special permits for educational or science purposes, and special management areas such as mātaitai (customary fishing areas), which are discussed in more detail below. Spatial Management also interacts with Aquaculture planning and process, especially for considering the effects of aquaculture on fisheries. Offshore includes a Deepwater, and a Highly migratory species team. Inshore includes staff charged with the Recreational sector, a team for the Customary sector, and the Commercial sector (Northern, Central and Southern).

5.3.3.2 Fishery plans

Feedback is continually sought via the Independent fishery forums on proposed research to find out a) whether research is relevant, and b) if it should be commissioned. There are also different levels of engagement if research is relevant to a particular rohe moana (territorial marine area). For example, Fisheries NZ consulted with Te-Waka-a-Maui (who represent Kai Tahu and Te Tau Ihu Iwi), as well as Te-Rūnaka-o-Kaikōura, a sub-tribe of Kai Tahu located at Kaikōura, regarding research being conducted in Kaikōura, after the Kaikōura earthquake (R. Ford, *pers. comm.*, 2018). The Independent fishery forums have developed independent multi-fisheries management plans for their regions which are considered by the Fisheries Management directorate of Fisheries NZ.

Fisheries plans are a key entry point for influencing NZ fisheries management. There are Deepwater, Highly migratory species, Inshore finfish, Inshore shellfish, and Freshwater fisheries plans. The Mai-i-Nga-Kuri-a-Whārei Fisheries Forum (the Forum) have also

developed a fisheries plan for the Bay of Plenty Iwi they represent, which lists kahawai as a taonga species (Mai i Nga Kuri a Whārei ki Tihirau Fisheries Forum, 2012). This plan includes four high level objectives, each with its own outcomes, and performance measures, to be delivered by the Forum via annual operating plans. The plan was due for review in 2017 and was developed with support from the Ministry for Primary Industries.

There are also National Plans of Action (NPOA) for sharks and seabirds and Threat Management Plans (TMP) for species that are particularly under threat, i.e. Hector's and Maui dolphins, NZ sea lions and yellow-eyed penguins. These plans were developed in partnership with other relevant ministerial parties such as the Department of Conservation (DOC) who administers the Marine Mammals Act 1978. The fishery plans, NPOAs and TMPs influence the research needs. The Science team commissions research from Researchers who either access existing data from the Data managers or collect new data.

5.3.3.3 Working group meetings

The role of working groups is to improve our understanding of NZ's marine ecosystems in terms of species diversity, marine habitat diversity, and the processes that lead to healthy ecosystem functioning, and the role that biodiversity has for such key processes. The relevant working group assesses the research findings. There are three types of working groups: Fishery Assessment Working Groups (FAWGs), who assess target species stock assessment research; Biodiversity Research Assessment Working Groups (BRAGs), who assess NZ marine biodiversity and ecosystems research; and Aquatic Environment Working Groups (AEWGs), who assess environment interactions, and seafood sector interactions research.

Anyone may register with Fisheries NZ, and attend working group meetings, at their own expense. Working group meetings are typically held during working hours in central locations, e.g. Wellington or Auckland. Working group discussions, amongst other things, then inform Fisheries management teams who develop initial position papers (IPPs) to ultimately propose to the Minister either keeping status quo, or alternative management options to address issues.

5.3.3.4 Submissions and lobbying

The public can make submissions on IPPs. IPPs provide relevant data, views, and typically three options for consideration. Each position needs to be justifiable in court. The IPPs are distributed to a wide list of Stakeholders for feedback in the form of a Submission, within a given timeframe. This consultation process is the key point of influence for the General public. Lastly, a Final Advice Paper (FAP) is generated, incorporating the submission feedback. Sometimes the IPP feedback contains information that radically changes the FAP. In these cases, submissions may have new science that the team were unaware of when making the IPP.

However more often, little to no feedback is received and a summary of who has made submissions, e.g. a commercial fisher or a non-government organisation; and what they favour, is provided along with the FAP.

5.3.3.5 Final advice paper

The FAP goes to the Chair of Fisheries NZ for approval, then the Director General of MPI for approval, before reaching the Minister of Fisheries. The Director General, or Minister of Fisheries, can also be directly informed by Submissions and/or influenced by Lobbying. Lobbying is the act of petitioning elected officials to take up the cause of the Lobby group as the decisions will affect their daily life. Tangata whenua can also advise the Minister of Fisheries directly. The Minister of Fisheries then decides based on the FAP. Once the decision is made, the aforementioned are informed and an MPI Policy team amend the relevant policies to address the decision that was made.

5.3.4 Instruments to support Māori customary fishing interests

Instruments for allowing for Māori participation in customary fisheries management include temporary closures and restrictions on fishing methods; customary fishing authorisations, taiāpure, and customary fishing regulations.

5.3.4.1 Temporary closures and restrictions on fishing methods (186A and 186B closures)

Section 186A of the Fisheries Act 1996 provides for the temporary closure of a fishing area or restriction on fishing methods in North Island waters. South Island waters are covered in section 186B. They recognise and provide for the use and management practices of tangata whenua in the exercise of non-commercial fishing rights by either improving the availability, size, or both, of a species of fish, aquatic life, or seaweed in the area subject to the closure, restriction, or prohibition; or recognising a customary fishing practice in that area.

The Minister, who authorises all closures, must be satisfied that the method is having an adverse effect on the use and management practices of tangata whenua in the exercise of non-commercial fishing rights. The Minister must consult representatives of people with an interest in the species concerned or in the effects of fishing in the area concerned, including tangata whenua, environmental, commercial, recreational, and local community interests, and provide for the input and participation in the decision-making process of tangata whenua with a non-commercial interest in the species or the effects of fishing in the area concerned, having particular regard to kaitiakitanga.

The temporary closure must be publicly notified. The closure or restriction may be in force for a period of less than 2 years and will be revoked at the end of that 2-year period. The closure

or restriction may be in force for any particular year or period, or for any particular date or dates, or for any particular month or months of the year, week or weeks of the month, or day or days of the week. A person who takes any fish, aquatic life, or seaweed from a closed area; or takes any fish, aquatic life, or seaweed using a prohibited fishing method will be penalised. These closures are only designed for longer term closures to rebuild a fishery in an area, not for drowning or other purposes. The 186A closure can be renewed if it has not achieved its goal, but MPI encourages tangata whenua to move on to more permanent management measures.

5.3.4.2 Customary fishing authorisations

Some customary harvest is provided for under Regulations 50-52 of the Fisheries (Amateur Fishing) Regulations 2013. This was previously covered by Regulation 27 and 27A of the Fisheries (Amateur Fishing) Regulations 1986. Under Regulation 50, a person may take fish, aquatic life, or seaweed for a hui or tangi if they have an authorisation that was issued by an authorised representative, of either a marae committee, a Māori committee, a rūnanga, or a Māori Trust Board. Regulation 51 states that representatives must represent the tangata whenua of the area to which the authorisation relates. These representatives may not issue an authorisation if a tangata kaitiaki/tiaki has been appointed for the area. A tangata/kaitiaki is a notified representative of the tangata whenua entity for their respective rohe moana/ customary food gathering area, or mātaitai area, who has been notified in the official newspaper of the NZ government, the NZ gazette.

Tangata whenua who are non-commercial customary fishers, report their customary harvest (amount of fish caught) to Tangata whenua representatives or tangata kaitiaki/tiaki. Tangata whenua then inform Data managers, in the Science and Information directorate, of customary harvest information. The volume of fish caught under customary fishing authorisations indicates how much fish is caught for customary purposes. This is an entry point for customary catch information into the NZ fisheries management system. The annual customary fishing allowance is based on this information.

5.3.4.3 Taiāpure

Part 9 of the Fisheries Act 1996 provides for taiāpure, areas of special significance to Iwi or Hapū, as a food source, or for spiritual or cultural reasons. They can only be established in estuarine or coastal waters. A management committee is then appointed to the taiāpure who recommends regulations to the Minister on species fished, fishing seasons, sizes and amounts of fish, fishing areas and fishing methods. Commercial and non-commercial fishing is allowed in a taiāpure, unless its management committee recommends changes to the fishing rules and

the Minister of Fisheries approves them. For example, the East Otago Taiāpure was established in 1999 on the coast north of Dunedin by members of Kati Huirapa Runaka ki Puketeraki.

5.3.4.4 Fisheries (Kaimoana Customary Fishing) Regulations 1998

The Fisheries (Kaimoana Customary Fishing) Regulations 1998 and Fisheries (South Island Customary Fishing) Regulations 1999 recognise and provide for customary food gathering and the special relationship between tangata whenua and important customary food gathering areas (Ministry of Fisheries, 2008). The Fisheries (Kaimoana Customary Fishing) Regulations 1998 which relate to the North Island are the focus here. The South Island regulations are not covered because they do not relate to the Mōtū kahawai fishery. These regulations include rohe moana tangata kaitiaki/tiaki, honorary fisheries officers, and mātaitai reserve areas.

5.3.4.5 Rohe moana tangata kaitiaki/tiaki

Tangata kaitiaki/tiaki are customary fishery representatives of tangata whenua entities for their respective rohe moana/ customary food gathering area. Similarly, to authorised representatives mentioned above, they have the power to authorise individuals to take fish, aquatic life, or seaweed for customary food gathering purposes from their respective rohe moana. Tangata kaitiaki/tiaki must keep accurate records of who they have issued authorisations to, what was taken and regularly report to the local Fisheries New Zealand office. This means they also have an important role in providing information on which customary fisheries are assessed and customary allowances allocated.

Fisheries officers can view permits to ensure fishers are adhering to the authorisations kaitiaki have issued. Kaitiaki report to the Ministry four times a year on what they have issued and what fishers have reported they have caught. This information can only be used to set allowances and to make sustainability decisions. Kaitiaki are autonomous fisheries managers not directed by the Crown. In addition to this responsibility, they may also participate in fisheries management for their respective area, including setting or varying sustainability measures or developing management measures; and they can nominate Honorary fisheries officers under the Fisheries Act 1996.

5.3.4.6 Honorary fisheries officers

Māori are also able to be part of the MPI Compliance team as Honorary fisheries officers (HFOs). HFOs are volunteer warranted officers who patrol NZ's coastline to help improve compliance with NZ fisheries regulations. They work alongside full-time fishery officers, helping recreational fishers understand rules and regulations.

5.3.4.7 Mātaitai reserves

Mātaitai reserve areas recognise a special relationship between tangata whenua and their respective customary food gathering area. There are mātaitai gazetted for rivers, harbours, lagoons and coastal marine areas. Anyone may apply for a mātaitai for part or all of their rohe moana, and once established, regulations follow the Fisheries (Amateur Fishing) Regulations and allow for customary food gathering. Mātaitai areas typically exclude commercial fishing unless special regulations are made. Mātaitai differ from taiāpure in that they are part of the Fisheries (Kaimoana Customary Fishing) Regulations 1998, and are specific to tangata whenua, where taiāpure are not.

Tangata kaitiaki/tiaki are appointed for the mātaitai area and can then propose bylaws for part or all the mātaitai area to support sustainable fishing in the mātaitai. Bylaws proposed can cover: species of fish, seaweed, or aquatic life that may be taken; the quantity of each species that may be taken; size limits for each species; the method used to take species; the area or areas that species may be taken from; anything else the tangata kaitiaki/tiaki consider is needed for the sustainability of fisheries resources in the mātaitai. The bylaws must be consulted on by the wider public. The Minister makes the final decision on whether a proposed bylaw is approved and/or revoked. Despite any bylaws in the mātaitai area, tangata kaitiaki/tiaki may authorise customary fishing for sustaining the functions of a marae, excluding fishing from a registered commercial fishing vessel.

5.3.5 Instruments to support fisheries and wider marine ecosystem management

Here we describe instruments for recognising Māori interests in fisheries and from an ecosystem perspective, including regulations tailored through Individual Iwi Treaty settlements, customary marine title in Marine and Coastal Areas (MACAs), and Resource Management Act 1991 (RMA) processes.

5.3.5.1 Individual Iwi settlements

Settlements regarding claims made by Iwi under the Treaty of Waitangi, i.e. individual Iwi settlements, are a relatively new way of recognising Indigenous fisheries rights through tailored regulations, fisheries accords and bylaws. The Waikato-Tainui Raupatu (confiscation) Claims (Waikato River) Settlement Act 2010, recognises the significance of the Waikato River to the Waikato-Tainui people, and recognises their vision and plan for the Waikato River over and above any inconsistent national policy statements issued under the Resource Management Act 1991. The vision and plan are part of the Waikato Regional Policy Statement and are exercised through an integrated management plan and co-management arrangement (Section 36B of the Resource Management Act 1991).

Section 93 of the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010 ensures the Minister of Fisheries makes bylaws as recommended by Waikato-Tainui Iwi restricting or prohibiting fishing of Waikato River fisheries, unless the bylaws will prevent other fishers taking their lawful entitlements. For example, fisheries bylaws were introduced to the Waikato-Tainui rohe (region) in March 2014 to limit the minimum harvest size to 300g for short-fin eels (*Anguilla australis*), and to 400g for long-fin eels (*Anguilla dieffenbachii*). Bylaws have also been put in place to protect the 'tuna heke' (eel spawning migration) on the Waikato River. This includes seasonal closures in some reaches, and an upper weight limit of 2kg for both species, preventing the taking of long-fin females that are in a migratory state. Bylaws also provide for rāhui for drownings, by making a closure of an area mandatory if the closure has been notified in the media.

Further to this, a Waikato River vision, plan and co-management arrangements for upper Waikato River catchment Iwi are recognised in the Ngāti Tūwharetoa, Raukawa, and Te Arawa River Iwi Waikato River Act 2010. The Ngāti Tūwharetoa, Raukawa, and Te Arawa River Iwi Waikato River Act 2010, provides for the co-management framework for the upper Waikato River recognising the special relationship each Iwi has with its part of the Waikato River, and the mana of the Iwi. The Fisheries (Ngāti Tūwharetoa, Raukawa, and Te Arawa River Iwi) Regulations 2017 provide support for the quality, health and well-being of the river. Mātaitai are not to be established in the area, customary gathering under the customary authorisation process is permitted, however by customary authorisers, not tangata kaitiaki/tiaki.

The purposes of customary gathering are expanded to include: taking, releasing, using, possessing and depositing fisheries resources in the upper Waikato River catchment; and gathering for a wider range of customary purposes including: providing food at hui, tangi, sustaining the functions of the marae, and other customary purposes, educational research, environmental research, enhancing species, and restoring species. There is a special clause for establishing pātaka kai (food cupboards), and pā tuna (eel weirs), which are specific customary activities.

A fisheries management committee is set up to advise the Trusts, develop policy, manage customary fishing in the upper Waikato fisheries area, and coordinate the customary authorisations system. Bylaws may be proposed for fishing activities to regulate types or species, quantity, size limits, methods, dates, times or seasons when fisheries resources may be taken. A Trust proposes the bylaws and the Minister decides if they have any undue effect on fishing. If approved, the bylaws can be notified and enforceable 28 days later.

5.3.5.2 Customary marine title

The Marine and Coastal Area (Takutai Moana) Act 2011 must recognise the mana tuku iho (authority through whakapapa) exercised in the marine and coastal area by Iwi, Hapū, and whānau as tangata whenua; provide for the exercise of customary interests in the common marine and coastal area (MACA); and acknowledge the Treaty of Waitangi. In this legislation, the MACA refers to the foreshore and seabed, including riverbeds, which are part of the coastal marine area. Until April 2017 Iwi, Hapū or whānau could apply for their customary rights to MACAs to be recognised through the Act by demonstrating exclusive use and occupation of the area since 1840, when the Treaty was signed (Ministry of Justice, 2017). If approved, this gives 'customary marine title,' meaning the right to decline RMA consents or permits; rights over some minerals and taonga (special treasures, anything prized); and the ability to transfer title, but without the right to sell or restrict public recreational access to the area (Ministry of Justice, 2017). It also gives 'protected customary rights,' meaning the right to conduct certain activities, such as collecting hāngī (earth oven) stones, without having to get a resource consent. This Act is relatively new. Customary marine title groups recognised through this Act will have further influence in resource management decision-making as any planning document prepared by a customary marine title group under Section 85 of the Marine and Coastal Area (Takutai Moana) Act 2011 must be considered when regional authorities are amending policy and planning documents.

5.3.5.3 Resource management

The Resource Management Act 1991 (RMA) aims to promote the sustainable management of natural and physical resources and is administered by the Ministry for the Environment (MfE) and local authorities. Māori rights to manage natural resources are a key part of the RMA. For example, Section 7 states that 'kaitiakitanga must be taken into account when working under the Act,' and Section 8 states that the Treaty must be taken into account. Kaitiakitanga is interpreted in the RMA to mean, 'the exercise of guardianship by the tangata whenua of an area, in accordance with tikanga Māori in relation to natural and physical resources, including the ethic of stewardship.'

Section 3 states that 'a local authority shall consult with tangata whenua of the area who may be affected by a proposed policy statement or plan, with any marine customary title group in the area, and Iwi authorities. Where appropriate, the Ministers for Conservation, Transport and Fisheries must also be consulted.' At the very least, a letter will be sent to relevant Māori representative entities in the area (*Personal obs*., 2014). Tangata whenua may enter submissions for resource consents in a similar process to the one described for fisheries IPPs.

Following on from this, the local authority will then provide a copy of the decision report considering submissions, to tangata whenua via Iwi authorities, to provide comments.

Individual Iwi Treaty Settlement and customary marine title legislation are implemented through the RMA. Under Section 95 local authorities will read Statutory Acknowledgements listed in Section 11 to determine if an Indigenous group needs to be notified of a resource consent application (application to conduct an activity), and the Minister for the Environment will decide if they are affected. This is part of individual Iwi Treaty settlement legislation. Section 95F allows for protected customary rights groups to give written approval of activities in their protected customary rights areas. Section 95G allows customary marine title groups to give written approval for activities that may affect their accommodated activities in their customary marine title area. Section 165W gives preferential rights of Iwi regarding coastal permits in the common MACA as provided in individual Iwi Treaty settlements.

Section 58 details the New Zealand Coastal Policy Statement (NZCPS) which includes: protecting the character of the coastal environment of special value to the tangata whenua including: wāhi tapu (sacred sites), tauranga ika (canoe landing sites), mahinga mātaitai (seafood activities), and taonga rāranga (weaving resources). Section 58 also outlines Mana Whakahono a Rohe, a mechanism for Iwi to participate in resource management and decision-making processes with local authorities. Iwi authorities can also be consulted on heritage protection orders and water conservation orders. Councils must also take Iwi planning documents into account. Planning documents are explored further in Chapter 9 (Holistic Mōtū kahawai fisheries management).

5.3.6 Te Whānau-a-Apanui involvement in NZ fisheries management

In 1991, Te Whānau-a-Hikarukutai/Ngāti Horomoana Hapū members wrote submissions to the Minister of Fisheries, regarding the introduction of kahawai to the QMS. In the submissions they asked for commercial fishing to be banned at the Mōtū river mouth, and for associated species and habitats to be considered in kahawai management. Mechanisms in place to support the first request were outlined in Chapter 2 (History and background of the Mōtū kahawai fishery). There are currently no notified tangata kaitiaki/tiaki representatives, no rohe moana, and no mātaitai gazetted for Te Whānau-a-Hikarukutai/Ngāti Horomoana. Although, preliminary discussions about creating a mātaitai at the Mōtū river mouth have occurred (E. Howell, *pers. comm.*, 2014)

Te Whānau-a-Apanui do not have representatives on the BOP customary fishery forum. However, three Te Whānau-a-Apanui Hapū are utilising legislative customary fishing management tools. Te Whānau-a-Kaiaio, have a gazetted rohe moana/ customary gathering

area at Te Kaha, Te Whānau-a-Maruhaeremuri have a gazetted mātaitai in their rohe moana at Raukōkore, and Te Whānau-a-Kauaetangohia are applying for a mātaitai in their rohe moana at Cape Runaway. Initial Treaty Settlement agreements with Ngā Hapū o (the sub-tribes of) Te-Whānau-a-Apanui, include developing a 'One plan' to incorporate a Te Whānau-a-Apanui Iwi Management Plan (for the RMA), an Environmental Covenant (for the MACA Act), and a Fisheries Management Plan for new tailored fisheries regulations following the individual Iwi Treaty settlement (Ngā Hapū o Te Whānau-a-Apanui, 2008).

5.4 Discussion

The visual of the NZ fisheries management system and descriptions of the Independent fishery forums, the key parts of the fisheries management system, i.e. the entry points for information, and how it flows through the system to inform decision-making, provided in this chapter will help to increase transparency of the current NZ fisheries management system. The descriptions of customary fisheries management tools, and wider marine ecosystem management instruments that Māori are using to recognise fisheries interests will help to inform Māori who are not currently engaged, in the options available to them. Then we briefly described how Te-Whānau-a-Apanui Hapū and Iwi have participated in the NZ fisheries management system.

Independent fishery forums and the plans they develop are the key entry point for Māori to influence fisheries management, as their plans inform the subsequent fishery plans. Independent fishery forums and respective management teams are sector-based, meaning that they are not holistic for Māori, who participate in all sectors. Representatives often describe themselves as wearing different hats, depending on which fishery sector they are representing that day (*Personal obs*., 2014).

This is the point where social, economic, and cultural research required to adequately inform the associated 'use' fisheries objectives needs to enter the system. Fishery plans are varied in focus, i.e. based on groups of fishes or invertebrates, spatial areas, species behavioural traits, or conservation status. How the different plans link to one other remains unclear and requires further investigation. Fishery plans then inform research needs, and the commissioning of research which is then assessed by working groups.

Having specific management, research and working group teams that focus on human dimensions, i.e. social, economic, and cultural, can potentially provide a more transparent process for considering non-ecological information. This process would be consistent with how ecological information is considered, rather than relying on forum feedback, and public submissions. The existing working groups mandate suggests a high emphasis on monitoring stocks in the QMS, and researching the ecological aspects of fisheries systems, with limited

emphasis on the human dimensions. Of the three working group types, 'seafood sector interactions' are just one of two types of research being assessed by the AEWGs.

At present it is difficult to know if the most suitable people are involved in assessing research. Anyone that has the time and money to attend a working group can, therefore they do not reflect the Treaty principle of partnership. Working group meetings typically take place when Iwi and Hapū representatives are working at their regular jobs. Therefore, representatives need to take time off work, and need to compensate for this potential loss of income, if they attend. TOKM represent Māori on customary and commercial fisheries management interests but they are not mandated to represent all Māori, as this poses a challenge to individual Iwi and Hapū rights.

The submissions process results in surprise information that can radically change the FAP. This suggests that occasionally relevant information is missed altogether, if a member of the public does not make the time or effort to make a submission. The submissions process is a secondary, reactionary entry point for influencing fisheries management decision-making, which is predictably under-utilised.

For Māori, the submissions process does not reflect the Treaty principle of partnership, but rather challenges it, as it is the same opportunity provided for all New Zealanders. There is no indication of whether mandate is factored into submissions when they are considered. This means submissions from non-mandated groups and individuals can potentially have the same weighting as submissions from mandated representatives.

Although customary fishing is carried out under the recreational regulations, these issues are unlikely to be expressed in recreational forums because they relate to customary fishing. Fisheries NZ need to be informed if customary fishing is taking place under the recreational allowance, or if customary fishing is not taking place, i.e. a rāhui is in place as an act of kaitiakitanga, e.g. to allow the stocks to replenish. This allows Fisheries NZ to take this information into account. Often authorisations are the only information available regarding the level of customary fishing effort. If customary fishers do not fish for customary purposes under an authorisation, this may result in the allowance being reduced in the future.

How customary fisheries and the rest of NZ fisheries are managed, appears disconnected. In particular, how the implemented customary management tools, i.e. rohe moana, kaitiaki/tiaki, mātaitai, taiāpure, and 186A and 186B temporary closures; contribute to the overall management of NZ fisheries is unclear. This is either separately or together as customary fisheries management tools collectively, or together with the QMS. It is also unclear how the customary management tools are performing, or what their performance is based on, compared to the QMS, whose performance is robustly monitored.

Customary fishery management tools appear to be inadequate. Māori with individual Iwi Treaty Settlements, e.g. Waikato-Tainui, have chosen to create tailored fisheries regulations to meet their customary fisheries needs rather than accessing the array of customary fisheries management tools already available. The tools are typically accessible for Iwi, rather than for Hapū or pan-Iwi, which is what the Ngāti Tūwharetoa, Raukawa, and Te Arawa Iwi Regulations 2017, have accommodated. Other barriers to their use may be the lengthy process to implement the tools that is surpassed via the tailored regulations, regulations which additionally support rangatiratanga through co-management.

Individual Iwi settlements may also provide adequate resourcing for Iwi to create tailored regulations rather than to utilise existing tools. Individual Iwi fisheries regulations bylaws are essentially in place to support kaitiakitanga. The bylaws must be consistent with sustainable utilisation and cultural reasons, such as traditional management practices, the death of a human, the special status of a species of fisheries resource in the upper Waikato fisheries area, or the need to increase the availability of a species of fisheries resource in a particular area in the upper Waikato fisheries area. These tailored fisheries regulations set a precedent for all Iwi to aspire to which if implemented for 99 Iwi poses a much higher administrative burden for NZ fisheries management, and decision-making workload for the Minister of Fisheries.

In terms of EAF, and ecosystem-based marine management, the RMA is the most useful legislation. Fisheries are largely managed separately from other natural and physical resources, which is not a holistic approach. Fisheries are currently managed nationally, although for large-scale regional fisheries. Natural and physical resources are managed on smaller regional scales. So essentially there are two separate regional management approaches operating over not quite overlapping regions.

Going forward the Fisheries agency might consider amalgamating with the Environmental policy agency but separating out the enforcement responsibilities of both. Fisheries representative groups might consider co-operating and consulting with the environmental management agency alongside other coastal and offshore interest groups, as shown in Figure 5-3, or coming together as a community of practice, e.g. Hauraki Gulf Forum, to achieve marine ecosystem-based fisheries management. Compared with the EAF framework shown in Figure 5-1, this framework has balanced engagement between the Environmental policy agency and the Interest groups and Indigenous communities, who are clearly identified.

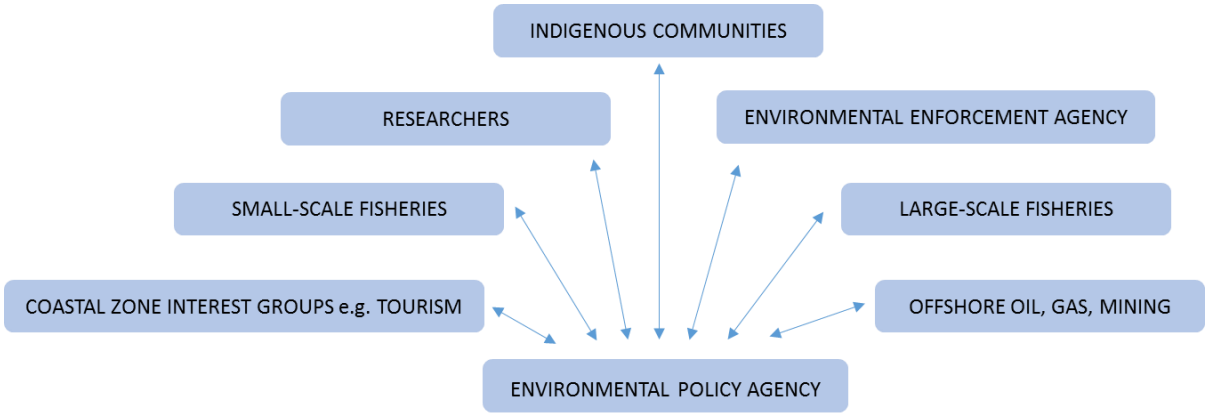


Figure 5-3 Engagement for EAF management (action) – Fisheries agency becomes part of the Environmental policy agency and Environmental enforcement agency is separated from Fisheries agency.

There are increasing layers of Māori rights and interests being created. For example, the MACA legislation will create mandated customary marine title groups which represent whānau groups, as well as Hapū and Iwi. This gives rise to multiple layers of mandates and entities to engage with, subsequently increasing the administrative burden and the need for more resourcing. Surely these are existing rights under the Treaty of Waitangi that simply require more resourcing and investment.

This calls for a review of how the system is working for Māori. Firstly, the separation of fisheries sectors, and of customary fisheries management tools, and the QMS. Secondly, managing fisheries within the wider resource use and management framework centred on regions. Lastly, reducing the administrative burden being created. Canadian National Indigenous Fisheries Institute (2018) report includes phase one of a two phase engagement process used to review Fisheries and Ocean Canada's Aboriginal programs. The process included a comprehensive desktop review of work related to the programs that resulted in seven discussion papers. Indigenous groups and communities, and any interested Canadians, were invited to give feedback. Then a series of direct engagement sessions, workshops, plenaries, and interviews, with program participants took place. Seventeen 'What we heard' reports and 25 graphic recordings, along with engagement materials, were posted on the Institute's website. A recommendations report was developed from the information. Phase two is underway. This process is thorough, and transparent and may be useful in guiding a similar review of Māori participation in NZ fisheries management instruments.

To date, Te Whānau-a-Apanui involvement in NZ fisheries management is limited. Te Whānau-a-Apanui probably does not have a representative on the BOP customary fishery forum as the forum consists of Iwi representatives, Te Whānau-a-Apanui operates administratively at the Hapū level. Te Whānau-a-Apanui are utilising some existing customary

fisheries management tools as they await their Individual Iwi Treaty Settlement, which will focus on addressing multiple Hapū interests simultaneously, in a holistic way.

In the 'One Plan' way proposed by Ngā Hapū o Te Whānau-a-Apanui, planning documents can be a holistic approach to recognising the collective interests, objectives, and outcomes sought for fisheries within the wider environment. These One plans can then be directed into the multiple pathways of the much-divided fisheries and wider ecosystem management systems to inform the respective processes, in a way that is administratively less burdensome for the Hapū and potentially also NZ fisheries and natural resource managers.

In the current system, Independent fishery forums and plans are key to Māori informing NZ fisheries management. This is where information needs on human dimensions of fisheries need to be identified. Specific management, research and working group teams can potentially provide a more transparent process for considering non-ecological information that is consistent with the ecological information commission and review process. Open access working groups make it difficult to know if the most suitable people are involved in the research reviews. The submissions process further emphasises the need for a robust means for considering non-ecological information and does not reflect the Treaty principle of partnership. The customary authorisations process is probably being undermined by recreational regulations, and the reasons for underutilisation are not being addressed in forums. Customary fisheries and wider NZ fisheries management are disconnected, and customary fisheries management tools appear inadequate. Resourcing through Individual Iwi Treaty settlements provides adequate resourcing for Iwi to create tailored fisheries regulations which set a precedent for all Iwi. Looking to the future, addressing the customary fishing interests of 100 Iwi and/or 800 Hapū is also a big responsibility for Fisheries New Zealand. Devolving decision-making responsibilities to regional groups that have vested interests in their respective fisheries as recommended for EAF, combined with taking a more holistic marine management approach overall, seems much more practical. This will reduce the administrative burden placed on the national Fisheries NZ team, especially on the Minister of Fisheries, who has more than just the Fisheries portfolio to address. As Te Whānau-a-Apanui are in a remote area of NZ, do not have an individual Iwi Treaty settlement, and operate on the Hapū level, it is understandable that they do not attend Independent fishery forums and are focusing their energy on creating a plan that will reflect their fisheries interests in the scope of the overall environment. In the next Chapter, we look at how the Hapū culturally values the Mōtū kahawai fishery.

Chapter 6 Hapū cultural values of the Mōtū kahawai fishery

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ABSTRACT
Fisheries management has an important role in sustaining fisheries-dependent cultures. We describe the cultural values of the Mōtū kahawai (*Arripis trutta*) fishery for Te Whānau-a-Hikarukutai/Ngāti Horomoana (TWAH/NH). Using a kaupapa-Māori approach and culturally appropriate social science methods, cultural values of the Mōtū kahawai fishery were shared. The Identified Cultural Influence (ICI) index determined if kahawai is a cultural keystone species (CKS) for TWAH/NH. TWAH/NH have developed distinct, centuries-old wisdom, protocols and practices through their interactions with the kahawai. The fishery contributes to their identity and the ICI results suggest that kahawai is TWAH/NH's CKS. Indigenous knowledge and management systems can provide sustainable management practices improving how cultural values connected to fisheries are enhanced. We recommend culturally appropriate information sharing and analysis methods used here, for efficiently describing the cultural significance of fisheries. Increasing the CKS fisheries recognised, will emphasise the need for fisheries managers to sustain cultural values.

This chapter investigates how the Hapū values the Mōtū kahawai fishery culturally in four sections. The first section provides the background to cultural values, cultural keystone species (CKS), and their connection to fisheries. The second section describes the methods followed to gather, analyse, and review information and conduct a CKS assessment. The next section provides the cultural value of the Mōtū kahawai for TWAH/NH and the CKS assessment results. In the last section these results are discussed.

6.1 Introduction

The New Zealand (NZ) government aims to protect the rights and interests of NZ Māori, NZ's Indigenous peoples, as set out in the Treaty of Waitangi, 1840. This includes the right to participate in fisheries and to manage fisheries using Indigenous practices. NZ fisheries managers are increasingly supporting these rights and interests through Deeds of Settlement and customary fishing regulations (Stephenson et al., 2014). What is not apparent is the role fisheries management has for protecting and enhancing the cultures of fisheries-dependent societies.

Culture refers to the: 'customs, practices, languages, values and worldviews that define social groups based on nationality, ethnicity, region or common interests' (Ministry of Social Development, 2016). Cultural identity is important for people's sense of self and how they relate to others and can contribute to people's overall well-being' (Ministry of Social

Development, 2016). Durie (2001) emphasises how important a secure identity is for Māori mental health. Cultural heritage and practices of a society ground cultural values, the 'shared principles and virtues held and expressed in society' (Frey, 1994; Ratana et al., 2017).

In this chapter, we explore the role of cultural keystone species for Indigenous people using the Mōtū kahawai fishery case study. A keystone is the weight-bearing central stone of an arch, locking the whole together and preventing it from falling down, which would happen if it were to be removed (Pearsall, 1999). This concept was transferred to ecological systems, as ecological keystone species, by Paine (1969) who demonstrated how the sea star *Pisaster ochraceus* could maintain species diversity in intertidal ecosystems through predation. Removal of the sea star resulted in competitors excluding each other, and less diversity overall. The ecological keystone concept has since been broadened beyond individual species to include processes, guilds and species complexes (Platten & Henfrey, 2009). The keystone concept was later transferred to human systems to describe the cultural importance of certain species, such as ironwood (*Olneya tesota*) to the Seri Indian and Mexican communities of Sonora, Mexico (Nabhan & Carr, 1994). Platten and Henfrey (2009) argue that the cultural keystone is not a biological species per se, but a complex combining a biological species, with knowledge, and technical practice. This doesn't quite fit with the actual definition of a keystone, which is a single stone (Pearsall, 1999). Using another term which better reflects a bio-cultural complex would avoid confusion and the need to explain the use of the metaphor inaccurately.

Much work has since gone into creating and applying tools for determining if a species is culturally important, defining the species' influence on culture (Baumflek & Chamberlain, 2019; Cristancho & Vining, 2004; de Grenade, 2013; De la Torre et al., 2018; Garibaldi & Turner, 2004; Uprety et al., 2013), as well as the value of the species. For example, the nutritional value of the Pacific herring on the Northwest Coast of North America (Moss, 2016). The CKS model has been used to support local management and prioritise restoration for CKS species (Bonifácio et al., 2016; Partasasmita, 2017; Uprety et al., 2017). For example, the Cree, Dene and Métis community applied the model to address reclamation efforts in the large oil sands extraction area in Fort Mackay, Alberta by focusing discussions on several CKS (Garibaldi, 2009). Using the model engaged community members as it was being directed by existing cultural values, and was noted as a means of re-engaging with the landscape (Garibaldi, 2009). The model also support the use of associated ecological knowledge (Indigenous or otherwise) in the management of the species (Partasasmita, 2017).

In order to protect and enhance the cultural values of fisheries-dependent societies, the cultural values first need to be identified and described in ways that are culturally appropriate. Cultural keystones are species that are fundamental to a culture, much like ecological keystones are essential to the overall structure and functioning of their ecosystems (Cristancho & Vining, 2004; Garibaldi & Turner, 2004). Without the keystone, the ecosystem or the society's culture would be completely different. Therefore identifying cultural keystone species (CKS) creates focal points for sustaining the cultures of socio-ecological systems (Rozzi et al., 2006). This supports Indigenous communities to apply their wisdom and practices to culturally important fisheries and better recognise their rights in fisheries management (Stephenson et al., 2014).

In NZ, CKS are similar to 'taonga species', species that local communities are known for. McCarthy et al. (2014)'s interviewees emphasised that each Hapū (sub-tribe) or marae has a particular signature species, which acts as their cultural keystone. Examples mentioned in McCarthy et al. (2014) were: kōura (red rock lobster, *Jasus edwardsii*) for Kaikōura; tūaki (cockles, *Austrovenus stutchburyi*) for Puketeraki and Ōtakou; and tītī (muttonbird, *Ardenna grisea*) for Rakiura. However, from the South Island-wide data collected, only pāua (black-foot abalone, *Haliotis iris*) was identified as a CKS and for Māori generally, where the data potentially contained valuable information identifying numerous CKS for numerous South Island communities. Eels (*Anguilla spp*.) and blue cod (*Parapercis colias*) were also mentioned as CKS, however without identifying the associated communities. In the North Island, Paul-Burke (2015) investigated the management of kūtai, green-lipped mussels (*Perna canaliculus*), in Ōhiwa Harbour as a taonga species.

This raises the importance of scale when researching CKS, to ensure that the operational level of the society's culture is not surpassed by a larger heterogeneous conglomerate. NZ Māori cultural values are grounded in NZ Māori cultural heritage and shared by NZ Māori society (Mead, 2003). Using this term may minimise the distinct contextual cultural values expressed by NZ Māori at their operational territorial level of Iwi or Hapū. Therefore, a Hapū case study is presented here.

However all NZ species could be considered taonga species as they each have their unique role within NZ's interconnected ecosystems. Applying the taonga species term does help to differentiate NZ species from culturally significant species found elsewhere in the world, but it does not help to determine how many culturally significant species there are globally. This is where universal terms such as the cultural keystone species concept can be useful. Noble et al. (2016) found that by formally recognising culturally significant species such as the key freshwater species underpinning Indigenous fisheries in North America, Australia and NZ,

their cultural importance and the depth of Indigneous ecological knowledge (IEK) associated with the species can be recognised in the management of the species.

TWAH/NH do not currently engage with the government to manage kahawai at the QMA-level. However, the Hapū recognises that engaging with the government can lead to managing the wider community that impacts the Mōtū kahawai fishery, in ways that better align with their values. Butler et al. (2012) found that species with higher cultural value scores, such as turtles (*Chelonia* spp. and *Eretmochelys imbricata*), and dugong (*Dugong dugon)* for Indigenous Melanesians in the Torres Strait Islands, Australia, are positively correlated with co-management stage and use of Indigenous knowledge in management. Noble et al. (2016) reviewed global Indigenous freshwater CKS (eels, other fish, bivalves and freshwater crayfish) and concluded that their formal recognition as CKS was a first step leading to restoration through Indigenous-led co-management. Our objective is to describe the cultural values of the Mōtū kahawai fishery for the local Hapū, TWAH/NH, and to determine if kahawai is their CKS.

6.2 Methods

This section outlines the cultural values information gathering, analysis and review, followed by the CKS assessment. The research was carried out in three phases: 1) relationship building and research preparation, 2) information gathering through extended engagement, and 3) analysis and review (Dale & Lane, 1994; Smith, 2012; Wheeldon, 2012). Phase 1: relationship building and research preparation, was described in Chapter 4 (Māori engagement for fisheries research, Section 4.3 Mōtū kahawai fishery engagement process). Phase 2: Information gathering through extended engagement, took place between September 2013 and July 2014, and included five months of participatory observations, 18 semi-structured interviews, and gathering 32 documents. Information about the importance of the Mōtū kahawai fishery and the key components of the Mōtū kahawai fishery were collected.

Participatory observations included three hui (meetings), six site visits, three hīkoi (conversing with knowledgeable elders while on a journey), fishing at the river mouth, and two workshops (Table 6-1). Notes were recorded in a field notebook, and videos and photos were taken during the activities.

Table 6-1 Details of participatory observation activities.

Type	*Date*	*Participants*	*Activity*
Hui	15 September 2013	32 participants	Mōtū kahawai fishery management hui, Maraenui
Hui	22 September 2013	Number not recorded	Te Whānau-a-Hikarukutai/Ngāti Horomoana Hapū hui, Maraenui
Hui	13 October 2013	Number not recorded	Follow-up fisheries hui, Maraenui
Site visit	11 March 2014	Solo	Cyberwaka, Ōpōtiki
Site visit	21 March 2014	>37	Ashbrook School trip to Mōtū River Kahawai Fishing
Site visit	Not recorded	>40	Te Teko Kōhanga Reo Trip to Maraenui Marae, hosted by Te Kōhanga Reo o Maraenui
Site visit	Not recorded	>40	Te Kōhanga Reo o Maraenui
Site visit	Not recorded	>40	Te Teko Kōhanga Reo and Te Kōhanga Reo o Maraenui Trip to Whitianga Bay
Hīkoi	26 March 2014	Miro Heurea and Daphne Maxwell	Te Kaha Area School
Workshop	30 March 2014	Daphne Maxwell	Bottling kahawai workshop
Hīkoi	6 April 2014	Daphne Maxwell	Hukuwai and Maraenui Foreshore
Workshop	13 April 2014	Fred Poihipi	Fishing lure making workshop
Hīkoi	28 May 2014	Daphne Maxwell	Tōrere and Maraenui Foreshore, looking at the signs
Site visit	9 June 2014	Solo	Maraenui Foreshore looking at signs

The Hapū committee advertised a Mōtū kahawai fishery management hui in the local newspaper inviting the local community to share their views on Mōtū kahawai fishery management. Attendance at the hui was considered an indicator confirming someone's interest in how the Mōtū kahawai fishery was managed, and provided an opportunity to invite them to participate in the interviews. The Hapū committee minutes of the Mōtū kahawai fishery management hui, notes 32 attendees from Te-Whānau-a-Apanui, Ngāitai, Whakatōhea and Waioweka. No names were given. In my notes of the meeting, I only recorded the names of 22 attendees (including myself), therefore 10 were not identified.

Of those that attended, five had their views captured during the Mōtū kahawai fishery management hui only. They were from the neighbouring Hapū (2), from Waioweka in the neighbouring tribe (1), from the neighbouring Whakatōhea tribe (1) and a partner to a Hapū member (1). Of those that attended, five had their views further captured during the participatory observations, including one who was asked to be interviewed but declined, two who were unable to be contacted for interview, one who was in the Hapū committee, and the Hapū committee chairperson. Of those that attended, 12 were interviewed further.

There were eight additional interview participants who did not attend the Mōtū kahawai fishery management hui. Of these, two were from the neighbouring Whakatōhea tribe and were respondents to the newspaper article about the research, four were Hapū members who lived outside of the immediate area, who were suggested by the Hapū committee, and two were spouses who contributed significantly to the interview discussions.

Of the 21 potential interview participants contacted, 20 consented to being interviewed. The other participant provided their views during participatory observations. Two other potential participants were unable to be contacted regarding interviews. However, their views were provided during participatory activities and in two documents that were analysed. When there was information saturation, meaning little to no new information arose, no more people were interviewed (Bernard, 1988; Bickman & Rog, 2009; Boeije, 2010). Two fishers who were suspected of illegal fishing were not interviewed as the aim was to present the collective Hapū perspective and those fishers' views were expected to be compromised by these suspicions. Their views had not been included in previous information gathering activities and they were not members of the Hapū.

Eighteen semi-structured interviews involving 20 people were conducted between February and June 2014, following the 2013-14 summer fishing season. Two interviews included spouses who contributed significantly to the discussion. Interview participants were asked open-ended questions about the importance of the kahawai fishery. The participants chose an interview location where they could speak freely and in private, either at home, work or the marae. Interviews were 40-180min duration and both Te Reo Māori and English were spoken. Participants varied in age, gender, generation, living proximity to the study site, interview language, interview location and whether they attended the kahawai management hui (Table 6-2).

Although Te Whānau-a-Apanui Iwi demographics were available for 2013, and could be used as a proxy for Hapū demographics, they are unlikely to indicate who has an interest in the management of the Mōtū kahawai fishery. Therefore the demographics of the interview

participants more likely reflect the latter population, rather than the Hapū population. For example, a greater number of men were interviewed, reflecting the fact that the fishery was traditionally a male only fishery. The perspectives of women were also captured, largely during participatory observation activities. A demographic analysis of the people who contributed during participatory observations and through documents was not conducted but would be useful to include in future studies.

Table 6-2 Demographic information about interview participants including age (<50, 50-70 or >70 ears), gender (female or male), generation (parent, grandparent or great-grandparent), living proximity to the study site (local 1-2 km, district 2-50 km or outside >50 km), interview language (English, Mixed or Te Reo Māori), interview location (home, marae or work) and attendance at kahawai management hui (no or yes).

Demographics	*Categories*		
	<50	**50-70**	**>70**
Age	3	12	5
	Female	**Male**	
Gender	6	14	
	Parent	**Grandparent**	**Great-grandparent**
Generation	4	10	6
	Local	**District**	**Outside**
Proximity to site	10	7	3
	English	**Mixed**	**Te Reo Māori**
Interview language	10	5	5
	Home	**Marae**	**Work**
Interview location	14	2	4
	No	**Yes**	
Attended hui	8	12	

All interviews were conducted by the same interviewer who also transcribed the Te Reo Māori interviews. TMS Transcription Services Ltd (TMS) transcribed the English components of the bilingual interviews. A research assistant then checked the spelling of Māori nouns and transcribed the Te Reo Māori components of the bilingual interviews using Express Scribe (*NCH Software*). All the transcripts were reviewed for accuracy. To maintain participants' privacy, identification (ID) numbers were assigned to the audio recordings and transcripts.

Participants suggested 41 documents (artefacts, photographs, published and unpublished literature, audios and videos) to include in the analysis (Table 6-3). Nine of the documents were not obtained. Documents were given unique ID numbers. All notes, transcripts and documents were uploaded to a project database in the NVIVO 10 for Windows *(Version 10.0.573.0 SP5 64-bit)* software package. If the information source was a video or photo, the source was viewed, and a description included in the database for coding.

I performed a qualitative thematic analysis following Boeije (2010). The text was first read for familiarity, followed by coding. Coding is the process of grouping similar phrases to identify

themes. Initial themes used were the Māori cultural values: aroha, kaitiakitanga, kotahitanga, manaakitanga, mana, tikanga, tino rangatiratanga, wairuatanga, whakapapa and whanaungatanga (see Definitions of Māori words in English) (Harmsworth & Awatere, 2013). This initial set was expanded during coding to include themes emerging from the information analysed. Emerging themes included: food source, identity, pūrākau (narratives; Lee, 2009), whānau (family) and tohatoha (to share, distribute). Some phrases were coded to more than one theme. Phrases that demonstrate how each value is expressed through the fishery were presented at a hui for Hapū confirmation on 13 July 2015 at Maraenui Marae.

Based on the thematic analysis results of the above provided information, I used Garibaldi and Turner's (2004) seven criteria for examining CKS, called the Identified Cultural Influence (ICI) Index to assess whether kahawai is a cultural keystone species (CKS) for TWAH/NH (Table 6-4). Question responses for each criterion were either: yes, very high; yes, high; yes, moderate; yes, low; yes, though very low or infrequent; or no, not used. The higher the rating for all questions the more likely a species is a cultural keystone (Garibaldi & Turner, 2004).

Table 6-3 Documents in video, photo, music, art and written form recommended by participants in the project to represent their views of the kahawai fishery at the Mōtū river mouth. The document ID number, reference, document type and document description are provided for the documents that were obtained. Documents that were not obtained are also included.

