Pūtaiao

MANAAKI WHENUA SCIENCE SUMMARY / ISSUE 20 / NOVEMBER 2024

Focus of attention

Science for our biodiversity & biosecurity

Pūtaiao

Science for our land and our future

Tēnā koe and welcome to Issue 20 of *Pūtaiao (Science)*, our quarterly publication showcasing the work of our scientists at Manaaki Whenua.

It's now been five years since we started publishing *Pūtaiao*. Each issue of *Pūtaiao* shares the benefits and outcomes of our science in helping to ensure a sustainable, productive future for Aotearoa New Zealand (AoNZ). In this issue, many of the stories focus on progress in restoring biodiversity and beating invasive species, through collaborative science with real-world impact.

Read on about our work in the monitoring and management of introduced predators, including new tools and insights for predator-free groups. Among other stories, we also outline progress in understanding invasive weeds and natural enemies in Rarotonga, the long-term problems caused by small-sizing of reserves for native dryland vegetation, and the surprising rediscovery of a population of wallabies that had been hiding in plain sight in the Bay of Plenty.

We begin with news of the recovery of native forest after Cyclone Gabrielle, tracing the establishment of permanent monitoring plots to assess change over time in forest fragments between Wairoa and Whareponga.

If you wish to be included on the mailing list for *Pūtaiao*, or to find out more about any of the stories, contact Dan Park on parkdj@landcareresearch.co.nz

You can also sign up to our popular online webinar series LinkOnline, a series of webinars to share our science with stakeholders, here: landcareresearch.co.nz/events/linkonline/

Cover image: Senior Technician (Ecology) Paul Robbins using a sighting compass to establish a permanent monitoring plot in Rākaukākā Forest.

Back cover image: Kuaka/bar-tailed godwit taken by Jeremy Sanson.

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Te Tairāwhiti forest fragments: protecting precious pieces of biodiversity

"It was like a blanket of sediment suffocated our vulnerable taonga species."

This is how Mere Tamanui (Te Aitanga a Hauiti) describes the devastating impacts Cyclone Gabrielle had on lowland native forests in Te Tairāwhiti / Gisborne.

The danger of losing these forests and taonga species due to climate change and an increase in extreme weather events such as Cyclone Gabrielle has sparked new partnerships between local kaitiaki and Manaaki Whenua – Landcare Research scientists.

The goal is simple – to understand forest fragments and protect the region's precious biodiversity.

Manaaki Whenua Plant Community Ecologist Dr Warwick Allen and Senior Technician Plant Ecology Paula Godfrey (Ngāpuhi, Ngāti Whātua o Kaipara, Ngāti Whakaue) recently led a team who partnered with local mana whenua and landowners to establish 41 permanent monitoring plots in 19 floodplain forest fragments between Wairoa and Whareponga.

Forest fragments, small patches of precious native forest, have their own unique threats and management needs because of their small size, isolation from other forests, and the range of activities that occur on the land around them.

Extreme weather events have caused disturbance in North Island lowland forests for millennia, such that many of their plant species could be considered 'flood-adapted', like the towering kahikatea (*Dacrycarpus dacrydioides*), sub-tropical pukatea (*Laurelia novae-zelandiae*), and nationally vulnerable heart-leaved kōhūhū (*Pittosporum obcordatum*).

However, the natural process of forest regeneration after these weather events now faces pressures such as increased sediment deposition (a result of historical clearance of native forest for pasture and plantation forest), browsing by stock and feral animals, and invasive weeds.

"Without management to mitigate these pressures, regeneration may be disrupted or prevented entirely, meaning that we are in danger of losing the few lowland forest fragments that remain in Te Tairāwhiti," says Warwick.

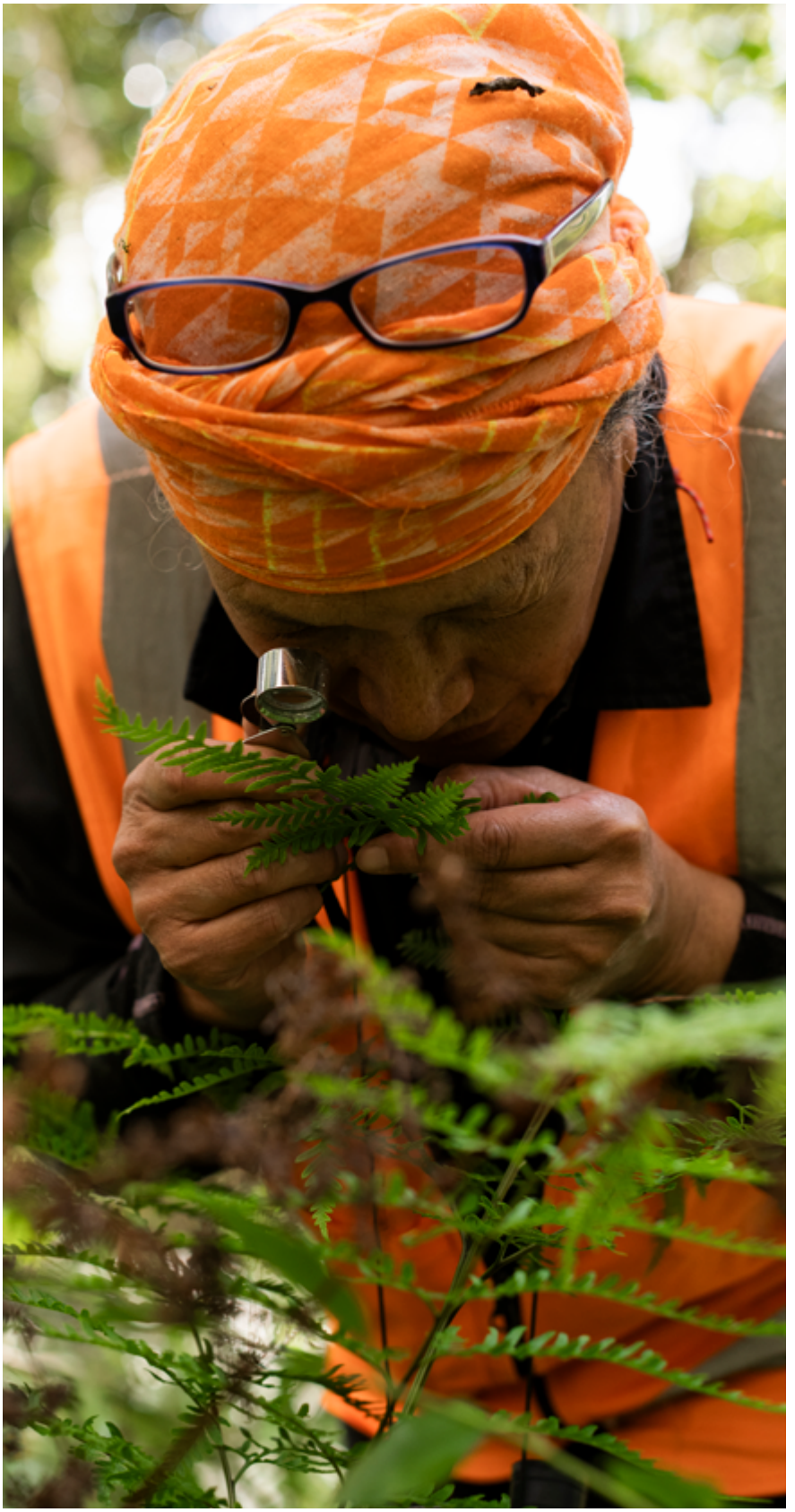
The team aimed to quantify damage to lowland forests from Cyclone Gabrielle and assess whether management practices such as fencing and weed control promote regeneration after disturbance from extreme weather events.

