Pūtaiao

MANAAKI WHENUA SCIENCE SUMMARY / ISSUE 12 / NOVEMBER 2022

Biodiversity & biosecurity

Scaling-up predator control in Aotearoa

Pūtaiao

Science for our land and our future

Tēnā koe and welcome to Issue 12 of *Pūtaiao* ('science' in te reo Māori), our quarterly publication showcasing the work of our scientists at Manaaki Whenua.

I hope you enjoy reading this issue of *Pūtaiao* as much as I did. I'm delighted to be joining Manaaki Whenua as its new CEO, and I look forward to connecting with you, our partners, in the coming months, and working with you towards our ambition – Kia mauriora te whenua me tōna taiao (Make the life-force and the vitality of the land strong).

Each issue of *Pūtaiao* shares the benefits and outcomes of our science in helping to ensure a sustainable, productive future for Aotearoa New Zealand. This issue covers our latest progress in biosecurity and biodiversity science, from large-scale predator and pest plant eradication to the better understanding of one of our most unusual and most fragile forest-floor ecosystems.

James Stevenson-Wallace, CEO
Manaaki Whenua - Landcare Research

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Cover image: Harlequin gecko, a jewel in Rakiura Stewart Island's native fauna.
Photo: Phil Melgren.

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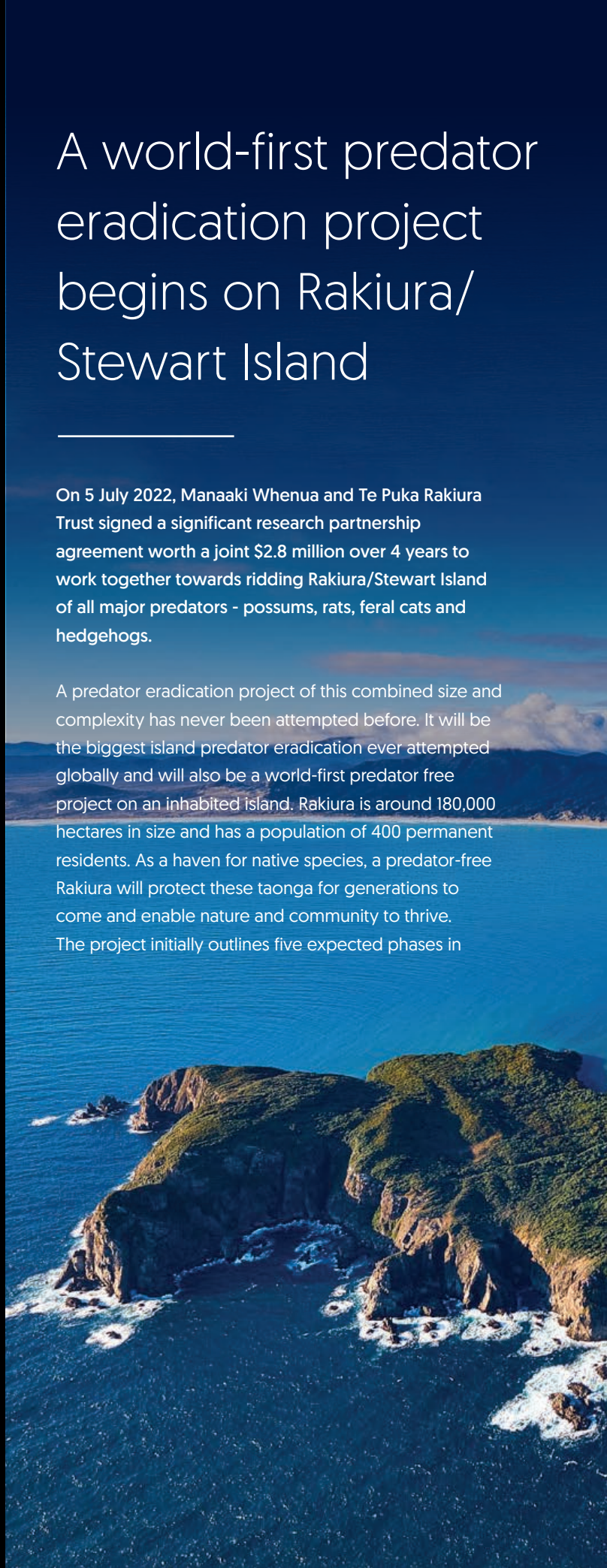
A world-first predator eradication project begins on Rakiura/ Stewart Island

On 5 July 2022, Manaaki Whenua and Te Puka Rakiura Trust signed a significant research partnership agreement worth a joint $2.8 million over 4 years to work together towards ridding Rakiura/Stewart Island of all major predators - possums, rats, feral cats and hedgehogs.

A predator eradication project of this combined size and complexity has never been attempted before. It will be the biggest island predator eradication ever attempted globally and will also be a world-first predator free project on an inhabited island. Rakiura is around 180,000 hectares in size and has a population of 400 permanent residents. As a haven for native species, a predator-free Rakiura will protect these taonga for generations to come and enable nature and community to thrive. The project initially outlines five expected phases in



the coming years: preparing for the work ahead, including technical feasibility and planning; securing Rakiura against predators; restoring native biodiversity; protecting Rakiura's gains from predator freedom, working with communities on and off the island; thriving thanks to the ecological, social and cultural benefits of continued predator freedom via the management of a robust biosecurity border.