ID Number	*Reference*	*Type*	*Description*
D1	Richards, P. and Paora, R. (1992) He Tipuna Whakahirahira. *Printhouse Ltd.* Hamilton, NZ. 44 p.	Book	Research findings on the pou (posts) erected at the Te Whānau-ā-Apanui Area School, Te Kaha including tipuna, ancestors and genealogy. In Te Reo Māori.
D2	Penlington, B. P. (1988). The kahawai fishery at the Mōtū River mouth. *Technical Report* No. 103 MAFFish. Rotorua, NZ. 27 p.	Technical Report	A study was carried out from November 1982 to April 1983 to determine the factors influencing kahawai aggregations at the Mōtū River mouth which concluded that they were part of adult kahawai summer spawning migrations creating an important fishery to the people of the district.
D3	Ngāti Horomoana/Te Whānau-a-Hikarukutai (1990) Submission to the Ministry of Agriculture and Fisheries on the Proposed Auckland Fishery Management Plan. Signed: 14/03/1990.	Submissions to select committee	Six submissions made by Ngāti Horomoana/Te Whānau-a-Hikarukutai and the Honorary Fisheries Officers to the Ministry of Agriculture and Fisheries regarding the management of fisheries at the Mōtū River area.
D4	Hartill, B. and Walsh, C. (2005) Characterisation of the kahawai fisheries of NZ and review of biological knowledge. *Final Research Report* for Ministry of Fisheries Research Project KAH2004/01 Objective 1 (Unpublished Report held by Mfish, Wellington.)	Technical Report	Includes a questionnaire filled out by Jack Parata, Fisheries Manager for Te Rūnanga o Te Whānau, the tribal authority for 11 of the 13 Hapū of Te Whānau-ā-Apanui, including Te Whānau-a-Hikarukutai/Ngāti Horomoana.
D5	Mahinga Kai 28/12/2010, video recording, Hīkoi NZ Ltd, NZ/Aotearoa	Video	In the village of Maraenui in the Whānau-a-Apanui tribal lands, the traditional foods of the tribe are still gathered daily. Local kaumātua (elder) Fred Poihipi talks about the continuing practice of mahinga kai, those traditions that are declining and those that are now lost.
D6	Whakahuihui kōrero: Ripene 8 Kahawai, Television NZ, NZ/Aotearoa, Directed by Morehu McDonald	Video	Tells of the ancestor Poumātangatanga and his journey from Hawaiiki to Whangaparaoa and Maraenui. After marrying Ōhinemōtū, they had a son a He Kōpara. He Kōpara was lost and Poumātangatanga thought Tangaroa (a sea deity) had taken him. Poumātangatanga fashioned a net to capture Tangaroa. In the end the children of Tangaroa were killed. Each year the kahawai returns

ID Number	*Reference*	*Type*	*Description*
			to the beach. This is the history of the ancestors Ōhinemōtū, He Kōpara, Poumātangatanga, Wheao, Pikituariki me Te Wharau. Also talks about fishing and the kahawai season, the good days for fishing, tao kahawai (hāngī preserved kahawai), and the tikanga carried on today and the laws passed by the government.
D7	Waka Huia: Daniel Poihipi and traditional methods of fishing. 29 Jun 2014. TVNZ, directed by Ngatapa Black	Video	Danie Poihipi grew up in Ōpōtiki and Te Kaha under the guardianship of his grandfather, Tuakanakore Nikorima, who taught him traditional methods of catching kaimoana (seafood).
D8	Kai time on the road Series 3, Episode 10, 2004, Maui Productions Ltd, NZ/Aotearoa	Video	The story focuses on kahawai. The guests are: Kawe Samuels, Hakopa Haimona.
D9	Tangaroa with Pio. 28/02/2010, Aka Productions, NZ/Aotearoa	Video	Māori Fishing Programme. This week the Tangaroa with Pio team go to the East Coast, Rangitukia to catch kahawai. The guests are John Manuel, Chris Haenga, Hal Hovell, Rawiri Wanoa, Matekino Smith, Darryl Bishop, and Paul Dewes.
D10	Fusion Feasts, Series 1 Episode 4, Tuesday 22 April 2014, Raukatauri Productions Ltd, NZ/Aotearoa	Video	International chef and restaurateur Peter Gordon visits Ōmaiō to hunt and cook venison and revive a steam pudding recipe not seen there for 40 years. Also cooks kahawai as one of the dishes.
D11	He Kōrero Mo Te Kahawai, unpublished, author unknown	Notes	Gives information about the kahawai, the pūrākau of Poumātangatanga and Ōhinemōtū, the fishing nets, waves and whakapapa. Provided during interview with Participant 21.
D12	Rimini, T.W. (1891) Te Rironga o te pāua a Tapa-kakahu. *The Journal of The Polynesian Society*. No. 4, Volume 10, December. P 188-189	Journal Article	Tells the pūrākau of Tāpuikākahu who lost his prized fishing lure while fishing for kahawai and followed it to the Mōtū.
D13	No. 104 in Ngā Mōteatea Part II edited by Apirana Ngata	Waiata (song)	Not obtained.
D14	Edited by Apirana T. Ngata (1949) 221 He Patere Na Te Whakatōhea. *Journal of The Polynesian Society* Supplement. Ngā Mōteatea, Volume 58 p 297-420	Waiata Pātere (Chant)	Tells the pūrākau of Tāpuikākahu who lost his prized fishing lure while fishing for kahawai and followed it to the Mōtū. Gives the whakapapa of Tāpuikākahu.
D15	Callaghan, D. (2013) Underwater video.	Video	Images of kahawai swimming in the left-hand arm estuary of the Mōtū River during the 2012/2013 summer.

ID Number	*Reference*	*Type*	*Description*
D16	Video of Te Kura Mana Māori o Maraenui learning to tao kahawai (hāngī preserve kahawai) 20 years ago.	Video	Not obtained.
D17	Video from Whiripare Mclean about kahawai.	Video	Not obtained.
D18	Video from Millie Gerard of kaumātua talking about the history of Maraenui during an expedition up the Mōtū River/Houpoto 20 years ago.	Video	Not obtained.
D19	Haka, composed by Nehu Gage and performed by Te Whānau-ā-Apanui at Te Matatini Festival, Gisborne 2011.	Waiata Haka	Not obtained.
D20	Poi, composed by Danie Poihipi and performed by Te Whānau-ā-Apanui at Te Matatini Festival, Christchurch, 2015.	Waiata Poi (dance with a light ball on a string)	Not obtained.
D21	Poi, composed by Danie Poihipi and performed by Te Whānau-ā-Apanui at Te Matatini Festival, Rotorua, 2013.	Waiata Poi	Not obtained.
D22	Mural art at Cyberwaka	Images	Depicts the pūrākau of He Kōpara.
D23	Participant 35 University assignment about kahawai.	Report	Not obtained.
D24	Dobie, K. (2011) Te Aka Kūmara. Master of Māori Studies Thesis, Te Whare Wānanga o Awanuiārangi.	Thesis	The thesis focuses on mātauranga Māori of the kūmara (sweet potato, *Ipomoea batatas*) however a section at the beginning of the thesis focuses on the kahawai fishery at the Mōtū.
D25	Martin, R. Hi Ika ki Mōtū.	Book	A children's book about going fishing for kahawai at the Mōtū River.
D26	Poisoning from kahawai caught at the Mōtū. Ōpōtiki News.	Newspaper article	Not obtained.
D27	Kupa-Kora, C. (2014) Warning for online fish sellers. Your News. Ōpōtiki News, Whakatāne. Published Thursday 20 February 2014.	Newspaper article	Creates awareness of illegal activities taking place online.

ID Number	*Reference*	*Type*	*Description*
D28	Black, T. Literature Review of the Kahawai Fishery at Mōtū.	Literature Review	Bound copies of some of the relevant documents that have been published that relate to the Kahawai Fishery at Mōtū including a preface by the compiler.
D29	Best, E. (2005) Fishing Methods and Devices of the Māori. Te Papa Press. Wellington, NZ. 264 p.	Book	Describes different kahawai fishing lures.
D30	Ringatū Church (2005) Te Pukapuka o ngā Kawenata e Waru a te Atua me ngā Karakia Katoa a te Hāhi Ringatū ngā Kawenata a te Atua.	Book	Contains 8 Books of the Christian Old Testament and all of the prayers of the Ringatū Church. All written in Te Reo Māori. Describes the Pure and Huamata ceremonies that govern the kahawai fishing season.
D31	Binney, J. (2012) Redemption Songs: A Life of Te Kooti Arikirangi Te Turuki. Bridget Williams Books. Wellington, NZ. 689 p.	Book	This biography of Te Kooti Te Turuki, a Māori guerrilla fighter, places equal weight on his leadership after the wars. This text rests on oral narratives, recorded sayings and song texts, and the diaries and letters of Te Kooti himself to record this period of NZ history.
D32	Tawhai, W. K. (2013) Living By The Moon – Te Maramataka a Te Whānau-a-Apanui. *Huia Publishers* Wellington, Aotearoa, NZ. 76 p.	Book	A record of traditional knowledge handed down orally and through practical demonstration to Te Whānau-ā-Apanui from their forebears. It describes the maramataka (lunar calendar) and the knowledge of the cycles in nature that guided fishing, planting, harvesting and community activities.
D33	Te Kōhanga o Maraenui (2014) Waiata. Performed by Te Kōhanga o Maraenui at Te Kōhanga o Maraenui, Maraenui. Video recording.	Waiata	While visiting the Te Kōhanga o Maraenui alongside Te Kōhanga o Te Teko, the teachers and children performed a song about the pūrākau of the kahawai.
D34	Kōhanga o Maraenui (2014) Map of significant sites. Video recording.	Map	A map of significant sites of the Maraenui Bay area was drawn on the wall and I took a video recording of it.
D35	Photo of Nannies with Kahawai	Photograph	Not obtained, Phillipa Callaghan.
D36	Rally Recipe Book	Book	A Rally fundraiser recipe book with Kahawai Recipes.
D37	Waiotahe Valley School Recipe Book	Book	A Waiotahe Valley School recipe book with Kahawai Recipes.
D38	Jay Dobie YouTube video clip	Video	A video clip of Ashbrook School trip to Mōtū River.
D39	Waaka, T. (2013) Te Whatukura-o-Tangaroa. Ministry of Education, NZ.	Book	Traditional story about the sacred relic and fishing talisman ‘Te Whatukura o Tangaroa’, treasured by Te Whānau-a-Apanui, which was brought to NZ from Hawaiiki. Rua-te-pupuke places a fishing charm on a stone, creating a sacred whatukura that will bring the

ID Number	*Reference*	*Type*	*Description*
			fish. He gives it to his son Manuruhi, with the advice not to be greedy and remember the fish are the children of Tangaroa. However, Manuruhi doesn't say enough attention. Eventually he is kidnapped and pulled down to the depths of the sea by Tangaroa while fishing to feed his hungry child. Rua-te-pupuke is determined to find Manuruhi, and eventually finds Manuruhi as a tekoteko (carved figure on the gable of a meeting house) on top of Tangaroa's wharenui (big house). The next day Tangaroa and his children are unaware that the sun had risen because Rua-te-pupuke had covered the window and door of the wharenui. Rua-te-pupuke then sets the house on fire and takes the pou (posts) and the tekoteko in the image of Manuruhi from the wharenui, but leaves the sacred whatukura below the water where it will be safe, waiting for the time when the right man or woman arrives to take care of it.
D40	Cowan, James (1930) *The mauri of the fisheries.* The Māori: Yesterday and Today. Whitcombe and Tombs Limited, Christchurch, NZ.		Some of the *mauri-kohatum*, or stone emblems sacred to the gods of the fisheries, are preserved and are used to-day as they were centuries ago. At the mouth of the Mōtū River, in the Bay of Plenty, the local people, the Whānau-a-Apanui tribe still treasure as a sacred and most potent fishing talisman a very ancient stone called '*Te Whatukura-a-Tangaroa*' (The Sacred Red Stone of Tangaroa). The *Whatukura-a-Tangaroa* is preserved as a holy relic; it is very seldom that it is revealed to public gaze by the Ringatū folk of Maraenui, who have it in charge.
D41	Rimini, T.W. (1901) *Te Puna Kahawai i Mōtū.* The Journal of the Polynesian Society. Volume 10, No. 4, pages 183-190.	Journal article	Tells the Pūrākau of He Kōpara and how the kahawai came to Mōtū. Also talks about the extent of the Mōtū kahawai fishery at the end of the 19th century.

6.3 Results

TWAH/NH have multiple types of values (cultural, economic, environmental and social) associated with the Mōtū kahawai fishery however only the cultural values are presented here. In the following section, examples of cultural values the Hapū expresses through the Mōtū kahawai fishery, are presented followed by the CKS/ICI assessment findings.

6.3.1 Cultural values expressed through the Mōtū kahawai fishery

Table 6-5 provides examples of TWAH/NH expressing the cultural values: whānau, whanaungatanga, kotahitanga, manaakitanga, tohatoha, pūrākau, whakapapa, mana, tino rangatiratanga, kaitiakitanga, tikanga, aroha, food source, wairuatanga and identity, through the Mōtū kahawai fishery. As the values are interconnected, the examples of how they are expressed through the fishery often reflect multiple values. The participants' words are used ensuring their voices are heard. These values have been continually expressed through the fishery and TWAH/NH aim for this to continue indefinitely.

6.3.2 Kahawai as a cultural keystone species

The elements that indicate a CKS, ICI ratings and information supporting the ICI ratings are presented in Table 6-4. Overall, kahawai scored a 'very high' ICI rating for six criteria (intensive use; vocabulary; narrative, ceremonies, or symbolism; topical; irreplaceable; and traded) and a 'high' ICI rating for one criterion (multiple uses). The ICI ratings suggest kahawai is a CKS for TWAH/NH.

Table 6-4 Index of Identified Cultural Influence (ICI) for kahawai (Arripis trutta) as a Cultural Keystone Species (CKS) for Te Whānau-a-Hikarukutai/Ngāti Horomoana people. Question responses were either: yes, very high; yes, high; yes, moderate; yes, low; yes, though very low or infrequent; or no, not used. The higher the rating for all questions the more likely a species is a cultural keystone (Garibaldi & Turner, 2004).

Elements that indicate a cultural keystone species	*Rating*	*Supporting information*
Intensity, type and multiplicity of use		
(1) Is the species used intensively (routinely, and/or in large quantities)?	Yes, very high	For centuries of summers, kahawai have been caught as necessary and eaten by individuals and whānau for physical and spiritual nourishment, at gatherings, with visitors, and in preserved form during winter (Participants 30 and 8). Large catches were reported. In the late 1800s in D41: "When the sun begins to descend, and the sky is yellow, the ovens are prepared; there are four or five sub-tribes (*Hapū*) to one oven. Each oven is about three or four chains long and four feet wide. There are about twenty or thirty thousand fish in one oven." In the 1940-1950s: Every home put in a hundred fish into the hangi (Participant 17). In the 1980s Ritchie et al. (1982) surveyed 3270 kahawai caught over a 15-week period.
(2) Does the species have multiple uses?	Yes, moderate	There are multiple ways of cooking each part of the kahawai: head, hawa (fleshy part around the pectoral fins, throat), hua (gonads), fillets and vital organs (D10, D36 and D37; Participants 10, 11, 15, 16, 17 and 24); and the remains (bones, fins, tails, gills and bile) are used as garden fertiliser or fed to the pigs, dogs or seabirds (Participant 9 and 10).
Naming and terminology in a language, including use as seasonal or phenomenological indicators, names of months or seasons, place names.		
(3) Does the language incorporate names and specialised vocabulary relating to the species?	Yes, very high	The local dialect contains extensive specialised vocabulary relating to the fishery, such as makamaka (the local method of fishing for kahawai) and pāua (the local kahawai fishing lures) (Participant 10 and 17). There are tohu (indicators) to signal both the beginning and the end of the kahawai season (D6, D11 and D41).
Role in narratives, ceremonies, or symbolism		
(4) Is it prominently featured in narratives and/or ceremonies, dances, songs, or as a major crest, totem, or symbol?	Yes, very high	The pūrākau 'He Kōpara' is a rich narrative depicting the connections between the Atua, the Mōtū, the fishery, the people and their derived knowledge, practices and beliefs (D2, D6, D11 and D41). Special ceremonies open and close the fishery (D30), the kahawai features prominently in Hapū performances (D19, D20, D21 and D33), kahawai is the emblem of the local kōhanga reo (Māori language preschool) and is depicted in local murals, whakairo (carvings) and pou (totem posts) (i.e. D22).
Persistence and memory of use in relationship to cultural change		

Elements that indicate a cultural keystone species	*Rating*	*Supporting information*
(5) Is the species ubiquitous (present everywhere) in the collective cultural consciousness and frequently discussed?	Yes, very high	The community continuously converse about kahawai, the fishing, eating, management and importance of the kahawai generally, particularly during the fishing season (*Personal obs*., 2013 i.e. kahawai management hui, D3, D25, D26, D27 and D38).
Level of unique position in the culture		
(6) Would it be hard to replace this species with another available native species?	Yes, very high	It would be impossible to replace this species with another available native species because the cultural connections are so well-developed that the fishery is part of the Hapū identity (Participant 11). In addition, no other fishes congregate in such a phenomenal way at the Mōtū River (D2). No other fishes have the high fat and protein yields, ease of catching and processing during their presence in the area, and versatility (*Personal obs.*, 2014).
Extent to which it provides opportunities for resource acquisition from beyond the territory		
(7) Is it used as a trade item for other groups?	Yes, very high	Through reciprocal relationships, the Hapū exchanged kahawai for other resources from beyond their territory. For example, neighbouring inland Tūhoe people previously exchanged kererū (native wood pigeon, *Hemiphaga novaeseelandiae*) for kahawai prior to the banning of kererū harvesting (Fieldnotes, 2014).

Table 6-5 Examples of Te Whānau-a-Hikarukutai/Ngāti Horomoana expressing cultural values through the Mōtū Kahawai Fishery.

Theme	*Examples*	*Description*
Whānau	'Well to me its whānau and I mean, when you hear the story of the kahawai and He Kōpara and all that and how whakapapa is so important in all that; well that's, and I was going to say, well, what do I value most in life? Whānau.'	Whānau was the most important value for many participants in the interviews. Whānau is the immediate and extended family connected through whakapapa (genealogy). The story of the kahawai and He Kōpara refers to the ancestor Poumātangatanga from who the Hapū descends from, connecting the living generation to the Mōtū kahawai fishery.
Whānaungatanga	'For us it's a lot of – for me anyway, it's been a tradition in the whole family …how we catch it, we process it, you know the way of bottling even as far as the whanaungatanga by smoking it and taking it to others…' A Hapū member who is also a primary school teacher, promotes paternal interest in children's education by inviting parents on the annual school fishing trip to the Mōtū. Leading up to the trip, families learn Mōtū kahawai fishery tikanga, how to make pāua (kahawai fishing lures), and how to cast a line. The families then put their skills to use at the river mouth and afterwards process, cook and eat the kahawai together.	In the broad sense of the word, whanaungatanga is about relationships. The Mōtū kahawai fishery provides the Hapū, the local community and the wider community with social experiences that create and/ or strengthen relationships (social cohesion). When participating in the Mōtū kahawai fishery as a community, people are passing on distinct knowledge, practices and beliefs to the younger generations (intergenerational knowledge transfer).
Kotahitanga	'With us putting up signs and that sort of thing on our side as well as Tūtāwake putting up their signs…we've sort of come together in an agreement on that sort of thing.'	The Hapū work together with neighbouring Hapū and Iwi to manage the Mōtū kahawai fishery reflecting the value of kotahitanga (unity).
Manaakitanga	Hei whāngai manuhiri (To adopt, foster, care for, feed, nourish, nurture visitors).	Expressing manaakitanga (acts of giving or caring for) through the fishery was almost implicit because within Māori society it is common knowledge that a Hapū's ability to exercise manaakitanga reflects their mana or status. Hapū members express manaaki through the Mōtū kahawai fishery by keeping the beach clean, taking care of themselves and others while fishing and the most well-known way, by caring for visitors and offering them signature dishes of kahawai in particular.
Tohatoha	'Engari mēnā kua rahi i to rātou ika arā ka haere mai rātou ki te whakakī tāhau ipu, koira te whanaungatanga o te awa	Tohatoha (to share, distribute), is a value that sits alongside manaakitanga. In the Mōtū fishery context, tohatoha is expressed

Theme	*Examples*	*Description*
	mēnā he kanohi kitea koe taua awa e ka waimarie koe ka waimarie koe' (If they have a lot of fish, then they will come to fill my container, that's the social connections of the river, if you are a regular face at the river you are fortunate, you are very fortunate).	when fishers share their catch of kahawai with others who were unsuccessful, with people who are unable to fish for themselves, or who are visiting. Generally speaking no one would go without. Tohatoha was a common practice observed and experienced during the field work and it was noted by 13 interview participants.
Pūrākau	'For our Hapū, Te Whānau-a-Hikarukutai, it's [the Mōtū kahawai fishery] about Ōhinemōtū and Poumātangatanga…it's more about our tikanga [protocols], our whakapapa [genealogy], and what makes us special…based on our karakia [prayers], our rāhui [prohibitions] and everything else we do at home and the protection of our awa [river] and its resources.'	The pūrākau of Poumātangatanga, Ōhinemōtū (or Kōhinemōtū) and their son, He Kōpara, was the most common reference. Pūrākau are rich sources of knowledge, rituals, karakia (prayers) and history dating back many generations. The terms: 'kōrero' (narrative), 'pakiwaitara' (story that contains a moral within), 'history,' 'oral history,' and 'hītori o te kahawai' (history of the kahawai), were used by the participants when discussing the pūrākau. He Kōpara's story describes how the Mōtū kahawai fishery was established and connects Te Whānau-a-Hikarukutai/Ngāti Horomoana to the Mōtū area.
	A second pūrākau, Te Whatukura-a-Tangaroa, is about Manurihi being punished for taking more fish than he needed and disrespecting the sea. A third pūrākau, discussed by neighbouring Te Whakatōhea people is about their ancestor, Tāpuikākahu, who lost his pāua (kahawai fishing lure) which he recovers at the Mōtū river mouth. Although he is invited to dine there, he declines because he has plenty of food at home.	Kaua e tūkino te kahawai (do not disrespect the kahawai) is a principle that may be derived from the Te Whatukura-a-Tangaroa pūrākau and is reflected in the tikanga of the Mōtū kahawai fishery. For example, to take only what you need. This pūrākau describes historical fishing of Te Whakatōhea people for kahawai and provides further knowledge about the Mōtū kahawai fishery.
Whakapapa	'If there is a pakiwaitara (stories that contain a moral within) at the back or some tikanga or whakapapa behind something, it means that it's been there for over a thousand years, it just didn't get created.'	Te Whānau-a-Hikarukutai/Ngāti Horomoana people can recite their whakapapa back to Poumātangatanga, who is referred to in the pūrākau. This demonstrates their long-term connection with the Mōtū kahawai fishery.
Mana	Figure 6-1 shows a sign at Maraenui Beach where Te Whānau-a-Hikarukutai/Ngāti Horomoana state their mana taiopuru (paramount authority) over the Maraenui area.	Whakapapa also establishes the mana (authoritative status) of the Hapū to the Mōtū kahawai fishery and their place as tangata whenua at Maraenui.
Tino rangatiratanga	'He started talking to this fella [a MAF Ranger], and he said, 'Nah, nah, nah, we're looking after the place, we're	Tino rangatiratanga is another expression of mana, where the Hapū have a self-determined management system operating at the Mōtū River and over the Mōtū kahawai fishery.

Theme	*Examples*	*Description*
	taking over, we're the tangata whenua, eh, we have the rights.'	
Kaitiakitanga	Kaitiakitanga is the responsibility to: 'look after the stock coming to the next generations.' 'That's our taonga [special treasures], it's special to us and if we live here, and the river's always going to be here, the kahawai will, if we do it right, the kahawai will always be here too. And we owe the kahawai that much I reckon.' 'Fisheries is one of those taonga [special treasures] that we as tangata whenua … have equal access to and responsibility … for. I'm a great one in thinking you can't just put your hand out and expect not to give something and my view, the giving something is the responsibility and how we safeguard that … resource for āpōpō [tomorrow/future].' 'I know that I am a kaitiaki, I haven't got a label, I haven't got a badge, but I know I'm a kaitiaki. You know, because of what I do and how I treat the environment and then with my hunting and respect for … just the air that I breathe, I know that I'm a kaitiaki. I don't need someone to promote me.' 'The responsibility is everyone's not just a few designated personnel.'	These examples explain kaitiakitanga from the Hapū perspective and highlight the reciprocal nature of kaitiakitanga. The Mōtū kahawai fishery is such an important resource for the Hapū, for survival and identity, that it commands continual care. This example refers to the practice of legally gazetting kaitiaki for fisheries management purposes allowing particular people to issue customary fishing authorisations. This may have confused people's views of who is a kaitiaki and who is not. This participant points out that this is a role for all, it is a part of who we are as Māori and is not determined by law.
Tikanga	'Tera tonu te āhua manaaki a te tangata whenua i te kahawai.' (That is how the Indigenous people show care for the kahawai). 'Kaua e tūkino te kahawai' (do not mistreat the kahawai).	The Hapū have developed and maintained tikanga (protocols) for the fishery to support their overarching values. Tikanga are how local Indigenous people show care to the kahawai. All practices reflect this tikanga such as: caring for the environment on which the kahawai depends; fishing during the season when the kahawai are in good condition; catching only what you need; handling the fish to maintain its quality; utilising all of the fish caught; and the whole body of the fish, not just the fillets.
Aroha	'Āe katahi anō ka pera a Hikarukutai kaha i te pūpuri te tiaki i tana awa. Ko Tūkairangi te tangata mutunga te kaha ana kit e āwhina i tana Hapū a kaore he utu, kaore he aha, ko tana aroha tēnā, tana aroha ki te whānau' (Yes that's how Hikarukutai are, driven to maintain care for their river.	The Hapū demonstrate aroha (care, respect, love and compassion) for the kahawai when they participate in the fishery as a kaitiaki or fisher following the Hapū tikanga. Tūkairangi was a Hapū member, who in recent times, demonstrated what it meant to look after the Hapū and the Mōtū kahawai fishery together.

Theme	*Examples*	*Description*
	Tūkairangi was a man whose enthusiasm to help his Hapū was endless, without any payment, without any return whatsoever, that was his love, his love for the family).	
Food source	During the research, kahawai was the main dish served in a variety of ways, in local homes, at the marae and kōhanga reo.	Kahawai is a versatile staple food source for Te Whānau-a-Hikarukutai/Ngāti Horomoana. Participants were brought up eating kahawai, and it continues to be a main part of their diet – fresh in summer and preserved in winter.
Wairuatanga	'Fisheries is just one part of what this body needs to function. It also requires a lot of other things. So, for me, the kahawai specifically is one part of my diet for my tinana [body] and wairua [spirit] that I can't go without. It needs constant feeding, constant feeding on a physical and mental basis, mostly just wairua, feed the wairua.'	This participant describes how kahawai enhances the physical and metaphysical well-being of Hapū members. Hapū members are connecting to their past by participating in the fishery and eating kahawai just as the ancestors did centuries ago.
Identity	'You can cook kahawai a hundred ways aye? We are from the land of the kahawai, we should just be dishing up kahawai all the time and then you get some of the manuhiri [visitors] who are like a few of them go, 'E hoa [hey mate], I didn't come here for a sandwich, I come here for a kahawai,' you know that sort of stuff? So, we just keep the old kahawai rolling out.' 'It's definitely…Maraenui, it's us and it's the Mōtū…take the kahawai away and hell.'	These examples describe how the Mōtū kahawai fishery provides the Mōtū, Maraenui and Te Whānau-a-Hikarukutai/Ngāti Horomoana people with a source of identity. It is what they are known for. Through the Mōtū kahawai fishery the Hapū express Māori values in their own unique way.

Figure 6-1 Sign at Maraenui Beach to the right of the Mōtū River indicating that Te Whānau-a-Hikarukutai/Ngāti Horomoana have mana over the area (K. Maxwell, 2013).

6.4 Discussion

TWAH/NH not only value kahawai highly as a customary food source but also as an essential means for expressing their distinct culture. Kahawai are part of the community's cultural identity and well-being and are their irreplaceable CKS or taonga species. High cultural value of turtles and dugong has led to co-management and the use of traditional ecological knowledge in managing these fisheries in the Torres Strait Islands, Australia (Butler et al., 2012). Kahawai provide a focal point for co-managing the Mōtū kahawai fishery socio-ecological system and applying local Indigenous knowledge and practices.

Indigenous knowledge and practices, specifically for CKS, may provide additional sustainable management tools. For example, Mōtū kahawai fishery practices include fishing during the kahawai season; catching only what is needed; handling the fish to maintain quality; utilising all fish caught and the whole fish, not just fillets, thereby reducing the catch and maximising the value gained from the catch. These practices are essential for improving how fisheries management protects and enhances cultural values. Fisheries (Kaimoana Customary Fishing) Regulations 1998 and Iwi settlement fisheries bylaws are two avenues for recognising Indigenous knowledge and practices in NZ fisheries management (Ministry of Fisheries, 2008; Waikato-Tainui Fisheries Area Bylaws, n.d.).

Only experiencing the Mōtū kahawai fishery can truly emphasise its importance to TWAH/NH and much is lost through the written word. However, this work is useful for communities

wishing to communicate the importance of their taonga species to the wider global community. The information gathering exercises worked well, but they were time-consuming, as was the analysis. More direct group discussions focusing on the key questions of the ICI assessment may reduce the time taken to identify CKS in future. However, this may not bring out the wealth of information that can be used for additional purposes, such as creating a management plan or identifying Indigenous or local ecological knowledge associated with the fishery. See Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery) and Chapter 9 (Holistic Mōtū kahawai fishery management) for examples of how the information gathered in this chapter was analysed further to address questions 6 (What knowledge does the Māori community hold regarding the fishery?) and 7 (What are the key components of the fishery from a Māori perspective?). Ideally, it depends on the goals the research is aiming to achieve through the research.

Supporting communities to conduct this research for themselves will allow more CKS to be identified quickly, with sensitive cultural knowledge being interpreted accurately while remaining private. Collectively, these Hapū expressions of culture embody the NZ Māori culture. More fisheries CKS need to be identified, to emphasise the importance of fisheries to culture, and the important role fisheries management has in protecting and enhancing fisheries-dependent cultures like TWAH/NH.

Understanding the cultural value of CKS fisheries may help to develop more appropriate and robust indicators. Presently, the trend in number of customary authorisations fulfilled (the proportion of fish, seaweed or aquatic life authorised to be caught for customary purposes that is actually taken) is the indicator for 'maximising cultural benefits' for NZ fisheries (Ministry of Fisheries, 2011). However, this indicator is probably negatively biased because customary catch can also be taken under the recreational catch regulations but without the need for paperwork (Maxwell, 2012). This indicator neither demonstrates whether the customary fishery is being sustained or cultural benefits maximised.

The Mōtū kahawai fishery was previously only recognised as an important traditional food source to the Hapū. This research demonstrates the cultural importance of the Mōtū kahawai fishery as a unique means of expressing cultural, a source of identity and enhanced well-being. The concern expressed by Māori over the fishery will continue until the fishery is adequately addressing the cultural needs of the Hapū. This includes having the tikanga of the fishery respected, rather than challenged. Another need was to see the associated species and habitat considered in the management of the fishery, which will be addressed in the next chapter, Chapter 7 (Ecological relationship between kahawai and the Mōtū).

Chapter 7 Ecological relationship between kahawai and the Mōtū

In this chapter the ecological relationship between kahawai and the Mōtū river mouth is investigated, as this is the foundation of the Mōtū Kahawai Fishery. The chapter has four sections. In the first section the importance of estuaries to fish is described, and four hypotheses to explain the ecological relationship between kahawai and river mouths are proposed. In the second section the methods followed to measure environmental variables, sample kahawai, and investigate each of the four hypotheses are described. In the third section the findings are presented for environmental variables, kahawai characteristics, and each of the four hypotheses. In the fourth section we discuss the findings and which hypothesis most likely explains the Mōtū-kahawai relationship, before surmising why this might be the case. As the chapter is large, it also has a conclusion section.

7.1 Introduction

High productivity, coupled with shallow water and sheltered conditions, makes estuaries ideal fish nursery grounds, permanent residences, and feeding grounds for transient visitors from the open sea (Webb, 1973). Estuarine triplefins (*Forsterygion nigripenne*) complete their life cycles in estuaries. Adult parore (*Girella tricuspidata*) and īnanga (*Galaxias maculatus*) come in from the sea to spawn there, while others such as sand and yellow-belly flounder (pātiki, *Rhombosolea plebe* and pātiki-totara, *R. leporina*, respectively), enter as larvae or juveniles and grow to maturity before migrating to the open sea (Kilner & Akroyd, 1978). Seventeen of the 27 NZ freshwater fishes migrate upstream or downstream through NZ's river estuaries, with migrations peaking in spring and autumn (McDowall, 1977).

There appear to be two groups of kahawai utilising river estuaries, a resident juvenile group and a seasonally migrating adult group. Kilner and Akroyd (1978) reported kahawai using Ahuriri estuary as a feeding ground, with small numbers of kahawai in Ahuriri estuary year-round and a seasonal migration of kahawai into the Ahuriri estuary occurring from February to April, when more fish were caught. This description of kahawai utilising the Ahuriri estuary is similar to that described for adult kahawai at the Mōtū River (Penlington, 1988). Here we look in more detail at the use of the Mōtū river estuary by kahawai. We propose four hypotheses to explain why kahawai enter the estuary: (1) to forage for food; (2) to remove parasites; (3) to avoid predators; and (4) to reproduce.

7.1.1 The Mōtū river mouth as a food source for adult kahawai

The food source hypothesis is based on Penlington (1988), who indicated that several kahawai prey species were present at the Mōtū river mouth. As mentioned in Chapter 2 (History and background of the Mōtū kahawai fishery), black flounder (pātiki-mohoao, *R. retiaria*),

common bully (*Gobiomorphus cotidianus*), grey mullet (kānae, *Mugil cephalus*), īnanga, kahawai, parore, estuarine triplefin, and yellow-eyed mullet (aua, *Aldrichetta forsteri*) are all found in the Mōtū river estuary (Penlington, 1988). Kahawai appear to be very capable of shifting between prey types and feeding methods. Juvenile kahawai (total length<10cm) predominantly eat copepods and crustaceans before shifting to eating small fish as adults (Baker, 1971; Hughes et al., 2013). Fish prey are mainly anchovies (kokowhāwhā, *Engraulis australis*), pilchards (mohimohi, *Sardinops* spp.) and yellow-eyed mullet (aua, *A. forsteri*) (Baker, 1971; Hughes et al., 2014; Penlington, 1988). However a wide variety of small fishes and crustaceans, most notably krill (*Nyctiphanes australis*), other small invertebrates, and algae, have also been found in kahawai stomachs suggesting adaptive (opportunistic) foraging is possible (Baker, 1971; Graham, 1953; Kilner & Akroyd, 1978; Moreland, 1963; Stewart et al., 2011).

Kahawai stomachs typically contain a single prey type of a similar digestive state, and the stomachs themselves are capable of rapid digestion and considerable distension (Baker, 1971; Hughes et al., 2014). These traits suggest that kahawai prefer to gorge themselves quickly on aggregated prey and then stop feeding until the stomach is empty again, rather than persistently feeding. This is consistent with the observation of fish usually caught with empty stomachs in kahawai diet studies (Baker, 1971; Hughes et al. 2014; Kilner and Akroyd, 1985; Webb, 1973), and the prey herding behaviour of kahawai (Foster et al., 2001). Indeed, one juvenile kahawai (TL=5.5cm) contained 436 copepods and 18 decapods and another (TL=5.3cm) 8 juvenile sole (pātiki-rore, *Peltorhamphus novaezeelandiae*, Baker, 1971). Two larger kahawai (FL=30.8cm and FL=46.8cm) were reported with respectively, 27 anchovies, and 11 anchovies and 19 pilchards, in their stomachs (Baker, 1971).

Kahawai may therefore be taking advantage of other prey fish migrations through the estuary. Banded kōkopu (*Galaxias fasciatus*), bluegill bully (*Gobiomorphus hubbsi*), kōaro (*Galaxis brevipinnis*), longfin eel (tuna, *A. dieffenbachii*), redfin bully (*Gobiomorphus huttoni*), shortfin eel (tuna, *A. australis*), shortjaw kōkopu (*Galaxias postvectis*), and torrentfish (panoko, *Cheimarrichthys fosteri*) live in the upper reaches of the river but migrate through or spawn in the estuary (Rowe, 1981). Tiny "glass" eels enter the estuary between July and December (NZ Freshwater Fish database, https://nzffdms.niwa.co.nz/, *accessed 22 January 2019*). Whitebait species (īnanga *G. maculatus*), banded kōkopu, kōaro, and shortjaw kōkopu), redfin bullies and juvenile torrentfish enter freshwater during spring, where they are fed on by black flounder (pātiki-mohoao, *R. retiaria*). Kahawai previously caught at the Mōtū river mouth contained anchovies (kokowhāwhā, *E. australis*), yellow-tail kingfish (hakū, *Seriola lalandi lalandi*),

sausage worms (*Echiura* sp.), freshwater eels (tuna, *Anguilla* spp.), triplefin blennies (*Tripterygion* sp.) and common freshwater bully (*Gobiomorphus* sp.) in their stomachs. However it was not clear if these were juvenile or migrating adult kahawai (Penlington, 1988). Regional and seasonal variation in *A. trutta* diet has been observed in both Australia and NZ and is likely due to seasonal changes in prey abundance and distribution (Baker, 1971; Hughes et al., 2013). Fish are more frequent year-round while crustaceans are also frequent in summer and winter when there are more present (Baker, 1971). Adult *A. trutta* consume ~4.8 times their own weight per year with digestion being 1.3 times faster at 20°C than at 15°C (Hughes et al., 2014). *A. trutta* may also consume a larger volume of prey to compensate for increased metabolism in warmer waters. Kahawai can also switch to opportunistic feeding, at times containing a variety of species including benthic prey such as opalfish (*Hemerocoetes ancanthorhynchus*) and Scorpaenids (Baker, 1971). *Arripis trutta* are also relatively resilient to long-term shifts in prey abundance. Historically, euphausiids or krill (*N. australis*) were the main prey of the eastern Australian *A. trutta* (Malcolm, 1959). However, in south-east (SE) Australia *A. trutta* diet has recently shifted from pelagic crustaceans to small pelagic fishes, thought due to the increased intensity of the East Australian Current reducing the availability of krill (Hughes et al., 2013).

7.1.2 The Mōtū river mouth as a place for kahawai to remove parasites

The parasite removal hypothesis is based on a previous report documenting that freshwater baths are used to treat farmed yellow-tail kingfish (haku, *S. lalandi*) for *Bendenia* flatworm infections (Bardach et al., 1972). Baker (1971) found 12.6% of kahawai from Wellington Harbour were parasitized. Known kahawai parasites are listed in Table 7-1 and include: *Caligus kahawai, Caligus pelamydis, Ceratothoa imbricata, Nerocila orbignyi,* externally; *Kahawaia truttae*, in the gills; and *Hysterothylacium aduncum, Hysterothylacium* spp., *Parahemiurus, Neoechinorhynchus (Neoechinorhynchus) chilkaensis, Nybelinia* sp., *Telorhynchus arripidis,* and trematode adults, internally. Marine external or stomach parasites may therefore be removed by swimming in and/or ingesting freshwater.

Penlington (1988) compared gill and mucous scrapings of kahawai that had been bathed in individual freshwater baths for 20 minutes with a control group, i.e. not bathed in freshwater. He found no parasites in any of the samples and suggested that kahawai did not congregate at the river mouth to remove parasites. However, Penlington (1988) used a small sample (n=5). Here we examine the hypothesis again, using a larger sample, looking at both external and internal parasites.

Table 7-1 Metazoan parasite fauna from A. trutta from published literature.

Taxonomic group	*Species*	*Location*	*Reference*
Ancanthocephala: Eoacanthocephala: Neoechinorhynchida: Neochinorhynchidae: Neoechinorhynchinae:	*Neoechinorhynchus (Neoechinorhynchus) chilkaensis* (Podder, 1937) – published as *Neoechinorhynchus chilkaensis* (Podder, 1937)	Intestine	Webb (1973) Updated using Gibson ()
Arthropoda: Crustracea: Multicrustacea: Hexanauplia: Copepoda: Neocopepoda: Podoplea: Siphonostomatoida: Caligidae	*Caligus kahawai* (Jones, 1988)	Body surface	Jones (1988) Updated using Walter & Boxshall (2018)
Arthropoda: Crustracea: Multicrustacea: Hexanauplia: Copepoda: Neocopepoda: Podoplea: Siphonostomatoida: Caligidae	*Caligus pelamydis* (Krøyer, 1863)	Operculum, gills, buccal cavity, body surface	Jones (1988) Updated using Walter & Boxshall (2018)
Arthropoda: Crustracea: Multicrustacea: Malacostraca: Eumalacostraca: Peracarida: Isopoda: Cymothoida: Cymothooidea: Cymothoidae	*Ceratothoa imbricata*, Fabricius, 1775) – published as *Codonophilus imbricatus* (Fabricius, 1787)	Tongue and throat	Baker (1971) Updated using: Boyko, et al. (2008)
Arthropoda: Crustracea: Multicrustacea: Malacostraca: Eumalacostraca: Peracarida: Isopoda: Cymothoida: Cymothooidea: Cymothoidae	*Nerocila orbignyi* (Guérin-Méneville, 1832) – published as *Nerocila orbignyi* (Guerin)	Body (?)	Thomson (1889) in Hewitt and Hine (1972) Updated using: Boyko, et al. (2008)
Cnidaria: Myxozoa: Myxosporea: Bivalvulida: Variisporina: Ceratomyxidae	*Ceratomyxa annulata* (Meglitsch, 1960) – published as *Leptotheca annulata*	Gall bladder	Meglitsch (1960) in Hewitt and Hine (1972) Updated using: WoRMS (2018)
Cnidaria: Myxozoa: Myxosporea: Bivalvulida: Variisporina: Ceratomyxidae	*Ceratomyxa minima* (Meglitsch, 1960) – published as *Leptotheca minima*	Gall bladder	Meglitsch (1960) in Hewitt and Hine (1972) Updated using: WoRMS (2018)
Nematoda: Chromadorea: Chromadoria: Rhabditida: Spirurina: Ascaridomorpha: Ascaridoidea: Anisakidae: Anisakinae	*Anisakis* sp. Larva (Dujardin, 1845) – published as *Anisakis* sp. Larva	Encapsulated on viscera, mesenteries and under peritoneum	Brunsdon (1956) in Hewitt and Hine (1972) Updated using: Bezerra et al. (2018)

Taxonomic group	*Species*	*Location*	*Reference*
Nematoda: Chromadorea: Chromadoria: Rhabditida: Spirurina: Ascaridomorpha: Ascaridoidea: Raphidascarididae: Raphidascaridinae: Raphidascaridinea	*Hysterothylacium aduncum* (Rudolphi, 1802) – published as *Contracaecum (Thynnascaris) aduncum* (Rudolphi, 1802)	Intestine	Brunsdon (1956), Baker (1971) and Webb (1973) Updated using: WoRMS (2018)
Nematoda: Chromadorea: Chromadoria: Rhabditida: Spirurina: Ascaridomorpha: Ascaridoidea: Raphidascarididae: Raphidascaridinae: Raphidascaridinea	*Hysterothylacium* spp. (Ward & Magath, 1917) larvae two types – published as *Contracaecum (Thynnascaris)* spp. Larvae two types	In stomach, intestine and body cavity	Brunsdon (1956) in Hewitt and Hine (1972) Updated using: Bezerra et al. (2018)
Platyhelminthes: Neodermata: Monogenea: Polyopisthocotylea: Mazocraeidea: Microcotylidae	*Kahawaia truttae* (Dillon and Hargis, 1965) – published as *Gonoplasius truttae*	Gills	Dillon and Hargis (1965) in Hewitt and Hine (1972) Updated using: WoRMS (2018)
Platyhelminthes: Neodermata: Cestoda: Eucestoda: Trypanorhyncha: Trypanobatoida: Tentacularioidea: Tentaculariidae	*Nybelinia* sp. Larva (Poche, 1926) – published as *Nybelinia* sp. Larva	Stomach (ingested?)	Baker (1971) Updated using: WoRMS (2018)
Platyhelminthes: Neodermata: Trematoda: Digenea: Plagiorchiida: Hemiurata: Hemiuroidea: Hemiuridae: Hemiurinae	*Parahemiurus* (Vaz and Pereira, 1930) – published as *Anahemiurus sp.*	Stomach, intestine of small kahawai	Baker (1971) Updated using: WoRMS (2018)
Platyhelminthes: Neodermata: Trematoda: Digenea: Plagiorchiida: Bucephalata: Bucephaloidea: Bucephalidae: Prosorhynchinae	*Telorhynchus arripidis* (Crowcroft, 1947)	Intestine, digestive tract	Manter (1954) in Hewitt and Hine (1972) Updated using: WoRMS (2018)
Platyhelminthes: Neodermata	Trematoda adults	Not stated however fins, gills, digestive tract examined	Webb (1973) Updated using: WoRMS (2018)

7.1.3 The Mōtū river mouth as a haven for kahawai to avoid predators

The predator avoidance hypothesis is based on the fact that some fish migrate to avoid predators. For example, adult sockeye salmon (*Oncorhynchus nerka*) in south-western Alaskan streams avoid brown bear (*Ursus arctos*) predation during the reproductive season by migrating into the lake for most of the day. Then during the night, when bear activity on streams is lowest, the salmon returned to the streams to spawn (Bentley et al., 2014). This greatly increased the salmon's odds of survival, with migrating fish living 120-310% longer than non-migrating fish early in the spawning season, and later in the season, when predation pressure was highest, migrating fish living 10-60% longer than non-migrating fish (Bentley et al., 2014).

Roach (*Rutilus rutilus*), a fish in southern Sweden, migrates from Lake Krankesjön to adjacent streams in autumn and stays there until spring to avoid predatory Northern pikes (*Esox lucius*) that are present in the lake over winter (Brönmark et al., 2008). As the roach have low growth rates in winter compared to summer, it is better to leave the lake and avoid being eaten, than to stay and risk being eaten for a small increase in size (Brönmark et al., 2008).

In the northern hemisphere, apex marine predators undertake migrations following shifts in prey distributions that are driven by species-specific thermal tolerances and oceanic processes (Block et al., 2011). These top predator migrations most likely take place in the southern hemisphere too. The warm, poleward-flowing currents near south-east Australia allow skipjack tuna (*K. pelamis*) to extend their distribution to 40^{o}S, which roughly corresponds to the 20°C surface isotherm (Ministry for Primary Industries, 2017). Skipjack tuna are prey of larger tunas, highly migratory sharks and billfish (Jones, 2008). McDowall (1977) reported a skipjack tuna being caught some kilometres up the Whakatāne River. Therefore, kahawai, which often school together with skipjack tuna, jack mackerels and blue mackerels, may migrate with skipjack tuna to rivers, to avoid the large predators that come with the tuna. Kahawai may enter estuaries because the shallow water and/or increased habitat complexity may decrease predation, or because predators may be less able to tolerate reduced salinity than the kahawai.

7.1.4 The Mōtū river mouth as a place for kahawai to reproduce

The reproduction hypothesis is based on the strong evidence supporting kahawai spawning during the summer months. Malcolm (1966) suggested Australian *A. trutta* spawn from December to February in Lakes Entrance, Victoria, and Eden, New South Wales, the centre of the adult fishery; and from November to February in Ulladulla, New South Wales. Australian *A. trutta* also spawn from late spring to early autumn between Coffs Harbour and Eden, New South Wales (Hughes, 2012). In NZ, 'ripe' kahawai have been reported from Cape Campbell, Marlborough, and Bean Rock, Waitemata Harbour, in January and February; Cape Maria van

Diemen, Northland in March (Thompson, 1892 in Baker 1971); and four 'ripe' or 'running ripe' kahawai were caught off the Wairarapa coast and Hokitika in February and March (Hurst et al., 2000). Over 50% of kahawai sampled from the Mōtū River had ripe (stage 3) or greater gonad development in January and February of 1983 (Penlington, 1988).

Ministry for Primary Industries (2017) states: "The spawning habitat of kahawai is unknown but is thought to be associated with the seabed offshore. Schools of females with running ripe ovaries have been caught by bottom trawl in 60-100m in Hawke Bay (Jones et al., 1992). Other females with running ripe ovaries have been observed in east coast purse-seine landings sampled in March and April 1992, and between January and April in 1993 (McKenzie NIWA, unpublished data)." This is, therefore, in conflict with an estuarine spawning hypothesis. However, there is no mention of schools of females with running ripe ovaries being caught by bottom trawl in 60-100m in Hawke Bay in Jones et al. (1992). Jones et al. (1992) states: "it is not known where kahawai spawn (either in Australia or NZ), but there are unconfirmed reports that it is on the seabed in open water (No reference)." Spawning habitat is not mentioned in the latest KAH1 stock assessment (Hartill & Bian, 2016). Hurst et al. (2000) also state: "kahawai spawn on the seabed (60-100m water depth) in open water (No reference)," before adding "Spawning females are caught in January and February in trawl bycatch off the north coast of the North Island (Annala et al. 1999). Annala et al. (1999) state that kahawai spawn on the seabed (60-100m deep) in open water. Spawning female occurred in January and February 1993 in trawl bycatch in northern New Zealand. This is likely referring again to: McKenzie NIWA, unpublished data. Therefore, it seems a passing anecdotal mention by Jones et al. (1992) has been broadly taken as evidence. However, it is more reasonable to conclude that kahawai spawning habitat is unknown.

A lack of specific spawning habitat information may be due to gamete release taking place some distance from beaches, or at night when observations are difficult to make (Hughes, 2012). Malcolm (1960) suggested that after spending some time offshore, *A. trutta* return inshore to spawn in a very limited area. This is more consistent with an estuary rather than open ocean spawning hypothesis. *Arripis georgianus* is thought to spawn near Rottnest Island, Western Australia (Lenanton, 1978). For the eastern subspecies, *A. trutta marginata*, no spawning activity was observed in Tasmanian waters but was deduced to occur at the Lakes Entrance, Eden and Bermagui areas, all large bays with large river mouths (Stanley & Malcolm, 1977). Hughes (2012) suggested a critical water temperature for spawning in SE Australia of 16-18°C. *A. trutta marginata* is either a fractional spawner, with only part of the eggs present

in the ovary ripe at any given time, or has a prolonged spawning period with individuals extruding their entire ovary contents at different times (Stanley & Malcolm, 1977). Kahawai are thought to be serial spawners, with a prolonged spawning period, spawning multiple times in one season (Smith and Suthers, 1999).

Populations with skewed sex ratios, an unequal number of males to females, are also a common feature of spawning aggregations. In the spawning shoals of Atlantic Cod (*Gadus morhua*) from the northern Grand Bank and southern Scotian Shelf/Bay of Fundy, catch was dominated by males when the cod were spawning, and dominated by females after the cod had completed spawning (Morgan & Trippel, 1996). Morgan & Trippel (1996) propose the males arrive at the spawning area first, with females moving into the area when ready to spawn and then returning to deeper, warmer water once they completed spawning. A skewed sex ratio of 0.67 males to every female was observed at the Mōtū river mouth across the 21 sampling days between November 1982 and April 1983 (Penlington, 1988), further supporting a spawning aggregation there.

Another indicator of spawning location is the presence of hydrated eggs, which occurs within hours of spawning in temperate teleost fish (Cerdà, 2009). Kahawai eggs were described by Robertson (1975) as having a smooth chorion, 0.90-0.98mm in diameter, with a single oil droplet of 0.24-0.28mm diameter. Crossland (1982) cited in Jones et al. (1992) collected eggs, presumed to be kahawai eggs as they fitted the description, in February 1978, just north of Ngatamahine Point, Little Barrier Island, in the outer Hauraki Gulf. This was also nearshore, further supporting the hypothesis that NZ kahawai spawn close to shore, rather than offshore.

Condition is another indicator of reproduction, as fish need fat reserves to start the spawning process. Fish also mobilise energy reserves during the spawning cycle, but the pattern varies according to species, with some fish utilising lipids stored in the flesh and others utilising lipids stored in the livers (Hoar, 1957). Therefore, a decline in either body condition or liver condition would be expected post-spawning.

7.2 Methods

In this study we collect biological and habitat observations for kahawai in the Mōtū estuary, and further offshore in the Bay of Plenty, in order to evaluate these hypotheses for the seasonal kahawai fishery at the Mōtū River. This section has six parts describing how the data to investigate each of the hypotheses was collected and analysed. Part one describes environmental data collection to determine if the sampling year was typical or unusual, and part two describes how kahawai were sampled and characteristics tested to ensure the kahawai were suitable for comparison. Parts three to six describe the specific data collection and

analysis for each of the four hypotheses i.e. food source, parasite removal, predator avoidance and reproduction. Table 7-2 lists the data collected and the statistics derived for each section.

Table 7-2 Summary table of data collected, and derived statistics where applicable.

