Awhipapa: Safeguarding Our Whenua & Awa Through Reducing Sediment in Tamaūpoko Tupuna Rohe – Wānanga Proceedings, Rānana Marae, 22–23 November 2024

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Prepared for Te Rūnanga o Tamaūpoko, Te Atawhai o Te Ao Charitable Trust, & Department of Conservation

Compiled by EOS Ecology – Zoë Dewson

Reviewed by Rawiri Tinirau & Wānanga Presenters

www.eosecology.co.nz
info@eosecology.co.nz
PO Box 4262, Christchurch 8140
P 03 389 0538

SCIENCE + ENGAGEMENT

Cover photo: Confluence of Whangamōmona and Whanganui rivers, by Thomas Nathan.

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Nei ka noho i te roro o tōku whare, ko Te Morehu

Ko tōna pou-kaiāwhā, ko Tamaūpoko

Ko āna uri ka toro, ka noho ki uta, ki tai!

Nau mai, haere atu rā ko tōna reo pōhiri

Ki a kautau te whānau, ngā hapū me ngā kairangahau,

Ki te whiriwhiri kōrero, ki te whakatakoto huarahi,

Kia awhi i a Papatūānuku e takoto ake nei,

I ngā manga iti, i ngā manga nui o Te Awa Tupua

E rere atu rā ki Te Mimi o Rere-ō-maki, ki a Ruaka

Tīhei mauri ora!

1 INTRODUCTION

The Ministry for the Environment's Access to Experts Panel (A2E) was established to help community catchment groups, regional councils, and iwi and hapū navigate Essential Freshwater policy. Te Rūnunga o Tamaūpoko, a hapū collective from the tupuna rohe (mid to lower reaches of the Whanganui River), sought advice from A2E to address a key challenge in the Whanganui catchment: high suspended sediment loads.

This project aims to integrate the latest erosion and sediment reduction science with mātauranga Māori and hapū aspirations, following a community-led approach grounded in Indigenous values. To support this kaupapa, Te Rūnanga o Tamaūpoko, in collaboration with Te Atawhai o Te Ao and the Department of Conservation, hosted a wānanga at Rānana Marae on 22–23 November 2024. The wānanga brought together diverse expertise to discuss the health of Whanganui waterways, with a particular focus on high sediment loads.

Gabrielle Baker captured the hapū and community kōrero[1], while this proceedings document summarises the technical presentations and workshop discussions. The wānanga began with reflections from Te Pou Tupua and Te Morehu Whenua, then proceeded through four key sessions:

» **Session One:** Impacts of sediment on Tamaūpoko hapū and freshwater values.

» **Session Two:** Exploring the scale of the problem within Tamaūpoko tupuna rohe.

» **Session Three:** Projects underway in the Whanganui catchment already.

» **Session Four:** Land use options for reducing suspended sediment in Tamaūpoko tupuna rohe – what is happening elsewhere.

The following sections of this document mirror these sessions, capturing key insights from presentations and discussions to support ongoing kōrero and solutions for sediment reduction in Tamaūpoko tupuna rohe.

1 Baker, G. 2024. Awhipapa – safeguarding our whenua and Awa through reducing sediment in Tamaūpoko tupuna rohe – hapū and community voices – wānanga report. Baker Consulting. 17 p.

2 OPENING KŌRERO

Chaired by Dr Rāwiri Tinirau. Kaikōrero Te Pou Tupua and Te Morehu Whenua shared how the issue of sediment fits into the bigger picture of Te Awa Tupua legislation and Te Heke Ngahuru. What was the river like before it was impacted, and what are their reflections of change?

2.1 Te Pou Tupua

Keria Ponga – Te Pou Tupua

The signing of Ruruku Whakatupua between Whanganui Iwi and the Crown in August 2014 established an unprecedented set of arrangements for a river system in Aotearoa, and indeed, the world. These arrangements are collectively known as Te Pā Auroa. It required disestablishing the Whanganui River Māori Trust Board and establishing Ngā Tāngata Tiaki o Whanganui, the post-settlement governance entity. A key element of Te Pā Auroa is the legal recognition that te Awa o Whanganui is a living and indivisible whole, defined by a set of innate values stemming from the kawa, or law system, of Whanganui iwi. Known as Tupua te Kawa, these values encapsulate the living and indivisible nature of the Awa, while also affirming the inalienable connection of hapu and iwi with the Awa – a holistic connection that hapū and iwi have fought for a century and a half to have recognised in law.

In 2017, Te Pou Tupua was established by Te Awa Tupua (Whanganui River Claims Settlement) Act, which gave the Whanganui River the status of a legal person. The first appointees to be the human face of Te Awa Tupua were inaugurated – Dame Tariana Turia as the Crown appointee and Turama Hawira as the Iwi appointee. In 2021, the second appointments were made for a term of three years – Keria Ponga as the Crown appointee and Turama Hawira as the Iwi appointee. Te Pou Tupua is responsible for taking the requirements and aspirations of hapū to the Crown. The role of Te Pou Tupua is wide ranging, including to uphold the status of Te Awa Tupua and its values, to promote and protect the health and well-being of Te Awa Tupua, to administer the Korotete Fund ($30 million to support initiatives for the health and well-being of Te Awa Tupua), to perform landowner functions for Te Awa Tupua and riverbed land, to report publicly on matters relating to Te Awa Tupua, and to engage with stakeholders to understand, apply and implement Te Awa Tupua status. Te Pou Tupua appointees are supported by a team of advisors, known as Te Karewao, who support Te Pou Tupua in the exercise of its functions.

The station of Te Pou Tupua exists to serve the totality of interests in Te Awa Tupua. A 'pou', or support post, was included within Te Pā Auroa as a trustee arrangement to act as the face and voice for the legal person status of the Awa. Hence, the station of Te Pou Tupua, comprised of two people performing a singular role, expressed with one voice. The role of Te Pou Tupua is to serve the legal status of Te Awa Tupua, enabling hapū, iwi, the community at large, and all other interested parties to collaborate through Te Pā Auroa in the best interests of the health and well-being of the Awa. At the forefront of its responsibilities, Te Pou Tupua actively protects the legal status of Te Awa Tupua from being ignored or undermined. If anyone exercising functions and powers fails in their duty to uphold the new status or Tupua te Kawa in planning and decision-making, Te Pou Tupua may act in the name of Te Awa Tupua.

Te Korotete Fund was established to support initiatives for the health and well-being of Te Awa Tupua and is administered by Te Pou Tupua. Te Korotete Fund is contestable and open to all groups. It complements existing funding sources and could create potential research partnerships.

Te Awa Tupua is the Whanganui River, from the mountain to the sea, including all its tributaries, its physical and metaphysical elements, and is a living and indivisible entity. Tupua te Kawa is the natural law and value system of Te Awa Tupua, which binds the people to the river and the river to the people. Tupua te Kawa is driven by four universal truths, as follows:

» Te Awa Tupua is our source of spiritual and physical sustenance.

» Te Awa Tupua is an indivisible and living whole from the mountains to the sea, incorporating the river and all of its physical and metaphysical elements.

» The iwi and hapū of the river have an inalienable interconnection with, and responsibility to, Te Awa Tupua and its health and well-being.

» Te Awa Tupua is a singular entity made up of many elements and communities, working together for the health and well-being of Te Awa Tupua.

2.2 Te Morehu Whenua

Dr Rāwiri Tinirau, Manaaki Hogg, Pani Marshall, Inglis Tinirau-Williams, Kaedyn Matthews – Te Morehu Whenua

Summarised in Wānanga Report by Gabrielle Baker – Baker Consulting

As Gabrielle Baker's report[2] discussed, Te Morehu Whenua's presentation highlighted the importance of inspiring a tamariki movement and reshaping how the next generation thinks about the land and the Awa as a pathway to addressing challenges in the Whanganui catchment. Te Morehu Whenua is a tamariki and rangatahi-led environmental group established by hapū of Rānana Marae.

The harms caused to the Awa, through the process of colonisation and taking of lands by the Crown, have also interrupted the ability for whānau and hapū to share and use traditional practices connected to the Awa. This was highlighted during a Te Morehu Whenua presentation on the Moutoa Island Restoration Project, where Rāwiri Tinirau talked of pā ngaore built near Moutoa Island to catch ngaore or smelt. The increased fine sediment in the Awa has meant that the methods developed over generations no longer work after a heavy rain.

Te Morehu Whenua's presentation was used as evidence by several wānanga participants of the value in building a love for the Awa and for the whenua with tamariki. The wānanga was held the week following Hikoi mō te Tiriti, which ended at Parliament on 19 November 2024. This reinforced the power of popular movements and fed optimism around the potential of young people working together for a common goal and to develop and share knowledge. As part of sparking a tamariki movement, the community kōrero also emphasised the importance of access to mātauranga Māori and Indigenous data (for example, how many trees are planted in the forest, and what types of trees there are). However, Indigenous data needs to be accessed and shared in line with the principles of Indigenous data sovereignty.

The return to distinctively Māori ways (of knowing, being, and doing) was also behind many of the opportunities outlined in hapū and community kōrero, especially the use of mātauranga, which is transmitted across generations, in a way that supports curiosity and play. Te Morehu Whenua captured the imagination of attendees and holds significant potential to shift the way the next generation thinks about land and the Awa.

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[2] Baker, G. 2024. Awhipapa – safeguarding our whenua and Awa through reducing sediment in Tamaūpoko tupuna rohe – hapū and community voices – wānanga report. Baker Consulting. 17 p.

3 IMPACTS OF SEDIMENT ON TAMAŪPOKO HAPŪ & FRESHWATER VALUES

Chaired by Rosemary Miller. Kaikōrero Professor Russell Death, Hana Rainforth and Peter Fraser explored how suspended sediment impacts values, the impact of suspended and deposited fine sediment on water quality, biodiversity, mauri, human health, and the economy. Other panellists included Kuru Ketu and Vanessa Tipoki.

3.1 How Healthy are the Invertebrate Communities of the Whanganui River

Professor Russell Death – River Research, Pohangina

The ecological health of rivers and streams in New Zealand is increasingly under pressure from the impacts of agriculture, exotic forestry, and urban land use practices. These land use impacts often have a more significant detrimental effect in areas of New Zealand with highly erodible geology, such as that which occurs in much of the Whanganui River catchment.

The main causes of the decline in health of New Zealand rivers are as follows:

» Too many nutrients (mainly nitrogen and phosphorus) that cause massive increases in the growth of benthic slime (periphyton; Figure 3-A) – this in turn alters water chemistry and the food base of stream food webs.

» Too much deposited fine sediment (silt, mud) that smothers the food and habitat of instream life. High levels of suspended sediment in the water column (muddy waters) are not such an issue for most instream life, but of course this can settle out of the water column and deposit on the stream bed. We have known about the land use effects on instream sediment deposition and the consequent impacts on instream life in the Whanganui River catchment for over 30 years.

Figure 3-A Examples of too much periphyton/slime (left) and too much deposited fine sediment (right) in waterways.
Images © Russell Death

One of the most effective methods to assess the health of a waterway is to sample the invertebrate communities living in a stream or river. Since these animals live continuously in the water, exposure to toxic chemicals can result in their death and disappearance, even if those chemicals have long since dispersed. In contrast, detection of a particular chemical in a water sample requires it to be present at the time of collection. The makeup of stream invertebrate communities (animals such as snails, worms, and the juveniles of flies, dragonflies, mayflies, stoneflies, midges and caddisflies) reflects the ecological health of a stream (Figure 3-B) in just the same way that human health is assessed by measuring blood pressure, kidney function, weight, lung capacity, blood sugar, and more. Some of these animals can only live in places with good habitat and/or high-water quality, while others can survive in degraded habitat or poor water quality. Different invertebrate species vary in their sensitivity to environmental changes such as increases in sediment, temperature, or periphyton, and decreases in oxygen or water flow – impacts that can result from certain land use practices.

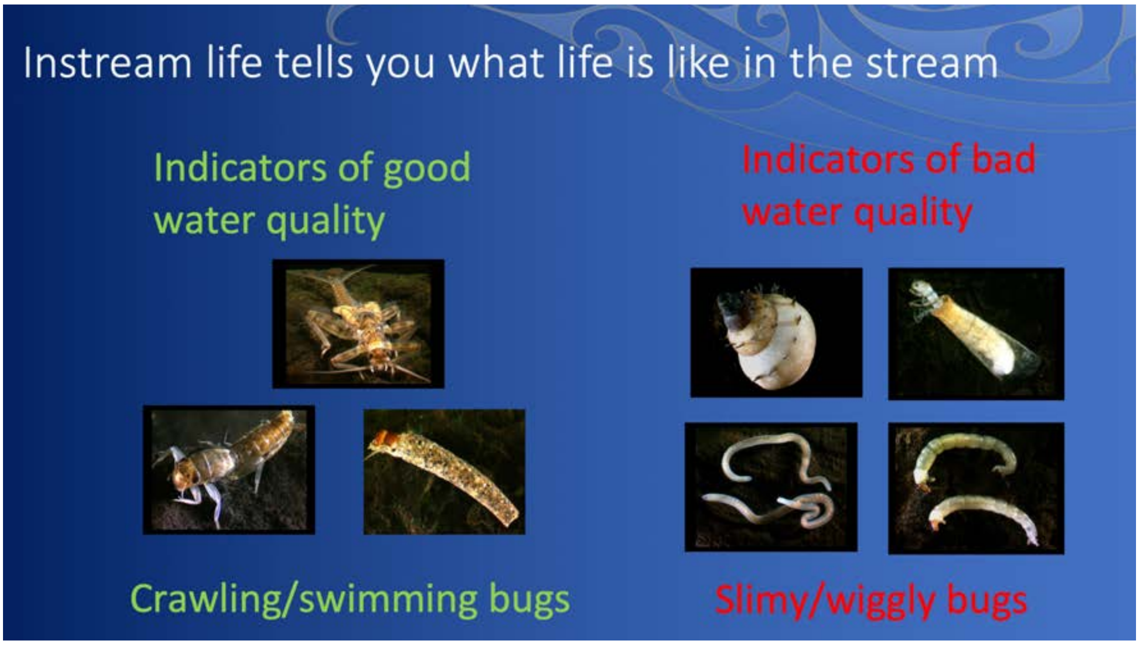

Figure 3-B The composition of invertebrate communities tells you about the ecological health of a waterway – some invertebrates are indicators of good habitat and/or water quality, while others are indicators of bad habitat and/or water quality.
Image © Russell Death

To investigate the ecological health of the Whanganui River, Jane Taylor and Rosemary Miller (Department of Conservation) and local tangata whenua sampled 28 streams in the Whanganui River for stream life between 2022 and 2024. The MCI (Macroinvertebrate Community Index) and QMCI (Quantitative Macroinvertebrate Community Index) convert the type and abundance of invertebrates collected from a stream into a biotic index, with higher values indicating greater ecological health (Figure 3-C). For the recent samples from the Whanganui River, both the MCI and QMCI declined as the percentage of deposited fine sediment at a site increased.

In conclusion, there is a mix of healthy and unhealthy invertebrate communities in the Awa in the catchment. Too much fine deposited sediment on the stream bed (silt) is bad for life in the Awa. Some streams and rivers in the Whanganui River catchment have too much fine deposited sediment for a healthy river ecology. Just because the geology is soft rock in much of the Whanganui River catchment does NOT mean it is 'natural' to have high levels of deposited sediment in the river. Fine sediment comes predominately from inappropriate land use.

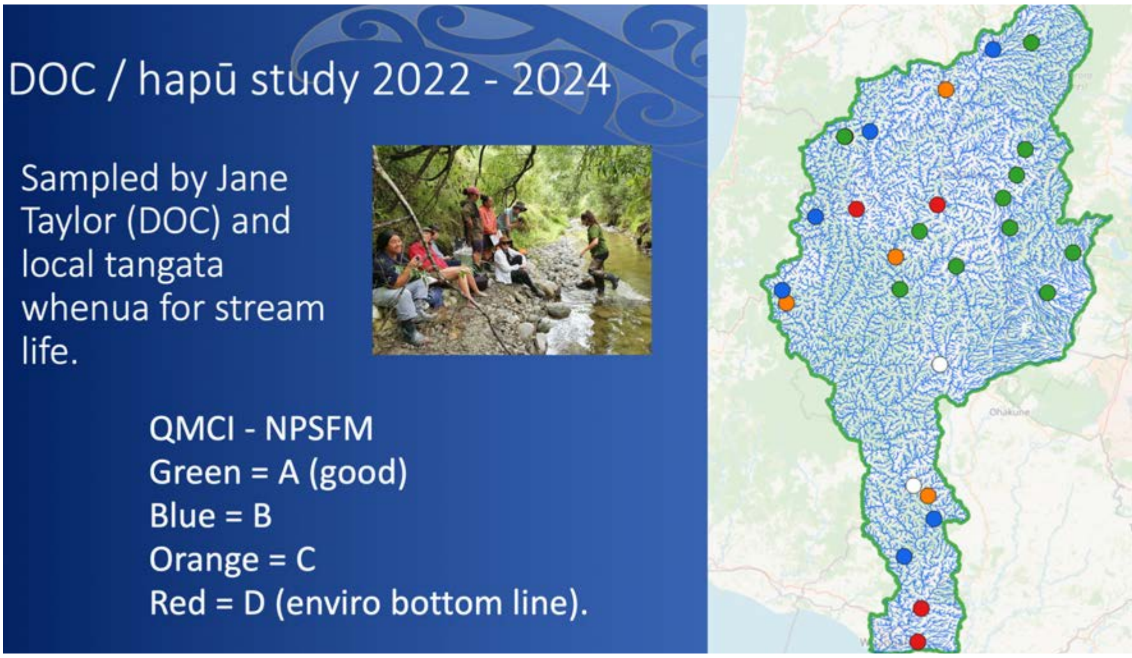

Figure 3-C Ecological health of sites within the Whanganui River catchment based on interpretation of QMCI values against NPS-FM attribute bands. Image © Russell Death

3.2 Sediment Impacts on Maru & Ngā Uri o Te Awa Tupua

Hana Rainforth – Kaupapa Taiao Specialist at Kāhu Environmental

3.2.1 He Kupu Whakawāwahi

Maru is the atua of wai māori – of freshwater. This memorandum covers some of the effects of sediment on Maru, on the creatures that live in the water, and on the iwi and hapū who belong to Te Awa Tupua.

3.2.2 'Taonga' Species

The concept of 'taonga species' is somewhat problematic. The term is often not well-defined. It can be used to highlight some species and exclude others, when in reality all species are connected and important, have a place within whakapapa and the ecosystem, and need to be equally protected.

Dr Karaitiana Taiuru (2022)[3] defines a taonga species as:

"…species that were present in New Zealand prior to the first European contact with Māori in 1642 (Abel Tasman's Dutch East India Company expedition) and the descendants of those species who have a whakapapa *that can be traced back to Ranginui and Papatūānuku, Tangaroa, the Māori spirit world deities."*

[3] Dr K. Taiuru, 2022. *Tikanga Tawhito: Tikanga Hou* – Guidelines for DNA Research, Storage and Seed Banks with Taonga Materials. ISBN 978-0-9582597-8-1. www.taiuru.co.nz/wp-content/uploads/Tikanga-Tawhito-Tikanga-Hou-KTaiuru2022.pdf

Therefore, for us in Whanganui, we would consider any species connected with the Awa to be a taonga. However, for the purposes of this memo, we will focus on some of the larger and more well-known species in the Whanganui Awa, such as tuna, kākahi, atutahi, ngaore, kōaro, kōkopu, kōura and piharau.

3.2.3 Impacts of Sediment

It's Hard to Breathe

Sediment suspended in the water can clog or damage gills of both fish and aquatic insects. Sediment deposited on the stream bed can reduce oxygen within the bed. This happens when there is organic matter in the sediment that microbes break down, and the microbes use the oxygen up as they break down the organic matter.

Suspended sediment can also bring more nutrients into the water, leading to more filamentous algal growth. Too much algae in the water strips out the oxygen, as the algae use up oxygen at night in respiration. This means nightly dips in oxygen that are stressful for fish and insects.

Smothered Habitat

Sediment covers the places fish and insects live and hide – under and between rocks, pebbles and wood.

In a stream that has spaces between the rocks and pebbles, fish can live up to a metre down in the stream bed. The rocks are like apartment buildings for them, creating a myriad of homes and making the streambed into a thriving city. More places to live means more insects and more fish. When the bed is smothered with sediment, it's like a wasteland with nowhere to hide (Figure 3-D). The remaining creatures are vulnerable to being preyed upon.

Figure 3-D Waterway with habitat smothered by fine sediment. Image © Hana Rainforth

Fewer Insects

Stream insects are the kai that our fish and eels feed on. They are essential for aquatic ecosystems. When there is more sediment, there are fewer insects. In addition to the places the insects live being smothered (as above), any rocks that aren't covered in sediment get sandblasted. This happens when sediment is picked up and carried by the flowing water. As that water passes over the rocks at speed, the sediment in the water acts like sandpaper, scouring off algae growing on the rocks. Insects need (good) algae to feed on, so sandblasted rocks mean hungry insects, and fewer insects.

The sediment also blocks light from reaching the stream bottom, and because algae need sunlight to grow, this also means less good algae, and again, fewer insects.

When there aren't many insects in the stream, this has flow on effects for the whole system. There is less food for atutahi, tuna, kōaro, kōkopu, ngaore and the other fish. Also, the insects that are present are not the high quality, high nutritional value insects that are good for our ika, but only the low nutritional insects that are able to survive in degraded conditions.

Fish Can't Find their Food

Some of our fish are visual feeders, meaning they seek out food using their eyes. When there's sediment in the water it makes it very hard for them to see and catch their prey.

Hard on Filter Feeders

Kākahi and larval piharau are filter feeders – they filter out their food from the water column. When there's a lot of sediment floating in the water, filter feeders have to work harder to find the food amongst the sediment. It's like having a plate of baked beans mixed with dirt served to you for dinner, and you need to pick out the baked beans to get some sustenance.

Smothered Eggs, Trapped Larvae

Fine sediment can smother the places fish like to lay their eggs – like under rocks and in the plants at the side of the river – making it hard for them to find anywhere good to spawn. After the eggs are laid, sediment can also smother the eggs themselves. This can kill the larvae within the eggs or trap the larvae when they try to hatch.

3.2.4 Impacts on Specific Species

Atutahi (*Galaxias maculatus*)[4]

Atutahi whitebait (juveniles) will not swim into water that is muddy. This means that as they swim upstream, they will bypass muddy tributaries, and those tributaries do not get restocked with atutahi.

Atutahi rely heavily on sight to feed. This means they find it difficult to feed in turbid water. Juveniles feed less in very muddy water, and in the long term, juveniles have stunted growth even in moderately muddy water.

Atutahi lay their eggs on plants in very shallow water, on a spring tide (Figure 3-E). The aerial root mats of the plants help keep the eggs moist when the tide recedes. Sediment deposited on streamside root mats reduces the humidity at the base of plants, leaving the eggs to dry out and die. Furthermore, sediment deposited during floods smothers the eggs entirely.

Deposited sediment also means there are fewer of the stream insects that atutahi commonly eat living on stream bed (for example chironomids), and therefore fewer of these drifting in the water for them to eat.

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[4] M. Hickford, M. Melchior and M. Mayall-Nahi, 2023. Impacts of Sediment on Īnanga. https://niwa.co.nz/sites/default/files/Sediment%20factsheet_īnanga_0.pdf

Figure 3-E Atutahi lay their eggs on plants in very shallow water, on a spring tide. The aerial root mats of the plants help keep the eggs moist when the tide recedes. Image © Shane Orchard, iNaturalist

Longfin Tuna (*Anguilla dieffenbachii*)[5]

Deposited sediment reduces the number of small fish and the amphipod *Paracalliope fluviatilis*, which is a favourite kai for longfin tuna. With less kai, it's harder for the streams to support as many tuna.

Longfin tuna are more abundant in streams with rocky bottoms or wood to hide under. This means that when there is too much sediment covering the rocks and wood, there are fewer longfin tuna around.

Banded Kōkopu (*Galaxias fasciatus*)[6]

Banded kōkopu are much less common in muddy streams than other streams. They will avoid streams when the turbidity is more than 25 NTU (Figure 3-F).

Banded kōkopu juveniles also avoid turbid water, meaning they won't migrate into muddy streams as they come upriver as whitebait. This means these muddy streams have a lower chance of being restocked with banded kōkopu, and the amount of habitat available for banded kōkopu gets reduced. The juveniles also feed less when the water is muddy, which will affect their health in the long-term.

Banded kōkopu need boulders and logs for cover to hide under. When the boulders and logs are smothered with deposited sediment, banded kōkopu have nowhere to shelter and get eaten or washed out. They are poor swimmers, and the adults can't climb, so if they are washed out of an area, they can't get back upstream to return there.