As of October 2022, research priority-setting is now underway between Manaaki Whenua and Te Puka Rakiura Trust. Manaaki Whenua will provide $350K per year over the next 4 years of the project to undertake the fundamental underpinning science. This funding will be matched by Te Puka Rakiura Trust. The research partnership will drive deep insights into achieving freedom from predators, a critical part of which is understanding the social aspects of resourcing, achieving and maintaining freedom from predators from the perspective of the local community and iwi.

This ambitious work will be a major step towards the goal of a predator free Aotearoa New Zealand. Rakiura is the anchor for Aotearoa, and what we learn here will help to pave the way for the whole country to become predator free.

Contact: Araceli Samaniego
samaniegoa@landcareresearch.co.nz

www *predatorfreerakiura.org.nz*

Ngāi Tahu

Building biosecurity capability in the Pacific

Over the past year, and despite ongoing Covid-19 travel restrictions, researchers in Manaaki Whenua's Weed Biocontrol group have been able to extend their expertise overseas, working with teams in eight Pacific nations as part of the collaborative Managing Invasive Species for Climate Change Adaptation in the Pacific (MISCCAP) resilience-building programme.

In May 2022, before borders had been reopened, we were able to successfully ship a courier package containing African tulip tree (*Spathodea campanulata*) leaves infested with gall mites (*Colomerus spathodeae*) to collaborators in Tonga.

The African tulip tree is considered one of the 100 worst alien invasive species in the world and one of the top 30 terrestrial invasive plants. Introduced to many Pacific islands as an ornamental plant, the trees pose a huge threat to island biodiversity across the region. Native to tropical Africa, this fast-growing evergreen tree infests rainforests, out-competes native vegetation and impacts agricultural production. Natural enemies are now the only possible solution for reducing the impacts of this tree in many Pacific nations.

Work to control the African tulip tree project is one of many projects being supported by the Global Environment Facility and New Zealand's Ministry of Foreign Affairs (MFAT) to better manage invasive species in the Pacific. Manaaki Whenua, the Secretariat of the Pacific Regional Environmental Programme (SPREP), and the New Zealand Department of Conservation have joined forces under the auspices of MISCCAP to support Pacific Island countries and territories (PICTs) to take stronger action against invasive species, and thereby build resilience to climate change.

Manaaki Whenua's Pacific Natural Enemies – Natural Solutions (NENS) coordinator Temo Talie says this shipment was an important milestone for Tonga, representing the first natural enemy imported to control an invasive plant there since 2008. Although natural enemies have been safely and successfully used to control invasive weeds in the Pacific for more than 100 years, there has been little activity in this space in most Pacific nations in recent years. So, rebuilding the capability to undertake this critical work in the Pacific has become an urgent task, which Manaaki Whenua is assisting with.

"The gall mites are a specialist natural enemy of the African tulip tree and form leaf galls known as erinea, which stunt new growth and reduce the invasive plant's competitive ability," says Temo.

After the gall mites were brought to New Zealand from Ghana, via South Africa, in 2016, they were mass-reared in our containment facility in Auckland before being released in the Cook Islands. The mites have established readily on Rarotonga, and have now spread to some outer islands.

In 2021, a second natural enemy for African tulip tree was imported into New Zealand in the same manner. The African tulip tree flea beetle (*Paradibolia coerulea*) was reared in containment in Auckland for a few months before being released in Rarotonga when a travel bubble opened up. Both the adults and larvae damage the leaves. Monitoring for establishment and impact is ongoing, and more beetles were shipped to Rarotonga in September 2022 to increase the likelihood of success.

It is expected that both natural enemies will be needed to reduce the invasiveness of African tulip tree. The gall mites and beetles have been extensively tested to ensure no other plants are at risk. Great care is undertaken to ensure that all risks, costs and benefits are weighed up before a decision is made by a Pacific nation to introduce a natural enemy in this manner.

While the introduction of both African tulip tree agents to Rarotonga was a world first, many other Pacific nations are now keen to benefit from them too. Following the shipment to Tonga, gall mites were taken to Vanuatu in July. Also, at recent workshops held in Fiji and Samoa facilitated by the Manaaki Whenua team, stakeholders determined the African tulip tree natural enemies to be their highest priority, and work is now underway to gain permission to introduce them to these countries.

Both African tulip natural enemies are currently being reared in containment at Lincoln until such time as these Pacific nations, and others, are ready to receive them.

Contact: Temo Talie
taliet@landcareresearch.co,nz

Above: Weed Biocontrol technician Stephanie Morton boxing African tulip tree flea beetles to be sent to Rarotonga.

At right: Gall mite Colomerus spathodeae *damage on an African tulip tree.*

An update on our Myrtle Rust research

Three years into the Beyond Myrtle Rust research programme, Manaaki Whenua researchers are moving into a key phase. Studies to understand the ecosystem impact of the disease have produced a substantial body of data, and researchers are now heading to the genetic laboratory, and to analysis and reporting.

Senior Researcher Dr James McCarthy says the role that some Myrtaceae species, such as ramarama, play within a forest ecosystem is largely unknown. "Unless you know how Myrtaceae species contribute to the functioning of New Zealand forests, you don't know what the impact will be if we start to lose them."

James says very little was known about some of New Zealand's 28 native Myrtaceae species, 27 of which are endemic, before myrtle rust appeared in the country. "Pōhutakawa, mānuka and kānuka are the big ones we are relatively familiar with, but ramarama for example is a common nursery plant that no-one really knew much about in native settings."

