eDNA reveals awa's secrets

eDNA as a holistic measure of pastoral landscape effects on taonga species

Why: To enable farmers to see where wildlife and farmed animals are contributing to environmental DNA (eDNA), provide a method to detect positive change in future, and give communities a way to connect more deeply with their awa and its ecosystems.

Where: Dairy farm at the culturally significant headwaters of the Manawatū River in the Ruahine Ranges.

Who: Arapera Paewai (Taiao Ora Contracting), Penelope Drysdale (Te Miro Farm/Drysdale Dairies), Adrian Cookson (AgResearch), Shaun Wilkinson and Amy Gault (Wilderlab Ltd).

What:

- The native species that live in our rivers leave eDNA, which can be detected to help communities understand the health of the water and the taonga species it supports.
- Identification of fish, bird and plant species via eDNA includes taonga species and aligns with the key indicators currently used by regional councils.
- Among the taonga species identified using eDNA in the case study were whio/blue duck (not previously recorded in the area), ruru/morepork, kōtare/kingfisher, tuna/longfin and shortfin eels, kaharore bully, dwarf galaxias and kōura.
- The number of individuals of each species cannot be identified via eDNA.
- The results provided an opportunity to have honest conversations with farmers as it enabled them to see where wildlife and farmed animals are contributing eDNA.

More: ourlandandwater.nz/outputs/edna-taonga-species

Environmental DNA identified native and exotic species of fauna and flora in a culturally significant headwaters.

For generations, the Manawatū River was an important source of food and means of travel for local hapū who lived alongside its sacred headwaters.

"We have been collecting and re-telling stories of the awa as a way of reconnecting with it for a long time," says Arapera Paewai of Taiao Ora Contracting.

Now science, through environmental DNA, has provided yet another way to tell the stories of the awa and reveal its secrets.

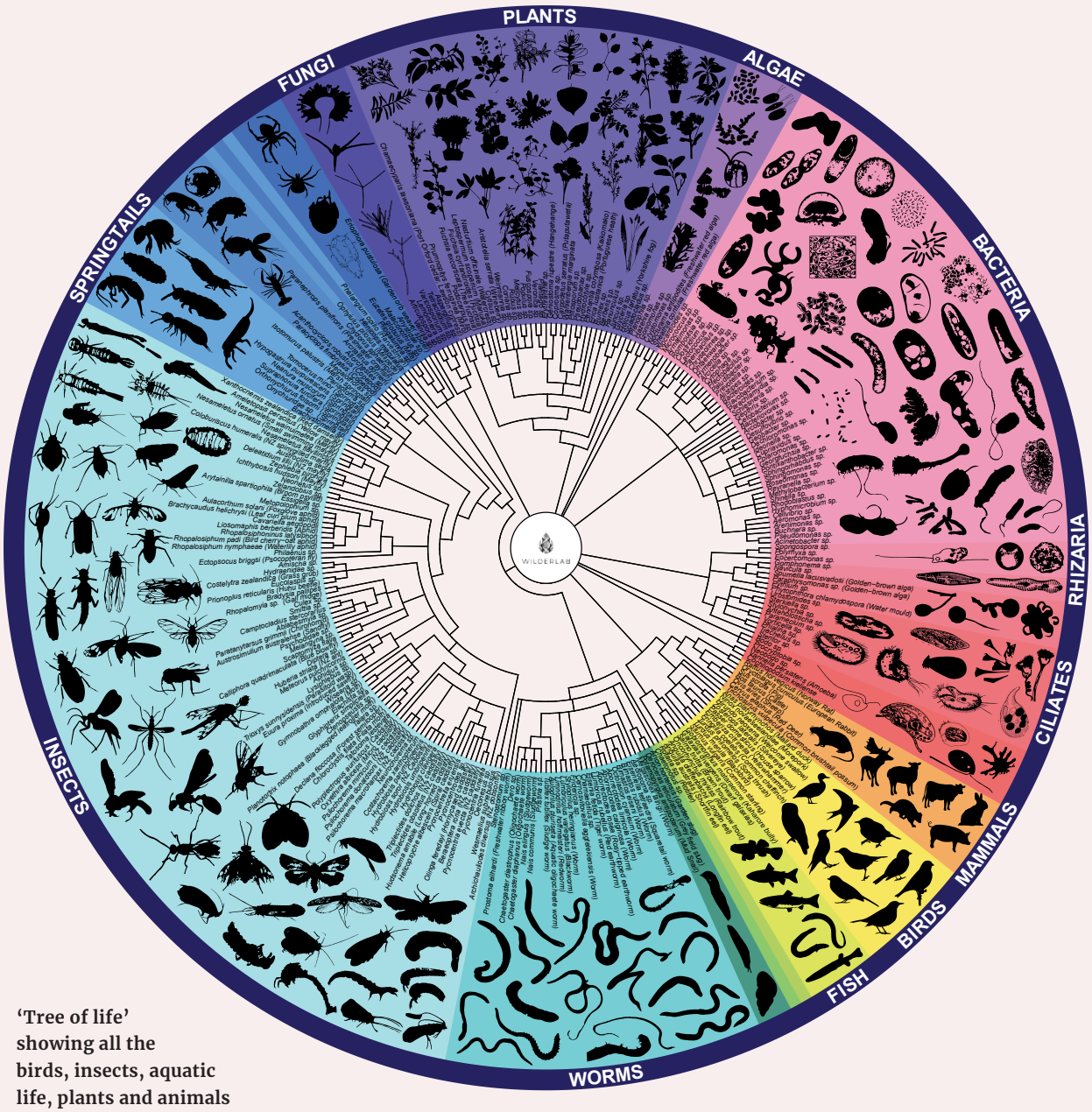
Funded through the Our Land and Water Rural Professionals Fund, the nine-month long project 'eDNA as a holistic measure of pastoral landscape effects on taonga species' involved collecting water samples and using eDNA to identify native and exotic species of fauna and flora that live in or near the river.