Section	*Observations*
Environment	River discharge rate ($m^3 \cdot s^{-1}$) Air temperature (T°C) Dissolved oxygen (DO, %) pH (pH units) Salinity (ppt.) Water temperature (T°C)
Kahawai characteristics	Fork length (FL, cm) Length-weight relationship Wet weight (WW, g)
Food source hypothesis	Stomach contents Stomach fullness index (SFI, %) Stomach fullness scale (SFS) Stomach contents freshness (SCF)
Parasite removal hypothesis	Parasite types Parasite prevalence Parasite mean intensity and intensity range
Predator avoidance hypothesis	Literature review of kahawai predators Field observations of predators
Reproduction hypothesis	Sex ratio Macroscopic gonad stage (MGS) Gonadosomatic Index (GSI, %) GSI over Lunar phase Lipid Index (LI, %) Hepatic Index (HI, %)

7.2.1 Assessing the Mōtū river mouth environmental conditions

Data collection took place monthly during the traditional kahawai fishing season (from December 2014 to April 2015). For the Mōtū river mouth, the river discharge rate ($m^3 \cdot s^{-1}$), air temperature (°C), water temperature (°C), dissolved oxygen saturation (DO %), pH, (pH units), and salinity (ppt.) were measured.

River discharge rate was measured monthly for the full width of the river and the right arm of the river, but only once for the left arm of the river (Figure 7-1). The total river width was measured and divided into five equal sections. At each intersection the depth of the river was measured and at the centre of each section, at 60% depth, the velocity ($m \cdot s^{-1}$) was measured using a Swoffer (*Model 3000*) current velocity meter/flow meter. This meter counts the number of propeller revolutions in a 20s time period. Dividing the number of revolutions by the time period gives the velocity ($m \cdot s^{-1}$).

For river edge sections, the section width was multiplied by the section depth and then divided by two, as they are approximately triangle sections, before multiplying by velocity. For centre sections, the section width was multiplied by the section depth and velocity. The average discharge rates of the five sections were summed to represent total river discharge rate. The rate could not be measured for December 2014 because the river was in flood and it was too dangerous. Official Mōtū River discharge rates measured at the Houpoto Bridge were accessed through NIWA's Aquarius web portal (https://hydrowebportal.niwa.co.nz/, accessed *24 March 2018*, to compare with the measurements made and to give an overall picture of the river flows.

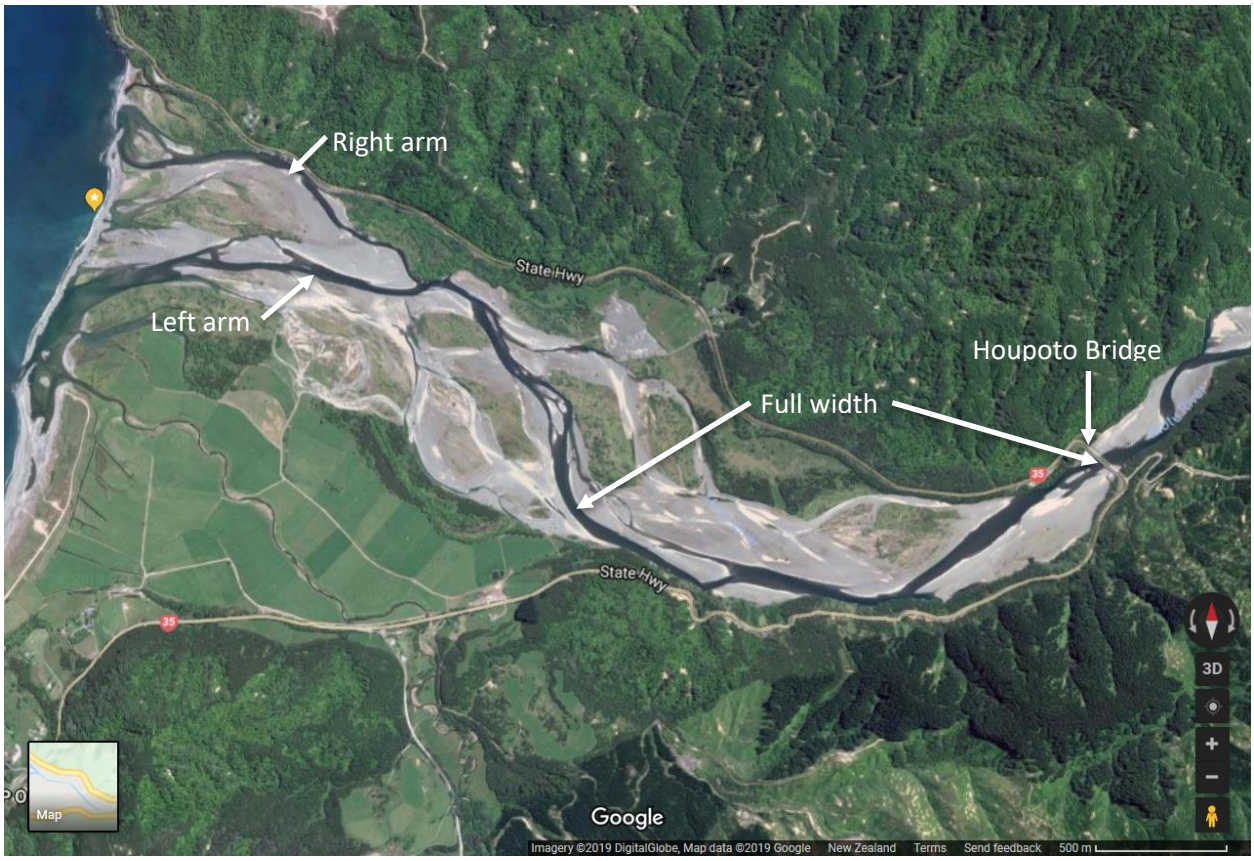


Figure 7-1 River discharge rate measuring locations for the full width, left arm and right arm of the Mōtū River.

Water temperature was measured in the river, at the mouth and in the sea. DO (to the nearest 0.1% saturation), air and water temperature (to the nearest 0.1°C) and were measured using a portable DO meter and InsiteIG (*Model 3100+*) fluorescence DO sensor. Conductivity (to the nearest 2000±10µS·cm^{-1}) was measured using a *Eutech ECTestr11* Dual Range conductivity tester and converted to salinity (ppt.) online at http://www.chemiasoft.com/chemd/salinity_calculator; and pH was measured (to the nearest 0.1±0.2pH) using a pH meter pen (*Digitech Model QM-1670*).

For the wider Bay of Plenty region, the long-term average monthly sea surface temperatures (°C) were located online at World Sea Temperatures (www.seatemperature.org). During the sampling period the Southern Oscillation Index (SOI) was neutral (Ministry for the Environment & Statistics New Zealand, 2016); and the Interdecadal Pacific Oscillation (IPO) was in a positive phase, which is linked to drier than normal conditions in the north and east of NZ (Ministry for the Environment, 2017).

7.2.2 Assessing kahawai biological characteristics

Kahawai (mean FL=49.42cm, range=26.40-57.50cm) were sampled monthly between December 2014 and April 2015 (Victoria University of Wellington Animal Ethics Committee Project No. 2014R25). River fish were sampled from the Mōtū kahawai fishery. The river fish were sampled from handline and lure catch, meaning only fish that strike at the lures were caught. The analyses for different hypotheses, have different samples sizes because some of the fish sampled had already been gutted, i.e. either gills, stomachs and/or roe removed. Commercial fishers based in Whakatāne and Tauranga provided sea fish from the Bay of Plenty for comparison. The commercial fishers did not provide their catch locations, therefore catch and effort data were accessed from the Ministry for Primary Industries (MPI) to estimate where the fish had been caught by plotting tow start points, during the sampling period, on a map of the Bay of Plenty (Figure 7-2).

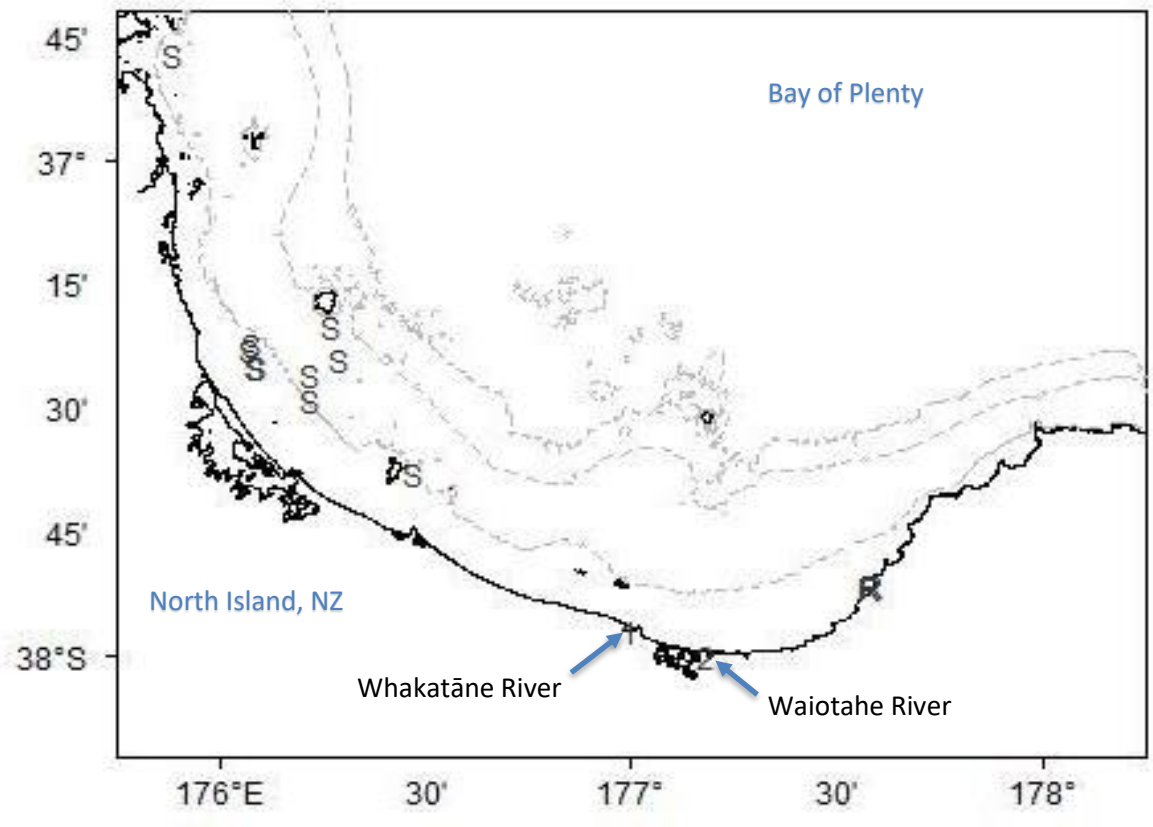


Figure 7-2 Sampling location and specific sites for river and sea (S) kahawai and two additional sample sites: Whakatāne River (1) and Waiotahe River (2), however samples from these sites were not included in the final analysis.

Weather permitting, the aim was to sample >30 fish per month from each location (river and sea). However, no sea fish were available from commercial fishers for December, the sea fish were only available from Whakatāne (site 1) for January, and from Tauranga (S sites; Figure 7-2) for February, March, and April. A storm event in April also prevented sufficient samples being collected from the Mōtū river mouth for that month. Instead, fish were sampled from local catch taken at Maraenui Beach, which is adjacent to the Mōtū river mouth, and from a net set in the nearby Waiotahe River.

After capture, sea fish from Whakatāne were chilled and sea fish from Tauranga were frozen. River fish were predominantly fresh prior to processing, however 6 were chilled, 49 were frozen, 5 were hung and 7 were kept underwater. Fork length (FL) was measured to the nearest 0.1cm, and wet weight (WW) was measured to the nearest 0.1g using a balance (*AND EJ-6100*). Sea and river fish mean monthly FLs were compared using a linear regression model to confirm that it was reasonable to compare these fish in further analyses. The relationship between logWW and logFL was calculated using a linear regression model to determine if it was as expected. A backwards stepwise Akaike Information Criterion (AIC) determined the

best model for predicting logWW using the predictors logFL, month, location, gonad stage, location-month interaction, month-gonad stage interaction, and sex. This guided the choice of which predictors to include and how to include them, for the models used to test the food source and reproduction hypotheses. Where low sample size meant that reliable statistical models could not be constructed, only summary statistics are presented.

7.2.3 Determining if the Mōtū river mouth is a food source for kahawai

To investigate whether kahawai were entering the river to target a food source, their stomach contents were examined. A high proportion of stomachs full of fresh food from the river would support the food source hypothesis. Contents (n=297) were removed from the stomach and intestines, rinsed into a 1mm mesh sieve, blotted and weighed to the nearest 0.1g. Stomach fullness was assessed using a stomach fullness index (SFI) and stomach fullness scale (SFS), and stomach contents freshness was assessed using a stomach contents freshness scale (SCF). Stewart et al. (2011) determined that kahawai caught in large commercial nets regurgitated less than 5% of stomach contents and that this amount was too small to bias any diet analysis assessments. This was also assumed to be true for the net and line caught kahawai in this study.

7.2.3.1 Quantitative stomach fullness

SFI was calculated for each fish using the following equation: $SFI=(W_{contents}/(W_{wet}-W_{contents}))\times100$, where $W_{contents}$ is stomach contents WW, and W_{wet} is fish WW. SFI values greater than zero indicated that food was eaten in the previous 40h (Hughes et al., 2014).

7.2.3.2 Qualitative stomach fullness

Contents volume was assigned to one of four fullness categories (0-3) where: 0=empty, 1=under 1/3 full, 2=between 1/3 and 2/3 full, and 3=over 2/3 full. SFS values greater than 0 indicated that the fish had eaten in the last 40h. For some of the location-month interactions there were fullness categories with no fish assigned to them, e.g. no empty sea fish in March. Therefore, the fish were reassigned to binary fullness categories where 0=empty and 1=not empty. The full dataset of binary category allocations were analysed using a logistic regression model (family=binomial, link=logit) to determine the probability of a fish having stomach contents, based on the predictors, location and month sampled (Liao, 1994).

To assess the predictive ability of the SFS model, two datasets were created from the full dataset. One for training the model, and another for testing the model (cross-validation). The full dataset was randomly conditioned based on the dependent variable (fullness) and 2/3 of the data selected for the training dataset and 1/3 for the testing dataset. Then using the model parameters estimated from the training dataset, the predicted probability of stomach fullness for each fish in the testing dataset was determined. The fitted model and the data agreed where

the predicted probability of a full stomach was greater than 0.5 and the observed fullness was 1, i.e. if P(y=1|X)>0.5, then y=1 (not empty). Likewise, when the predicted probability of fullness was less than 0.5 and the observed fullness was 0, y=0 (empty). All other outcomes were considered as disagreement.

The Receiver Operating Characteristic (ROC) curve was plotted, and the Area under the Curve (AUC) calculated to measure performance of the model (predictive ability). The ROC is a curve generated by plotting the true positive rate (TPR) against the false positive rate (FPR) at various threshold settings, while the AUC is the area under the ROC curve. As a rule of thumb, a model with good predictive ability should have an AUC closer to 1 (1 is ideal) than to 0.5.

7.2.3.3 Stomach contents freshness

Where prey was present, contents were assigned to one of four freshness categories (0-3) where: 0=totally digested, 1=well digested, 2=partially digested and 3=fresh. Analysis was only performed on the data for fish with stomach contents. Similarly, to the SFS data, SCF data had some location-month combinations with no data. Therefore, categories 2 (partially digested) and 3 (fresh) were combined and recoded as: 0=fresh and compared with category 1=well digested. The full dataset of binary category allocations was analysed using a logistic regression model (family=binomial, link=logit) to determine the probability of a fish having well digested stomach contents based on the predictors, location and month sampled (Liao, 1994). The predictive ability of the model was assessed using the same methods described for the SFS model, only using the dependent variable freshness with y=1 (well digested), otherwise y=0 (fresh).

7.2.4 Determining if the Mōtū river mouth is a place for kahawai to remove parasites

To investigate if kahawai were entering the river to remove parasites, the number of parasites on river fish and sea fish were compared. If river fish had fewer parasites, then this would support the parasite removal hypothesis. To reflect parasite removal that could possibly take place in the river mouth, parasite sampling focused on body surfaces that would come into direct contact with estuarine water during the migrations.

7.2.4.1 Parasite sampling

The fish (n=371) heads, oral and opercula cavities, nares, body and fins were examined for parasites, which were then removed, counted and identified to taxonomic order. The gills (n=333) were removed and placed in a freshwater bath containing a methylene blue stain for 10min. The bath water was then rinsed into a 75μm mesh sieve and parasites counted, collected and identified. For internal parasites, the gut cavity, stomach and intestine contents (n=329)

were rinsed into a 1mm mesh sieve, parasites counted, collected and identified. The parasite locations, total number and types were recorded for each fish. The gonads were not examined.

7.2.4.2 Parasite prevalence, mean intensity, intensity range

Parasite prevalence, mean intensity, and intensity range were calculated following the American Fisheries Society – Fish Health Section (2014) procedures. Parasite prevalence (P) $= (\frac{Number\ of\ infected\ fish}{Number\ of\ fish\ examined}) \times 100$. Mean intensity (MI) $= (\frac{Total\ number\ of\ parasites}{Total\ number\ of\ infected\ hosts})$ and intensity (I) is the minimum and maximum number of parasites on an individual host expressed as a range.

Fish were also assigned to a binary category where 0=parasites absent, and 1=parasites present. Based on these assignments, parasite prevalence was compared for river and sea fish across months using a logistic regression model (family=binomial, link=logit). The predictive ability of the model was assessed using the same methods described for the SFS model in the food source section, only using the dependent variable parasite prevalence instead with y=1 (parasites present), otherwise y=0 (parasites absent).

7.2.5 Determining if the Mōtū river mouth is a haven for kahawai to avoid predators

To investigate if kahawai were entering the river to avoid predators, first kahawai predator species were determined, and then the river mouth was observed for signs of these species. A lack of kahawai predators and predatory activity would support the predator avoidance hypothesis.

Literature on the diets of potential predator species, i.e. large pelagic fish, marine mammals, seabirds and sharks, was reviewed, noting when kahawai or the proxy species, Australian herring (*A. georgianus*) and western Australian salmon (*A. truttaceus*) were identified as prey. The proxy species were included because they are difficult to distinguish from kahawai and have an overlapping geographical distribution with kahawai (also known as eastern Australian salmon) in southern Australia (Catalano et al., 2011; Ministry for Primary Industries, 2017). The data collected in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery), i.e. participant interviews, photos, video descriptions, and documents; was reviewed for LEK regarding kahawai predators at the Mōtū River and elsewhere. Six marine scientists also provided comments based on their previously unrecorded research observations. These are listed as Scientific ecological knowledge (SEK) in Table 7-26. Where possible kahawai predators were identified, the field notes, photos, and video recordings taken during the sampling period were reviewed for predator and predatory activity observations at the Mōtū river mouth.

7.2.6 Determining if the Mōtū river mouth is a place for kahawai to reproduce

To investigate whether kahawai were entering the river for reproduction and spawning, kahawai reproductive condition was observed. If the kahawai at the river were in peak reproductive condition, then this would suggest that kahawai were entering the river for reproductive purposes. Reproductive condition was assessed using sample sex ratios, gonad macroscopic stage (GMS), Gonadosomatic index (GSI), lipid index (LI) and hepatic index (HI).

7.2.6.1 Determining the sex ratio of the kahawai schools

The sex ratio is the number of males for every female present (Hughes, 2012). Skewed sex ratios, where there are an unequal number of males and females, are often observed during the reproductive season in fish populations (Morgan & Trippel, 1996). Therefore, a skewed sex ratio would support the reproduction hypothesis. Gonads (n=427) were examined and fish assigned to a sex (male, female or immature). The sex ratio was calculated for river and sea fish for each month of the sampling period. We excluded two immature fish, i.e. unable to be sexed, one caught at the river in December, and one caught in January.

7.2.6.2 Qualitative assessment of kahawai reproductive condition

Fish gonads (n=427) were examined and assigned to one of six reproductive stages (immature, resting, maturing, ripe, running ripe or spent, Table 7-3). A multinomial regression analysis was attempted to compare the six MGS groups between location-month groups, however there were multiple groups with low counts (only 0-2 fish) which was inflating the statistics. Six groups were reduced to four. Nine river fish that were still immature, i.e. had not recruited to the reproductive population, but had been identified as male or female were removed. The ‘resting’ and ‘spent’ fish were combined as ‘resting’ fish, because they both represent non-reproducing mature fish. But, even with this grouping, there were location-month groups with low counts (0-2 fish), meaning that a multinomial logistic regression on four stages (resting, maturing, ripe and running ripe) also produced unstable and unreliable results due to a poor fit. Ultimately the fish were reassigned to two groups. ‘Resting’ and ‘maturing’ fish were assigned ‘not ripe,’ and ‘ripe’ and ‘running ripe’ fish were assigned to ‘ripe.’ Based on these assignments, MGS was compared for river and sea fish across sampling months using a logistic regression model (family=binomial, link=logit). The predictive ability of the model was assessed using the same methods described for the SFS model in the food source section, only using the dependent variable MGS instead with y=1 (ripe), otherwise y=0 (not ripe).

Table 7-3 Female and male macroscopic characteristics of each stage in the development of Arripis trutta gonads (Hughes, 2012).

Stage	*Male characteristics*	*Female characteristics*
1. Immature	Determination of sex extremely difficult.	Determination of sex extremely difficult. Fine, translucent, jelly-like and tubular in cross-section.
2. Developing/Resting	Cream in colour, strap-like, tough and leathery (not translucent and jelly-like).	Reddish-brown in colour, translucent and jelly-like. No oocytes visible through ovary wall.
3. Maturing	Cream-white in colour, becoming soft and lobular. Much larger than stage 2 testes.	Yellow orange in colour, small oocytes visible through ovary wall gives ovary a grainy appearance. Capillaries visible in ovary wall.
4. Ripe	Pinkish-white in colour, soft and easily ruptured, no milt expelled with pressure on abdomen. Much larger than Stage 3.	Yellow orange in colour, vitellogenic oocytes clearly visible through ovary wall, but no hydrated oocytes. Extensive vascularisation of ovary wall.
5. Running ripe	Pinkish-white in colour, copious milt easily expelled with gentle pressure on abdomen. Very soft and difficult to remove without rupturing. Same length as stage 3 but more massive occupying most of the visceral cavity.	Hydrated oocytes visible through ovary wall throughout ovary, oviduct full of hydrated ova and shed through genital pore with gentle pressure on abdomen. Same length as stage 3, but more massive occupying most of the visceral cavity.
6. Spent	Brownish, rubbery and bloodshot, particularly towards posterior end. Small amount of residual milt may be expelled with pressure on abdomen.	Flaccid, rubbery and bloodshot, particularly towards posterior end.

7.2.6.3 Quantitative assessment of kahawai condition

Gonads increase in size with increasing development and then return to a spent/resting sizes after reproduction (Elliott & Hemingway, 2002) therefore a high proportion of fish with a high GSI would strongly support the reproduction hypothesis. The gonads (n=411) were removed and weighed to the nearest 0.1g. GSI was calculated following Hughes (2012): $GSI=(W_{gonad}/(W_{wet}-W_{gonad}))\times 100$, where W_{wet} is the fish WW and W_{gonad} is gonad WW. A linear regression model was used to compare the mean GSI values of river and sea fish between months. Males and females were analysed separately.

7.2.6.4 Effect of lunar phase on gonadosomatic index

Fish (n=99) were caught at varying times across the lunar cycle and this analysis was conducted to rule out lunar phase as a significant factor affecting mean GSI. Fish caught on one of the seven days surrounding a lunar phase were assigned to that phase, i.e. third quarter: 9-15 February; new moon: 16-22 February; first quarter: 23 February-1 March; and full moon: 2-8

March. A linear regression model was used to compare mean GSI between the phases for males and females separately.

7.2.6.5 Determining the lipid content of kahawai across the season

Prior to maturing, many fish store lipids (fat) either surrounding or in the liver and muscle fibres (Hoar, 1957). Stored fat and protein provides energy during migration and spawning and are also transferred to the gonads (Hoar, 1957). If river and sea fish significantly different this would support the reproduction hypothesis. For 323 fish fat surrounding the visceral organs was removed and weighed to the nearest 0.1g. Lipid index (LI) was calculated using the equation: $LI=(W_{fat}/W_{gutted})\times100$, where W_{fat} is fat WW, and W_{gutted} is the fish WW with the liver, fat, stomach and gonads removed. The LI values were very low, including many zeros, so no statistical analysis was performed and the mean values are provided in a location-month interaction summary table (Table 7-40).

7.2.6.6 Determining the liver weight of kahawai across the season

If river fish had a significantly different hepatic index to sea fish this would support the reproduction hypothesis. The livers (n=323) were dissected from the gut cavities, the fat removed, and livers weighed to the nearest 0.1g. HI values were calculated using the equation: $HI=(W_{liver}/W_{gutted})\times100$, where W_{liver} is liver weight, and W_{gutted} is fish WW with the liver, fat, stomach and gonads removed. A linear regression model with the predictors: location, month and gonad stage, was used to assess mean HI for each of the sexes separately.

7.3 Results

The results are presented in six sub-sections as follows: environment, kahawai characteristics, food source, parasites, predator avoidance, and reproduction.

7.3.1 Mōtū river mouth environmental conditions

7.3.1.1 Mōtū River discharge rate

Mean discharge rates for each sampling period are shown in Figure 7-3. The mean discharge rate was $42.67 m^3 \cdot s^{-1}$, the rate peaked in January and was lowest in February before increasing again. The average rate for the right arm of the river was $4.68 m^3 \cdot s^{-1}$ and for the left arm was $13.27 m^3 \cdot s^{-1}$ in January.

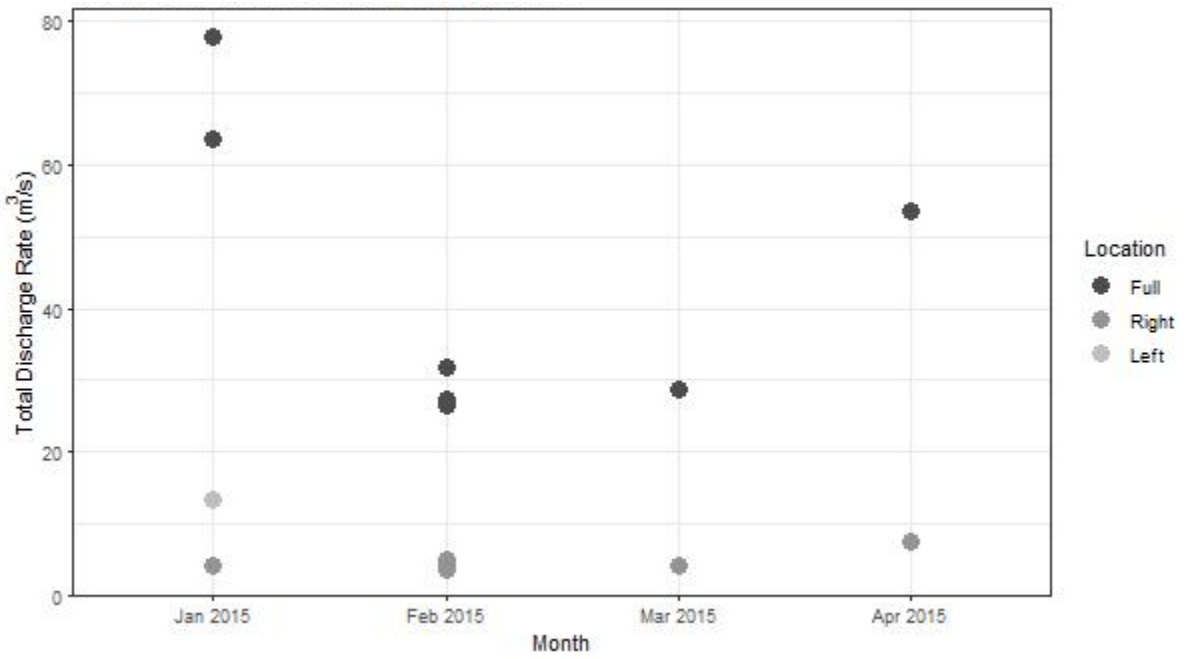


Figure 7-3 Total Mōtū River discharge rates ($m^3 \cdot s^{-1}$), for full river width (full), right arm of the river (right) and left arm of the river (left) across the five months of the sampling period.

Mōtū river discharge rates measured by NIWA are shown in Figure 7-4 and Figure 7-5. Data prior to 1985 was not included as the variability was greater and the median flows were higher than those of the data collected after 1985. The inconsistencies look to be related to how the measurements were taken, rather than actual differences. Figure 7-4 shows that the median monthly flows for 2014 and 2015 were relatively low compared to other years but were within the range. Figure 7-5 shows that for the sampling years and months the range in median flows was relatively narrow compared to previous years. The discharge rates measured in the study were taken on fine days and are within the range reported by NIWA.

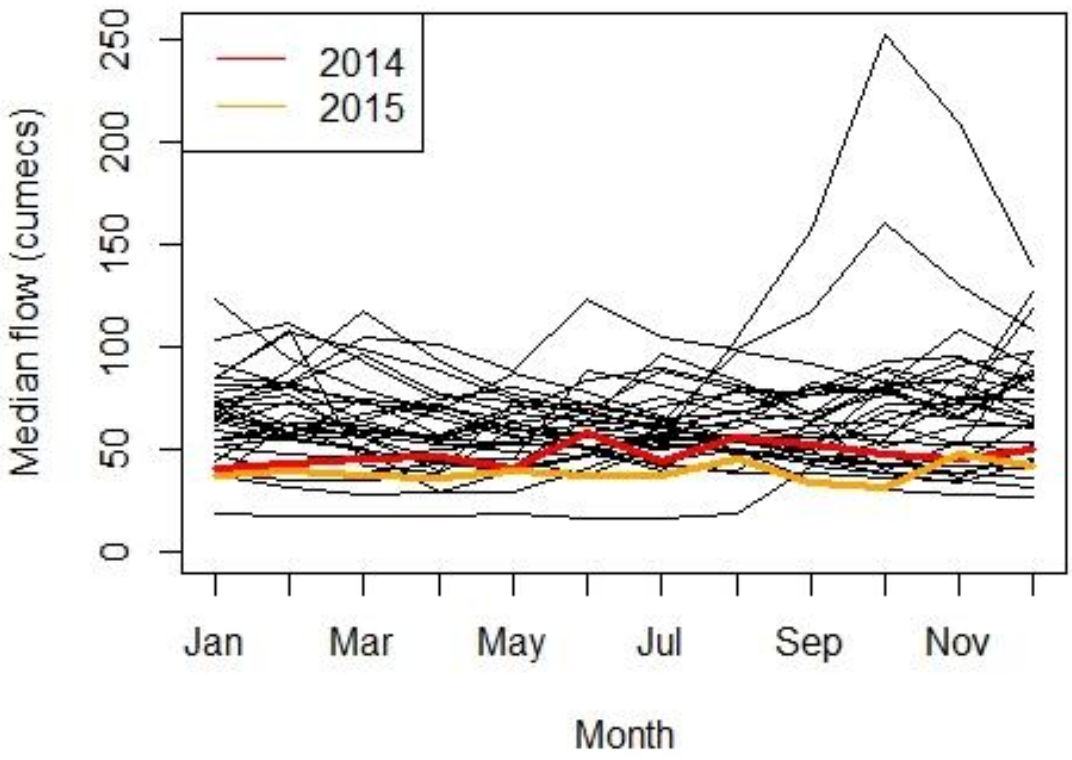


Figure 7-4 Mōtū river monthly median flows ($m^3 \cdot s^{-1}$) for the years 1985 to 2017 recorded at the Houpoto Bridge by NIWA. The sampling years are shown in red (2014) and yellow (2015).

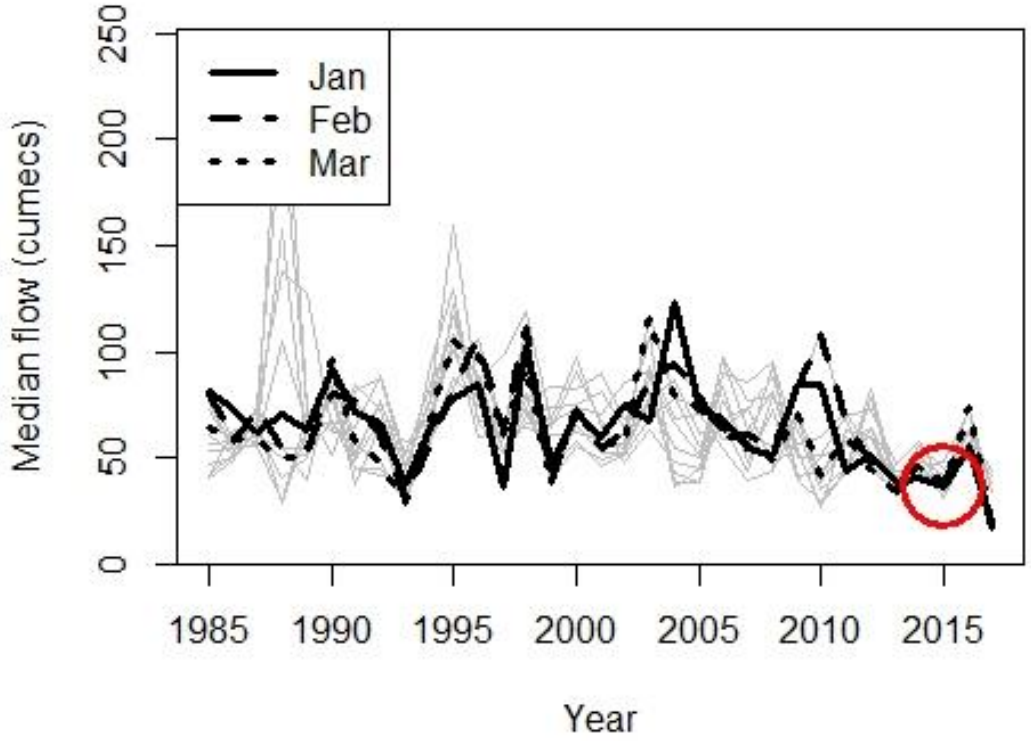


Figure 7-5 Mōtū river median flow ($m^3 \cdot s^{-1}$) for the years 1985 to 2017 recorded at the Houpoto Bridge by NIWA. All months are shown separately. The months of the sampling period, i.e. January, February, and March, are shown in bold as per the legend. The months outside of the sampling period are shown in grey. The 2014/2015 sampling period is highlighted in red.

7.3.1.2 Air temperature, dissolved oxygen, pH and salinity at the Mōtū river mouth

Table 7-4 shows the monthly mean, minimum and maximum air temperatures, dissolved oxygen (DO), pH and salinity for the river mouth and the expected values for an estuary. Mean air temperature peaked in March. DO, pH and salinity were within the expected limits for an estuary.

Table 7-4 Mean and range of air temperature (°C), river mouth dissolved oxygen (DO% saturation), pH (pH units) and salinity (ppt.) measured at the Mōtū River across the months of the sampling period; and expected median, upper and lower quartiles of DO% (Ministry for the Environment & Statistics New Zealand, 2016), expected mean pH and expected salinity values (Ohrel Jr. & Register, 2006) for an estuary are presented, however expected mean air temperature for the Mōtū River was not available (NA). NB: The pH meter was not working in April therefore data was not available (NA).

	Air temperature	*DO*	*pH*	*Salinity*
December	20.7 (17.0-26.9)	93.3 (88.4-101.0)	8.2 (8.1-8.3)	0.03 (0.01-0.06)
January	No data collected	90.7 (83.6-101.0	7.8 (7.6-8.1)	0.07 (0.06-0.12)
February	21.8 (17.4-27.8)	92.8 (75.0-115.0)	8.0 (6.5-9.0)	3.87 (0.07-18.50)
March	24.5 (21.9-25.5)	94.0 (87.0-100.0)	7.8 (7.5-8.2)	0.58 (0.07-2.90)
April	16.8 (16.7-16.8)	83.2 (76.6-86.7)	NA	4.50 (0.11-17.90)
Expected	NA	95.9 (89.2-100.7)	7.0-8.6	0.00-30.00

7.3.1.3 Mōtū river mouth water temperatures

Water temperatures were relatively low in December and April, and relatively high from January to March (Figure 7-6).

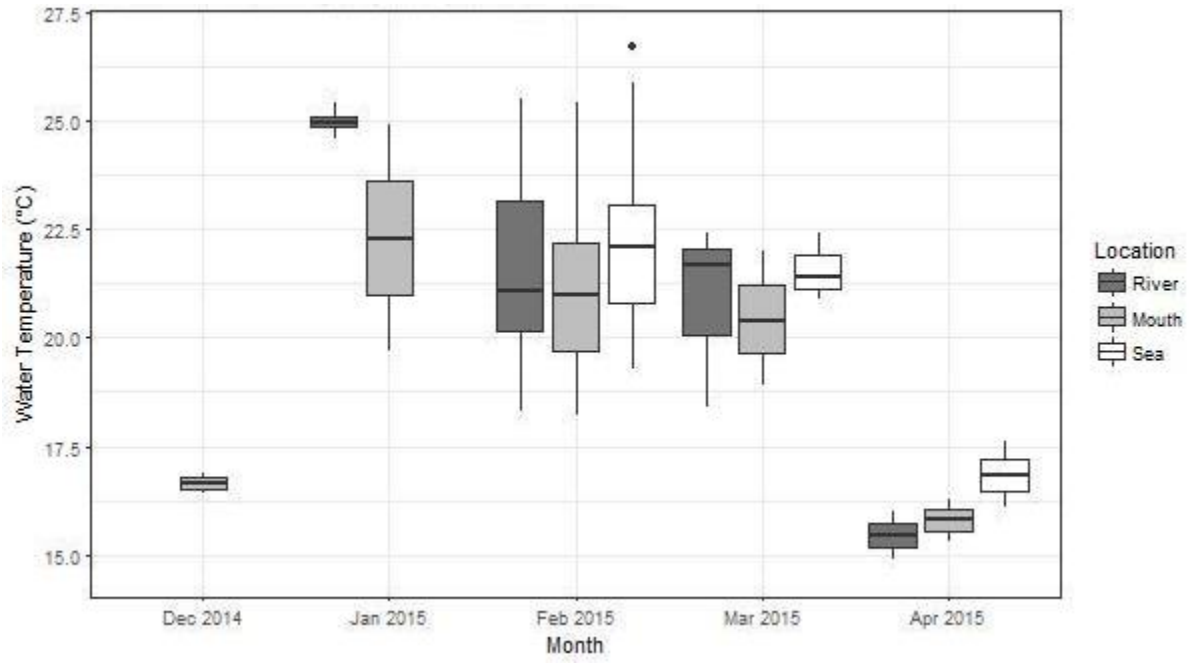


Figure 7-6 Water temperature (°C, including medians, outliers, upper, lower and interquartile ranges) in the Mōtū River, mouth and sea adjacent to river mouth across the months of the sampling period.

Table 7-5 shows the monthly river water temperatures and Bay of Plenty inshore sea surface temperatures (SST). Mōtū River water temperatures were lower than the SSTs for December and April, had higher maximums than the SSTs in January and February and had a greater

temperature range in March. The sea water temperatures measured at the Mōtū river mouth for February and March (Figure 7-6) were comparable with the expected ranges (Table 7-5), however for April the Mōtū river mouth sea temperature was lower.

Table 7-5 Mōtū River monthly water temperatures (average, minimum and maximum, °C) from field observations and Bay of Plenty sea surface temperatures (SST's, average, minimum and maximum, °C) from World Sea Temperatures (www.seatemperature.org). The SST figures were calculated from all the recorded years of daily satellite readings provided by the NOAA.

	River (Mōtū)	*Sea (Bay of Plenty)*
December	16.65 (16.4-16.9)	18.6 (17.0-20.2)
January	24.44 (19.7-25.4)	20.1 (18.0-22.3)
February	21.62 (18.2-26.7)	21.2 (19.3-23.1)
March	20.94 (18.4-22.4)	21.1 (20.1-22.2)
April	16.03 (14.9-17.6)	19.7 (18.5-21.0)

7.3.2 Kahawai biological characteristics

7.3.2.1 Fork length

Figure 7-7 shows the FLs of all the fish sampled. The ANOVA results shown in Table 7-6 show that location (F=6.29, p=0.01), month (F=6.73, p<0.0001) and their interaction (F=13.36, p<0.0001) all had a significant association with mean FL. The linear regression results shown in Table 7-7 show that the January sea fish (t=-5.73, p<0.0001) and April river fish (t=-3.55, p<0.0001) were significantly shorter than the December river fish group mean. Based on this analysis, comparing all of the fish sampled was considered unsuitable as the size variation would likely mask other significant effects that are being analysed. For example, if the fish were smaller because they were juveniles then they were unlikely to be in reproductive condition. Therefore, some data was removed as described below.

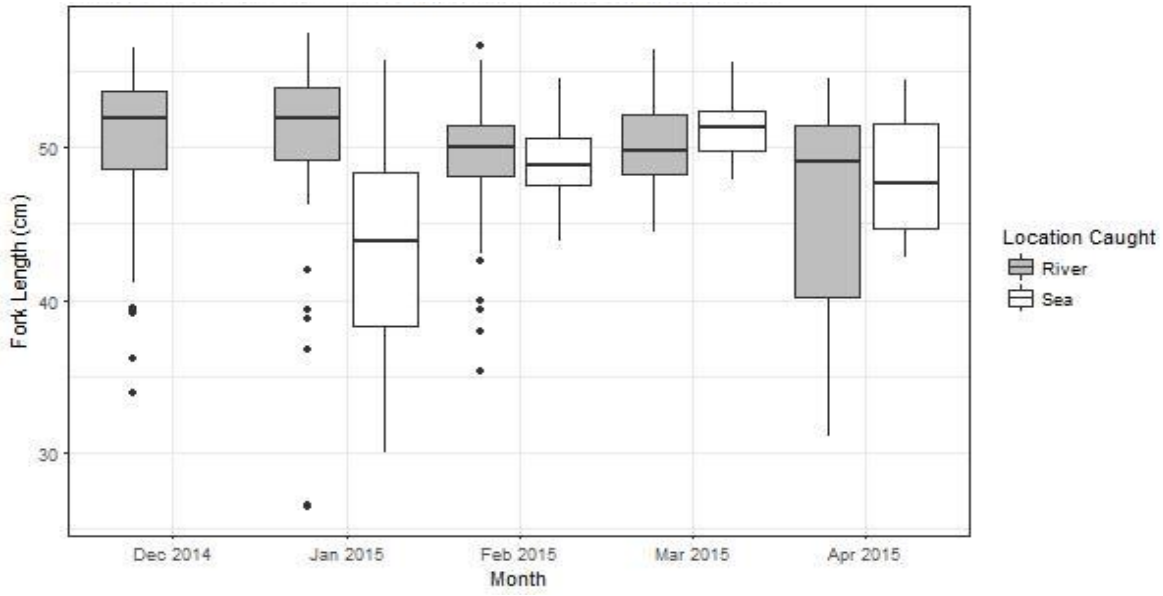


Figure 7-7 Original Fork lengths (cm, including medians, outliers, upper, lower and interquartile ranges) of all river (grey) and sea (white) kahawai sampled across the months of the sampling period. NB: No sea fish were available in December.

Table 7-6 Analysis of Variance (ANOVA) table for linear regression model: FL~location-month, for all fish sampled. Bold p-values indicate a significance at 5% level.

	DF	*SS*	*MS*	*F-value*	*p-value*
Location	1	132.9	132.86	6.29	**0.01**
Month	4	567.8	141.95	6.73	**<0.0001**
Location-Month	3	846.2	282.08	13.37	**<0.0001**
Residuals	424	8949.4	21.11		

Table 7-7 Results of the linear regression model: FL~location-month, for all fish sampled (adjusted R^2=0.13, DF=8 and 424, F=9.16, p<0.0001. Bold p-values indicate a significance at the 5% level. One coefficient was not defined because of singularities (NA).

Coefficients	*Estimate*	*Std. Error*	*t-value*	*p-value*
Intercept (River, December)	49.76	0.77	64.99	**<0.0001**
Location (Sea)	2.21	1.14	1.95	0.05
Month (January)	0.04	1.00	0.04	0.97
Month (February)	-0.32	0.87	-0.36	0.72
Month (March)	0.26	1.10	0.23	0.82
Month (April)	-3.84	1.08	-3.55	**<0.0001**
Location-Month (Sea-January)	-8.98	1.57	-5.73	**<0.0001**
Location-Month (Sea-February)	-2.58	1.32	-1.95	0.05
Location-Month (Sea-March)	-1.04	1.74	-0.60	0.55
Location-Month (Sea-April)	NA	NA	NA	NA

Figure 7-8 shows the median FLs of all the fish sampled and the specific sampling location. The ANOVA results shown in Table 7-8 show that specific location caught had an association with mean FL (F=25.58, p<0.0001), suggesting that it was not suitable to compare all these fish. The linear regression model results in Table 7-9 show that Sanford and Maraenui Beach fish had similar mean FLs to Mōtū River fish (t=-0.98, p=0.33 and t=-1.92, p=0.06, respectively); however, Iceman (t=-7.49, p<0.0001) and Waiotahe River fish (t=-7.07, p<0.0001) were significantly shorter. To avoid confounding subsequent analyses with a fish length effect, the Iceman and Waiotahe River fish were removed from the final dataset. The Maraenui Beach and Mōtū River fish were combined to represent 'river' fish for April 2015, and Sanford fish represent 'sea' fish in the following analyses.

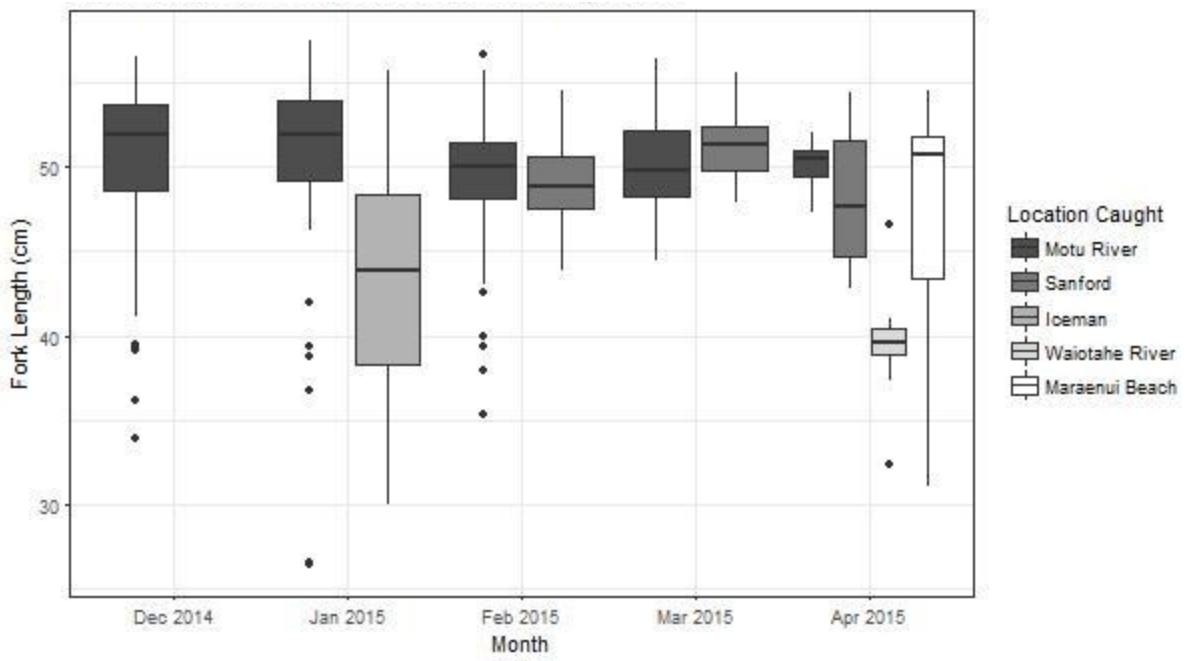


Figure 7-8 Original FLs (cm, including medians, outliers, upper, lower and interquartile ranges) of all river and sea kahawai sampled across the months of the sampling period showing the specific locations caught. River locations are: Mōtū River, Waiotahe River and Maraenui Beach and sea locations are: Sanford and Iceman.

Table 7-8 Analysis of Variance (ANOVA) table for linear regression model: FL~specific location caught, for all fish sampled. Bold p-values indicate a significant difference at the 5% level.

	DF	*SS*	*MS*	*F-value*	*p-value*
Specific location caught	4	2025.3	506.34	25.58	**<0.0001**
Residuals	428	8470.9	19.79		

Table 7-9 Results of the linear regression model: FL~specific location caught, for all fish sampled; adjusted R^2=0.18, F=25.58, DF=4 and 428, p<0.0001. Bold p-values indicate a significant difference at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*t-value*	*p-value*
Intercept (Mōtū River)	49.66	0.28	179.30	**<0.0001**
Sanford	-0.48	0.49	-0.98	0.33
Iceman	-6.63	0.88	-7.49	**<0.0001**
Waiotahe River	-10.13	1.43	-7.07	**<0.0001**
Maraenui Beach	-2.08	1.08	-1.92	0.06

The median FLs presented in Figure 7-9 and ANOVA results presented in Table 7-10 shows that removing the Iceman and Waiotahe River fish provided a sample that was suitable to compare in further analyses as the values were not significantly different (F=0.65, p=0.53). However, this meant that there were no sea fish samples for January. Figure 7-9 also shows that adults (FL>39.0cm, n=383) and sub-adults (<39.0cm, n=12) were sampled from the river, but only adults were sampled from the sea.