"It was confronting to see how the cyclone had impacted some of the forest fragments. Many trees were dead or dying in some of the worst-affected areas," says Warwick.

"However, at other sites I was left feeling hopeful by the presence of a diverse and healthy understory with various sizes of seedlings and saplings, suggesting that regeneration is possible with appropriate management."

Monitoring in action

The monitoring sites were chosen through discussion with local ecologists and kaitiaki, including Malcolm Rutherford (QEII National Trust), Don McLean (Gisborne District Council), Mere Tamanui (Te Aitanga Hauiti), Damian Whaanga (Rongowhakaata Iwi Trust), and Margaret Ngārimu and Jade Gibson (Whareponga).



Margaret Ngārimu (Whareponga) identifying ferns at the Rākaukākā forest site. Margaret's rich wealth of knowledge of flora and fauna in Te Tairāwhiti was invaluable to the fieldwork.

At each forest fragment, the team established up to three permanent 20 x 20 metre monitoring plots.

In each plot, they measured cyclone damage (sediment depth, flood height, and tree survival), characterised the plant community (plant species identity and percent cover), and quantified potential for forest regeneration (seed bank composition, seedling and sapling counts, browsing mammal signs).

Partnering with kaitiaki

Warwick and Paula worked closely with mana whenua, landowners, and engaged with local kura (schools) to establish the monitoring sites.

The team spent a day with Rongowhakaata Iwi Trust at Rākaukākā Forest in Manutūkē (near Gisborne), where they provided training in the permanent plot method. The land has felt the impacts of multiple cyclones and is facing pressures from surrounding land use, including sediment deposition and invasive weeds.

Not only did flooding from Cyclone Gabrielle reach almost 2 m and deposit up to 12 cm of sediment but, in 1990, Dr Bev Clarkson (recently retired from Manaaki Whenua but an ongoing Research Associate) found that Cyclone Bola (1988) had deposited over 1 m of sediment in some parts of the forest.

Rongowhakaata Iwi Trust Taiao Team Lead Damian Whaanga (Rongowhakaata, Ngāti Kahungunu) says it's great meeting and working with people who are dedicated to learning and exploring.

"I could feel everyone's passion for a bigger kaupapa (project). It doesn't feel like work when you are vibing together.

"Relationships are important to me, with the taiao (environment) and with people. In this mahi you can harmonise the two."

Rongowhakaata Iwi Trust Taiao team member Kevin Hare (Rongowhakaata, Ngai Tamanuhiri) says the knowledge shared by Manaaki Whenua through this project has significantly contributed to their growth, particularly in plant identification.

"For us, this mahi holds deep significance," says Kevin. "Our whenua and taonga species are central to our identity and well-being. The recent devastation caused by extreme

The Rākaukākā Forest in Manatūkē, Gisborne, is managed by the Rongowhakaata Iwi Trust and filled with a beautiful canopy of taonga species. This forest fragment was impacted by Cyclone Bola in 1988 and Cyclone Gabrielle in 2023.

weather events has highlighted just how critical it is to protect and restore our natural environment.
"Being part of this work ensures that we are not only safeguarding our whenua but also upholding the values and responsibilities passed down through our whakapapa."

Jade Gibson and Margaret Ngārimu (Whareponga) helped the team facilitate site access and relationships in their beautiful rural community, Whareponga, just north of Waipiro Bay.

"This wasn't just about data collection or setting up permanent plots — it was about building a relationship, one that I hope will be long-lasting and genuinely reciprocal," says Jade.

"The purpose of the project was to understand how Cyclone Gabrielle might impact the natural regeneration of our precious kahikatea stands. For me, as tangata whenua, this felt like more than research — it was an opportunity for our whānau to connect more deeply with our ngāhere and to understand how we can best carry out our role as kaitiaki in our lowland kahikatea stands."

Mere Tamanui (Te Aitanga a Hauiti) has links to many projects throughout the region and helped facilitate access to sites in Ūawa / Tolaga Bay.

She said the devastation Cyclone Gabrielle caused to their whenua was staggering.

"It was like a blanket of sediment suffocated our vulnerable taonga species, with 80- to 100-year-old freshwater mussels ploughed up by turbidity and dumped on riverbanks. The cyclone deposited over two foot of sediment in some areas and shifted our saltwater wedge due to the riverbed build-up," says Mere.