The small research project brought together rural professionals, scientists, farmers and mana whenua from three hapū environmental groups, as well as students to sample the river's water and record the results from five sites.

Paewai says the eDNA research is an exciting extension of work begun four years ago by Te Kāuru Eastern Manawatū River Hapū Collective and Penelope and Blair Drysdale of Te Miro dairy farm at the headwaters of the Manawatū River in the Ruahine Ranges (see **Figure 1**). The focus of the work has been to restore 18 ha of retired land along the river.

"Ultimately, we are all trying to improve the awa and build relationships, showing other areas how much can be achieved by working together," says Paewai.

The project compared eDNA from farmland and the culturally significant headwater site, to understand the ecosystem changes as the awa travels through different landscapes. As well as eDNA sampling, conventional water quality assessment of *E. coli*, total nitrogen, nitrate, phosphorus and turbidity were also measured.



'Tree of life' showing all the birds, insects, aquatic life, plants and animals that left their eDNA signatures at the sample sites, produced by Wilderlab

What was found in the water?

Sampling began in December 2022 and was repeated in January, March and May 2023. Those samples were sent to Wilderlab for DNA sequencing where the tiny traces of genetic material, or eDNA, they contained revealed the myriad of life the awa supports. The results provide a living context for understanding the ecological health of waterways.

Among the taonga species identified using eDNA were whio/blue duck (not previously recorded in the area), ruru/morepork, kōtare/kingfisher, tuna/longfin and shortfin eels, kaharore bully, dwarf galaxias and kōura.

The results of the eDNA sampling enabled farmers to see where wildlife and farm animals are contributing to eDNA, provided a method to detect positive change, and give communities a way to connect more deeply with their awa and its ecosystem.

"The eDNA data links what a community can see themselves with what can be detected from the freshwater samples," says Adrian Cookson of AgResearch. "While there were a few instances where detections were made of species not noted in the catchment, it was encouraging that many species known to be in the area were detected by eDNA analysis, including tree fuchsia, native beech trees, longfin eel, dwarf galaxias and kererū.

The nine-month long project involved collecting water samples and using eDNA to identify native and exotic species of fauna and flora that live in or near the river.

"This generates confidence that the eDNA results can give genuine insights into what might be lurking unseen.

"The eDNA results and species identified have been a great way to promote storytelling, and a shared ownership of potential mitigations and intervention for the improved ecosystem health of the catchment," says Cookson.

