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RESEARCH

He korowai o Matainaka / The cloak of Matainaka: Traditional ecological knowledge in climate change adaptation – Te Wai Pounamu, New Zealand

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Auheke: Ko ngā mahinga kai o ngā whenua puta noa i whakaingoatia, kia mōhio tōtika ai he aha ēnei taonga, kei hea, ā, nā wai. Ka tuituia ēnei ingoa ki nga tātai mātauranga taiao, hei whakarangatira ia iwi, ia hapū, ia whānau hoki. I ara ake tēnei tuhituhinga mai tētahi mahi rangahau mo ngā wāhi mahi inaka o Kāi Tahu i ngā tau kua pahure. Ko te awa o Waikōuaiti, o roto o te rohe o te Rūnaka o Kāti Huirapa ki Puketeraki, te wāhi i mahia ai tēnei mahi. Na rātou ngā kōrero, me te mōhiotanga e pā ana ki te īnaka; ka tiritiria ki to te mātauranga Pākeha, kia kitea ai mehemea he hua ka puta mai hei tiaki i ngā kōhanga o te inaka mo āke tonu atu.

Abstract: In the New Zealand landscape, the mahika kai sites (resource gathering areas) are marked through place names, which act as central reference points (whai take) for a wider ecosystem catchment area and indicate changes over time. The traditional ecological knowledge, awakened through place names, informs and influences the way Māori realise cultural, social, environmental, and economic aspirations and practices (past and present). This paper will draw from a research project in Te Wai Pounamu (South Island), New Zealand that utilises traditional ecological knowledge (TEK) surrounding the place name, Matainaka, which indicate places where Kāi Tahu (South Island Māori tribal group) gathered whitebait (īnaka, *Galaxias maculatus*): an important fresh water species. A major focus of the research project is the knowledge around socio-cultural tipping points that will impact directly on the future cultural, social and economic sustainability within a specific catchment location, the Waikōuaiti River. The river has spawning and fishing sites for the īnaka mahika kai and comes under the mana whenua (recognised traditional authority) of the Māori tribal group, Kāti Huirapa Rūnaka ki Puketeraki. Traditional ecological knowledge kōrero (speech) explains the importance of Matainaka and its contribution to the surrounding catchment area, and – in contemporary times – works alongside that of scientific knowledge. The project merged TEK and science to find ways to improve future planning and adaptation for habitat restoration and modification, and to lessen impacts on īnaka spawning sites from the expected impacts of climate change.

Keywords: climate change adaptation; co-production of knowledge; freshwater fisheries; Mātauraka Māori

Introduction

This article grew from a research project investigating past, present and future feedback loops (cultural and environmental) detrimental to the survival of the īnaka fishery (whitebait; *Galaxias maculatas*) on the Waikōuaiti River in the Matainaka area of East Otago.[1] Kāti Huirapa Rūnaka ki Puketeraki (takata whenua) identified the sustainability and resilience of the īnaka fishery as a major concern going forward. Any future reductions in the fishery will reduce the community's ability to engage with this species (which may be an important link to mahika kai in general). The reduced engagement will (1) generate knowledge feedback loops that will increase in occurrence over time, (2) may include a proportionate reduction in use and transmission of traditional knowledge, (3) lead to loss of tradition-based management practices. These losses and reductions in engagement and knowledge transmission could lead to a cultural tipping point between the runaka's engagement with the īnaka, and the īnaka's engagement with other factors of the ecosystem in which it lives. These losses may or may not be overcome as more stress is placed upon the environs.

The research project was carried out with funding from the National Science Challenge, BioHeritage: Tipping Points Theme and was led by LC and Dr Rose Clucas (Kāti Huirapa). The social and scientific research focussed on the sustainability of the īnaka habitat and future management practices. The methodology chosen was positioned in the notion that whakapapa (genealogies, layering relationships)

[1] The southern Māori dialect is used throughout the paper: In this dialect the letter 'k' replaces the 'ng' of northern Māori dialects. The 'K' is not a phoneme change, but rather a sound difference to the 'ng' phoneme – meaning that using the 'k' does not change the meaning of the word. This is indicated by underlining the 'k' when it is used in this way.

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is an organisational tool and method for clarifying the intertwining relationships surrounding Matainaka. Mātauraka Māori (MM; Māori knowledge frameworks) underpins and informs the formation, management and renegotiation of all these relationships and is therefore the guiding framework used for conducting the research. The vehicle for expressing MM was the notion that place names are indicators of environmental change over time and as such the traditions, values and changing stories associated to the names Matainaka and Waikōuaiti were used to frame the research questions. The research method combined key knowledge frameworks to provide a management overview and ways forward. Key to this were the relationships built between the wider community and Kāti Huirapa to develop a joint-management approach for future adaptation that ensured ecosystem resilience.