5 M. Hickford, M. Melchior and M. Mayall-Nahi, 2023. Impacts of Sediment on Tuna Longfin Eel. https://niwa.co.nz/sites/default/files/Sediment%20factsheet_tuna%20longfin%20eel_0.pdf

6 M. Hickford, M. Melchior and M. Mayall-Nahi, 2023. Impacts of Sediment on Banded Kōkopu. https://niwa.co.nz/sites/default/files/Sediment%20factsheet_banded%20kōkopu.pdf

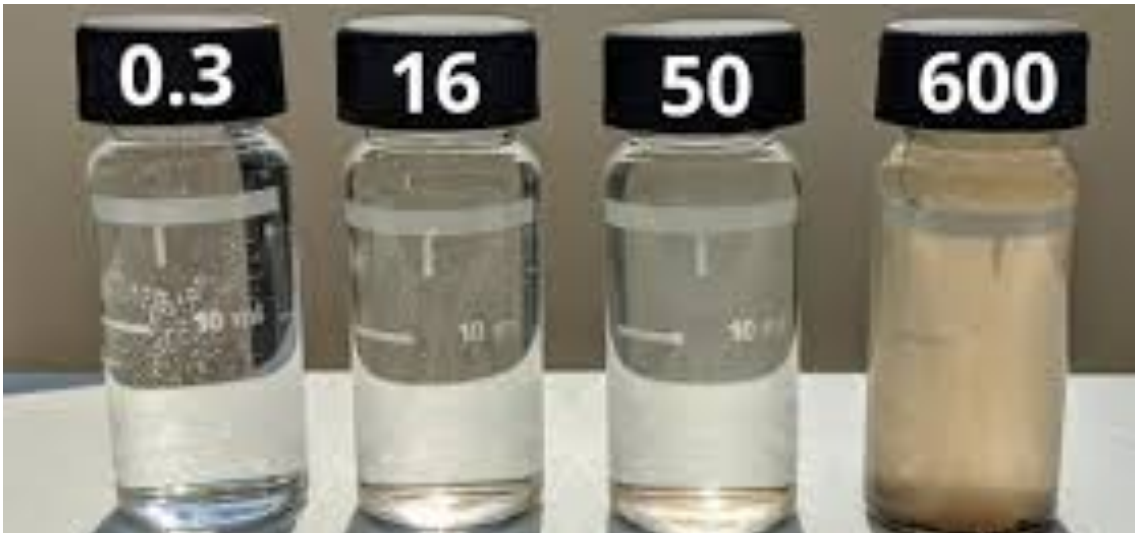

Figure 3-F To give you an idea of what 25 NTU looks like, these vials show water with an NTU of 16 next to one of 50; 25 is between these two. Image from https://freeup.world/turbidity

Shortjaw Kōkopu (*Galaxias postvectis*)[7]

Shortjaw kōkopu need cobbles and boulders to live amongst, so find it hard when these are smothered by deposited sediment. They like to eat cased caddisflies, which are usually absent when deposited sediment or filamentous algae is high. So, the sediment affects their ability to live there, and their kai.

Sensitivity of Some of our Fish

The sensitivity levels of some of our native fish to sediment are shown in Figure 3-G. Of these, banded kōkopu is the most sensitive, with giant kōkopu and shortfin tuna being the least sensitive.

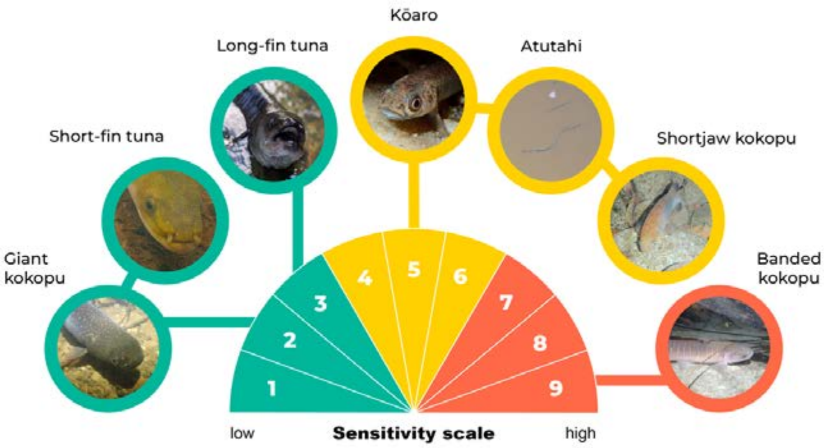

Figure 3-G Sensitivities of some native fish to sediment. Data sourced from NIWA Factsheets. https://niwa.co.nz/coasts/impacts-sediment-freshwater-and-estuarine-and-freshwater-fish-species

[7] M. Hickford, M. Melchior and M. Mayall-Nahi, 2023. Impacts of Sediment on Shortjaw kōkopu. https://niwa.co.nz/sites/default/files/Sediment%20factsheet_shortjaw%20kōkopu_0.pdf

3.2.5 Impacts on People

Physical Difficulties

Mud is not just hard on the fish and insects. It's hard on people too. Mud makes it harder to:

- get to the water for karakia and ruruku, especially for our elders
- access the wai for swimming and paddling – how safe the water is for swimming?
- set hīnaki
- build pā – for example you can't build a pā ngaore from mud; you need cobbles for this
- see karohi (juvenile atutahi) when whitebaiting
- see tuna when doing rama tuna.

These things affect the way we interact with the water, the *places* we interact with the water, and our ability as hapū of the river to undertake our traditional practices. Some examples of these impacts are below:

- Setting hīnaki when your sink up to your knees in mud or slide down a muddy bank to get to the water, is much more difficult than when you can walk out onto a firm riverbed.
- When choosing a place to do karakia in Whanganui, we often go to the Pūtiki Boat ramp, because it's less muddy and people can easily access the water. However, if we had full access to sandy or pebbly areas close to the marae, we may choose a different spot.
- When dip netting for karohi, you need to be able to see the karohi swimming in the water. When the water is turbid, it's much harder to do this, and you might miss more fish.
- Pā ngaore can only be built at places on the river where the bed is still stony. The mud limits our options to undertake this traditional fishing practice.
- Swimming in muddy water isn't as safe. You can't see any hazards such as logs in the water. Getting your waka into the water is also much more difficult.

Impacts on Manaakitanga

The effects on fish, kōura and kākahi identified above means there is less kai around in general for us to catch and harvest. This impacts us in many ways. It impinges on our ability to manaaki our manuhiri, for example when we can't provide abundant traditional kai for them and instead must rely on shop-bought mussels for the hākari table. It makes it difficult to pass on knowledge and practices around fishing, harvesting and processing kai to the next generation. When there is not much to catch, it's hard to teach someone how to catch it. This hinders our ability to maintain our traditions and keep our reo. When you can't go fishing because there aren't enough fish or it's too muddy to get there, how do you pass on the words and language connected with that work? All of this affects our mana, our tikanga, and our identity.

Bugs & Dirt

Another way that sediment impacts on people is by making the water less safe for us to be in. When animals defecate on the land, their faeces have bacteria in it. Those bacteria attach to sediment. When it rains, the sediment, along with the bacteria, all gets washed into the water. This leads to an increase in the number of bacteria in the water and increases the risk of getting sick when you swim in that water.

Overall, too much fine sediment means…

…it's harder to get to the awa

…we can't do our karakia as easily.

…we can't swim there safely

…we can't find the fish, kākahi, and kōura that we used to.

…we can't manaaki our manuhiri in the way that we should be able to.

…our reo is put in danger

…our practices are left at risk

…it undermines our Whanganuitanga.

3.3 What are the Economic Impacts of Sediment

Peter Fraser – Agricultural Economist

This presentation explored the economic impacts of sediment, highlighting the limitations of conventional economic frameworks in capturing environmental values – particularly those aligned with te ao Māori (the Māori worldview). Western economic models typically view people as separate from the environment, treating land as a resource that only gains value through development. Economic analyses rely on concepts such as benefits, costs, and contingent valuation, but these approaches fail to reflect the true impact of sedimentation. As a result, building a traditional business case for reducing sediment in the Whanganui catchment is difficult.

One challenge in valuing sediment reduction is the absence of a direct market price. Contingent valuation – a method where people are asked how much they would be willing to pay for an environmental benefit – would be necessary to assign a monetary value to reducing sedimentation. By contrast, costs associated with farming are more easily quantified, as there are observable market prices for products like wool and meat. This imbalance makes it easier to justify economic activities that contribute to sedimentation than to argue for its reduction.

Land use changes occur when there is financial incentive – if money can be made, people will make the change without needing to be told. When land use remains unchanged, it signals that no more profitable alternative exists. This logic suggests that attempts to justify sediment reduction through a traditional business case will likely fail, as economic calculations would prioritise industries like sheep farming over ecological restoration. Instead, it was suggested that those advocating for sediment reduction should rely on their own knowledge and cultural values rather than trying to fit their case into a Pākehā economic system. A more effective approach would be to quantify current sediment levels, determine the reduction needed for ecological improvement, and calculate the costs of changing current land use. Rather than monetising the benefits, the focus should be on listing tangible ecological and cultural gains – mana and environmental health have inherent value that does not require economic validation. Meanwhile, monetising only the cost side – such as the potential impact on regional GDP if sheep farming were reduced – would reveal that the economic loss would be minimal.

4 EXPLORING THE SCALE OF THE PROBLEM WITHIN TAMAŪPOKO TUPUNA ROHE

Chaired by Jane Taylor. Kaikōrero Nicolaas Portegys, Maree Patterson, and Jake Robinson discussed erosion processes, the geology of the catchment, and the susceptibility to climate change. They also identified which catchment produces the most sediment and how much sediment leaves the whole catchment. Other panelists included Rangiwhakateka Ron Hough and Joey Marshall.

4.1 SedNetNZ Model Results for the Whanganui Catchment

Memorandum prepared by Harley Betts – Manaaki Whenua – Landcare Research

Presentation by Jane Taylor – Department of Conservation

4.1.1 Introduction

Manaaki Whenua – Landcare Research (MWLR) have summarised suspended sediment yield and load results for the Whanganui catchment from SedNetNZ modelling undertaken by MWLR for the Horizons region[8] [9] and prepared a memorandum for the Department of Conservation[10]. The memorandum provides a summary of the modelling and specifically addresses the following questions:

- What are the main erosion processes occurring in the Whanganui catchment?
- What are the biggest erosion process contributors to fine sediment entering the Whanganui River?
- What is the Whanganui catchment's annual suspended sediment load under contemporary climate conditions and Policy Scenario 1?
- What is the effect of future climate change projections on the Whanganui catchment's erosion and suspended sediment loads for mid- (2040) and late (2090) century for Policy Scenario 1?
- What are the load reductions required to achieve better water clarity (i.e., meet National Policy Statement – Freshwater Management (NPS-FM 2020) attribute bands and the national bottom line (NBL) for suspended fine sediment (visual clarity) for Policy Scenario 1), with and without the effects of climate change?

4.1.2 Catchment Overview

The Whanganui catchment covers around 7,200 km^2 of mostly steep hill country in the western North Island. Most of the catchment consists of steep hill country underlain by soft, highly erodible, Tertiary-aged sandstones and mudstones. Volcanic cover beds dominate the central-eastern part of the catchment which includes the southwestern

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[8] Vale, S.S., Smith, H.G., Neverman, A. & Herzig, A. 2022. Application of SedNetNZ with SLUI erosion mitigation and climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC5033, prepared for Horizons Regional Council.

[9] Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

[10] Betts, H. 2024. Memorandum: Summary of SedNetNZ model results for the Whanganui catchment. Manaaki Whenua – Landcare Research, Palmerston North. Prepared for Department of Conservation. 24 p.

part of the of the central North Island volcanic plateau. Nearer the Whanganui coast, marine terraces, floodplains and coastal sand dunes are prevalent.

Over half of the catchment is under Indigenous Forest cover, particularly in the west (Matemateaonga Range) and northeast (Hauhungaroa Range). Around a third of the catchment is used for sheep and beef farming, most of which is in the Ōhura and Ōngarue catchments in the northern part of the catchment, with a smaller area of farming on marine terraces and coastal sand country at the far southern part of the catchment near Whanganui City.

The maps and data presented here have been extracted for the Whanganui freshwater management unit (FMU) from the updated Horizons Regional Council (HRC) SedNetNZ modelling[11]. The Whanganui FMU comprises the Whanganui catchment as well as several very small coastal catchments draining to the sea near the Whanganui River mouth. It is referred to here as the 'Whanganui catchment'.

4.1.3 SedNetNZ Modelling

The SedNetNZ sediment budget model represents the diversity of erosion processes occurring in the Manawatū-Whanganui region and more widely across New Zealand. This includes shallow landslide, earthflow, gully, surface, and streambank erosion[12,13]. Model outputs for these erosion processes are combined with losses due to floodplain deposition and lake sediment trapping to estimate mean annual suspended sediment loads at the sub-catchment level defined by the REC2 digital stream network model[14].

Horizons Regional Council (Horizons) originally contracted MWLR to model erosion and suspended sediment loads across the region (including the Whanganui catchment) for a range of erosion mitigation and climate change scenarios to support implementation of the NPS-FM 2020[15]. Erosion mitigation focused on works completed under Horizons' Sustainable Land Use Initiative (SLUI) and Whanganui Catchment Strategy (WCS).

SLUI is New Zealand's largest hill country erosion programme. The initiative began in 2006 and is informed by the 'Highly Erodible Land' (HEL) map[16] which identified that the Manawatū-Whanganui region has the largest area of HEL on private land in New Zealand. To date, SLUI has completed whole farm plans (WFPs) for over 700 farms in the Horizons region, covering more than 500,000 ha of land, and completed more than 35,200 ha of works, predominantly in the form of afforestation, bush retirement, riparian retirement, space-planted trees, and gully tree planting. The previously separate WCS, established before the SLUI, has been integrated into the programme. This includes 39 WCS plans covering approximately 22,000 ha as of 30 June 2021[17].

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11 Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

12 Dymond, J., Herzig, A., Basher, L., Betts, H.D., Marden, M., Phillips, C.J., Ausseil, A-GE, Palmer, D.J., Clark, M. & Roygard, J. 2016. Development of a New Zealand SedNet model for assessment of catchment-wide soil-conservation works. Geomorphology 257: 85–93.

13 Smith, H.G., Spiekermann, R., Dymond, J., Basher, L. 2019. Predicting spatial patterns in riverbank erosion for catchment sediment budgets. New Zealand Journal of Marine and Freshwater Research 53(3): 338–362.

14 NIWA, 2024. REC2 (River Environment Classification, v2.0). Available from https://niwa.co.nz/freshwater/river-environment-classification-2

15 Vale, S.S., Smith, H.G., Neverman, A. & Herzig, A. 2022. Application of SedNetNZ with SLUI erosion mitigation and climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC5033, prepared for Horizons Regional Council.

16 Dymond, J. & Shepherd, J. 2006. Highly erodible land in the Manawatu-Wanganui region. Landcare Research Contract Report No. 0607/027, prepared for Horizons Regional Council.

17 Horizons Regional Council 2019. Hill country erosion and sediment management in the Manawatu Whanganui region. HRC Report No. 19–94.

The scope of work undertaken by MWLR for HRC involved:

» modelling region-wide suspended sediment loads under current land cover and SLUI/WCS work to date

» assessing load reductions required to achieve NPS-FM (2020) attribute bands and the national bottom line (NBL) for suspended fine sediment (visual clarity)

» comparing reductions in modelled suspended sediment loads under future SLUI implementation scenarios (i.e., Policy Scenario 1 (PS1) and Policy Scenario 2 (PS2)[18]) to the current baseline and determining whether they meet the required load reductions for each NPS-FM (2020) attribute band and the NBL

» modelling suspended sediment loads under future climate change for the SLUI implementation scenarios and assessing the load reductions required to achieve each NPS-FM (2020) attribute band and the NBL.

Policy Scenario 1 (PS1) is considered as part of the current scope and is summarised below[19]. The future projection for PS1 represents future implementation of SLUI and non-SLUI works, including the maturity level of erosion control works. The future projection comprised the following:

» SLUI works continue for SLUI/WCS at the current rate of SLUI/WCS farm plan implementation used in Vale *et al.,* 2022[20] (i.e., new farms are mapped at the rate of 10,000 ha per year, and works implementation occurs at a rate of 1.14% once the farm is mapped). This only occurs for top, high, and low priority farms and 'not' SLUI priority farms, which have sediment loads generated from mass movement processes. This requires minor reselection of mapping dates due to the removal of 'not' priority farms from SLUI mapping.

» Non-SLUI works were modelled to reflect full implementation of stock exclusion regulations by 1 July 2025. This includes a further 80 km of fencing per year from 2025 to 2030 for land not included in the National Environmental Standards for Freshwater (NES-FW) to reflect ongoing fencing and planting rates from the HRC Freshwater Team.

4.1.4 Whanganui SedNetNZ Modelling

What are the main erosion processes occurring in the Whanganui catchment?

Mass movement, mostly shallow landsliding on the soft-rock hill country, is the main erosion process in the Whanganui catchment. Shallow landslides are generally triggered by intense and/or prolonged rainfall events and landslide erosion is therefore critically important under future climate change scenarios in which intense rainfall events are expected to increase in frequency and severity.

What are the biggest contributors to sediment loads in the Whanganui River?

Shallow landsliding is by far the dominant erosion process contributing to suspended sediment in the Whanganui River, accounting for around 76 percent of the load as modelled for the 2021 baseline. Surface erosion accounts for around 14 percent, while the other erosion processes modelled (gully, earthflow and bank erosion) contribute four percent, three percent and three percent respectively.

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18 Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

19 Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

20 Vale, S.S., Smith, H.G., Neverman, A. & Herzig, A. 2022. Application of SedNetNZ with SLUI erosion mitigation and climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC5033, prepared for Horizons Regional Council.

What is the Whanganui catchment's contemporary annual suspended sediment load under Policy Scenario 1?

The contemporary (2021) suspended sediment yield (tonnes per km^2 per year) for the Whanganui catchment, and the contemporary net suspended sediment load (million tonnes/year) are shown in Figure 10-A and Figure 10-B in the appendices. The total mean annual suspended sediment load from all erosion processes (referred to as the 'total erosion load') for the 2021 baseline is estimated to be 2.79 million tonnes/year. Allowing for deposition and long-term storage of sediment on floodplains and in lakes, the net mean annual suspended sediment load is estimated to be 2.65 million tonnes/year.

Under Policy Scenario 1, the total erosion load for the Whanganui catchment is projected to decline from the 2021 baseline of 2.79 million tonnes/year to 2.57 million tonnes/year by 2040, 2.33 million tonnes/year by 2060, 2.03 million tonnes/year by 2080 and 1.72 million tonnes/year by 2100[21]. Net suspended sediment loads are expected to decrease from 2.65 million tonnes/year in 2021 to 2.44 million tonnes/year by 2040, 2.21 million tonnes/year by 2060, 1.92 million tonnes/year by 2080 and 1.63 million tonnes/year by 2100[22]. These results do not include the effects of future climate change.

What is the effect of future climate change projections on the catchment's erosion and suspended sediment loads?

Total erosion loads under climate change are reported as the minimum, median and maximum based on the six regional climate models (RCMs) for four representative concentration pathways (RCPs) at mid- (2040) and late (2090) century. Figure 10-C in the appendices shows the predicted sediment yield for mid-century (2040) and late century (2090), covering the range between the minimum RCP2.6 climate change scenario and the maximum RCP8.5 climate change scenario, for Policy Scenario 1. The predicted total erosion load for mid-century (2040) and late century (2090) under Policy Scenario 1, including climate change scenarios, is shown in Figure 10-D in the appendices, which uses data from Vale & Smith (2023)[23].

What are the load reductions required to achieve better water clarity, i.e., to meet NPS-FM 2020 attribute bands and the national bottom line (NBL) for suspended fine sediment (visual clarity) for Policy Scenario 1, with and without the effects of climate change?

The load reductions needed to meet the NPS-FM 2020 attribute bands and the National Bottom Line (NBL) without the effects of future climate change are shown in Figure 10-E (Band A), Figure 10-F (Band B), and Figure 10-G (NBL) in the appendices.

Accounting for the range of climate change scenarios modelled (from the minimum RCP2.6 scenario to the maximum RCP8.5 scenario), the reductions in suspended sediment load required to meet the NPS-FM attribute bands and the National Bottom Line (NBL) are shown in Figure 10-H (Band A), Figure 10-I (Band B), and Figure 10-J (NBL) in the appendices.

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21 Table 6 in Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

22 Table 8 in Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

23 Data from tables 11 and 12 in Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

4.1.5 Model Evaluation & Limitations

Model performance and model limitations are evaluated by Vale *et al.* (2022)[24] and Vale & Smith (2023)[25]. In summary, the SedNetNZ model is designed to predict mean annual erosion, and suspended sediment loads over multi-decadal timescales. Shorter-term variations relating to clusters of storm events or individual large storm events may temporarily mask the longer-term spatial and temporal patterns in erosion and suspended sediment loads. The modelling of erosion processes is also limited by the availability of input data for the model components, as well as assumptions made with respect to climate change scenarios, the implementation of erosion mitigations, the estimation of reductions required to meet visual clarity attribute bands, and reductions in sediment load due to SLUI. These limitations should be considered when interpreting the model outputs for the Whanganui catchment.

4.1.6 Conclusions & Recommendations

» The estimated total contemporary (2021 baseline) suspended sediment load from all erosion processes for the Whanganui catchment is estimated to be 2.79 million tonnes/year. Allowing for deposition within the catchment, the total net suspended sediment load is estimated to be 2.65 million tonnes/year.

» Under Policy Scenario 1 without the effects of climate change, the total erosion load for the Whanganui catchment is projected to decline from the 2021 baseline of 2.79 million tonnes/year to 2.57 million tonnes/year by 2040, 2.33 million tonnes/year by 2060, 2.03 million tonnes/year by 2080 and 1.72 million tonnes/year by 2100. Net suspended sediment loads are expected to decrease from 2.65 million tonnes/year in 2021 to 2.44 million tonnes/year by 2040, 2.21 million tonnes/year by 2060, 1.92 million tonnes/year by 2080 and 1.63 million tonnes/year by 2100.

» Total erosion for scenario PS1 under projected climate change for the different RCPs ranges from 2.46 to 3.60 million tonnes/year for mid-century, and from 1.53 to 3.05 million tonnes/year for late century.

» Shallow landsliding on steep hill country accounts for around 76 percent of the total erosion load, with surface erosion making up around 14 percent. Gully erosion, earthflow erosion and bank erosion are relatively minor contributors (four percent, three percent, and three percent respectively).

» Shallow landsliding is usually triggered by intense and/or prolonged rainfall events, which are anticipated to increase in frequency and severity over time with climate change. It is therefore recommended that efforts to improve water clarity in the Whanganui catchment preferentially target this erosion process. Mitigations may include afforestation, spaced tree/pole planting, and the reversion to scrub (retirement) of steep, highly erodible land currently under pasture.

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[24] Vale, S.S., Smith, H.G., Neverman, A. & Herzig, A. 2022. Application of SedNetNZ with SLUI erosion mitigation and climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC5033, prepared for Horizons Regional Council.

[25] Vale, S.S. & Smith, H.G. 2023. Application of SedNetNZ using updated erosion mitigations with climate change scenarios in the Horizons region to support NPS-FM 2020 implementation. Manaaki Whenua Landcare Research, Palmerston North. MWLR Report No. LC4295, prepared for Horizons Regional Council.

4.2 Regional Perspective – Suspended Fine Sediment Science & Policy Interface

Maree Patterson – Principal Scientist, Horizons Regional Council

Nicolaas Portegys – Policy Team Leader, Horizons Regional Council

4.2.1 Introduction

This presentation discusses the role that Horizons Regional Council (Horizons) plays in implementing the National Policy Statement for Freshwater Management (NPS-FM) within this region, from both a policy and science perspective. Horizons have the responsibility of putting the NPS-FM into a framework that can be used in this region to improve water quality and other outcomes for our awa, estuaries, and coastal environment.

4.2.2 Policy

The Horizons One Plan has been the key planning framework for the region since 2014. The One Plan contains the tools that are available to manage sediment in the region. Water quality degradation, including sediment, as well as unsustainable hill country land use and associated erosion are identified in the One Plan as two of the big four issues that need to be tackled to look after the environment in this region.

The One Plan addresses sediment issues using rules for activities such as earthworks and point source discharges, as well as for cultivation and tracking. There are also other non-regulatory methods that are used to implement initiatives such as the Sustainable Land Use Initiative (SLUI) and Whanganui Catchment Strategy (WCS). These initiatives deal with some of the biggest sources of sediment in our catchments. The One Plan also sets water quality targets for visual clarity and deposited fine sediment, so that we know what we are aiming towards.

The current NPS-FM has two main sediment related attributes that Horizons need to set targets for and manage – these are visual clarity and deposited fine sediment. To implement this, Horizons is required to set resource use limits (rules) to manage suspended fine sediment and to develop action plans (non-regulatory plans) for the management of deposited fine sediment. They may also use non-regulatory methods for suspended fine sediments or rules for deposited fine sediments under the current framework.