Myrtle rust, an invasive disease caused by the fungal pathogen *Austropuccinia psidii*, originally reached Australia and then was wind-blown across to New Zealand, arriving in 2017. The two big components of Manaaki Whenua's study include microbiome research as part of a disease assessment in mānuka patches north of Auckland, and a survey for microorganisms across large transects of ramarama in the forests of Mt Taranaki.

"In the mānuka patches we are looking at whether there are any fundamental differences in ecosystem processes between planted and natural stands. At this point, mānuka hasn't really been badly affected but there is always the potential for the disease to change, so it is important to understand these ecosystems, especially since so much is being planted for the honey industry." Because the fungus reproduces sexually, resistance among New Zealand's Myrtaceae may change. "It's the reason we do need to keep researching it," says James.

The Auckland mānuka study includes work on the plant microbiomes. "We are studying whether the bacteria and fungi associated with these plants might help them fight off myrtle rust, or if any combination of these microbes could help make them more resistant," notes James. "If the plants' microbiome does create some defence against the disease, that could be used to help control the disease."

The second trial is analysing ramarama in Taranaki, specifically whether disturbed populations of the trees are more heavily infected. "Do populations close to the edges, where the forest may be less intact, have more infections than those in the forest interior?" asks James. "Do we see lots of myrtle rust on ramarama because we tend to travel along tracks where the forest is less natural, and where the disease might have more opportunities to infect? Might populations in more pristine forests be infected less?

Work on Beyond Myrtle Rust has been strongly collaborative and James has praised the skill sets Scion, Plant & Food Research and Manaaki Whenua researchers have brought to the programme. The work underway has seen New Zealand take a lead in myrtle rust research, with a request from Australia for Kiwi representation on a new working group to address the increasing build-up of inoculum levels in the environment.

"New Zealand is in a more fortunate position than Australia," says James. "Of the almost 6,000 different Myrtaceae species found globally, Australia has over a quarter of them, while we have only 28. It's easier for us to keep an eye on 28 species in a smaller country." Unfortunately, it can take years before the impacts of myrtle rust are realised. The disease only affects soft, young plant tissue, with the plant becoming immune once it gets hard or woody. However, because of this, it can be a while before it's noticeable that a plant hasn't produced any seeds or flowers. New seedlings that emerge from the forest floor can be affected immediately. "It's an ecosystem-level issue because old trees are dying without new ones growing to replace them," says James.

Myrtaceae are now known to be an important family in our forests, but the final outcomes of the research are at least 18 – 24 months away.

Contact: James McCarthy
mccarthyj@landcareresearch.co.nz

www *landcareresearch.co.nz/beyond-myrtle-rust*

Manaaki Whenua technicians James Arbuckle and Dr Chantal Probst washing equipment used to sample soil for microbial DNA.

The right tree in the right place? A major economic tree species poses major ecological threats

Radiata pine (*Pinus radiata*, or Monterey pine) is native to North America, where it is narrowly distributed along the Californian coast, but is one of the most widely planted tree species in the southern hemisphere. It had naturalised in New Zealand by 1904.

At present, radiata pine is by far the largest contributor to New Zealand's forestry industry, comprising 90% of the total plantation area. It supplies most domestic wood products, and is the third largest export earner, contributing around 3% of GDP.

In a recent paper published in the journal *Biological Invasions*, lead author Dr Peter Bellingham of Manaaki Whenua and colleagues reassessed the prevailing view, stemming from the late 1980s, that radiata pine is only a minor invasive species in New Zealand. Thirty years on, the researchers undertook the first comprehensive review of where invasive radiata pine occurs in New Zealand, and evaluated whether climatic conditions are suitable for radiata pine to invade nationally. The modelling showed that up to 76% of the land area of New Zealand is climatically capable of supporting radiata populations – only the very coldest and wettest areas are unsuitable. Plot and site data from the National Vegetation Survey database showed that radiata pine occurs far more widely across New Zealand than previously appreciated. It has invaded grasslands and shrublands, but also some forests. It has invaded ecosystems mostly below 1000 m altitude, including revegetating landslides, down to sea level, where it was historically planted to stabilise sand dunes. Notably, it has often invaded areas of lower-statured vegetation, and at least three classes of naturally uncommon ecosystems: geothermal; gumlands; and inland cliffs, scarps, and tors. Because of its rapid growth rates and its flammability, it is likely to alter naturally uncommon ecosystems, and it is likely to drastically alter forest regeneration. Abandonment of grazing near plantations also results in more land likely to be invaded.

The invasiveness of radiata pine suggests to the researchers that the risk of spread of radiata pine seeds on the wind from existing and new plantations is almost certainly underestimated. They conclude that greater emphasis is needed both on managing current radiata pine invasions and proactively preventing future invasions. Although management of invasive radiata pine is already widespread in New Zealand and other southern hemisphere countries, more proactive planning is needed given ongoing large-scale afforestation efforts and potential future increases in invasion.

The researchers suggest that a levy on economic uses of invasive species to offset costs of managing invasions, alongside stricter regulations to protect vulnerable ecosystems, could help to prevent or avert the future negative impacts of those invasions.

Contact: Peter Bellingham
bellinghamp@landcareresearch.co.nz

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Controlling wilding conifers: are people willing to pay?