An increase in flood events was identified as one of the main impacts from climate change in Kati Huirapa's takiwā (region; NIWA 2016, confidential report to Te Runanga o Ngai Tahu). The name, Waikōuaiti, refers to the river's past and present prevalence to flooding as it means a sudden increase of water in the river and estuary and the speed at which it empties out (K Russell, Kati Huirapa; T Norton, Kāi Tahu; B Flack, Kati Huirapa, pers. comm.). Flooding also impacts negatively on spawning sites (Fig. 2), so habitat that is more resilient to flood events would benefit future īnaka spawning. Ways to improve the habitat were investigated to ensure that for example, any riparian plantings contained the most appropriate plant species and one that the īnaka found ideal spawning habitat. The MM specific to the river and its environs merged with science to better understand the impacts from flood events.

Mātauraka Māori tends to be environmentally referenced and region-specific in terms of weather, soil types, plant growth, coastal environment, and fauna and flora over a long period of time and is 'unheralded source of adaptive capacity' (McNamara & Westoby 2011; Carter 2018). The IPCC forth report on climate change adaptation recommends that indigenous knowledge (IK) will be a key component for future adaptation strategies and practice. The IPCC term IK is often used interchangeably with TEK which this article uses in preference alongside MM, which is the New Zealand Māori specific knowledge framework. The focus is around the local and intergenerational experiences for indigenous peoples who have "lived" the environment and added to its stories over time. The cooperation between scientific knowledge and IK can be used successfully to understand environmental changes, and in some circumstances research has shown that IK can improve the scientific knowledge (Riseth et al. 2011). Berkes (2012) claims that "local knowledge can supplement the explanatory power of global climate change models, and provide grounded information on the actual impacts." In order for this to happen Davidson-Hunt et al. (2013) note that developing knowledge in response to environmental change requires "new institutional

Figure 1. Spawning in straw bales at Orbell's Crossing spawning site (R. Clucas).