4.2.3 Science

At Horizons, science is used to inform policy. Everyone here is very familiar with the sediment problem in the Whanganui catchment and Horizons have been monitoring visual clarity for many years. Visual clarity is a measure of how far you can see through the water column with the naked eye. It is easy to measure and is a great monitoring tool to use with community groups, whether that be using a black disk to measure the distance that you can see within the channel or collecting water to measure using a clarity tube.

The sediment that gets into the river takes a long time to get out, being deposited, resuspended, mobilised and over time moving down to the estuary and the sea. Even once the sediment is out of our Awa, it is still affecting the processes that go on in our Awa, such as recruitment of fish.

The monitoring that Horizons does within the catchment confirms what the community already knows about the visual clarity problem. When we score visual clarity against the interpretation bands in the NPS-FM, we see that the river is in a poor state, falling within the D band and below the national bottom line for this attribute. This means that Horizons is required by the current NPS-FM to do something to bring visual clarity above the national bottom line.

The Horizons monitoring site at Pipiriki is within the worst 25% of sites and shows a declining trend since measurements began, which means that things are getting worse, so it is not a good story. Horizons is responsible for improving degrading trends as part of the current NPS-FM, even if a site is not below the national bottom line.

Modelling that has been completed by Manaaki Whenua is being used by Horizons to understand the scale of sediment reduction required for river reaches or segments (i.e., not the entire river length) within subzones of the Whanganui catchment (Figure 4-A) and to talk to communities about what might be needed to achieve these targets. The map in Figure 4-A provides a visual representation of the number of reaches that require more than 20% reduction in sediment load within that area, with darker colours representing a larger number of reaches that require greater than 20% sediment reduction, although other reaches may also require sediment reduction (of less than 20%). Horizons also tested the influence of an acceleration of implementation of the SLUI programme, to see the effects on the number of reaches that need a greater than 20% reduction in sediment. Key messages out of this work included an understanding that with climate change, sites that are currently meeting the National Bottom Line for clarity might no longer meet this in the future and that this will influence our ability to improve. Modelling showed that doubling the rate of SLUI implementation would not provide twice as good an outcome but also showed that significantly speeding up the implementation of SLUI would achieve an outcome faster and make us less vulnerable to climate change effects compared with other scenarios. We know that SLUI and WCS farm plans take on average 88 years to be fully implemented from time they are written, but we are still much better off implementing erosion control works than not.

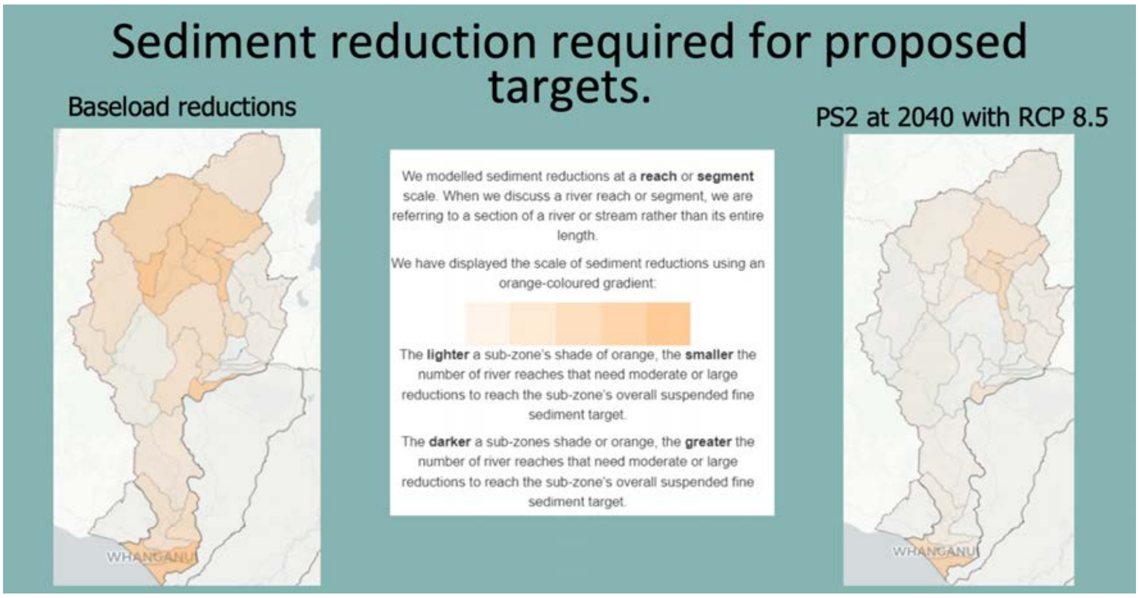

Figure 4-A Sediment reduction required for proposed targets. Image © Maree Patterson & Nicolaas Portegys

4.3 Resilient Catchments

Jake Robinson – Ministry for Primary Industries

The Whanganui catchment has undergone significant changes over time, and these have impacted on the catchment's resilience, or ability to recover from disturbances. This lack of resilience is a key factor for the current health of the Awa. While much of this resilience has been lost due to land use changes and economic pressures, not all is gone. Historically, the catchment supported thriving ecosystems, and the community was able to harvest food from the river. However, deforestation and land use practices have disrupted natural systems and resulted in the sediment issues that we have been discussing today. It is important to understand that the sediment itself is not the core issue, but rather it is a symptom of the way that land is managed within the catchment. Addressing these challenges requires a holistic approach that considers the entire catchment, since rivers can heal themselves if given the right conditions.

Key factors influencing resilience include forest and soil health, wetland extent, and pest management. Forests play a crucial role in stabilizing landscapes and enabling rivers to recover from erosion, yet only 40% of native forest cover remains within the Whanganui catchment, with many catchments having even less. Wetlands, once covering up to 42,000 hectares, now make up just 6.5% of the catchment, despite their essential role in sediment capture, water regulation, and habitat provision. Most of the fine sediment enters the Awa during large flood events, where it lingers long-term, highlighting the need for strategies that enhance resilience to these occurrences. Healthy soils, with deeper root structures and better water retention, are fundamental to slowing water movement and mitigating erosion. Improving catchment resilience can also help prepare for emerging threats, such as the intensifying effects of climate change and the potential for invasive pests like gold clam, to arrive in the catchment. Long-term solutions should prioritise improved resilience rather than quick fixes, ensuring a more sustainable and resilient future for the Whanganui catchment.

5 PROJECTS UNDERWAY IN THE WHANGANUI CATCHMENT

Chaired by Te Aroha McDonnell. Kaikōrero Gordon Cribb, Malcolm Todd, Tania Bramley, Tash de Rose, and Philip Tezlaff share what is practically being done within the catchment.

5.1 Mouri Tūroa

Gordon Cribb – Mouri Tūroa Project Lead

Mouri Tūroa is an initiative designed to improve the health and well-being of the Whanganui River and to create nature-based employment opportunities for descendants of Whanganui iwi. This initiative is funded by the government's Jobs for Nature fund and is a four-year programme of works which aims to mitigate soil erosion, improve water quality, and enhance biodiversity within the Whanganui River catchment. The project consists of phases from initial engagement and relationship building, to developing capacity, and the implementation and continuation of fencing, planting, and pest control. The outcomes of the project over its four-year timeframe are:

- waterway protection through riparian fencing, planting and maintenance, including,
  - 290 km fencing
  - 450,000 riparian trees planted
  - 180,000 non-riparian trees planted
  - 100 ha pest/weed control
- freshwater fish biodiversity habitat restoration
- animal and plant pest control to protect riparian planting
- eco-sourced native tree supply and seed raising
- job creation, community engagement, education, and capacity building (particularly in environmental management).

5.2 Sustainable Land Use Initiative (SLUI)

Malcolm Todd – Team Leader Hill Country Erosion, Horizons Regional Council

The Manawatū-Whanganui region suffered extensive hill country erosion during the February 2004 storm event. In response, representatives from the community and stakeholder organisations joined together and formed the Sustainable Land Use Initiative (SLUI). The purpose of SLUI was to build resilience to storm events to avoid the devastating effects of massive-scale hill erosion in the future (Figure 5-A, Figure 5-B, Figure 5-C). The initiative implements whole farm plans to manage highly erodible land in the region, using a range of interventions to prevent erosion and keep hill country soils out of waterways. This assists in preventing the silting up of rivers downstream, helping to reduce flooding, and improving water quality.

Within the Whanganui catchment, SLUI is doing a range of things to combat erosion and sediment, such as contributing to the fencing and planting waterways within the catchment.

Figure 5-A Severe slip erosion in a steep to very steep hillside undercut by a river. Image © Malcolm Todd

Figure 5-B Slip damage on hill country in the Whanganui catchment. Image © Malcolm Todd

Figure 5-C Slip damage within a replanted forestry block on hill country in the Whanganui catchment. Image © Malcolm Todd

5.3 Whanganui Region Catchment Collective (WRCC)

Tarsh de Rose – Lower Catchment Co-ordinator, Whanganui Region Catchment Collective (WRCC)

Tania Bramley – Regional Co-ordinator Manawatū/Whanganui, NZ Landcare Trust Ngā Matapopore Whenua

Catchment groups are led by farmers, landowners, iwi, and other members of rural communities, working together to sustainably achieve common goals, improve practices, and share information. The Whanganui Region Catchment Collective (WRCC) works alongside catchment groups and has the vision ***to enhance rural communities, land, and water.*** WRCC try to be as holistic as possible in their work and provide learning opportunities to the catchment groups while striving to improve the health of the land and waterways. They support strong resilient farm businesses, connected rural communities, hapū and schools, and provide a collective voice for telling the story of the catchment and engagement with all stakeholders.

The current groups that are part of the WRCC include: Matiere, Upper Ōngarue, Taumarunui West, Tuhua, Retaruke, Whakapapa, Upper Manganui o Te Ao, Whanganui West, Ōkoia, Tauraroa (Figure 5-D).

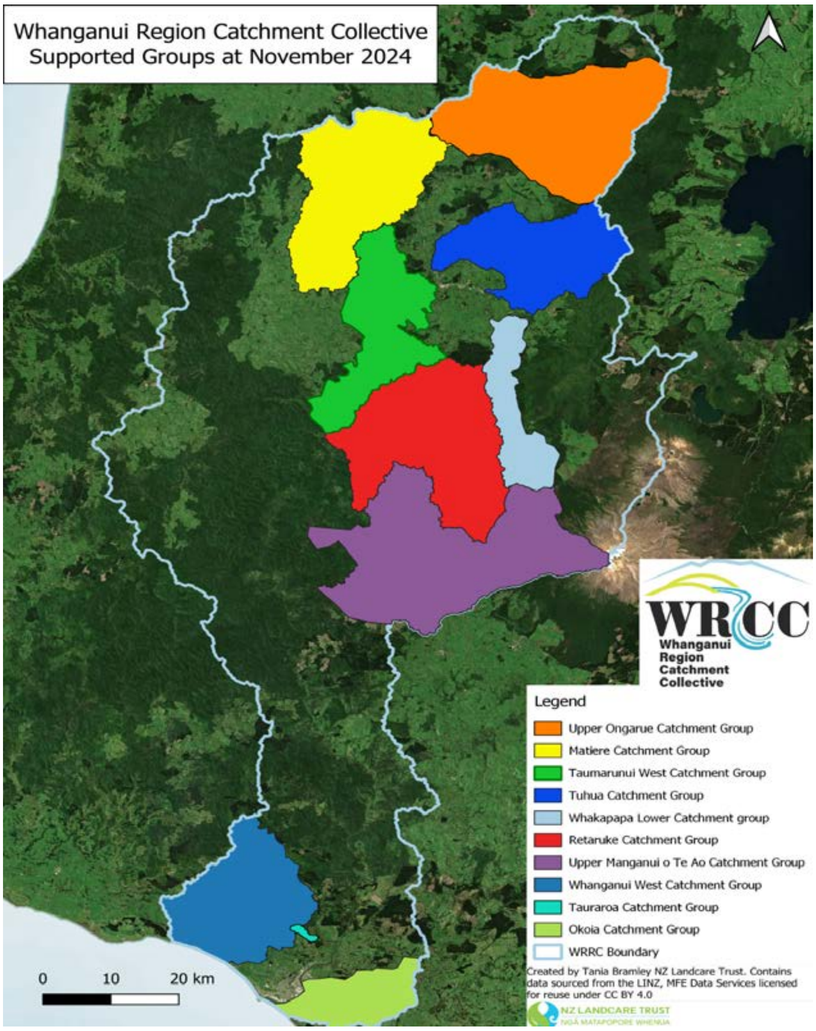

Figure 5-D Catchment groups supported by the Whanganui Region Catchment Collective as of November 2024. Note that titles on this map do not adhere to standard written conventions of te reo Māori, including the use of macrons or double vowels to indicate vowel length. Image © Tarsh de Rose

There are several reasons to start a catchment group and become involved in the work of WRCC. WRCC can provide access to co-ordination and expert advisors. They also undertake monthly water quality testing and the analysis of results for 81 sampling sites throughout the region. They provide access to biodiversity monitoring resources (eDNA, MCI, SHMAK) and work alongside the Department of Conservation, Horizons Regional Council, and iwi to ensure that monitoring efforts are not being duplicated. WRCC can also help to improve knowledge of your catchment and its key issues. They have a role in bringing people together to showcase work so that people can learn from and alongside other farmers and catchment groups (Figure 5-E). Other benefits include support to understand and get ahead of environmental regulation, including providing help finding information and funding that is needed to get things done. Catchment groups can contribute to community resilience and help people feel like they are not battling these big issues alone.

Figure 5-E Proposed showcase project. Image from presentation by Tarsh de Rose. Note that titles on this map do not adhere to standard written conventions of te reo Māori, including the use of macrons or double vowels to indicate vowel length.

The WRCC focuses not only on water-related projects but also on pest management and education on effective planting practices. They hold stream health days with landowners and tamariki, wetland workshops, and have several showcase projects underway. The purpose of these showcase projects is to highlight practical things that have been done throughout the region, so that others may learn from them. An example is a 'leaky weirs' project in the Retaruke catchment, where they have been sampling water upstream and downstream to compare water quality, with noticeable improvements in *E. coli*, phosphates, and nitrates as the water works its way through the weirs. Another showcase project at Waimeha has landowners working alongside Horizons land management officers to remove crack willows while keeping root balls intact and trialling the planting of cabbage trees to minimise erosion.

Within the Ōhura catchment, there is a trial underway that will compare native planting, pole planting, natural reversion, and the spaced planting of native trees to assess which method is the best way to manage erosion (Figure 5-E).

5.4 Plantation Forestry in the Whanganui Catchment

Philip Tezlaff – Senior Forestry Adviser, Te Uru Rakau New Zealand Forest Service

The National Environmental Standards for Commercial Forestry (NES-CF) were previously known as the National Environmental Standards for Plantation Forestry (NES-PF) and came into effect in 2018. The NES-CF provides a nationally consistent set of standards to manage the environmental effects of eight core plantation forestry activities, including afforestation, pruning and thinning to waste, earthworks, river crossings, forestry quarrying, harvesting, mechanical land preparation, and replanting. The NES-CF is implemented by regional councils, who are responsible for enforcing and managing the regulations within their area.

For harvesting to be a permitted activity, foresters must submit a harvest plan to their local council if requested. The plan should identify environmental risks, including erosion susceptibility. Erosion susceptibility may be assessed with the Erosion Susceptibility Classification (ESC) tool which is available online (Erosion Susceptibility Classification tool). There are four classifications in the ESC – low, moderate, high, and very high (Figure 5-F). These classifications are based on topography, dominant erosion process, and rock type. The harvest plan must also list the mitigations to be used to respond to those risks and achieve compliance with permitted activity conditions (Figure 5-G; Figure 5-H; Figure 5-I). Permitted activities are subject to conditions under the regulations that are based on industry good practice standards. Activities are permitted where there is minimal risk to the environment, whereas if there is significant risk to the environment, then a resource consent is required.

The NES-CF states that sediment originating from harvesting (and earthworks) must be managed to ensure that, after reasonable mixing, it does not give rise to any of the following effects in receiving waters: a conspicuous change in colour or visual clarity, the rendering of fresh water unsuitable for consumption by farm animals, or any significant adverse effect on aquatic life.

There are requirements for the notification of forestry activities to the regional council. Forestry activities require a harvest plan that must identify environmental risks and responses. If there are to be earthworks involving greater than 500 m^2 of soil disturbance in any three-month period, the regional council must be notified, either 20-60 days beforehand, or annually for ongoing earthworks. The regional council may request an earthworks management plan to be supplied within five days. The management plan must identify the risks associated with the earthworks and the measures undertaken to avoid, remedy, or mitigate adverse environmental effects.

The NES-CF also contains rules for minimising the sediment from earthworks. These include the following:

» Earthworks setbacks from water bodies – 10 m from perennial river, wetland larger than 0.25 ha, lake larger than 0.25 ha, outstanding freshwater body, or water subject to a water conservation order.

» Fill – fill must contain no more than 5% (by volume) of vegetation and wood.

» Spoil – cannot be deposited over unstable material or land; over slash or woody debris; into a water body, coastal water, or significant natural area; or onto land that might result in the spoil or sediment entering water.

» Sediment – disturbed soil must be stabilised or contained to minimise sediment entering water and resulting in diversion or damming of a water body, or damage to downstream infrastructure.

» Stormwater control measures – stormwater, water run-off, and sediment control measures must be installed and maintained.

» Stabilisation – batters, cuts, and side cast construction must use methods that maintain stability. Exposed areas of soil that may result in sediment entering water must be stabilised as soon as practicable after completion. Suitable stabilisation measures include seeding, vegetation cover, and compacting, draining, roughening or armouring by the placement of rocks or other rigid material.

» Roads, tracks and landings – forestry roads, forestry tracks, and landings must be managed and aligned to divert water run-off and disperse water flows to stable ground and away from constructed fill and minimise disturbance to earthflows and gullies.

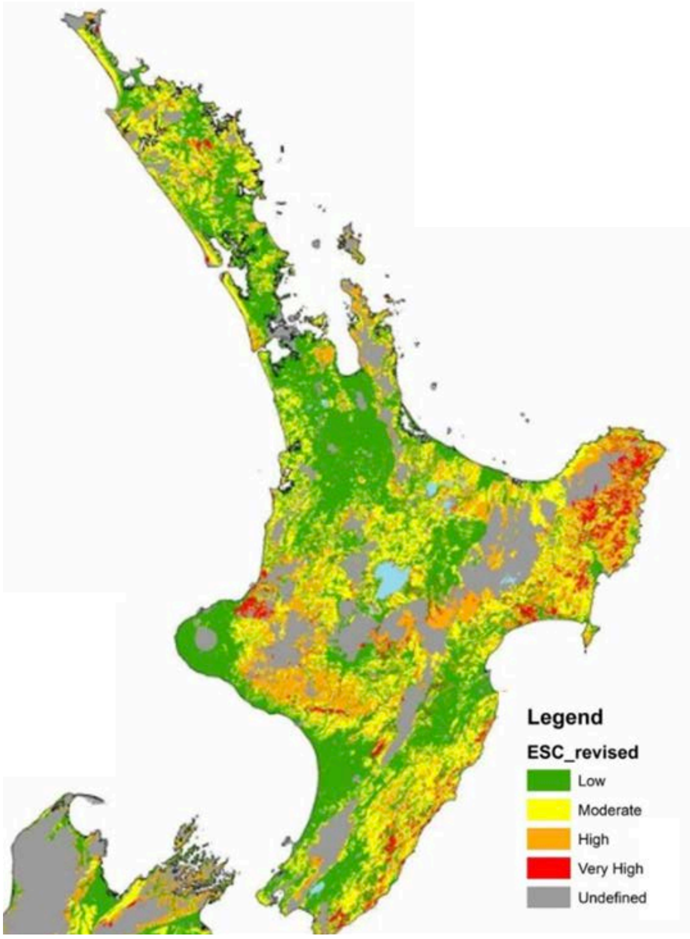

Figure 5-F Erosion Susceptibility Classification (ESC) for the North Island of New Zealand. Image from presentation by Philip Tezlaff

In addition to the rules and regulations in the NES-CF, the New Zealand Forest Owners Association has produced 26 Forest Practice Guides to limit adverse effects to the environment. These cover earthworks construction, erosion and sediment control measures, stream crossings, tracks, vegetation to manage erosion, and harvest slash.

Figure 5-G An example of land that was logged around five years previous, with many tracks and lots of potential for sedimentation, but that has greened up post-harvest. Image © Philip Tezlaff

Figure 5-H An example of logging at Lismore Forest, above SH4. The hauler is sited as close to the edge as possible, using backline machine to maximise deflection. There is minimal ground disturbance other than scuff marks from stems being dragged up the hill. Image © Philip Tezlaff

Figure 5-I A logged area of around eight hectares, which has been harvested using a small hauler pulling trees to the top of the hill. Previous methods for this type of area would have been to dig multiple extraction tracks into the hill and to harvest using ground-based machinery. Image © Philip Tezlaff

6 LAND USE OPTIONS FOR REDUCING SUSPENDED SEDIMENT IN TAMAŪPOKO TUPUNA ROHE

Chaired by Fiona Shaw. Kaikōrero Dr. Tom Mackay-Smith, Nic Conland, and Amy Whetu explored some of the solutions required to reduce sediment.

6.1 Native Silvopastoral Systems

Dr. Tom Mackay-Smith – Landscape Ecologist & Soil Scientist, Verdantia Research

6.1.1 Introduction

Verdantia Research is a native silvopasture implementation and research organisation founded by Dr Tom Mackay-Smith and Dr Raphael Spiekermann. We are scientists with nearly two decades of combined research experience in integrative tree-pasture systems formally based at Massey University (MU) and Manaaki Whenua – Landcare Research (MWLR). After researching native silvopastoral systems at MU and MWLR, we wanted to continue our research independently and develop infrastructure for implementing native silvopastoral systems on farms. This report will give details of our scientific research to date, and the products and services we are developing that are required to adopt native silvopastoral systems across New Zealand hill country.

6.1.2 What are Native Silvopastoral Systems?

Native silvopastoral systems are where livestock farming and 12–15 m spaced native trees co-exist in the same paddock, forming mixed integrative tree-pasture systems. These systems have been used in many countries in the world for millennia to balance agricultural production and environmental preservation. The most notable and well-documented example is the Dehesa system in Spain and Portugal, where oaks are used[26] (Figure 6-A).

These systems are also used in New Zealand, with the most common example being with poplar and willow. Poplar and willow have been planted at great scale throughout hill country to mitigate mass movement events (shallow soil slips), earthflows and gully erosion[27]. Poplar and willow have been selected because of their extensive root systems, quick growth rate, deciduous native and ability to plant them as sharpened coppiced 'poles' in grazed sheep and cattle paddocks (although exclusion for 1–2 years is required for cattle paddocks)[28].

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[26] Joffre, R., Rambal, S. & Ratte, J.P. 1999. The dehesa system of southern Spain and Portugal as a natural ecosystem mimic. Agroforestry Systems 45: 57–79.

Plieninger, T., Pulido, F.J. & Konold, W. 2003. Effects of land-use history on size structure of holm oak stands in Spanish dehesas: implications for conservation and restoration. Environmental Conservation 30: 61–70.

Moreno, G. et al. 2016. Exploring the causes of high biodiversity of Iberian dehesas: the importance of wood pastures and marginal habitats. Agroforestry Systems. 90: 87–105.

[27] Spiekermann, R.I., McColl, S., Fuller, I., Dymond, J., Burkitt, L. & Smith, H.G. 2021. Quantifying the influence of individual trees on slope stability at landscape scale. Journal of Environmental Management 286. https://doi.org/10.1016/j.jenvman.2021.112194

Kemp, P.D., Hawke, M.F. & Knowles, R.L. 2018. Temperate agroforestry systems in New Zealand. In: Gordon, A.M., Newman, S.M. & Coleman, B.R.W. (eds) Temperate Agroforestry Systems. CAB International, Oxfordshire, U.K. Pp. 224–236.

[28] Mackay-Smith, T.H., Burkitt, L., Reid, J., López, I.F. & Phillips, C.A. 2021. A framework for reviewing silvopastoralism: a New Zealand hill country case study. Land 10(12): 1386. https://doi.org/10.3390/land10121386

Charlton, D., McIvor, I.R., Gawith, P. & Douglas, G. 2007. Growing poplar and willow trees on farms - guidelines for establishing and managing poplar and willow trees on farms. 72 p. https://www.poplarandwillow.org.nz/documents/growing-poplar-and-willow-trees-on-farms.pdf

You can also use natives in silvopastoral systems; however, they are typically not currently planted and those that exist will be old remnants of cleared bush or scrub (Figure 6-B). The environmental benefits of these silvopastoral systems have been well-researched[29]. Trees help stabilise slopes[30], reduce sediment loss to streams[31], provide habitat to native biodiversity[32], reduce livestock heat stress[33], and offset greenhouse gas emissions[34].

Figure 6-A Native silvopastoral system using oak in Spain. Image © Verdantia Research

[29] Mackay-Smith, T.H., Spiekermann, R.I., Richards, D.R., Harcourt, N. & Burkitt, L.L. 2024. An integrative approach to silvopastoral system design: perspectives, potentials and principles. New Zealand Journal of Agricultural Research 68(2): 218–258. https://doi:10.1080/00288233.2023.2298922.