Partnering with kaitiaki: The team spent a day with Rongowhakaata Iwi Trust at Rākaukākā Forest, where they provided training in the permanent plot method. Pictured [from left]: Kevin Hare [Rongowhakaata], Paula Godfrey, Dr Warwick Allen, Paul Robbins [Manaaki Whenua], Damian Whaanga [Rongowhakaata] and Margaret Ngārimu [Whareponga].

"This project has given us tools and skills to gather information to help validate our natural observations and provide a record of impacts and recovery in the face of climate change," she says.

Next steps, results, and recommendations

Warwick and his team hope to release initial results from the monitoring later this year, as well as supporting iwi and other groups to expand on this forest monitoring.

"We aim to resurvey the plots in 5-10 years to evaluate long-term impacts and post-cyclone recovery and regeneration. A key benefit of permanent monitoring plots is that they allow us to assess change over time."

In the meantime, Warwick suggests landowners look to fence and manage weeds in any remaining lowland forest fragments.

"We recommend fencing forest fragments to prevent stock and animal access and promote regeneration.

"Stock access means that almost no saplings are coming through to replace mature trees, because seedlings are munched or trampled before they even have a chance."

However, excluding stock and animals could encourage growth of weeds, so regular weed control is also required in any forest that has been fenced.

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Fortune favours the timid: how a better understanding of stoat behaviour will help predator control in Aotearoa

It's well-known that AoNZ's native ecosystems are under threat from introduced pest predators such as rats, cats, possums and stoats. Trapping efforts, such as those undertaken by Predator Free NZ groups, are effective up to a point – but it is very difficult to achieve 100% eradication of these predators, especially across large, remote areas.

One of the aims of the 5-year MBIE Endeavour science programme *Eradication Science*, coordinated by Manaaki Whenua, is to evaluate the current toolkit of trapping technologies from the perspective of the pest. New knowledge is needed on why some pest animals evade or fail to interact with physical traps, and to devise ways to make the traps more enticing.

As part of the research, Dr Patrick Garvey and Dr Kyla Johnstone, working with Dr Catherine Price at the University of Sydney, tested the responses of wild-caught stoats to three types of stoat trap. The traps were disabled so they could be triggered without harming the animals. This enabled the intrinsic behaviours of the stoats to be assessed across different trap encounters.

The experiment was run over 81 nights with 28 stoats – 13 male and 15 female – and the stoats' behaviour was filmed each night using infrared cameras. The research complied with all relevant animal welfare and ethics requirements.

In a rewriting of the phrase "fortune favours the brave", the researchers found that fortune favours the shyer, more cautious, less active, and less risk-prone stoats – known as "recalcitrant" animals in pest-control circles – that are less likely to interact with all types of traps. Shy female stoats, and female stoats generally, were more cautious and less likely to interact with the traps than male stoats. This finding is known from field trapping, where successful capture is strongly skewed towards males. Often, all it takes for an area to be repopulated is the survival of females that evade trapping. Almost all adult female stoats are pregnant throughout the year, so understanding sex biases in trap capture is essential to achieve eradications.

By contrast, "neophile" stoats – those attracted to risk and novelty – were more likely to approach and then trigger a trap. Enclosed box traps were the most effective type of trap all round, but neophile stoats were also attracted to tunnel traps. Stoats tended to interact least with head-up traps.

Is the answer to deploy more traps, to ensure that the more cautious individuals will be more likely to encounter devices? Not necessarily, say the researchers, since stoats that encountered a trap for the first time and failed to trigger it were quite likely to avoid all traps in the future – trap shyness is a persistent problem for predator control. Although the box trap performed well, capturing three in four stoats during their first encounter, no single design covered all spectrums of personality, suggesting that less "scary" trap designs, plus more effective baits and lures, are what's needed.

Compounding the problem of trap shyness, the researchers suspect that they have actually underestimated recalcitrance in the wild. By definition, all the stoats in the study had the characteristics of risk-taking neophiles, since they had already been caught in a trap for the study. This suggests that trapping the most recalcitrant animals might be even more difficult than this study suggests, which itself is an important finding in planning future pest control efforts.

The researchers conclude that increasing the likelihood of engagement with a trap during a first encounter, and improving the susceptibility of the animal to triggering that trap, is fundamental to increasing capture success in future predator management programmes. Next steps for the *Eradication Science* programme involve the development and deployment of novel lures to do just that.

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Hiding in plain sight – an undetected population of wallabies in Aotearoa

Wallabies are a significant invasive pest in AoNZ, causing damage to pasture, woodland and native plant communities – and are subject to a national eradication programme.

They have been present in AoNZ since around 1870, when the then-Governor Sir George Grey introduced at least four species to his menagerie on Kawau Island in the Hauraki Gulf. The two smallest species, the dama wallaby (*Notamacropus eugenii*) and the parma wallaby (*N. parma*), are very difficult to tell apart. Parma wallabies have a broader diet than dama, and therefore may be more of a threat to native biodiversity.

Dama wallabies established themselves in the North Island around the Bay of Plenty after being additionally released there in 1912, while the parma wallabies were thought to have stayed put on the island.

Funded by the Tipu Mātoro National Wallaby Eradication Programme, research was carried out to look at the extent of wallaby populations across the Bay of Plenty. Scientists at Manaaki Whenua, led by Dr Andrew Veale, undertook a landscape genomics study of dama wallabies.

How was the work done? Ears of wallabies were collected from dead animals culled in control operations, roadkill, and found bodies in the Bay of Plenty – 173 samples altogether, plus two further samples from Taranaki and four from Wellington. DNA was extracted using standard methods, sequenced, and mapped to the recently completed dama wallaby genome that Andrew contributed towards assembling. This genomic sequencing and analyses were in collaboration with researchers at AgResearch.

Surprisingly, the work confirmed that parma wallabies have been living essentially undetected. This is likely due to their solitary behaviour, preference for dense scrub and forested areas, and visual similarity to the dama species.

Misidentifications of species are most common in groups such as plants and invertebrates, where identification can be a challenge even for experts. It is very rare to misidentify something as large as a wallaby – especially in a country well-attuned to the problems caused by invasive plant and animal species.