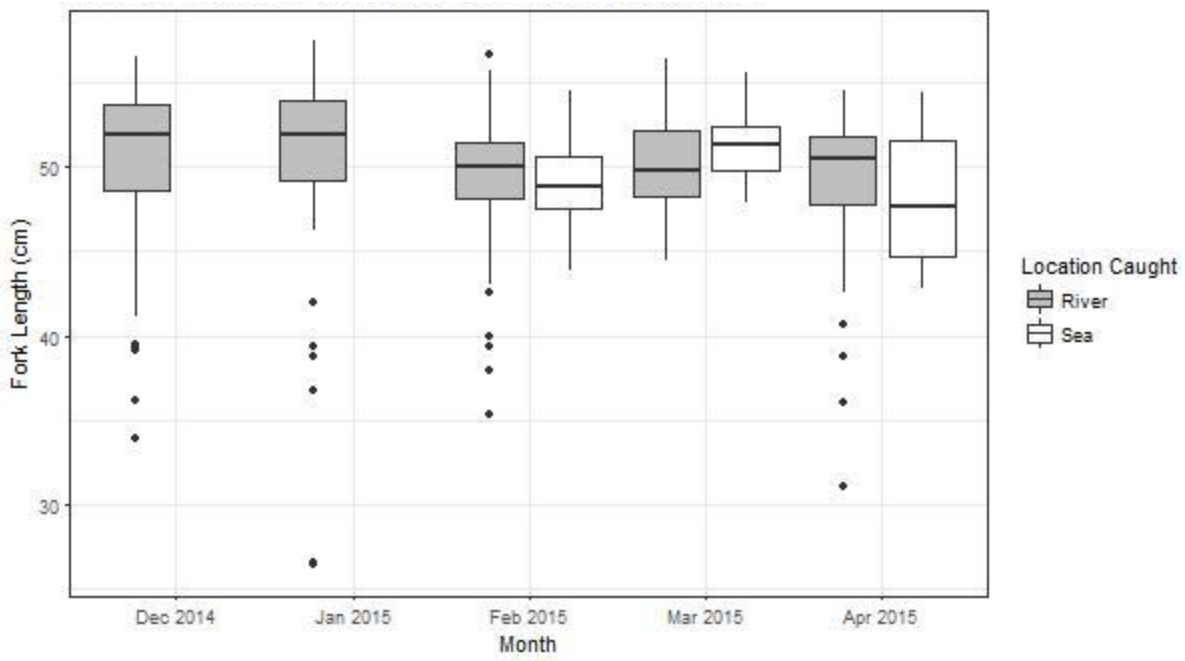


Figure 7-9 Fork lengths (cm, including medians, outliers, upper, lower and interquartile ranges) of river (grey) and sea (white) kahawai for each month of the sampling period.

Table 7-10 Analysis of variance (ANOVA) table for linear regression model: FL~location-month for final river and sea kahawai sampled across the months of the sampling period. Bold p-values indicate a significant difference at the 5% level.

	DF	*SS*	*MS*	*F-value*	*p-value*
Location	1	10.1	10.12	0.56	0.46
Month	4	136.5	34.11	1.88	0.11
Location-Month	2	23.5	11.73	0.65	0.53
Residuals	387	7034.0	18.18		

Table 7-11 presents the monthly mean and median FLs for river and sea kahawai in the sample that all further analyses were conducted on. Please note that for each analysis below the sample size differs slightly. This is because some of the fish sampled did not contain stomachs, gonads or gills, but could be used in other analyses that were not weight dependent. The total sample size for each analysis is indicated in the respective section.

Table 7-11 Mean and median FLs (±SE, cm) for final river and sea kahawai across the months of the sampling period (n=sample size). Median standard errors were calculated by multiplying mean standard errors by 1.2533 (Shen, 1935).

	River			*Sea*		
	Mean	**Median**	***n***	**Mean**	**Median**	***n***
December	49.76 ± 0.71	51.90 ± 0.89	36	NA	NA	0
January	49.80 ± 0.93	51.90 ± 1.16	51	NA	NA	0
February	49.45 ± 0.80	50.00 ± 1.01	129	49.64 ± 1.31	48.85 ± 1.64	70
March	50.02 ± 1.02	49.75 ± 1.28	34	51.19 ± 1.67	51.30 ± 2.10	19
April	48.38 ± 1.10	50.50 ± 1.38	26	49.52 ± 1.14	47.65 ± 1.43	30
		Total	276		**Total**	119

7.3.2.2 Length-weight relationship

Figure 7-10 demonstrates the expected strong positive log relationship between kahawai FL and WW, with logFL explaining 87% of the variation in logWW. The backwards stepwise AIC removed the predictor variable sex and chose: logFL+location-month+month-gonad stage, as the best model for predicting logWW (AIC=-1981.38).

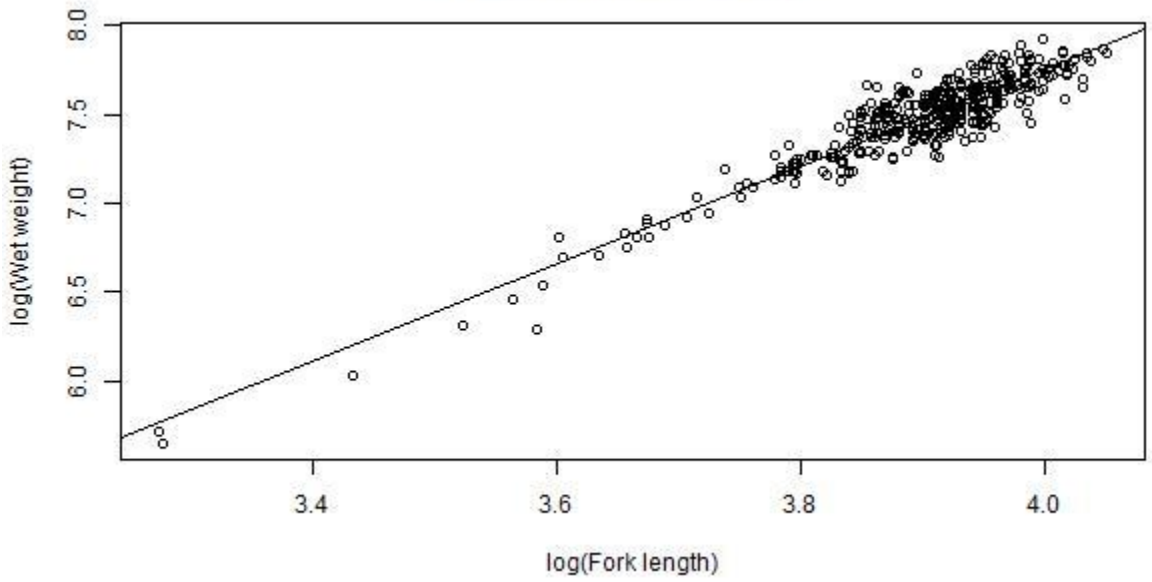


Figure 7-10 Length-weight relationship: logWW=0.0396+2.75xlogFL, adjusted R^2=0.87, F=2683, DF=1 and 393, p<0.0001).

Table 7-12 presents existing length-weight parameters published for kahawai, and length-weight parameters for kahawai sampled in the current study. The parameters in the current study are slightly larger than those previously reported.

Table 7-12 Estimates of weight, = a(length)^b (weight in g, length in cm FL).

Stock	*Comment*	*a*	*b*	*Reference*
KAH 2	Wellington Harbour, 1990	0.026	2.233	Jones et al. (1992)
KAH 1	Resting	0.0306	2.82	Hartill & Walsh (2005)
KAH 1	Mature	0.0103	3.14	Hartill & Walsh (2005)
KAH 1		0.0236	2.89	Hartill & Bian (2016)
KAH 1		0.0396	2.75	Current study (2015)

7.3.2.3 Wet weight

Figure 7-11 presents kahawai wet weight (WW). River fish mean WW peaked in January and then decreased further on in the season. The ANOVA results presented in Table 7-13, show that all predictors had a significant association with logWW. The best model for predicting the WW patterns observed was: logWW~logFL+location-month (backwards stepwise AIC=-1963.6).

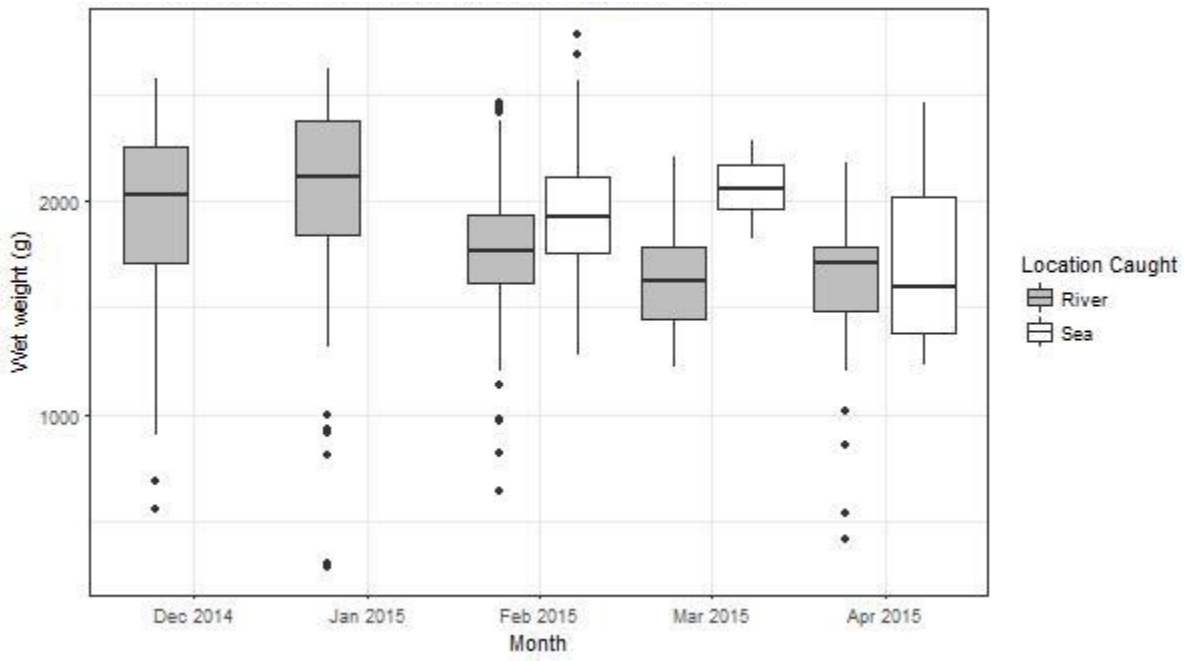


Figure 7-11 Wet weight (g, including medians, outliers, upper, lower and interquartile ranges) of river (grey) and sea (white) kahawai across the months of the sampling period.

Table 7-13 Analysis of variance (ANOVA) for the linear regression model: logWW~logFL+location-month. Predictor variables and levels are: logFL (continuous), location (2 levels: river and sea), and month (5 levels: December, January, February, March, April). Bold p-values indicate a significant difference at the 5% level.

	DF	*SS*	*MS*	*F-value*	*p-value*
LogFL	1	15.19	15.19	2619.52	**<0.0001**
Location	1	0.68	0.68	117.69	**<0.0001**
Month	4	0.92	0.23	39.51	**<0.0001**
Location-Month	2	0.05	0.03	3.95	**0.02**
Residuals	374	2.17	0.01		

Table 7-14 Results of the linear regression model: logWW~logFL+location-month; adjusted R^2=0.88, F=362.9, DF=8 and 374, p<0.0001. Bold p-values indicate a significant difference at the 5% level. Predictor variables and levels are: logFL (continuous), location (two levels: river and sea), month (5 levels: December, January, February, March, April). Two coefficients were not defined because of singularities (NA).

Coefficients	*Estimate*	*Std. Error*	*t-value*	*p-value*
Intercept (December, River)	-2.63	0.21	-12.49	**<0.0001**
LogFL	2.59	0.05	48.46	**<0.0001**
Location (Sea)	0.11	0.02	5.46	**<0.0001**
Month (January)	0.05	0.02	2.96	**0.00**
Month (February)	-0.03	0.02	-1.77	0.08
Month (March)	-0.12	0.02	-6.56	**<0.0001**
Month (April)	-0.11	0.02	-5.57	**<0.0001**
Location-Month (Sea-January)	NA	NA	NA	NA
Location-Month (Sea-February)	0.00	0.02	0.03	0.98
Location-Month (Sea-March)	0.07	0.03	2.26	**0.02**
Location-Month (Sea-April)	NA	NA	NA	NA

For sea fish, WW was invariant, and the results were consistent with the corresponding pattern for FLs shown in Figure 7-11. In the food source and reproduction sub-sections of the results, the difference in WW will be explored further.

7.3.3 Mōtū river mouth as a food source for kahawai

This sub-section has five parts: stomach contents, stomach fullness index (SFI), stomach fullness and freshness, stomach fullness scale (SFS) and stomach contents freshness (SCF).

7.3.3.1 Kahawai stomach contents

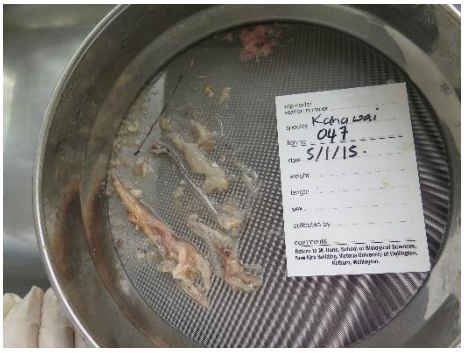
The prey composition and number of fish caught with the particular diet type for each month-location interaction are presented in Table 7-15. Examples are shown in Figure 7-12. Only 6.52% of river kahawai had prey in their stomachs, whereas 82.35% of sea kahawai contained prey. River fish contained no prey in December 2014. The few river fish with stomach contents contained unidentified fish (Figure 7-12a). In January 2015, one river fish (FL=57.5cm) contained a small crab (*Ovalipes catharus*) shown in Figure 7-12b. In April 2015, one river fish (FL=42.5cm) was caught at Maraenui Beach containing two decorator crabs (*Notomithrax ursus*), five red cod (hoka, *Pseudophycis bachus*), and three snapper (tāmure, *Pagrus auratus*) (Figure 7-12c). Also, in April 2015, one fish (FL=50.6cm) was caught at the Mōtū river mouth with a *Galaxias* sp. fish in its stomach (Figure 7-12d).

Of the sea fish with stomach contents, 85.2% was krill (*N. australis*, Figure 7-12e), and 14.8% fish. Additional non-food contents found in fish stomachs were bone, grit, oil, slime, stomach lining, stones, wood, and unidentified objects.

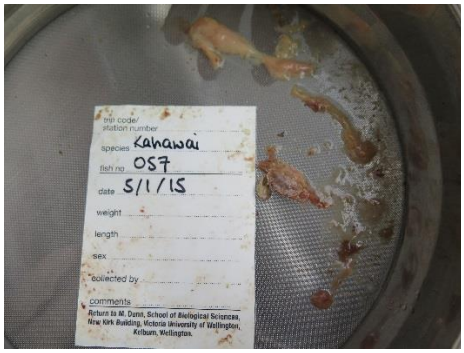
Table 7-15 Diet types for fish containing stomach contents for each month-location interaction. The number of fish with the diet type is shown in brackets. NB: There were no river fish with stomach contents in December 2014 and no suitable sea fish available for December 2014 and January 2015.

	Dec 2014	*Jan 2015*	*Feb 2015*	*Mar 2015*	*Apr 2015*
River	Empty	Unidentified fish (10) Paddle crab (1)	Unidentified fish (2) Krill (1)	Unidentified fish (1)	Unidentified fish (1) Snapper, Red cod, Decorator crabs, unidentified bivalve, and unidentified shrimp (1) Whitebait (1)
Sea	NA	NA	Unidentified fish (9) Mackerel (1) Krill (39)	Krill (19)	Krill (30)

a)



b)



c)

d)

e)

Figure 7-12 Diet types a) unidentified fish from a river kahawai (January 2015), b); a small crab from a river kahawai (January 2015) c) mixed fish and other species from a river kahawai caught off Maraenui Beach (April 2015), d) a Galaxias spp. fish from a river kahawai (April 2015), and e) krill from a sea kahawai.

7.3.3.2 Kahawai stomach fullness index (quantitative assessment)

River fish (n=178) typically had empty stomachs for all months except April, whereas sea fish (n=119) stomachs typically contained prey (Figure 7-13 and Table 7-16). Sea fish median SFI peaked in March at 2.36%.

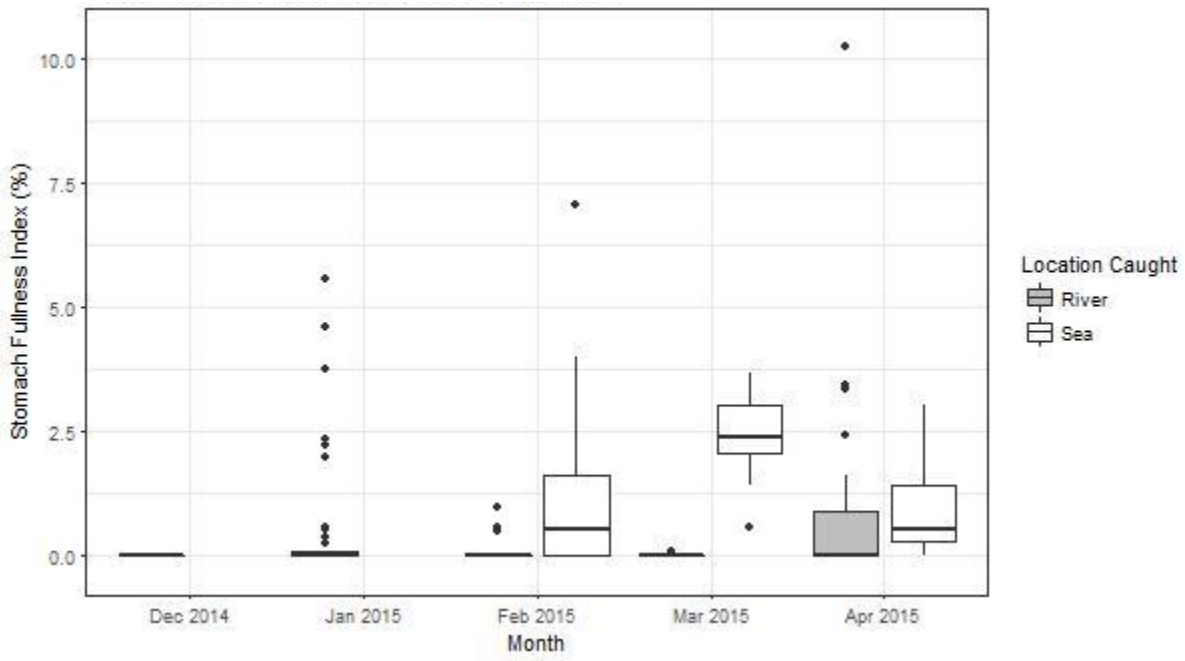


Figure 7-13 Stomach fullness index (SFI%, including medians, outliers, upper, lower and interquartile ranges) of river (grey) and sea (white) kahawai across the months of the sampling period. NB: No suitable sea fish were available for December and January.

Table 7-16 Stomach fullness index (SFI%, medians and interquartile ranges) of river (grey) and sea (white) kahawai across the months of the sampling period. NA indicates no fish were available for that treatment.

	River	*Sea*
December	0.00 (0.00-0.00)	NA
January	0.00 (0.00-0.07)	NA
February	0.00 (0.00-0.00)	0.52 (0.00-1.62)
March	0.00 (0.00-0.00)	2.36 (2.07-3.04)
April	0.00 (0.00-0.88)	0.53 (0.29-1.40)

7.3.3.3 Kahawai stomach fullness and freshness

There were 297 fish samples used in this analysis. Fish with stomachs '<1/3 full,' mostly contained 'well digested' diet (Figure 7-14). Fish with stomachs '>1/3 and <2/3 full' and '>2/3 full,' mostly contained partially digested food. Fresh food was only found in stomachs that were '<1/3 full' and >2/3 full.'

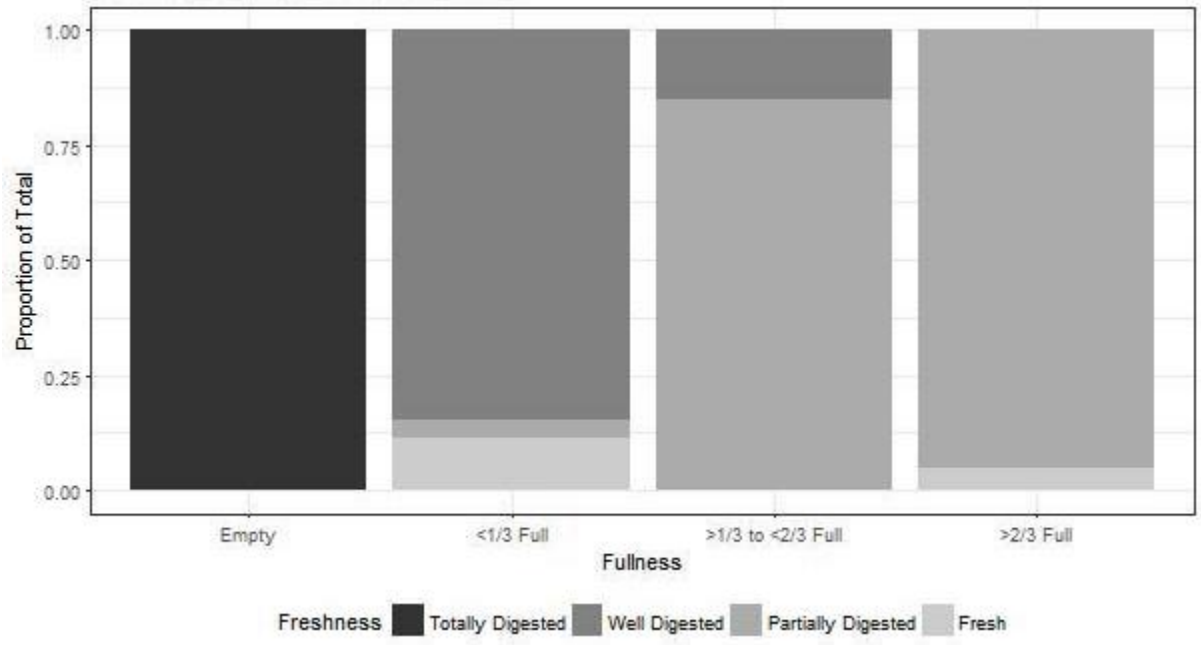


Figure 7-14 A comparison of the fullness of kahawai stomachs and freshness of stomach contents.

7.3.3.4 Kahawai stomach fullness scale (qualitative assessment)

Not all location-month interactions contained fish from every fullness category (Figure 7-15). For example, in March there were only 'empty' and '<1/3 full' river fish and only '>1/3 to <2/3 full' and '>2/3 full' sea fish. Therefore, the fish were grouped into binary categories for the analysis. 'Empty' fish stayed the same, while fish with stomach contents. Figure 7-16 presents fullness between locations and months using the new categories.

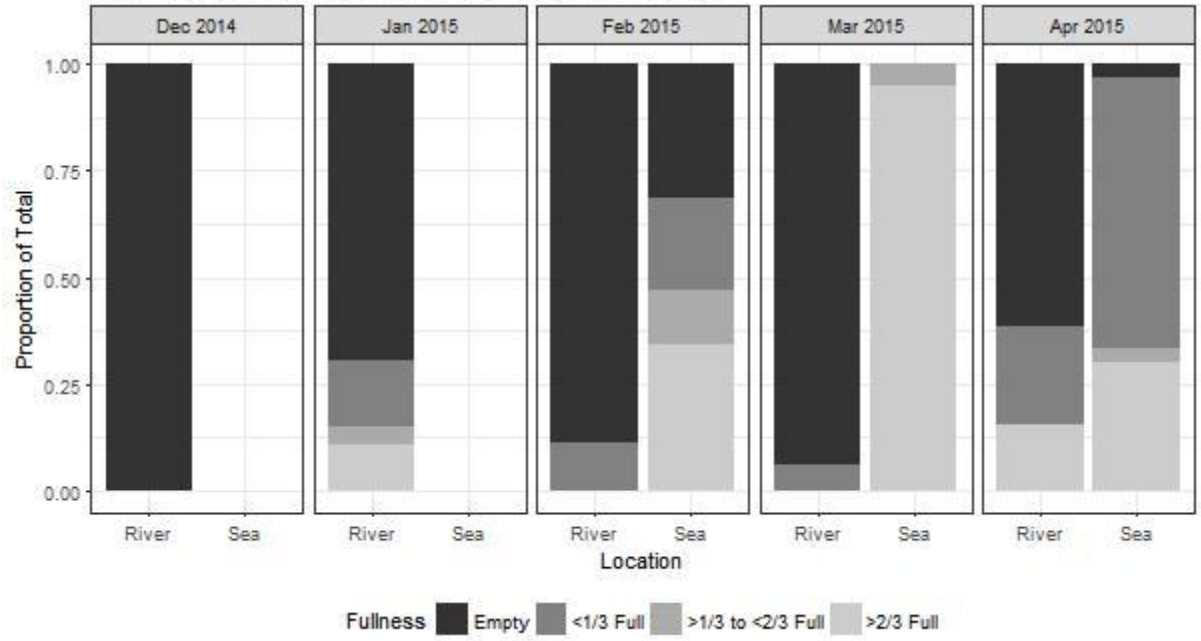


Figure 7-15 Stomach fullness scale (SFS, 4 levels: empty, <1/3 full, >1/3 to <2/3 full, >2/3 full) of river and sea kahawai across the months of the sampling period. NB. These values were not used in the analysis.

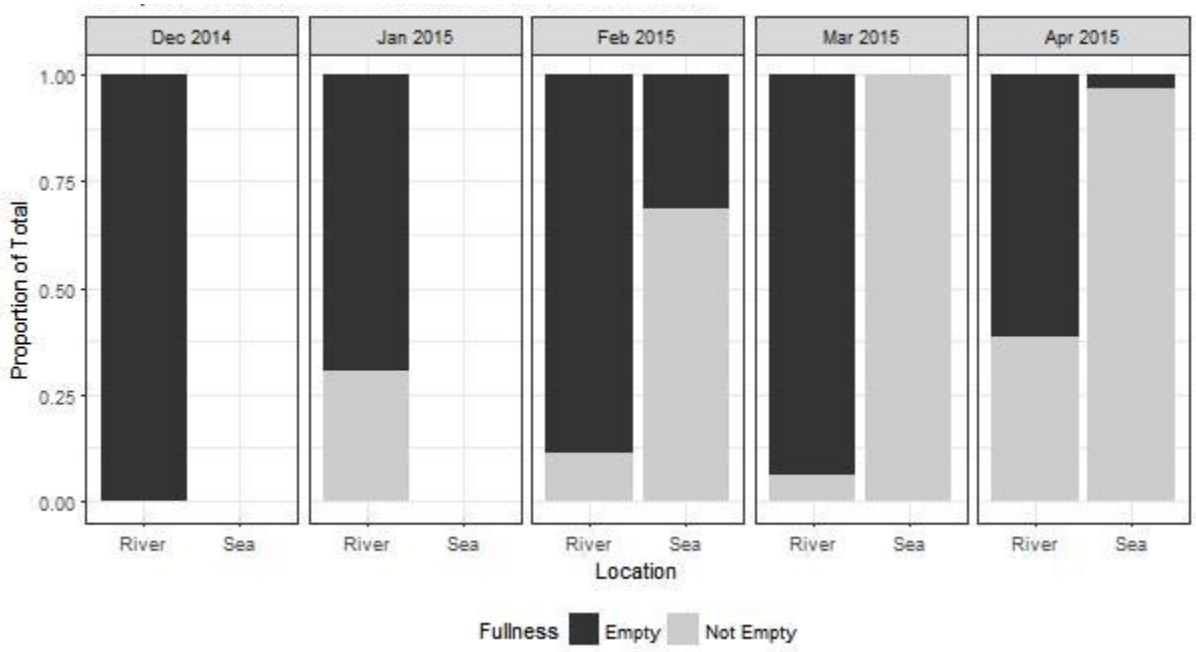


Figure 7-16 Stomach fullness scale (SFS, 2 levels: empty, not empty) of river and sea kahawai across the months of the sampling period. NB: These values were used in the SFS analysis.

The results of the logistic regression model show that sea fish were significantly more likely to have stomach contents (p<0.0001) than river fish (Table 7-17). Fish were also more likely to have stomach contents in April compared with February (p<0.0001). As there were no sea fish with empty stomachs in March, these estimates may be inflated (Figure 7-16).

Table 7-17 Results of the full logistic regression model: SFS fullness~month+location, family=binomial, link=logit; null deviance: 297.68 on 214DF, residual deviance: 180.16 on 211DF, AIC=188.16. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*z-value*	*p-value*
Intercept (February, River)	-2.97	0.53	-5.57	**<0.0001**
Location (Sea)	3.91	0.53	7.42	**<0.0001**
Month (March)	1.04	0.56	1.85	0.06
Month (April)	2.50	0.61	4.12	**<0.0001**

The table of deviance for the full logistic regression model is presented in Table 7-18. Location (p<0.0001) and month (p<0.0001) both significantly reduced the residual deviance compared with the null model.

Table 7-18 Table of deviance for full logistic regression model: SFS fullness~month+location, family=binomial, link=logit; test=Chi-squared, McFadden R^2=0.39. Bold p-values indicate a significant improvement in model fit at 5% level.

	DF	*Deviance*	*Residual DF*	*Residual Deviance*	*Pr.(>Chi)*
Null			214	297.68	
Location	1	94.33	213	203.35	**<0.0001**
Month	2	23.19	211	180.16	**<0.0001**

Figure 7-17 presents the ROC curve plot for the SFS logistic regression model which gives an AUC of 0.88, suggesting that the model has good predictive ability.

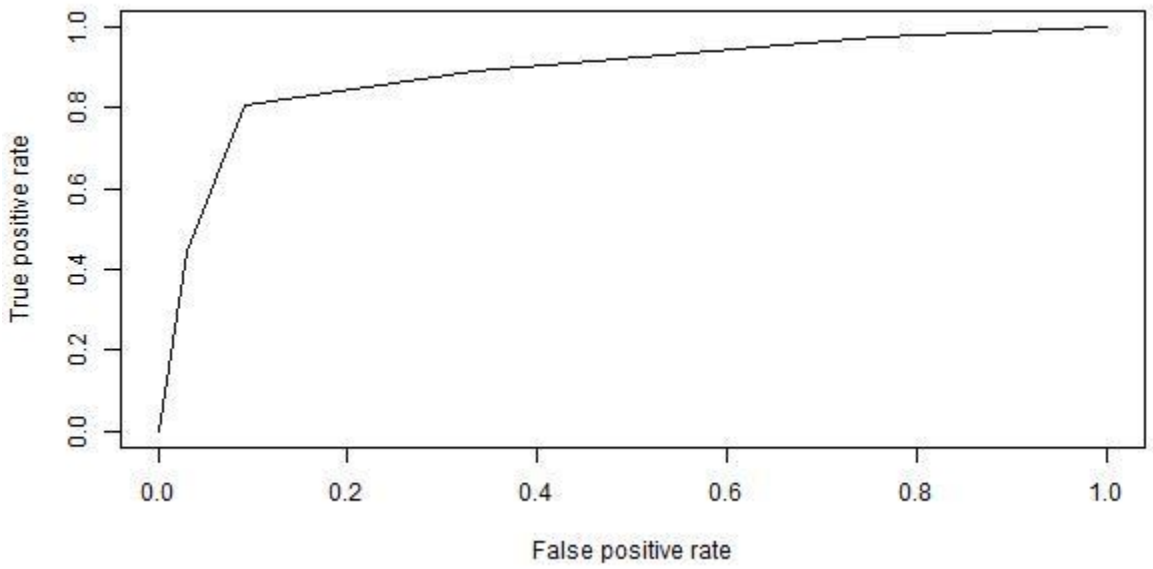


Figure 7-17 ROC curve plot for SFS logistic regression test model: SFS fullness~location+month, family=binomial, link=logit, AUC=0.88.

7.3.3.5 Kahawai stomach contents freshness

Figure 7-18 presents stomach contents freshness between months and locations. Table 7-19 presents counts of fish with each type of stomach contents freshness for each month-location interaction. Not all month-location interactions contained fish with stomach contents from every freshness category. In March for example, there were only river fish with 'totally digested' and 'well digested' stomach contents and only sea fish with 'partially digested' stomach contents. This would inflate the estimates in an ordered logistic regression analysis; therefore the fish were grouped into binary categories. Fish with 'totally digested' stomach contents were removed from the dataset, otherwise the analysis would have been the same as the SFS analysis. This removed the entire 'Dec 2014' dataset. Fish with 'fresh' stomach contents remained in the 'fresh' category. Fish with 'well digested' and 'partially digested' stomach contents were combined into a 'well digested' category.

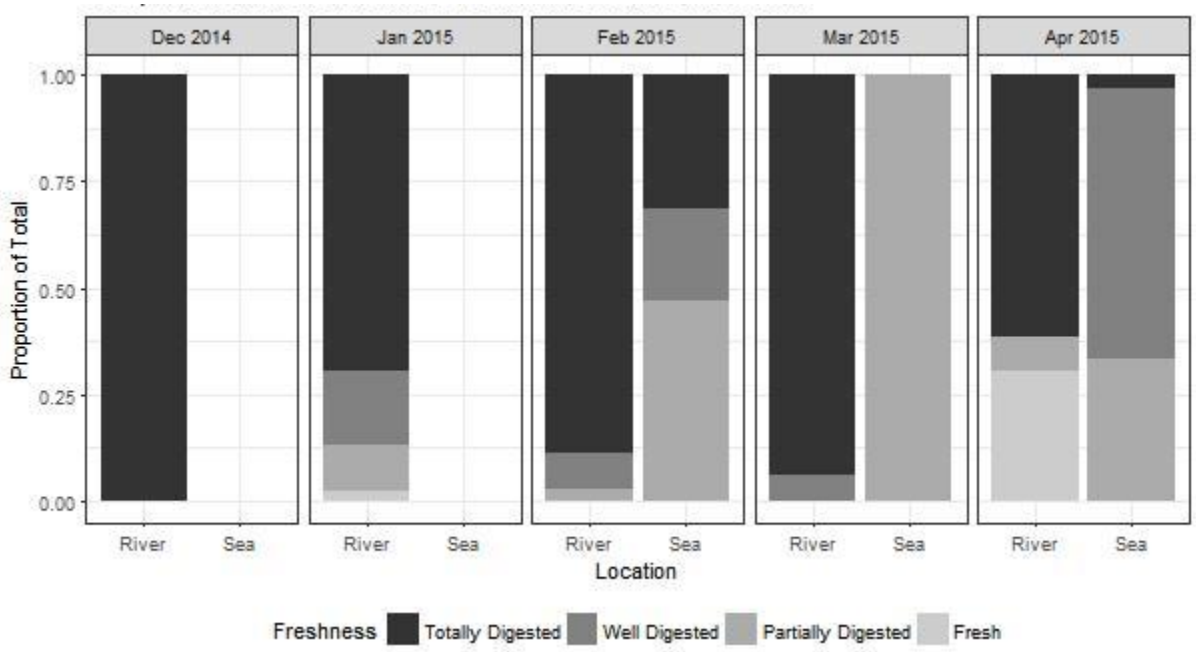


Figure 7-18 Stomach contents freshness (SCF, 4 levels: total digested, well digested, partially digested, fresh) of river and sea kahawai across the months of the sampling period. NB. These SCF values were not used in the final analysis.

Table 7-19 Stomach contents freshness (SCF, 4 levels: total digested, well digested, partially digested, fresh) frequency table for river and sea kahawai across the months of the sampling period. Zeros are in bold.

		River	*Sea*
December	*Fresh*	**0**	NA
	Partially digested	**0**	NA
	Well digested	**0**	NA
	Totally digested	36	NA
January	*Fresh*	1	NA
	Partially digested	5	NA
	Well digested	8	NA
	Totally digested	32	NA
February	*Fresh*	**0**	**0**
	Partially digested	1	33
	Well digested	3	15
	Totally digested	32	22
March	*Fresh*	**0**	**0**
	Partially digested	**0**	19
	Well digested	2	**0**
	Totally digested	32	**0**
April	*Fresh*	8	**0**
	Partially digested	2	10
	Well digested	**0**	19
	Totally digested	16	1

Figure 7-19 presents freshness of river fish (n=30) and sea fish (n=96) stomach contents between locations and months using the new categories. The proportion of river fish with 'well digested' stomach contents increased between January and March, and then in April all

stomach contents were 'fresh.' Sea fish contain 'fresh' stomach contents in every month sampled.

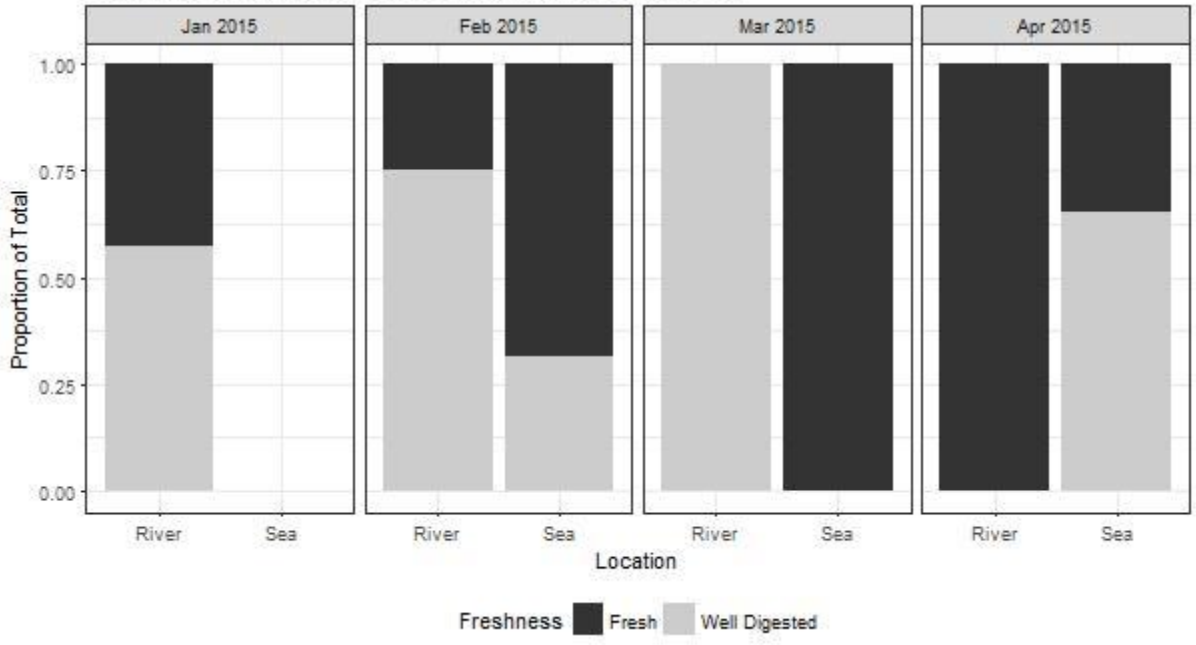


Figure 7-19 Stomach contents freshness (SCF, 2 levels: fresh, well digested) for river and sea kahawai across the months of the sampling period. NB: This data was used in the final SCF analysis.

The results of the full logistic regression model presented in Table 7-20 show that in March fish were more likely to have 'fresh' stomach contents (p=0.04) than in February. However, all river fish had 'well digested' stomach contents in March and 'fresh' stomach contents in April; and all sea fish had 'fresh' stomach contents in March. Therefore, these results are probably inflated and unreliable.

Table 7-20 Results of the full logistic regression model: SCF freshness~month+location, family=binomial, link=logit. Null deviance: 144.78 on 111DF, Residual deviance: 133.58 on 108DF, AIC=141.58. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*z-value*	*p-value*
Intercept (February, River)	-1.13	0.65	-1.73	0.08
Location (Sea)	0.53	0.62	0.85	0.39
Month (March)	-1.61	0.80	-2.02	**0.04**
Month (April)	0.68	0.68	1.52	0.13

The table of deviance for the full logistic regression model is presented in Table 7-21. Only month significantly (p<0.0001) reduced the residual deviance compared with the null model.

Table 7-21 Table of deviance for full logistic regression model: SCF freshness~month+location, family=binomial, link=logit, test=Chi-squared. McFadden R^2=0.09. Bold p-values indicate a significant improvement in model fit at 5% level.

	DF	*Deviance*	*Residual DF*	*Residual Deviance*	*Pr.(>Chi)*
Null			111	144.78	
Location	1	0.11	110	144.67	0.74
Month	2	11.09	108	133.58	**<0.0001**

Figure 7-20 presents the ROC curve plot for the SCF logistic regression model which gives an AUC of 0.75, suggesting that the model has moderate predictive ability.

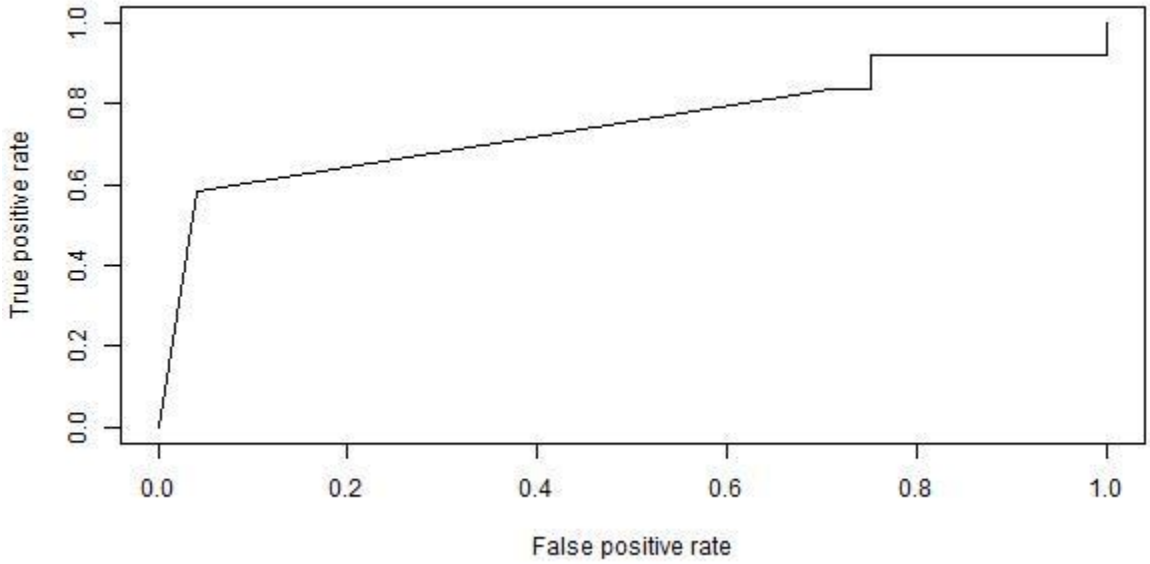


Figure 7-20 ROC curve plot for SCF logistic regression test model: SFC freshness~location+month, family=binomial, link=logit, AUC=0.75.

7.3.4 Mōtū river mouth as a place for kahawai to remove parasites

This sub-section has three parts. Part one describes the parasites found, part two presents the parasite prevalence, and part three presents mean parasite intensity and intensity range.

7.3.4.1 Kahawai parasite types

After the inspection of 371 kahawai, parasites were located on the kahawai gills, mouth, fins, anus, and opercula and in intestinal tracts. Parasites were not located on the buccal folds, eyes, or nares. A total of 306 parasites were found. Figure 7-21 presents examples of the three main types of parasites that were found. Isopods were found externally (Figure 7-21a, and b), monogeans were found on the gills (Figure 7-21c) and nematodes were found in the stomachs (Figure 7-21d).

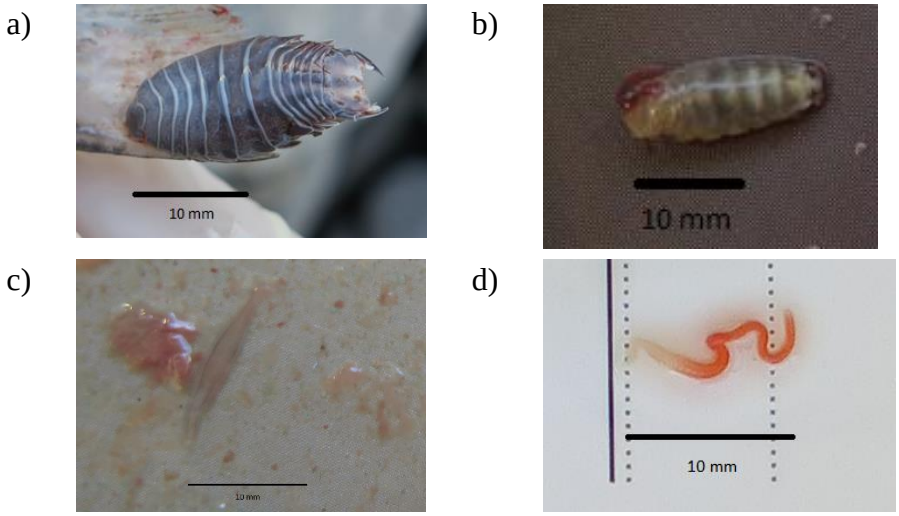


Figure 7-21 Examples of the main parasite types found on kahawai in the study. A) Cymothoidae Nerocila orbignyi, b) Cymothoidae Ceratothoa imbricata, c) Microcotylidae Kahawaia truttae, (Catalano et al., 2010), d) Nematoda.

7.3.4.2 Kahawai parasite prevalence

River kahawai show an upward trend in the prevalence of parasites across the sampling period, being lower from December to February and higher in March and April (Figure 7-22). For sea fish, parasite prevalence was variable.

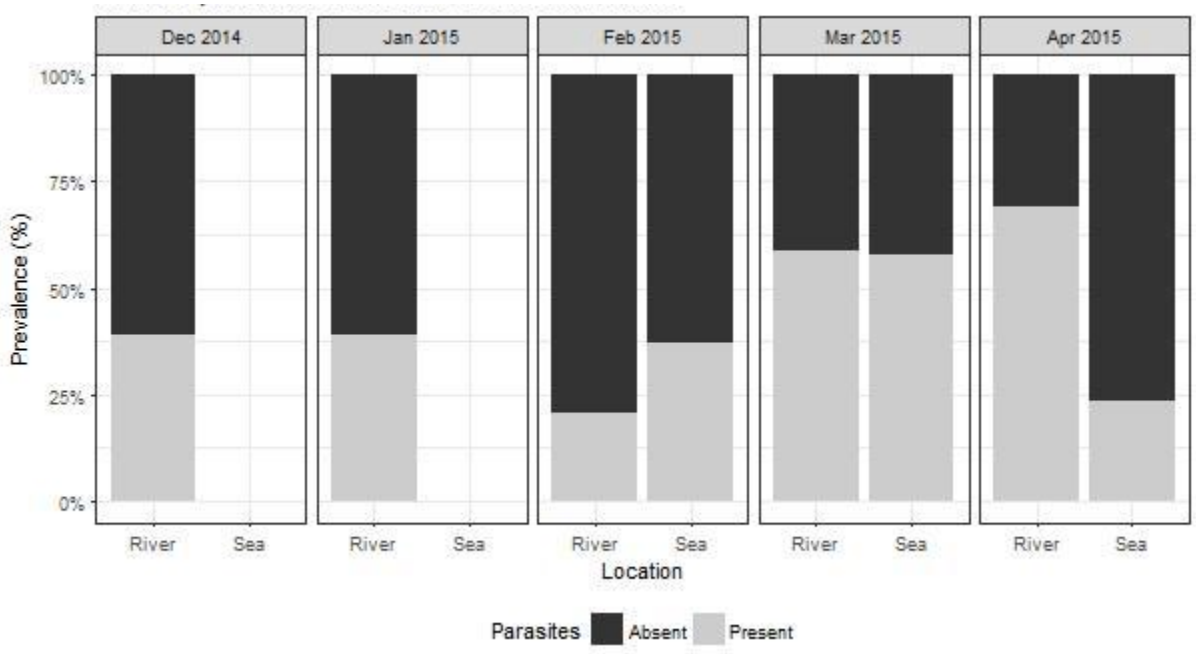


Figure 7-22 Parasite prevalence (proportion of fish examined that have parasites), comparing river and sea kahawai across the months of the sampling period. NB: No suitable sea fish were available for December and January.

The results of the logistic regression model are presented in Table 7-22. The parasite prevalence was significantly different between river and sea fish in February (p=0.04), between river fish in February and March (p<0.0001), and February and April (p<0.0001). Although, river fish in February and sea fish in April had significantly different parasite prevalence (p<0.0001), river

fish in February and sea fish in March did not have significantly different parasite prevalence (p=0.23).

Table 7-22 Results of logistic regression model: parasite prevalence~location-month, family=binomial, link=logit; null deviance=329.08 on 245DF, residual deviance=297.67 on 240DF, AIC=309.67. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*z-value*	*p-value*
Intercept (River, February)	-1.33	0.30	-4.43	**<0.0001**
Location (Sea)	0.81	0.39	2.07	**0.04**
Month (March)	1.69	0.46	3.67	**<0.0001**
Month (April)	2.14	0.52	4.12	**<0.0001**
Location-Month (Sea-March)	-0.84	0.70	-1.21	0.23
Location-Month (Sea-April)	-2.81	0.72	-3.90	**<0.0001**

The table of deviance for the parasite prevalence logistic regression model shows that the location-month interaction (p<0.0001) and month (p<0.0001) coefficients both significantly reduced the residual deviance compared with the null model (Table 7-23).

Table 7-23 Table of deviance for logistic regression model: parasite prevalence~location-month, family=binomial, link=logit, test=Chi-squared; McFadden R^2=0.10. Bold p-values indicate a significant improvement in model fit at 5% level.

	DF	*Deviance*	*Residual DF*	*Residual Deviance*	*Pr.(>Chi)*
Null			245	329.08	
Location	1	0.41	244	328.67	0.52
Month	2	14.34	242	314.33	**<0.0001**
Location-Month	2	16.67	240	297.67	**<0.0001**

Figure 7-23 presents the ROC curve plot for the parasite prevalence logistic regression model which gives an AUC of 0.67, suggesting that the model has low predictive ability.

