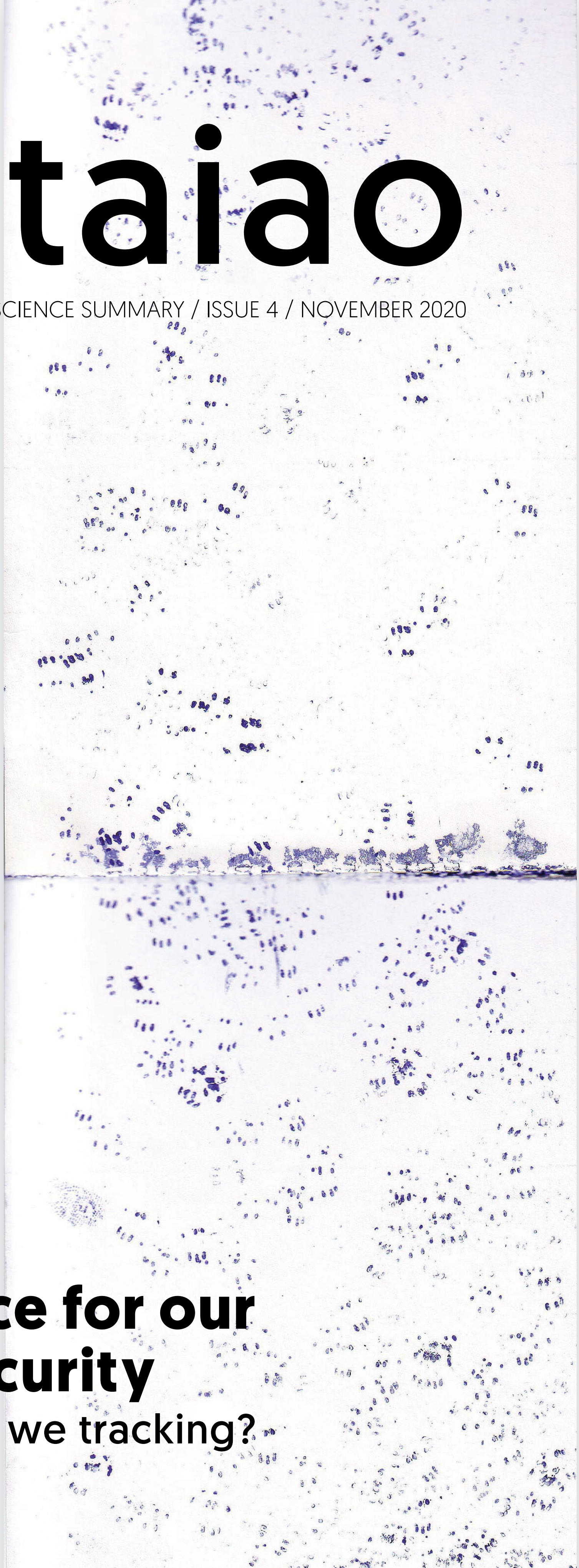
Pūtaiao

MANAAKI WHENUA SCIENCE SUMMARY / ISSUE 4 / NOVEMBER 2020



Science for our biosecurity

How are we tracking?

Pūtaiao

Science for our land and our future

Tēnā koe and welcome to the fourth issue of *Pūtaiao* ('science' in te reo Māori), our quarterly publication. In this issue many of the stories focus on science for our biosecurity – one of Manaaki Whenua's four science ambitions for Aotearoa New Zealand: that our land is protected from invasive biological threats.

We offer wide-ranging research capability in all aspects of biosecurity and predator control science, from fundamental genomics and taxonomy to biocontrol, pest trapping and animal behaviour manipulation, plant disease resistance, and early detection of border biosecurity risks. We collaborate with many partners to help New Zealand reach its biosecurity and predator-free goals. We also draw on the experience of our social scientists in building a 'social licence to operate' – a key ingredient of successful applied research.

This issue begins with some of our most recent work in vertebrate predator control. New Zealand has 30 years to achieve its target of being predator-free by 2050, and we still have critical science questions to solve:

- How do we target the most recalcitrant predators?
- How do we better understand the interactions between predators and native birds?
- When is best to control predators?
- Where and how do traps get the best results?
- Will predator genomics allow the development of targeted control options – and if so, will New Zealanders be supportive of such methods?
- How do we develop more humane, environmentally appropriate and selective predator toxins to reduce reliance on 1080?

Our progress towards answering these questions is outlined in the pages that follow.