Wilding conifers currently affect around 7% of New Zealand land and, despite ongoing management efforts, this area has been expanding over several decades. Without management change, wilding conifers could invade around 20% of the country within 20 years.

Previous studies of public preferences for controlling invasive species have found that people value and are willing to pay for the control of invasive plants and animals. Our researchers, led by Dr Maksym Polyakov, investigated whether this finding applied to wilding pines in native ecosystems, and if so, how strongly.

Using a method based on aspects of consumer theory, the researchers undertook an online survey of people across New Zealand. The survey included a choice experiment to elicit preferences and estimate values that people place on controlling wilding conifers over the next 20 years in the 10 New Zealand regions that are most affected by wilding pines. Choices were "spread" (no change in management), "contain" (manage wilding pines where they currently exist) and "reduce" (reducing wilding spread to approximately half their current extent), with various costs per household.

With 1,180 valid survey responses, the researchers were able to conclude with some confidence that the New Zealand public is willing to pay to control wilding conifers in native ecosystems. They found that the bigger the area needing control, the less per unit area people were ultimately prepared to pay. A distance decay effect was also noted: as would be expected, people are more willing to pay for control of wilding conifers near the place they live, especially if they are familiar with the wilding problem, than for similar control further away. However, interestingly, public willingness to pay does not diminish very much over long distances (with around a 30% decline in willingness per 1000 km), supporting the researchers' conclusion that the New Zealand public generally values wilding conifer control.

These methods and results about public attitudes and preferences may interest policymakers who face competing priorities in controlling invasive species. Estimates of willingness to pay will be useful in planning and targeting wilding pine control in the future, improving the allocation of limited management resources to the most efficient management strategies.

Contact: Maksym Polyakov
polyakovm@landcareresearch.co.nz

Brad White

Successful āwheto research spurs further collaboration projects with Māori

The successful conclusion of an ecological analysis of āwheto in a native forest (ngāhere) block belonging to the Te Awahohonu Forest Trust (TAFT) in the Hawke's Bay has opened the door for other similar initiatives with Māori landowners.

Over the past 2 years, Manaaki Whenua researchers led by molecular ecology researcher Dr Eva Biggs with support from Kaihautū Whenua – Māori Research Impact Leader Dr Nikki Harcourt (Ngāti Naho) have worked with TAFT to map the presence of āwheto, a New Zealand native natural structure formed by the fungus *Ophiocordyceps robertsii*, across their whenua.

The fungus, also known as the vegetable caterpillar fungus, infects caterpillars of the ghost moth species which live underground. The fungus germinates in the larva, killing and mummifying its host. Mātauranga Māori describes how āwheto has been used in the production of ink for tā moko, as well as for rongoā (traditional medicines).

"The initiative looked at finding ways to describe favourable and challenging conditions for the establishment and conservation of āwheto, and then from that we were able to propose long-term protection strategies," says Eva.

A team that included Manaaki Whenua's Dr Alex Fergus, Dr Claudia Lange and summer intern Floyd Walker (a chemistry student at Otago University, Ngāti Kahungunu), and Myka Nuku (Ngāti Kahungunu), Leon Collier, and Cara Dee from TAFT was expecting to find around 50 āwehto during the forest mapping but ending up finding over 100. "Alex was the ace at finding these. They look just like a stick on the forest floor, but somehow he managed to spot them everywhere," says Eva.

As news of the research collaboration with TAFT spread, enquiries have come in from other Māori whānau/hapū and iwi organisations to work with Manaaki Whenua on similar projects to help them reconnect with their own taonga species.

"Understanding the distribution of taonga species across the landscape is useful for landowners because it helps guide decisions about management, and this knowledge empowers kaitiaki," says Nikki.

"Increasingly, however, Māori partners have expressed interest in understanding how the bioactive properties of indigenous flora and fauna may vary across their landscapes," she notes.

In response to this aspiration from our Māori partners, Eva and Nikki have developed a research platform dedicated to address this need. "We need to be able to look at native plants and organisms that were traditionally, and are still, being used for medicinal purposes with an ecological and biodiversity focus. We want to be able to empower our Māori partners to be able to know that if they are using something for medicinal purposes we can answer the questions around, the concentration of the bioactives, do the seasons matter, will levels of bioactives be different depending on where in the ngāhere the plant is for instance."

Contact: Eva Biggs
biggse@landcareresearch.co.nz

Floyd Walker.

Āwheto on the forest floor.

Bee realistic: the latest Colony Loss Survey results

New Zealand beekeepers are among the world's most engaged when it comes to surveying the state of their hives.

More than 49 percent of Kiwi beekeepers complete the annual New Zealand Colony Loss Survey designed to measure over-winter colony losses in managed honey bee colonies. The survey has been adapted for New Zealand conditions from a European survey. In Europe, the average response rate is just 5.5 percent.

Manaaki Whenua Principal Scientist, Economics Dr Pike Stahlmann-Brown started running the survey in 2015 on behalf of MPI, after beekeepers became concerned about the high rate of colony losses over winter.

Because the survey gets good engagement, Dr Stahlmann-Brown says the data are robust and showing definite trends. The survey is now a widely-cited source of information for the New Zealand primary sector including the honey industry.

In 2015, New Zealand lost 8.4 per cent of its bee colonies over winter. In 2021 this number was 62% higher.