Nonetheless, the fact that a population of large animals has gone undetected for at least 30 years (and potentially for over a century), hidden amongst a morphologically similar species, highlights the continued need for monitoring of invasive species including genomic species identification. As the researchers comment, “if wallabies can go unnoticed, how many invasive insects are being missed?”

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Spot the difference: dama (left) and parma wallabies.

Not to be sniffed at: detection dogs help to keep Rangitoto Island, a reserve in the Hauraki Gulf, pest-free.

Barking up the right tree

Back in May 2022, *Pūtaiao* reported on research done by Manaaki Whenua's scientists in collaboration with Auckland Council and the University of Auckland, training dogs to detect *Phytophthora agathidicida*, the fungus that causes kauri dieback.

The dogs, Pip and Mawhai, certainly had a nose for it. They detected the culprit around 70% of the time, and even some of their false positives (when they thought they'd found the organism, but hadn't) were actually other species of *Phytophthora*.

Overall, the research was a good proof-of-concept with many potential applications – for example the detection of *Phytophthora* - contaminated soil in nursery specimens and on earth-moving equipment, or checking cargo and passengers being brought into pest-free areas, in much the same way that dogs are now used to detect substances at airports. In Australia, bushfire brigades have already used dogs to check vehicles for the spread of a *Phytophthora* species damaging to eucalypts.

Dogs also offer promise in the detection and management of small mammalian predators, in addition to trapping efforts. Traps only work if the target animal will approach and then interact with a trap. Some are trap-shy – they won't go anywhere near a trap, or are very wary of a bait, so they survive control operations. It's estimated that the per-hectare cost of eradicating the last 5% of a population of predators is more than ten times what it costs to eradicate the first 95%.

According to Manaaki Whenua's Dr Al Glen, writing in a recent review for the *Kiwi Rescue* MBIE research programme, the advantage of dogs over traps is that they can follow scent trails, so don't just depend on the target animal approaching a specific point. By following a scent trail, dogs can quickly track down animals that otherwise would avoid capture or detection. In this way, dog-handling teams have played an important part in creating and maintaining many of AoNZ's predator-free sanctuaries – for example, eradicating the last possums from Kapiti Island in 1986, block by 40-hectare block, after intensive trapping had eliminated most of them. Dogs were also used in a rat incursion on Motutapu Island in 2018 and a stoat incursion on the same island in 2021. In both cases, the dogs quickly narrowed down the location of the predators, aiding optimal trap and lure placement to catch the targets.

Dogs are also being used in the planning of eradication efforts by helping to gather information about the abundance, distribution and patterns of movement of a target species. For example, preparations have been made to eliminate feral cats from Auckland Island in the New Zealand sub-Antarctic. During a preliminary research and monitoring trip in 2019, dog-handling teams located more cat scats than human searchers did alone, and also detected nine cats without recourse to scats. By analysing DNA from the scats, EcoGene®, our DNA diagnostic service (ecogene.co.nz), was able to identify individual cats. The locations where the scats were found allowed researchers to trace how the cats travelled across the island.

In other recent work for Predator Free 2050, Manaaki Whenua scientist Dr Emma Feenstra investigated the potential contribution to New Zealand's predator-free goals of dogs trained to detect possum scat and to differentiate scat from different possums. In northwestern Taranaki, dogs with handlers searched for possum scat in 8-hectare "cells", to see if discovery of scat could enable better targeting of control measures to particular cells. The work showed that dog teams were able to rapidly assess an area for possum presence, even in areas with very few possums, thereby enabling more precise application of control.

Dogs clearly have potential to contribute to predator control. Suggested future research includes work on the optimal search paths followed by dog-handler teams, whether it's better to train dogs on specific animal species' scats or to find a range of scats then use DNA analysis to identify the species, the best ways to eliminate predator dens once found, and the possibilities of using detection dogs to identify diseases carried by invasive animal species.

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Understanding invasive weeds and natural enemies in the Pacific using multi-scale remote sensing

Rarotonga, the largest of the Cook Islands, is well-known for its crystal-clear lagoons, sandy beaches and unique biodiversity. However, invasive weeds introduced into Pacific Islands like Rarotonga pose a serious threat to native biodiversity, ecosystems, primary production, and human health.

Under predicted climate change scenarios these problems will worsen, as invasive weeds are likely to grow faster if there is more CO_2 in the atmosphere. Storms are also predicted to be more severe in the future, creating greater disturbance and promoting weed invasions.

Manaaki Whenua's Biocontrol and Molecular Ecology Senior Technician Paul Peterson and his colleagues have been working for decades on ways to reduce the negative impacts of invasive weeds in AoNZ using natural enemies, and have recently started working in the Pacific Islands too.

"Introducing natural enemies to control invasive weeds in Pacific Island countries will often be the only practical solution to this growing problem," says Paul.

The team setting up drones in Rarotonga.

Over the past two years Paul and colleagues have partnered with local government and environmental organisations in Niue and Rarotonga (Cook Islands) as part of a larger Ministry of Foreign Affairs and Trade (MFAT) funded project to develop natural enemies for key invasive weeds in the Pacific and to help countries to introduce and establish them.

This work was funded to develop a method to help better understand the extent of invasive weeds in the Pacific, and the impact of natural enemies being released by Manaaki Whenua to control them.