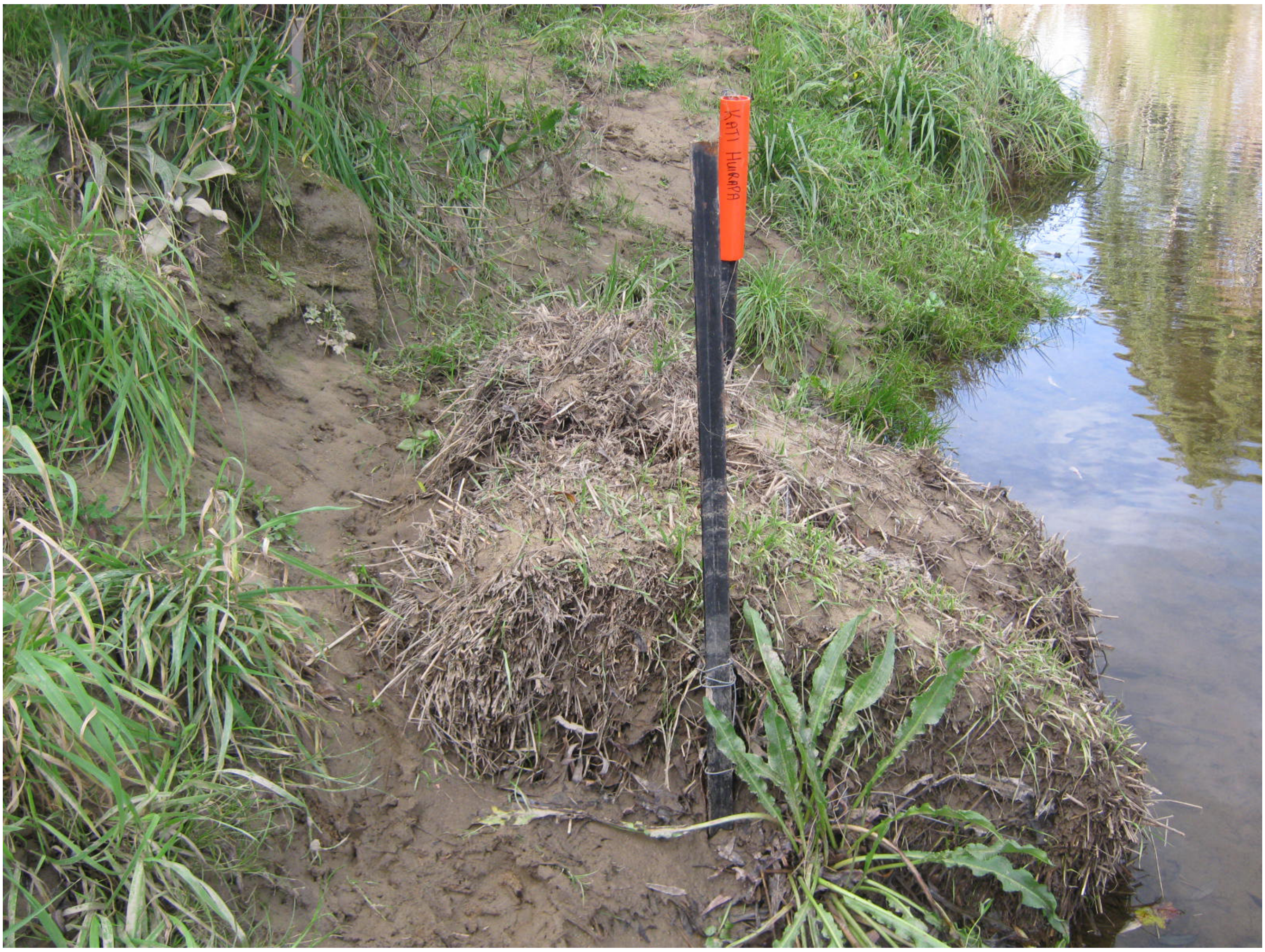

Figure 2. Straw bales in position at Orbell's Crossing spawning site (R Clucas). Note the fines deposited on and around the bales following a fresh tide. Good drainage of the bales was required between spring tides to encourage spawning.

arrangements that provide community control, meaningful collaboration and partnership, and significant benefit sharing." Coining this as coproduction of knowledge will ensure that adaptation will occur through complex interactions among knowledge systems. Over time and generations, the practices are reworked when changing circumstances come into play. Davidson-Hunt et al. (2013) refer to changing circumstances as a process of adaptation that has been forced upon 'aboriginal societies' in the context of colonisation and global natural resource markets. The legislative and other changes that have occurred over time to modify the Matainaka catchment area are examples of this. Berkes (2012) rightly claims merging of knowledge frameworks is long overdue and "too much time and effort [wasted] on science v. traditional knowledge debate; we should reframe it instead as a science and traditional knowledge dialogue and partnership."

A tipping point in the terms of this research is defined as the point where the current management system can no longer be sustained or continued, and a new management strategy must be introduced (Kwadijk et al. 2010). From a cultural perspective, feedback loops (factors that create an uneven relationship) and the potential tipping points refer to changes in the way relationships are being carried out, how new rules for engagement are negotiated, and how these transition the relationship into a new state (Carter 2018). Past feedback loops in the Waikōuaiti/Matainaka catchment include land-use changes, modifying the behaviour of harvesters, legislation and other policy changes that impact on cultural practices, breaches of tikaka (processes for engagement; correct way of doing something) such as poaching, and the loss of MM throughout hapū (sub-tribe) diaspora.

One way that MM is understood and acknowledged on the landscape is through place names which are key to understanding spaces within the environment. Helander-Renvall states "a place begins to exist when people give it a name and a meaning, thus differentiating it from the larger, undifferentiated space" (quoted in Riseth et al 2011, 2013). People talk about a place in ways that are relevant to how they best understand their particular connection and histories, which provides a rich mosaic of understanding land and resource-use changes over time (Carter, 2004). Helander-Renvall claims that "terminology connected to the long-term success…" also plays a key part (quoted in Riseth et al 2011). She further insists that notions of space and places are not fixed in temporal and spatial terms and that symbols such as a place names opens up means "to imagine, make available and explain far-away places, people, and animals" without being physically located in the named place (Risseth et al 2011). This enables a time-space continuum that develops through a lived experience of the world and creates an understanding of the world around us. In the case of Waikōuaiti and Matainaka, the stories surrounding the names trace history, traditions, engagement, and the importance of intergenerational practices and knowledge between Kati Huirapa and the local environment, Kati Huirapa and the īnaka, and the īnaka and the environment. The stories also map challenge and change to the engagement.