If you wish to be included on the mailing list for *Pūtaiao*, contact Dan Park: parkdj@landcareresearch.co.nz

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Outsmarting the smartest – progress in eradicating the last 5%

New Zealand is a world leader in controlling and, in some areas, eradicating invasive mammalian predators. Much of that innovation has been in developing and deploying devices such as traps and bait delivery mechanisms, but those devices and methods can only achieve complete eradication if all individuals in the target population interact with them – and we know that some don't.

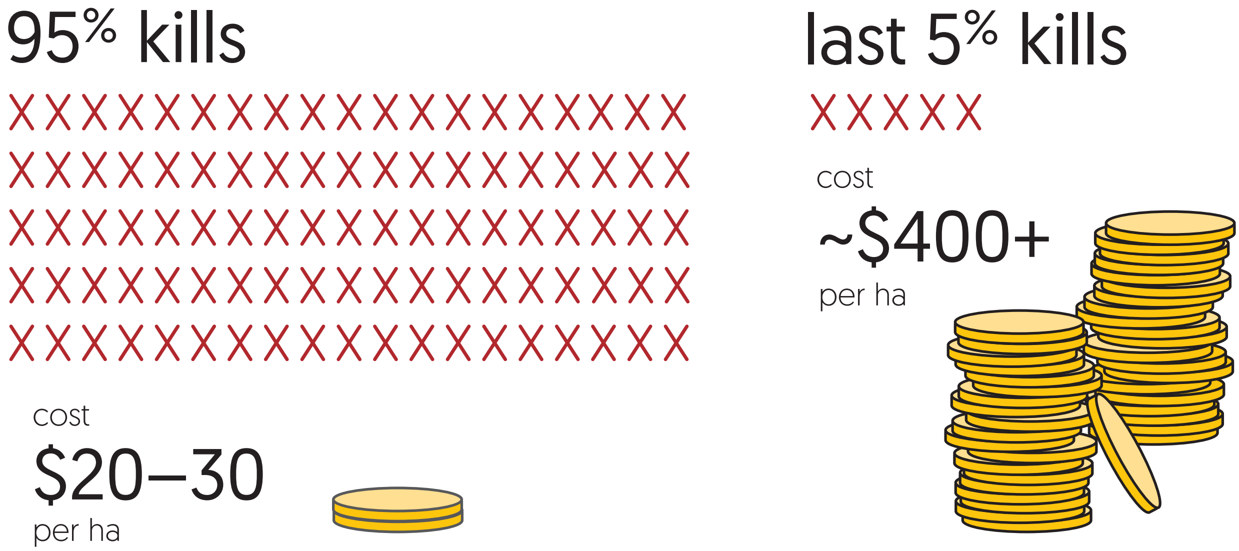
Predator control routinely removes approximately 95% of a target population. However, New Zealand's Predator Free 2050 initiative requires scientific breakthroughs to achieve 100% kills (i.e. eradication) of rats, mustelids and possums.

Although 95% kills typically cost $20–$30 per hectare, 100% kills cost over $400 per hectare. Pest eradication from Rangitoto and Motutapu Islands cost $1,200 per hectare. The prohibitive cost of eradicating the last 5% using current technology is a barrier to us achieving our Predator Free 2050 eradication goal.

As well as it being hugely expensive to remove the last 5% in a pest population, survivors remaining in an area with plentiful resources are likely to breed successfully and at close to their maximal rates. This, in turn, means that more money has to be spent on controlling them, and so the cycle of control continues.

The 5-year MBIE programme 'Eradicating the Last 5%', which began in October 2019, is focused on the careful study of behaviours among pest populations to offer solutions to these problems. The fundamental questions addressed by the programme are as follows:

Cover image: Mice footprints. Tracking cards are used in predator control to identify what animals are in an area.



- what makes survivor individuals survive control?
- do they have predictable behavioural characteristics (why do these animals not take baits or enter traps when 95% of their species do)?
- how can we manipulate those behaviours using novel cues or combinations of cues to overcome survival behaviours?

The research now underway is a combination of many interdependent approaches:

Animal behaviour: We will improve our understanding of survivor 'personalities' (behavioural traits) and how these differ from the 'average' individual in a population. This will allow us to use specific cues to alter the attractiveness of sites/traps to exploit those motivations.

Identification and development of cues: The extent to which a pest responds to a cue is a trade-off between the perceived risk, the value of the reward, and the traits of the individual. We will identify and develop a range of cues that deliberately alter the target's perception of risk and reward.

Working with mātauranga Māori on animal behaviour: We will work with our iwi/imi and hapū partners to identify mātauranga associated with traditional trapping and luring, such as the use of sound lures or recognition of cyclical or seasonal variations in animal behaviour.