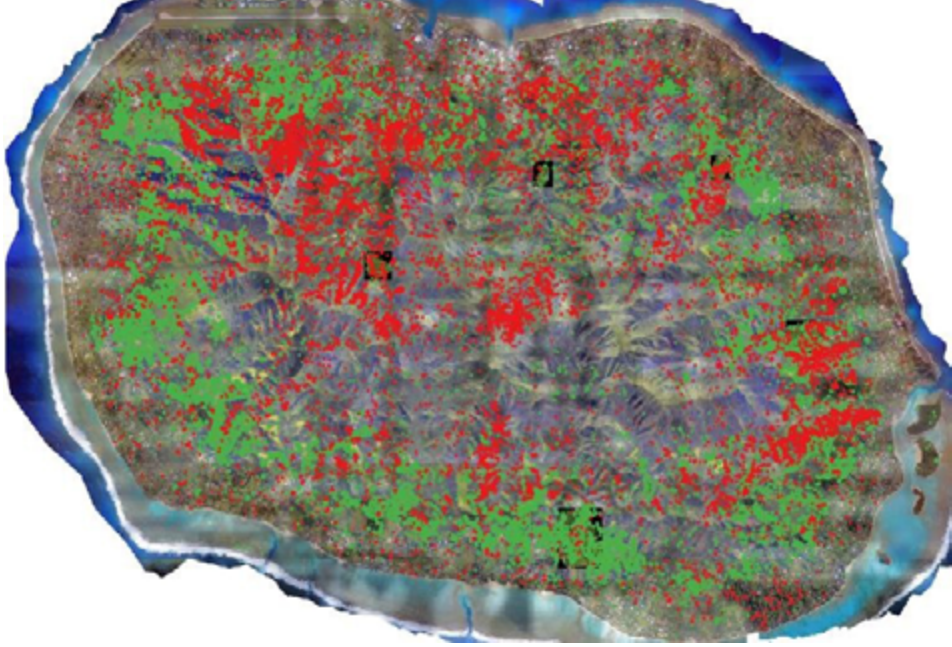
"While natural enemies have an excellent weed control track record, monitoring weed populations and evaluating impacts following introductions is important, and challenging, especially for large tree species", says Paul.

During August 2023, Paul and his team travelled to Rarotonga to map African tulip tree (*Spathodea campanulata*) and falcataria (*Falcataria moluccana*).

The African tulip tree is a large, destructive, invasive tree that is widespread throughout the Pacific region and considered one of the 100

worst invasive species in the world. Falcataria is also a large invasive tree which is spreading quickly on some Pacific Islands.

"We wanted to accurately map these two species using a multi-scale, multi-spectral approach so we started by commissioning satellite and aeroplane imagery over the entire island (70 sq km) and collecting a range of drone imagery over five smaller areas across the island," says Paul.



This map shows the distribution of the invasive African tulip tree (red dots) and falcataria *(green dots) across Rarotonga.*

Manaaki Whenua Remote Sensing Researcher Dr Andrew McMillan was with Paul in Rarotonga, and says the team tested various remote sensing techniques with the aim of developing practical solutions for Pacific Islands wanting to monitor their own weed control projects.

"The best method we found was to use an artificial intelligence model to map the weeds in 10 cm resolution aeroplane imagery at the island-scale using training data from drone imagery of the smaller areas to identify the weeds," says Andrew.

As far as the team is aware, the project is the first time a detailed multi-scale approach has been used to accurately map invasive weeds over a large area.

The map the team produced showed that there are approximately 10,500 flowering African tulip trees (22,000 in total because only 48% were flowering), and 12,000 falcataria trees on Rarotonga – covering 8.3% of the entire island.

When the team presented these findings in Rarotonga at a recent conference, locals were shocked at the extent of the invasion. "They knew that the weed invasion was bad but seeing the map really highlighted the true extent of the distribution and spread," says Paul.

The imagery collected by Paul and his team can also be used to track the progress of natural enemies.

"A gall-forming mite (*Colomerus spathodeae*) and leaf-mining flea beetle (*Paradibolia coerulea*) have recently been released onto Rarotonga by Manaaki Whenua to help control the African tulip tree, and we are hoping to measure their impacts over the coming years," says Paul.

The multi-scale imagery collected allows them to zoom in from an island-scale tree map to a leaf-scale natural enemy damage assessment.

"This is a unique approach that allows land managers to monitor not only changes in vegetation extent but also the severity of natural enemy impacts, especially in treetops that are otherwise inaccessible," says Paul.

The team hopes other Pacific Islands adopt this approach and collect similar baseline imagery.

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About this work:

Manaaki Whenua is the technical lead for the Natural Enemies - Natural Solutions Programme (PRISMSS). PRISMSS is a coordinating mechanism designed to facilitate the scaling up of operational management of invasive species in the Pacific.

The programme brings together experts to provide support within the Pacific region with a focus on protection of indigenous biodiversity and ecosystem function and provides a comprehensive suite of support services in a cohesive, effective, efficient, and accessible manner to Pacific Island countries and territories.

New flora species recorded in Niue

Botanist Dr Peter Heenan has made a special botanical discovery on the tiny island nation of Niue, by identifying three new flora species.

Noted for its limestone cliffs and coral reefs, relatively little is known about the indigenous and naturalised plants of Niue, a beautiful and solitary small island in the South Pacific.

Peter has recently published a paper in the *New Zealand Journal of Botany* titled '*New records for the flora of Niue*' which details previously undocumented flora he noted on two trips to Niue earlier this year.

These represent new naturalised records of *Erigeron bellioides* DC. (Asteraceae) and *Psidium cattleyanum* Sabine (Myrtaceae). *Crepidomanes saxifragoides* (C.Presl) P.S.Green (Hymenophyllaceae) is also an addition to the indigenous flora.

"*Crepidomanes* is a completely new genus record for the indigenous flora of Niue", says Peter.

The paper details the background to these new records and information on their biostatus, collections, distribution and habitats.

As a botanist, Peter says it is significant to be able to find records of previously undocumented species.

"It is about knowing what species they have and where they are – and it might seem a simple statement but so much of conservation work is knowing the flora and knowing where the richest parts of the island may be. Then when they know what they've got, they will know what they need to do to protect it."

Erigeron bellioides DC., naturalised, collected from Matata Chasm Track car park, Hikutavake.

Part of this work has also been about establishing a simple interactive checklist app called 'NaturaList', which can be used by Peter's colleagues and the public in Niue.

"The app is a tool that runs off an Excel spreadsheet. Data infrastructure in Niue is relatively limited but with this we can ensure people on the island can easily access records of the flora and fungi. We have now documented over 1,200 species of flowering plants, fungi and lichens on the app and over 500 of these are illustrated."

Peter hopes to extend his work in the Pacific and strengthen the app for use across the region.

Specimens of *Erigeron, Psidium* and *Crepidomanes* collected from Niue have been deposited in the Allan Herbarium at Lincoln and include georeferenced location information.