[30] Douglas, G.B., Mcivor, I.R., Manderson, A.K., Koolaard, J.P., Todd, M., Braaksma, S. & Gray, R.A.J. 2013. Reducing shallow landslide occurrence in pastoral hill country using wide-spaced trees. Land Degradation & Development 24:103–114. https://doi.org/10.1002/ldr.1106

Spiekermann, R.I., McColl, S., Fuller, I., Dymond, J., Burkitt, L. & Smith, H.G. 2021. Quantifying the influence of individual trees on slope stability at landscape scale. Journal of Environmental Management 286. https://doi.org/10.1016/j.jenvman.2021.112194

[31] Dodd, M.B., McDowell, R.W. & Quinn, J.M. 2016. A review of contaminant losses to water from pastoral hill lands and mitigation options. NZGA: Research and Practice Series 16: 137-147. https://doi.org/10.33584/rps.16.2016.3269

Zhu, X., Liu, W., Chen, J. et al . 2020. Reductions in water, soil and nutrient losses and pesticide pollution in agroforestry practices: a review of evidence and processes. Plant Soil 453: 45-86. https://doi.org/10.1007/s11104-019-04377-3

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[33] Betteridge, K., Costall, D., Martin, S. Reidy, B., Stead, A. & Millner, I. 2012. Impact of shade trees on angus cow behaviour and physiology in summer dry hill country: grazing activity, skin temperature and nutrient transfer issues. 10p.

Richards, D., Dewhurst, Z., Giltrap, D. & Lavorel, S. 2024. Tree contributions to climate change adaptation through reduced cattle heat stress and benefits to milk and beef production. Global Change Biology 30: e17306. https://doi.org/10.1111/gcb.17306

[34] Richards, D., Dewhurst, Z., Giltrap, D. & Lavorel, S. 2024. Tree contributions to climate change adaptation through reduced cattle heat stress and benefits to milk and beef production. Global Change Biology 30: e17306. https://doi.org/10.1111/gcb.17306

Figure 6-B Example of a native silvopastoral system in New Zealand using kānuka. Image © Verdantia Research

6.1.3 How Can We Use Silvopastoral Systems to Increase the Productivity of Farms?

What isn't commonly known is the potential of native silvopastoral systems to improve on-farm production. The native genus kānuka (*Kunzea* spp.) has the potential to form intergenerational and multifunctional silvopastoral systems that build soil resources and positively impact pasture production. This is because of the genus's potentially advantageous bio-physical tree attributes, such as its longevity, potentially reduced competition for soil, water, and nutrients compared to faster-growing and more resource intensive trees typically planted in hill country, and evergreen nature, potentially influencing livestock behaviour and soil organic matter return to the soil[35]. Despite being locally very common in New Zealand hill country[36], the study described below is the first to measure the influence of kānuka silvopastoral trees on the pastoral environment at the field scale.

The study conducted as part of Dr Tom Mackay-Smith's PhD at MU investigated the impact of kānuka on pasture production, pasture stability, and soil condition within a kānuka silvopastoral system[37] (Figure 6-C). At two sites over two years, there was on average 107.9% more pasture production under individually spaced and mature kānuka trees compared to open pasture. This pasture production increase was associated with significantly greater Olsen-phosphorus, potassium and porosity. Soil moisture was similar between kānuka pasture and open pasture positions. The improvements to the agricultural environment were hypothesised to be because of livestock excreta deposition under the trees in the sheltered tree environment and tree litterfall.

The increased pasture production under the trees was the result of trees facilitating the growth of a few dominant and competitor pasture functional groups via the mass ratio effect such as perennial ryegrass (*Lolium perenne*), cocksfoot (*Dactylis glomerata*), soft brome (*Bromus hordeaceus*), and barley grass (*Critesion murinum*). Moreover, despite reduced species richness and functional richness in kānuka pasture, there was evidence that pasture stability was maintained under the trees because functional evenness and functional dispersion were statistically similar in kānuka pasture and open pasture, and the functional groups that grew had mixed (cocksfoot) or annual (soft brome and barley grass) survival strategies. This indicates that kānuka has the potential to increase pasture production sustainably by not negatively impacting the pasture's response to stress.

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35 Mackay-Smith, T.H., Burkitt, L., Reid, J., López, I.F. & Phillips, C.A. 2021. A framework for reviewing silvopastoralism: a New Zealand hill country case study. Land 10(12): 1386. https://doi.org/10.3390/land10121386

36 Spiekermann, R.I., McColl, S., Fuller, I., Dymond, J., Burkitt, L. & Smith, H.G. 2021. Quantifying the influence of individual trees on slope stability at landscape scale. Journal of Environmental Management 286. https://doi.org/10.1016/j.jenvman.2021.112194

37 Mackay-Smith, T.H., López, I.F., Burkitt, L.L. & Reid, J.I. 2022. Kānuka trees facilitate pasture production increases in New Zealand hill country. Agronomy 12(7): 1701. (2022). https://doi.org/10.3390/agronomy12071701

Mackay-Smith, T.H., López, I.F., Burkitt, L.L. & Reid, J.I. 2023. Pasture production-diversity relationships in a kānuka silvopastoral system. Ecological Solutions and Evidence 4: e12218. https://doi.org/10.1002/2688-8319.12218

These preliminary results are promising, however, more work is required to confirm them on additional farms and regions. If more can be undertaken that confirms these findings, we believe native silvopastoral systems could transform hill country farms, making them more productive alongside stabilising slopes and reducing sediment loss to streams.

Figure 6-C Tree effect under mature and individually spaced kānuka trees in Hill country. Image © Verdantia Research

6.1.4 Where should we Target Plantings for the Best Soil Erosion Outcome?

In addition to the potential positive impacts on pasture production, improving our methods for targeting landslide erosion is essential, and the effectiveness of widely spaced trees in reducing shallow landslide erosion and sediment delivery at hillslope to catchment scales remains largely unknown. This section describes the results of Dr Raphael Spiekermann's PhD at MU, which was funded by MWLR's Smarter Targeting of Erosion Control programme[38].

The project began by quantifying the impact of individual trees in hill country on landslide erosion. Using a study area in the Wairarapa (840 km^2), a method was developed using open-source remote sensing products to generate high-resolution individual tree influence models for the dominant tree species. This research aimed to develop spatially explicit modelling to assess the impact of differing tree species, planting densities, and individual tree location, on rainfall-triggered landslides and sediment delivery while accounting for varying environmental conditions, such as slope gradient, lithology, or soil type.

The key results of the study included:

» of exotic tree species that were planted for erosion and sediment control, poplars (*Populus* spp.) and willows (*Salix* spp.) make up 51% (109,000) of trees located on hillslopes at a mean density of 3 trees/ha

» poplars and willows have the greatest contribution to slope stability, with an average maximum effective distance of 20 m

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[38] Spiekermann, R.I., McColl, S., Fuller, I., Dymond, J., Burkitt, L. & Smith, H.G. 2021. Quantifying the influence of individual trees on slope stability at landscape scale. Journal of Environmental Management 286. https://doi.org/10.1016/j.jenvman.2021.112194

Spiekermann, R.I., Smith, H.G., McColl, S., Burkitt, L. & Fuller, I.C. 2022. Quantifying effectiveness of trees for landslide erosion control. Geomorphology 396: 107993. https://doi.org/10.1016/j.geomorph.2021.107993

Spiekermann, R.I., Smith, H.G., McColl, S., Burkitt, L. & Fuller, I.C. 2022. Development of a morphometric connectivity model to mitigate sediment derived from storm-driven shallow landslides. Ecological Engineering 180: 106676. https://doi.org/10.1016/j.ecoleng.2022.106676

» native kānuka (*Kunzea* spp.) is the most abundant woody vegetation species on hillslopes within the study area, with an average of 24 trees/ha, providing an important soil conservation function.

» A large proportion (56% or 212.5 km^2) of erosion-prone terrain in the study area remains untreated.

This individual tree data was then used to input individual tree data into a landslide susceptibility model using binary logistic regression to quantify the effectiveness of silvopastoral systems in reducing landslide erosion and to support targeted erosion mitigation. Models were trained and tested using a landslide inventory consisting of 43,000 landslide scars mapped across the study area. Application of the landslide susceptibility model was illustrated using two farms from within the study area (Site 1: 1,700 ha; Site 2: 462 ha) by quantifying the reduction in shallow landslide erosion due to trees. This model produced maps that showed how susceptible to erosion land is on farms (Figure 6-D). The key results of this part of the study included that:

» compared to a pasture-only baseline, landslide erosion was reduced by 17% at Site 1 and 43% at Site 2 due to all existing vegetation

» the effectiveness of individual trees in reducing landslide erosion was shown to be less a function of species than that of targeting highly susceptible areas with adequate plant densities

» the terrain occupied by the 'high' susceptible class – defined as the terrain where 80% of mapped landslides were triggered in the past – occupies only 12% of Site 1 and 7% of Site 2.

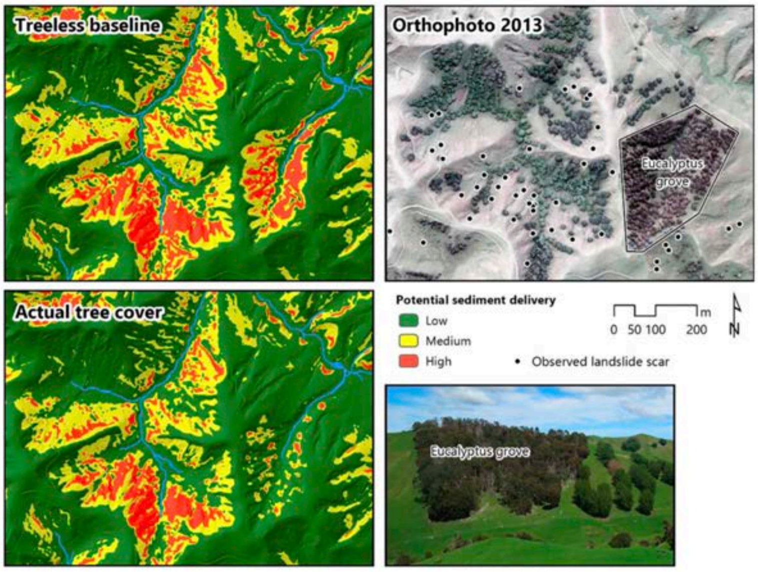

Figure 6-D Potential landslide-derived sediment delivery to streams based on modelling landslide susceptibility and landslide connectivity modelling for a small pastoral area in the Wairarapa, New Zealand. The comparison of a treeless baseline scenario with the actual tree cover (shown in the orthophoto from 2013) demonstrates that the eucalyptus grove (photo insert) has led to a much greater reduction in future sediment delivery compared with the poplars and willows to the west, which were largely planted in areas where landslides are unlikely to occur with or without trees present.
Image © Verdantia Research

Finally, to improve the accuracy of the model for predicting sediment delivery to streams, a connectivity function was included in the model. Using past landslide data, this predicted areas on the farm that have a high chance of landslide erosion (landslide susceptibility) in addition to having a high chance of being connected to streams if they erode (landslide connectivity). The aim was to identify the highest-risk areas of the farm. By coupling landslide susceptibility and connectivity predictions, the cost-effectiveness of targeted versus non-targeted approaches to shallow landslide mitigation was then quantified. Targeted mitigation of landslide-derived sediment was found to be approximately an order of magnitude more cost-effective than a non-targeted approach. Compared with a pasture only baseline, a 34%

reduction in sediment delivery can be achieved by increasing slope stability through spaced tree planting on 6.5% of the pastoral land. In contrast, the maximum reduction achievable through comprehensive coverage of widely spaced planting is 56%.

The coupled landslide susceptibility and connectivity predictions (maps) provide an objective basis to not only target mitigation to areas where future shallow landslides are likely to occur but – perhaps more importantly – target future tree planting to locations that are likely to be future sources of fine sediment.

6.1.5 What Natives Should We Plant

A key limitation to native silvopastoral systems is there are currently no viable methods for establishing native seedlings in the presence of sheep and cattle that can be used at scale. We believe this is a major barrier to their adoption. Since being founded in April 2023, Verdantia Research has been developing and testing portable and cost-effective tree guard prototypes for establishing natives in the presence of sheep and cattle. We have been undertaking trials in 2023 and 2024 to develop the tree guard. In addition to testing the tree guard, we are interested in learning which native species will survive and flourish as silvopastoral trees in various regions, considering slope class, soil type, aspect, and climate. Using our guard, we have planted a range of native species across four regions that include lemonwood, kānuka, tōtara, pūriri, rewarewa, NZ broadleaf, karo, red māpou, kōhūhū, makomako, and houhere.

These projects are ongoing and later in 2025, we will do a full evaluation of survival and growth rates so we can start moving towards developing spatial plans for farms. Below is a selection of our sites.

Taranaki

On two sites we planted kānuka and rewarewa at a density of 65 stems per hectare, collaborating with the Toi Foundation and Taranaki Regional Council (Figure 6-E).

On a dairy farm, near Hawera, the landowner wanted to create a multifunctional silvopasture system incorporating browsable native species (Figure 6-E). We have planted a diverse mix including lemonwood, kānuka, New Zealand broadleaf, karo, red māpou, kōhūhū, makomako, and houhere. This project was carried out in collaboration with the Toi Foundation.

Figure 6-E Example of native silvopasture site in Taranaki hill country (photo on left) and on a Taranaki dairy farm (photo on right).
Image © Verdantia Research

Auckland

The two sites below compare survival and growth rates of tōtara, pūriri, kānuka, and poplar wands at coastal and inland properties in the Kaipara catchment, Auckland Region (Figure 6-F). Both sites have been planted at 65 stems per hectare. We are collaborating with the Kaipara Moana Remediation (KMR) and Auckland Council on these projects.

Figure 6-F Examples of native silvopastoral systems in Auckland hill country. Image © Verdantia Research

Hawke's Bay

These two sites feature kānuka and rewarewa plantings on steep, dry, and highly erodible hill country in Hawke's Bay (Figure 6-G). Hawke's Bay Regional Council contributed to these plantings through their innovation fund. Both the farmer and council were keen to identify native species that could thrive in dry hill country where poplar and willow struggle to survive.

Figure 6-G Examples of native silvopastoral systems in Hawke's Bay hill country. Image © Verdantia Research

6.1.6 What Next for Verdantia Research?

Spatial Plans for Tree Planting Decisions

A key goal of Verdantia Research is to develop the knowledge required to make informed planting decisions for hill country farms. This requires more information from our planting trials, and the development of technology required to create spatial plans on farms based on individual farm characteristics. This is an internal project that we will be working on throughout the year.

Effectiveness of Widely Spaced Kānuka, Tōtara & Poplar Trees for Erosion Control

We recently secured a multi-year contract with Auckland Council to create an idealised silvopasture planting design for mitigating soil erosion on an Auckland hill country model farm based on root data collected from widely spaced kānuka, tōtara, and poplar trees. This project will collect and compare root data between widely spaced kānuka and tōtara, and poplar from two different sites with comparable aspects and topography, but different soil types. The root data will be used to model the effectiveness of each species at reducing shallow landslide probability under various planting scenarios (density and targeted versus nontargeted planting scenarios). These outputs will then be used to create the idealised silvopasture planting design for a model Auckland hill country farm.

Tree Guard Development

As previously mentioned, a fundamental aspect of the development of silvopastoral systems will be developing a cost-effective and portable tree guard. We will continue testing our new guard concept and will be bringing out a new iteration for the 2026 planting season.

6.2 Sequestration – Where to Start?

Nic Conland – Director, Verdi New Zealand

6.2.1 Introduction

This brief memo is prepared to accompany the presentation given in support of the Awhipapa wānanga at Rānana. Verdi attended and was privileged to witness the passion, energy, and integrity of the hapū who are supporting the journey and life force of Te Awa Tupua.

Verdi operates with the conviction that a regenerative future for Aotearoa New Zealand is not only possible but essential. This report outlines opportunities where Verdi's scientifically validated Measurement, Reporting, and Verification (MRV) protocols and sustainable land use solutions can align with the goals of Te Awa Tupua, contributing to healthy soils, thriving ecosystems, and resilient communities.

Te Awa Tupua framework provides an opportunity to integrate ecosystem-based solutions into the governance and management of the Whanganui River, recognising it as a living entity with intrinsic rights. As farmers, scientists, and land stewards, the founders of Verdi NZ understand the profound responsibility of working with the land, ensuring that soil health, ecosystem vitality, and community well-being are at the forefront of every decision.

6.2.2 Alignment with Te Awa Tupua Principles

The following four legal principles underpin Te Awa Tupua (Whanganui River Claims Settlement) Act 2017, ensuring a holistic and iwi centred approach to river and land management:

- Ko Te Awa Te Mātāpuna o Te Ora – The River is the source of spiritual and physical sustenance.
- Te Mana o Te Awa – The mana of the river must be maintained and enhanced.
- Te Mana Motuhake o Te Awa – The river has its own identity, and decision-making should reflect its needs.
- Te Awa Tupua Governance Framework – Decision-making must involve hapū-led governance structures, ensuring that land and water use respect the rights of the river.

Verdi shares these principles, recognising that land and water are inseparable and that a thriving river system requires regenerative land management practices. The company's focus on soil carbon sequestration, biodiversity restoration, and sustainable land use is a natural complement to aspirations for Te Awa Tupua.

6.2.3 Opportunities for Verdi to Support Te Awa Tupua

The following key areas of collaboration have been identified:

Enhancing Soil Carbon Sequestration to Support River Health

- Developing MRV-based carbon sequestration projects.
  - Utilising Verdi's on-farm soil carbon measurement protocols to track soil carbon stock changes, offering verifiable insights into soil health improvements.
  - Establishing regenerative soil health programmes that prevent erosion, reduce runoff, and enhance Te Mana o Te Awa.
- Promoting regenerative farming and riparian buffer zones.
  - Working alongside hapū to integrate regenerative agriculture principles that build soil health and protect waterways.
  - Supporting the restoration of riparian buffer zones with native vegetation, improving biodiversity and water filtration.
- Facilitating carbon and biodiversity credit stacking.
  - Creating revenue streams for landowners through verified carbon sequestration credits.
  - Supporting hapū in accessing biodiversity credit markets, ensuring environmental and financial co-benefits.

Implementing Nature-based Solutions for River & Ecosystem Restoration

- Restoring wetlands and riparian zones.
  - Supporting wetland restoration as a climate resilience tool, enhancing carbon sequestration and water purification.
  - Integrating wetlands into a broader carbon and biodiversity credit framework to fund long-term restoration.

- Advancing afforestation with native vegetation.
  - Using high-resolution GIS mapping to identify priority afforestation areas that maximise carbon capture and ecological resilience.
  - Aligning afforestation efforts with hapū-led conservation initiatives.

Strengthening Data Sovereignty & Sustainable Land Management

- Developing hapū-owned environmental data systems.
  - Ensuring that Whanganui hapū retain ownership over environmental and soil carbon data.
  - Providing training and technical support to establish culturally appropriate monitoring frameworks.
- Integrating mātauranga Māori with scientific MRV methods.
  - Combining Verdi's scientific carbon tracking methodologies with hapū-based monitoring systems that respect traditional knowledge.
  - Supporting hapū-led decision-making that incorporates historical land use knowledge and contemporary environmental science.

Enabling Circular Economy & Sustainable Finance for Hapū-led Enterprises

- Developing sustainable land-based enterprises.
  - Assisting in the development of regenerative farming, agroforestry, and biochar production, providing localised economic opportunities.
  - Designing long-term business models that integrate cultural values with environmental resilience.
- Facilitating access to environmental finance and markets.
  - Connecting hapū to voluntary carbon markets and sustainable investment funds.
  - Supporting the establishment of carbon trading agreements that align with ethical investment principles.

6.2.4 Evidence-Based Support for Nature-based Solutions

Verdi's science-backed MRV methodologies provide credibility for nature-based solutions that align with global sustainability frameworks, including:

- IUCN on Nature-Based Solutions: Nature-based solutions enhance biodiversity, reduce climate risk, and improve livelihoods
- World Bank Climate Resilience Reports: Investing in wetland and forest restoration generates high economic returns and strengthens community resilience
- UN Sustainable Development Goals (SDGs): Verdi's work aligns with SDG 13 (Climate Action) and SDG 15 (Life on Land).

6.2.5 Next Steps: Building a Verdi–Te Awa Tupua Partnership

To formalise collaboration, the following steps are suggested:

Establish a Verdi–Whanganui Hapū Working Group

» Hosting hui to co-design hapū-led land and water management strategies.

» Developing agreements to define roles, responsibilities, and data sovereignty frameworks.

Implement Pilot Projects & Feasibility Studies

» Identifying priority sites for MRV-based soil carbon sequestration and ecosystem restoration.

» Conducting feasibility studies to assess financing and market opportunities.

Provide Technical & Financial Support

» Offering expertise in soil carbon MRV, sustainable finance, and market access.

» Linking hapū with funding mechanisms[39] from carbon credits and regenerative investment platforms[40].

6.2.6 Conclusion

Verdi was founded by farmers, scientists, and land stewards who are deeply aware of the responsibility to safeguard Aotearoa's future. The company's regenerative approach aligns with the vision for Te Awa Tupua for a thriving river system, where land, water, and people exist in balance.

The Verdi team is focused on developing a future where health is understood holistically as starting with the soils and ecosystems that underpin a thriving healthy community. Verdi is currently working with ahu whenua and Māori trusts to support changes to regenerative practices and develop evidence to support adding value to food and fibre products from the whenua.

The global obligations to reach Paris Climate and UN Sustainable Development Goals need the success of Te Awa Tupua.

By working in partnership with Whanganui hapū and iwi, Verdi can help restore ecosystem health, enhance soil carbon sequestration, and create economic resilience through culturally aligned land management practices. This collaboration will contribute to a future of healthy soils, thriving ecosystems, and strong communities, within and along the Whanganui Awa, reinforcing the deep ecological and spiritual connection between people, land, and water – principles at the heart of Te Awa Tupua.

[39] https://toha.network
[40] https://maearth.com

6.3 Digital Tools Supporting Kaitiakitanga

Amy Whetu – CEO, The Stream

6.3.1 'The Stream' – Visualising Te Taiao for the Future

'The Stream' is a digital company that provides a range of Software as a Service (SaaS) product across the environmental data sector.

» These were developed by experts with deep experience in ecology, agriculture, te ao Māori, technology, policy, and more.

» Our tools are developed to improve decision-making at all scales.

» We focus on data delivery that speaks to our communities and that has mātauranga Māori at its core, alongside scientific data.

We acknowledge the unique role that data plays and will play in planning for the future of Aotearoa and the importance of finding solutions to support decision-making in our unique context.

Working alongside kaitiaki, we have found that data equity is a big issue. Kaitiaki are frequently being asked to contribute to kōrero, water management, land use and resource management kaupapa without being given consistent and easy access to all available information to support their decision-making. We have developed digital tools specifically for this purpose, and centred around these needs to support, enhance and streamline the mahi engaged in every day.

We are focused on delivering organisations tools that are focused on data driven decision-making, deliver data equity, and track change over time.

Our tools (Figure 6-H) can be used to support existing work programmes, enhance decision-making, and save time:

» **Resource consents**: our tools enable visibility of data that is available within an area where that data is shared with the platform owner, including public data. It visualises this data and enables data driven decision-making about te wai and te whenua, with all available information, as opposed to only the information provided by an applicant for a consent.

» **Monitoring**: our tools enable kaitiaki to gather information on their terms and share with those they choose on the platform. The tools can also be used to undertake observations for and on behalf of resource users and managers, through partnerships or through paid contracting.

» **Ongoing management**: we can adapt tools for decision-making based on your own indicators of well-being so that you can understand the pressures on your resources and report against this when engaged in resource management processes. Requests can be made to other consent holders to contribute their data to a platform owner as conditions of consent or through existing stakeholder relationships.

6.3.2 Data Sovereignty at the Core

We subscribe to Aotearoa data sovereignty principles as advocated by Te Mana Raraunga and Te Kāhui Raraunga through:

» being a Māori-owned company

» all tools being designed to increase data equity and get useful data into Māori hands

» ensuring the decisions around access, privacy, and control all remain squarely with Māori owners

» focusing on te ao Māori methodologies

» enabling kaitiaki to make decisions with their data.