The relationships and accompanying stories that Kāti Huirapa have built up over time with the Matainaka catchment, non-Māori community, and science institutions has been invaluable in developing understanding of the contemporary environment. Ware et al. (2018) termed this as kaupapa kōrero, which allows for both Māori and non-Māori stories to be integrated into the layers of relationships within specific whakapapa systems. This ensures that the way stories are presented "aligns with Māori cultural preferences" (Ware et al. 2018), which integrates non-Māori knowledge into a whakapapa system privileging Māori voices, knowledge, relationships, and experiences with the eco-systems. Within the Matainaka catchment it allows the Kāti Huirapa voice to be prioritised over others and retain the cultural integrity needed. The combined narratives (written and oral) can, "make visible the consequences and actions and events over time" (Ware et al. 2018), as they apply to the past, present and future management of the wider resource catchment area.

Project location

The Waikōuaiti River sits within an area of 425 km located 25 km north of Dunedin within the Matainaka catchment area (Williams 2004). The Matainaka lagoon (Hawkesbury Lagoon) catchment is adjacent to the Waikōuaiti River and both were once connected via large extensive wetlands, with far greater continuity than exists since drainage. The large wetland that supported at least three of the migratory galaxiid species (īnaka *G. maculatus*, banded kōkopu *Galaxius fasciatus*, giant kōkopu *Galaxias argenteus*) is now largely drained (Clucas, unpublished report to the BioHeritage National Science Challenge [a]). It is estimated New Zealand has approximately 90% of its wetlands drained with most converted to pasture (Ratana et al. 2019). The greater proportion of these lost areas are lowland wetlands, with the Waikōuaiti/Matainaka catchments typical of that level of loss (S McEwan, Hawkesbury Lagoon Inc., pers. comm.). There were 650 ha of wetland drained on the Merton tidal arm (Waikōuaiti south branch) and 15–20 ha of saltmarsh lost through imposition of floodgates (Clucas, unpublished report [a]). The remaining saltmarsh is a particular feature of the Waikōuaiti estuary and is the largest remaining saltmarsh extent in Otago. Over the entire area there is approximately 200 ha of wetland still surviving (ORC 2010). The name Matainaka remains linked to the old wetlands area, despite its current shape and appearance.

In the past the name indicated the prevalence of the īnaka resource and key wetland spawning sites. The terms mata and īnaka have been used interchangeably by Kāi Tahu, and early informants of Herries Beattie (a 20th century ethnographer) recognised mata as the whitebait (the newly hatched fry) and īnaka (*Galaxias maculatus*) as the adult form (Clucas, unpublished report [a]). The species is diadromous, meaning the fish migrates between sea and fresh water. The stream channel (named Mata-kai-inaka) that drains the old wetland to the sea at the beach would have been readily observed from Ohinemaio (Cornish Head; Matainaka Headland), where "there is likely to have been a settlement acting as a vantage point from where whitebait could been seen swimming into the lagoon on their heke [journey] from the sea" (B Allingham, pers. comm.). The fishery was harvested as the newly hatched mata migrated down the river to the open sea. This was done by digging a channel along the river edge and into the bank. The mata were then "herded" into the channel and scooped out (K Russell, Kati Huirapa, pers. comm.). Around 6 months later, the larger fish (īnaka) were trapped as they returned to the river from the sea (Williams 2004). This method of channel harvesting is now no longer practised. The fishery is now managed and regulated through New Zealand's Department of Conservation which forbids any disturbance of river and stream banks when harvesting mata and īnaka. The preferred method now is netting, with the shape, length and mesh size strictly controlled through the Department of Conservation regulations (see https:/www.doc.govt.nz/nature/native-animals/freshwater-fish/whitebait).

In 2016 a mātaitai (area of customary significance) was established over the lower part of the Waikōuaiti river and the estuary at Karitane under the South Island Customary Fisheries Act, 1999 (SICFA). Under SICFA, mātaitai recognise and provide for traditional fishing by iwi/takata whenua, but usually don't allow commercial fishing. This allowed Kati Huirapa to reassert control over the fishery by managing the access and use of the mātaitai area. Under the SICFA, takata tiaki (Minister of Fisheries appointed rangers) are authorised to manage customary activities, enabling customary fishing and management traditions both inside and out of the reserve areas. Recreational bylaws can be created by the committee formed under the regulations that fully restrict access to commercial fishers. The Waikōuaiti mātaitai is one of the five riverine freshwater mātaitai, all of which are in the South Island. The resulting interest in the mahika kai species has led to reassertion of Kāti Huirapa mana whenua and knowledge associated with managing the river, suggesting that a cultural knowledge tipping point has not yet been reached. The feedback loops leading to loss of cultural practices and knowledge have been slowed (Carter 2018). The resilience of both the various resources within the catchment area and the people, Kati Huirapa, demonstrates that although cultural and environmental feedback loops have accelerated over time, the tipping points for loss have not yet happened. In the case of the īnaka and Kati Huirapa: īnaka have adjusted the location of their spawning sites (from wetland areas to river tributaries); Kati Huirapa have adopted legislative harvesting methods, and used the SICFA to establish a customary fisheries reserve (the mātaitai). As each new challenge has presented itself, Kati Huirapa have adjusted and adapted to the challenge. This provides a history of solutions and practices to be referred to when new challenges occur.