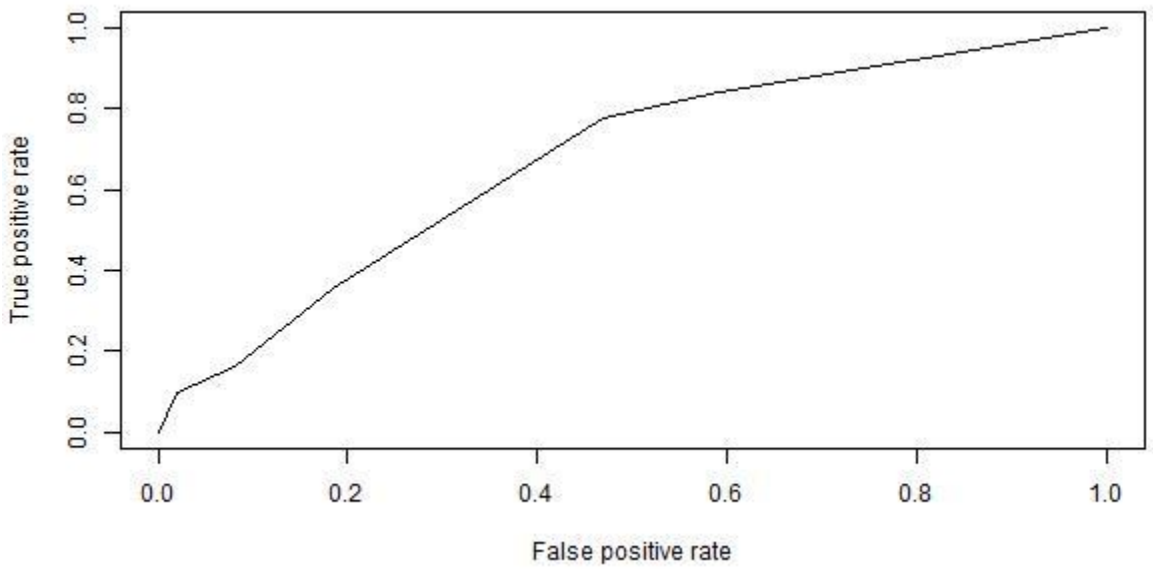


Figure 7-23 ROC curve plot for logistic regression test model: parasite prevalence~location-month, family=binomial, link=logit, AUC=0.67.

7.3.4.3 Kahawai parasite intensity

The mean parasite intensity for river fish was low for December, January and February, and then increased in March and April, peaking in March (Table 7-24). The intensity range for river fish followed a similar pattern with a narrow range in the first three months and a wider range in the last two months, peaking in March. For sea fish, the mean parasite intensity was similar between February and March and then was lower in April. The intensity range for sea fish was wide in February and was narrow in March and April.

Table 7-24 Mean parasite intensity (no. of parasites per host) and intensity (range) location-month summary.

	Mean Intensity (Intensity)	
	River	*Sea*
December	0.56 (0-3)	NA
January	0.49 (0-3)	NA
February	0.33 (0-3)	1.04 (0-28)
March	2.47 (0-41)	1.05 (0-4)
April	1.77 (0-18)	0.53 (0-5)

7.3.5 Mōtū river mouth as a haven for kahawai to avoid predators

This sub-section has two parts. The first part describes known kahawai predators. The second part presents observations of kahawai predators and predatory behaviour near the Mōtū river mouth.

7.3.5.1 Kahawai predators

Here types of kahawai predators are identified based on the literature reviewed, local ecological knowledge (LEK), and scientific community ecological knowledge (SEK). Kahawai, Australian herring, and western Australian salmon were identified in the literature as prey for the species presented in Table 7-25. The literature reviewed presents a good case for sharks, dolphins and seals as key kahawai predators, and for fishes and seabirds as minor predators.

Kahawai was identified as a prey for: black marlin (taketonga, *Istiompax indica*), other kahawai (*A. trutta*), southern bluefin tuna (*Thunnus maccoyi*), striped marlin (takaketonga, *Kajikia audax*), bottlenose dolphin (terehu, *Tursiops truncatus*), false killer whale (maki, *Pseudorca crassidens*), killer whale (*Orcinus orca*), New Zealand fur seal (kekeno, *Arctocephalus forsteri*), short-beaked common dolphin (aihe, *Delphinus delphis*), Australasian gannet (takapu, *Morus serrator*), pied shag (Kawau, *Phalacrocorax varius*), bronze whaler shark (horopekapeka, *Carcharhinus brachyurus*), grey nurse shark (*Carcharias taurus*), whaler sharks (*Carcharinus* spp.), mako shark (mako, *Isurus oxyrhinchus*), and white shark (mangō-ururoa, *Carcharodon carcharias*; Table 7-25).

Australian herring (*A. georgianus*) was identified as a prey for three sharks: bronze whaler (*C. brachyurus*), common thresher (*Alopias vulpinus*) and smooth hammerhead (*Sphyrna*

zygaena); and western Australian salmon (*A. truttaceus*) was identified as a prey for dolphins (Delphinidae), seals (Otariidae) and four sharks (mangō): bronze whaler (*C. brachyurus*), dusky (*Carcharhinus obscurus*), grey nurse (*C. taurus*), and white (*C. carcharias*; Table 7-25). Sharks often evert their stomachs on capture and lose the contents making it difficult to determine their prey based on contents analysis (C. Duffy, *pers. comm.*, 2017). However, sharks, dolphins, and occasionally seals have been observed preying heavily on schools of Arripids along north-eastern NZ and Australia's south-east and south-western coasts. This, coupled with kahawai being found in stomach contents, strongly suggests that they are in fact major predators of kahawai.

However, marlins, sharks, and yellowtail kingfish are also known to associate with kahawai, blue maomao, and trevally schools (Grey, 1926; Wilkins & Sale, 1982), and in NZ, only kahawai amongst these species was identified as a predator (Horn et al., 2013; Stevens et al., 2011). These reviews frequently listed 'unidentified fish' as a prey item, therefore kahawai cannot be totally ruled out as a prey for these species, but it is unlikely to be an important one (Horn et al., 2013; Stevens et al., 2011). The single observation by Wilkins and Sale (1982) of southern bluefin tuna 'hammering' sprats, herring, kahawai and other varieties of baitfish did not confirm that kahawai were eaten; and the kahawai reported in the striped and black marlin may have been the bait the fishers reported using (Grey, 1926; Wilkins & Sale, 1982). Illingworth (1961) noted a lack of kahawai in 40 marlin stomachs he examined and suggested: koheru (*Decapterus koheru*), snapper (*P. auratus*), pink maomao (*Caprodon longimanus*), barracouta (mangā, *Thyrsites atun*), jack mackerel (hāture, *Trachurus* spp.), small yellowtail kingfish (haku, *S. lalandi*), trevally (araara, *Pseudocaranx dentex*), and skipjack tuna (*K. pelamis*), as preferred marlin prey; with black marlin regularly bottom feeding, and striped marlin feeding in the open ocean. Kahawai comprised a very small portion of the diet of gannets and the proportion was not specified for shags (Machovsky-Capuska et al., 2016; Powlesland, 2013; Tait et al., 2014). LEK and SEK presented in Table 7-26. LEK and SEK provide a good case for large teleost fish, dolphins, and sharks as key kahawai predators. The types of large teleost fish include marlins (*I. indica, K. audax*), tunas *(K. pelamis, T. maccoyii, and Thunnus albacares*), hāpuku (*Polyprion oxygeneios*) and especially, yellow-tail kingfish (*S. lalandi*). The types of sharks include bronze whaler (*C. brachyurus*), mako (*I. oxyrinchus*), school (tūpere, *Galeorhinus australis*) and white sharks (*C. carcharias*).

Table 7-25 Literary examples of kahawai (A. trutta), Australian herring (A. georgianus) and western Australian salmon (A. truttaceus) predators including predator type, predator species, location reported and the literature reviewed.

Prey species	*Predator type*	*Predator species*	*Location*	*Reference*
Australian herring (*A. georgianus*)	Shark	Bronze whaler shark (*Carcharhinus brachyurus*)	Southern Australia	Rogers et al. (2012)
	Shark	Common thresher shark (*Alopias vulpinus*)	Southern Australia	Rogers et al. (2012), Rogers & Huveneers (2017)
	Shark	Smooth hammerhead shark (*Sphyrna zygaena*)	Southern Australia	Rogers et al. (2012)
Kahawai (*A. trutta*)	Large pelagic teleost	Black marlin (*Istiompax indica*)	Bay of Islands, NZ	Grey (1926)
	Large pelagic teleost	Kahawai (*A. trutta*)	Otago, NZ	Graham (1938, 1953) in Stevens et al. (2011)
	Large pelagic teleost		Wellington Harbour, NZ	Baker (1971) in Stevens et al. (2011)
	Large pelagic teleost	Southern bluefin tuna (*Thunnus maccoyi*)	Milford Sound, NZ	Wilkins and Sale (1982)
	Large pelagic teleost	Striped marlin (*Kajikia audax*)	Bay of Islands, NZ	Grey (1926)
	Marine mammal	Bottlenose dolphin (*Tursiops truncatus*)	Bay of Islands, NZ	Zaeschmar et al. (2014)
	Marine mammal	False killer whale (*Pseudorca crassidens*)	Hauraki Gulf, NZ	Zaeschmar et al. (2013; 2014)
			Bay of Plenty, NZ	Zaeschmar et al. (2014)
			Bay of Islands, NZ	Zaeschmar et al. (2014)
	Marine mammal	Killer whale (*Orcinus orca*)	Hauraki Gulf, NZ	Zaeschmar et al. (2014, 2013)
	Marine mammal	New Zealand fur seal (*Arctocephalus forsteri*)	Bay of Plenty, NZ	Zaeschmar et al. (2014)
	Marine mammal	Short-beaked common dolphin (*Delphinus delphis*)	Whāngarei Heads, NZ	Visser (2000)
			Kaikoura, NZ	Emami-Khoyi et al. (2016)
	Seabird	Australasian Gannet (*Morus serrator*)	Mercury Bay, NZ	Neumann et al. (2005)
			Mōtūkaramarama, NZ	Wingham (1985)
			Farewell Spit, NZ	Tait et al. (2014), Machovsky-Capuska et al. (2016)
	Seabird	Pied shag (*Phalacrocorax varius*)	Hauraki Gulf, NZ	Tait et al. (2014)
	Shark	Bronze whaler shark (*Carcharhinus brachyurus*)	New Zealand	Powlesland (2013)
	Shark		Australia	Last and Stevens (1994)
	Shark	Grey nurse shark (*Carcharias taurus*)	Australia	Kailola et al. (1993)
	Shark	Whaler sharks (*Carcharinus* spp.)	Australia	Jones (1992)
	Shark	Mako shark (*Isurus oxyrhinchus*)	New Zealand	Illingworth (1961)

Prey species	*Predator type*	*Predator species*	*Location*	*Reference*
		White shark (*Carcharodon carcharias*)	Newcastle/Port Stephens, Australia	Malcolm et al. (2001)
Western Australian salmon (*A. truttaceus*)	Marine mammal	Dolphins (Delphinidae)	Western and southern Australia	Kailola et al. (1993)
	Marine mammal	Seals (Otariidae)	Western and southern Australia	Kailola et al. (1993)
	Shark	Bronze whaler shark (*Carcharhinus brachyurus*)	Sceale Bay, Anxious Bay, Avoid Bay, South Australia and Western Australia	Kailola et al. (1993)
	Shark	Dusky shark (*Carcharhinus obscurus*)	Sceale Bay, Anxious Bay, Avoid Bay, South Australia and Western Australia	Kailola et al. (1993)
	Shark	Grey nurse sharks (*Carcharias taurus*)	Western and southern Australia	Kailola et al. (1993)
	Shark	White shark (*Carcharodon carcharias*)	Western and southern Australia	Kailola et al. (1993)

Table 7-26 Local ecological knowledge (LEK) and scientific ecological knowledge (SEK), denoted by two asterisks (*), of kahawai predators. Please note that where multiple species have been mentioned the quote has been repeated.

Local Ecological Knowledge	*Predator type*	*Predator species*	*Location*	*Record type and number*	*Reference*
"We generally release kahawai but sometimes keep the odd one for bait if we are short, or for live baits when **marlin** or kingfish fishing."	Large pelagic teleost (marlins)		Northland, between Hen and Chicks and North Cape	Questionnaire response from Pete Saul	Hartill et al. (2005)
"**Marlin** I think was the ones that chase them at the Mōtū." "Some of those fish like that I've seen them zooming along behind them in the surf." "Yeah coming down in the waves chasing the Kahawai" "Yeah but people have caught them like that Kieran Hickey got one a **black marlin** I think it was off the Mōtū during the season chasing thing…"	Large pelagic teleost (marlins)	Black marlin (*Istiompax indica*)	Mōtū river	Interview with Participant 15	Current study (2014)
"Finally, I have also seen a kahawai in the stomach of a large Hapūku taken off south Wairarapa. This species and other large teleosts like kingfish and **marlin (striped and black)** were probably also once important predators of kahawai as well."	Large pelagic teleost (marlins) Large pelagic teleost (marlins)	Black marlin (*Istiompax indica*) Striped marlin (*Kajikia audax*)	South Wairarapa	C. Duffy, *pers. comm.**	Current study (2017)
"The decimation of kahawai stocks has other effects on the ecosystem. …Big predators such as **striped marlin**, sharks and kingfish also suffer."	Large pelagic teleost (marlins)	Striped marlin (*Kajikia audax*)	Hauraki Gulf, Bay of Plenty, Northland	Questionnaire response from Sam Mossman	Hartill et al. (2005)
"…it'd 'e eaten by the likes of **tuna**…"	Large pelagic teleost (tunas)		Mōtū river	Interview with Participant 15	Current study (2014)
"It is not uncommon to see schools of **skipjack tuna** feeding aggressively on these larval and post-larval kahawai when they are abundant."	Large pelagic teleost (tunas)	Skipjack tuna *(Katsuwonus pelamis)*	Offshore Urapukapuka Island and Cape Brett	Questionnaire response from Craig Worthington	Hartill et al. (2005)
And do you know of any other species that ah eat the kahawai or? "Well, well there's just those tunas and that they've all disappeared now the t- like the **Yellow fin** and the **Blue fin** and that. The kingfish	Large pelagic teleost (tunas)	Southern blue fin tuna (*Thunnus maccoyii*)	Mōtū river	Interview with Participant 7	Current study (2014)

Local Ecological Knowledge	*Predator type*	*Predator species*	*Location*	*Record type and number*	*Reference*
numbers are still good but there no one's even seen a bloody **Blue fin** or a **Yellow fin tuna** in years around here now."		Yellow fin tuna (*Thunnus albacares*)			
"Finally, I have also seen a kahawai in the stomach of a large **Hapūku** taken off south Wairarapa. This species and other large teleosts like kingfish and marlin (striped and black) were probably also once important predators of kahawai as well."	Large benthic teleost (wreckfish)	Hapūku (*Polyprion oxygeneios*)	South Wairarapa	C. Duffy, *pers. comm.**	Current study (2017)
"Ring netting can be a very selective method compared to set netting. Only rarely do we catch other species such as **kingfish**. Usually the catch is 100% kahawai."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Hauraki gulf, inner gulf islands, Kawau and the Happy Jacks down to Waiheke and Ponui.	Phone interview with Brendan Taylor	Hartill et al. (2005)
"Target them [kahawai] specifically for live bait when fishing for **kingfish**."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Russell, Bay of Islands	Questionnaire response from Craig Worthington	Hartill et al. (2005)
"We generally release kahawai but sometimes keep the odd one for bait if we are short, or for live baits when marlin or **kingfish** fishing."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Northland, between Hen and Chicks and North Cape	Questionnaire response from Pete Saul	Hartill et al. (2005)
"The decimation of kahawai stocks has other effects on the ecosystem. …Big predators such as striped marlin, sharks and **kingfish** also suffer."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Hauraki Gulf, Bay of Plenty, Northland	Questionnaire response from Sam Mossman	Hartill et al. (2005)
"Kahawai are a very important part of the inshore ecosystem involving fish, seabird and plankton feeding relationship. At a fisheries liaison meeting in Blenheim when kahawai was being discussed I asked a Mfish officer of the effects of depleted kahawai numbers on **kingfish** populations. He didn't know what I was asking, i.e. kahawai are the major food	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Marlborough/ southern North Island region	Questionnaire response from Tony Orman	Hartill et al. (2005)

Local Ecological Knowledge	*Predator type*	*Predator species*	*Location*	*Record type and number*	*Reference*
source of **kingfish** so what happens when they are "removed" from the food chain. … Incidentally the effect of severely depleted kahawai numbers has been to force the **kingfish** to bottom feed instead of surface predation on kahawai with a noticeable increase of **kingfish** being caught as "bycatch" by bottom fishing methods for blue cod and snapper."					
*Do you go for **kingfish**?* "Yeah. Caught about three this year." *Is it easy to get legal sized ones?* "Yeah. Oh yeah especially down the river here yeah." *Oh, down here? So, it is sweet to what livies do you use for those?* "Kahawai." *What size?* "Big as ones." *Oh really?* "Bigger than 30cm oh well that'll be the smallest ones you use but normally bigger nah you try and get the biggest kahawai." "Cause he'll swim out further [laughs] with your balloon yeah."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Mōtū river	Interview with Participant 7	Current study (2014)
"Sometimes you'll just catch them fluke them on a spinner." "Yeah when you are pulling in your Kahawai and next minute you've got a **kingie** on there."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Mōtū river	Interview with Participant 11	Current study (2014)
"But yeah, I haven't hooked up with a bloody Kingfish yet. My son-in-law caught one a few years ago. He was rapt."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Mōtū river	Interview with Participant 14	Current study (2014)
"Yeah, and usually the tere, and where there's a tere there's kahawai and where there's kahawai there's **kingies**."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Mōtū river	Interview with Participant 15	Current study (2014)
"**Kingfish** maybe? Those sort of predators, I'd say."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	Mōtū river	Interview with Participant 17	Current study (2014)
"The fish is being marked by the **kingfish**." *Can you see where they have been trying to eat them?* "Yeah trying to catch the kahawai, you know they are starting to go down in condition."	Large pelagic teleost	Yellowtail Kingfish (*Seriola lalandi*)	South Wairarapa	C. Duffy, *pers. comm.**	Current study (2017)

Local Ecological Knowledge	*Predator type*	*Predator species*	*Location*	*Record type and number*	*Reference*
"Finally, I have also seen a kahawai in the stomach of a large Hapūku taken off south Wairarapa. This species and other large teleosts like **kingfish** and marlin (striped and black) were probably also once important predators of kahawai as well."					
"Like the **gannets**. When you see those fellas- *Those really big birds?* -Yeah. When you see those fellas diving, they're diving for the anchovies eh? Or even small kahawai. When you see those birds diving there's a school of fish and usually they're kahawai. You hardly see them now, I hardly see them at home."	Seabird	Australasian Gannet (*Morus serrator*)	Mōtū River Ōpape	Interview with Participant 14	Current study (2014)
"Very often they would simply sit on the surface with thousands of tails sticking out in the sun. It was a mystery why they schooled in this manner. Protection from **sharks** may have been part of the answer. Many of the fish [kahawai] exhibited fresh bite marks."	Shark		Northland, Ruakaka river, Waipu river, Mangawhai and Ocean Beach	Questionnaire response from Craig Worthington	Hartill et al. (2005)
"The decimation of kahawai stocks has other effects on the ecosystem. …Big predators such as striped marlin, **sharks** and kingfish also suffer."	Shark		Hauraki Gulf, Bay of Plenty, Northland	Questionnaire response from Sam Mossman	Hartill et al. (2005)
"I have a confirmed record of a 2.0-2.1mTL juvenile great white and a 2.8mTL **bronze whaler (*Carcharhinus brachyurus*)** caught in the mouth of Mōtū River in Feb 1971. The stomachs of both were reported to be 'full of kahawai'. "While I have not personally found kahawai in the stomachs of **bronze whalers** I have not examined many adults or large sub-adults, and of those that I have most have been caught on rod and line which often means they have everted their stomachs during capture."	Shark	Bronze whaler shark (*Carcharhinus brachyurus*)	Mōtū river	C. Duffy, *pers. comm.**	Current study (1971)
"**Bronze whalers** and Mako sharks hang around in coastal/shelf waters in summer (and other seasons to	Shark	Bronze whaler shark	Coastal/shelf waters	M. Francis, *pers. comm.**	Current study (2017)

Local Ecological Knowledge	*Predator type*	*Predator species*	*Location*	*Record type and number*	*Reference*
a lesser extent) and both feed mainly on schooling fish presumably kahawai, jack mackerels and skipjack tunas, blue maomao, koheru, sweep and pilchards."		(*Carcharhinus brachyurus*)			
"…won't be eaten by sharks and that, it won't catch 'em" *Why wouldn't sharks catch 'em?* "Not fast enough." "**Mako Sharks** they chase the old not **Mako** yeah I think it is."	Shark	Mako shark (*Isurus oxyrinchus*)	Mōtū river	Interview with Participant 15	Current study (2014)
"**Mako** definitely feed on kahawai – I have seen a very small juvenile **mako** take a large, free swimming kahawai in a burley trail off Manukau Heads. Having said that I have never found a kahawai in a **mako** shark however as most of the **mako** that I have examined have been caught in game fishing competitions off Hawke Bay that is not surprising. As I said sharks frequently evert their stomachs when caught on hook and line. Also game fishers usually target large fish well offshore beyond the normal range of kahawai. You wouldn't expect kahawai to turn up in the stomachs of **mako**, or any other shark caught on tuna longlines or tuna purse-seines because kahawai generally don't occur in areas where you would fish for tuna. The small **mako** (i.e. <60kg), the ones most likely to be feeding on coastal pelagics, are generally ignored by sport fishers. These small **mako** are common over the inner shelf and often occur in areas where kahawai are common. Like bronze whalers and small whites they are generalist fish predators and so will take whatever is locally available."	Shark	Mako shark (*Isurus oxyrinchus*)	Manukau Heads, Hawke Bay Inner shelf	C. Duffy, *pers. comm.**	Current study (2017)
"Bronze whalers and **mako sharks** hang around in coastal/shelf waters in summer (and other seasons to a lesser extent) and both feed mainly on schooling	Shark	Mako shark (*Isurus oxyrinchus*)	Coastal/shelf waters	M. Francis, *pers. comm.**	Current study (2017)

Local Ecological Knowledge	*Predator type*	*Predator species*	*Location*	*Record type and number*	*Reference*
fish presumably kahawai, jack mackerels and skipjack tunas, blue maomao, koheru, sweep and pilchards."					
"**School shark** are an ancient shark that grow up to 2m which feed close inshore in the pelagic. Gut analysis was carried out from 1983-1985 on **school sharks** caught by: set net off New Plymouth, long-line in the Cook Strait, close inshore in the Marlborough Sounds and at the Mōtū river near Te Kaha. **School shark** caught off New Plymouth (and possibly Cook Strait) were larger and no kahawai were found in the stomach contents. We did catch small **school shark** off the Mōtū River when we were tagging kahawai (Brent Wood's team). **School shark** caught in the Marlborough Sounds and Mōtū River had small kahawai in the stomachs. The larger kahawai are probably too fast and large for **school sharks** to catch however juvenile kahawai do comprise part of the smaller shark's diet along with other small fish and crustaceans. Their small teeth suggest **school shark** are opportunistic feeders or scavengers and not voracious predators like the mako, blue and white sharks."	Shark	School shark (*Galeorhinus australis*)	Mōtū river Marlborough Sounds	M. Bird, *pers. comm.**	Current study (1985)
"The mouth of Mōtū River is well known for juvenile **great white sharks**. I have a confirmed record of a 2.0-2.1mTL juvenile **great white** and a 2.8mTL bronze whaler (*Carcharhinus brachyurus*) caught in the mouth of Mōtū River in Feb 1971. The stomachs of both were reported to be 'full of kahawai'."	Shark	White shark (*Carcharodon carcharias*)	Mōtū river	C. Duffy, *pers. comm.**	Current study (1971)
"I also tracked a 2.76mTL **great white** there from Stewart Island in 2010. It spent about two days hanging around the mouth of the river."	Shark	White shark (*Carcharodon carcharias*)	Mōtū river	C. Duffy, *pers. comm.**	Current study (2010)

Local Ecological Knowledge	*Predator type*	*Predator species*	*Location*	*Record type and number*	*Reference*
"Other records of **white sharks** feeding on kahawai that I have are: 240cmTL, set net, 60m depth off New Plymouth – stomach contents included two kahawai; 210cmTL, 18m depth, Ninety Mile Beach – stomach contained 6 kahawai. I have also seen a small **great white** chase a hooked kahawai to the boat in Kaipara Harbour. Those are all of the records of kahawai being found in great white stomach contents that I have but I have to qualify this by saying that for most of the records that I have there are no records of stomach contents, for the few that I have stomach content information for the fish remains generally are not identified beyond the generic categories fish, shark, or stingray. Demersal and coastal pelagic fishes do however make up an important part of the diet of **great whites**, particularly juveniles (i.e. less than 3.5mTL)."	Shark	White shark (*Carcharodon carcharias*)	New Plymouth Ninety Mile Beach Kaipara Harbour	C. Duffy, *pers. comm.**	Current study (2017)

7.3.5.2 Observations of predators and predatory behaviour at the Mōtū river mouth

Table 7-27 lists field notes of kahawai predators and predatory behaviour at the Mōtū river mouth. Figure 7-24 and Figure 7-25 provides a series of photos of predators, predatory behaviour, and evidence of predators preying on kahawai at the Mōtū river mouth. Field notes of predators at the Mōtū river mouth included: yellow-tail kingfish, sharks, bronze whalers, mako, and white sharks. Sharks (bronze whalers and whites) were seen jumping from the water. A school shark was caught on a hand line at the river mouth. A long-finned pilot whale (*Globicephala melas*) beached itself at the right side of the river mouth. Yellow-tail kingfish were caught at the river mouth. Predatory behaviour observed included kahawai caught with flesh wounds that resembled shark bites, stunned kahawai swimming on the surface of the water, large splashes and predators jumping from the water, injured kahawai swimming in the estuary.

Table 7-27 Field notes of kahawai predators and predatory behaviour at the Mōtū river mouth in the 2014-2015 season.

Observation	*Comment*	*Predator species*	*Record type and number*	*Record details*
"Talking about the **kingfish** catching someone caught a 20kg one! Heavy lines getting broken 8lbs. Chasing them at the [Mōtū] mouth now instead of the kahawai."	Predator observation	Yellowtail kingfish (*Seriola lalandi*)	F. Porter, *pers. comm.* Field notes, 9 April 2014	Current study (2014)
"Fish jumping in eddy on other side of mouth 11.00AM"	Predator behaviour		Field notes, 16 December 2014	Current study (2014)
"**Kingfish** caught in early hours of the morning by someone in a white truck around 5.30-7AM."	Predator observation	Yellowtail kingfish (*Seriola lalandi*)	Field notes, 17 December 2014	Current study (2014)
"Right hand river mouth – George trying to catch a **kingfish**."		Yellowtail kingfish (*Seriola lalandi*)	Field notes, 09 February 2015	Current study (2015)
"**Kingfish** chase kahawai & stun them before they eat them 9.00AM."		Yellowtail kingfish (*Seriola lalandi*)	P. Brown, *pers. comm.* Field notes, 09 February 2015	Current study (2015)
No **kingfish** although people targeting them.		Yellowtail kingfish (*Seriola lalandi*)	Field notes, 16 February 2015	Current study (2015)
People are trying to fish for **kingies** but haven't landed any.		Yellowtail kingfish (*Seriola lalandi*)	Field notes, 17 February 2015	Current study (2015)
There is a boat about 150m offshore. Name of boat: Kelsey. Trolling for **kingfish** using live kahawai.		Yellowtail kingfish (*Seriola lalandi*)	Field notes, 26 February 2015	Current study (2015)
Someone caught a **kingfish** here while I was away.		Yellowtail kingfish (*Seriola lalandi*)	Field notes, 31 March 2015	Current study (2015)
Kingfish caught last night after 4.30 PM by Stewart Poihipi.	Predator observation	Yellowtail kingfish (*Seriola lalandi*)	Field notes, 01 April 2015	Current study (2015)
Observation by a guy from Taneatua: **Sharks** keeping kahawai in close. Jumped out of water this morning. Taking bait.		Shark	Guy from Taneatua, *pers. comm.* Field notes, 17 February 2015	Current study (2015)
Didn't see shark		Shark	Field notes, 18 February 2015	Current study (2015)

Observation	*Comment*	*Predator species*	*Record type and number*	*Record details*
Someone saw a shark when we arrived ~9.30AM.		Shark	Field notes, 04 March 2015	Current study (2015)
Saw a shark jump out of the water when we arrived.		Shark	Field notes, 31 March 2015	Current study (2015)
"…during the week fishing had been good too. They had also caught a 2-3m **Bronze shark**."	Predator observation	Bronze whaler shark (*Carcharhinus brachyurus*)	M. Black *pers. comm.* Field notes, 21 March 2014	Current study (2014)
"**Bronze whaler shark** here this morning. Jumped out of the water 09.00AM."	Predator observation	Bronze whaler shark (*Carcharhinus brachyurus*)	P. Brown, *pers. comm.* Field notes, 09 February 2015	Current study (2015)
Recent sightings of **white pointers** and **mako sharks**		White shark Mako shark	Field notes, 22 February 2015	Current study (2015)
"**Gannets** diving, seagulls and shags diving."		Gannets	Field notes, 17 December 2014	Current study (2014)
"Gannets diving, **seagulls** and shags diving."		Seagulls	Field notes, 17 December 2014	Current study (2014)
"Gannets diving, seagulls and **shags** diving."		Shags	Field notes, 17 December 2014	Current study (2014)
"**Shags** fishing."		Shags	Field notes, 18 December 2014	Current study (2014)
"Fish were jumping out of the water all afternoon 6.00AM."	Predatory behaviour		Field notes, 05 January 2015	Current study (2015)
"One-two fish could be seen swimming in the waves, multiple fish jumping 5.20PM."	Predatory behaviour		Field notes, 05 January 2015	Current study (2015)
I swam to mouth and found a dead kahawai – I took it to shore and gave it to a fisher.	Predatory behaviour		Field notes, 09 February 2015	Current study (2015)
I saw three injured in a large school of at least 30 fish. One had been attacked 2 cuts/lesions.	Predatory behaviour		Field notes, 09 February 2015	Current study (2015)
No observations of predators but in afternoon ~3PM Dave saw a **shark**	Predator observation	Shark	Field notes, 09 February 2015	Current study (2015)

Observation	*Comment*	*Predator species*	*Record type and number*	*Record details*
jumping at the mouth from his house (not a confirmed sighting).				
Good shots of an injured fish down low with scars on it. Seen twice. The fish are just gently cruising around not eating.	Predatory behaviour		Field notes, 10 February 2015	Current study (2015)
11:09AM Fish are jumping out of the water, a huge school from the mouth out at least 100m.	Predatory behaviour		Field notes, 15 February 2015	Current study (2015)
RH mouth on far side where fish are jumping. The fish are in a school on the far side of the mouth. Fish are jumping…They are jumping out of water and have tails out in the waves.	Predatory behaviour		Field notes, 17 February 2015	Current study (2015)
Fish in the river looked very battered, tails missing, fins missing, holes on side, all sorts.	Predatory behaviour		Field notes, 18 February 2015	Current study (2015)
GoPro 16:30 munched fish	Predatory behaviour		Field notes, 18 February 2015	Current study (2015)
GoPro 9.12 fish with missing tail.	Predatory behaviour		Field notes, 18 February 2015	Current study (2015)
This morning fish were jumping 30-50cm out of water as if they were chased. One fish splashed, jumped vertically pretty high & then swam upside down in circles. Big splash 200m offshore.	Predatory behaviour		Field notes, 23 February 2015	Current study (2015)
Fish jumping out of water 10m offshore (where fish were jumping).	Predatory behaviour		Field notes, 23 February 2015	Current study (2015)
Something huge splashing in the school of fish just behind the waves – looked **brown/bronze** & at least human size. Fishermen came down	Predator observation	Shark	Field notes, 24 February 2015	Current study (2015)

Observation	*Comment*	*Predator species*	*Record type and number*	*Record details*
and went straight away again. Little fish jumping out of water in river. Big splash also.				
One kahawai was injured like so (picture of fish with a lower half circle wound on right hand side behind fin another few had patches. One was videoed very injured.	Predatory behaviour		Field notes, 26 February 2015	Current study (2015)
Saw 3 fish jump 1m out of water. One with fresh raw chunk on side. One with bloody fin tip. May have seen little fish jump out of the water.	Predatory behaviour		Field notes, 27 February 2015	Current study (2015)
Three dead fish in the lagoon with no apparent marks. Eight dead kahawai. Watched one fritter around and then die, jumped out of water, swam around upside down tried to swim out of the water and then drowned.	Predatory behaviour		Field notes, 01 March 2015	Current study (2015)
Seven more dead fish in lagoon, one died in front of my eyes. It did that fritter around thing and then came ashore and died. Fritter around means jump, swim upside down in circles.	Predatory behaviour		Field notes, 02 March 2015	Current study (2015)
Big splash again beyond breakers. Fish in a huge school at mouth on shallow with tails out. Splashing in groups leaping out of the water.	Predatory behaviour		Field notes, 02 March 2015	Current study (2015)
Saw a number of injured fish.	Predatory behaviour		Field notes, 04 March 2015	Current study (2015)
Hole in fish anus area Wound Part of tail missing	Fish 243, 251 and 262 all look like they	White shark (*Carcharodon carcharias*)	Photo_Fish_ID_126_Fish Photo_Fish_ID_243_Wound Photo_Fish_ID_251_Tail	Current study (2015) Current study (2015) Current study (2015)

Observation	*Comment*	*Predator species*	*Record type and number*	*Record details*
Wound	were bitten, probably by a shark, during capture (C. Duffy, *pers. comm*.).	White shark (*Carcharodon carcharias*)	Photo_Fish_ID_262_Wound	Current study (2015)
Wound	The injuries to fish 267 look like they may have been inflicted prior to capture, there seems to be some tissue changes around the edges of the wounds. The fish that inflicted these injuries was definitely a shark, I would say probably a great white shark (*Carcharodon carcharias*) judging by the spacing between the tooth cuts on the caudal peduncle (C. Duffy, *pers. comm.).*	White shark (*Carcharodon carcharias*)	Photo_Fish_ID_267_Fish	Current study (2015)
Wound			Photo_Fish_ID_267_Wound1	Current study (2015)
Wound			Photo_Fish_ID_267_Wound2	Current study (2015)
Wound		White shark (*Carcharodon carcharias*)	Photo_Fish_ID_299_Fish	Current study (2015)
Wound on tail			Photo_Fish_ID_299_Tail	Current study (2015)
Injury mid-body			Photo_Fish_ID_300_Injury	Current study (2015)

a)

b)

c)

d)

e)

Figure 7-24 Observations of kahawai predators at the Mōtū river mouth a) Long-finned pilot whale at the right-hand mouth (February 2014, D. Callaghan); b) Long-finned pilot whale at the right-hand mouth (February 2014, D. Callaghan); c) Yellowtail kingfish hand-line off the beach (2012, Weka Digital Media https://www.youtube.com/watch?v=t4luWjys3A4&list=PL-vc-a95lZa0rd5a_VuH7BbyS4Jh2fLwp; d) School shark hand-line off beach with kahawai bait (2014, Weka Digital Media https://www.youtube.com/watch?v=6Cvs9wkNN_o&list=PL-vc-a95lZa0rd5a_VuH7BbyS4Jh2fLwp&index=16, e) Shark splashing (same video as previous).

a)

b)

c)

d)

e)

f)

Figure 7-25 a) live bait kahawai (same video as previous); b) Fish ID 243 Wound (March, 2015, J. Tiano); c). Fish ID 251 Tail wound (March, 2015, J. Tiano); d) Fish ID 262 Wound (March, 2015, J. Tiano); e) Fish ID 267 Wound (March, 2015, J. Tiano); f) Fish ID 267 Wound (March, 2015, J. Tiano).

7.3.6 Mōtū river mouth as a place for kahawai to reproduce

This sub-section has six parts. Part one is sex ratio of kahawai in samples, part two is macroscopic gonad stage, part three is lunar phase, part four is Gonadosomatic index, part five is lipid index, and part six is hepatic index.

7.3.6.1 Kahawai school sex ratios

Table 7-28 shows that, for the river fish, there were more females caught in the earlier months (December, January and February) and more males caught in the later months (March and April). For sea fish, there were more females caught in all months (February, March and April).

Table 7-28 Sex ratio (number of males for every female) location-month summary.

	River	*Sea*
December	0.67	NA
January	0.47	NA
February	0.61	0.89
March	1.62	0.36
April	1.17	0.67

7.3.6.2 Qualitative reproductive condition of kahawai across the season

A female river kahawai was sampled with its gonad in running ripe condition with hydrated eggs on the 26 February 2015 (Figure 7-26). These are only observed within hours of spawning taking place.

a)  b) 

Figure 7-26 a) A female river kahawai gonad in running ripe condition with hydrated eggs, b) a hydrated egg (K. Maxwell, 26 February 2015).

Figure 7-27 presents the proportion of fish examined at each of the four reproductive stages: running ripe, ripe, maturing and resting, across the months of the sampling period. There were river fish with gonads in all four stages during December, January and April. However, in February and March there were no resting river fish present. There were also sea fish with gonads in all four stages during February and April. However, in March there were no resting fish present.

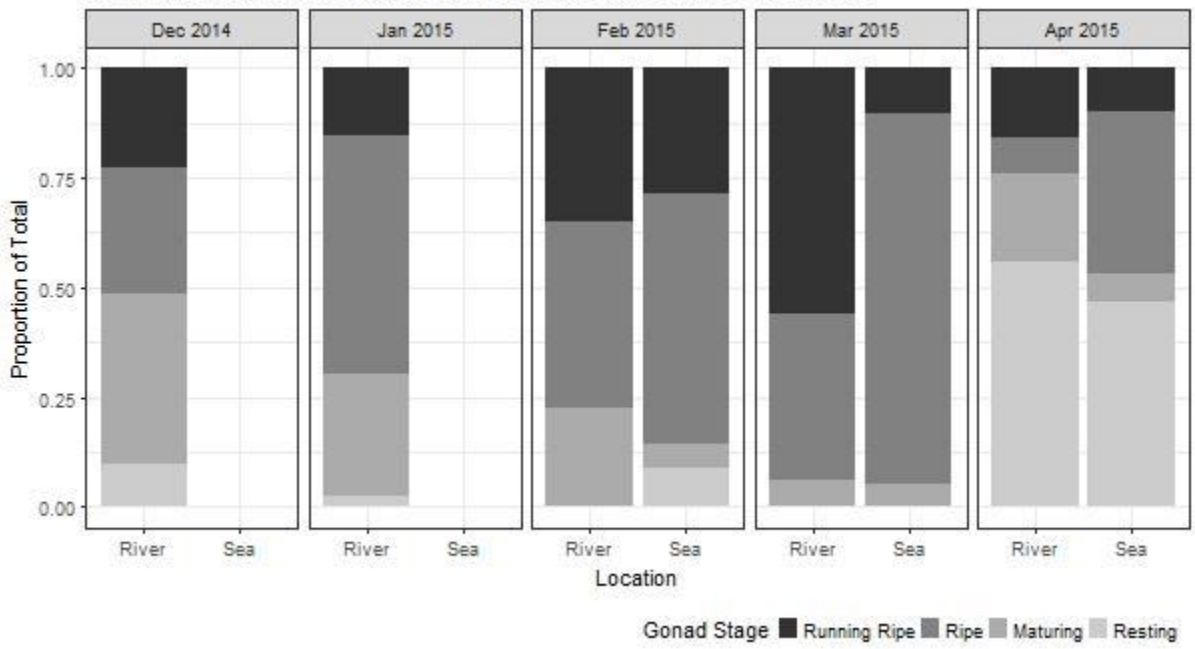


Figure 7-27 Macroscopic gonad stage (MGS, proportion of fish examined at each of the four reproductive stages: running ripe, ripe, maturing and resting) for river and sea kahawai across the months of the sampling period. NB: No suitable sea fish were available for December and January, immature fish were removed and spent fish were combined with resting fish.

Table 7-29 presents counts of fish gonads in each of the four macroscopic stages for each location and month. For ten of the location-month groups there were no or low (1-2) counts. An ordinal logistic regression analysis would be unsuitable for this data as the low counts would inflate the coefficients, therefore the fish were reassigned to the binary gonad stages. The 'running ripe' and 'ripe' fish were combined into a binary 'ripe' category and the 'maturing' and 'resting' fish were combined into a 'not ripe' category.

Table 7-29 Macroscopic gonad stage (MGS, 4 levels: running ripe, ripe, maturing and resting) frequency table for river and sea kahawai across the months of the sampling period. Zeros and low counts are in bold.

		February	*March*	*April*
River	*Resting*	**0**	**0**	14
	Maturing	29	**2**	5
	Ripe	54	13	**2**
	Running ripe	45	19	**4**
Sea	*Resting*	6	**0**	14
	Maturing	4	**1**	**2**
	Ripe	40	16	11
	Running ripe	20	**2**	3

Figure 7-28 presents the proportion of the 306 fish examined in each of the binary reproductive stages, 'ripe' and 'not ripe.' The proportion of river and sea fish with 'ripe' gonads increased across the season and then decreased in April. A backwards stepwise AIC on the logistic regression model: MGS~location-month, family=binomial, link=logit, AIC=298.46) removed

the interaction factor and kept the final model: MGS~location+month, family=binomial, link=logit, AIC=295.06).

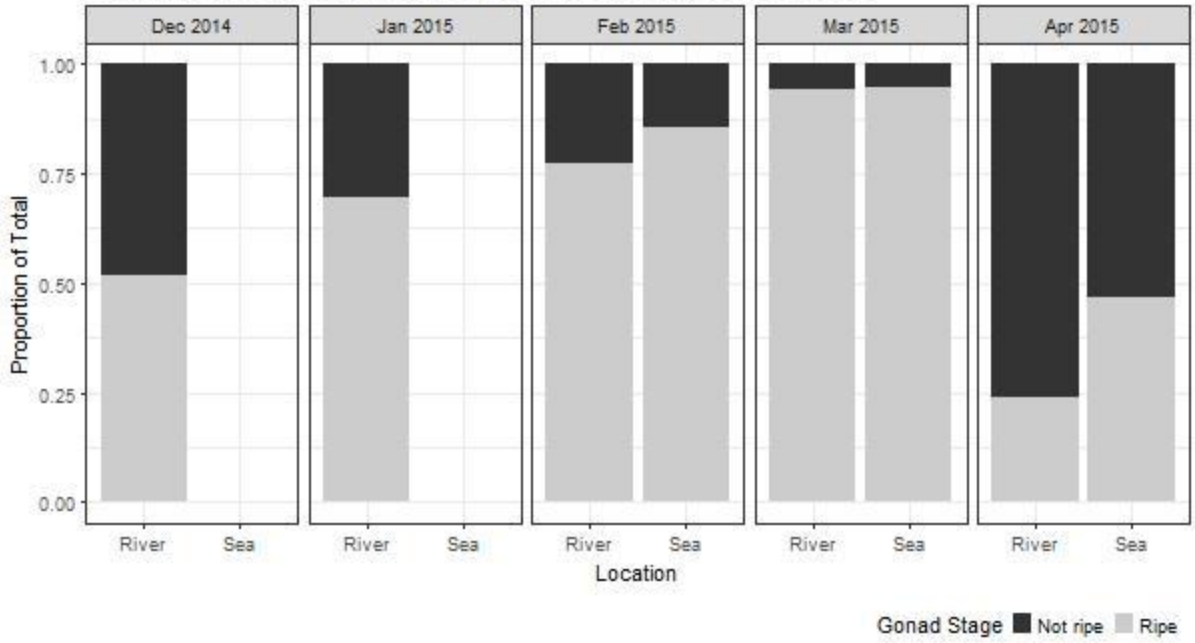


Figure 7-28 Macroscopic gonad stage (MGS, proportion of fish examined in each reproductive stage: not ripe and ripe) for river and sea kahawai across the months of the sampling period. NB: Resting and maturing fish were combined as 'not ripe' and ripe and running ripe fish were combined as 'ripe.' These categories were used in the final analysis.

Table 7-30 Results of the logistic regression model: MGS~month+location, family=binomial, link=logit; null deviance=345.24 on 305DF, residual deviance=287.06 on 302DF, AIC=295.06. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*z-value*	*p-value*
Intercept (River, February)	1.20	0.20	6.02	**<0.0001**
Location (Sea)	0.68	0.33	2.08	**0.04**
Month (March)	1.42	0.62	2.28	**0.02**
Month (April)	-2.14	0.35	-6.07	**<0.0001**

The results of the MGS logistic regression model are presented in Table 7-30. A similar trend was found in both river and sea fish, with the proportion of 'ripe' fish increasing and peaking in March, and then declining significantly in April (p<0.0001). The table of deviance for the MGS logistic regression model is presented in Table 7-31. Only the predictor month significantly reduced the residual deviance compared with the null model (p<0.0001).

Table 7-31 Table of deviance for full logistic regression model: MGS~location+month, family=binomial, link=logit, test=Chi-squared; McFadden R^2=0.17. Bold p-values indicate a significant improvement in model fit at 5% level.

Predictor	*DF*	*Deviance*	*Residual DF*	*Residual Deviance*	*Pr.(>Chi)*
Null			305	345.24	
Location	1	0.64	304	344.60	0.42
Month	2	57.55	302	287.06	**<0.0001**

Figure 7-29 presents the ROC curve plot for the MGS logistic regression model. This gives an AUC of 0.79, suggesting that the model has moderate predictive ability.

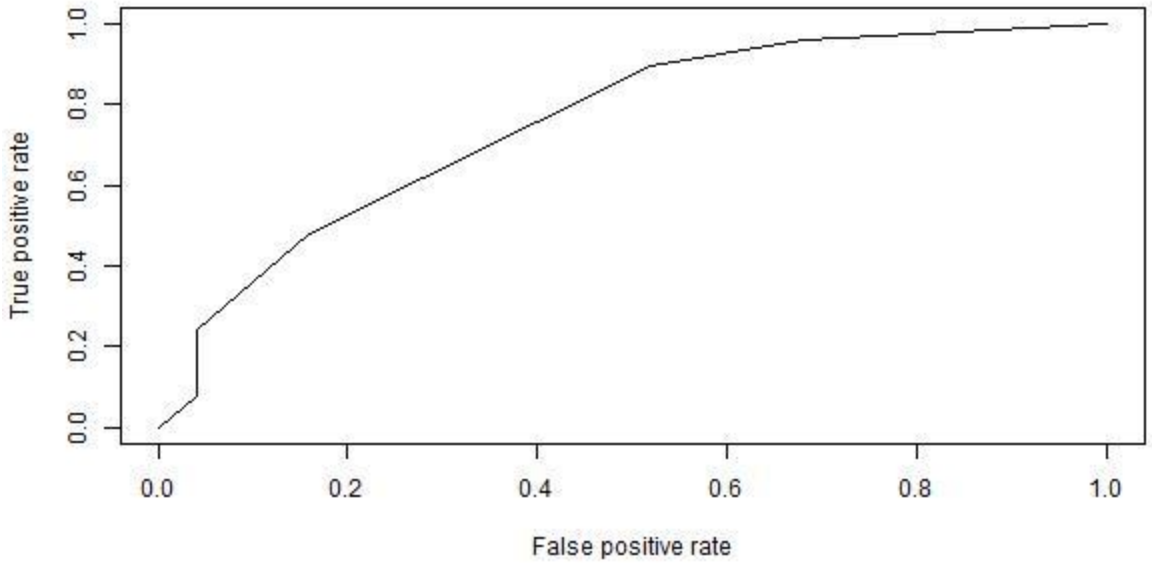


Figure 7-29 ROC curve plot for logistic regression test model: GMS~location+month, family=binomial, link=logit, AUC=0.75.

7.3.6.3 Effect of lunar phase on kahawai quantitative reproductive condition (gonadosomatic index)

Figure 7-30 presents the GSI for male and female river kahawai (n=99) across the four lunar phases. Figure 7-30 shows that males had a consistently higher median GSI than females throughout the lunar cycle. Table 7-32 presents the ANOVA table, showing that lunar phase had a significant association with female GSI (p=0.02). Table 7-33 presents the results of the linear regression model, showing that female GSI was significantly lower than that of fish sampled in the third quarter phase (p=0.02).

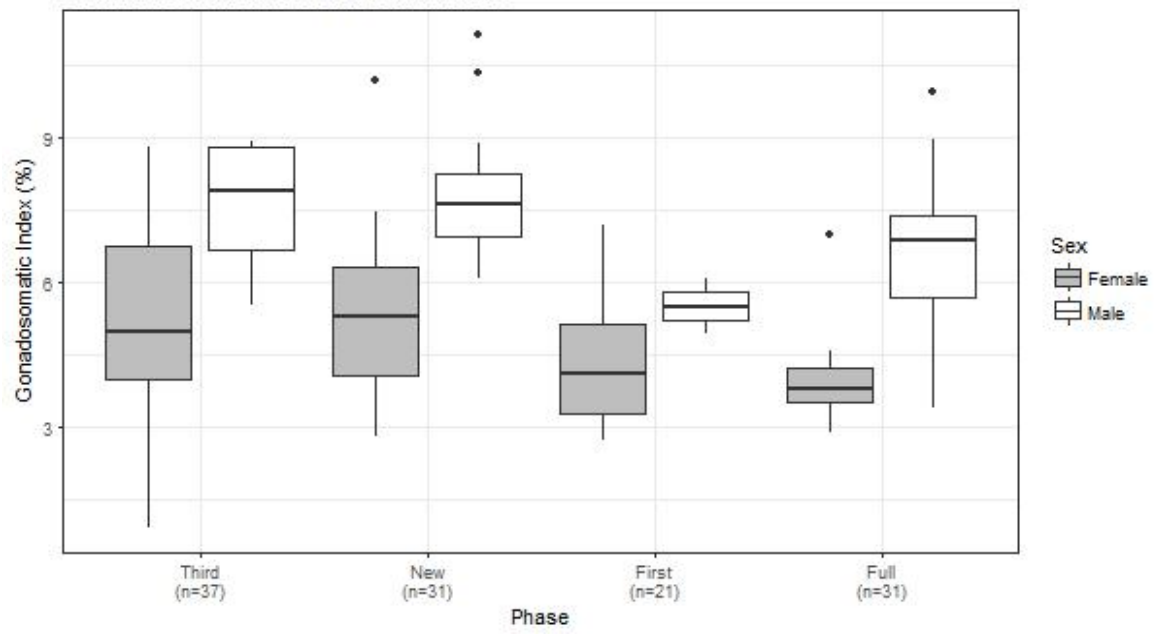


Figure 7-30 Gonadosomatic index (GSI%, medians, outliers, upper, lower and interquartile ranges) of 'female' (grey) and 'male' (white) river kahawai for each phase of the February-March 2015 lunar cycle.

Table 7-32 Analysis of variance (ANOVA) table for linear regression model: female GSI~phase. Bold p-values indicate a significant predictor at the 5% level.