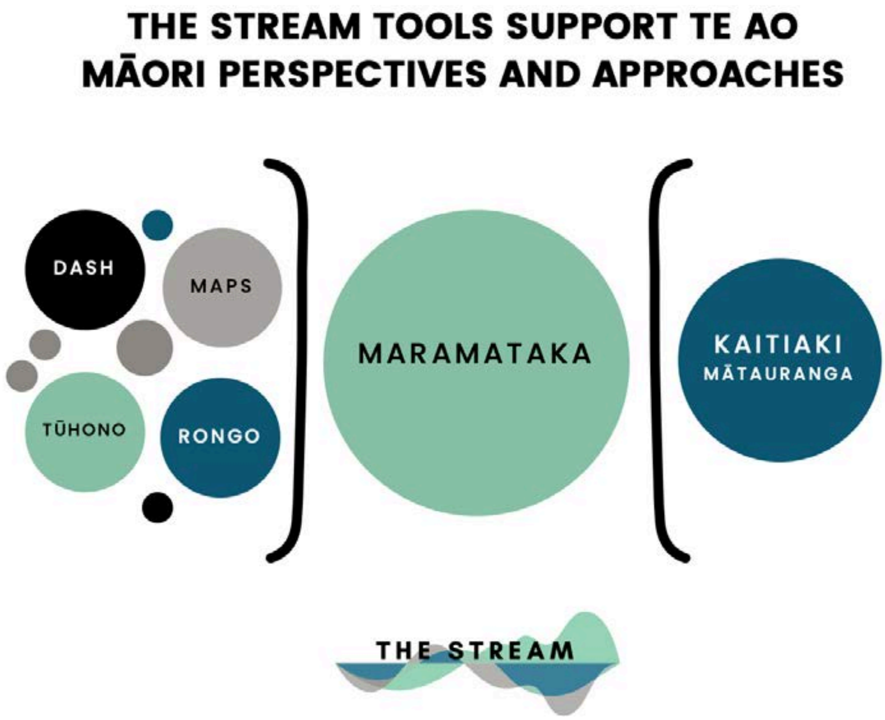

Figure 6-H 'The Stream' tools support te ao Māori perspectives and approaches. Image © The Stream

6.3.3 StreamDASH – Environmental Monitoring Dashboard

StreamDASH is a data visualisation dashboard (Figure 6-I) that gives a holistic understanding of the environment. Key features include the following:

» **Centralised data visualisation**: Bringing together data from various sources, including scientific data. Stream tools like Tūhono Lens and Rongo bring kaitiaki observations onto a single platform.

» **Customisable visualisation**: Enabling mana whenua to create personalised dashboards to visualise data to suit their specific needs and interests.

» **Integrated mapping:** Providing a map view of all data collection points, allowing mana whenua to visualise spatial context.

By offering a central platform for comprehensive and customisable data visualisation, StreamDASH empowers our users to gain deeper insights into environmental health and make informed decisions.

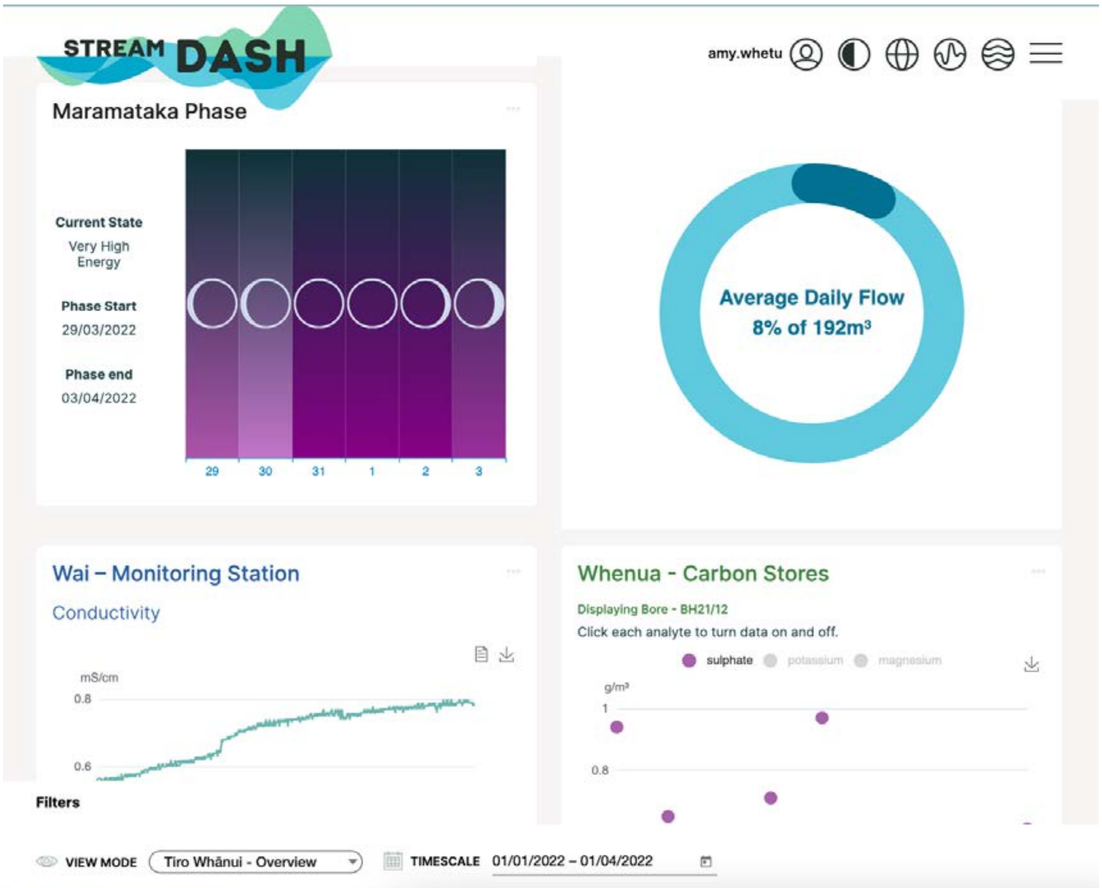

Figure 6-I An example of the StreamDASH environmental monitoring dashboard. Image © The Stream

6.3.4 StreamMAP – Spatial Data Mapping

StreamMAP consolidates and maps diverse data for spatial analysis (Figure 6-J). Key features include:

» **Customisable spatial mapping**: This primary mapping tool allows users to tailor maps to specific spatial layers and data types.

» **Data integration**: StreamMAP displays kaitiaki observations recorded through Rongo alongside other relevant data.

» **Mātauranga Māori integration**: StreamMAP integrates indigenous knowledge captured by kaitiaki with environmental monitoring and management.

By offering a flexible, customisable, and culturally inclusive spatial mapping solution, StreamMAP empowers users to gain a deeper understanding of the spatial relationships between environmental data points, contributing to more informed decision-making for the well-being of te taiao. Rongo can also be customised for use by other resource users to contribute their observations on site and share across the platform to kaitiaki.

Figure 6-J An example of StreamMAP spatial mapping data. Image © The Stream

6.3.5 Tūhono – Environmental Monitoring Tool Demo

Tūhono is a data visualisation lens (Figure 6-K) that brings together scientific data alongside mātauranga derived cultural indices, and kaitiaki monitoring observations. Tūhono operates on the maramataka calendar and provides a te ao Māori lens to govern data within a catchment.

It also provides a platform for mana whenua to influence the monitoring and reporting parameters to align with their own measures of health and well-being for te taiao. With a focus on data transparency and equity, Tūhono provides a holistic, time driven snapshot of available data, in one te ao Māori centred view.

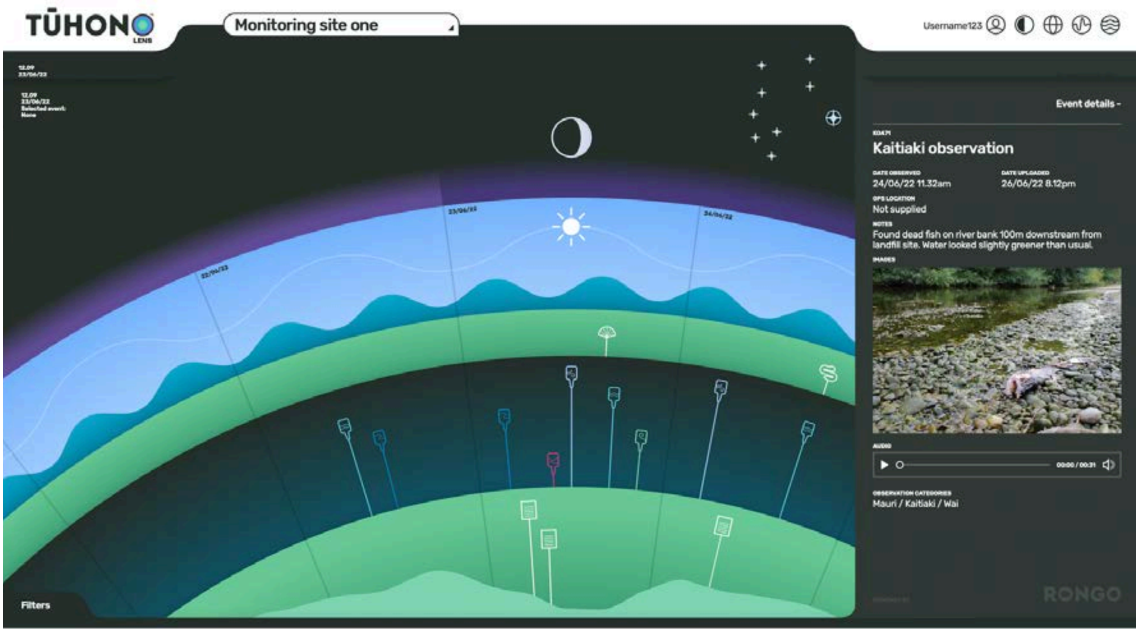

Figure 6-K An example of the Tūhono data visualisation lens. © The Stream.

6.3.6 Rongo – Digital Kaitiaki Observation App

Rongo is a digital kaitiaki observation tool developed specifically for use by mana whenua in Aotearoa. Key features include:

» **Real-time observation recording:** Capture observations directly on-site with timestamps and location data, both when in range or when remote.

» **Spatial mapping:** Integrate observations with mapping tools to visualise spatial context and distribution.

» **Multimedia support:** Upload videos, audio recordings, images, and written descriptions to provide a rich and comprehensive record of observations.

» **Culturally specific customisation:** Tailor Rongo to include fields of observation and components specific to the unique cultural practices and knowledge of each mana whenua group.

» **Integration:** Used in conjunction with StreamDASH, it can connect kaitiaki observations to other environmental monitoring in the area.

By empowering mana whenua with a culturally appropriate and user-friendly digital tool, Rongo enables kaitiaki observations to be valued and form a critical part of resource management practice, contributing to the well-being of whenua and te taiao.

6.3.7 Mahi in the Catchment

We are privileged to be working with three awesome rōpū on a couple of projects within the takiwā:

» Te Maru o Ruahine

» Rānana Māori Committee (Te Morehu Whenua)

» Ngā Wairiki Ngāti Apa

These projects will see each rōpū having the opportunity to utilise all of 'The Stream' tools including building their own version of Rongo – Kaitiaki Observation App and connecting with other data in their rohe.

7 REFLECTIONS FROM DAY ONE

At the beginning of day two, participants were asked to reflect on what they had learnt, what inspired them, and what they would like to explore next, as well as general reflections on the previous day.

7.1 What did You Learn?

Having been presented with a range of information outlining the nature and scale of the fine sediment problem facing the Whanganui catchment, there was an understanding among the participants that there is no magic bullet to solve the sediment problem and a feeling that there is not fast enough movement towards making any improvements to the existing situation.

Participants took home several learnings and increased understanding from the day, including:

» The amount of sediment coming out of the catchment in pre-European times was 0.7 million tonnes per year, compared with 2.7 million tonnes per year now. While 2.7 million tonnes of sediment per year on average is a lot, it is substantially less than for Gisborne, which has 14 million tonnes per year.

» Nutrients are higher with erosion from farmland and possibly from gorse, where nitrogen travels as overland flow from hill country. Water quality sampling is showing that nitrate levels are okay, except in springs upstream and downstream in the catchment from Tamaūpoko. Sustainable Land Use Initiative (SLUI) afforestation projects are modelled to achieve reductions in nitrogen across 63,000 ha @ 10kg/ha down to 3kg/ha post afforestation (444,000 kg = 444 less tonnes of N in the Whanganui catchment).

» It takes on average 88 years to implement a SLUI farm plan.

» Pirahau larvae are filter feeders.

» Fine sediment has impacts on our biota, on spawning and on food webs.

» The Whanganui catchment is one of the 12 worst rivers in Aotearoa.

» Riparian buffers need to be at least 15 m wide to be self-sustaining.

» Degrading trends over time.

» Sediment gets into the river system and takes ages to get out, ending up in the estuaries and sea.

» The coverage of catchment groups is growing.

» We need wetlands throughout forestry areas, intercepting all sediment sources, and need to make wetlands in the gullies.

» Regulation doesn't work in isolation. If regulation was the only tool used to get landowners to do things people only do the minimum they can get away with. It needs to be combined with farmer/forester and farm/forest specific information, education, advice on where and how to succeed with environmental improvements that will reduce sediment in the Awa, and financial help.

» A catchment, full agency, community approach is needed to solve these issues.

» $10 note falling and the $10 note philosophy (there's no such thing as a ten dollar note on the ground because if it was there someone else would already have picked it up) – farmers don't invest in sustainable management because they don't see that it helps them to do so.

7.2 What Inspired You – Lightbulb Moments & Insights

Participants were inspired by the day because of passionate people and promising emerging actions. Many were left with the feeling that we all have a job to do. Some of the lightbulb moments and insights that inspired participants included the following:

» Leaky weirs – flood management on land holds water, what happens after floods. Need lots of these across the catchment to make a difference. Also adds habitat to streams when done well.

» Design to suit our ecosystems that suits the environment.

» Rain gardens/hydraulic neutrality/soakage areas for new papakāinga and urban development.

» Te Morehu Whenua mahi revitalising and continuing traditions and identifying the change from impacts on the awa ngā rangitira mō āpōpō.

» Root systems – adapt, pivot, do well, keep doing well, tried and true methods.

» Using trees to heal soil – how to do that in paddocks, regenerative grazing and management.

» Having people in the same room with the same goals.

» Revitalising Awa kaupapa.

» Unique challenges.

» Morikau Station rocks in their SLUI implementation.

» We want our tamariki to fall in love with their whenua – can we get catchment groups to do this for water.

7.3 General Reflections

» Emissions Trading Scheme (ETS) is a black hole, hard to get head around – it is complex and not fit for full purpose.

» Cautious optimism, desire for change.

» Need to scale up.

» Connections (people) important.

» We know what the Awa is facing in terms of sediment.

» Respect for past/future.

» How are we communicating?

» Values.

» Pest impacts on native understory and erosion.

» Grow empathy – what is achievable given current environment – set SMART goals and actions.

» We need fast changes now in the forestry industry and farming agriculture.

» Need to put more effort into learning te reo.

» Are we our own barriers?

7.4 What do You want to Explore Next?

- Te Awa Tupua legislation – how can we use it?
- How can we bring others on the journey? Those in the room are already on board.
- How can the strategy be shaped to support the mahi?
- Focus on low hanging solutions – long-term effects.
- How to transition farmers off the land – and how to pay for control of pests once the land is regenerating back at a big level? How to keep iwi land producing if we're not farming (because we can't go elsewhere).
- What contribution can commercial forestry do for Te Awa Tupua? Maybe fund initiatives in areas of plantations – funding starts from the start not down the track.
- One Plan – what analysis has been done on past period of the One Plan – status of projects/initiatives (eg., Farm plans, development, commercial forestry, evidence base and analysis of the One Plan policies and provisions). Did the rules work? Have compliance and complaints been analysed?
- Monitoring in remote locations (e.g., Pipiriki, Rānana) – could tāngata tiaki be designed as compliance officers for their remote areas to monitor/report/do enforcement.
- Can hapū be included in the plantation plan process for consideration on areas to be harvested, tāngata tiaki as part of the implementation process?

8 PROJECTS UNDERWAY IN OTHER CATCHMENTS

Chaired by Fiona Shaw. Kaikōrero Adrienne Livingston, Nic Peet, and Justine Daw explored solutions to the current sediment issues.

8.1 Natural Ecosystem Restoration

Adrienne Livingston – Site Specific Ecological Design & Consultancy

Understanding ecological succession is invaluable when attempting to restore native forest (ngahere) to an area. We are constantly learning and revising restoration techniques after knowledge gained from practical experiences in the field. Ngahere succession is a series of stages of different plant communities that each improve the conditions for the next group, ultimately making it no longer suitable for themselves.

8.1.1 Native Forest Restoration Techniques

If land is too damaged to regenerate naturally, it must be restored through planting appropriate vegetation. To mimic natural succession – allowing nature to take over much of the process – it is crucial to understand the restoration site's current stage in the successional cycle. As the above-ground environment changes, so does the soil beneath it. Over time, decomposing vegetation accumulates, altering soil composition and supporting further ecological development.

When restoring an area, selecting the appropriate successional group of plants is essential to ensure successful establishment and long-term resilience[41]. Planting species that are too advanced for the current soil conditions may result in poor survival rates, wasting time and resources.

Eco-sourcing native plant seed is a key principle in ecological restoration. By using seeds collected from local wild populations, genetic integrity is preserved, and plants are better adapted to the specific environmental conditions of the restoration site. This enhances their ability to withstand local climate variations and soil conditions.

While soils under pasture are generally dominated by bacteria, soils under native forest are fungal dominant. Ectomycorrhizal networks form in native forests, with over 100 species of fungi. The symbiotic (mutually beneficial) relationship between fungi and tree roots facilitates water and phosphorous uptake, with trees growing better and being more resistant to disease, pests and drought.

During 1993 *Native Forest Restoration: A Practical Guide for Landowners* was published (expanding on the *Revegetation Manual* printed 10 years earlier) with information and techniques on revegetation from scratch and the restoration of existing forest remnants; including the identification and control of over 40 weed species and propagation advice on 60 common native trees and shrubs[42]. The guide covers key topics such as controlling domestic and feral animals, establishing a nursery, and revegetating under bracken or gorse. It also outlines the essential

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41 Department of Conservation (DOC) 2024. Natural Succession. https://www.doc.govt.nz/get-involved/run-a-project/restoration-advice/bush-restoration/understand-the-bush/natural-succession/ (accessed 13/11/24)

42 Porteous, T. 1993. Native Forest Restoration: A Practical Guide for Landowners.

QEII National Trust, Wellington, New Zealand. https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://qeiinationaltrust.org.nz/wp-content/uploads/2018/02/Native-Forests-Restoration.jpg.pdf&ved=2ahUKEwiMmYaQ3teJAxVgxjgGHdQmMAEQFnoECCUQAQ&usg=AOvVaw1DW1y76auZeMiJDnv16Ktl (accessed 12/11/24) planning required for a successful revegetation project. Without careful consideration of all factors – including long-term maintenance and budgeting – restoration efforts may fail despite significant time, effort, and resources.

A core selection of hardy pioneer species is typically used for revegetation. Plants like mānuka and kānuka are well-suited to exposed conditions, providing shelter, nesting sites for birds, and attracting insects that feed species such as fantails and grey warblers. Other native bird-attracting pioneers, including flax, cabbage trees, kāramū, and koromiko, are also commonly included to enhance native seed dispersal and hence biodiversity and resilience.

Typically, the aim of a restoration planting is to achieve canopy closure above the soil surface as fast as possible (4–5 years) to prevent weed invasion and reduce ongoing management requirements. To achieve this, high density plantings (1–1.5 metre spacings) of higher grade (PB3) container plants is the typical method. Some weeds will reinvade, and ongoing maintenance is necessary. High density plantings can be very effective at restricting weeds, but they may also restrict the natural establishment of native seedlings. This can delay succession until natural thinning occurs to provide more favourable light conditions for seedlings to germinate[43]. High density planting using high grade plants is also expensive. Most large land areas requiring land use change are located on dry stock farms where profit margins and cash reserves are low. This can make the $30,000+ per hectare cost of broadscale retirement prohibitive.

8.1.2 The Timata Method

The Timata Method translates from te reo Māori to begin, start, kick-off, or commence the natural succession to restore ngahere. It involves low-cost planting techniques and imitates the natural regeneration process, with kānuka and mānuka used as a nursery crop for successional trees to establish later. The method uses forestry grade seedlings and increased plant spacings to significantly reduce the cost of establishment. Spacings range from 2 m x 2 m (2,500 stems/ha) spacings for most sites to 3 m x 3 m (1,100 stems/ha) spacings on more fertile, easy contoured land, or land adjacent to a wetland or critical source area.

The development of the Timata Method builds on past learnings and aims to address the trade-off between weed suppression and natural regeneration. This approach relies on mānuka and kānuka, making up 70% of the plant mix, as they are less palatable to browsing animals. Dry northerly sites may use 50% kānuka, 20% mānuka, 30% bird-attracting species, while cold wet southerly sites would use 50% mānuka, 20% kānuka, 30% bird-attracting species. By using smaller forestry-grade seedlings and increasing plant spacings to 2–3 m, the method reduces overall planting density, significantly lowering the cost per hectare. On more challenging sites, such as cut-over pine or Kikuyu grass, higher grade plants may be necessary but the density remains the same at no less than 2 m spacings. 'Green' fire breaks should also be considered as mānuka and kānuka are flammable species.

The estimated total cost per hectare for the Timata Method ranges from $10,000 to $13,500, based on 2–3 m spacings. This includes labour, fencing, scheduled plant releasing, weed and pest control, and the introduction of later-succession trees. In comparison, the high-density PB3-grade method costs approximately $38,000 per hectare[44].

In nature, mānuka and kānuka initially grow densely before naturally thinning out over 30–50 years, reaching a spacing of 2–3 m (Figure 8-A). This allows diffused light to filter through, creating a sheltered understory where other pioneer and secondary colonising species can germinate and grow. Over time, broadleaf, conifer, and podocarp species establish, eventually giving way to tall successional trees. However, if no native forest seed source is nearby, secondary

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[43] Reeves, P., Meleason, M. & Matheson, F. 2006. Sustainable riparian plantings in urban and rural landscapes. NIWA Vol.14 No.1, March 2006. https://niwa.co.nz/water-atmosphere/vol14-no1-march-2006/sustainable-riparian-plantings-urban-and-rural-landscapes (accessed 14/11/24)

[44] Dewes, A., Burke, J., Douglas, B. & Kincheff, S. 2023. Retiring Farmland into Ngahere. Our Land and Water Science Challange https://ourlandandwater.nz/outputs/retiring-farmland-into-ngahere/ (accessed 12/11/24)

colonising species should be strategically planted in groves of 100–200 trees per hectare. This should be delayed until the mānuka/kānuka nurse crop is well established, typically after five or more years.

Another advantage of the Timata Method is its higher planting efficiency. An experienced planter can plant up to 1,000 forestry-grade seedlings per day, compared to just 200 PB3-grade seedings. For example, in 2022, the Wai Kōkopu Catchment Group coordinated the planting of 68,000 trees across 27.5 hectares of critical source areas and erosion-prone slopes on nine properties. With a team of 23 forestry workers, the project was completed in just 3.5 days[45].

Canopy closure in the Timata Method takes longer (5–8 years) compared to the higher-density PB3-grade method (4–5 years). While the higher density approach reduces weed incursion, it does not exclude infestation of weeds such as Taiwanese cherry, woolly nightshade, barberry and Japanese honeysuckle which are bird dispersed[46]. Ongoing weed control is required for these species regardless of the planting density.

Manaaki Whenua – Landcare Research[47] suggests incorporating species such as makomako and kōtukutuku into the colonising mix, as these semi-deciduous species can outcompete mānuka and kānuka, naturally creating gaps in the canopy. These openings allow more light to reach the forest floor, providing ideal conditions for planting succession trees nearby or directly within these gaps[48].

In summary, chasing canopy closure with the high-density/PB3 method needs to be weighed against the advantages of the Timata Method, where potentially five times the area can be planted at the same cost while achieving the same long-term outcome.

Figure 8-A Kānuka has naturally colonised this north-facing hill slope (left) and naturally thinned over time to approximately three metre spacings (right), allowing diffused light to reach the understory. This creates suitable conditions for secondary coloniser species to establish, provided livestock are excluded and browsing pests are controlled.

Image © Adrienne Livingston, Site Specific

45 Wai Kōkopu Catchment Group. 2022. Forestry-grade native planting August-September 2022. https://vimeo.com/749345750 (accessed 12/11/24)

46 Dewes, A., Burke, J., Douglas, B. & Kincheff, S. 2023. Retiring Farmland into Ngahere. Our Land and Water Science Challange https://ourlandandwater.nz/outputs/retiring-farmland-into-ngahere/ (accessed 12/11/24)

47 Simcock, Robyn, Alex Fergus, Jo Cavanagh. 2022. Improving resilience of native New Zealand woody seedlings to drought. MPI Technical Paper No. 2022/13 Manaaki Whenua – Landcare Research https://www.mpi.govt.nz/dmsdocument/51274-Improving-resilience-of-native-New-Zealand-woody-seedlings-to-drought (accessed 4/03/2025)

48 Dewes, A., Burke, J., Douglas, B. & Kincheff, S. 2023. Retiring Farmland into Ngahere. Our Land and Water Science Challange https://ourlandandwater.nz/outputs/retiring-farmland-into-ngahere/ (accessed 12/11/24)

8.1.3 Wetlands

Wetlands once covered 9% of Aotearoa. Since people arrived 90% have been destroyed. The trend continues with another 13% of remaining wetlands lost between 2001 to 2016. Therefore, wetland restoration in New Zealand is an urgent priority. These ecosystems provide a range of essential services, including reducing water flow, trapping sediment, removing nutrients, detoxifying chemicals, improving oxygen levels in the water, and offering habitat for many native species throughout their life cycles. A wetland does not need to have open water or remain wet year-round. We need to put them back.