Peter and co-author Huggard Tongatule (Niue Department of Environment, Ministry of Natural Resources) wish to thank Haden Talagi (Director, Department of Environment, Niue) and Poi Okesene (Director, Department of Agriculture, Forestry and Fisheries, Niue) for their support of this research.

View the full article here:

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Crepidomanes saxifragoides *(C.Presl) P.S.Green, indigenous, collected from Huvalu Forest Conservation Area.*

Psidium cattleyanum *Sabine, naturalised, collected from Puluhiki Sea Track, Lakepa.*

Losing our edges: why reserves need to be bigger

Native shrublands were once common across the Canterbury Plains, but over time, conversion of land to other uses including irrigated pasture have contributed to their gradual decline. Now, a new study by scientists at Manaaki Whenua has found that spillover of nutrients and water from adjacent intensive agriculture is facilitating invasions by exotic plants into reserves set up to protect the last remnants of these native shrublands.

Warren Chinn.

Overspray from paddock to neighbouring reserve, Medbury, Canterbury.

Writing in the *New Zealand Journal of Ecology*, the scientists describe how nitrogen enrichment, likely from irrigated animal effluent, is detectable 10 m inside reserve boundary fences. Their study has observed increases in exotic herbs and grasses, along with declines in native species, up to 40 m in from irrigated boundaries.

"These distances are significant as some of these reserves are only 100 m across, meaning that more than 60% of these reserves can be affected," says co-author Dr Gretchen Brownstein.

The researchers looked at changes in plant composition with increasing distances from irrigated and unirrigated reserve boundaries, and also monitored changes in soil nitrogen and its chemical forms to better understand the sources of nutrient spillover. Exotic plant species that specialise in disturbed habitats like roadsides were the primary invasive species, rather than pasture species.

The reserves had a long history of low intensity agriculture prior to being gazetted as reserves, but still contained significant and diverse populations of native species back in the 1970s. Since then, the researchers found that they have lost more than half their endemic species while experiencing a surge in exotic species.

Co-author Dr Adrian Monks notes: "This loss of species is likely due to a combination of factors, including random extinctions that afflict small populations, lack of ecological connections to other fragments to allow replenishment of species, and competition with invasive plant species. Two separate fires spreading from a neighbouring property have also destroyed around 70% of the shrubland in the 50 ha Medbury Scientific Reserve, the largest of these protected areas."

The ongoing effects of more intensive land use adjacent to the reserves could be managed with better rules around buffers. "Irrigation and effluent buffers around these reserves would help to limit further degradation of these reserves," says Gretchen. However, the study highlights the larger problem of establishing representative reserves that are too small.

"While it is too late to set aside larger blocks on the Canterbury plains, there are lessons in this for areas such as the Mackenzie Basin, which still have large areas of indigenous dryland vegetation that are at risk from irrigation, renewable energy schemes and wilding conifers" says Adrian. "The Mackenzie Basin is at a similar level of intensive development to the Canterbury plains when the shrubland reserves were established more than 50 years ago. To maintain viable indigenous populations in that landscape will require protection of blocks in the 100s of ha to avoid past mistakes in reserve design made on the plains."

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Nest survival drives positive responses of native forest birds to predator management

It is well known that predation by invasive mammals is the primary threat facing AoNZ's remaining native forest birds. Past research by Manaaki Whenua ecologists has demonstrated that distributions of our treasured birds have particularly shrunk in warmer, more northern forests, most likely due to predation pressure being more constant in such places. However, the demographic mechanism – whether failed nesting attempts or lower adult survival – behind such observed declines remains unknown. While research on individual, often most imperilled, species receives most research attention, general mechanisms across the wider bird community are less understood. Such understanding, though, is useful for refining conservation management approaches and to ensure benefits across the bird community, as some species may benefit more than others or some may even be disadvantaged.

Recent research published by Manaaki Whenua ecologists in *Biological Conservation* sought to address this knowledge gap as part of the MBIE Endeavour-funded project *More Birds in the Bush*. Researchers used the opportunity presented by AoNZ's long history of predator management programmes and studies of the demography of forest birds across AoNZ to compile observed demographic rates of native forest birds under different management and temperature gradients in forests.

Their literature review resulted in demographic rates recorded for 26 species, with 5,582 nests monitored and 10,023 adults followed. In total, this represented a staggering amount of fieldwork by hundreds of people from community groups, students, agencies and researchers from different organisations.

Importantly, the analysis showed that across the bird community invasive predator management increases nest survival but not adult survival. Invasive predator suppression and eradication therefore reduces impact on precious native avifauna, and ideally is targeted to coincide with the vulnerable period of nesting. Surprisingly, there was no strong relationship with temperature for either demographic rate despite the known more constant predation pressure in warmer forests. In part this may be due to many of the most imperilled species already only being able to hang on in places with lower predation pressure. AoNZ is similar to other island ecosystems where climate change is likely to exacerbate existing threats such as invasive mammals. Further research tracking the fate of native birds is urgently needed.

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Possum preying on eggs. Image: Ngā Manu Images.

TrapSim Plus: a new tool for predator control

Funded in part by the BioHeritage National Science Challenge, scientists at Manaaki Whenua and the University of Canterbury recently launched a free, user-friendly online application, TrapSim Plus, to help people to plan better, more cost-effective predator control.

The user-friendly simulation tool is designed for use by many different groups, from landowners and land managers to trapping groups, community predator-control groups, mainland sanctuaries, forest regeneration projects, conservation organisations and schools. It allows users to compare scenarios in planning and designing ground-based predator suppression and control.

TrapSim Plus is the culmination of four years of collaboration between wildlife scientists and social scientists. By simulating real-world situations to show the likely outcomes from different control methods and levels of effort, users can work out the cost and benefits of each approach, says project leader Dr Chris Jones, a Wildlife Biologist at Manaaki Whenua. "We know that all predator control initiatives nationwide, with limited resources, face the challenge of choosing which control methods and how much effort to use."

"One of the advantages of TrapSim Plus is that users can compare different regimes, such as combinations of devices, taking into account factors such as the type of predator targeted, the level of previous control and the duration of the programme. The model adds scientific rigour to any decision about how to best invest resources to maximise the effectiveness of predator control."