"There were approximately 807,950 honeybee colonies in New Zealand at the start of winter 2021," he says. "We estimate the overall winter loss rate to be 13.59 percent, meaning that New Zealand lost approximately 109,800 colonies over winter 2021. "If rates had remained at 2015 levels, we estimate there would have been 42,000 fewer colonies lost."

The presence of varroa mites appears to be driving the increase. For example, Dr Stahlmann-Brown estimated that 1.6 per cent of all living colonies going into winter 2017 were lost to what beekeepers described as varroa. For winter 2021, that figure had risen to 5.3 per cent. That said, "these losses are based on beekeepers' attributions of losses, not lab tests".

Dr Stahlmann-Brown says it is important to study these trends as varroa is an invasive species that arrived in New Zealand in 2000. Varroa established itself in Australia for the first time this year.

"4.4 per cent of New Zealand beekeepers didn't treat for varroa at all during the 2020-2021 season, which is an issue as the mites spread easily between hives. In addition, 40 per cent of beekeepers who used the most popular miticide used less than the recommended dosage, which has the potential to contribute to resistance." Currently working on a paper to put a dollar value on colony losses, Dr Stahlmann-Brown notes that 2021 was a particularly difficult year for many beekeepers. He hopes to see a trend reversal for 2022; the survey for this year runs until 15 November.

Contact: Pike Stahlmann-Brown
brownp@landcareresearch.co.nz

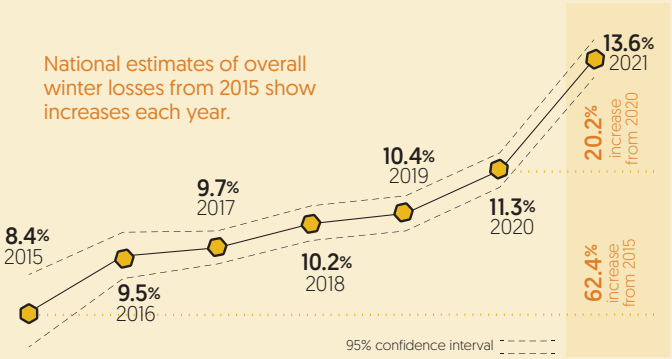
www *landcareresearch.co.nz/2021-colony-loss-survey*

NZ COLONY LOSS SURVEY

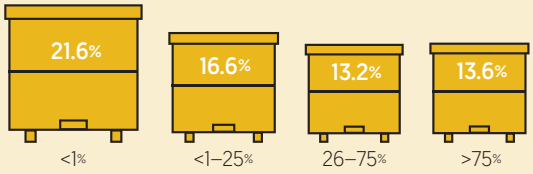
Overall loss rates

Overall loss rates attributed to all causes

National estimates of overall winter losses from 2015 show increases each year.



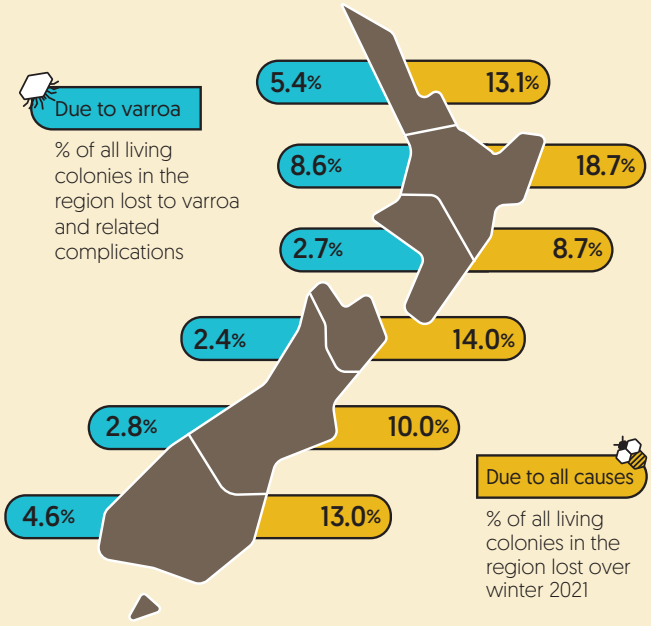
Acceptable winter loss rates



% Household income derived from beekeeping

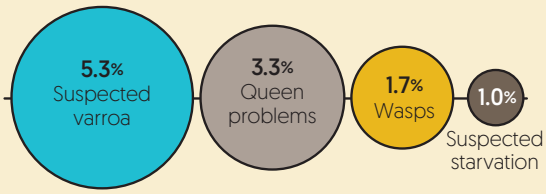
Winter losses meet or exceed the loss rates considered 'economically acceptable' among those who depend on beekeeping for a living.

Regional estimated loss rates



Losses attributed to selected causes

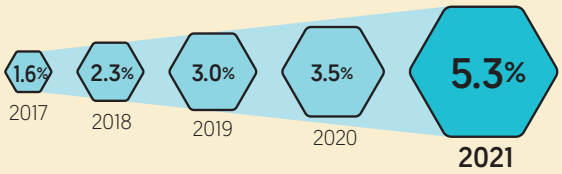
Estimated overall losses attributed to selected causes



Beekeepers across all size classes reported that suspected varroa and related complications and queen problems accounted for more losses than other causes.