Critical source areas are small, low-lying parts of farms, gullies, and swales where runoff accumulates after high rainfall (Figure 8-B). These areas need to be retired and left to function as a sediment trap and to purify water after high rainfall.

Figure 8-B **Critical source areas are small, low-lying parts of farms, gullies, and swales where runoff accumulates after high rainfall.** Image © Adrienne Livingston, Site Specific

8.1.4 Conclusions

Successful native forest restoration requires continuous learning and refinement of cost-effective techniques, particularly for large-scale projects targeting erosion-prone hillslopes, riparian margins, and wetlands. However, investment in planting alone is not enough. Sustained investment in a paid labour force for ongoing monitoring and the management of invasive weeds and pest animals is crucial. These persistent threats will continue to challenge restoration efforts. Additionally, while retiring erosion-prone land and reestablishing native forests play a significant role in reducing the sediment load entering waterways, reinstating wetlands is equally vital to effectively capture sediment before it reaches waterways.

8.1.5 Lessons from Tiritiri Matangi

Tiritiri Matangi Island, a 220-hectare scientific reserve in the Hauraki Gulf north of Auckland, has become a leading example of successful ecological restoration techniques. Since 1984, efforts have focused on revegetation, threatened species translocations, and invasive species management. Following a long history of Māori and European occupancy, only 6% of the island's forest cover remained. However, forty years after grazing ceased, Tiritiri Matangi has been transformed into a thriving sanctuary, with recovering native biodiversity and restored habitats.

Key lessons from the successful restoration of Tiritiri Matangi include the following:

» Mimicking natural forest succession and accelerating its process led to the formation of dense tree canopies in most places, which now shade out grasses and create leaf litter, enabling natural germination of bird-dispersed seeds.

» There was pressure to accelerate forest restoration to support early translocation of native birds, allowing the island to become an open sanctuary and actively engage the public in conservation efforts.

» Planted canopy species influenced bird foraging patterns, creating a feedback loop where bird usage shaped understory composition and future forest succession[49]. This is an important consideration when aiming to restore original forest types.

» Some areas of Tiritiri Matangi were deliberately left in pasture so that natural rates of regeneration could be studied and to provide a reference point for the changes resulting from direct interventions (Figure 8-C).

» It was assumed that mānuka and kānuka would invade the pasture areas, since this is known to occur on poorly managed sites throughout Aotearoa/New Zealand, where over-grazing has opened the soil surface.

» Tiritiri Matangi Island was left ungrazed for 14 years before restoration began, allowing a very dense sward of pasture grass to develop. The dense sward, along with highly compacted soil prevented the natural establishment of mānuka or kānuka, since these species have a high light demand for germination and establishment. Therefore, the use of managed grazing animals to keep grass cover low before a restoration project should be considered if possible.

» Studies on Tiritiri Matangi have demonstrated that if nothing had been done to enhance restoration processes following the removal of stock in 1971, the island would not now be forested, and it would take many more decades to achieve this naturally[50].

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[49] Allen, J. 2012. Ecology of Restored Forests on Tiritiri Matangi. MSc Thesis. University of Auckland, New Zealand. https://researchspace.auckland.ac.nz/handle/2292/19310 (accessed 12/11/24)

[50] Mitchell, Neil. D. 2013. Tiritiri Matangi Island: what if nothing had been done? New Zealand Journal of Ecology, Vol. 37, No. 3: 261–265.

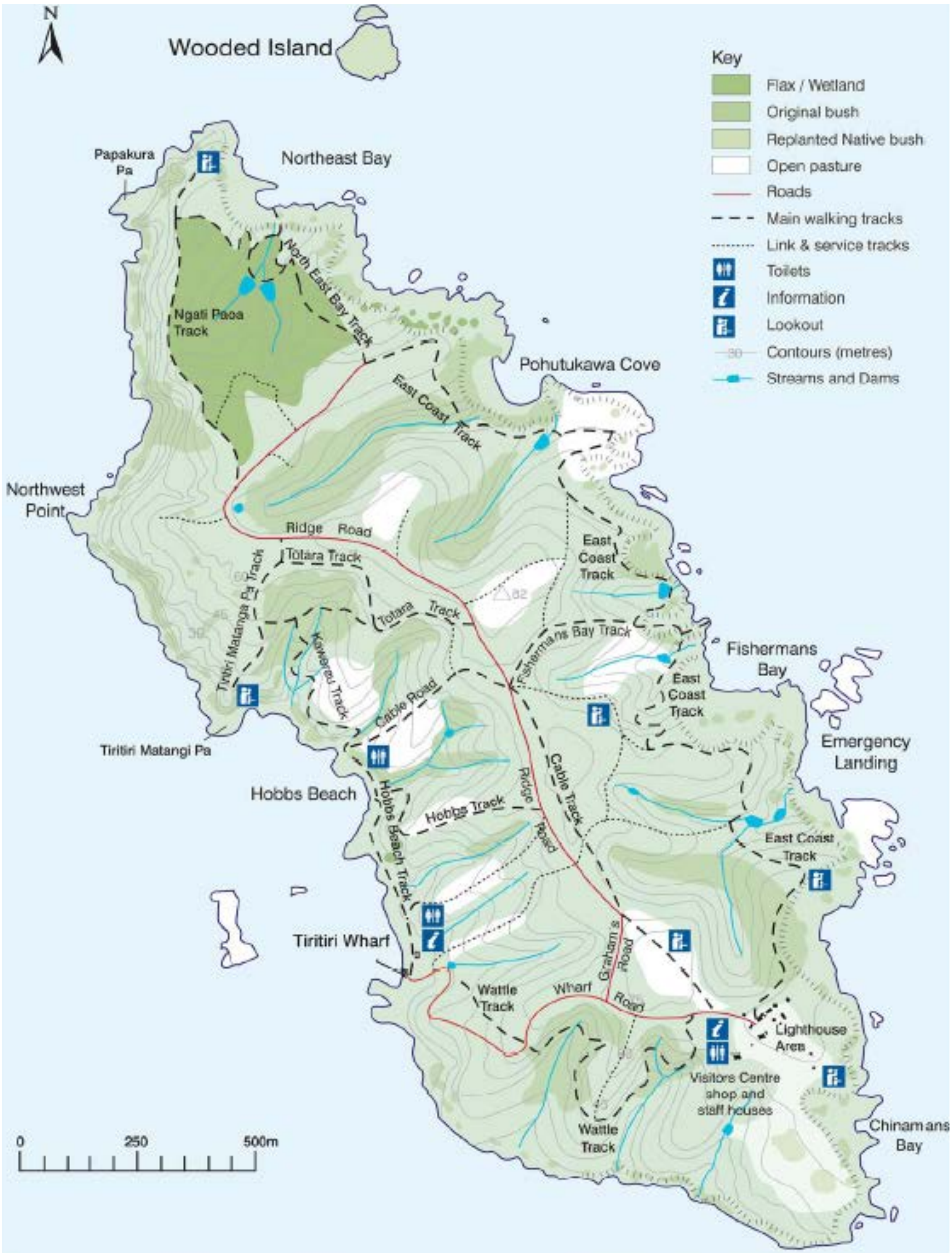

Figure 8-C Map of Tiritiri Matangi Island. Image © Supporters of Tiritiri Matangi Incorporated

8.1.6 Example from Whaingaroa Harbour Care – Raglan

Whaingaroa Harbour Care was an early example of a successful community led environmental restoration project, with the organisation beginning in 1995 to revegetate the catchment and improve the state of their harbour (Figure 8-E).

The group achieved fencing of 95% of the harbour edge (170 km), as well as 450 km of fencing along streams and wetlands. This has dramatically reduced the amount of sediment entering the harbour. Plants were grown from seed in a nursery and planted into riparian buffers or stream corridors of between 7 and 15 metres (Figure 8-D). These stream corridors were fenced to exclude stock, and plants were spaced at 1 to 1.5 m apart. The initial planting mix included flax, cabbage tree, mānuka, tōetoe, kāro, kōromiko, and karamū. These initial planting used PB3 grade plants, to reduce losses through competition with pasture species. The aim was to establish fast canopy closure (4–5 years) to shade out grass and weeds. Further planting was carried out in subsequent years, as needed to increase the species diversity. For example, kāhikatea was planted around wetland areas.

Figure 8-D Restoration plantings completed by Whaingaroa Harbour Care – Raglan, 2006. Images © Adrienne Livingston, Site Specific

Whaingaroa Harbour Care have received funding for plants and planting programmes from various sources, including regional and city councils, Department of Conservation, and Waikato Tainui. However, ongoing management such as weed control is limited by the availability of funding. For this reason, quick canopy closure using high density PB3 grade plantings has been the method most commonly adopted in this project. However, a NIWA study has found that seedling growth under densely planted restoration canopies is slow until natural thinning can occur, so there is a trade-off between weed suppression and natural regeneration.

Figure 8-E Photos demonstrating the benefits of riparian fencing and planting in terms of improvements observed in Whaingaroa Harbour – Raglan. Images © Whaingaroa Harbour Care

8.2 Hawkes Bay Policy Climate Change Projects

Dr Nic Peet – Chief Executive, Hawkes Bay Regional Council

Soil is valuable, so keeping the soil on the land is important. Soil provides several functions, including food production, water filtration, carbon sequestration, habitat for biodiversity, and cultural and recreational value.

Within the Hawkes Bay region, the land provides a competitive advantage. Productive land is created when the correct balance of soils, terrain, and climatic factors are combined with an appropriate land use. An example of this is the Heretaunga Plains where deep loam soils, flat land, and a favourable climate combine to create a unique production zone. Globally and nationally, this combination of natural factors is extremely rare but may not be enough to take this potential and convert it into sustainable production without anthropogenic interventions (such as drainage, irrigation, and management). For example, until 130 years ago, the Heretaunga Plains was a swamp. Major drainage schemes, the addition of irrigation, and outcome-based management has transformed this potential into the core of the Hawke's Bay economy. Other regional examples, with different natural factors and interventions, are the Ruataniwha Plains and the Gimblett Gravels. These areas are the competitive advantage for Hawkes Bay and need to be valued as such.

Just as natural factors can create highly productive land, a different combination of factors can create land that is highly susceptible to erosion. This is further exacerbated by poor land management decisions. For example, steep land with shallow soils and on unstable geologies is naturally susceptible to erosion. These factors are further compromised by changing the land use or land cover from deeper rooted tree cover to pasture. It is during extreme events, such as large storms or cyclones, that these land use decisions are brought into sharp focus, particularly downstream.

Within the Hawkes Bay region, there is approximately 252,000 hectares of highly erosion prone land, which equates to around 3.2 million tonnes of sediment lost into the region's waterways every year (Figure 8-F). If all that land was planted, then there could be an up to 90% reduction in sediment lost from the catchments (SedNet). Hawkes Bay Regional Council (HBRC) have an ambition to plant 100,000 hectares, which would reduce sediment yield by 50–60%.

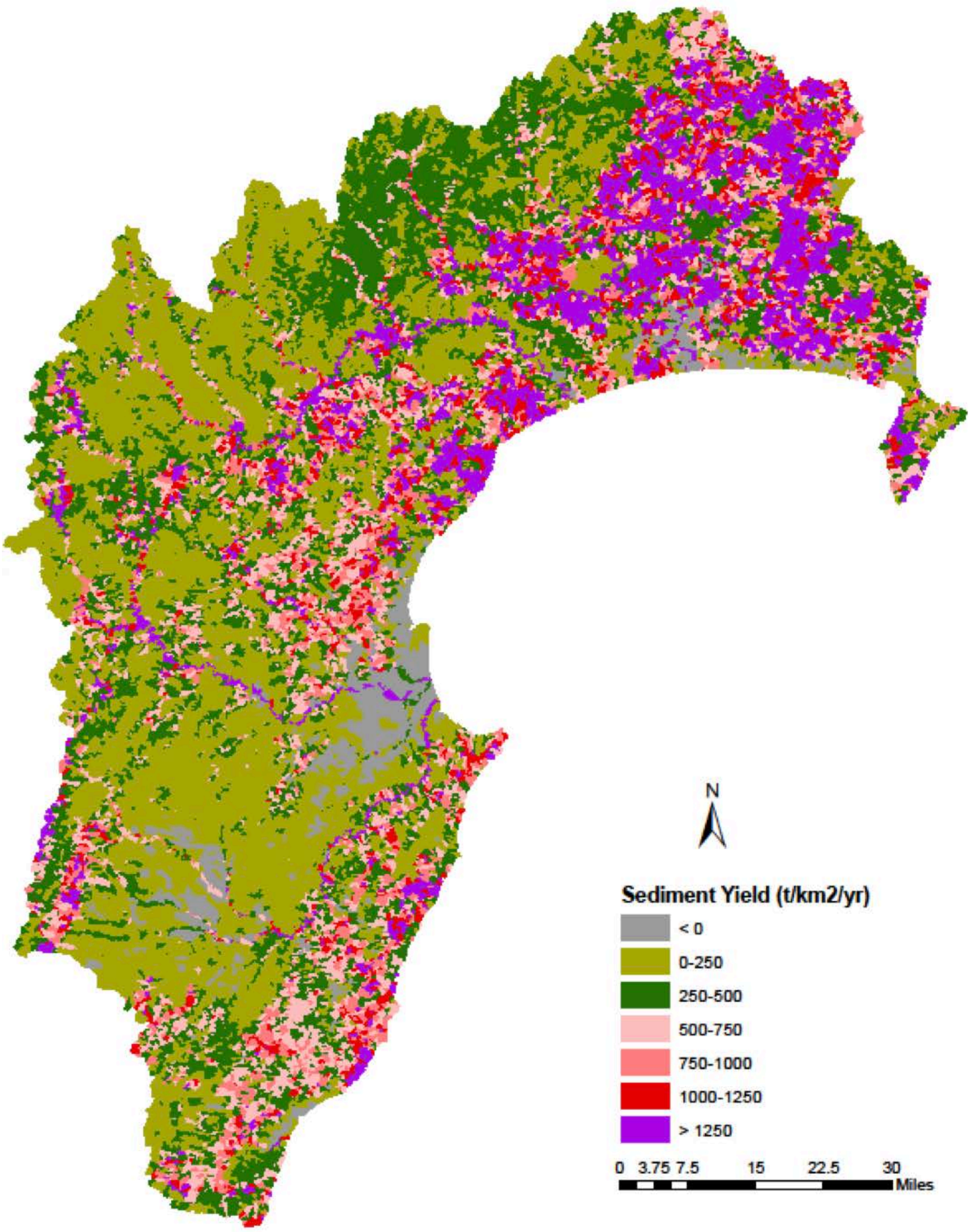

Figure 8-F Hawkes Bay region sediment yield map. Image © Nic Peet

Soil erosion has a big impact on land in Hawkes Bay. Over 300,000 landslides occurred along the East Coast after Cyclone Gabrielle, each typically involving approximately 1,000 tonnes of soil[51] (Figure 8-G). Around 61% of the cyclone damage was located in the Hawke's Bay and of that, 63% was located within in high producing grassland, while only 13% was in exotic forest land use. Modelling has shown that woody vegetation would reduce the landslide probability by 90%.

51 Manaaki Whenua Landcare Research 2023. Rapid assessment of land damage – Cyclone Gabrielle. Report prepared for Ministry for the Environment. Maanaki Whenua Landcare Research Report No. LC4292. 34 p.

Figure 8-G Post cyclone view of land in Hawkes Bay. Image © Nic Peet

Soil erosion is affecting Hawkes Bay regions rivers, lakes, estuaries, and coast, with estuaries being the most at-risk coastal environments because they are the depositional endpoint for contaminants (including sediment) from the river. Soil from land made up 98% of coastal sediment deposits post cyclone. This has resulted in impacts on marine and freshwater ecosystems, with almost half of the state of the environment monitoring sites in Hawke's Bay's rivers being moderately to highly impacted by suspended sediment. The mechanism for this impact is that sediment smothers organisms, their food sources, and their habitats. Sediment abrades and damages gills, clogs up filter feeders with indigestible silt/clay, limits fish ability to see prey, limits water clarity for native macrophyte and seaweed growth (which means less habitat), and smothers habitat and refugia (there is no refuge if it is clogged up with fine sediment; Figure 8-H).

In the face of the erosion and sediment challenges outlined above, what are HBRC doing to improve the situation? Initiatives include the Erosion Control Scheme (ECS) which provides financial support for erosion control work, the *Land for Life* partnership, research and investigations to develop tools and solutions, and rural partnerships.

The Land for Life partnership is a collaboration between HBRC, Ministry for Primary Industries, and The Nature Conservancy Aotearoa New Zealand (www.hbrc.govt.nz/environment/farmers-hub/land-for-life/). Land for Life is a process where the landowner is in full control. It takes a holistic look at the biophysical farm system, considers optimal land use options (including optimising the pastoral platform, forestry, agro-forestry and native revegetation), models financial returns, creates an integrated Farm Business Plan, and links the owner to financing entities, technical assistance, and implementation entities if required.

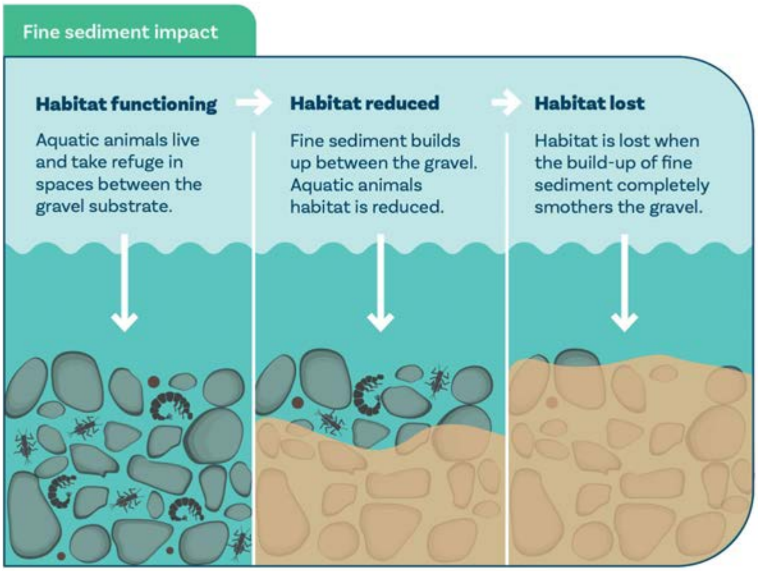

Figure 8-H **Impacts of fine sediment.** Image © Nic Peet

8.3 Kaipara Moana Remediation

Justine Daw – Pou Tātaki, Kaipara Moana Remediation

The Kaipara Moana catchment covers an area of 6,000 km² (600,000 hectares) and falls within both the Northland (75%) and Auckland (25%) regions. There are seven major river systems within the catchment, including around 3,500 sub-catchments, 16,200 km of river and stream banks, and nine planting eco-districts. One eighth of the catchment is highly erodible and there are an estimated 1,500 pastoral landowners with greater than 20 ha of land.

Kaipara Moana Remediation (KMR) work across this huge catchment, with the entire area draining into Kaipara Moana. The Kaipara Moana is the largest natural harbour in the Southern Hemisphere and one of the largest in the world. Sediment is the core contaminant to the Moana and the main challenge facing this catchment. Therefore, KMR's primary focus is to work with others to reduce this sedimentation. More than seven times the natural rate of sediment is flowing into the Kaipara Moana every year. This is around 700,000 tonnes of sediment per year. This sediment smothers river and sea beds and reduces light penetration through the water. It has major impacts on life, such as shellfish, fish, and seagrass, and flow on impacts on economic, tourism, recreational and cultural values. The valuable soils of the catchment are best when they stay on the land where they started.

KMR have found that building an economic case for protecting and restoring the harbour was really important. For putting a business case together, it is important that the numbers make sense economically and that the cost benefit stacks up. In the case of KMR, research has shown that sediment is affecting the snapper fishery, among other environmental impacts. Snapper is New Zealand's top commercial inshore fisheries catch and contributes around $35 million in exports per year, $69 million to GDP, and provides approximately 570 jobs. Therefore, the economic value of the snapper fishery is significant and a snapper fishery collapse would be very costly, not just as a 'one off' cost, but in terms of reduced national wealth and jobs every year. These numbers certainty help to highlight the relative cost/benefit of the investment in KMR.

KMR is underpinned by a memorandum of understanding (MOU), which formalises the commitments of signatories including the Crown, Councils, and Kaipara Uri. The MOU was signed at Waihaua Marae on 9 October 2020. The MOU formalised the Crown and Council funding contributions, committed to establish a KMR Joint Committee for governance purposes and set out KMR's vision, operating principles, and investment objectives. This was an important foundation to ensure that KMR is sustained and supported through to 2031, as a ten-year programme.

KMR protects and restores the Moana, with an aim to halve sediment flows into the Moana. While KMR have a primary focus on sediment, there are clear co-benefits of the programme, including diversifying on-farm income, helping farmers to meet environmental standards for carbon and biodiversity, increasing resilience to storms, floods and other extreme weather, and helping valued species to thrive. The project is a Jobs for Nature initiative and, as such, it includes a focus on creating new local jobs, training, and career pathways. The funding includes $100 million funded by the Crown, which is unlocked by matched co-funding (Councils are contributing $10 million each and $80 million is to be met by landowners or others). Governance of the project comprises of the Crown (Ministry for the Environment), Kaipara Uri, and Councils (Northland and Auckland).

The KMR operating model has several key benefits. The first is collaborative governance, where decision-making integrates scientific, cultural and local priorities. The next is investing in people, with tailored training, mentoring, skills development, and career pathways for intergenerational action. Another is catalysing on-the-ground action, by working 'with-and-through' others to engage landowners and communities. The final benefit is wrap-around support, where trained field advisors 'walk alongside' landowners to optimise projects. KMR has locally based field advisors all over the catchment and when landowners contact KMR, one of their field advisors will be in touch to line up a visit.

KMR is a voluntary programme; they only work with the willing. There are a growing number of strategic partnerships that help KMR to reach landowners and groups and unlock KMR investment (Figure 8-I). These channels are important, as over 60% of landowners come to KMR through word of mouth.

Figure 8-I Partners committed to Kaipara Moana Remediation. Image © Justine Daw

KMR uses a landscape approach to sediment reduction. If you look around the landscape, you can see lots of examples of the activities that KMR can co-fund. For example, fencing of and/or planting waterways and wetlands, fencing of existing bush blocks to exclude stock, managing erodible hill country through stock exclusion fencing (for native planting and/or natural regeneration on areas to be retired), space planting poplars in grazed areas, and afforestation with non-pine species such as redwoods and eucalyptus. These types of activities are the basis for a whole of landscape approach to reducing sediment (Figure 8-J). The goal of this approach is to de-risk the landscape by cloaking it in ways that are appropriate.

Figure 8-J **The whole of landscape approach to reducing sediment in the Kaipara Moana catchment.** Image © Justine Daw

The KMR has locally based field advisors all over the catchment who visit landowners to provide free advice. The field advisors walk the land with landowners and discuss their aspirations and project options with no obligations. The field advisors then prepare a plan for the landowner to access KMR funding for their project, with KMR typically paying up to 50% of the cost of eligible sediment reduction projects. For collectives/groups, KMR also supports some engagement and project management costs.

Scaling up the remediation is where KMR are at now. There are now hundreds of landowners and groups involved (currently about 900) and working together to develop sediment reduction projects that KMR can co-fund. With 781 plans prepared and 118 more in development, landowners and groups over more than 899 properties are already taking action, with many now on their second or third project (Figure 8-K).

In terms of the challenges that KMR have faced, the KMR team have experienced the same COVID challenges as everyone else, as well as facing some challenges specific to Auckland and Northland, particularly in relation to extreme weather events. However, landowner sentiment is positive and surveys validate the KMR direction and approach. Two independent surveys of the landowners and groups working with KMR confirmed high levels of satisfaction with engagement, support, and the approach to granting. The vast majority of those surveyed 'agreed' or 'strongly agreed' that their interactions with KMR were positive (88%) and their questions were answered adequately (86%). The vast majority of those surveyed found it 'easy' or 'very easy' to obtain the information (81%) or advice (83%) they needed from KMR.