	DF	*Sum of Sq.*	*Mean Sq.*	*F-value*	*Pr.(>F)*
Phase	3	24.36	8.12	3.32	**0.02**
Residuals	74	180.97	2.45		

Table 7-33 Results of the linear regression model: female GSI~phase; residual std. error=1.56 on 74DF, adjusted R^2=0.08, F=3.32 on 3 and 74DF, p=0.02. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*t-value*	*Pr. (>t)*
Intercept (Third quarter)	5.21	0.29	17.94	**<0.0001**
Phase (New moon)	0.09	0.48	0.18	0.86
Phase (First quarter)	-0.96	0.48	-2.00	0.05
Phase (Full moon)	-1.24	0.50	-2.49	**0.02**

The male GSI ANOVA results are presented in Table 7-34 and the results of the male GSI linear regression model shown in Table 7-35, both show that lunar phase did not have a significant association with male GSI.

Table 7-34 Analysis of variance (ANOVA) table for linear regression model: male GSI~phase. Bold p-values indicate a significant predictor at the 5% level.

	DF	*Sum of Sq.*	*Mean Sq.*	*F-value*	*Pr.(>F)*
Phase	3	17.63	5.88	2.62	0.06
Residuals	38	85.11	2.24		

Table 7-35 Results of the linear regression model: male GSI~phase; residual std. error=1.50 on 38DF, adjusted R^2=0.11, F=2.62 on 3 and 38DF, p=0.06. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*t-value*	*Pr. (>t)*
Intercept (Third quarter)	7.59	0.53	14.35	**<0.0001**
Phase (New moon)	0.24	0.65	0.37	0.71
Phase (First quarter)	-2.10	1.18	-1.78	0.08
Phase (Full moon)	-0.91	0.65	-1.40	0.17

7.3.6.4 Quantitative reproductive condition of kahawai across the season (gonadosomatic index)

As sex was the most significant predictor in the full model (location-month-sex), the data were fitted separately for each sex.

Female kahawai gonadosomatic index

For females, the interaction term (location-month) was not significant and was therefore removed from the model. Figure 7-31 presents the female GSI for river and sea kahawai across the sampling period. The ANOVA results presented in Table 7-36 indicate that month had a significant association with female GSI (p<0.0001), however location did not. The results of the linear regression model presented in Table 7-37, show that female GSI was the same for February and March, but significantly lower for April (p <0.0001).

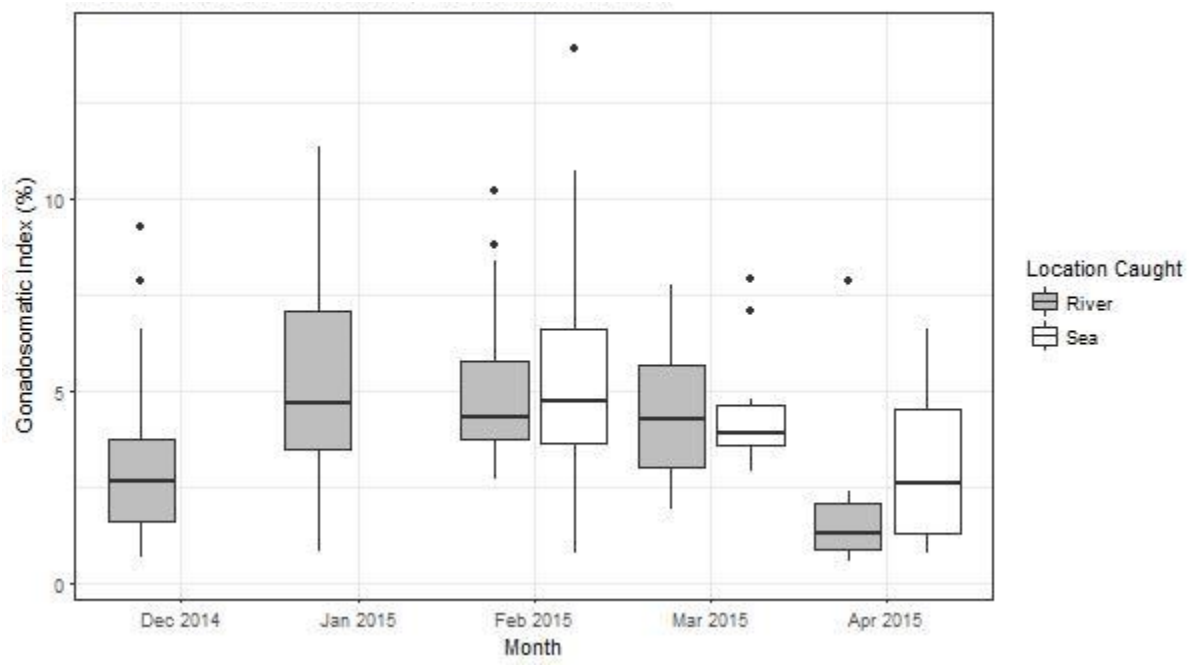


Figure 7-31 Gonadosomatic index (GSI%, including medians, outliers, upper, lower and interquartile ranges) for female 'river' (grey) and 'sea' (white) kahawai across months of the sampling period.

Table 7-36 Analysis of variance (ANOVA) table for linear regression model: female GSI~location+month. Bold p-values indicate a significant predictor at the 5% level.

	DF	*Sum of Sq.*	*Mean Sq.*	*F-value*	*Pr.(>F)*
Location	1	0.42	0.42	0.10	0.75
Month	2	148.62	74.31	18.02	**<0.0001**
Residuals	167	688.46	4.12		

Table 7-37 Results of the linear regression model: female GSI~location+month; residual std. error=2.03 on 167DF, adjusted R^2=0.16, F=12.05 on 3 and 167DF, p<0.0001. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*t-value*	*Pr. (>t)*
Intercept (River, February)	4.83	0.22	22.21	**<0.0001**
Location (Sea)	0.52	0.33	1.60	0.11
Month (March)	-0.72	0.44	-1.64	0.10
Month (April)	-2.56	0.43	-6.00	**<0.0001**

Male kahawai gonadosomatic index

Figure 7-32 presents the male GSI for river and sea kahawai across the sampling period. Male GSI was higher in February and March and declined in April. The ANOVA results presented in Table 7-38, show that the location-month interaction (p<0.001) and month (p<0.0001) had a significant association with male GSI. However, location did not (p=0.12). The results of the linear regression model presented in Table 7-39, show that river male GSI was higher in February, and declined in March (p<0.0001) and April (p<0.0001). Also, that sea male GSI was lower than river male GSI in February (p=0.01), but higher than river male GSI in March (p=0.03) and April (p=0.01).

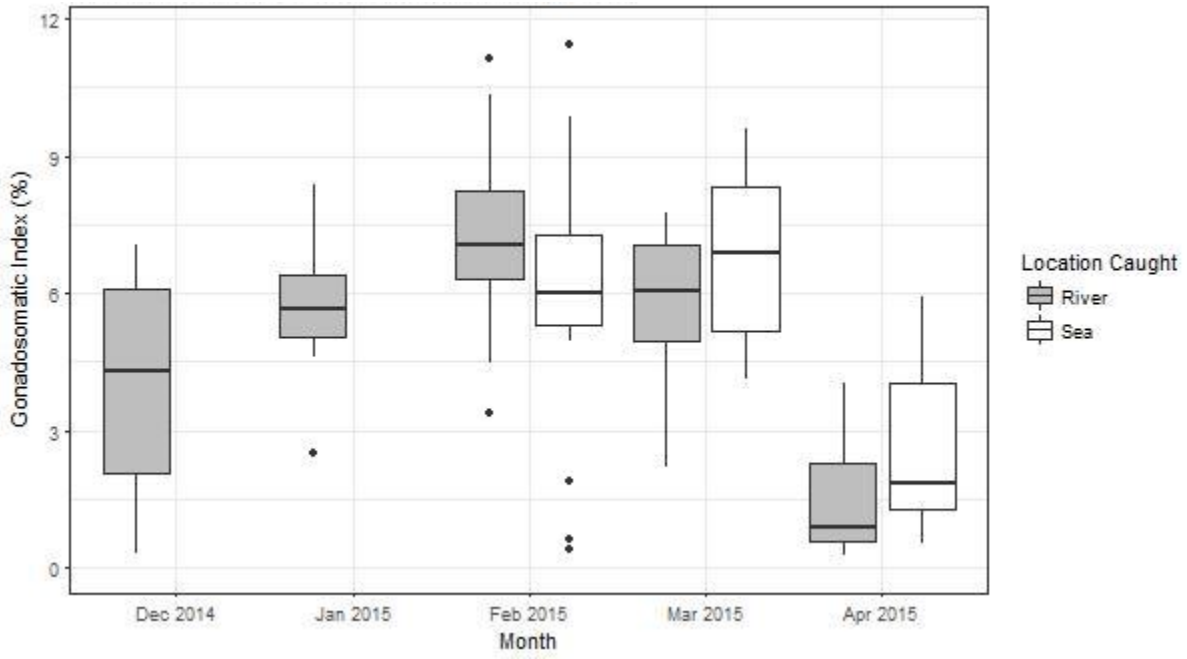


Figure 7-32 Gonadosomatic index (GSI%, including medians, outliers, upper, lower and interquartile ranges) for male 'river' (grey) and 'sea' (white) kahawai across the months of the sampling period.

Table 7-38 Analysis of variance (ANOVA) table for linear regression model: male GSI~location-month. Bold p-values indicate a significant predictor at the 5% level.

	DF	*Sum of Sq.*	*Mean Sq.*	*F-value*	*Pr.(>F)*
Location	1	8.25	8.25	2.51	0.12
Month	2	404.14	202.07	61.54	**<0.0001**
Location-Month	2	34.64	17.32	5.27	**0.01**
Residuals	120	394.03	3.284		

Table 7-39 Results of the linear regression model: male GSI~location-month; residual std. error=1.81 on 120DF, adjusted R^2=0.51, F=27.23 on 5 and 120DF, p<0.0001. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*t-value*	*Pr. (>t)*
Intercept (River, February)	7.24	0.28	25.89	**<0.0001**
Location (Sea)	-1.16	0.42	-2.76	**0.01**
Month (March)	-1.42	0.48	-2.92	**<0.0001**
Month (April)	-5.74	0.58	-9.98	**<0.0001**
Location-Month (Sea-March)	2.16	1.00	2.17	**0.03**
Location-Month (Sea-April)	2.73	0.84	2.83	**0.01**

7.3.6.5 Kahawai fat content across the season (lipid index)

Figure 7-33 and Table 7-40 present the median river and sea kahawai lipid indices across the sampling period. Both illustrate a downward trend in kahawai fat reserves across the sampling period. Lipid indices were high earlier in the season (0.51%) and were very low to no visceral fat in April (0.00%).

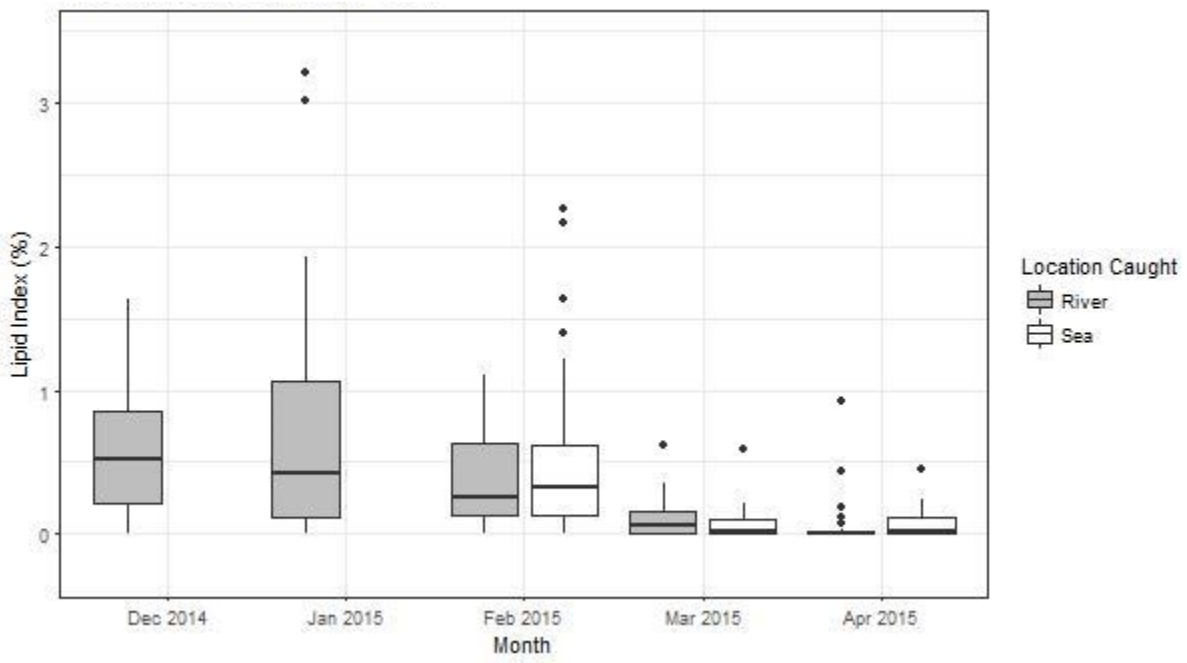


Figure 7-33 Lipid index (LI%, including medians, outliers, upper, lower and interquartile ranges) for river (grey) and sea (white) kahawai across months of the sampling period.

Table 7-40 Lipid index (Median and interquartile ranges of LI as a proportion of gutted fish WW) for river and sea kahawai across the months of the sampling period.

	River	*Sea*
December	0.51 (0.16-0.85)	NA
January	0.45 (0.13-1.09)	NA
February	0.25 (0.13-0.63)	0.32 (0.13-0.62)
March	0.06 (0.00-0.15)	0.02 (0.00-0.11)
April	0.00 (0.00-0.02)	0.02 (0.00-0.11)

7.3.6.6 Kahawai liver volume across the season (hepatic index)

Sex was largely significant in the full linear regression model (HI~location-month-gonad stage-sex), therefore the data were fitted separately for each sex.

Female kahawai liver volume across the season (hepatic index)

Figure 7-34 presents the female HI for river and sea kahawai across the sampling period. The ANOVA table presented in Table 7-41 shows that location (p=0.04), month (p<0.0001), gonad stage (p<0.0001) and location-month interaction (p<0.0001) all had significant associations with female HI. The results of the linear regression model are presented in Table 7-42. The HI of river females shows a downward trend across the sampling period being lowest in April (p<0.0001). For February, female HI was lower for sea fish than river fish (p=0.04), however in March (p <0.0001) and April (p<0.0001) the sea fish had significantly higher HI values than river fish. Female HI was significantly higher for maturing (p=0.02), ripe (p<0.0001) and running ripe (p=0.01) fish compared to resting fish, as expected. The female HI values suggest

that for river fish the liver reserves were being used across the sampling period which supports the reproduction hypothesis.

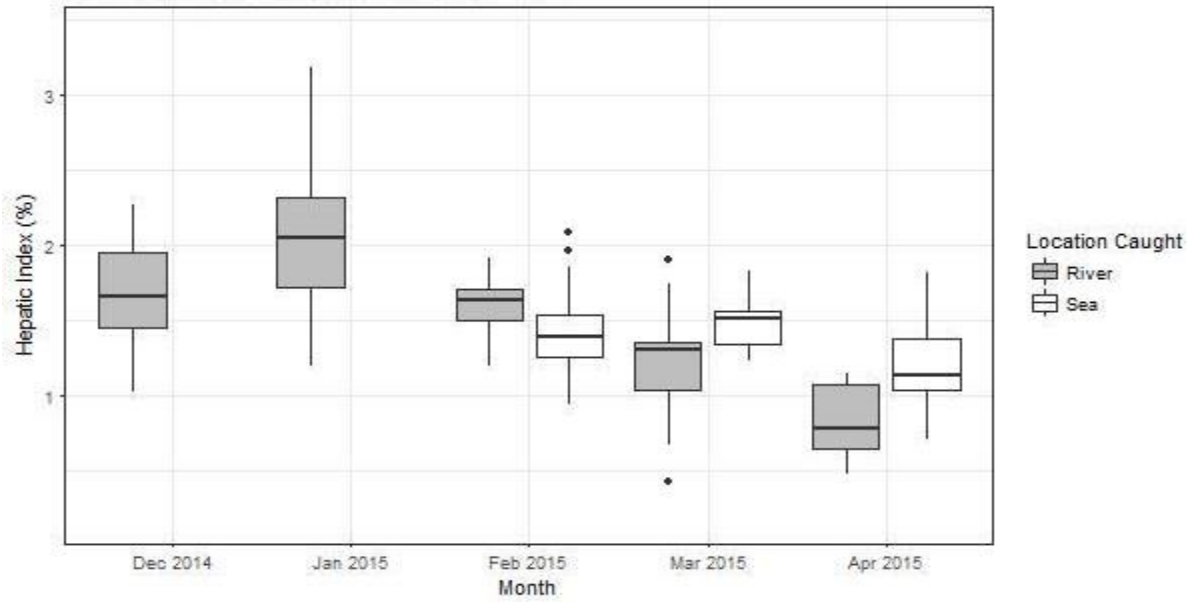


Figure 7-34 Hepatic index (HI%, including medians, outliers, upper, lower and interquartile ranges) for female river (grey) and sea (white) kahawai across months of the sampling period.

Table 7-41 Analysis of variance (ANOVA) table for linear regression model: female HI~location-month+gonad stage. Bold indicates a significant predictor at the 5% level.

	DF	*Sum of Sq.*	*Mean Sq.*	*F-value*	*Pr.(>F)*
Location	1	0.26	0.26	4.23	**0.04**
Month	2	3.59	1.79	29.02	**<0.0001**
Gonad stage	3	1.27	0.42	6.85	**<0.0001**
Location-Month	2	1.21	0.60	9.79	**<0.0001**
Residuals	103	6.36	0.06		

Table 7-42 Results of the linear regression model: female HI~location-month+gonad stage; residual std. error=0.25 on 103DF, adjusted R^2=0.46, F=12.8 on 8 and 103DF, p-value<0.0001. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*t-value*	*Pr. (>t)*
Intercept (River, February, Resting)	1.36	0.11	12.49	**<0.0001**
Location (Sea)	-0.20	0.09	-2.10	**0.04**
Month (March)	-0.42	0.11	-3.77	**<0.0001**
Month (April)	-0.62	0.11	-5.55	**<0.0001**
Gonad stage (Maturing)	0.24	0.10	2.43	**0.02**
Gonad stage (Ripe)	0.27	0.08	3.31	**<0.0001**
Gonad stage (Running ripe)	0.31	0.11	2.84	**0.01**
Location-Month (Sea-March)	0.47	0.14	3.45	**<0.0001**
Location-Month (Sea-April)	0.51	0.13	4.02	**<0.0001**

Male kahawai liver volume across the season (hepatic index)

Following a backwards stepwise AIC model selection starting with male HI~location-month-gonad stage, month-gonad stage and location-month only improved the model by AIC=1.4. Therefore, there interactions were left out of the final model. Figure 7-35 presents the male HI for river and sea kahawai across the sampling period and shows a downward trend in HI for male river kahawai across the sampling period. HI for sea males appeared stable across the sampling period. The ANOVA table presented in Table 7-43 shows that both month (p<0.0001) and location (p<0.0001) had a significant association with female HI. However, gonad stage did not (p=0.59). The results of the male HI linear regression model are presented in Table 7-44. HI for male river kahawai was significantly lower in March (p<0.0001). HI for sea males was also higher than HI for river males (p<0.0001). Gonad stage did not have a significant association with male HI (Maturing p=0.41, Ripe p=0.29 and Running ripe p=0.31).

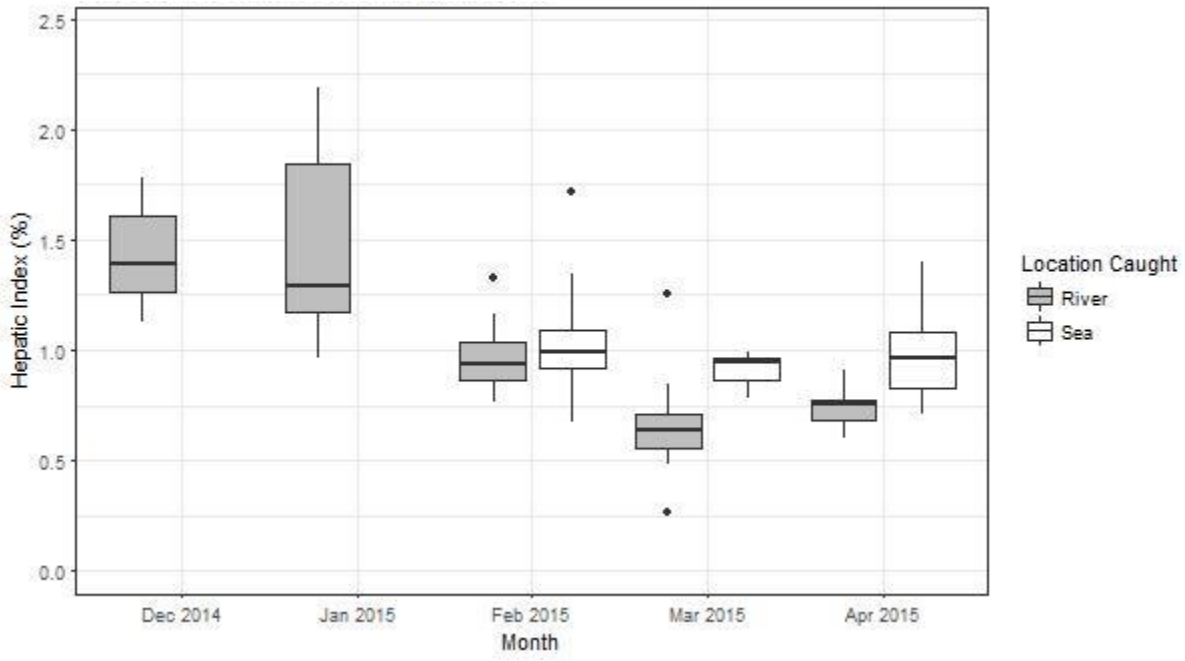


Figure 7-35 Hepatic index (HI%, including medians, outliers, upper, lower and interquartile ranges) of male river (grey) and sea (white) kahawai across months of the sampling period.

Table 7-43 Analysis of variance (ANOVA) table for linear regression model: male HI~location+month+gonad stage. Bold p-values indicate a significant predictor at the 5% level.

	DF	*Sum of Sq.*	*Mean Sq.*	*F-value*	*Pr.(>F)*
Location	1	1.32	1.32	39.78	**<0.0001**
Month	2	0.73	0.36	11.05	**<0.0001**
Gonad stage	3	0.06	0.02	0.64	0.59
Residuals	90	2.99	0.03		

Table 7-44 Results of the linear regression model: male HI~location+month+gonad stage; residual std. error=0.18 on 90DF, adjusted R^2=0.38, F=10.63 on 6 and 90DF, p<0.0001. Bold p-values indicate significant predictor variables at the 5% level.

Coefficients	*Estimate*	*Std. Error*	*t-value*	*Pr. (>t)*
Intercept (River, February, Resting)	0.82	0.07	11.01	**<0.0001**
Location (Sea)	0.17	0.05	3.76	**<0.0001**
Month (March)	-0.23	0.05	-4.57	**<0.0001**
Month (April)	-0.09	0.06	-1.54	0.13
Gonad stage (Maturing)	0.10	0.12	0.83	0.41
Gonad stage (Ripe)	0.06	0.07	0.86	0.39
Gonad stage (Running ripe)	0.08	0.07	1.27	0.21

7.4 Discussion

Here the key findings of each analysis (environment, kahawai characteristics, food source, parasite removal, predator avoidance and reproduction), and the findings implications for kahawai fisheries management are discussed.

7.4.1 Mōtū river mouth environmental conditions

The environmental observations showed that air and water temperatures, DO, pH, and salinity level were all within the expected ranges for December to April at the Mōtū river mouth and Bay of Plenty inshore. The low salinity range (0.01-18.50) indicates that the Mōtū river mouth is an oligo/mesohaline estuary. River discharge rates for 2014 and 2015 were low compared to previous years, but still within the expected range. River discharge rates show that most of the river flowed out through the left arm. In future research, measuring organic matter and water chemistry would be valuable. Organic matter consists of carbon and nutrients (carbohydrates, proteins, fats and nucleic acids) and is a source of food and energy for microbial communities. Regularly measuring organic matter can indicate changes in nutrient concentrations. Measuring water chemistry and comparing trace element concentrations with those in the otoliths might be used to indicate the natal/juvenile origins of adult kahawai (Hughes, 2012). Smith et al. (2008) discuss how the use of magnesium and barium could be used with 75% probability of accuracy to correctly assign collection site of kahawai from a northern site at Okahu Bay, Waitemata Harbour, North Island and a southern site at Hakahaka Bay, Port Underwood, South Island. The otoliths of the fish sampled in this study were collected for such an analysis, however it was beyond the scope of the current research objective. The analysis may provide useful information for understanding stock structure.

7.4.2 Kahawai biological characteristics

The sea fish caught in Whakatāne (Iceman samples) and the river fish caught at Waiotahe were smaller than the rest of the fish sampled and were removed from the final data set. These fish were likely juvenile kahawai residing in the rivers, rather than migrating adult kahawai. After

removing those small fish, the FLs of the remaining fish suggested that the kahawai were suitable for making comparisons.

The river kahawai sampled in the study included sub-adults. Length-maturation data suggest that the onset of sexual maturity in males occurs at around 39cm and in females at 40cm (McKenzie NIWA, unpublished data); which closely matches the estimate of 39cm for Australian *A. trutta* (Morton et al., 2005). This length corresponds to a four-year old fish in both countries (Ministry for Primary Industries, 2017). The river kahawai FLs (mean=49.42cm, range=26.40-57.50cm) were consistent with the mean length of 55cm for kahawai caught between November 1982 and April 1983 by Penlington (1988). Penlington (1998) also reported that 15% of his sample comprised of sub-adults (<35cm). This suggests that there was a mixture of cohorts present at the Mōtū river mouth. In contrast, no kahawai under 40cm were caught at sea.

The differences in sampling methods may have created bias in the data. It may be difficult to catch fish that are not striking at lures, for example, while they are spawning, reducing the presence of running ripe fish in the sample. The sea fish were sampled from purse-seine catch, and even though purse-seiners typically only catch kahawai as bycatch between February and April, the FL and WW data ranges were narrow, suggesting that only a single cohort, or a few cohorts, were sampled each month. In April, the school of sea fish caught may have been from a younger year class than the other months, explaining why there was a lower median FL and corresponding lower WW for that month. Parameters presented in this study for the relationship between logFL and logWW was consistent with previously reported parameters. Previous reports may have come from kahawai caught in the commercial fishery which are targeted between June and November. Whereas the fish caught in this study were sampled during the reproductive season (December to April).

7.4.3 Mōtū river mouth as a food source for kahawai

Overall, food source analyses suggest that kahawai were not at the river to target a food source between December and March. River fish had mostly empty stomachs (83.15%) and a mean SFI of 0.00% for all months of the sampling period. Of the fish containing stomach contents, most were well digested. Fasting is a common practice amongst fish during the reproductive season (Hoar, 1957). In contrast, many of the sea kahawai contained stomach contents (87.39%), which were either partially or well digested, indicating that some kahawai do eat during the reproductive season.

Also, some river fish caught in April contained fresh stomach contents. A fish caught off Maraenui Beach, adjacent to the Mōtū river mouth, contained a variety of juvenile fish. As

these stomach contents were relatively fresh, this suggests there may be a juvenile fish nursery offshore adjacent to Maraenui Beach, possibly the rocky reefs at either end of the beach. Another kahawai caught at the river mouth, contained a single *Galaxias* sp. Fish. In April, kahawai may be present to take advantage of the main īnanga, *G. maculatus* spawning period which is during autumn in upper river estuaries, immediately after new or full moon spring tides when the tidal range is largest (Hickford & Schiel, 2011; Taylor, 2002). The eggs hatch on the next spring tide and are swept out to sea where they develop in the pelagic zone for 4-6 months (Hickford & Schiel, 2011). However, one single fish in the stomach contents is hardly conclusive of this and suggests extending the sampling season further into autumn and winter to investigate this hypothesis further. These results highlight that month and location are important contributing factors to prey composition observed in kahawai diet studies.

7.4.4 Mōtū river mouth as a place for kahawai to remove parasites

The parasite prevalence, the mean intensity and intensity range results did not support the hypothesis that kahawai are at the river to remove parasites. For river fish, parasite prevalence, mean intensity and intensity range increased over the sampling period. For sea fish, parasite prevalence was variable, however there was a decrease in parasite mean intensity and intensity range. Smith et al. (2008) highlight the need to interpret differences in parasite prevalence, abundance and intensity on NZ fishes cautiously. Recent studies have reported complex variation in parasite abundance and even between tow variations (Smith et al., 2008). As kahawai have strong cohort schooling behaviour, fish in the same catch share the same history and likely have a similar parasite level. However, with low mixing between schools, there is likely to be variation between schools and therefore catches of different schools.

7.4.5 Mōtū river mouth as a haven for kahawai to avoid predators

Observing kahawai predators, predatory behaviour, and wounded kahawai at the river did not support the hypothesis that kahawai were there to avoid predators, possibly the reverse. These results give new insight into the role of kahawai in the wider ecosystem as prey of some of top apex predators, including bronze whaler and white sharks, cetaceans, and gannets. Yellow-tail kingfish were also reported as kahawai predators, which is a new finding. It was not clear if the predators were herding the kahawai along the coastline, or if they were opportunistically targeting the kahawai schools while they were present at the river mouth. Regardless, these migrations provide promising targets for studying shark, cetacean, and yellow-tail kingfish predatory behaviour further.

7.4.6 Mōtū river mouth as a place for kahawai to reproduce

The reproduction results do suggest that the kahawai migrate to the river mouth for reproduction. While kahawai are at the Mōtū river mouth, they are caught with skewed sex ratios. Hydrated eggs were observed in one of the female river kahawai caught on 26 February 2015. River kahawai were in peak reproductive condition (gonad stage, GSI, LI and HI) during February and March. Condition declined in April, suggesting reproductive activity had occurred. No spawning events were observed, however all sampling took place during the day and, like the sockeye salmon (Bentley et al., 2014), the kahawai may be spawning at night. The results here are consistent with Penlington's (1988) findings and agree with his suggestion that kahawai are present at the Mōtū river mouth for reproductive purposes.

The sea kahawai were also in peak reproductive condition during the sampling period, suggesting that kahawai may have separate reproductive groups that spawn in different locations. The sea kahawai were likely to have been caught in the western Bay of Plenty inshore, near Mōtiti Island, Mayor Island, and off the coast of Waihi Beach and Matakana Island, where the Tauranga Harbour discharges. This is consistent with previous reports of large schools of kahawai at Bait Pond, Mayor Island (Illingworth, 1961); and kahawai eggs being collected just off Little Barrier Island (Crossland, 1982).

It is notable that kahawai appear to store fat in the liver, all around the visceral organs, and in the body tissues. Fish typically only employ one energy storage strategy, i.e. in the liver or between the body tissues. These results suggest that kahawai use both strategies. However, the liver condition of sea kahawai was constant over the sampling period, whereas that of river kahawai declined. The high energetic cost associated with osmoregulation, required to move from seawater to freshwater, may have caused this, rather than reproduction (gamete production) itself. Geolocating plaice (*Pleuronectes platessa*) in the North Sea demonstrated highly directed seasonal migrations from the winter spawning area to the summer feeding grounds with 100% returning to the previous season's spawning location (Hunter et al., 2003). Teo et al. (2007) also demonstrated spawning ground fidelity in Atlantic bluefin tuna (*T. thynnus*). It indicates that there may be multiple spawning locations and possibly subpopulations of kahawai.

7.4.7 Kahawai parental investment

Spawning at river mouths may be a form of parental investment. Entering the rivers has a higher energetic cost because of osmoregulation, with the added pressure of becoming a target for predators. Estuaries are juvenile kahawai nursery areas so spawning in proximity to the estuaries may increase the chances of larval fish reaching the nurseries areas and thus surviving.

This could be considered a form of parental investment, where larvae hatching in closer proximity to a suitable nursery environment, with abundant food sources and shelter, have better chances of survival. Shelter provided by stones and nutrient source of river would increase primary production just outside the mouth (Maas & Nodder, 2010).

7.4.8 Implications of findings for kahawai fisheries management

This study provides deeper understanding of the ecological processes underpinning the Mōtū kahawai fishery. Kahawai most likely migrate to the Mōtū river mouth for reproductive purposes. This indicates that the Mōtū river mouth is a spawning area, or is very near to a spawning area for this group of kahawai, the Mōtū kahawai. The different liver and fat patterns expressed in sea and river kahawai also suggest Mōtū kahawai are a sub-population, separate to those at sea. Therefore there is some autonomy and a need to recognise this in management. The Mōtū area should be considered as a Mōtū kahawai 'habitat of particular significance for fisheries management (HPSFM).' The definition of these HPSFM areas is still being developed. Localised management over the summer months may be critical for managing Mōtū kahawai because if the kahawai form separate reproductive groups then, if depleted, Mōtū kahawai are unlikely to be replenished from elsewhere.

7.5 Conclusion

The results provided in this chapter, support the reproduction hypothesis and reject the food source, parasite removal and predator avoidance hypotheses regarding the ecological relationship between adult kahawai and the Mōtū river mouth. Kahawai were in peak reproductive condition during the sampling period. Although spawning activity was not observed, this may be happening at night. The sea kahawai sampled were also in reproductive condition. The river kahawai liver condition declined while that of sea kahawai did not. These two observations both suggest that there could be multiple reproductive groups of kahawai and discrete spawning locations. The Mōtū river mouth area should be considered a HPSFM for Mōtū kahawai, and localised management is critical for sustaining this local fishery. In Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery), hapū knowledge associated with the Mōtū kahawai fishery is explored.

Chapter 8 Indigenous ecological knowledge of the Mōtū kahawai fishery

This chapter looks at Indigenous ecological knowledge (IEK) for informing fisheries management. The chapter has four sections, the first introducing IEK and how it contributes to fisheries management. The second section describes the methods followed to gather IEK and the third section presents the IEK findings relating to food source, reproduction, the environment and wānanga (research process). Lastly the IEK findings are discussed and related to the use of IEK in fisheries management.

8.1 Introduction

After long being marginalised in favour of written records and scientific observations, more qualitative forms of knowledge such as mātauranga Māori (Māori knowledge), local ecological knowledge (LEK) and Indigenous ecological knowledge (IEK) are being more frequently accepted as valid in their own right. Wiremu Tāwhai shared Te Whānau-a-Apanui (Apanui) mātauranga-a-maramataka (lunar-calendar-knowledge), its application, and transmission in 'Living by the Moon' (2013). This book is based on Tāwhai's experiences and is recorded in his Masters thesis investigating Te Maramataka a Te Whānau-a-Apanui (the Te Whānau-a-Apanui Lunar Calendar).

Tāwhai (2013) points out that this knowledge is based largely on an oral tradition that is, and was, stored in the minds of the old people, placing a heavy reliance on remembering. Therefore, remembering was highly developed by Apanui elders, using ancient mythology, stories, and personalities from history, old songs, proverbs and practical demonstrations to facilitate retention of the knowledge (Tāwhai, 2013). The pūrākau of He Kōpara, which is often referred to in relation to the Mōtū kahawai fishery, is one example presented in Chapter 1 (General Introduction). Te Koko ki Ōhiwa is another example of a pātere (chant) composed in the 1950s by Te Kapo o Te Rangi of Tūhoe and Ngāti Ranginui, about managing, re-telling and protecting the past knowledge of Ōhiwa Harbour, as it relates to the Te Ūpokorehe, Te Whakatōhea, Ngāti Awa and Tūhoe residents (Black et al., 2014).

Tāwhai also describes his view of the old people using the memory devices and discussing the knowledge: "Such knowledge would be reflected upon by them as they sat by themselves in the sun, on the paepae of the marae and in their private conversations and discussions" (Tāwhai, 2013). Tawhai was concerned that opportunities to be part of these conversations were diminishing in modern society, which motivated him to write the thesis and record the information, lest it be lost. Apanui wind, cloud, rainfall and season terminology; storm, flood and landslide events; and weather and climate-based events, trends, and indicators have also

been recorded, as they provide important contributions to local environmental management and practices (King et al., 2008; King et al., 2007).

IEK can also contribute to fisheries management, particularly at a localised level relevant to Indigenous communities, that is often masked at the larger fisheries management spatial scales (Ban et al., 2017). Ban et al. (2017) combined IEK with simulation modelling to demonstrate how local depletion, which was negatively impacting Indigenous fishers' access to traditional foods, was widespread and undetected by government managers. Local depletion of fisheries resources in NZ's South Island, that is not observed at government management scales, was also detected through IEK (McCarthy et al., 2014). When Māori express concern over the kahawai fishery, it is not just about the number of fish in the sea, rather it is about localised depletion, and recognition of cultural management practices and IEK.

IEK can provide insights into wider social and ecological fishery concerns that population biomass models do not. Kahawai are a relatively resilient species as they are medium-lived and are able to change their diet when prey availability changes. Kahawai also school, therefore catchability might remain relatively constant over a large geographical scale. However, if the fishery is based on a persistently spatially structured spawning stock, this may not be the case at a localised scale.

In Chapter 7 (Ecological relationship between kahawai and the Mōtū), LEK, SEK, and field notes about the predator avoidance hypothesis were presented. In Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery), many references were made to the pūrākau of He Kōpara. Within the pūrākau are references to the ecology of the kahawai that give us some clues to the ecological relationship between the kahawai and the Mōtū river mouth. For example, the kahawai were expected to arrive in the long days of summer and karaka (*Corynocarpus laevigatus*) berries are used as an indicator of the start and end of the kahawai fishing season.

Therefore, the aim of this chapter is to document as small part of the wider IEK associated with the Mōtū kahawai fishery that exists. There was also IEK shared in the Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery) interviews that related to the food source and reproduction hypotheses proposed to describe the ecological relationship between the kahawai and the Mōtū River. In fact, we often referred to this information when discussing the Chapter 7 (Ecological relationship between kahawai and the Mōtū) reproduction hypothesis results regarding sex ratios and fish condition, because of the similarities with the IEK. It seems that the Hapū wanted scientific research to support their existing knowledge.

This chapter has four sections: first introducing the use of IEK in fisheries management; then outlining the methods followed to gather IEK; third, presenting the IEK; and finally connecting

the IEK to the Chapter 7 (Ecological relationship between kahawai and the Mōtū) findings and kahawai fisheries management. We argue that there is a large volume of IEK that can contribute to fisheries management and its use should be integral to the management of CKS species fisheries. We argue that IEK be included in current national kahawai fisheries management. Kahawai has been demonstrated to be a cultural keystone species to TWAH/NH (Maxwell et al., 2018), and it is highly likely that there is associated IEK for this fishery.

8.2 Methods

IEK was shared during the information gathering exercises carried out in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery). Where appropriate, the interview transcripts and documents were coded and grouped into environmental categories using QSR NVIVO10. This information was reviewed and IEK relating to potential kahawai prey in the estuary, parasite removal, reproduction (spawning, sex ratio and fish condition), river condition, and karaka berries were identified. Table 8-1 lists the Environmental nodes used to code the information gathered in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery).

Table 8-1 List of environmental nodes used to code the information gathered in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery).

Environmental Components			
Biology	Body size Australian kahawai Big kahawai Condition in decline Condition peaks in summer Kahawai body size has changed Kahawai fast growth Distribution Depth distribution Kahawai river specific Kahawai season Migrate inland to Mōtū bridge Perth Tere kahawai distribution Kahawai a brown fleshed fish Kahawai have different skin colours Migration Spawning Kahawai don't spawn in all rivers Spawning location Tāpurapura Tere kahawai Change in abundance Jack run smaller	**Ecology**	Associated species Decline in seagull abundance Fishes Freshwater species Land-based species Predation Prey Rocky reef species Shellfish Ballast
		Environment	Climate warmer and drier Habitat Dredging Land use in catchment Ocean Pollution Rivers Rain Seasons for different species Tides Unique landscape Wind

Hapū research processes (wānanga) were not a key focus of the interviews, however they create a distinction between knowledge that is merely the observation of one person and long-term

observations of a localised phenomenon created by multiple generations of people. Therefore, the comments of a research interview participant regarding such a process, are included here to show that such a process exists for the Hapū and what it was/is like. Photos were taken of a karaka tree near the Mōtū River across the sampling period. Photos were also taken of the riverbed and river mouth.

8.3 Results

The following IEK is presented below:

- Prey species (Food source)
- Spawning (Reproduction)
- Sex ratio (Reproduction)
- Fish condition (Reproduction)
- Karaka berry (Environment)
- River condition (Environment)
- Wānanga (Research process)

8.3.1 Mōtū river mouth as a food source for kahawai

8.3.1.1 Indigenous ecological knowledge of Mōtū kahawai prey species

IEK regarding potential kahawai prey species at the Mōtū river estuary are provided in Table 8-2. Interview participants discussed a range of other species, including anchovies, crabs, eels, flounder, herrings, moki, mussels, parore, snapper, tarakihi, trevally, and whitebait. One suggested kahawai prey on anything, and another suggested kahawai eat anchovies, all baitfish, and whitebait.

Table 8-2 Prey species IEK, including record type and number for the current study conducted in 2014. Interviewer's kōrero (narrative) is in italic font, interviewee's comments are in standard font with relevant comments in bold font, and translations of the Te Reo Māori comments are in square brackets []. Where there is no Te Reo Māori, the square brackets contain contextual information to aid comprehension.

Prey species IEK	*Record type and number*
"They [**moki**] like **crabs.** Or **mussel** for the **tarakihi.** Yeah. **Tarakihi** and, and **moki** they like **mussels.** And other fish like **trevally** and-" "*Mmm do you go for trevally?*" "Yeah well you catch them here. The **whitebait** like you can be in the, like have your net here but you can see them crawling through the stones" "Yeah even the tidal push you can see them coming up in the stones like cause the **whitebait** here is green." "Yeah the, the ones in town are like a black colour like the normal clear with the black yeah with the black line in the middle, black line and these ones here are green." "Oh other sort of species like um the **eels**, you know the **mullet** the, that are in the river already now."	Interview, Participant 7
"There's **flounder** in the Mōtū. Uncle George and them used to always – he was the one to go out floundering, way back in the day. You know, just float around on the lilo and – old George Ngamoki." **"Tāmure, tāmure** ka mau mai i reira hoki o kona inaianei katoa ka mau mai i te ākau."	Interview, Participant 10

Prey species IEK	*Record type and number*
[Snapper, snapper you could get there too, now all catch them at the beach.]	
"**Anchovies**, all the **bait fish**. That's a good sign eh, when you see them on the – Cos sometimes they run up onto the stones aye, those little **whitebait** and the thing, so if they're up there, then you know the kahawai-." "*They chased it."* "Yeah, yeah. Seen that heaps. It's still there. So, they're getting fed, you see them out on the boat, they're chasing schools of **bait fish**, so it must be happening up the river, must be spawning or something." "*When you empty out the pukus is there anything in there?"* "Yep. Now [April] they got **whitebait** in them." "*Okay. Yeah 'cos the few I opened up there was nothing in there and I was like, if I'm going to study them-."* "That might have been **the ones coming down the river**."	Interview, Participant 14
"But you know they'd be a **cannibal** sort of a thing, looking to eat anything." "*Do you see herrings in the Mōtū?*" "Well I've never looked for herrings but obviously they will be there 'cause they've been caught in the sea so they'll go into the river mouth for sure. But I mean no one oh no I have see- **Uncle ah Chippo used to catch them." "*Herrings?*"** "**Yeah.** 'Cause I had a feed there at the marae when he was staying there once."	Interview, Participant 15
"Now just about everybody used that then here even the old kuias yeah and they throw their line its just over the waves, next minute they catch a **moki** [laughs] and its time its time too now. Yeah. And that's the time they the **moki** come around the beach." "The bloody **moki** is only over the waves, not out there." "You know on those ah, those big stones? It's covered with those **little mussels**."	Interview, Participant 17
"Yeah the **parore**." "Come back out at the river mouth and get pulled out over there and it was a big resource eh the **eels**."	Interview, Participant 32

8.3.2 Mōtū river mouth as a place for kahawai to reproduce

The reproduction section presents spawning, sex ratio, and fish condition IEK separately.

8.3.2.1 Indigenous ecological knowledge of Mōtū kahawai spawning

Spawning IEK is presented in Table 8-3. The participants suggested that reproduction was the main purpose of kahawai migrating to the Mōtū, with some people having observed spawning activities in the estuary. Detailed spawning location information has been removed to protect it. One participant referred to the history of the kahawai meaning the pūrākau of He Kōpara in relation to spawning.

Table 8-3 Spawning IEK, including record type and number for the current study conducted in 2014. Interviewer's kōrero is in italic font, interviewee's comments are in standard font with relevant comments in bold font, and translations of the Te Reo Māori comments are in square brackets []. Where there is no Te Reo Māori, the square brackets contain contextual information to aid comprehension.

Spawning IEK	*Record type and number*
"Oh about after Christmas aye e _____ when they are really running then **that's when they really thing their eggs**. That's when you are really catching them… yeah yeah **koina kua whakawhānau ngā heki [that's it spawned the eggs]** and then…**kua makere ngā heki [the**	Interview, Participant 6

Spawning IEK	*Record type and number*
eggs have come off] 'cos when you stand in amongst them –and **they just go and lay their eggs yeah in those shallow water** yeah."	
"What do you think the kahawai are doing here?" "What I think they are doing here? **Spawning.** *"Yeah? Do you think it's an important? Oh should I look at that?"* "Yeah because **they come up the river and spawn.**" "*Have you ever seen spawning?"* "Yeah. I've seen the like um 'cause now they are all empty now but like February and March and that they the roes are all full up and then just a month after that like April to now they empty out." "And you can actually see them right up in the in the awa [river] like sometimes back in the day we used to see them right up at the bridge." "Mmm but sudd- like all and across by _____ and that **you see them thinging into the sand** and that and I think that's that they do **they sort of spawn into the sand into the mudflats in here** and they go back out into the ocean." "Yeah into the sand and that up, up and around the awa here **and spawn**. And just our history of the kahawai coming back. Our history of the kahawai." "Like I just said that you know **the** kahawai **and that all spawn in the**."	Interview, Participant 7
"Koira te wa o tera ika i tenei aw aka haere mai ratou ki te whānau **heki**. He taumaha tera mahi." "Tera oku whakaaro mo me ngā mo ka**hawai mo ki te haere ki te spawn te haere ki te...whānau i a ratou heki**." [That's the time that fish is at this river they come to spawn eggs. That's an onerous job. That's what I think regarding the kahawai regarding to go to spawn to go to spawn their eggs.] "Kei te haere mai ratou he kaupapa tā ratou **kei te haere mai ki te whānau heki koina te kaupapa ko te whakawhānau heki aye**? Tena taku whakamarama i tera." [They come they have a purpose to come here to spawn eggs that's the purpose to spawn eggs aye? That is my understanding of that.] "**Kei te haere ratou ki te ki te whakawhānau i a ratou heki** migration nē? Mmm ki nga awa kaore i ngā awa katoa." [They go to to spawn their eggs migration isn't it? Mmm to the rivers not all of the rivers.]	Interview, Participant 10
"We'd just put it up above the mouth – in the river. Um **I think around about that time it was spawning time.**" "I remember Koro Spady telling me**, _____ _____, he said that's one of the main spawning grounds** and I've seen that river, it's a lot shallower, I think sometimes that place is exposed now aye. When the water comes up?" "*Do you still see fish going up that far?*" "I haven't been over and had a look. But **he was saying it was one of the main spawning grounds.** He said don't tell many people, 'cos they'll be up here bloody catching them." So, they're getting fed, you see them out on the boat, they're chasing schools of bait fish, **so it must be happening up the river, must be spawning or something**."	Interview, Participant 14
"I'm just trying to remember whether it was Uncle Rusty or BoSheep that told me that's there the kahawai **used to go to spawn** was up to I think they call it _____ that's there that _____is…. Yeah there used to be a pool down there…. Yeah down there was a big hole **and that's how far the** kahawai **went up to spawn**…. Oh ...It's only a _____maybe must be just out of the, **I don't know**	Interview, Participant 15

Spawning IEK	*Record type and number*
whether they spawn in the freshwater or whether it's…'cos to me...It must be just out of the ...I yeah nah **to me it's out of the tide**. Just though. And that's what I was told by one of the old guys. I can't remember if it was, might have been Uncle Rusty. Yeah and he said that's 'here the kahawai, **that's where they used to go to spawn is up there**. No I've never sort of watched. But obviously it pushes up. Yeah it does sort of, not far from _____ you know _____, somewhere out there. Yeah. Yeah. And that's not that far up. That'd only be a _____ off the sea." "*What would be the point of spawning up there? Any ideas?"* "I don't 'now. Maybe getting away from, laying their eggs away from predators. I don't 'now 'cos you know you're getting away from sea fish I don't 'now how far the likes of um herrings and that go up."	
"What about the Kahawai why do they come along?" "Well **the** Kahawai **is different. They are coming to spawn.** *So they spawn in the river?* **Yeah."** "*Have you seen any? What have you seen any spawning happening?"* "Yeah **well they the water turns like milk**…**With the male aye. Thinging the eggs of the female.** Yeah they go up the river. [taps] **That's all they come in for.** They only go as far as the tide. Tide tidal." "*So is the tide sort of changed how far up it goes?"* "Well yeah it goes up how far the tide finishes you know salt water? And **they lay their eggs and all the eggs are caught up in the boulders and the gravel and all it stays there and they hatch in there.** [laughs] Yeah it's ah, **it's like the, ah the Salmon**…Yeah but the Salmon you they go up there and they eggs and they die."	Interview, Participant 17
"Report says: Kahawai **don't spawn in the river** and I haven't seen it myself. They come in the river muck around and go out, they don't it on the bed like salmon."	Interview, Participant 21
"*What do you think they go up the river for?*" "**Spawning.** Our kahawai is specific to our river eh. I go to our other river and see some weird looking fish. Just (inaudible) some kahawai and it is that eh, they go back to their same awa, so our kahawai are darkey bluey, they've got that bluey greeny – that beautiful pounamu colour, but you don't get to see that in different rivers, or even in Whakatane, I went fishing up there in (inaudible) I think it was, caught a kahawai there, and I thought wow, that's a green looking – we do get the green ones that come around but I think those ones might be just, you know, tere, they might be getting together with the other ones that own the area. Because we did have a lot of green big huge long ones a couple of years ago, they were about that long [indicates]. I caught one, that was like, holy crap, what is that and it was green. It looked like a kingfish." "they come from down from the top of the North Island and they hit that Te Puku o te Ika [The stomach of the fish], and then come down and follow that pathway down until **they find the rivers that they spawn back to**, so we must look at all that."	Interview, Participant 30
"…You know **ka haere mai ki te whakawhānau i ētahi i waho atu** ah." [You know some come here to spawn out]	Interview, Participant 31
"'Cos you know, **they're doing their business, they're spawning eh**, they don't want to be disturbed." "I remember one year when I was across the other side looking for some spinners and you could see their footprints – their fin prints on the rocks…Nah truly… On the rocks, no it wasn't – that's what I thought 'cos I went across and it was quite	Interview, Participant 32

Spawning IEK	*Record type and number*
slippery and I started rubbing them and like, nah, they must have been hanging on that hard that you couldn't just rub it off."	