Losses attributed to varroa

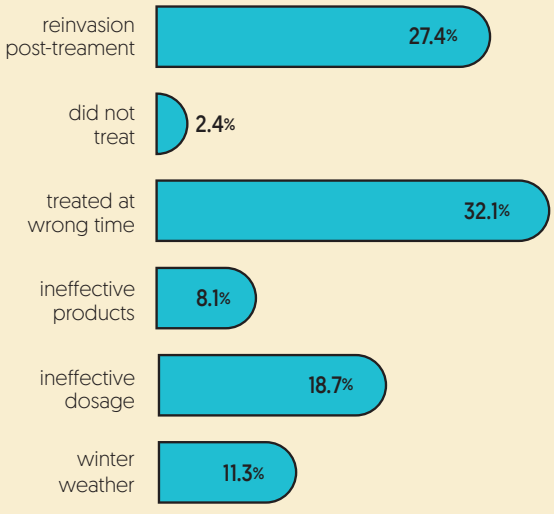
Overall loss rates attributed to varroa and related complications



An estimated 5.3% of all living colonies were lost to varroa and related complications over winter 2021, significantly higher than in any previous survey.

Main factors attributed to varroa losses

Single largest factor underlying losses attributed to varroa and related complications, according to respondents



Advocating for a Tiriti-based dual governance and management system for Waimāori (fresh water)

It's time to stop tinkering around the edges of water use policy and legislation and address the fundamental issues, says Kairangahau Māori Lara Taylor (Ngāti Tahu Ngāti Whaoa, Te Arawa, Ngāti Kahungunu, Ngāi Tahu) from Manaaki Whenua's Landscape Policy and Governance team.

As a Māori-Pākehā-Dutch woman passionate about Indigenous and environmental justice and well-being, Lara is advocating for a Te Tiriti o Waitangi framework for water use, based on Te Tiriti (the Māori text) rather than watered-down Treaty principles. She says that means tangata Tiriti remembering that rangatiratanga was guaranteed in Article II of Te Tiriti, and that sovereignty was never ceded, and couldn't be, under tikanga Māori.

"The Tiriti talks about rangatiratanga or sovereignty over taonga (or resources) which includes freshwater. Rangatiratanga requires control and decision-making power over water use and allocation. However the focus on on water quality distracts us from water access and allocation. There is a lot of nervousness about addressing use rights and who owns water, but water use, allocation, access, and quality all need to be considered together – holistically, which for Māori is consistent with our worldview and values and is what we would consider 'common sense'."

"We actually need to go right back to this and redesign our institutions and frameworks so they reflect dual sovereignty."

In a recently published opinion, Lara says a dual system would be a more equitable one that would empower and enable both tangata whenua and tangata Tiriti (all others who have come here since the first peoples, tāngata whenua, and can call Aotearoa home due to the space provided for them by the Treaty/Te Tiriti o Waitangi signed in 1840 by the British Crown and Māori chiefs) equally.

"The Māori way means we would be caring for our fresh water differently, so we need to establish, in practice, a hierarchy of use. The latest National Policy Statement for Freshwater Management gives effect to this principle, where you look after the river or body of water first, then people, and commercial gains last. The current policy lacks appropriate implementation guidance to ensure that we transition to such as system. Our paper provides a framework and guidance to help agencies, iwi and hapū, with this transition which needs to happen now without further distractions or delays".

A Tiriti-based system would also confer mana in the respective iwi and hapū that whakapapa to any particular water body, which is also necessary for implementation of the policy which recognises Te Mana o te Wai but not of the people themselves. Recognising and giving effect to the mana of any taonga (resource) requires leadership and engagement of mana whenua (Māori that hold mana over a particular area and taonga) at all levels. Despite ambiguity in the policy itself, which could be interpreted by councils to mean that they can decide how to give effect to Te Mana o te Wai, nobody except mana whenua can articulate Te Mana o te Wai, or how to give that effect".

Lara says while she is advocating for water allocation rights in this particular paper, the philosophy behind the framework could be applied across all natural resources, and Aotearoa has the opportunity to lead the way globally in creating Indigenous-centred water and land governance and management.

While a whole of system view makes sense, there would need to be compromises and a willingness to re-learn, says Lara. "For non-Māori it's a completely different way of looking at things where people don't put themselves first, but they put the land and water first with the understanding

Above: Ohaki Marae, Waikato Awa.
Right: Lara Taylor and her tamariki.

that what is at stake is actually the collective wellbeing of ourselves and our future selves."

For Lara, not achieving water governance and management equity would be a massive disappointment. "Personally, I would really feel like I've let down Papatūanuku, my whānau and future generations. If we don't do something, I worry for the water itself. We are not taking care of it the way we should and not enhancing it or even sustaining it into the future. My fear is that I leave it in a worse state than it is at the moment, and what kind of tipuna would that make me?"

Contact: Lara Taylor
taylorl@landcareresearch.co.nz

Northland ngāhere mapped to help kaitiakitanga efforts

Russell Forest on the east coast of Te Tai Tokerau/Northland is a diverse native ngāhere (forest). Researchers say it is an important example of a warm temperate rainforest in the region as it contains kauri, taraire, tawa, and totara along with threatened bird species, including the North Island brown kiwi.

The ngāhere covers over 11,000 hectares between the Bay of Islands and Whangārei, and comprises mostly forest and small areas of shrubland and mangroves with highly dissected topography and steep valley slopes. Māori have been working on a kaitiakitanga plan for safeguarding and restoring this ngāhere after years of disturbance from logging, fire, and invasive pests following European colonisation.