Research discussions with Kati Huirapa Rūnaka ki Puketeraki

Project one of the overall research programme developed an historic and contemporary overview of the region's ecosystems and tohu (signs; indicators of change) that influenced the long-term sustainability of the īnaka fishery. A desk-top analysis of archival manuscript material for the Waikōuaiti River, Matainaka and its wider catchment area, and Kāti Huirapa's associations with the area was conducted. This highlighted the impact from past flooding events and impact from European agricultural and settlement practices that detrimentally affected the Matainaka catchment area. Traditional fishing, and management practices were also researched. Two K̲āti Huirapa kaumatua (elders) provided personal accounts of their respective whānau (family) involvement with the fishery and accompanied the researchers on the spawning site field trips. The research was informed through associations and knowledge of past environmental challenges and changes and how these have been mitigated and adapted to (Carter 2018, unpublished report to the BioHeritage National Science Challenge). One kaumatua reported that they had preferred to fish the Waihemo/Shag (a neighbouring river), and noted that. "Whitebaiting of the river [Waikōuaiti] is now mostly done by Pākehā [non-Māori New Zealanders], some coming as far as inland central Otago to fish it" (H Ferrall-Heath, Kati Huirapa pers. comm.). Another remarked that members of her whānau (family; extended family) still come from Moeraki to fish the Waikōuaiti and trade [sea] fish for a part of the catch. This is a long-standing tradition between her whānau and the Moeraki whānau "though of course Dad has passed on now so there is no wet fish to trade – we have other things though" (K Russell, K̲ati Huirapa, pers. comm.).Other forms of fishing the estuary still occur by whānau, such as the gathering of cockles and paua, but freshwater fishing is less common (H Ferrall-Heath, K̲ati Huirapa, pers. comm.). The resultant loss of traditional knowledge and practices had created a state of disassociation with the īnak̲a mahik̲a kai although the hapū continues to consider īnak̲a is a taonga species associated with the Waikōuaiti River.

Alongside the archival research and kaumatua kōrero, a second project carried out an analysis of the dominant *Galaxias* species (Clucas, unpublished report to the BioHeritage National Science Challenge [b]). It had been previously established that īnak̲a (*Galaxias maculatus*) composed the majority of the Otago fishery (McDowell, 1965). We sought to confirm this and gain an appreciation of the diversity of the catch composition and hence variety of migratory whitebait species within the river system. In addition, it gave us an opportunity to engage with the fishers and establish a relationship. The purpose for confirming the dominant species was to identify if any of them were on the declining or endangered list and if so how this may be interpreted in a future fisheries management plan.

Prior to the 2018 whitebaiting season a number of fishers were approached and asked if they would donate 50 ml of their catch on full and new moon tides for catch analysis. Three fishers gave portions of their catch on five occasions across September and October. Of the 655 fish identified to species īnak̲a (*G. maculatus*) composed the bulk of the catch (98%), 1.2% were banded kōkopu (*G. fasciatus*) and 0.6% kōaro (*Galaxias brevipinnis*) (Clucas, unpublished report [a]). All three of these species are listed as 'declining' by the Department of Conservation who manages the fishery (Dunn et al. 2017).

Key spawning sites were also identified and observed through the 2016 and 2017 spawning seasons. The main site for observation was at Orbell's Crossing which is beyond the current reach of the salt water wedge in the river. The habitat was a key part of the work with the Orbell's Crossing spawning sites.