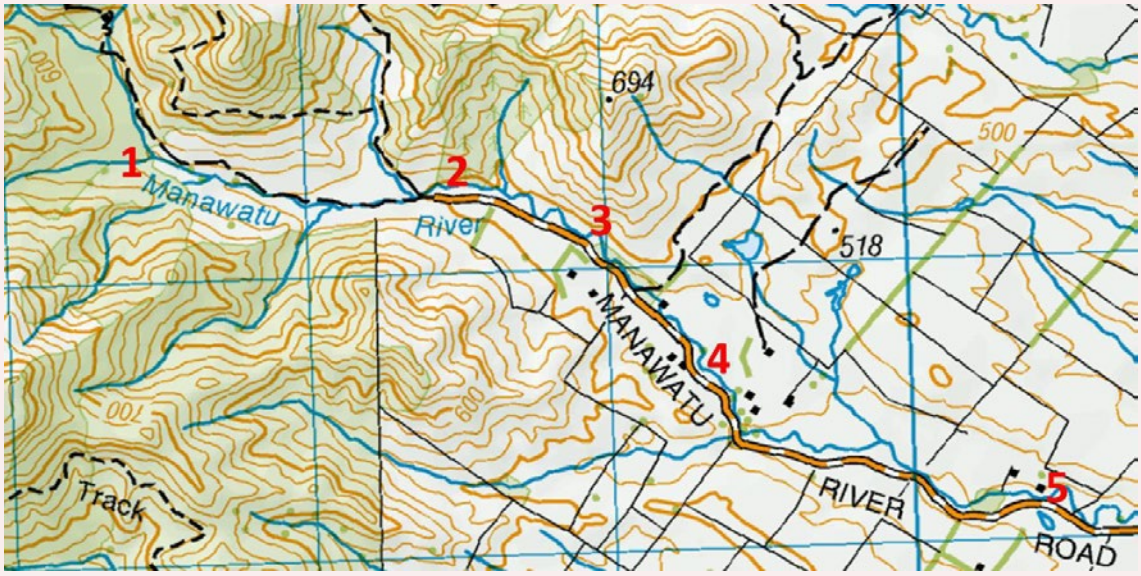
Penelope Drysdale says the research has highlighted that Te Miro Farm ecosystems have the ability to filter out pathogens and create habitats for taonga species to thrive. "Our ability to filter *E. coli* is evident. The last testing showed that there was significantly less *E. coli* leaving the farm than was coming in."

AgResearch's Cookson says that while *E. coli* counts from water are notoriously variable, "it is clear from the results that the retirement from grazing and planting of riparian margins is having a beneficial impact on reducing contaminants from the Te Miro Farm dairy platform reaching the waterway. Importantly, we were able to see when elevated *E. coli* counts did rarely occur, a specific farm practice could be pinpointed as being the potential cause.

"The striking thing for me was the range of species identified using the eDNA analysis and the way in which it facilitated community engagement. I was also excited by the apparent changes in ecosystem health as we moved downstream from the reserve site and the apparent resilience of the ecosystems to the recent heavy rainfall events, including the dump from Cyclone Gabrielle."

Growing community understanding

Involving the wider community was an important focus for the project from the beginning, with eDNA sampling kits that children were able to use.



1. Native bush reserve
2. Ngāmoko whare/information kiosk within hill-country sheep and beef farm
3. Site where Manawatū River enters Te Miro Farm
4. School's freshwater quality wānanga site
5. Site where Manawatū River exits Te Miro Farm

Figure 1. Spatial representation of Manawatū River sample sites for eDNA investigation.

Study site in full flood associated with Cyclone Gabrielle heavy rainfall event, 14 February 2023

eDNA results can give genuine insights into what might be lurking unseen.

The water sampling provided an opportunity for kaihautū and rangatahi from Pūhoro STEMM Academy to participate in the kaupapa and experience new technologies that align with mātauranga Māori and cultural health measurements of ecosystem health.

From the data collected, Wilderlab produced a 'tree of life' graphic showing all the birds, insects, aquatic life, plants and animals that left their eDNA signatures at the sample sites.

However, there isn't currently a way to determine how many individuals of each species are identified by the sample. Susan Welsh, data scientist and developer with Wilderlab, explains: "Different species shed DNA at different rates and interact with the water differently. For example, the 413 sequence reads for kererū [at Reserve, Site 1, February 2023] could come from one large deposit of DNA from one individual emptying their bowels in the water as they fly over, or it could come from numerous smaller deposits of DNA such as from multiple birds drinking from the water."

Wilderlab hosted a workshop for Māori environmental groups, the Drysdale whānau and Pūhoro STEMM Academy, to go through the results in more detail and provide further information about the technical aspects of the eDNA analysis. Results from this analysis have also been widely socialised during community events at Te Miro Farm and a riparian community planting day attended by farmers, teachers, school children, Horizons Regional Council staff and local conservation workers.

The project report links to the eDNA results and Wilderlab website have been made available to the local community through Facebook posts. Permanent posterboards highlighting the 'tree of life' associated with different sample sites have also been installed at the Te Miro Farm Wānanga nursery.

Insights and next steps

The project team is hoping to carry the project on for a further six to 12 months. They identify several opportunities created and demonstrated by their project: the progression of science; hapū reconnection and engagement; education; awareness of a new tool as a holistic measure of the health of waterways on-farm; and helping conservation by identifying species that need extra protection and those that require extra pest management.

The Drysdales plan to hold an event at Te Miro Farm to release the project's findings and celebrate its achievements. "We will also promote the use of eDNA as a holistic measure of the health of ecosystems in and around our waterways on-farm," says Penelope Drysdale.

Drysdale says collaboration is why the project worked so well. "We all have different strengths and different things we are wanting out of the project, but ultimately we all want the same thing – the health of our awa."

Elaine Fisher for the Our Land and Water National Science Challenge

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