Another advantage is that while science underpins the model, users don't need to be scientists or know about wildlife modelling to use TrapSim Plus, says Chris. "The online practical tool is easy to use, and it can be used by non-experts for local, community projects as well as larger-scale operations to compare the relative costs and effectiveness of different predator control programmes."

TrapSim Plus shows the cost to achieve a specific project goal, and can also be used by predator control projects or funders to estimate what is realistically achievable given the level of funding available. The model can rank each option, show how much effort is required to control target species, and the feasibility and cost-effectiveness of each option.

"The tool isn't designed to predict the exact number of individual predators remaining after a control programme," says Chris, "but it does help understand a system and gives insight when comparing the relative effectiveness of approaches, which ultimately helps guide managers and communities in their decision-making."

TrapSim Plus is available free at:

HTTPS *trapsimplus.landcareresearch.co.nz*

News in brief

One Biosecurity on the horizon

The COVID pandemic underscored a global need for integrated responses to combat emerging threats to human health – a so-called One Health approach. But a recent paper contributed to by Manaaki Whenua researchers – mathematical modeller Dr Rachelle Binny, molecular ecologist Dr Manpreet Dhami and social scientist Dr Susanna Finlay-Smits – argues that One Health remains heavily focused on transmission of pathogens from animals to humans, while potential impacts on human health of declining ecosystem health, and of plant pathogens, pests and weeds, are largely overlooked.

The paper outlines the additional concept of One Biosecurity, a combination of emerging advances in biosecurity that could underpin human, animal, plant and ecosystem health. The paper arose from an interdisciplinary horizon scan that identified four major interlinked biosecurity advances: implementation of new surveillance technologies adopting state-of-the-art sensors connected to the Internet of Things; deployable handheld molecular and genomic tracing tools; the incorporation of well-being and diverse human values into biosecurity decision-making; and sophisticated socio-environmental models and data capture.

These innovations emphasise the opportunity to build critical mass around interdisciplinary teams at a global scale that can rapidly advance science solutions targeting biosecurity threats, building on the collaborative momentum achieved during the COVID pandemic.

HTTPS *doi.org/10.1016/j.isci.2023.107462*

Kingdom of rust

The Environmental Protection Authority (EPA) approved the release of the rust fungus *Uromyces pencanus* as a biological control agent for the weed Chilean needle grass (*Nassella neesiana*, CNG) in July 2024. The rust fungus was released in Marlborough on 7 October and there are further planned releases to come in Canterbury – both areas with significant CNG infestation. Our weeds biocontrol scientists hope that this will eventually be a game-changer for farmers against CNG, which has sharp seeds with a corkscrew-like awn that can penetrate the hides of livestock, cause blindness in stock, compete for nutrients from pasture, and adversely affect farm production.

Life's a beech

Recent work led by Dr Alex Boast and Dr Janet Wilmshurst from the Long-term Ecology Laboratory has expanded the potential sites for future kākāpō population recovery. Ancient DNA and pollen analyses of preserved kākāpō coprolites (droppings) revealed that the birds were historically eating almost twice the range of plants they are known to consume at present, including seeds and leaves of southern beech as well as nutrient-rich beech mistletoes, and therefore their dietary range and habitat was much wider than it is today. As a direct result of this study, the Department of Conservation (DOC) is now considering beech forest within its candidate sites for the future management of kākāpō, representing a considerable increase in suitable locations.

HTTPS *doi.org/10.3389/fevo.2023.1058130*

Is it really here?

In a recent presentation at the 2024 Fungi Colloquium, Manaaki Whenua's Biota of NZ information system was described as the most powerful resource for fungi of its kind in the world. It includes all fungal species and their hosts reported from AoNZ, provides up to date names and classification for the fungi, an opinion about biostatus (is it really here? is it exotic or indigenous?), and contains links to the information sources supporting those statements. In addition to being an essential tool for managing biosecurity, the information on Biota of NZ has been used to ask questions like 'what is the impact of exotic fungal pathogens on native plants?', and 'how has increasing levels of trade impacted the rates of introduction of new fungal pathogens?'

But it's not all fungi – Biota of NZ also holds information on bacteria, land invertebrates and plants, including seed plants, ferns and allies, mosses, liverworts, hornworts, lichens, and some algae. Biota of NZ is constantly updated by experts and users can subscribe to any notifications of changes to taxonomic data. Biota of NZ is free to use at biotanz.landcareresearch.co.nz

Geoprivacy for indigenous biodiversity management data

Manaaki Whenua ecologists Cecilia Arienti and Dr Dean Anderson were recent co-authors, with researchers from the University of Auckland, Simon Fraser University in British Colombia, Canada, and communications consultant Waitangi Wood, on an important research paper that proposes a mechanism for scientists, environmental managers and indigenous land stewards to securely store data on the web while protecting the data sovereignty of indigenous peoples. The resulting approach protects data that is shared online with sovereign data owners via public-key encryption and tamper-free blockchain notarisation (for example, about the specific location of taonga species) but also permits sharing an anonymised, less accurate dataset with less privileged users (for example, a "geomasked" or "obfuscated", but still useful, version of the taonga location data). One important aspect of the approach is that no third party is needed to manage security or access to the data: the information remains in the direct control of the people to which it belongs. The proposed application was designed for protecting and sharing data pertaining to Biodiversity Management Areas stewarded by Māori iwi and hāpu, but is applicable globally in the context of indigenous data sovereignty.

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HTTPS *onlinelibrary.wiley.com/doi/10.1111/tgis.13153*

Ngā Hekaheka o Aotearoa – Fungi of New Zealand

The great forests of Tāne Mahuta hold a treasure trove of fungi (hekaheka), many only found in AoNZ. Certain kinds of fungi were traditionally valued by Māori, like āwheto (vegetable caterpillar) which was burned and used to make ink for tā moko (tattooing).

Fungi, plants, and animals live together, and all have important roles to play in our ecosystem. Fungi such as hakeke feed on dead wood, causing it to rot and returning its nutrients to the soil.