Īnaka habitat: short-term strategy

Observation around the habitat took place during 2017–2018. The research identified that the bank profile was the principal element providing īnak̲a access to spawning vegetation during high tide events (Clucas, unpublished report [a]). The research findings found that low profiled banks and flat areas in the tidal amplitude range were the most accessible for spawning. In the lower sections of river the tidal amplitude creates undercuts and access to root mass for spawning that can only occur on the highest spring tides. Modifying habitat in the upper reach of the river in order to improve the spawning conditions and habitat availability, and recreating more flat, benched areas along the bank would expand the amount of effective spawning area available above the saltwater wedge (M Hickford, University of Canterbury, NZ, pers. comm.; Hickford & Schiel 2011, 2013). The research team consulted archival material to see what management strategies were applied in the past, in particular around habitat modification. Habitat modification for species survival has been documented by Williams (2004): his work was based upon personal conversations with kaumatua, and from extensive archival research. Two examples of past kaitiakitak̲a practices (guardianship; respect of care) are as follows "Hāpua or lagoons at the mouths of rivers …were periodically flushed of their silt to enhance the fishery… traditionally, every few years, ohu were called to open lagoons, and these involved hapu over a wide area…" (Williams 2004), and "In the past, harvesting practices allowed for consideration of other resources. When raupō was harvested for kōareare, which was prepared from edible rhizome, harvesting took place in the centre of the patch, so that not only was it thinned, but the perimeter, where nesting waterfowl sheltered, was not diminished. The practice focused on wider environmental concerns…" (Williams 2004).

Īnaka habitat: Long-term strategy

The research team invited Professor Mike Hickford (University of Canterbury) to help assess the best ways forward for improving habitat for long-term management. Habitat modification was proposed using long-term bank realignment (Hickford & Schiel 2013), mimicking and thereby increasing the kind of habitat where spawning most commonly occurred. This type of bank realignment has not yet been tried in the context of īnak̲a spawning sites. Hickford & Schiel (2013) identified that using coir matting to stabilise the created flat areas was the best option. Funding constraints prevented the research team from implementing this although Department of Conservation permits had been obtained for bank realignment in the Orbell's Crossing area. The gradient of the bank or grass clumps appear to be an important factor in spawning, because īnak̲a prefer to wriggle into substrate with bank low angle. Where clumps of spawning vegetation such as tall fescue (*Lolium arundinaceum*), jointed rush (*Juncus articulatus*), and creeping bent (*Agrostis stolonifera*) were present the vegetation or roots had to be of enough density to encourage spawning (Hickford & Schiel 2011a; Clucas, unpublished report [a]). Where there was a steep angle to the bank the available width for spawning was narrowed and vertical surfaces did not encourage access. Although consents were obtained and methods finalised, lack of funding through the current project prevented bank realignment from occurring; the proposed works will be incorporated into future management. Low gradient areas allowed for ready access to spawning vegetation and the resulting lack of steep undercut reduced the presence of slumping and mass loss of spawning habitat. Permanently engineered banks in critical areas above the highest extent of the saltwater wedge, where the tidal amplitude is still present, are considered to be part of the long-term planning and strategies for future ideal spawning conditions (Hickford & Schiel 2011a; K Jones, Whitebait Connection NZ, pers. comm.). In the short term artificial sites using straw bales was the method trialled alongside riparian plantings to stabilise the river bank.

Flood damage mitigation

A recent flood event in 2017, during and after spawning, highlighted the damage that can occur to spawning habitat with (1) mass movements of fines and sand which is deposited into spawning vegetation (Fig. 2), (2) mobilisation of the bed, (3) slumping of banks. Flood events are projected to increase with climate change (Clucas, unpublished report [a]); the aim is to counter the impact of flooding with effective management practices. Whitebait fisheries management practices developed in Ōtautahi (Christchurch) in collaboration with other Kāi Tahu kaitiaki (Eos Ecology, 2019), were utilised to establish temporary spawning habitat by situating straw bales in known spawning sites within the mātaitai boundary (Figs 1, 2). The artificial habitat augmented the existing depleted spawning habitat following a cyclonic flood (July 2017), which scoured banks and dumped sand throughout the riparian vegetation. The amount of sand dumped in īnaka spawning habitat appeared to severely diminish the habitat value for egg deposition, development and maturation, as very little root mass, in which the eggs develop, remained exposed. The damage was such that at autumn spawning the riparian root masses were still largely buried in sand deposits. The straw bales were placed early in the spawning season to allow them to develop biofilms and naturalise with the riparian vegetation. The straw bales were largely successful with nearly all showing egg retention (Fig 1.), although two were destroyed from the tidal flows. The research team changed the way that strawbales were positioned and attached to suit the different conditions in the Waikōuaiti river from those in Ōtautahi – trial and error showed the need to adapt the methods to suit the Waikōuaiti river (Clucas, unpublished report [a]). The results from the 2018 spawning season were encouraging enough to conclude that straw bales would be a good short-term measure for maintaining spawning conditions during high tidal flows and flood events.