Manaaki Whenua researchers including Dr James McCarthy and Dr Peter Bellingham, partnered with a group, 'Te Roopu for Russell State Forest,' made up of nine hapū and marae surrounding Russell Forest to map the vegetation and bird life for a better understanding of where to focus their key kaitiakitanga efforts.

In the project, funded by MBIE Vision Mātauranga and SSIF, researchers mapped over 5,000 hectares of the ngāhere.

To do this, teams including Te Roopu kaimahi conducted field surveys of vegetation and birds in key areas surveying 106 plots. At each plot, the vegetation was measured by determining the canopy cover of all plant species present in fixed-height tiers. Birds were tallied in two 5-minute bird counts per plot (to allow comparison with earlier surveys of the ngāhere from 1979 and 1993). Birds were also measured using acoustic recorders and camera traps at 11 locations along with detecting pest mammals.

These data were then modelled across the area to create a baseline map of vegetation and biodiversity within the ngāhere. The results and maps were shared with Te Roopu at a recent wānanga alongside a report to contribute to the 20-year Russell Forest Health Plan for long-term kaitiakitanga to maintain and enhance the ngāhere.

The project was supported by Northland Regional Council, Massey University and DOC.

Contact: James McCarthy
mccarthyj@landcareresearch.co.nz

Meet the ancestors: tracing the lineage of extinct plants using ancient DNA techniques

A passing comment over morning tea one day solved a decades-long problem for Manaaki Whenua researcher Dr Peter Heenan.

"I was lamenting the fact centuries old plant material from some extinct species was too degraded to collect any meaningful DNA that would confirm family relationships, and Dr Jamie Wood suggested we try and use ancient DNA methodologies instead," says Peter.

The approach was successful, and Peter and Jamie were able to show the now extinct *Streblorrhiza* found on Phillip Island, off Australia's southern coast and collected by a botanist called Ferdinand Bower in 1836, was in fact related to New Zealand's native brooms (*Carmichaelia*).

If the process worked once, Peter and Jamie reasoned, it should work again. "We had a sample in the Allan Herbarium of *Logania depressa*, a now extinct diminutive plant that has only been collected once, from the central North Island, by William Colenso in 1847," Peter says. "We just never knew if this plant was the only New Zealand member of the *Logania* genus, of which there are 24 species in Australia."

An ancient DNA laboratory, physically isolated from other molecular laboratories at Manaaki Whenua's Lincoln site, was purpose-built and genomic DNA was extracted from leaf fragments.

"While the relationship with the Australian genus remains unresolved," says Peter, "the results show using ancient DNA processes and methods does work to study old plant samples."

Another two specimens from extinct plants have headed into the ancient DNA lab, with impressive results.

"There is a story that a tree grown from a seed collected from the last remaining *Sophora toromiro* on Rapa Nui (Easter Island) was planted in Christchurch's Victoria Park. This extinct species is closely related to the New Zealand kōwhai and the fabled 'Victoria Park toromiro' was touted as an *ex-situ* conservation programme of threatened species."

Sadly for the story, the research showed the Victoria Park tree was not a survivor of an extinct species, but was in fact *Sophora godleyi*, a species named earlier by Peter after late Manaaki Whenua botanist Dr Eric Godley.

The fourth study of an extinct plant, *Trilepidea adamsii* successfully showed relationships among three genera of New Zealand's endangered mistletoes, *Trilepidea*, *Alepis* and *Peraxilla*.

"Using ancient DNA process and methods lets us explore both the stories around extinct species, and the actual relationships. The samples may be old, but they can be brought into contemporary science using modern techniques and approaches," says Peter. "We've been able to resolve the status of some unique and poorly studied members of New Zealand flora."

Peter emphasises, however, that this work underscores the importance of the collections in herbaria around the world. "The collections provide a baseline for what we have and what has been lost. While it is impossible to say whether *L. depressa* was always rare, or whether the type locality represented the last refuge of a once more widespread species, either way, it is clear the species would have vanished without record had Colenso not collected the single specimen."

New Zealand has lost about 70 per cent of its forest ecosystems since the first arrival of people on its shores. Six plant species have gone extinct, with another further 350 species on the nationally threatened list. "In future, genomic analysis of ancient environmental DNA from sediments and fossil plant remains could provide a tool for exploring potential post-settlement species losses in the New Zealand flora," says Peter.

Contact: Peter Heenan
heenanp@landcareresearch.co.nz

House sparrow still our most-counted garden bird

Preliminary results of this year's New Zealand Garden Bird Survey are in, and the house sparrow remains the most often seen bird species in our gardens.

The survey, run by Manaaki Whenua, has been held annually since 2007. At the end of June, we invite members of the public to become citizen scientists for an hour and count the number of birds in their garden.

This year, more than 15,000 people took part nationally, submitting over 6,000 surveys. The numbers of birds counted were also similar to the numbers counted last year, both at a national and local level, says survey founder Dr Eric Spurr.

Nationally, the top 10 species were house sparrow (tiu), silvereye (tauhou), blackbird (manu pango), starling (tāringi), tūī, fantail (pīwakawaka), myna (maina), greenfinch, rock pigeon (kererū toka), and song thrush (tarāhi waiata), the same order as last year.