Sadly, some fungi have lost their place to live or have been affected by other changes and are now rare. Protection of Tāne Mahuta is important for all his descendants – the fungi, animals, and plants.

Dr Peter Buchanan, Dr Bevan Weir, Māori Communications Advisor Pip Swift, and Senior Graphic Designer Nicolette Faville helped to create a wonderful educational resource for this year's Te Wiki o te Reo Māori (Māori Language Week, see below).

To download a copy of our bilingual teacher guide or a student booklet in te reo and learn more about ngā hekaheka, see:

www *landcareresearch.co.nz/news/ancestral-knowledge-in-the-classroom*

Wetland delineation tool launched

At the 2024 National Wetland Trust Symposium held in Paihia, a new revised method to map the pre-human wetland extent layer for AoNZ was presented by Dr Olivia Burge to approximately 190 attendees including staff from regional councils, iwi groups, central government including DOC, industry consultants and other Crown Research Institutes. Next steps are for the method to be written up fully as a set of case studies, before seeking funding to roll it out nationally.

Celebrating our achievements

A paper entitled *Participatory biosecurity practices: Myrtle rust an unwanted pathogen in Aotearoa New Zealand* published in 2022 in the *New Zealand Geographer* by **Dr Gradon Diprose, Robyn Kannemeyer, Dr Peter Edwards and Dr Alison Greenaway**, was in the top 10% of downloaded papers in its first 12 months of publication. The paper [https://doi.org/10.1111/nzg.12347] used social practice theory to investigate the social aspects of risk mitigation in the management of biosecurity invasions, specifically how 'shared responsibility' has emerged in the shift from a government-led incursion response to myrtle rust, to passive disease reporting using iNaturalist.

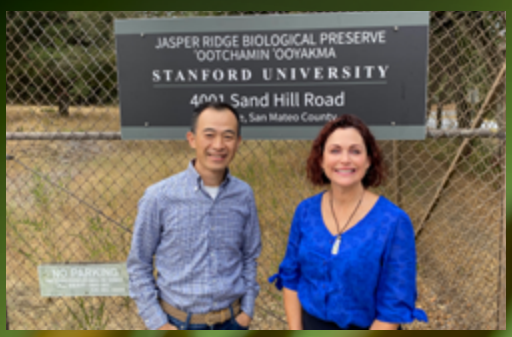
In August 2024, **Dr Shaun Pennycook** was honoured at the 12th International Mycology Congress in Maastricht, the Netherlands, by being made a Fellow of the International Mycological Association (IMA) in recognition of his outstanding contribution of nomenclature to MycoBank. This is the IMA's online database, which serves a twofold purpose: (1) to catalogue all existing fungal names published since the "nomenclatural starting date" of 1 May 1753; and (2) to check newly proposed fungal names for compliance with the rules of the International Code of Nomenclature for algae, fungi, and plants (ICN) so that each can be issued with an identifier number that must be cited to validate the protologue of a new fungal name. Shaun's contribution over many years of his "retirement" has been with this second function, checking the incoming e-mails (up to 200 on a hectic day!) in conjunction with the MycoBank Curator, Dr Konstanze Bensch.

Shaun Pennycook

Senior researcher **Dr Peter Edwards** is a lead author for a chapter on Regional Similarities and Differences in UNEP's flagship report, the *Global Environmental Outlook* (GEO-7). GEO provides an integrated assessment of the state of the global environment. The chapter Peter is involved in assesses the likely regional and sub-regional implications for different solutions pathways. GEO-7 will be launched in early 2026.

Peter Edwards (pictured at right)

Overseas, many research institutions are now exploring how they can collaborate meaningfully with their First Nations people and are looking to experienced Māori researchers for advice and strategic support. Stanford University professor Dr Tadashi Fukami was impressed by **Dr Nikki Harcourt's** presentation at a New Zealand Microbial Ecology Consortium event in February at Waipapa Taumata Rau (University of Auckland) and invited her to speak at Stanford. The presentation was about what an authentic ao Māori (Māori world) framing of microbiology could look like, and how it could enhance environmental health beyond technoscientific knowledge alone. Professor Fukami is committed to promoting research efforts guided by both western and Indigenous science, the approach known as two-eyed seeing. Nikki has now presented two talks at Stanford and is exploring a potential research collaboration with the Fukami Lab.



Nikki Harcourt and Stanford professor Tadashi Fukami.

Tracking the most mobile species for better conservation outcomes

Whether the stunning migrations of shorebirds returning from coastal wintering haunts to inland river beds, flocks of feeding kererū gorging on heavily fruiting trees, or bitterns wandering unseen, many of AoNZ's most imperilled species move great distances throughout the year. In doing so, they leave managed places behind as they pass between different rohe or takiwā (regions) and other human-drawn borders, into and out of privately owned land.

Maintaining such 'mobile species' populations is complex as the full range of the threats facing such species is still not well understood. In addition to predation by introduced mammals, mobile fauna are exposed to many anthropogenic pressures, especially on private land in lowland and coastal regions where human activities are most concentrated. Mobile species are affected by ongoing habitat loss through land conversion for development, agriculture and forestry, or invasion by weeds. Climate change also affects habitats and access to resources through, for example sea-level rise, floods and sedimentation. Transport corridors, higher-rise buildings, transmission lines, and wind and solar energy developments also pose increasing threats to some taxa. It therefore requires collaboration between communities, research and management agencies to address threats in different places across the range of such species.

Manaaki Whenua's ecologists are working to address challenges in the conservation management of mobile species and improve conservation outcomes for mobile species. In recent years, our detailed work with multiple partners has tracked and mapped the activities of the charismatic herald of spring, the migratory South Island pied oystercatcher/tōrea, and the clown of the forest birds, kākā. This work has given early insights into how such species connect people and places across the motu and need a joint approach to protection that takes into account their journeys throughout the seasons. It also has started to reveal how threats at a particular time or place result in population limitation, and enable different management options to be properly evaluated.

As we expand to more species we are covering regional to international scales and different movement strategies, by starting to track the international migrant long-tailed cuckoo/koekoeā, as well as sacred kingfisher/kōtare and tomtit/miromiro. There is much more to do.

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