Habitat enhancements

The research found that future riparian plantings should focus on providing *Juncus* spp. and *Carex* spp. plantings that optimise the provision of a dense root mat (particularly *Juncus articulatus*). Although īnaka will spawn effectively in exotic grasses, native restoration planting enhances riparian habitat with a range of other ecological services such as providing fish cover with overhanging vegetation (Hickford & Schiel 2011a), and providing for a variety of terrestrial insects, which also provide fish food (Clucas, unpublished report [a]). Important amongst these is the improvement of the indigenous aesthetic from a cultural perspective, and the continued relationships between all factors in the fisheries ecosystem (Clucas, unpublished report [a]). In the Waikōuaiti catchment Kati Huirapa are undertaking re-planting initiatives in partnership with the River Care Estuary Group, Hawkesbury Lagoon Restoration Trust, and local land users such as farmers. Volunteer labour is used to carry out planting and on-going maintenance of the planted areas, including students from the University of Otago Indigenous Development course 2013–2015 (Fig. 3). This collaboration maintains mana whenua status through ensuring intergenerational kaitiakitaka of resources, and maintains culturally-based relationships within specific landscape ecosystems.

Discussion

Mātauraka Māori was crucial to the research project on mahika kai sustainability in the era of climate change. One way we could continue to recognise the knowledge, practices and values in a landscape is through unlocking the many stories around the purpose of a place name. The name Matainaka acts as a reference point in a landscape, and a cultural marker that integrates and imbues that landscape with environmental knowledge, practices and values. Mātauraka Māori has proven to be resilient in the face of environmental challenges and change and although it may be hidden within a maze of legislative and other controls, has survived. The Matainaka research project used indigenous knowledge for restoring īnaka spawning sites and sustaining harvest priorities. The findings from project one maintained that through establishing a conceptual framework for understanding the mechanisms that drive social and cultural tipping points, Kāti Huirapa hapū can utilise these to influence ecosystem resilience and social adaptive capacity. Another finding concluded that place names can act as environmental indicators of change over time, and this is evident in how the changing landscape stories introduce the feedback loops that have influenced community practices. This is evidenced through the establishment of the mātaitai – a legislative tool used to good effect to ensure Kāti Huirapa knowledge, values and practices work to maintain control over access and use of the Waikōuaiti īnaka fishery.

As Berkes (2012) states, "Survival is the ultimate criterion for verification of traditional ecological knowledge and adaptation is the key…TEK is, above all, the story of how social/cultural systems adapt to specific ecosystems." Holling (quoted in Berkes, 2012) proposed that "…the concept of ecosystem resilience as the ability of a system to absorb change and still persist." Resilience relies on what Riechel-Dolmatoff (quoted in Berkes 2012) has referred to as "social controls of necessity" and in a MM context these are things like tapu (restrictions), noa (allowing access), mauri (life force), utu (reciprocal exchange), kaihaukai (ability to practice recognised authority of resources), and tuku whenua (land and/or resources given for a purpose). These are values-driven controls and as such remain as a strong part of the way Māori think of themselves to belong to particular landscapes and ecosystems. The social roles also go beyond the practical and spread out to become: "An essential function of interrelatedness of all things means that a person has to fulfil many functions that go far beyond his or her social roles, and that are extra societal extensions of a set of adaptive norms. These norms guide a person's relationship not only with other people but also with animals, plants, and other components of the environment" (Reichel-Dolmatoff quoted in Berkes, 2012).

The research project highlighted not only some ways to overcome habitat loss through future flooding events, but