Of these, only three species are native; silvereye, tūī, and fantail, with four other native species occurring in the top 20; kererū, welcome swallow (warou 'nau mai'), kingfisher (kōtare), and grey warbler (riroriro).

Based on preliminary results, the counts of all native species appear to be the same or greater than last year. Final results of the 10- and 5-year trends to 2022 are expected later in the year.

Andrew Walmsley

A female house sparrow.

This year Nelson bird enthusiasts swooped in and knocked Otago off its perch as the country's top counting region on a per capita basis – a title they've held for years. We sense a challenge may be on for the 2023 New Zealand Garden Bird Survey.

Contact: Angela Brandt
brandta@landcareresearch.co.nz

www *nzgardenbirdsurvey.nz*

New Zealand GARDEN BIRD SURVEY

Celebrating our achievements

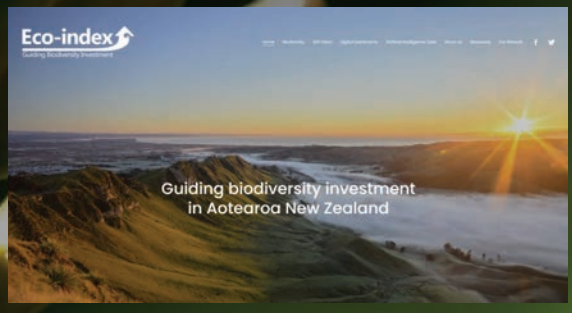
Dr Gradon Diprose has been invited to join the reference group for the Office of the Prime Minister's Chief Science Advisor's project on food rescue and waste. To support other work addressing waste and emissions reductions, the OPMCSA is undertaking a major project on combatting food waste in Aotearoa. Gradon will contribute expertise on food rescue, based on research he has done funded through the Resilience to Natures' Challenges National Science Challenge.

Gradon Diprose.

Our Weeds Biocontrol team has been much in demand. **Dr Angela Bownes, Arnaud Cartier, Dr Amy Vaughan** and **Dr Ronny Groenteman** gave webinars during the 2022 Biosecurity Bonanza in June, showcasing the latest biosecurity research being undertaken at Manaaki Whenua. The Bonanza, a virtual event, was attended by 961 people across the country, with 2,692 registrations across nine webinars, which were watched over 2,100 times either live or via the recording. Hugh Gourlay assisted with hosting the event. The team has also reached the finals of the 2022 New Zealand Biosecurity Awards, run by MPI.

Weeds Biocontrol team.

Eco-index, a BioHeritage National Science Challenge programme, which counts Manaaki Whenua researcher Dr Rachelle Binny as a team member, has recently qualified as the first Digital Public Good from Aotearoa New Zealand. This qualification describes an open-sourced digital tool designed for public good. The Eco-index Biodiversity Dashboards can be used for monitoring the current state of, and changes in, biodiversity levels. They also allow for the correlation of those changes with economic investments being made to improve biodiversity outcomes. The tool has its foundations in Te Ao Māori concepts and is intended to aid decision-making for land managers across Aotearoa.



Eco-index

Barriers and enablers to rural landowners engaging in native afforestation

Native forest establishment is an important mechanism to sequester carbon in the long term, increase biodiversity, prevent erosion, and improve water quality. For Aotearoa New Zealand, large-scale afforestation is a crucial part of our strategy for climate change mitigation. Establishing new forests and managing existing ones are currently the lowest-cost carbon emissions removal options.

Strategies to promote landowners and groups in preserving the existing and establishing new native forests include conservation covenants, payments for ecosystem services and incentive programmes. However, designing and implementing incentive programmes and other policy measures to encourage rural landholders to plant native forests on their land has first meant understanding what factors influence farmers' willingness to plant trees.

A team of Manaaki Whenua researchers including Drs Peter Edwards, Maksym Polyakov and Geoff Kaine has been working to determine the drivers, barriers, and efficacy of incentives for rural landowners to engage in native afforestation. In a project funded by MPI, researchers used a choice experiment to evaluate the trade-offs among various incentives to encourage native afforestation and regeneration on private lands.

The survey was completed by over 600 rural landholders throughout New Zealand, including dairy, sheep, beef and other livestock farmers and lifestyle block owners. Researchers found that rural landholders would be interested in joining voluntary programmes to establish native forests if they were provided with appropriate monetary and non-monetary incentives and tree planting is aligned with their properties' characteristics.

They found differences in preferences exist between afforestation/planting and reversion/regeneration programmes, and landholders had diverse preferences for different elements of the programmes. While monetary incentives were found to be vital to increasing enrolment and area commitment to both types of programmes, providing seedlings or finding seedlings suppliers were the most important non-monetary incentives for enrolment, along with Government assistance in applications and paperwork, planning and species selection for afforestation/planting programmes.

Results also showed:

- Rural landowners' property characteristics are important determinants of both enrolment and area commitment to the programmes.
- The size of the properties did not affect enrolment but is an essential determinant of the area committed.
- Farms with steeper topography are more likely to be enrolled in the reversion/regeneration programmes, but topography does not affect enrolment in afforestation/planting programmes.

It was also found the presence of wetlands is associated with a higher probability of enrolment and a larger area committed to both types of programmes, whereas the presence of bush and scrub on land is associated with a higher probability of enrolment and a larger area committed to reversion/regeneration programmes.

Contact: Peter Edwards
edwardsp@landcareresearch.co.nz

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Landcare Research