8.3.2.2 Indigenous ecological knowledge of Mōtū kahawai school sex ratios

Sex ratio IEK is presented in Table 8-4. When running ripe males dominate the schools, they are called jack runs. This participant suggests that the jack runs last for 3-4 weeks and the male fish are catchable whereas, female fish won't touch the spinners when they are spawning.

Table 8-4 Sex ratio IEK, including record type and number for the current study conducted in 2014. Interviewer's comments are in italic font, interviewee's comments are in standard font with relevant comments in bold font, and translations of the Te Reo Māori comments are in square brackets []. Where there is no Te Reo Māori, the square brackets contain contextual information to aid comprehension.

Sex ratio IEK	*Record type and number*
"I haven't seen yet the **jack run**." "*What's that?*" "**The big** kahawai **with the big white roe**. …this time of the year [early April]." "*Are they the boys, the jacks?*" "Yeah. I haven't seen it yet. **Those things usually go for at least three or four weeks. Those are big fellas**. …I haven't seen it. The last fish we went out, 15 last week, three of us, we got 15 like on every 20 minutes. One of those fish, we had one jack, and the roe was only small and it was a small fish it wasn't a big one. So, that's late. **They wouldn't have gone, I would have caught one in the runs**." "*Unless it was a tiny run?* Could have been. *'Cos there was a jack run, that might have been in the middle of March. Yeah 'cos they were – you know, you'd press the kahawai and the milk would come out, they were definitely boys, the jacks, and they were a bigger fish so-"* "**Must have been a small run, see look at that, that's small, that's changed." "***'Cos they were still big fish we were quite surprised at how big they were, everyone was expecting the fish to be smaller." "***No they're huge."** "*And then these big fish were coming in and they were all jacks, but then yeah after that it went back to females again, all a group of females."* **Nah, those runs used to be – even last year we had a big run last year, year before. They usually go for like three or four weeks,** 'cos those fellas camped, they were going up, coming down aye, **the males the jacks, they'll bite any time, even up the river.** Now – yeah **it's the female aye, once they're spawning they won't even touch it, the spinner**. I went out last Tuesday night we could have walked across the road that mouth, the kahawai was that thick aye [indicates]. And we turned our boat. Oh my gosh. Slow, fast, get one every 10th throw, or 20 throws. **Well the females won't touch them eh when they ---yeah, nah I must have missed the run aye**."	Interview, Participant 14

8.3.2.3 Indigenous ecological knowledge of Mōtū kahawai body condition

Fish condition IEK is presented in Table 8-5. Participants referred to kahawai being in good condition, i.e. full of fat, during the summer months from November to March but particularly after Christmas. The kahawai were bigger when they were fat. Participants referred to fat being between the skin and flesh, around the stomach and associated with livers. Participants also referred to kahawai as skinny in winter. Just prior to winter (April/May) when the kahawai has

lost condition and is being marked by the kingfish it was suitable for preserving for winter using the hangi method (tao kahawai). One participant suggested that the kahawai are not as fat now as they used to be.

Table 8-5 Fish condition IEK, including record type and number for the current study conducted in 2014. Interviewer's comments are in italic font, interviewee's comments are in standard font with relevant comments in bold font, and translations of the Te Reo Māori comments are in square brackets []. Where there is no Te Reo Māori, the square brackets contain contextual information to aid comprehension.

Fish condition IEK	*Record type and number*
"Crike **when they are fat man** don't take long to fill one of those sacks."	Interview, Participant 6
"But when they're here the Kahawai is running and they are over in Tauranga and over in Whakatane they come here. They don't want to go over there **all the fat** kahawai **from the Mōtū**."	Interview, Participant 7
"Nō te mea i te wa i kore ia i te wa **e tupuhi ana** te kahawai kaore i kaore i pai te kai." "**Ko nga wa o te hōtoke**." [Because when he isn't **when the** kahawai **is skinny** it's not good to eat. **Early winter time**.] **He nui nga momona kei runga i te puku o te ika.**" "***I te raumati****?"* "Āe whakahokihoki atu ai i ngā momo nunui te ate, ngā liver, kaore meatia te liver." ["**There is a lot of fat on the stomach of the fish.**" **"*In summer*?"** "**Yes return all the big parts, the liver, the livers, no use the liver**."	Interview, Participant 10
"You know like, we'd gut them, we'd turn the puku inside out and if there was a bit of fish **we'd stuff them full of livers, you know, the fat and all that.**"	Interview, Participant 12
"Mahau tonu i well ka **titiro koe i te kahawai tāima momona** ana te kahawai koira te reka o te kahawai ki te tūpuhi te kahawai pai atu noa mo te kuri." [I still well you see the kahawai **season the kahawai is fat** that's the tastiness of the kahawai if the kahawai is skinny it's only good for the dogs.] "Ko te tūpuhi noiho ra oh well i a matou hoki he kua tūpuhi te kahawai ah well hei aha." **[If it's just skinny, oh well, we also if the kahawai is skinny ah well never mind it.]**	Interview, Participant 13
"**The fattest time was after Christmas**….When the skin was, **when you get the yellow fat between the skin and the meat, and that was the, you never used oil, because we just used the natural fat from the fish, it would be yellow, used to be yellow as.** You hardly see the fish now, like that now, the kahawai."	Interview, Participant 14
"…**in the summer months when they are in good condition**… I'll say from November through to March."	Interview, Participant 15
"Mmm kaore hoki au he kaore anō matou i haere ki te hī i ngā kahawai **i te hōtoke kua mōhio kua tūpuhi**." [Mmm I also don't have we do not yet go to fish for **the** kahawai **in winter we know its skinny**]. "Hangi hangi the kahawai yeah you don't do that until you, the **fish is being marked by the kingfish you know they are starting to go down in condition**. Āe. **They start to get to the Māori oh tūpuhi [skinny]. Oh it's skinny.** That's 'he time to thing [prepare] it for the hangi. And you preserve them, that's for winter. Winter feed. 'Cos they when they are skinny they are quicker to dry. When they are fat they	Interview, Participant 17

Fish condition IEK	*Record type and number*
are too oily that's very slow to dry. Yeah. They only do that when they, when they like for the huihuis [gatherings] and all that, they hangied it when they fat and they put it on the table." *"Is that because it's going to be eaten straight away and not preserved?"* "Because preserved it takes too long to dry, but when they are skinny they are quick to dry."	
"Or you know, and then when the fish was gutted, **they put the livers in and that was our omega oils, fish oils**. And I told some of them, some of them went "Oh God, that's shocking, you all had to eat that?" And I said, "Thank about it, think how much money people pay for fish oils, you know, omega oils and that, and **that was our omega oils**. That was the thinking, it was fresh, it was straight from the fish, out in the sea, caught, eaten, on the beach, all of us kids had ika, ika, [fish] and we've had to sit around and eat our liver before we could go play, you know?"	Interview, Participant 18

8.3.3 Indigenous ecological knowledge of Mōtū river mouth environmental conditions

In this section karaka berry and river condition IEK and observations are presented.

8.3.3.1 Indigenous ecological knowledge of the relationship between karaka berry ripeness and Mōtū kahawai body condition

Details of karaka berry mātauranga are presented in Table 8-6. The key feature is when the karaka berry browns or turns orange the kahawai will arrive at the Mōtū River. This mātauranga prompted photos of the karaka tree to be taken during the field sampling season. Photos of the karaka berries are shown in Figure 8-1a-e. In December, the karaka berries were green. In January, they began to ripen. By mid-February they were completely ripe. By the end of February, almost all the berries had fallen off the tree. No photos were available for March. No berries were left on the tree in April.

Table 8-6 Karaka berries mātauranga, including record type and number for the current study conducted in 2014. Interviewer's comments in italic font, interviewee's comments are in standard font with relevant comments in bold font, and translations of the Te Reo Māori comments are in square brackets []. Where there is no Te Reo Māori, the square brackets contain contextual information to aid comprehension.

Karaka berries IEK	*Record type and number*
"E kore e ngaro, ka ura **te karaka** ko ahau tera." [Don't forget, **when the karaka browns,** that is me].	Takataka Koopu, n.d.
"**When the karaka berries are orange** and when the dust you know"	Interview, Participant 25
"That's when the blue kahawai turn up eh? The ones with the big blue backs, full of oil, **that's when the karaka berries are ready**…"	Interview, Participant 32

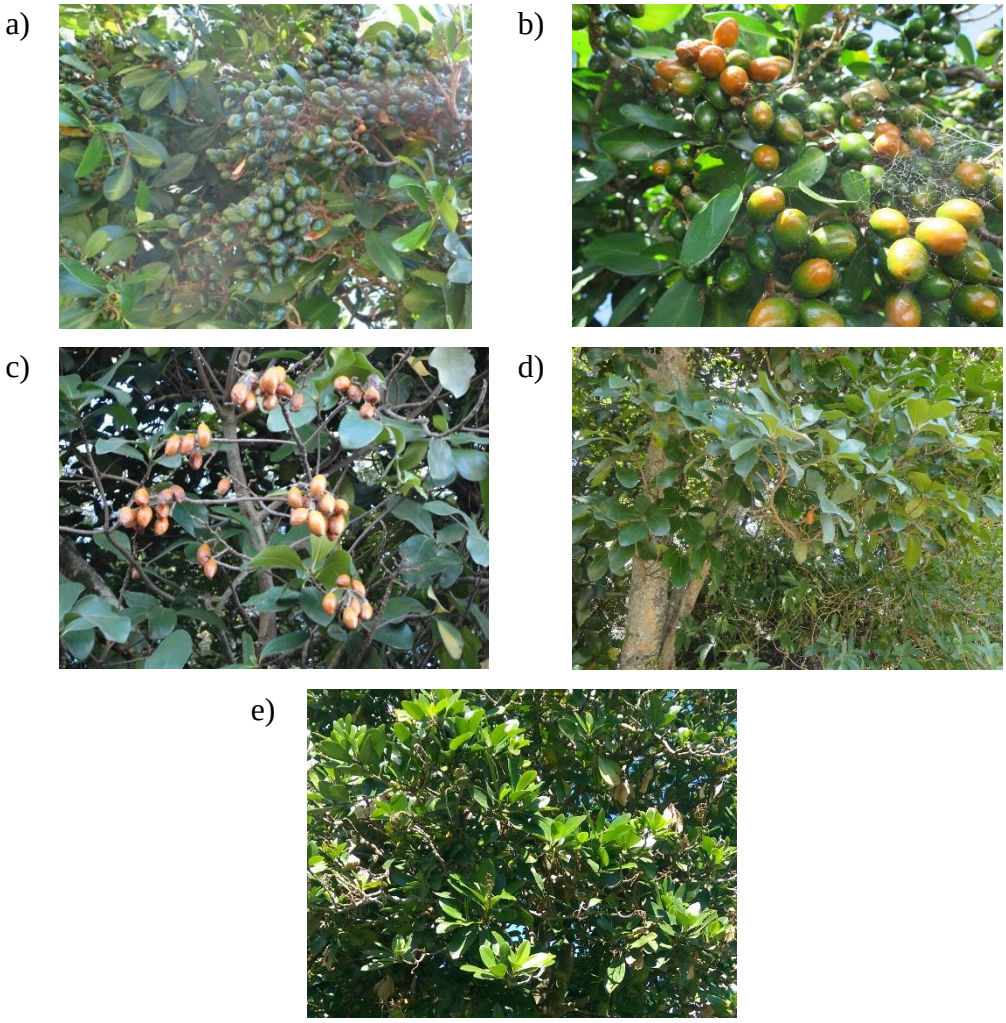


Figure 8-1 Photos of karaka berries on tree at the Mōtū River: a) 19 December 2014, b) 07 January 2015, c) 15 February 2015, d) 21 February 2015 and e) 25 April 2015 (credits: T. A. Walker and K. Maxwell).

8.3.3.2 Indigenous ecological knowledge of changes in the Mōtū River environmental condition

IEK regarding the river condition is provided in Table 8-7. Participants commented that the Mōtū was a big river, with a steep catchment and strong flow like the Hāparapara. Participants observed that kahawai were present at these large rivers and possibly needed the strong flow and depth to sense and enter the river. There were also observations that the Mōtū River used to be much deeper and greener in the past and had become shallower and now runs through the metal that comes down and settles on the flat. There were also predictions that the Mōtū river mouth would close the following summer (2014/2015). One participant suggested intervening to keep the river mouth open for the kahawai. The riverbed is stony (Figure 8-2a). The transition from sea water (cloudy) to river water (clear) at the river mouth is clear (Figure 8-2b). Participant 32 shows concern regarding the fate of the kahawai that are unable to enter into rivers that they could in the past because of the shallowing of the rivers.

Table 8-7 River condition IEK, including record type and number for the current study conducted in 2014. Interviewer's comments are in italic font, interviewee's comments are in standard font with relevant comments in bold font, and translations of the Te Reo Māori comments are in square brackets []. Where there is no Te Reo Māori, the square brackets contain contextual information to aid comprehension.

River condition IEK	*Record type and number*
"**Up the Mōtū there, there is more current** to sort of ah ah strain the salt and that…" "Here [Waioweka] you can see when the tide comes in, you can just about see the wave pushing, the same at Waiaua there, you see them they push just about up to the bridge there. But that's ah so flat aye, **not like down home there like with the Mōtū there it's all steep grade and Hāparapara is the same** but ah these ones are there's like a mudflat coming up yeah."	Interview, Participant 6
"**He awa nui …te ea o te wai…kia kaha te rere o te wai kia ahei e ratou ki te whakauru i te awa**." **[When the flow of the water is strong, they [the kahawai] are able to enter the river.]** "Koira …i **pīrangi ai ratou kia kaha te ea o te wai pea pai ai tā ratou hāunga ki te rite i te awa mena paku te ea te te current kaore ratou e e hau**." [That's, **they need the flow of the river to be strong perhaps so they can sense the right river if the current is small they don't sense it**.] "**He nui te wai i ngā awa i te mea he awa ano kua kohi rātou he awa kei a rātou i kohi 'cos he nui te wai**" **[A lot of water in the rivers because they gather at other rivers because there is a lot of water.]**	Interview, Participant 10
"But it's changed eh, **it's changed since that last thing**, so I don't know whether it will happen here again. It will be interesting. But then, I mean lots of – **everything is going to change by the next** kahawai **season eh. Probably no mouth here at all maybe**."	Interview, Participant 11
"I don't know whether it's the depth of the river or-**I think that depth of the rivers have a lot to do with it**." "And **another thing that's impacted too is the depth of the river now**. **You could never ever cross, walk across the river, but over there, there's places you can get right across, walking across this river you know**?" "Yeah. **It never got like that back then. It was deep. It was a dark blue, greenie river colour aye**. Yeah." "Yeah. 'Cos **it's a lot shallower**. **I've never seen the mouth go so low on the low tide, you know, it blocks off, that one. Te Kereu, Te Kereu is the same. Hāparapara, they used to be all open, but you know over the years all the metal's come down there and it's built up. I don't know whether man can intrude and go and go do something to the rivers to make it better, like this one out here, when they put in those groynes, it's going to do a lot when they dredge it, it's going to do a lot for the river.**"	Interview, Participant 14
"But I mean...**I'm sure the river mouth at the Mōtū is sort of um shallowed up a lot there was no way you could walk across that river mouth in the [past]**. "**Because the mouth had actually closed up**."	Interview, Participant 15
"Starting from Tōrere eh? The Waiaua that runs but he's fed from a native further back in the Mangamotus's eh, but you get ones at like Tōrere, they blocked up, kahawai. Yeah they won't spawn…The Mōtū won't block up 'cos he's too big. Go round to Hāparapara, he's	Interview, Participant 32

River condition IEK	*Record type and number*
blocked up, the Kereu, it blocked up and even further down to Raukōkore, that's blocked up, the water that used to flow to keep them open and those were all major kahawai rivers. Now it's only the – [Mōtū]. Those rivers don't flow anymore, so the fish aren't getting in there to spawn. …The rivers don't just run anymore. **They now come out and go underground and drain out through the stones, but back then they were big, fully river mouths** and the fish used to come in and spawn in those rivers. Now it's only the cape that's open, Ōmaiō, over here, full time, the Raukōkore's all closed up and that's a big river. It don't – river mouth just dries out in the lagoon, and it just goes under the stones." "*So the fish can't get in."* "They can't—no spawning—well what happened to those fish, where have they been going to? They must keep coming down until they find a bit of freshwater somewhere, but if you're born in that river, that's your river, eh, you're got to try and go through the stones eh to get to your river. **It never used to. Yeah that those rivers – our rivers have dried up. They have dried up.**"	

a) b)

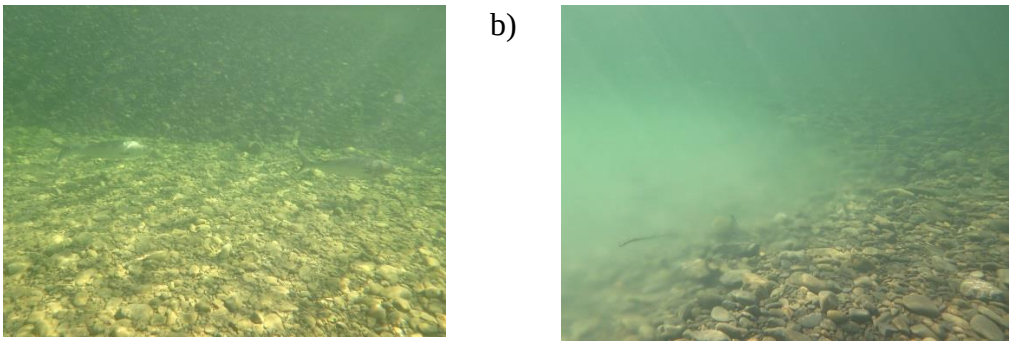


Figure 8-2 a) Riverbed, and b) Salt water meeting the freshwater at the river mouth. (K. Maxwell, 31 March 2015).

8.3.4 A description of Te Whānau-a-Hikarukutai/Ngāti Horomoana Hapū knowledge transfer processes (wānanga)

Wānanga IEK presented in Table 8-8, pertains to the process of reflection and discussion carried out by the old people of the Hapū regarding the local environment. The reference contains an example of Hapū mātauranga, recorded here for the use and discussion of further Hapū members.

Table 8-8 Wānanga IEK, including record type and number for the current study conducted in 2014. Interviewer's comments are in italic font, interviewee's comments are in standard font with relevant comments in bold font, and translations of the Te Reo Māori comments are in square brackets []. Where there is no Te Reo Māori, the square brackets contain contextual information to aid comprehension.

Wānanga IEK	*Record type and number*
"**He whare huihuinga ai i ngā kaumātua i te tuatahi kei konei** anō ngā whakaahua **e noho ana ngā koroua ra e huihui, kōrero mō ngā – mō ngā take. Mō ngā take ki te aha, ki te hī ika ki te aha**, mōhio ki te aha no nē? Taha mai. Koira te pai o tera ra, engari tae mai ngā taringa a rearea wā, pakupaku tonu au i tāua wa, e kōrero nei rātou katahi wētahi o ngā kōrero nei." "*Kei waenganui i te po?"* "Kao, kao **i te awatea, te awatea**. Ara ko te mea hoki ko te wharenui anake te whare i, tōku mea, e tu anei te wāhi e tu nei inaianei ko Te Iwarau ana...i mua atu i tera o te ra raki hoki te wahi tunu kai, he kauta. Pikikauta nei Wahatoto, te wāhi i noho	Interview, Participant 13

Wānanga IEK	*Record type and number*
nei matou. Te ingoa o tera pī whenua, Pihakore." *"Pihakore."* "Āe tera taha o te marae ara ka piki **ki tētahi parani ki Kaitangata**." *"Āe."* "Ah well kua tou mai ka puta ko te ingoa o **Te Umuhau Tuakana ana koira te wāhi i tu ra te wharenui**, tētahi piki nei i muri o te wharenui ki runga, koira taua mea. Kotahi anō te whare i reira but kaore au e mōhio kei a wai te wiki o te whakaahua nei he mea he whata kaanga katoa hoki i te pa o taua mea ra nei." "…Koira tētahi o ngā kai – ngā kai o te tuatahi [kaanga pirau]. **Ara ka kōrero ake ki ngā koroua nei, ka huihui rātou, ka noho ai i runga i te parani o te whare o taua tipuna, ka titiro atu i te moana**, na rātou hoki tēnei kōrero, kei te puta ngā matimati o Whakaari, ki waho o te moana, kei te raho pea te moana. Āe. Pēnei ka puta ana ngā tips o mea o Whakaari out of about that [indicates] off the sea aye. It's going to be a beautiful day. The sea is going to be flat. And us kids used to laugh at this kōrero raho pea te moana." *"Āe he kōrero heahea pea?"* "Well ki to wātou whakaaro nei." *"Ae."* "Pera ano te re ta rātou ma ratou, na o rātou ngā kōrero, ara, ko te tuakana nei te Tamaitikore nei wera katoa Taiaho ngā mea, Koopu Erueti." "...rātou katoa e kōrero mō pena. Ka noho ano hoki koe ki te parani ka titiro atu i te moana, ana, te mea ra i muri iho kua haere ngā poti kua haere ki waho. Kua hoki mai heke ngā peke Tāmure na ngā ika katoa nē? Tāmure, he ah he aha ana taua mea, gurnard ra ki te pākeha nei. Ko te – he a mea kei te Māori, he mea." ["**There was a house where the olds gathered before.** Here it was also taken photos of **the old men sitting gathered talking about the events, things to do with fishing and whatever you know whatever they talked about**. That's the good thing about those days. I was small at that time when they were talking. Here's is some of that discussion. *In the middle of the night*? No, no, **in the day, the day.** The reason being the wharenui was the only whare that stood here the place where Te Iwarau stands now, there. On the west was also where the food was cooked, a kitchen. This was a big kitchen, Wahatoto, was the place we stayed. The name of that piece of land was Pihakore. *Pihakore.* Yes that side of the marae **there you climb a parani to Kaitangata.** *Yes.* Ah well to me the name was **Te Umuhau tuakana, that's the place where the wharenui stood** there was a fig above the wharenui that I mentioned before. There was another house there but I don't know who has the photo/album At the pā there were all these maize drying racks there. … That was one of the first foods [rotten corn]. **The old men would sit on the verandah of that ancestral house we spoke about, and look out to the sea, this is also their kōrero,** If the fingers of White Island come out of the water, maybe the day will be beautiful.' "*Yes, silly talk perhaps?" "Well we thought so*" "*Yes."* "This was their, from their discussions, the eldest Tamaitikore, all of them Taiaho, and that Koopu Erueti. **They all talked like that.** And you too, sit on the verandah and look out to sea and before the boats would go out. They would return with heavy bags of snapper, all the fish aye. Snapper, what's that one gurnard to the Pakehā? What is it to Māori it's a thing.	

8.4 Discussion

The prey species IEK here and findings in Chapter 7 (Ecological relationship between kahawai and the Mōtū) both suggest kahawai are eating at the river mouth in April. The prey species IEK presented in Table 8-2 suggesting kahawai prey on 'anything' and 'whitebait' is supported

by the Chapter 7 (Ecological relationship between kahawai and the Mōtū) food source observations. In April 2015 one fish was caught on Maraenui Beach containing >5 species and another fish was caught from the mouth containing a whitebait. The kahawai migrations do coincide with the migrations of freshwater fish. For example, juvenile longfin and shortfin eels migrate upstream from estuaries in Dec-Apr, torrentfish spawn in estuaries in Jan-Apr and juveniles migrate upstream in Nov-Feb, and īnanga spawn in the tidal estuary vegetation from Mar-May (Hamer, 2007). The spawning and migration habits of other baitfish such as anchovies (*E. australis*), pilchards (*Sardinia neopilchardus*), and sprats (*Clupea antipodum*) was not investigated here but may require further investigation.

The spawning IEK presented in Table 8-3 suggesting kahawai spawn at the river mouth is supported by the Chapter 7 (Ecological relationship between kahawai and the Mōtū) macroscopic gonad stage observations of 'running ripe' males and females. The hydrated eggs shown in Figure 7-26a-b. Perhaps this is why kahawai are called salmon in Australia, because of their migrations into rivers to spawn. However, they are not closely related to salmonids. IEK reported kahawai migrating further up the river which is highly likely. An older record reported kahawai 50-60km up the Waikato River in the late 1800s (Sherrin, 1886; in Jones et al., 1992).

The sex ratio IEK presented in Table 8-4 reflects the observations made during the later months of the Chapter 7 (Ecological relationship between kahawai and Mōtū) field sampling observations where males dominated the catch. In March 2015, the sex ratio (males to females) was 1.62:1, and in April 2015 the sex ratio was 1.17:1. This was not observed in the sea caught kahawai where females dominated the catch every month. Therefore, these skewed sex ratios, undoubtedly observed in the catch, may be a product of the catch method (handline and lure vs. purse-seine), and be due to some females ignoring the lures as suggested.

Fish condition IEK presented in Table 8-5 demonstrates clearly that the Hapū were aware of kahawai being full of fat or in 'good condition' during the summer months, losing condition in April/May called 'slabby,' and having no fat in winter called 'skinny.' This is consistent with the Chapter 7 (Ecological relationship between kahawai and the Mōtū) lipid and liver indices measured for the Mōtū kahawai, indicating the lipid content was high from December to February and declined in March and April, particularly in the livers of the females. As children the participants remember having to eat the kahawai livers because they were full of good oils. Six kahawai caught in the Horowhenua-Kapiti coast area on the 26 February 1986 were assessed for protein and fat composition. The body tissues contained 4.6±3.2% fat, 21.8% of the total fatty acids being n-3 type polyunsaturated fatty acids (PUFA), and the roe contained

11.6% fat with 29.3% of the being n-3 type PUFA (Vlieg & Body, 1988). Compared with other NZ marine and freshwater fish species these PUFA levels are similar to those of quinnat salmon (*Oncorhynchus tshawytscha*), albacore (*Thunnus alalunga*), skipjack tuna (*K. pelamis*) fillets and, hoki (*Macruronus novaezelandiae*) roe. The livers were not assessed, but a further assessment specific to the Mōtū river kahawai would provide valuable information about the nutritional value of the Mōtū kahawai 7 (Ecological relationship between kahawai and the Mōtū) merely presents numerical information to support what was already a case for reproduction being the reason why kahawai enter the Mōtū river mouth as shown by the reproduction IEK, i.e. spawning, sex ratio, and fish condition. This adds to the current understanding of spawning habitat in the KAH1 area that spawning habitat is unknown or is on the seabed in open water (Hartill & Walsh, 2005). This reinforces the concept of there being multiple spawning locations.

The karaka berries presented in Figure 8-1, confirm the mātauranga stating that kahawai will arrive when the karaka berries ripen was still relevant in 2014-15. This is considered mātauranga rather than IEK because it is described in an ancient pūrākau that dates the knowledge almost back within 50 years of the arrival of the Tauira-mai-Tawhiti waka to New Zealand (ca. 13th Century, Hogg et al., 2003). The pūrākau is completed by whakapapa to a known eponymous ancestor of Te Whānau-a-Apanui shown in the Prologue of this thesis. There is more mātauranga in the He Kōpara pūrākau regarding the Mōtū River ecosystem that is not investigated here as it was considered better to leave this as an exercise for whānau to do at home.

In this study, resource depletion was not the major concern for the fishery, changes in the river and their impacts on kahawai and other Mōtū river species were. According to the river condition IEK provided in Table 8-7, the Mōtū River was much deeper and bigger in the past and has become shallow in recent times. Comparing these observations with the monthly median river flows from 1985 to 2017, shown in Figure 7-4 (Chapter 7 Ecological relationship between kahawai and the Mōtū), the Mōtū River certainly did have lower flow in 2014/2015 than previous years. These observations prompted an interest in investigating why the local rivers had become so shallow. The impact of exotic forest in the catchments was one hypothesis proposed to explain the decline in water quantity (Interview with Participant 32), the forest ecology, i.e. impact of possums and ungulates on the canopy, was another (R. Whitbourne, *pers. comm.*, 2018).

The possible kahawai spawning grounds discussed in the spawning IEK may be referring to location of the mauri of the kahawai, Te-Whatukura-a-Tangaroa. In the He Kōpara pūrākau,

Poumātangatanga goes to where Tangaroa (atua of the sea) resides to look for his lost son, He Kōpara. Tangaroa's home is also known as Te Puna-i-Rangiriri (also Te-Puna-o-Rēhua) which is the sacred pool at Hawaiki from where all fishes arose at the creation of the world (Maxwell, 2013; Roberts, 2013). Tangaroa then sends his children, the kahawai, as an extension of himself, to Poumātangatanga at the Mōtū. In Rimini's (1901) accounts of Tāpuikakahu venturing to the Mōtū to retrieve his paua fishhook, he describes the Mōtū as 'te puna o te kahawai [the source of the kahawai].'

Cowan (1930) reported that mauri kohatu (mauri stones, sacred to the gods of the fisheries), were preserved and still used in the 1920s, as they were centuries ago. Cowan (1930) details a sacred and most potent fishing talisman, a very ancient stone called "Te Whatukura-a-Tangaroa [the sacred red stone of Tangaroa]," treasured by Whānau-a-Apanui living at the mouth of the Mōtū River, as follows: The *Whatu-kura-a-Tangaroa* is preserved as a holy relic; it is very seldom that it is revealed to public gaze by the Ringa-tu folk of Maraenui, who have it in their charge. It is a small carved red stone, described as about two inches in length, and half an inch broad, with a piece of human bone attached to it for a hook. It was brought to New Zealand by one of the canoes from Hawaiki (Tahiti) about six centuries ago, one statement I have received says the canoe, *Tauira*. This *whatu* (locally called a *puna* in allusion to the *Puna-i-Rangiriri*, the legendary source of all fish) is believed to have the power of attracting great shoals of fish to the Mōtū River tidal waters. It is the *mauri* of the fisheries. Great quantities of the *kahawai* are taken at the Mōtū, and the Māori are careful to observe the ceremonies of thanksgiving, in recognition of the abundance of fish, the good things of the gods. Offerings of the first catches of the season are made to Tangaroa, and some of the largest of the *kahawai* are hung on the branches of the pohutukawa trees, near Maraenui village." This excerpt also refers to the mauri stone as a puna and the source of kahawai, which could resemble a spawning ground ecologically.

The wānanga IEK presented here in Table 8-8, demonstrates that TWAH/NH elders discussed their fishing and environmental knowledge associated with fishing in the 1930s when the participant was a child. These discussions and associated fishing practices were observed by current elders when they were children who may or may not have retained the knowledge. A whakataukī (proverb) was given as an example of such knowledge. How this knowledge is processed now was not discussed but the Ringatū church services and special kahawai hui (meeting) certainly facilitate discussion about the Mōtū kahawai fishery.

Regular opportunities for knowledgeable people and students to come together in the Mōtū area to discuss, re-tell and learn this important mātauranga requires support. Written records

ensure that the knowledge is retained but potentially at the risk of losing the wānanga process that facilitates remembering and the diminishing of Māori ways of knowing. In recent times, kapa haka (Māori cultural performance group) compositions have provided a place for recording mātauranga (Maxwell, 2013). This chapter demonstrates how IEK, and mātauranga in particular, can provide valuable contributions to the wider body of knowledge that is used in fisheries management. This is the end of Part II the Body-Tinana of the thesis, containing the original contributions. Next, we move on to Part III, the Tail-Hiku, which brings all of the information together. Chapter 9 (Holistic Mōtū kahawai fishery management) brings the previous information together as a Hapū plan and Chapter 10 (Conclusion) gives a summary of the thesis findings.

PART III – WAHANGA TORU
(HIKU)

Chapter 9 Holistic Mōtū kahawai fishery management

In this chapter, information from all of the previous chapters is brought together, to identify the key components of the Mōtū kahawai fishery to the Hapū and create a Hapū plan for the Mōtū kahawai fishery. The chapter has four sections. First, we look at planning documents for supporting the co-management of CKS fisheries within the wider environmental context. Next, we outline the methods followed for bringing the information together to identify key components of the fishery and outcomes for the Hapū plan. Then the key components of the Mōtū kahawai fishery and the Hapū plan are presented along with justifications for the outcomes, and descriptions of relevant policies and people to support achieving the outcomes. Lastly, the holistic nature of the plan and benefits to planning documents are discussed.

9.1 Introduction

To achieve a sustainable KAH1 fishery, Fisheries NZ has set a target for the kahawai spawning stock of 52% virgin biomass (B_0). B_0 was estimated at 50,000t in 1930, therefore 52% is 26,000t (Ministry for Primary Industries, 2017). Sustainability is achieved by estimating the recreational and commercial catches and adjusting the annual allowable catches to levels where catch is most likely to maintain 52% B_0. In terms of the customary fishery, the proportion of customary authorisations issued that are also fulfilled, indicates if a customary fishery is sustainable. Sustainable means a high proportion of authorisations are fulfilled.

With these targets and indicators, it is difficult to see how the Hapū worldview and values, traditional management practices, and IEK associated with the fishery are being sustained. The Hapū have demonstrated why the fishery is culturally important, the relationship of the fishery to the ecosystem, and the IEK they have associated with the fishery. A tangata kaitiaki/tiaki may prepare a management plan or plan for their respective rohe moana. This plan may also be treated as a planning document for the purposes of the Resource Management Act 1991, if it meets the requirements, and to help recognise use and management practices of Māori in the exercise of non-commercial fishing rights through section 10(b) of the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992.

Iwi planning documents are of great value for local authorities and national agencies, the wider community and tangata whenua. They assist the Crown by: identifying the Iwi and Hapū of the region; their rohe (area); their values and interests; aiding decision-making; providing a planning tool for engagement and partnerships; outlining preferred methods of engagement; identifying Iwi and Hapū who may be affected by activities subject to resource consent applications, proposed changes to policies and plans, and conservation orders (Māori Policy Unit, 2011). Planning documents also aid the wider community by: enhancing understanding;

helping to build community awareness, and helping resource consent applicants to identify relevant matters for assessments of environmental and cultural effects (Māori Policy Unit, 2011). Planning documents assist Māori by: facilitating knowledge transfer and documenting mātauranga Māori; providing a framework to articulate values, aspirations, outcomes and issues; and identifying specific natural resources and/or sites of cultural significance; ensuring Iwi/Hapū interests are recognised in the resource consent application process; and providing a template for others developing planning documents (Māori Policy Unit, 2011).

From Chapter 5 (Māori participation in NZ fisheries management) it was clear the planning documents are the key entry point for informing NZ fisheries management. However, plans such as those prepared by customary fisheries forums, Mai-i-Ngā-Kuri-a-Whārei in the Bay of Plenty, and Te Tai Hauāuru on the Taranaki coast are relatively high level, representing the interests of multiple Iwi, for multiple fisheries. The forums are then tasked with achieving the plan outcomes, not the tangata whenua or Fisheries NZ. At this level, the importance of CKS fisheries, like the Mōtū kahawai fishery, may be obscured, and determining which fishery is important to which Hapū, for the purposes of co-management, becomes difficult.

Māori fisheries plans have been developed by a range of Māori entities to support their aspirations for customary fisheries management. Iwi and Hapū are increasingly developing plans that include fisheries in the scope, including specific discussion of CKS fisheries. For example, Ngāti Maniapoto have produced a plan for the upper Waipā River fisheries including all species of interest but with special reference to freshwater eels (Tipa et al., 2014).

The aim of this chapter is to identify the key components of the Mōtū kahawai fishery and develop a Hapū plan based on the information collected in this research. We review the findings of the previous chapters to identify the key components of the Mōtū kahawai fishery. Outcomes that address these key components are developed and relevant policies and people to support achieving these outcomes are explored.

Developing a plan that addresses all the Hapū interests is supported here, to recognise the interconnectedness with which the Hapū view's the world. This has also been demonstrated by Ngā Hapū o Te Whānau-a-Apanui, who have signalled the intent to develop a 'One Plan,' incorporating an Iwi Management Plan under the Resource Management Act 1991, an Iwi Environmental Covenant, with legal status under the Marine and Coastal Area (Takutai Moana) Act 2011, an Iwi Fisheries Management Plan with legal status under the Individual Iwi Deed of Settlement, when enacted.

Such Indigenous plans are more holistic compared with national fishery plans that consider species apart from their ecosystems. Resource management plans are more holistic. Resource

management and fisheries plans are in fact, regional and can potentially be amalgamated as we move into an ecosystem-based marine management regime. Earlier we highlighted the need to increase interim capacity, i.e. social, cultural, and economic management, research, and working group teams, to implement holistic plans in fisheries management. The interim fisheries management system then needs to review their customary fisheries management plan to better support and monitor CKS fisheries in light of Hapū/Iwi plans.

9.2 Methods

The methods used to identify the key components of the fishery from the Hapū perspective, and to develop a Hapū plan are described.

9.2.1 Identifying the key components of the Mōtū kahawai fishery and developing a Hapū plan for the Mōtū kahawai fishery

The key components of the Mōtū kahawai fishery from the perspective of Te Whānau-a-Hikarukutai/Ngāti Horomoana were identified by first reviewing the information gathered in the previous three chapters. From Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery), this included:

- Comments on issues from last season, ideas regarding kahawai fishing at the Mōtū, and kahawai fisheries management from the 32 attendees of the Mōtū kahawai fishery management hui (13 September 2013), and for five attendees, further comments during participatory observations.
- Comments on the importance of the kahawai fishery and the key components of the fishery from the 20 interview participants (12 who attended the Mōtū kahawai fishery management hui, eight additional interview participants).
- Comments on the importance of the kahawai fishery and key components of the fishery in 32 of the 41 documents recommended by the participants of the participatory observations and interviews (the other nine documents could not be sourced).

During the interviews, participants were asked what they thought the key components of the Mōtū kahawai fishery were. In the first two cases, interview participants drew mind maps of the key components, but in further interviews participants declined to create mind maps, preferring to talk. This was expected, as Māori cultures are known for being primarily oral (Tāwhai, 2013). The two mind maps comprised the starting point of the visual. Further components were added from: the following interviews, additional information gathered in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery) as mentioned above, the findings of Chapter 7 (Ecological relationship between kahawai and the Mōtū), and additional information gathered in Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai

fishery). These were brought together in a workshop held on 19 June 2018 with Erica Williams and I mapping out the components, outcomes and overall vision on a digital whiteboard. I developed the vision and outcomes based on the whakataukī (proverbs) described in the information gathered above which reflected the key components. These were reviewed by 16 Hapū members (8 apologies), at a hui (meeting) held on 29 July 2018 at Maraenui marae. Everyone was given the opportunity to speak and one component was included as a result. The plan visual diagrams, including the Mōtū kahawai fishery key components, outcomes and vision, were produced in collaboration with Willie Franco using Adobe Illustrator after first being drafted on paper and in PowerPoint. I reviewed legislation and crown agency documentation to identify pathways to help achieve each outcome. From these documents, relevant people and agencies that could form a community of practice, like the Hauraki Gulf Forum, were identified.

9.3 Results

The key components of the Mōtū kahawai fishery from a TWAH/NH perspective are presented, followed by a Hapū plan, potential pathways for achieving outcomes and relevant people for creating a community of practice.

9.3.1 Te Whānau-a-Hikarukutai/Ngāti Horomoana key components of the Mōtū kahawai fishery

Key components of the Mōtū kahawai fishery as expressed by the Hapū are shown in Figure 9-1 (Te Reo Māori) and Figure 9-2 (English). The components have English and Te Reo Māori names, chosen to reflect the concepts described in Table 9-1. The Mōtū kahawai fishery is in the centre, as it is a pivotal connection between the Hapū, the fish, and the environment. The second central ring contains the key components connected to the Mōtū kahawai fishery. The third ring shows which components each outcome addresses, with the overall vision on the outside.

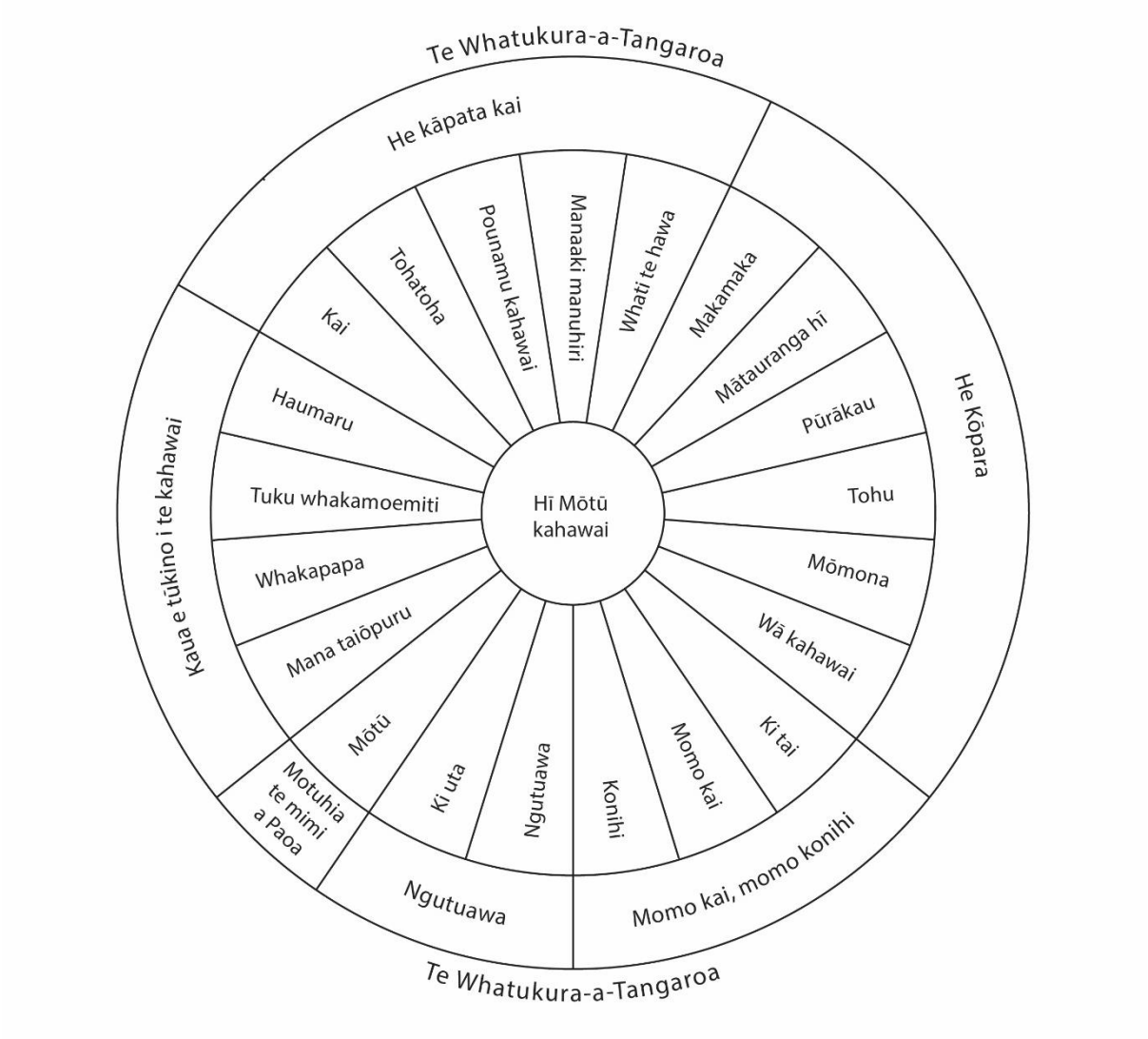


Figure 9-1 Key components of the Mōtū kahawai fishery from a TWAH/NH perspective in Te Reo Māori. The outer ring contains the Hapū plan outcomes that link to the adjacent inner components. Outside of the circle is the Hapū plan vision. (Created by Willie Franco for this project).

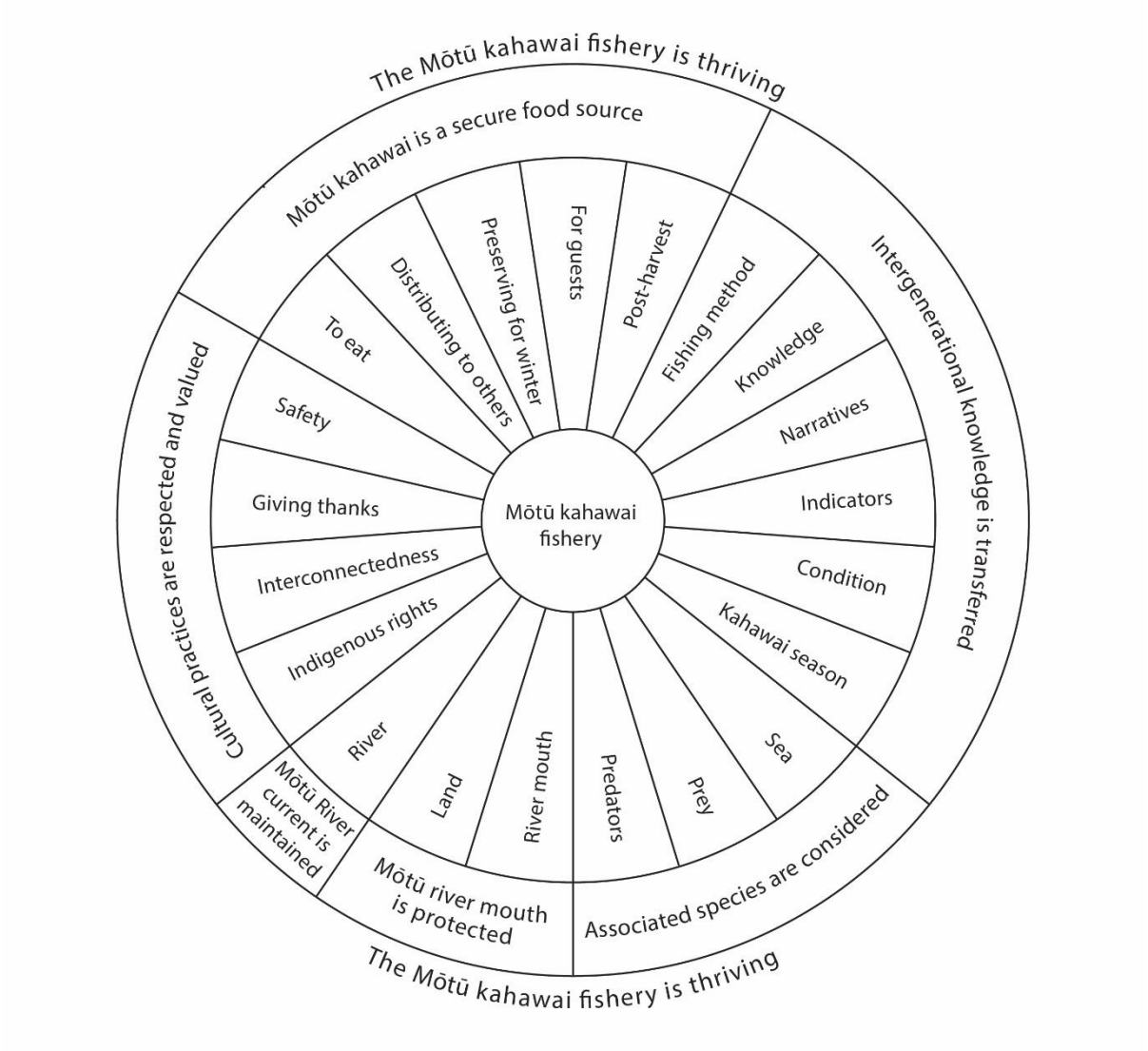


Figure 9-2 Key components of the Mōtū kahawai fishery from a TWAH/NH perspective in English. The outer ring contains the Hapū plan outcomes that link to the adjacent inner components. Outside of the circle is the Hapū plan vision. (Created by Willie Franco for this project).

Table 9-1 Key components of the Mōtū kahawai fishery in English, Te Reo Māori and a description of the concept each represents.

English components	*Te Reo Māori components*	*Concept*
Mōtū kahawai fishery	Hī Mōtū kahawai	Pivotal connection between people and place. Kahawai that are part of the Mōtū kahawai fishery and the TWAH/ NH Hapū.
River	Mōtū	The Mōtū River: water volume, nitrates, nutrients, sediments, flooding
Land	Ki uta	Landscape, animals and land use: Natural forests, wildlife, exotic forests, pests (goats and possums), dairy, farms and gravel extraction.
River mouth	Ngutu awa	Mōtū estuary and river plume out to sea: where kahawai spawn, where people fish and swim, whitebait spawning areas, bird nesting areas
Predators	Kōnihi	Kahawai predators: yellow-tail kingfish, sharks and cetaceans.
Prey	Momo kai	Kahawai prey: small fish, krill and other species.
Sea	Ki tai	Pelagic (from mid-water to surface): within 20km of the coast, shallower than 50m in Bay of Plenty area of KAH1.
Kahawai season	Wā kahawai	Open: 1st November (Pure) to 31st May. Closed 1st June (Huamata) to 31st October, Saturdays, 12ths, 1st Jan, at night, and when there are aituā (fatal accidents).
Condition	Mōmona	When kahawai are fat (good for bottling), slabby (good for tao kahawai) and skinny (not good).
Indicators	Tohu	Environmental indicators, i.e. karaka, rau aruhe, large waves and heavy rains, Whakaari (White Island).
Narratives	Pūrākau	Knowledge processes, i.e. oral histories containing information about the Mōtū kahawai fishery – He Kōpara.
Knowledge	Mātauranga hī	Fishing knowledge: maramataka (calendar), tides and weather are favourable. When there are fish visible at the river.
Fishing method	Makamaka	The preferred Mōtū kahawai fishing methods are using lines and pāua (specialised kahawai fishing lures). These methods are highly selective, affordable and successful. They also allow for highly controlled post-harvest handling of kahawai, where nets do not. There is a history of nets associated with the Mōtū kahawai fishery however their use is restricted.
Post-harvest	Whati te hawa	Processing the fish: i.e. bleeding the fish, keeping it cool, scaling, gutting.
For guests	Manaaki manuhiri	Providing kahawai for visitors of Hapū members at homes, schools, kurā, kōhanga

English components	*Te Reo Māori components*	*Concept*
		or in particular the marae during hākari (banquet).
Preserving for winter	Pounamu kahawai	Preserving kahawai so that it is available in the winter months, i.e. bottling kahawai or tao kahawai (hāngī preserve kahawai).
Distributing to others	Tohatoha	Distributing kahawai to others who would like some but do not have any because they are unable to fish, did not catch any personally or live away.
To eat	Kai	Personal or immediate family use of kahawai as a food, to nourish the body and the spirit, cooked in a variety of ways including boiled heads, smoked, fried, poached, soup, curried, puku ngako (haggis).
Safety	Haumaru	Food safety, travelling safety, water safety. This recognises the risks present at the river and sea. Water-related disasters are prominent in the Hapū's past as depicted in the He Kōpara narrative and the drowning tragedy of 1900. These accidents result in rāhui restrictions on the area. In the past, surfers have also drowned at the mouth and the Hapū wish to avoid any future accidents of this nature which is why they do not support surfing at the Mōtū river mouth.
Giving thanks	Tuku whakamoemiti	Performing the appropriate rituals and blessings for kahawai, acknowledging that they are a gift (taonga) and acknowledging the favourable circumstances pertaining to fishing for kahawai. Karakia (blessings).
Interconnectedness	Whakapapa	How Hapū members and kahawai are connected to the wider environment, our ancestors and each other.
Indigenous rights	Mana taiopuru	Mana regarding the Mōtū kahawai fishery is derived through whakapapa to atua (deities) and ancestors. This gives the Hapū the reciprocal right of looking after and accessing provisions from the river, the land in the catchment, the adjacent inshore, the kahawai and the people involved in the fishery. This is carried out through education, cleaning up rubbish, observations and adapting fishing rules according to what is required to respect the tikanga of the Mōtū kahawai fishery.