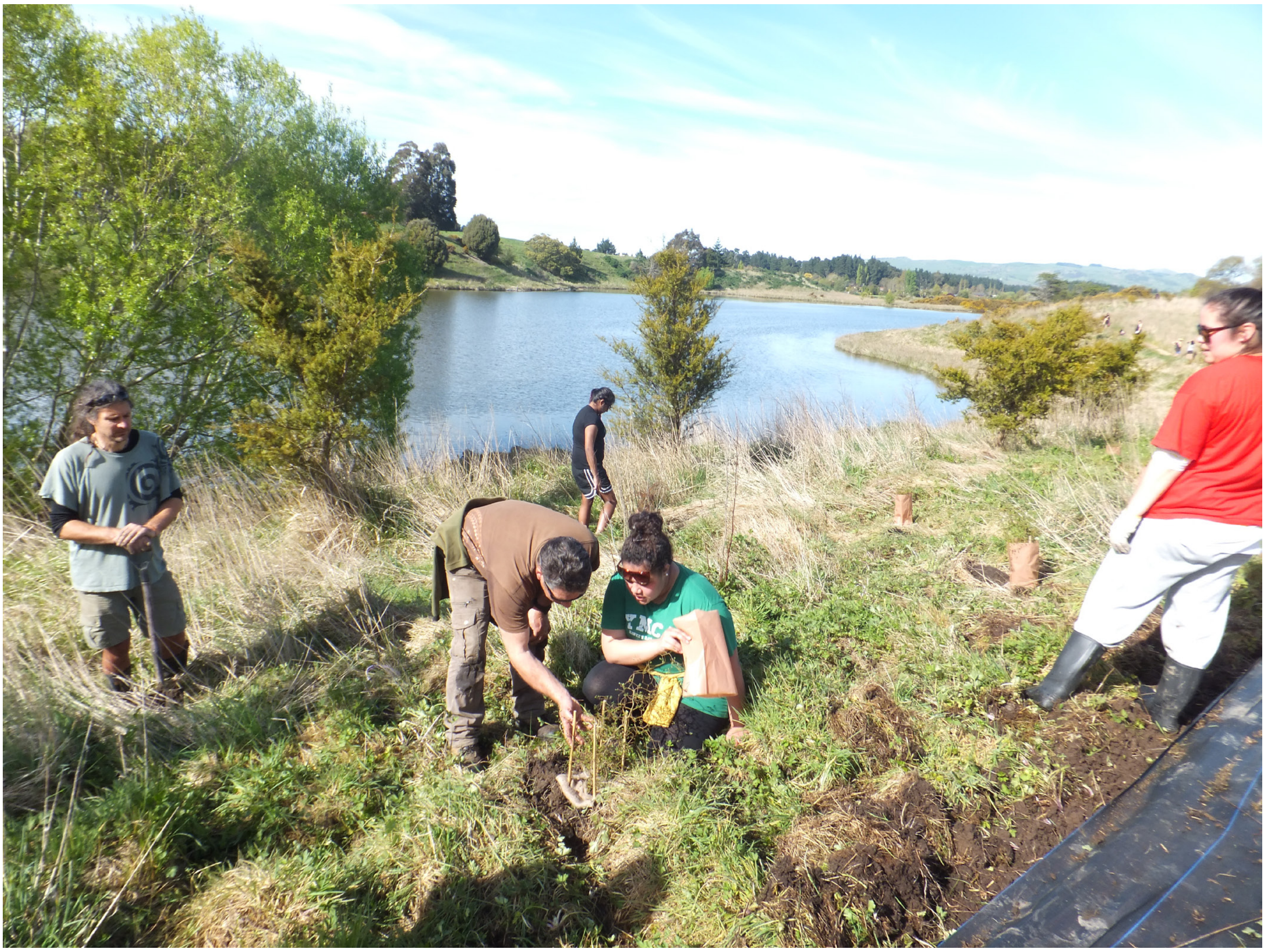

Figure 3. Riparian planting, Hawkesbury/Matainaka lagoon. Pupils from University of Otago Indigenous Development class, 2013.

also the mahika kai's own adaptive capacity and resilient nature throughout past changes and challenges. Differing land-use, extensive habitat modification (wetlands drainage), and introduced plant species were all challenges the īnaka had to overcome. Observing the species resilience in the Waikōuaiti/Matainaka catchment enables us to work within the new relationships it has created for its own survival and recognise that the whole catchment environment has a part to play in future sustainability.

What really counts in an ever changing world is the re-engagement between people and the environment that will reinstate MM processes into contemporary mahika kai management relationships and practices. To some extent the knowledge will be combined with science to ensure the most beneficial adjustments are made for efficient and sustainable future environmental management. This is recommended as the way forward for future environmental management in the climate change era we are now currently experiencing and will change our lived realities (Carter 2008a; Kahui & Cullinane 2019; Reihana et al. 2019).

The Research Project team (Carter and Clucas) found that under changing environmental conditions, with specific mitigation methods identified, there can be solutions found for intergenerational environmental resilience using shared knowledge – MM and scientific. The intended future management framework will promote intergenerational resilience tools such as the creation of resilient spawning sites (bank realignment); holding hapū wānanga to capture and pass on traditional knowledge and practices; working with the local communities in riparian planting to future proof spawning sites; and dealing with mahika kai by investigating alternative sites and/or alternative resources (Carter, 2018).

The engagement with traditional knowledge and practices, accompanied with scientific methods, will enhance and protect the intergenerational development and management practices for the overall health and well-being of īnaka and the Waikōuaiti River. Kāti Huirapa as the mana whenua have a bestowed interest in the catchment area that ensures cultural aspirations, objectives and practices are at the forefront of future management and planning for the īnaka mahika kai within the Kāti Huirapa takiwā. Mō tātou, ā, mō kā uri a muri ake nei – for us and our descendants still to come.

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