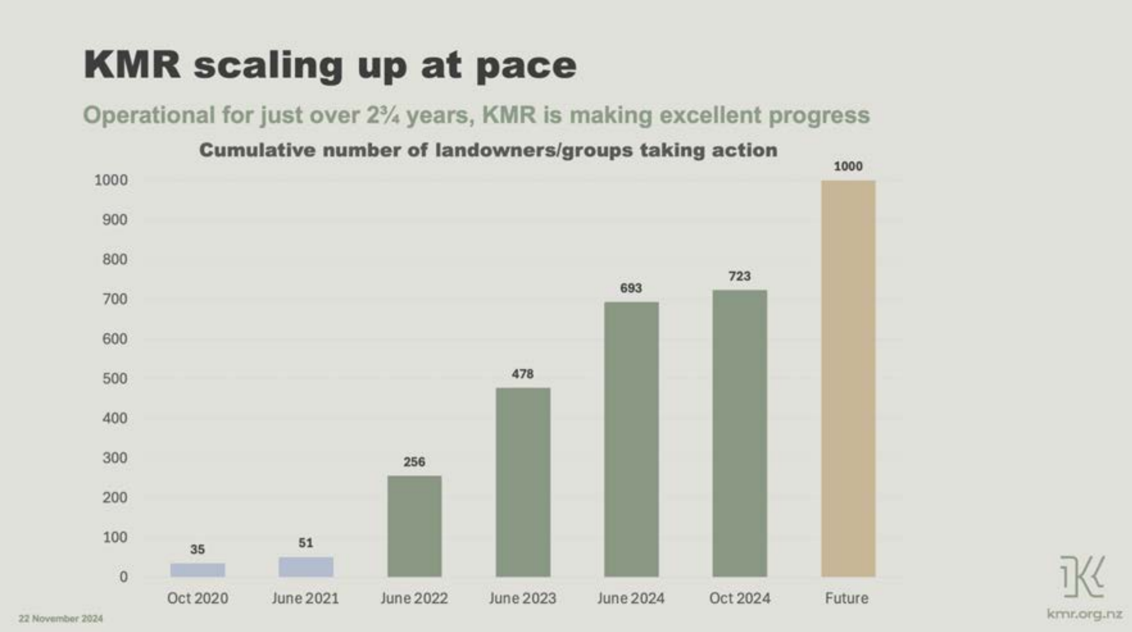

Figure 8-K Scaling up the remediation at Kaipara Moana Remediation (KMR). The green bars represent KMR activity of landowners and groups working with KMR, while the blue bars represent work undertaken in this space before KMR came about, largely led by regional councils. Image © Justine Daw

Outcomes of KMR, related to engagement and participation:

» KMR has engaged with over 1 in 2 pastoral landowners in catchment.

» Thousands of meetings with iwi/hapū, rural professionals, community, and landowners.

» >100 hapū, marae, schools, and community groups engaged.

» 92 group-led projects underway or in development.

» 1,208 landowners have expressed interest in KMR.

» 781 sediment reduction/Tiaki Plans completed with landowners (48% dairy, 38% drystock, 6% lifestyle, 5% other), and 118 more Plans in development.

Outcomes of KMR, related to skills and jobs:

» 28 local businesses and 19 nurseries accredited as KMR suppliers.

» Over 370,000 hours of new work created – a year's work for over 237 people (estimated at 31 March 2025).

» A further 92,000 hours of new work committed in contracts (estimated at 31 March 2025).

» 57 people trained as KMR Field Advisors – many from local iwi/hapū.

» To date, KMR has supported 217 people into other, relevant training (estimated at 31 March 2025).

» Over $22 million in project value invested or contracted, supporting local employment.

Outcomes related to nature and resilience:

» >2.08 million plants planted or contracted for planting.

- >959 hectares of land planted, contracted to plant, or regenerating into native forest.
- 924 km of fencing completed or contracted – the same distance as from Cape Rēinga to Palmerston North.
- >130,000 hectares are managed under Plans.

Part of KMR's success is attributable to the digital tools it has used to rapidly scale up its activities. The digital tools for farm planning are a simple, consistent, and science-based process for sediment reduction planning and grant delivery. The digital tools act as a one-stop-shop for the KMR project. Guided decision-making supports field advisors and landowners to identify, develop, and deliver projects, which enables optimised investment in sediment reduction. Property-scale risk assessment aligns to catchment context and supports prioritisation of KMR investment to high-impact projects. The spatial layers that are embedded in the digital tool support consistent use and interpretation by all users and provide for scalable relationship management and project delivery. Assigning users, notifications, and monitoring 'time in status' assists effective project management, supports smooth communication between contributors (e.g., field advisors, technical mentors, project reviewers), increases transparency between partners, and improves efficiency at all stages (e.g., planning and reporting).

The digital tools also contribute to growing collaboration, connectivity, and capability. Insight into local activity and collaboration supports landowner engagement and subcatchment efforts. The digital tools enable collaboration between field advisors, technical mentors, and reviewers, and supports tuakana/teina (mentoring) relationships between advisors. There is also potential for landowner direct access to the digital tools. The tools make the work verifiable, with structured accounting, monitoring, and reporting capabilities to track actions and dollars and contribute to an understanding of what is being done, where, and by whom. The integrity of this data and decision-making supports future collaborations with third parties such as banks and investors. For example, the calculations of area and stems planted that the digital tool provides assurance and confidence in the reporting.

To summarise, KMR's unique operating model rapidly 'scales up' environmental action in the following ways:

- Collaborative governance brings together central and local government and iwi/hapū to enable equity-based decision-making. With shared ownership, KMR integrates scientific, cultural, and local priorities in investments.
- KMR catalyses on-the-ground action by working 'with-and-through' local iwi/hapū, groups, and businesses to engage communities, scope restoration projects, and deliver grants across seven major river systems.
- KMR invests in people through tailored training, mentoring, and skills development. KMR develops career pathways for intergenerational action.
- KMR provides wrap-around support to project leaders, with trained field advisors walking alongside landowners to optimise projects.

However, KMR also face some less self-evident challenges. While they cannot change the geography of their catchment, which is fragmented and not easy to travel around, they can adapt the delivery model to suit. Because of this, having local boots on the ground is a critical success factor for KMR. They also play a role in shining a spotlight on misinformation, through their comms and engagement activities. However, they hear regularly from pastoral landowners that they want policy and regulatory certainty before they sign up to KMR. Landowners want to know that projects undertaken with KMR will ensure future compliance with policy and regulation.

Success factors and learnings may be gained from KMR's experience. KMR is an agile organisation and has evolved their settings as needed. It takes time to get something new up and running, particularly if you are working with and through others locally. KMR is essentially a $200M 'start up', so they needed to adapt and pilot new approaches as a learning organisation. Being an umbrella or backbone organisation has had many advantages, including being time and cost efficient. In particular, KMR ensures that landowners and groups taking action have immediate access to the advice and support they need to take action straight away, without having to identify themselves priority areas on farm, priority actions that most make a difference to environmental outcomes, the right places to plant trees/plants, the right species for planting in each location, or which areas on farm are best to retire from an economic standpoint. KMR methods are delivering outcomes, and they freely share their methods (open IP). They are using experts as needed and adapting 'tried and true' methods in preference to reinventing the wheel. They are also piloting novel approaches and these either fail fast or get scaled up if working well. They have gained an understanding of how environmental bottom lines amplify action, with incentives not sufficient alone (although they help). The people on the ground working with landowners are KMR's critical point of success or failure – this on-the-ground time is crucial as it really does take time to engage landowners in a highly-technical and voluntary programme.

KMR is designed to be an exemplar, and they regularly share their learnings with other programmes aiming at large-scale restoration. KMR's resources are available through Tūhono Taiao, which is a national digital platform for environmental projects and programmes to share their resources (www.tuhonotaiao.org.nz).

9 WHAT COULD FUTURE SOLUTIONS LOOK LIKE – WORKSHOP

9.1 Purpose & Context

Chaired by Dr Rāwiri Tinirau and Rosemary Miller, the purpose of this workshop was to keep exploring solutions to address the issue of fine sediment in the catchment. The session began with a brief recap of the information learnt the previous day and worked towards building ideas for actions to address the known issues for the catchment. The purpose was to identify some big actions and the stepping stones for getting there. This workshop was run by groups working together to answer the questions presented, with participants asked to think broadly, including social, cultural, environmental, and economic considerations in their thinking.

Questions asked were:

- What are the unique challenges for finding solutions in this catchment and ideas for addressing them?
- What are some of the 'out-of-the-gate' solutions?
- What are the unique opportunities for finding solutions in this catchment?
- How could we scale up work already happening in the catchment?
- What single action can you (as an individual/hapū or as an agency) do now?

9.2 Outcomes

Participants recognised several challenges that the Whanganui catchment faces in terms of finding solutions to the issues that have been identified. These included:

- Geology and climate change.
- The past, and that we can't slow the future.
- Lack of high-quality data to support decision-making.
- Constant change in relation to carbon and forest investment that holds investors back from planting because they are waiting for the uncertainty to decrease.
- Economic disincentives for retiring land and the control that commercial banks have over on-farm changes.
- Fragmented policies and values.
- Economic drivers conflict with values.
- Lack of political will, leadership, and accountability.
- Lack of regulation and stability in regulation – for example, the Freshwater Farm Plan system.

With these challenges in mind, participants put forward ideas that could be explored and implemented for the catchment. These ideas have been collated and presented in themes below.

9.2.1 Advocacy, Education & Engagement

- The coverage and momentum of catchment groups and land care groups is growing, and it is important that landowners get on board.
- Those in the room are already on board – how can we bring others on the journey? There is a need to get people involved so that they can be informed.
- There may be a place for catchment networking and communications – utilising channels such as podcasts and social media to reach a wider audience.
- Support non-Māori to join this journey.
- Keep listening to the uri of the Awa.
- The buy-in of people at place requires some education and understanding of te taiao issues.
- Te Awa Tupua/Tupua te Kawa in practice – the guiding principles of Tupua te Kawa are applied to the management of Te Awa Tupua.
- Te Awa Tupua legislation may be used for leverage.
- Support and understanding of Te Heke Ngahuru – Te Heke Ngahuru ki Te Awa Tupua is the strategy for Te Awa Tupua. The name symbolises the potential of Te Awa Tupua to provide for all if cared for and protected as a living spiritual and physical resource.[52]
- There is a disconnected and fragmented approach to improving this catchment now, with both individuals and organisations working independently – a collective approach should improve outcomes.
- We want our tamariki to fall in love with their whenua – can we get catchment groups to do this for water?
- Educate our tamariki/mokopuna to be tāngata tiaki.
- Support the youth movement to embrace the Whanganui catchment.
- Keep talking about Te Awa Tupua and its health and well-being – ongoing hui and showcasing examples of good mahi.
- Ongoing hui to support collective action with ~123 hapū and 8 iwi.
- Support education wananga/programmes – e.g., Te Morehu Whenua (rangatahi and tamariki led environmental group of the hapū of Rānana Marae) and ngā rangitira mō āpōpō (Leaders for Tomorrow).
- Promote good examples of farm sediment management to the community (e.g., the work of Morikau Station).
- Growing empathy and an understanding of what is achievable given the current environment is important – this may require the setting of SMART goals and actions for the catchment.
- The formation of reciprocal relationships can be beneficial – e.g., kura, iwi, organisations, local government.
- Communicate sediment goals and engage with the wider Whanganui community – an example would be to set up a visual representation in town of how far to a sediment reduction target we are (similar to the 'thermometer' signs you see when people are displaying their fundraising targets).
- Establish a central organisation or catchment collective to share what is working in the catchment – e.g., as for the KMR.
- Establish a scheme such as Te Awa Tupua Environmental Awards to provide for recognition and motivation – a monetary prize could be awarded to be spent on more environmental mahi.

[52] www.ngatangatatiaki.co.nz/our-story/ruruku-whakatupua/te-kopuka-na-te-awa-tupua

9.2.2 Economic Drivers & Funding

- Concerns over economic drivers influencing the catchment:
  - Economic drivers conflict with values in the catchment.
  - Commercial banks have control over on-farm changes and there are economic disincentives for retiring land.
  - Banks have an influence on policy about regulating and retiring steep land that should not be farmed.
  - Constant change in relation to carbon and forest investment holds investors back from planting because they are waiting for the uncertainty to decrease.
- Suggestions on what needs to be done to overcome economic influences:
  - Liquidate sheep farms.
  - Crown pay market value for retirement of land.
  - Decolonise land use and indigenising values.
- Economic issues to consider with any changes in land use:
  - Transitioning farmers off the land – but there will need to be a way to pay for control of pests once the land is regenerating back on a large scale.
  - How to keep iwi land producing if not farming?
- Possibilities for funding land use change and mahi within the catchment:
  - Government funding.
  - Land settlement funding.
  - Private funding.
  - The Nature Conservancy.
  - Corporate sponsorship.
  - Accreditation and provenance marketing based on SLUI (Sustainable Land Use Initiative)/FAP (Farm Assurance Programme)/Taiao.
  - Utilise impact investment funding – e.g., Toha Network (www.toha.network).
  - Emissions Trading Scheme – for native plantings.
  - Invest carbon credits locally.
  - Funding from commercial forestry companies.
  - Tourism potential.

9.2.3 Policy & Regulation

- How can policy and regulation contribute to improving environmental outcomes in the catchment:
- Change regional plan to incentivise mitigation activities.
- Reduce barriers to restoration – opportunities through the Horizons Regional Council Oranga Wai/Our Freshwater Futures programme.

- Regulation doesn't work in isolation – if regulation is the only tool used to get landowners to do things, people only do the minimum they can get away with. Regulation needs to be combined with farmer/forester and farm/forest specific information, education, and advice on where and how to succeed with environmental improvements that will reduce sediment in the Awa. The availability of financial help is also important.
- The Emissions Trading Scheme (ETS) settings for native vegetation could be improved – currently the ETS is a black hole that is hard to get your head around.
- Government policy should recognise carbon accumulation from native forest – regenerating canopy, understory following goat and red deer control, regenerating birds/biota/soils, regeneration from old logging.
- Te Awa Tupua biodiversity credits.
- Land settlements – carbon credits will not go offshore.
- Recognition of Te Awa Tupua within policy and on farms.
- The shaping of strategies to support the mahi.
- Improved stability of regulation – e.g., the changes to the Freshwater Farm Plan system.
- Improved understanding on the effects of rules and regulations – e.g., what analysis has been done on past period of the One Plan and status of projects/initiatives such as farm plans, development, commercial forestry. Have the rules worked to achieve what they set out to achieve? How is compliance and complaints analysed?

9.2.4 Land Management – Agriculture & Forestry

» Move away from clear-fell harvesting of entire forests.

» Encourage continuous cover forestry, or at least plant coppicing trees so that the tree stays alive and re-grows after harvest.

» Stop farming meat within the catchment and encourage wild protein.

» Can hapū be in included in the plantation plan process for consideration on areas to be harvested – tāngata tiaki as part of the implementation process.

» Focus on low hanging solutions – long term effects.

» We need fast changes now in the forestry industry and farming agriculture.

9.2.5 Practical Land Management Tools

» Implementation of the SLUI programme – how can this be leveraged? Excellent examples such as Morikau Station.

» It takes on average 88 years to implement a SLUI farm plan – why does it take so long and what are the barriers?

» Wetlands throughout forestry areas – need to make wetlands in the gullies, capable of intercepting fine sediment.

» Rain gardens/hydraulic neutrality/soakage areas for new papakāinga and urban development.

- Root systems – adapt, pivot, do well, keep doing well, tried and true methods.
- Using trees to heal soil – how to do that in paddocks, regenerative grazing, and land management.
- Coppice the trees for food for stock – ability for trees on the whenua to provide both soil retention and stock feed.
- No till cropping – reduces topsoil erosion and topsoil oxidation/loss of organic matter.
- No spray and pray – spray and pray is a nickname for using roundup spray to kill pasture and then helicopter oversowing of a fodder crop or improved pasture. The farmer then prays for rain, so that the crops grow. This is now illegal for winter cropping on slopes over 10 degrees.
- Emerging actions – e.g., land management techniques to maintain or improve soil carbon stocks have potential to contribute to reducing atmospheric carbon dioxide.
- How can trees increase livestock and pasture production?
- Install a predator fence around the whole catchment.
- Green corridor – create full enclosure of Whanganui National Park/catchment.

9.2.6 Alternative Crops & Land Uses

- Perennial wheat – this is an alternative to the annual crop that requires tilling the soil. Greatly increases soil retention, carbon storage and resilience to weather events. Unsure if you can grow wheat in our catchment though.
- Understand the tourism potential of the catchment – barely reaching tourism potential at present.
- Native silvopasture - organise a trial in the catchment.
- Microbe fermentation company – this is an option for replacing the protein we currently get from animals. It has about 60% protein, can be used in a manner like flour to make all sorts of products such as pasta, pancakes, scones, etc. It uses a very small amount of land and a very small amount of water. We could retire the farms in the catchment and have an alternative job option for the farmers.

9.2.7 Pest Management

- Pest species are having impacts on native understory and erosion.
- Install predator fencing around the whole catchment – pest free.
- Green corridor – full enclosure of Whanganui National Park/catchment.
- Have pest control hunting teams working their way down the maunga (goats, pigs, deer) and build fences behind them as they go.
- Pest killing drones – Playstation or Xbox or virtual/real games driving drones to remove pests.
- Pests are a big problem for regenerating bush on farms. Need a catchment approach to pest management. We do not hunt everywhere. We do not need all the pigs and deer we have in our bush. So, calculate:
    - How much meat is needed per year from hunting (for whānau, tangi, hui, recreational hunting)
    - How many deer and pigs that roughly equates to.

- Add on some for replacement and redundancy because you won't catch every animal.
- Work out how much area you need to support that number of animals.
- Work out the areas where people mostly go hunting.
- Overlay these two things and designate those spaces hunting areas.
- The rest gets intense pest control.

9.2.8 Technical/Science/Monitoring/Information Gathering

» Lack of high-quality data to support decision-making – e.g., Light Detection and Ranging (LiDAR).

» LiDAR can identify priority sediment sources on farms to target funding/advice/regulations. Funding would be required for Manaaki Whenua Landcare Research to make the slip risk and sediment risk maps.

» LiDAR erosion map for Whanganui catchment – would provide important information for farmers, catchment groups, and to inform policy. It would help identify priority sediment sources on farms and across the catchment.

» Photogrammetry slope is as good as LiDAR for identifying erosion risk on farmland – it just does not see under trees. This can be made available from Horizons Regional Council for specific farms/properties.

» Use AI to identify hotspots.

» Sea grass in Whanganui? What is its status? Could we have more of it? The proposed South Mole renewal is a major threat to the estuary. There is discussion about hard engineering right to Corliss Island. That would take out the estuary on the true left, where there are juvenile pipi living.

» Kaipara Moana Remediation (KMR) – digital tools – what and accessible to who – did they develop these themselves?

» Bring back moa (and tuna and pīrahau and ngaore).

» Monitoring in remote locations (e.g., Pipiriki, Rānana) – could tāngata tiaki be designated as compliance officers for their remote areas to monitor/report/do enforcement.

9.2.9 Instream Remediation

» Use of chiton flocculants as an immediate action.

» Leaky weirs – an example of a tool that improves water retention in the landscape, by slowing and filtering water flow. You would need lots of these across the catchment to make a difference, but they have the added advantage of providing habitat to streams when done well.

10 APPENDICES

10.1 Figures from Manaaki Whenua Memorandum

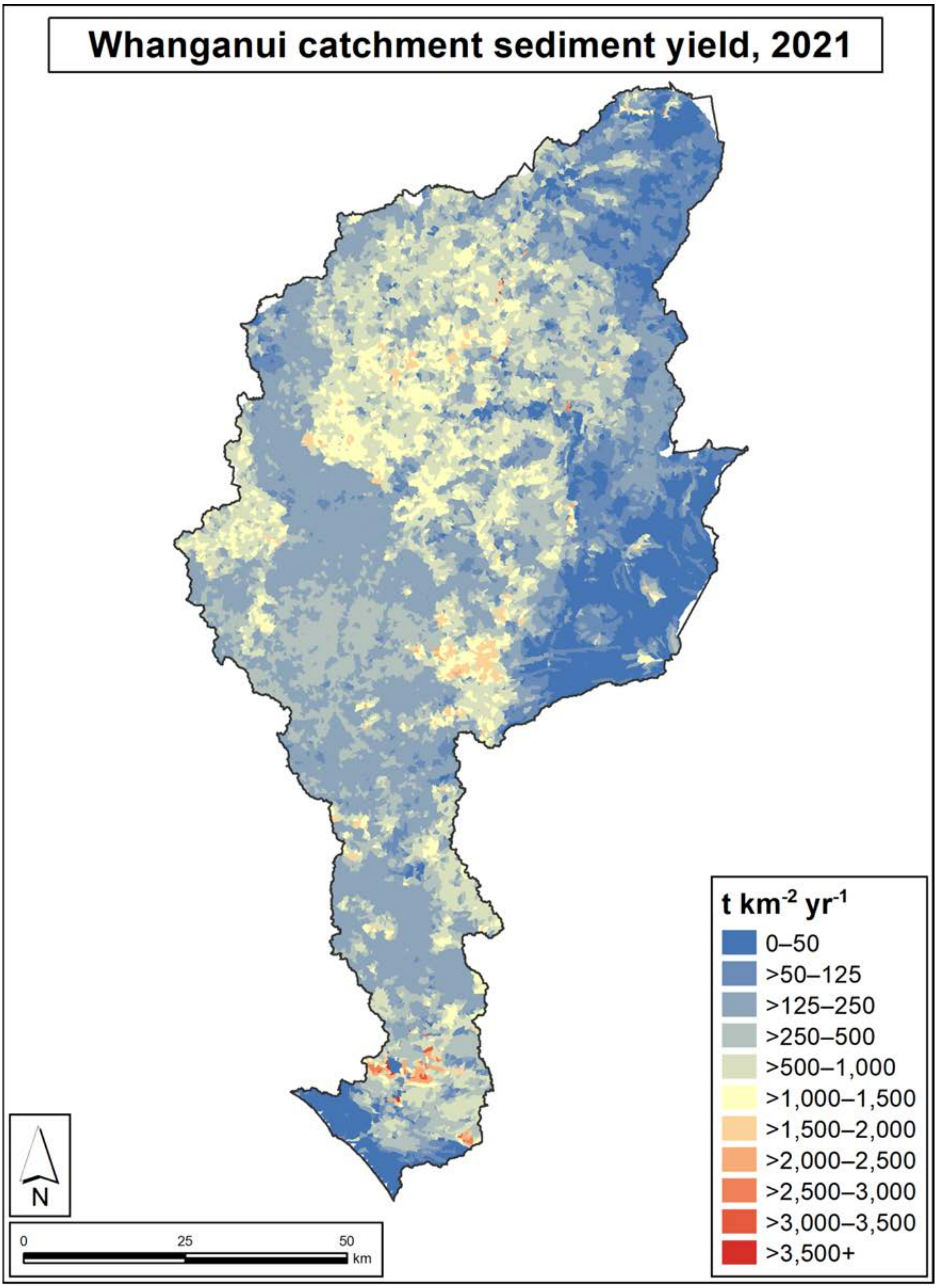

Figure 10-A Contemporary baseline (2021) mean annual suspended sediment yield for the Whanganui catchment.

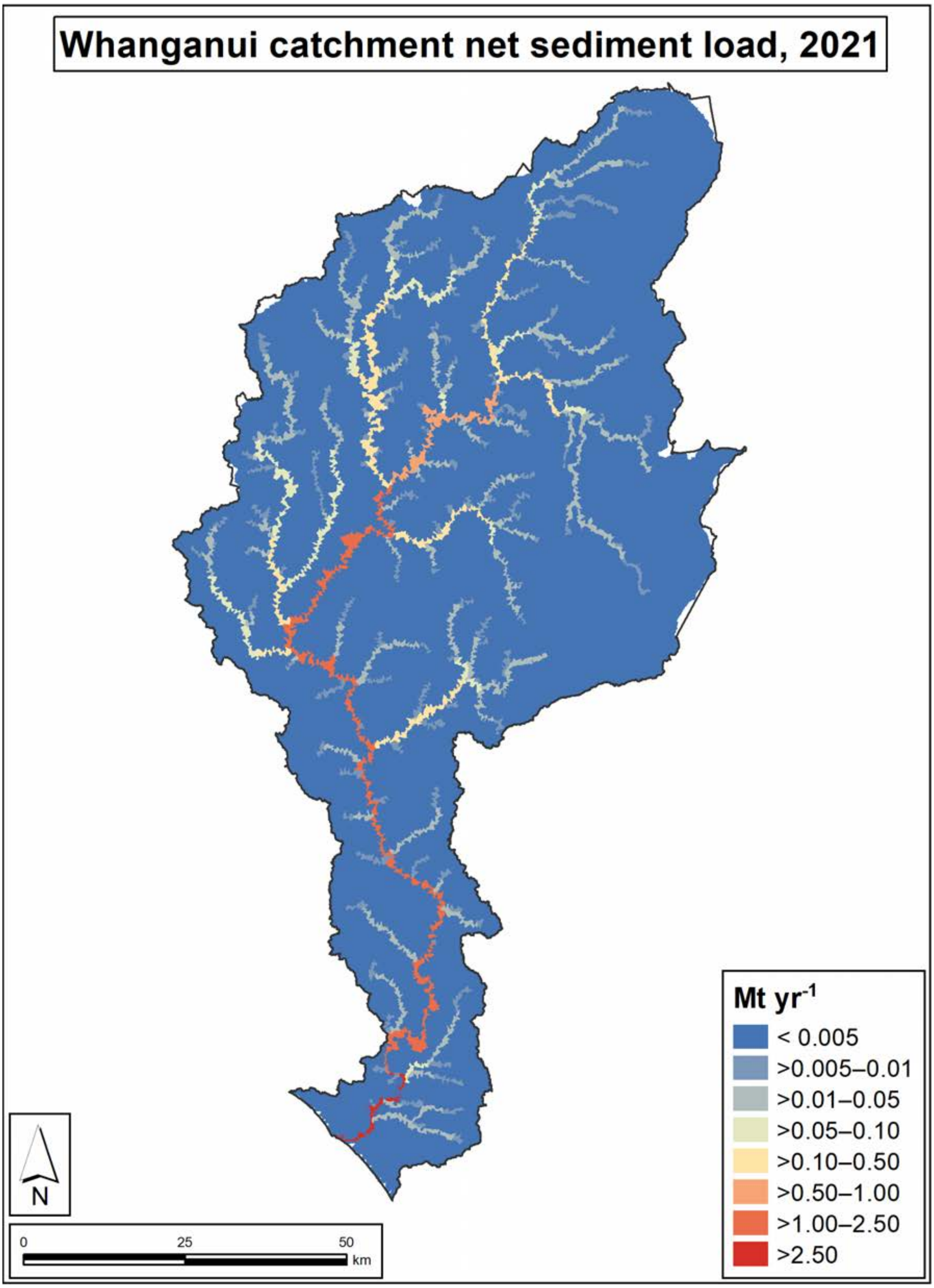

Figure 10-B Contemporary (2021) mean annual net suspended sediment load for the Whanganui catchment.