9.3.2 Te Whānau-a-Hikarukutai/Ngāti Horomoana Hapū plan for the Mōtū kahawai fishery

The following information is structured as a Hapū plan. This Hapū plan represents the priorities of Te Whānau-a-Hikarukutai/Ngāti Horomoana. The views of neighbouring Hapū (Te Whānau-a-Harawaka and Te Whānau-a-Tūtāwake) and Iwi (Ngāitai, Ngāti Porou, Te Whakatōhea and Te Aitanga-a-Mahaki) are not presented. Indicative Hapū boundaries are east from Parinui to Tokatā on the eastern side of the Mōtū rivermouth and back into Houpoto and the Raukūmara encompassing the Mōtū River catchment. The overarching values for this plan are: aroha, kaitiakitanga, kōtahitanga, mana, manaakitanga, rangatiratanga, tikanga, whanaungatanga, whakapapa and wairuatanga.

The overall vision is Te Whatukura-a-Tangaroa – The Mōtū kahawai fishery is thriving, the mauri of the fishery is enhanced. Te Whatukura-a-Tangaroa represents the mauri of the fisheries. Te Whatukura-a-Tangaroa, reminds us to respect the fisheries of Tangaroa and to give thanks for the bounty it provides us. Only when both the physical and spiritual components of the Mōtū kahawai fishery are sustained, is the mauri enhanced.

Table 9-2 Vision and outcomes for TWAH/NH Hapū plan.

Vision	
Te Whatukura-a-Tangaroa The Mōtū kahawai fishery is thriving	
Ecological outcomes	*Fishery outcomes*
Mōtū River current is maintained Mōtūhia te mimi a Paoa	Cultural practices are respected and valued Kaua e tūkino i te kahawai
Ngutu awa Mōtū river mouth is protected	Mōtū kahawai is a secure food source He kapata kai
Associated species are considered Momo kai, momo kōnihi	Intergenerational knowledge is transferred He Kōpara

Six key outcomes are proposed to achieve this vision (Table 9-2). There are three physical outcomes: Mōtūhia te mimi a Paoa – Mōtū River current is maintained; Ngutu awa – Mōtū river mouth is protected; and Momo kai, momo kōnihi – Associated species are maintained. There are three metaphysical outcomes: Kaua e tūkino te kahawai – Cultural practices are respected and valued; He kapata kai – Mōtū kahawai is a secure food source; and He Kōpara – Intergenerational knowledge is transferred. Each outcome supports one or more key components of the Mōtū kahawai fishery, outlined above.

Mōtūhia te mimi a Paoa – Mōtū River current is maintained, connects to the River/Mōtū component. The Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery) suggested that kahawai need a particular level of river current to detect the river plume off the coast, and a particular river water quantity and subsequent depth in order to enter the river

estuary (Penlington, 1988). The relationship between kahawai migrations and river currents needs to be better understood as neighbouring river mouths have closed causing concerns for fishers as what might happen to kahawai if the Mōtū river mouth was to close.

Ngutu awa – Mōtū river mouth is protected, connects to 2 key components: Land/ Ki uta, and River mouth/Ngutu awa. Chapters 7 (Ecological relationship between kahawai and the Mōtū) and 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery) support the hypothesis that the Mōtū river estuary is a spawning site for kahawai and this may be distinct from other areas. The availability and health of areas of importance to spawning fish populations may strongly influence recruitment to the adult population and associated fishery (Hurst et al., 2000). A decline in their extent or productivity due to fishing impacts or environmental changes such as sedimentation, pollution and urban development may subsequently reduce the adult population (Hurst et al., 2000). To achieve this outcome the river mouth would be protected from direct or indirect impacts that may adversely affect the extent or productivity of the habitat, such as changes to water quality or habitat.

Momo kai, momo kōnihi – Associated species are considered, connects to the Kōnihi/Predators, Momo kai/Prey, and Ki Tai/Sea components. Associated species were identified in the Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery) interviews. For example: “Ko te mea nui, ko te kai i roto i te moana pea? Nē. He nui ana te kai. [What’s the most important, the food in the sea perhaps?] Aye. That there is enough food.” (Interview, Participant 10). “The food chain” (Participant 15, Interview). Kahawai predators and prey were identified in Chapter 7 (Ecological relationship between kahawai and the Mōtū). The predators include yellowtail kingfish, sharks and cetaceans; and the prey include small fish and krill. Kahawai are also associated with blue mackerel, jack mackerels and trevally schools. Changes in these species may also influence the kahawai fishery which should be considered.

Kaua e tūkino i te kahawai – Cultural practices are respected and valued, connects to the Safety/Haumaru, Giving thanks/Tuku whakamoemiti, Interconnectedness/Whakapapa, and Indigenous rights/Mana taiopuru components. Kaua e tūkino i te kahawai is a tikanga that literally means: ‘do not disrespect the kahawai,’ and therefore is translated here as: ‘respect the kahawai.’ Examples of these practices include: taking only what you need, not wasting kahawai and eating all the flesh, i.e. the head, frames, roe, organs and fillets. The participants’ expressed the view that “...our fisheries has always been you only take what you need for your family and your friends and to take what you need. It’s not a commercial place for this particular taonga of ours, the kahawai. It’s quite a spiritual thing, having that resource available to us and we should not abuse it [Participant 18].”

He kapata kai – Mōtū kahawai is a secure food source, connects to the Post-harvest/Whati te hawa, For guests/Manaaki manuhiri, Preserving for winter/Pounamu kahawai, Distributing to others/Tohatoha, and To eat/Kai components. Kahawai has been a staple diet of the community for centuries, ensuring their survival and many cultural food practices have been developed over the years. As a community that was largely isolated until the opening of State Highway 35 in the late 1930s, and ranked in the highest material hardship/deprivation group in the nation in 2013, it is no surprise that food security is important for the Hapū.

He kōpara – Intergenerational knowledge is being transferred, connects to the Wā kahawai/Kahawai season, Condition/Mōmona, Indicators/Tohu, Narratives/Pūrākau, Knowledge/ Wā hī; and Fishing methods/Makamaka components. This outcome acknowledges the past, present and future of the fishery as part of a continual line. This outcome is about ensuring Indigenous cultural survival into the future by retaining and teaching the knowledge and practices associated with the fishery to the next generations. This is exercised through the fishery, kura and wānanga and is a source of whanaungatanga for the community.

9.3.3 Potential pathways for achieving each outcome of the Mōtū kahawai fishery plan

There are a number of avenues that these regulations may be implemented. The Hapū could put forward recommendations for bylaws i.e. changes to fishing season, size limits (upper or lower), catch limits, catch methods, on the basis that their recommendations will achieve their outcomes. Case study examples provided here include directly; through marine protected areas, i.e. mātaitai and 186A temporary closures; and through Deed of Settlement as fishery bylaws. Bylaws also provide for rāhui for drownings, by making a closure of an area mandatory if the closure is notified in the media. This will provide steps to developing an ecosystem approach for managing the Mōtū Kahawai fishery as a case study for a NZ marine CKS fisheries.

9.3.3.1 Outcome 1: Mōtūhia te mimi a Paoa – Mōtū River current is maintained

This would be managed under the Regional Freshwater Policy Statement of the RMA. Parts of the Mōtū River are protected under the National Water Conservation (Mōtū River) Order 1984 which was granted under the Water and Soil Conservation Act 1967 and is now administered through the Resource Management Act 1991 as mentioned above. Due to their wild and scenic characteristics and recreational amenities, the Mōtū River, from and including the Mōtū Falls to the State Highway 35 Houpoto Bridge, and the Waitangirua Stream; Mangaotane Stream; Te Kahika Stream; Mangatutara Stream; and the Takaputahi River below its confluence with the Whitikau Stream, are to be preserved as far as possible in their natural state (Water Conservation Order 1984).

The rest of the catchment was probably not included in the Order because it was modified. These modifications may have impacts to the natural state of the protected catchment further downstream. The Order includes clauses on water use: 'Water rights may not be granted, and a right to dam will not to be granted unless it will not affect the river. However, use of water for domestic needs, for the needs of animals, and for or in connection with fire-fighting purposes is not limited by the Act.' These allowances may be sufficient to impact river quantity and current if not managed closely. It is important for tangata whenua interests to be recognised when making decisions on what volume of water can be extracted from the catchment, and the impacts of catchment use and modifications on water quantity and flow regimes.

9.3.3.2 Outcome 2: Ngutu awa – Mōtū river mouth is protected

It is not clear which policy the management of the Mōtū river mouth falls under. Tangata whenua have the right to participate the management of their rohe (area) regardless of who owns the area. In addition, the New Zealand Coastal Policy Statement 2010's Objective 6, 'the potential to protect, use, and develop natural and physical resources in the coastal marine area should not be compromised by activities on land.' Under the Marine and Coastal Area (Takutai Moana) Act 2011, 'neither the Crown nor any other person owns, or is capable of owning, the common marine and coastal area…which includes the beds of rivers that are part of the coastal marine area.' This may be category that the river mouth falls under.

There is potential for the Mōtū river mouth to be recognised as a 'habitat of particular significance for fisheries management (HPSFM)' for kahawai as a spawning habitat. Section 9 of the Fisheries Act 1996 recognises three environmental principles: that associated or dependent species should be maintained above a level that ensures their long-term viability; that biological diversity of the aquatic environment should be maintained; and that HPSFM should be protected. A policy definition is currently being developed for HPSFM and this may be a direct avenue for protecting the Mōtū river mouth with respect to fisheries management.

The Mōtū river mouth may be subject to dairy, forestry, farming and gravel extraction land use impacts in the catchment and modified forest ecology in the forested catchment due to pests (possums and ungulates) eating the canopy. The Mōtū River Water Conservation Order 1984 protects a large area of the Mōtū river catchment but does not apply below the State Highway 35 Houpoto Bridge where gravel extraction, forestry and dairy farming are consented. There are also plans for increasing dairy farming in the upper catchment management by the Gisborne District Council (GDC) who have sought advice on water quality monitoring (Ballantine & Davies-Colley, 2009).

9.3.3.3 Outcome 3: Momo kai, momo kōnihi – Associated species are considered

As mentioned above, an environmental principle of Section 9 of the Fisheries Act 1996 is 'that associated or dependent species should be maintained above a level that ensures their long-term viability.' This outcome should be aligned with this national objective. In addition, Fisheries NZ and associated Ministries have developed a National Plan of Action for the Conservation and Management of Sharks 2013. Sharks that target kahawai are in different protection groups. For example, the white pointer is protected; the hammerhead is not to be targeted; school, blue and mako are commercially fished; and bronze whaler is open access. Collaborative group management between Fisheries NZ, the Department of Conservation (DoC), tangata whenua and additional interested parties, is required for sharks caught in inshore finfish (school shark), deepwater (school shark and other) and highly migratory species (HMS) (blue shark, mako shark, thresher shark, and bronze whaler) fisheries. Kahawai prey species are open access (e.g. krill) or are managed under the QMS (e.g. clupeids). The change in ocean temperatures and productivity may have flow-on effects to krill and small fish abundance and should be modelled to be better understood. Although the Aquaculture planning and process group were not discussed here, the Hapū are interested in knowing if the large aquaculture farm, proposed for the eastern Bay of Plenty, will have an impact on kahawai behaviour and productivity of kahawai predators and prey (C. Koopu, *pers. comm.*, 2018).

9.3.3.4 Outcome 4: Kaua e tūkino i te kahawai – Cultural practices are respected and valued

Changing regulations to recognise the Mōtū kahawai fishing season and associated rāhui would be a step towards achieving this outcome. This outcome is focused on enhancing the fishery, not merely sustaining it. Fisheries bylaws through Individual treaty settlement could provide for these rāhui (restriction or ban) as described in Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery). Fishing seasons have been instated for eels at Te Waihora/ Lake Ellesmere through the Arowhenua Fisheries (Lake Ellesmere Eel Fishery) Decontrolling Order 1997. The fishing year for all stocks extends from 1 October to 30 September except for ANG 13 (Te Waihora/Lake Ellesmere) which has a fishing year from 1 February to 31 January (since 2002). The Mōtū kahawai fishing year could be changed to reflect the kahawai season like the unique Te Waihora/ Lake Ellesmere eel fishing year.

'Ko te ika rā, mo te iti me te rawakore,' can be translated to mean, 'that fish, is for the those of humble means.' When a Hapū youth asked, "Why don't we charge people for a license to fish for kahawai, to pay those that care for the river?" Three of the elders replied, "No. That the fish is for those of humble means. That is their kapata kai [food cupboard]. It is important to

recognise the Mōtū kahawai fishery as a food source: “And our Hapū, its their kapata kai too and what you’re taking from them is their kapata kai.”

As kahawai are considered tapu (sacred) and as taonga gifted from the sea to provide for nourishment for the Hapū, particularly those in need, TWAH/NH do not support commercial fishing of kahawai at the Mōtū. “If you turn it into a commercial thing it makes people less respectful of it as a resource, because its free, you have access to it. And our Hapū, its their kapata kai too and what you’re taking from them is their kapata kai. I find my way of sharing the food resources is teaching the children at school and in that way they can feed themselves, their families too, to the extent of not being greedy, and not being wasteful. I think that’s what we were taught by our families, not to be wasteful of food and to share food. We always shared food wherever we went [Participant 18].” Gaining respect for the kahawai must come from every opportunity possible.

Part of this outcome is to revitalise our recognition of kahawai as a taonga. Commercialisation has led to the kahawai being disrespected, by being sold as bait and pet-food. Non-local fishers with different values such as a preference for other fish species and catching kahawai as bycatch or for recreation only has led to kahawai being caught, and heads and frames or whole fish being dumped or left on the beach to rot. These actions show a lack of respect for the kahawai, for TWAH/NH tikanga and subsequently for the Hapū members.

9.3.3.5 Outcome 5: He kapata kai – Mōtū kahawai is a secure food source

TWAH/NH elders recognised kahawai as a readily accessible, healthy food. And indeed, during the kahawai season, fillets and roe contain high levels of omega-3 polyunsaturated fatty acids (Vlieg & Body, 1988). Participants would like to see an increase in the number of kahawai so that it, “guarantees people get a feed when they go to get some.” Local kahawai fishers also have high catch rates at the Mōtū, averaging 4.17 fish/h during the kahawai season, mostly using handlines, compared with 2.24 fish/h caught by outsiders, who mostly use surfcasting rods (Ritchie et al., 1982).

The 1996 World Food Summit defined food security as “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.” This includes both physical and economic access to food that meets people’s dietary needs and food preferences. When a food is a CKS, like kahawai, it becomes a food preference and therefore restricted access can have greater health and well-being problems for the Hapū than for other people. Food insecurity is when people are unable to access enough healthy food, experience hunger, consume less nutritious foods due to limited options, experience anxiety due to difficulty in accessing nutritious food or rely on food relief. In New Zealand 20% of children

in the lowest of five material poverty groups, lack meals with meat, fish or chicken (or the vegetarian equivalent) every second day (www.childpoverty.co.nz/hardship, *accessed 9 July 2018*).

Any legislation or policy that prevents TWAH/NH from fishing for kahawai at the Mōtū River would be in conflict with the Hapū goal: Kapata kai – Mōtū Kahawai is a secure food source. Customary fishing under a customary fishing authorisation (Chapter 5 Māori participation in NZ fisheries management) does not provide for fishing kaupapa [purposes] listed above, to eat, to preserve for winter, to distribute to others who are unable to fish, or as hospitality for guests. When asking our Hapū chairperson about having rock lobsters for hui, the chairperson's reply was that our customary fish are only for tangi now (O. Barlow Tukaki, *pers. comm.,* 2018). Therefore, in the Te Whānau-a-Apanui rohe moana, customary fishing only focuses on fishing for tangi. Consequently, fishers at the Mōtū river mouth are increasingly tending towards the recreational regulations governing their fishing activities rather than tikanga.

Not having a clear set of customary fishing regulations which address fishing for: fish to eat, to preserve for winter, to distribute to others who are unable to fish, or as hospitality for guests are all fishing for purposes that the term 'recreational' does not encompass. Fishing for recreation is not common purpose for Hapū members, although it is a side benefit of fishing. Although fishing is enjoyable, it is for a purpose. One participant proposed to world 'domestic' to represent this type of catch. Perhaps bylaws can be introduced at the Mōtū River that allow for 'domestic' catch.

The Bay of Plenty District Health Board reviewed Food Security Policy for the Public Health Service and concluded that the best approach for local food security is for local communities and local government to develop a collaborative food policy council, and to develop a food charter, policy and strategies to address local food security. Developing policy around how land-use planning, urban agriculture, emergency food distribution, food retail access, community health, waste management and economic development could improve access to affordable, healthy, safe and nutritious food was recommended as a starting point in lieu of a food security toolkit which is yet to be developed. Supporting local food environment research was also recommended. The Mōtū kahawai fishery would make an excellent case study for developing an eastern Bay of Plenty food security policy and for development of traditional food gathering wānanga.

9.3.3.6 Outcome 6: He Kōpara – Intergenerational knowledge is transferred

The policies to address this outcome may include developing resources to support a Mōtū kahawai fishery focused education curriculum. There are already Hapū teachers who deliver

this type of information at early childhood/kōhanga and primary school/kura levels. This needs to reach the wider Hapū living outside the rohe so that they recognise the tikanga and history as their own.

9.3.4 Relevant people to support delivery of the Mōtū kahawai fishery plan

Potential people to involve in a community of practice would be the Hapū, local authorities, government agencies, and local community, e.g. landowners. For example, the Gisborne District Council (GDC), Environment Bay of Plenty (EBOP), and Ōpōtiki District Council (ODC) local authorities. DOC's East Coast Conservancy manage the Raukūmara National Park of which the Mōtū River flows through. Activities most likely to have an impact on the river mouth are managed by local authorities via the Regional Coastal Policy Statement and Regional Freshwater Policy Statement; and by the Department of Conservation for the Raukūmara National Park via the Bay of Plenty Conservation Management Strategy. Fisheries NZ, the Ministry for the Environment, and the Department of Conservation may be the lead government organisations involved in achieving associated species being considered in the management of the fishery. Landowners would also play an important role in achieving these outcomes. The Ministry of Health and District Health Boards may help to achieve Mōtū kahawai is a secure food resource outcome. Involving the Ministry of Culture and heritage, Te Puni Kōkiri (the Ministry for Māori Development), and the Ministry of Social Development may help to achieve the Cultural practices are valued and respected fishery outcome. Support from the Ministry for Education may help to meet the Intergenerational knowledge transfer outcome.

9.4 Discussion

In this chapter, we identified the key components of the fishery, outlined a Hapū plan to address the key components, explored existing policies to achieve outcomes and overall vision, and identified relevant personnel to create a community of practice. Twenty-two key components of the Mōtū kahawai fishery were identified Table 9-1. Central to the plan is the Mōtū, the kahawai, and the fishery, putting people and place in the fishery picture. The components are holistic, addressing mental, physical, and metaphysical components. Physical components include the river, land, river mouth, predators, prey, and sea. Mental components include kahawai season, condition, indicators, narratives, knowledge, fishing method, post-harvest, for guests, preserving for winter, distributing to others, and to eat. Metaphysical components include safety, giving thanks, interconnectedness, and Indigenous rights.

The vision and therefore plan are holistic, as they are about enhancing mauri –the physical, mental, and metaphysical elements of the fishery. The plan focuses on six outcomes to address

the key components of the Mōtū kahawai fishery that the Hapū have identified. The outcomes are informed by the previous chapters and align with the relevant policies of the current management systems (Table 9-3). Planning documents can identify and enumerate the rights and interests of the Hapū across sectors, fisheries and their associated ecosystems, reducing the capacity required to engage. A community of practice can be developed for the Mōtū kahawai fishery, connecting the Hapū with the relevant local and national authorities, and community members.

Table 9-3 How plan outcomes were informed and the relevant policies they will inform.

Outcome	*Informed by*	*Relevant policies*
Mōtū River current is maintained	Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery)	RMA – Freshwater policy, and/or Water Conservation Act
Mōtū river mouth is protected	Chapter 7 (Ecological relationship between kahawai and the Mōtū) and Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery)	RMA – Coastal policy, MACA policy and/or HPSFM (not yet developed)
Associated species are considered	Chapter 7 (Ecological relationship between kahawai and the Mōtū)	Fisheries and/or Protected Marine Species
Cultural practices are respected and valued	Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery)	Fisheries and/or Te Puni Kōkiri and/or Ministry of Cultural and Heritage
Mōtū kahawai is a secure food source	Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery)	Fisheries and/or Department of Health
Intergenerational knowledge is transferred	Chapter 6 (Hapū cultural values of the Mōtū kahawai fishery) and Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery)	Fisheries and/or Ministry for Education

Māori are wary of ecosystem-based fisheries management because if it removes the RMA and Fisheries Acts, it may also remove any existing Māori rights that are based on those Acts (T. O'Regan, Māori Fisheries Conference, 2018). Developing the plan is a low-risk option because it will remain even if the legislative tools change. For example, the plan may be incorporated into the larger 'One Plan' for Ngā Hapū o Te Whānau-a-Apanui and be recognised through Treaty Settlement. The Hapū too, first need to decide if they wish to engage in current management processes or await the Treaty settlement and develop new legislation. The Hapū are experiencing the challenge of the wider public increasingly travelling to the Mōtū river mouth to fish for kahawai but not recognising the local traditional management practices or

tikanga while they are fishing there. Instead telling the Hapū members who attempt to educate them on the local management system, that they are following the national recreational regulations and are within their rights. However, this type of fishing leads to the current situation which includes wasted fish, illegal fishing and overfishing being observed. Therefore, the benefit of engaging with the national management system is to have tikanga or traditional management better recognised by the wider public who do not respect these practices currently. Thriving customary fisheries can be a national fisheries management goal. A national customary fisheries plan can be created to support Iwi/Hapū plans. We can identify the number of CKS fisheries there are in NZ. Then we can also determine their status, i.e. diminished, enhanced, or no change, and if the customary fisheries require further support. The number of Indigenous fisheries management systems and their status, may be better indicators of success for national management providing for Indigenous rights in fisheries management, sustaining cultural practices and knowledge systems.

The processes applied here i.e. identifying the values, ecology, knowledge, management practices associated with the fishery and developing a plan, can be applied for other cultural keystone species to support Indigenous management. As the Mōtū kahawai fishery is a cultural keystone fishery it makes it a good pivot point with which to view the rest of the socio-ecological system, as the Hapū do. Plans are low risk documents that Hapū and Iwi can develop to inform fisheries and wider ecosystem management. We argue that planning documents can be more interconnected reflecting both the Hapū worldview and the ecosystem approach. Not only must the fishery in terms of numbers of kahawai be sustained, but also the knowledge and practices associated with the Mōtū kahawai fishery, if the culture is to continue with future generations.

Chapter 10 Conclusion

In this chapter we summarise the main findings of the thesis and discuss their implications for fisheries management.

10.1 History and Background of the Mōtū Kahawai Fishery

Background information on the Mōtū kahawai and KAH1 fisheries were collated. The Mōtū kahawai fishery has cultural, historical and local management information associated with it which is lost at the larger KAH1 management scale i.e. the age of the fishery and historical catch estimates. There may be more cultural information associated with kahawai fisheries. This chapter highlights the importance of scale for managing fisheries with dependent cultures, and high social and cultural value, so that these values are not surpassed by larger industrial fisheries interests.

10.2 Taking a transdisciplinary research approach

Investigating total fishery systems, i.e. both the ecological and human components using the most appropriate methods, is complicated. When the fishery is associated with an Indigenous community with their own IEK and management practices, the study becomes even more complicated. The transdisciplinary research approach provides some necessary structure to an otherwise very complex form of research. This helps to guide fisheries researchers through the research process. This is well suited for studying fisheries in ways that are empowering for the communities who are impacted by the research findings, and for equitably drawing on multiple disciplines and knowledge systems. The transdisciplinary research principles can also address three key questions of Te Ara Tika – the Māori ethics framework. By adding a further principle to address the Indigenous rights principle of self-determination, asking who has control over this study and demonstrating how Indigenous control is achieved, the approach can be very suitable for use by Māori. In bringing social and ecological sciences together with mātauranga-a-Hapū (TWAH/NH knowledge and knowledge systems) to inform the holistic management of the Mōtū kahawai fishery, I further advance Māori capability in the transdisciplinary fisheries research space. This is capability that is now accessible to TWAH/NH hapū, and can be further developed.

10.3 Māori engagement for fisheries research

Considerations for guiding Māori engagement for fisheries research were identified, and an engagement process was developed for this project. Key findings were:

- It is important to maintain the relationship from beginning to end;

- The research will benefit from the research team understanding the Māori culture and language;
- from identifying the correct entities to work with,
- from discussing and agreeing on appropriate levels of community involvement, power-sharing, and formality, on compensation for engagement, and culturally appropriate research methods early in the research; and
- Information sharing can start earlier if there is an existing relationship.

This means that engagement should begin prior to the research being funded, so that engagement and Hapū research methods can be factored into research proposals. This gives the Māori community more equality and respect, in terms of their contributions and ways of knowing, and can lead to positive experiences that benefit the community. This framework may be useful as a guide for future fisheries researchers engaging with Māori communities.

10.4 Māori participation in NZ fisheries management

NZ fisheries management was investigated to clarify how the system works and through what avenues Māori can inform the system. The system is complex and includes avenues for Independent fishery forums, and avenues available to all New Zealanders, i.e. General public submissions on Initial Position Papers, attending working group meetings, and submissions. Therefore, Independent fishery forums and plans are the key entry point for Māori to influence fisheries management. There are multiple tools available to Māori for customary fisheries and wider marine ecosystem management. However, the lengthy processes and resourcing required to implement the tools appear to be barriers to use. Well-resourced Iwi with Treaty Settlements prefer to develop tailored fisheries regulations as a means to recognise their rangatiratanga, rather than use existing tools. This sets a precedent for all Iwi including Te Whānau-a-Apanui and raises a flag over the administrative burden they may potentially create. How effective the tools are individually, together, and as part of the wider fisheries management system is unclear, suggesting the need to review customary fisheries management. Creating a streamlined process for considering social, cultural and economic information, including mātauranga, across the marine environment may simplify the system and reduce the administration of fisheries management.

10.5 Hapū cultural values of the Mōtū kahawai fishery

The cultural value of the Mōtū kahawai fishery to Te Whanau-a-Hikarukutai/Ngāti Horomoana (TWAH/NH) was investigated to determine what is at stake for the Hapū if the fishery is

managed poorly. TWAH/NH not only value kahawai highly as a customary food source but also as an essential means for expressing their distinct culture. Kahawai are part of the community's cultural identity and well-being and are their irreplaceable cultural keystone species (CKS) or taonga (special treasured) species. If the fishery is managed poorly, then TWAH/NH have more to lose than just a food source, they could also potentially lose their cultural uniqueness and sense of identity and even experience reduced well-being such as mental health issues such as wairua being diminished. The Hapū have developed an intimate relationship with the fishery over centuries and this has ensured their, and its survival, and has become part of the Hapū identity.

The Hapū will find it difficult to replace this CKS species with another. Identifying species as cultural keystones helps to communicate their importance to the wider world. In modern times, kaitiakitanga, e.g. imposing rāhui on a species, does not come at the loss of food supplies, because food can be readily sourced from elsewhere. However, if the fishery were to be closed to rebuild the stocks, while enhancing kaitiakitanga, there is a risk that the associated knowledge and cultural practice, would be lost through lack of discussion and practice. More fisheries CKS need to be identified, to emphasise the importance of fisheries to culture, and the important role fisheries management has in protecting and enhancing fisheries-dependent cultures like TWAH/NH.

10.6 Ecological relationship between kahawai and the Mōtū

Observations were made to investigate four hypotheses (food source, parasite removal, predator avoidance and reproduction), explaining why adult kahawai migrate to the Mōtū River every summer. The observations support the reproduction hypothesis with kahawai being in reproductive condition over the summer at both the river mouth and at sea. River kahawai lost condition (fat and liver weight) in March and April where sea kahawai did not. These results suggest that there may be structure in the spawning population, with some fish reproducing at sea and others reproducing at river mouths. These results demonstrate the risks associated with large-scale management. Had the spatial and temporal elements been removed from these observations then the subtle differences between the groups may have been lost. River kahawai are migrating to the river at high energetic cost, also at the risk of predation by sharks and yellowtail kingfish. But what are the benefits in undertaking these migrations? They may represent a form of parental investment in spawning so close to optimal juvenile nursery areas. Perhaps river kahawai are migrating to spawn in natal rivers? This study provides new insights into kahawai reproduction, spawning stock structure, kahawai feeding habits and the trophic interactions of kahawai with yellow-tail kingfish, cetaceans and whaler sharks as predators,

and galaxiids and juveniles fish as prey. This new information encourages localised management of this species.

10.7 Indigenous ecological knowledge of the Mōtū kahawai fishery

Hapū Indigenous Ecological Knowledge (IEK) associated with the local environment, and the food source and reproduction hypotheses investigated in Chapter 7 (Ecological relationship between kahawai and the Mōtū), were documented. The IEK supported the reproduction hypothesis to explain why kahawai enter the Mōtū river mouth. Also, that kahawai are feeding in the river mouth in April. The karaka berry mātauranga associated with the fishery is still relevant, and additional hypotheses about the Mōtū kahawai fishery were identified. For example, that strong river current allows kahawai to detect and enter the Mōtū River, making it a key component of the fishery. The findings in Chapter 7 (Ecological relationship between kahawai and the Mōtū) were consistent with existing Hapū IEK findings in Chapter 8 (Indigenous ecological knowledge of the Mōtū kahawai fishery). The Hapū IEK has passed on through memory retaining methods for many generations over the past ~600 years of living in the area and participating in the Mōtū kahawai fishery. IEK, particularly mātauranga, can provide valuable contributions to the wider body of knowledge that is used in fisheries management. This information can be useful in managing localised CKS fisheries as it demonstrates the Mōtū River estuary to be a Habitat of Particular Significance for Management (HPSFM). If the kahawai are unable to detect and swim into the river estuary because of the continual decline in river water quantity, what effect will this have on the fishery? Further investigation into what can be done about this threat is warranted. The IEK gathered here is helpful for understanding the importance of the river ecosystem to the fishery and understanding the changes to the system prior to instrumental measurements being taken.

10.8 Holistic Mōtū kahawai fishery management

In this chapter, we identified 22 physical, mental and metaphysical fishery components. A Hapū plan was developed to address the key components as a result of the research. There are several policies and processes for the Hapū to follow in order to achieve their fishery outcomes. Including this information in planning documents in the current political climate provides a wide-reaching platform for supporting Hapū to enhance their Indigenous fisheries management practices in wider environmental management.

The plan is holistic, as it is about enhancing mauri – the physical, mental, and metaphysical elements of the fishery. Holistic planning documents can identify and enumerate the rights and interests of the Hapū across sectors, fisheries and their associated ecosystems, reducing the capacity required to engage, i.e. being holistic provides the best opportunity to get it right from

the outset. Relevant personnel were identified to create a community of practice for the Mōtū kahawai fishery, connecting the Hapū with the relevant local and national authorities, and community members. The number of Indigenous fisheries management systems and their status, may be better indicators of success for national management providing for Indigenous rights in fisheries management, sustaining cultural practices and knowledge systems. The processes applied here, i.e. identifying the values, ecology, knowledge, management practices associated with the fishery and developing a plan, can be applied for other cultural keystone species to support Indigenous management with flow-on well-being benefits.

10.9 Conclusion

The Mōtū kahawai fishery is ca. 600 years old and is an important feature of the Mōtū area which is highly valued for its natural character. The fishery is part of a much larger national fishery management area, KAH1. At this scale the multiple objectives, knowledge and institutions of the 58 Iwi within the area may not be recognised. Māori engagement and the flow of information through the NZ fisheries management system was described to understand how the Hapū can best inform NZ fisheries management decision-making regarding the Mōtū kahawai fishery.

Plans are the key entry point at present. Therefore, wider Mōtū kahawai fishery information on the cultural values of the fishery, the ecological relationship between kahawai and the Mōtū River, and Indigenous ecological knowledge (IEK) associated with the fishery, was collated to help identify the key components of the fishery. This was developed into a Hapū plan to inform fisheries and wider ecosystem management. The plan is holistic in nature and can be recognised through multiple avenues to support holistic Mōtū kahawai fishery management.

The New Zealand Ecosystem Approach to Fisheries needs to be adaptable, not bound by existing legislation, and must recognise New Zealand's cultural contexts, the partnerships between Māori entities and crown agencies, and supportive sustainable cultural-ecological fisheries systems. This means going beyond the international definitions of EAF that recognise ecological and human dimensions of fisheries, to also reflect the spiritual elements of the fishery. The current NZ fisheries management system requires a review regarding customary fisheries programmes, and how wider ecological, social, cultural, and economic information is recognised in the system. The next chapter provides a personal reflection on the research.

Epilogue – Turukitanga

In this epilogue I provide a personal reflection on the research, a closing statement, and a song in support of my thesis.

Personal reflection on the research project – He hokinga mahara

In this section I share how I felt during the research, keeping mauri-tau (grounded), what it was like working away from home, what I have learnt, and how the work contributed to my Te Reo Māori journey.

My connections to the Mōtū kahawai fishery meant that I experienced many emotions while working on the Mōtū kahawai fishery. The hurt associated with the loss of children is intertwined with the fishery through the pūrākau of He Kōpara, and then through the loss of children at the river in 1900, which is remembered through the fishery in terms of rāhui, and the changing of names. This includes my great grandmother's name, Heeni Te Ao, which she changed to Horowai at the loss of her daughter, Tawhi, who my grandmother is named after. A Hapū steering group member pointed out that from their perspective, it is because I am a member of the Hapū that I can do this research. In Māori worlds, some forms of knowledge are taonga and entrusted to certain people, so it is a privilege and also a heavy responsibility to be the recipient of this wisdom. Along with the knowledge also came a reminder of the mamae (hurt) our whānau have endured.

I felt that it was important to stay grounded while working on the Mōtū kahawai fishery, particularly while away from home. On reading about the mauri of the kahawai and Te Whatukura-a-Tangaroa, I decided not to talk to a few specific people who I thought might be responsible for protecting the whereabouts of this taonga, in case they disclosed to me during an audio-recorded interview. That way I would not have to remove this information somehow from the recordings or decide whether to include this information in the thesis. The views of these two people were included in the information gathering exercises during the Mōtū kahawai fishery management hui, document analysis and participatory observations. I am happy in the knowledge that Te Whatukura-a-Tangaroa is being looked after, and I pray that the knowledge and skills required to keep this taonga safe are passed on to the correct members of our upcoming generation of Te Whānau-a-Apanui leaders. I also came upon a small red stone during my studies, and I kept it with me as the mauri of this thesis that I am bringing to life.

It was difficult to conduct this research between Wellington and Maraenui, a nine-hour commute. The technology and academic support required to complete the thesis were in Wellington. However, the Hapū and the fishery were in Maraenui. Prior to starting, I explored different host institutions to be closer to Maraenui but was convinced to learn from the highly

acclaimed academics that agreed to be my supervisors, to consider the reputation of the university internationally, and the support I would receive from previous work colleagues as mentors. I was able to frequently travel back to Maraenui from Wellington early in the research. After becoming a mum, the journey between Wellington and Maraenui was much more difficult mentally, physically, and financially. I would have liked to have spent much more time at Maraenui during the PhD, and generally.

I learnt a lot during the Mōtū kahawai fishery project. For example, human ethics approval is required for any research involving human participants, their data or tissue. To obtain human ethics approval, a researcher must submit an application to the human ethics committee who then review, approve and monitor the research project to ensure unethical practices are not taking place. These approvals must be obtained prior to beginning any formal research procedures, such as recruitment or data collection. As a result, I proposed a rather ambitious research process to the ethics committee that the Hapū then agreed on. However, the Hapū already had an information gathering process planned and the key points of the research were largely captured there. The volume of information gathered following on from the Hapū process was too big to address in the PhD timeframe, but I felt I had to carry on because of what I had put in the ethics approval. In future, exploring research methods with the Hapū will be priority over ethics approval.

During the sampling back in Wellington I was able to work with other younger marine scientists to pass on some of my skills and coordinate our work efforts. From this experience I learned that you need to be considerate of others needs and balance them with your own. It is easy to commit a large amount of time to your work as a PhD student, but you shouldn't expect others to do the same because their lives have more important things taking place in them is well.

My Nan, who is an ahi kaa (person keeping the home fires burning) and hau kainga (Iwi or Hapū member living at home), helped guide my communication with other members of the Hapū. Her guidance was incredibly helpful, to navigate politics within the community and not become involved to the point that it would negatively influence the research. This is a valuable life lesson.

I possibly raised the Hapū expectations during the research as I continuously expressed my wish to return home to live at the end of the PhD. I was naïve to make such a claim even though it was honest. This wish to return home has not changed, but my circumstances have. I must consider what is best for my family now, not just me.

I also reflected on the Ringatū church while working on the Mōtū kahawai fishery. The huamata or first fruits references in the Ringatū faith may also refer to the kahawai spawning. Like the Ringatū planting sacred seeds in the mara tapū (sacred gardens), the kahawai are planting the sea. On land the new plant came out of the old seed, symbolising rebirth and renewal. The arrival of adult kahawai to the Mōtū River can easliy have been associated with kahawai spawning in the river, to reflect the same concept in the marine environment.

My reo (language) journey is as old as I am, but is predominantly based in educational institutions, strengthened by conversations with relatives, fellow students, and more recently colleagues. Working in science, a field that clearly privileges English, makes me thankful for being an English speaker and writer, however, it does not help develop or maintain my Te Reo Māori abilities. Working on the Mōtū kahawai fishery greatly furthered my ability to speak and comprehend Te Reo Māori. Particularly the language of my home and connected to the fishery. During the first year of my PhD, I completed Te Aupikitanga, a Level 6 diploma in Te Reo Māori at Te Wānanga o Aotearoa in Pōrirua. In the second year of my PhD, during the extended field research I completed part of Te Pīnakitanga o Te Reo Kairangi, a Level 7 diploma at Te Wānanga o Aotearoa in Ōpōtiki. This was personally an important part of the research preparation because a large amount of the key information shared was in Te Reo Māori, particularly the local dialect, and being comfortable conversing in Te Reo helped the research to succeed.

My Te Reo journey continues with supporting my daughter to become a fluent speaker, this has allowed me the greatest learnings. In addition, the timeframe in which to write a thesis is limited, and as I am not going to be examined on my choice of language, I need to finish it more than anything else. Perhaps one day I will be in a position to rewrite my thesis in Te Reo Māori for our growing number of Te Reo Māori readers, because of the metaphorical and poetic depth that is lost in translating the information into English.

I have written this thesis with my daughter, Hinemoana, in mind. I wish that the Mōtū kahawai fishery remains a taonga that she can feel part of, and which reflects her identity in a positive, empowering way. I certainly felt a sense of autonomy throughout my PhD. This became an opportunity for me to reconnect to my people and place and now I can pass that on to all whanaunga (relatives) who are interested.

Song in support of this thesis – Waiata tautoko

As is Māori tradition, a whaikōrero is embellished with an appropriate song. This is also an opportunity for women to have their voice heard during formal marae proceedings. As a singer myself, with music certainly being part of my PhD journey, it is fitting that a waiata closes this thesis. I have to say learning the waiata 'He Kōpara' was the highlight of my PhD experience and demonstrates a modern-day version of passing on knowledge to the next generation to which it belongs. This is why I finish with its words.

He Kōpara, composed by Kylie Poihipi of Maraenui to teach the under 5-year old children of Te Kōhanga o Maraenui about the pūrākau (narrative) of He Kōpara. This waiata describes essential people in the pūrākau (Poumātangatanga, Ōhinemōtū and He Kōpara), the atua (deity) Tangaroa, pou-a-hao-kai, the fishing net used to catch large schools of kahawai, he rangi whero, a red sky acknowledging the reddening of the karaka berries and the bracken fern during the arrival of the kahawai. The song also shares the local names for the seven waves of a wave set. 'Piua' and 'hutia' are local terms used to describe fishing actions of 'casting out the fishing line' and 'pulling in the fishing line' respectively. 'Wharotai' is another name for Maraenui Beach. 'Heke ware kārekareka' describes the drooling associated with smelling a meal of kahawai cooking. I hope you have enjoyed partaking in this feast of chiefs.

He Kōpara

Ko Poumātangatanga, Ōhinemōtū

Ka puta mai ra ko He Kōpara

Ko Poumātangatanga, Ohinemōtū

Ka puta mai ra ko He Kōpara

Ka riro atu ra i a Tangaroa, he pou-a-hao-kai, he rangi whero

Tainui tairoa huaroa

Taringatoronga

Whatiwhatiraututu

Rangarangatemuri

Tuawharau!

Puia puia puia

Hutia hutia!

Heke ware kārekareka

Taku ika e

I haramai te kahawai ki Wharotai

Tainui tairoa huaroa

Taringatoronga

Whatiwhatiraututu

Rangarangatemuri

Tuawharau!

Puia puia puia

Hutia hutia

Heke ware kārekareka

Taku ika e

I haramai te kahawai ki Wharotai

I haramai te kahawai ki Wharotai

Heke ware kārekareka

Taku ika e…hi!

Definitions of Māori words in English

Māori words have been defined here as they appear in the thesis to assist the reader. Māori words may have a wider range of meanings in other contexts.

Kupu	*Definition*
aroha	a broad concept which encompasses the notion of care, respect, love and compassion
Atua	Deity
awa	Rivers
haka	posture dance performance
Hapū	kinship group, clan, Māori sub-tribal group
He Kōpara	son of Poumātangatanga
hīkoi	travelling, walking/talking workshops, conversing with knowledgeable elders while on a journey
hiku	Tail
hokinga mahara	looking back, reflections
huamata	Ringatū faith rites of planting, first of June, closing of the kahawai season
hui	a gathering, assembly or meeting
Iwi	extended kinship group, Māori tribal group, nation, people, nationality
kaimoana	seafood, shellfish
kaitiaki	a guardian, custodian, caregiver, keeper, steward
kaitiakitanga	the reciprocal act of guardianship, building upon the word kaitiaki
kanohi-kitea	seen face, regular face
kanohi-ki-te-kanohi	face-to-face, in person, in flesh
karakia	incantation, ritual chant, prayer, grace
kaumātua	adult, elder, person of status within the family
kaupapa	topic, use
kaupapa Māori	Māori focused approach, Māori topic, Māori customary practice, Māori institution, Māori agenda, Māori principles, Māori ideology (a philosophical doctrine), incorporating the knowledge, skills, attitudes and values of Māori society
kōhanga reo	Māori language preschool, language nest
kōrero	narrative, story, account
kotahitanga	collective action and unity, consensus, respect for individual differences and participatory inclusion for decision-making
makamaka	method of fishing for kahawai at the Mōtū River, to throw repeatedly
mana	authority, prestige, power, rights, authority over land and resources determined through whakapapa
manaaki	to support, take care of, give hospitality to, protect, look out for, show respect, generosity, and care for others
manaakitanga	acts of giving and caring for
Mana Whakahono a Rohe	a mechanism for Iwi to participate in resource management and decision-making processes with local authorities
Māori	Indigenous New Zealand peoples
marae	Māori pā, open area in front of the meeting house
maramataka	a Māori lunar planting and fishing almanac
mātaitai	seafood, shellfish, gazetted customary fishing areas
mātauranga	knowledge, wisdom, understanding, skill
mātauranga Māori	Māori knowledge, the body of knowledge originating from Māori ancestors, including the Māori world view and perspectives, Māori creativity and cultural practices
maunga	mountain/s

Kupu	*Definition*
mauri	an internal energy or essence, sometimes encapsulated in a mauri stone
moana	sea, lake, body of water
Ōhinemōtū	female personification of the Mōtū River
pā kahawai	kahawai fishing lures, trolling hooks
pāua, paua	black-foot abalone (*Haliotis iris*), kahawai fishing lures
pūrākau	a narrative that aids in learning knowledge, rituals, karakia, history and creation
pure	rites to lift the tapu (sacredness) at the Ringatū harvest to ensure a plentiful crop, first of November, opening of the kahawai season
rāhui	a temporary ritual prohibition, closed season, ban, reserve, ban on resource harvesting
rangatiratanga	Sovereignty
reo	Language
Ringatū	'The Upraised Hand' name of the Christian faith of Te Kooti Arikirangi Te Turuki
rohe	territorial area
rohe moana	territorial marine area
rūnanga	Māori council
taiāpure	areas of special significance to Iwi or Hapū, as a food source, or for spiritual or cultural reasons under Part 9 of the Fisheries Act 1996
tangata kaitiaki/tiaki	notified representatives of the tangata whenua entity for their respective rohe moana/ customary food gathering area or mātaitai area
tangata whenua	Indigenous people of a region, local Indigenous people
tangi	rites for the dead, Māori funeral ceremony
taonga	special treasures, anything prized
tapu	sacred, sacredness
Te Reo Māori	The Māori language
Te Tiriti o Waitangi/Te Tiriti	The Treaty of Waitangi
tikanga	customary practices, values and protocols
tinana	Body
tino rangatiratanga	self-determination
tohu	sign, mark, symbol
upoko	Head
waiata	Song
wairua	spirit, soul which extends beyond death
wairuatanga	the spiritual dimension
wānanga	research process, places of knowledge
whare	House
whare wānanga	place of higher learning
whakapapa	the ancestral lineages, genealogical connections, relationships and links to ecosystems as understood by Māori
whānau	immediate or extended family, family group, familiar term to address a number of people
whanaungatanga	relationship, kinship, sense of family connection, a relationship through shared experiences and working together which provides people with a sense of belonging that develops as a result of kinship rights and obligations, which also serve to strengthen each member of the kin group. It also extends to others to whom one develops a close familial, friendship or reciprocal relationship, social cohesion

Definitions of scientific terms and abbreviations

Scientific terms and abbreviations have been defined here as they appear in the thesis to assist the reader.

Term or abbreviation	*Definition*
ACE	Annual Catch Entitlement
AEWG	Aquatic Environment Working Group
AIC	Akaike Information Criterion
ANOVA	Analysis of Variance
AUC	Area Under the Curve
B_o	Virgin Biomass
BOP	Bay of Plenty
CASAL	C++ Algorithmic Stock Assessment Laboratory
CKS	Cultural Keystone Species
CPUE	Catch Per Unit Effort
DF	Degrees of Freedom
DO	Dissolved Oxygen
DoS	Deed of Settlement
EAC	East Australian Current
EAFM	Ecosystem Approach to Fisheries Management
EAs	Early Assessments
EAUC	East Auckland Current
EBFM	Ecosystem Based Fisheries Management
EBM	Ecosystem Based Management
EBOP	Environment Bay of Plenty Regional Council
EEZ	Exclusive Economic Zone
EL-MIST	Ecosystem-Level, Management-Indicator Selection Tool
ETP	Endangered, Threatened or Protected
FAO	Food and Agriculture Organisation
FAP	Final Advice Paper
FL	Fork Length
Food sovereignty	The right to define and access healthy and culturally appropriate food
FMA	Fishery Management Area
FMP	Fisheries Management Plan
FMU	Fisheries Management Unit
FPR	False Positive Rate
GDC	Gisborne District Council
GSI	Gonadosomatic Index
HI	Hepatic Index
HPSFM	Habitat of Particular Significance to Fisheries Management
ICI	Index of Cultural Influence
ICP	Iwi Collective Partnership
IEK	Indigenous Ecological Knowledge
IMPs	Iwi Management Plans
IPP	Initial Position Paper
IPO	Interdecadal Pacific Oscillation
ITQs	Individual Transferable Quotas
KAH1	Kahawai Fishery Management Area 1
LEK	Local Ecological Knowledge
LI	Lipid Index
M	Natural Mortality

Term or abbreviation	*Definition*
MACA	Marine and Coastal Area
MEC	Marine Environment Classification
MGS	Macroscopic Gonad Stage
MPI	Ministry for Primary Industries
NA	Not Available or Applicable
NIWA	National Institute of Water and Atmospheric Research
NPOA	National Plan of Action
NZCPS	NZ Coastal Policy Statement
ODC	Ōpōtiki District Council
PUFA	Polyunsaturated Fatty Acids
QMA	Quota Management Area
QMS	Quota Management System
Quota shares	Right to fish for a proportion of the catch
RMA	Resource Management Act
ROC	Receiver Operating Characteristic
SCF	Stomach Contents Freshness
SEK	Scientific Ecological Knowledge
SFI	Stomach Fullness Index
SFS	Stomach Fullness Scale
SOI	Southern Oscillation Index
SSB	Spawning Stock Biomass
T	Temperature (°C)
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TMP	Threat Management Plan
TOKM	Te Ohu Kaimoana
TPR	True Positive Rate
TROM	Target Resource Oriented Management
UN	United Nations
UNDRIP	United Nations Declaration on Rights of Indigenous Peoples
VEBMA	Value and Ecosystem-Based Management Approach
WW	Wet Weight

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