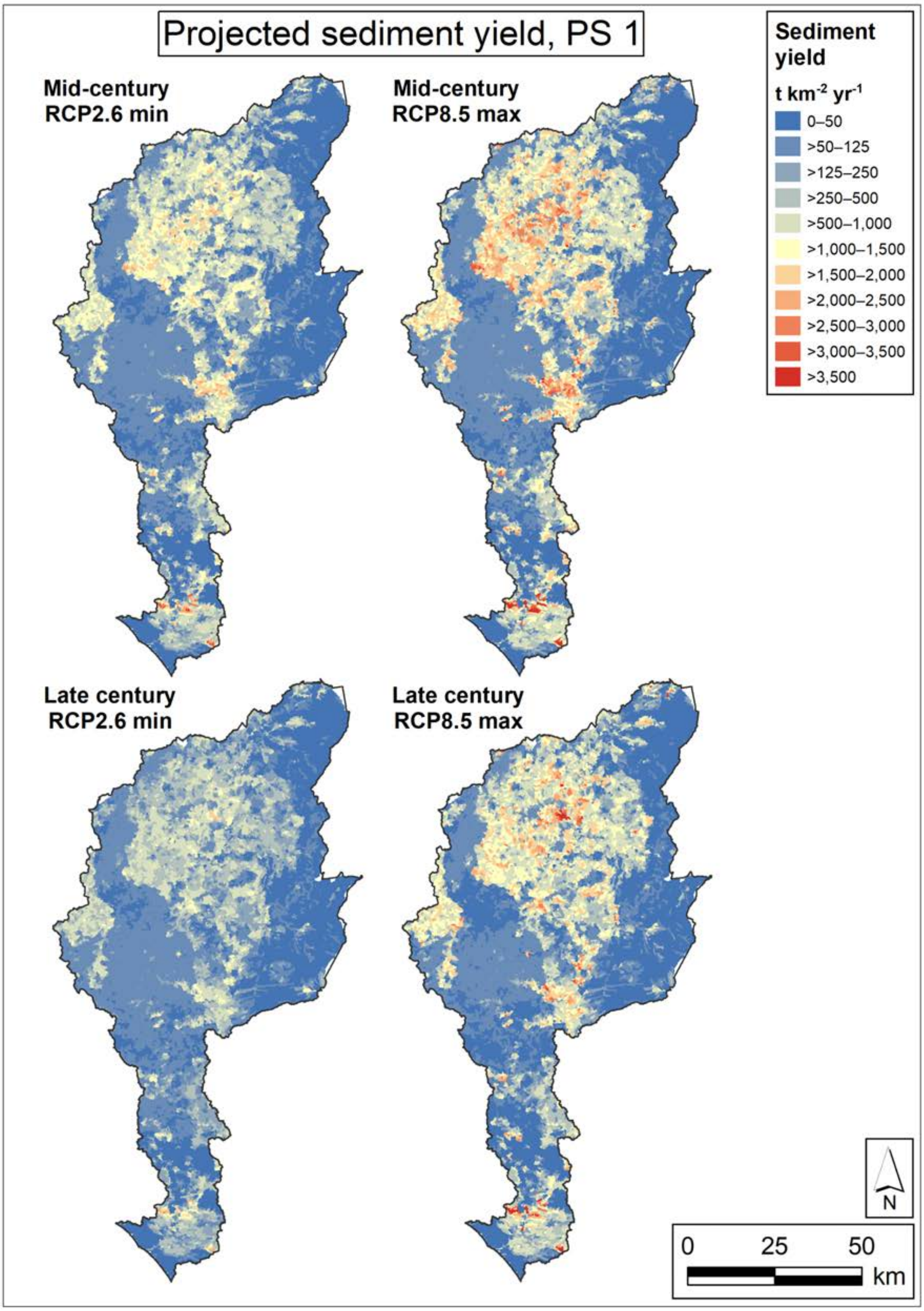

Figure 10-C Projected mean annual suspended sediment yield at mid-century (2040) and late century (2090) under future climate change scenarios represented by RCP2.6 minimum and RCP8.5 maximum for the Whanganui catchment.

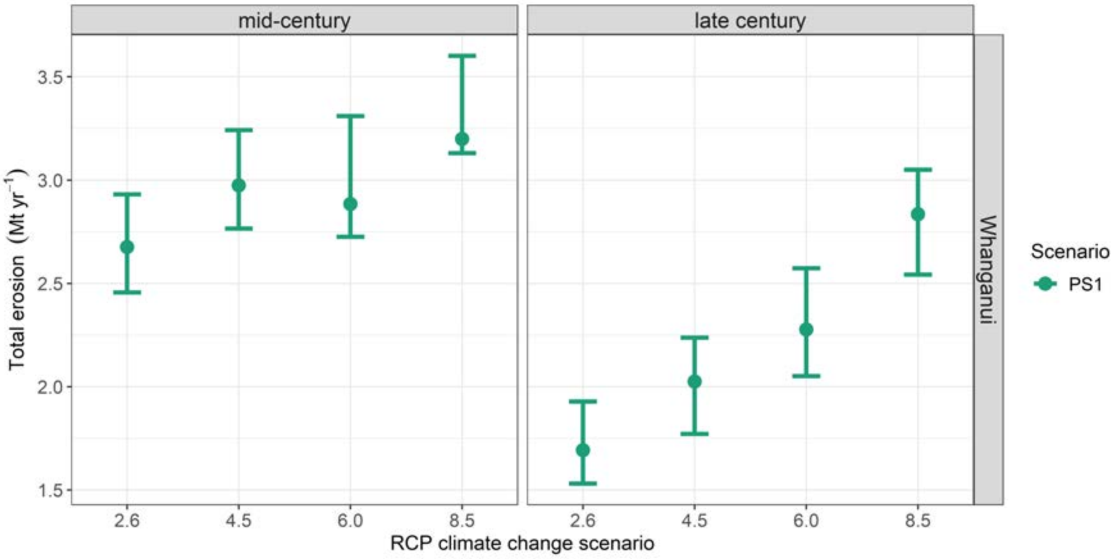

Figure 10-D Predicted total erosion load for mid-century and late century under future climate change represented by minimum, median, and maximum for each RCP, Whanganui catchment.

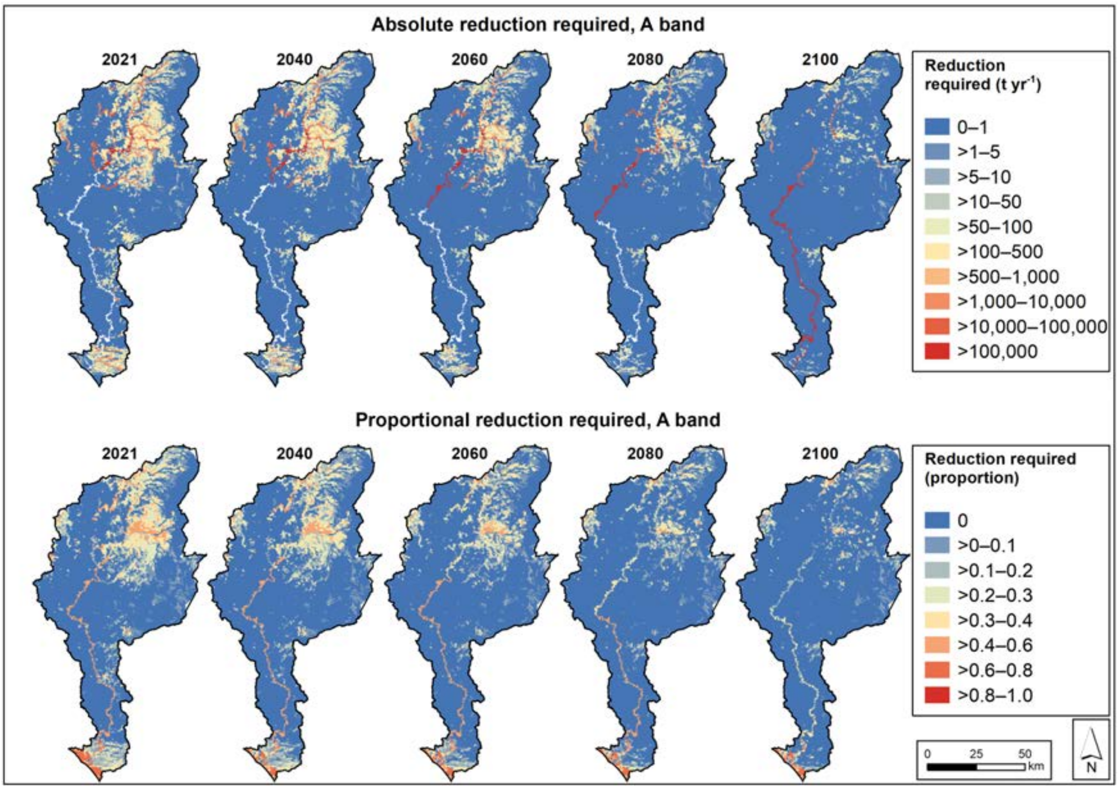

Figure 10-E Absolute and proportional sediment load reductions required to achieve NPS-FM visual clarity Attribute Band A.

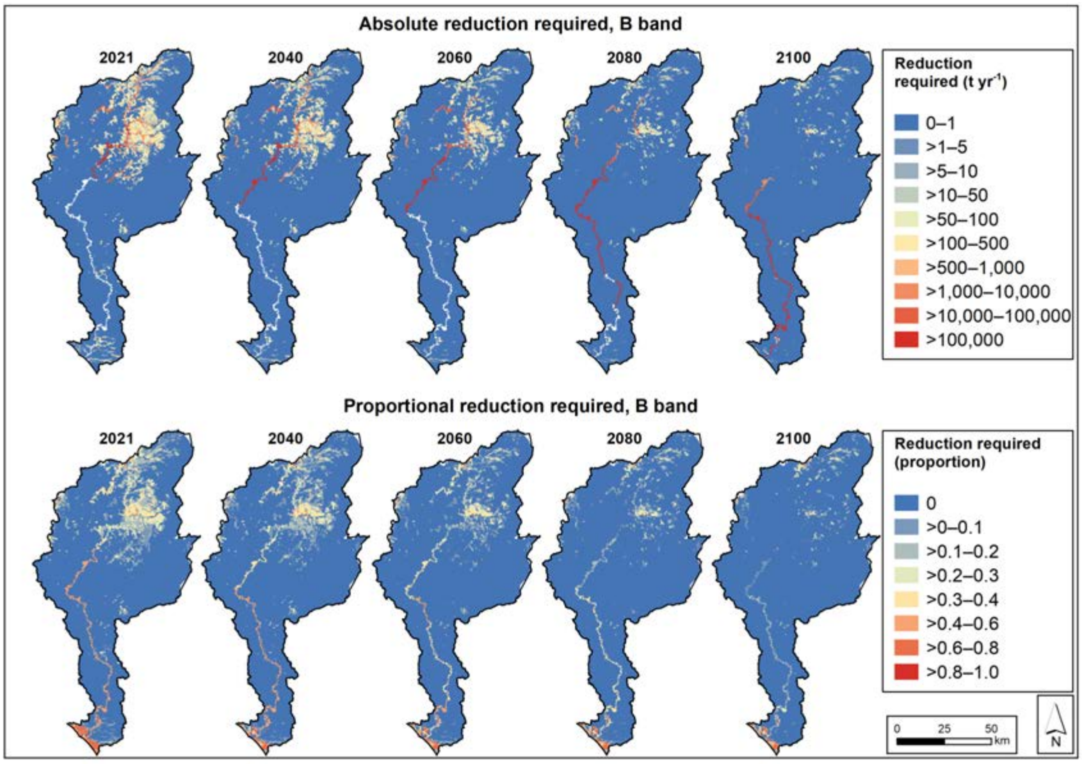

Figure 10-F Absolute and proportional sediment load reductions required to achieve NPS-FM visual clarity Attribute Band B.

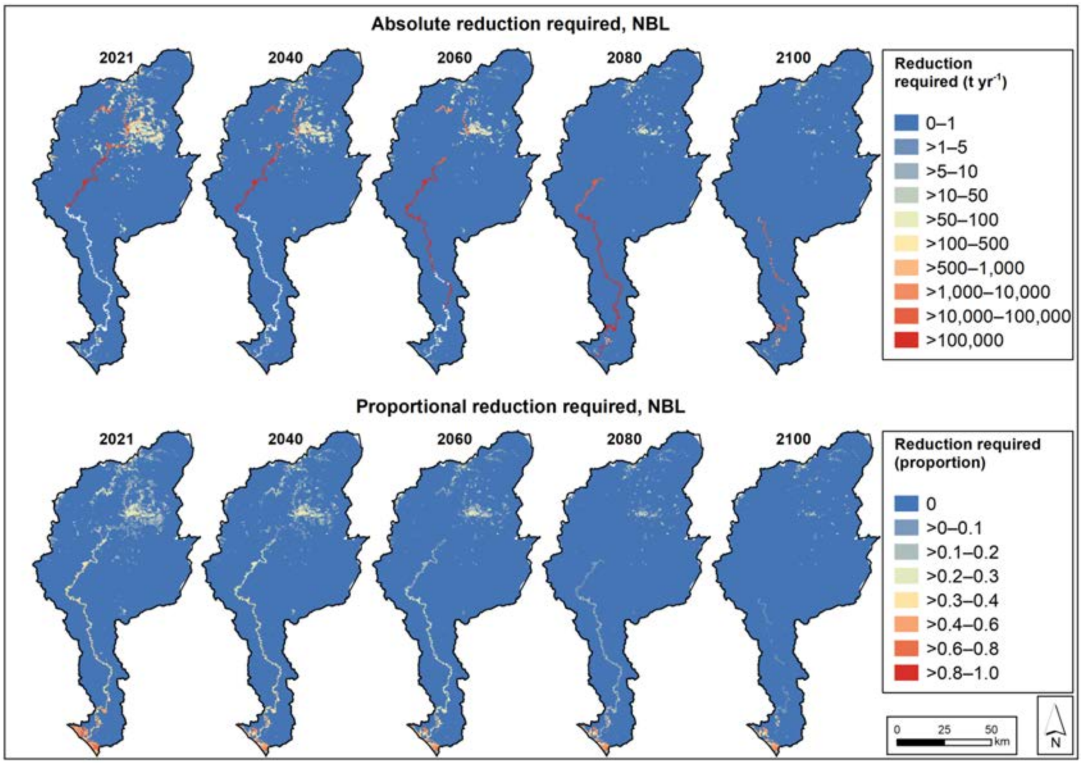

Figure 10-G Absolute and proportional sediment load reductions required to achieve NPS-FM visual clarity National Bottom Line (NBL).

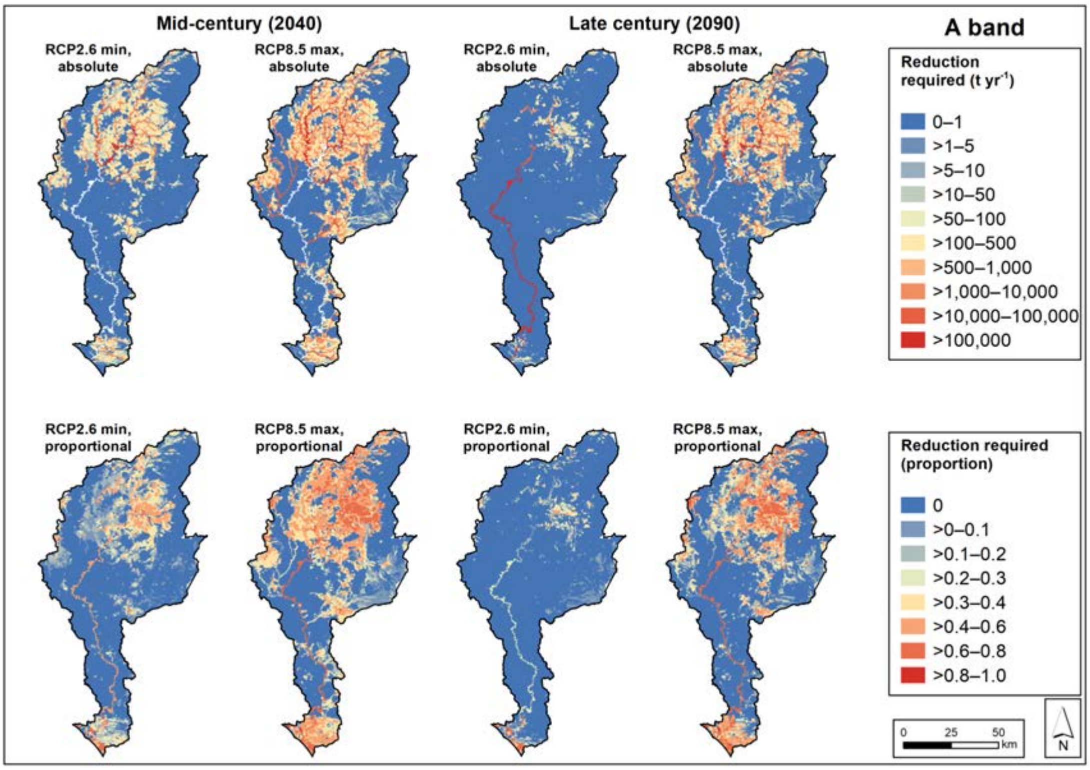

Figure 10-H Absolute and proportional sediment load reductions required to meet NPS-FM visual clarity Attribute Band A, at mid- and late century, represented by RCP2.6 min ad RCP8.5 max for PS1.

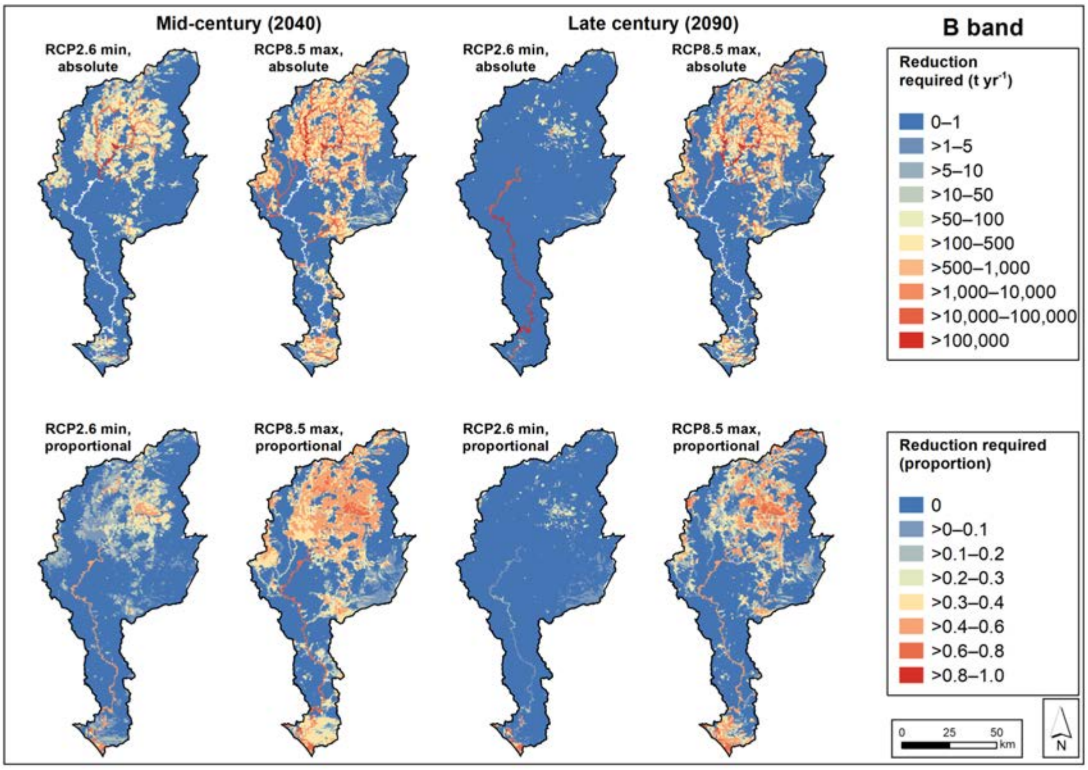

Figure 10-I Absolute and proportional sediment load reductions required to achieve NPS-FM visual clarity Attribute Band B, at mid- and late century, represented by RCP2.6 min and RCP8.5 max for PS1.

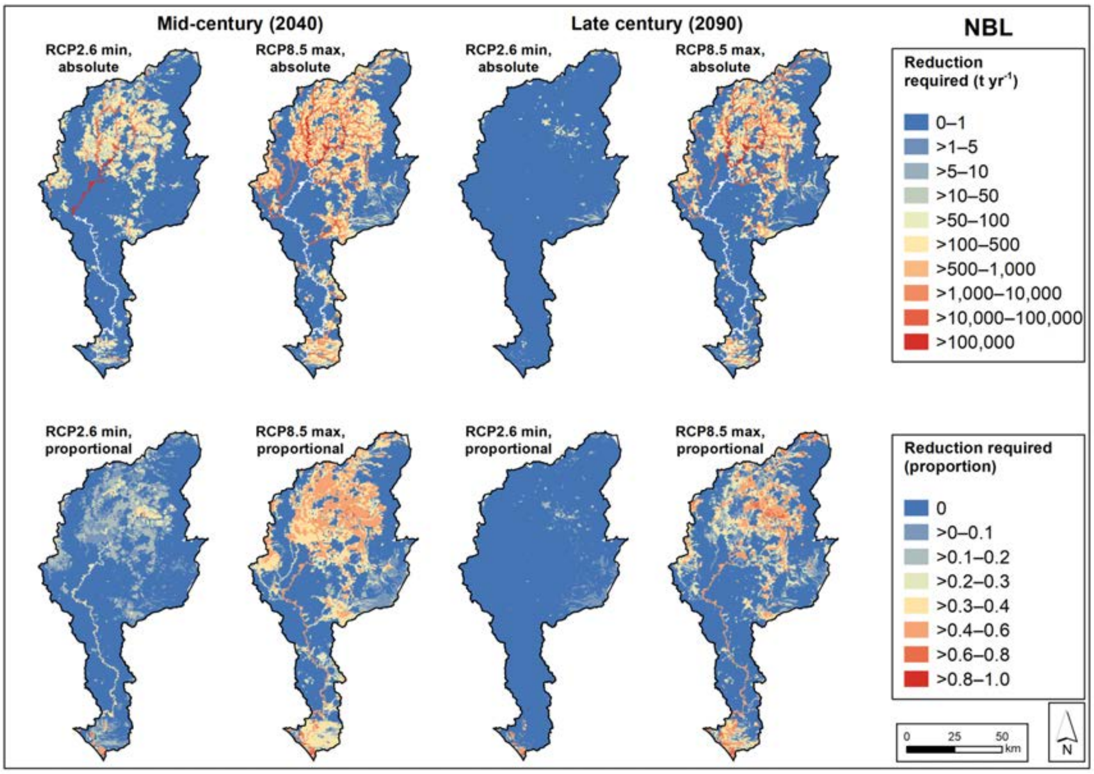

Figure 10-J Absolute and proportional sediment load reduction required to achieve the NPS-FM visual clarity National Bottom Line (NBL), at mid- and late century, represented by RCP2.6 min and RCP8.5 max for PS1.

www.eosecology.co.nz
info@eosecology.co.nz

PO Box 4262, Christchurch 8140
P 03 389 0538

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