AI in pest control: Artificial intelligence, including the use of image recognition to identify pest species, has huge potential to facilitate targeted pest control via smart traps.

Our research will help land managers to achieve full eradication cost-effectively. Our collaboration with Māori and Moriori partners will also ensure our research responds to their priorities – a first for predator tools research in New Zealand – and that any approaches we develop are culturally relevant and appropriate for use on the whenua.

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DNA codes broken for stoats and ship rats

The complete genome of the stoat (*Mustela ermine*) – one of New Zealand's most destructive introduced predators – is now available to researchers, courtesy of the US-based National Center for Biotechnology Information genome database. This work comes hard on the heels of work to sequence the ship rat genome.

The international collaboration to sequence the stoat genome was led by Dr Andrew Veale at Manaaki Whenua. "Stoats will be one of the trickiest pests to eradicate across Aotearoa, but the completed genome provides great opportunities to understand their biology, and to create tools to assist conservation," says Dr Veale.

The assembled stoat genome is over 2.4 billion DNA bases long, with over 20,000 identified protein-coding genes. This new genome is one of the highest-quality vertebrate genomes ever produced, with nearly gapless complete chromosomes assembled and annotated.

"This sets us up for the breakthrough research we will need to realise the Predator Free 2050 goal," says Professor Dan Tompkins of Predator Free 2050 Limited, which co-funded the research as part of its Science Strategy. "Knowing the genetic code of these devastating predators is an important step towards finding their Achilles heel."

The project was also co-funded by the New Zealand's Biological Heritage National Science Challenge and involved collaboration with scientists from the Vertebrate Genome Project, based at the Rockefeller Institute in the US and the Wellcome Sanger Institute in the UK.

The stoat genome is already being used to assist conservation efforts in New Zealand, and there are many other

projects on the horizon. Dr Veale is currently mapping the connectivity of stoat populations across the landscape using spatial models, relying on novel genetic markers. “Once we have the precise relatedness of each individual and their location of capture, we can create models showing how the animals disperse across the New Zealand landscape. These models can then be used to optimise trapping networks, enabling traps to be placed to prevent reinvasion into areas cleared of stoats.”

Dr Veale is also developing forensic genetic markers from the genome sequence to identify individual stoats from trace samples, such as scat, saliva and hair. These markers can then be used in a CSI-type setting. For instance, if a conservation programme discovers a dead kiwi with a bite mark, and a dead stoat in a trap, it is now possible to answer the question, “Was this the stoat that killed the kiwi, or is there another one out there?”

Dr Erica Hendrikse, a postdoctoral researcher at Manaaki Whenua working with Dr Veale and Dr Brian Hopkins, is currently using the stoat genome (along with the ship rat and possum genomes) to look for ways to develop species-specific toxins. This work is SSIF-funded.

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Smarter trapping for better results

Manaaki Whenua’s Dr Patrick Garvey and colleagues recently published new findings on the manipulation of stoat behaviour in work linked to the MBIE programme ‘Eradicating the Last 5%’.

“Pest management often focuses on the ‘average’ individual within a pest population,” says Dr Garvey, “neglecting individual behavioural traits or personalities of animals. If we focus on the ‘average’ pest, we fail to mitigate the damage done by rogue or recalcitrant individuals – the uncatchable stoat inside a fenced sanctuary, the domestic cat that targets a colony of birds, or the rat that refuses to enter a trap. These are the pests that cause most damage and are very expensive to remove.”

Conservation managers have three main ways to manipulate a trap when managing pests: the attractiveness of the bait or lure, fear of the trap, and the background environment. Altering any of these can increase the likelihood that an animal will interact with a device. Using different types of lures (visual, odour, auditory) based on different pest motivations (mates, food, predators) will also target more individuals.

> *“Rogue or recalcitrant individual pests cause most damage and are very expensive to remove.”*

Management that incorporates principles of behavioural ecology should enable these ideas to be tested in the field to increase the effectiveness of predator control.

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www **https://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(20)30187-7#%20**

Weasel (Mustela nivalis vulgaris) *footprints.*

Biosecurity Bonanza

Manaaki Whenua's annual one-day Biosecurity Bonanza is an established part of New Zealand's biosecurity research conference calendar, normally attracting around 100 stakeholders and research partners.

In 2020, due to the limitations of the nationwide COVID-19 lockdown, we were not able to hold an in-person event. Instead of a one-day conference, we held a virtual version over a week, which comprised 11 webinar sessions from the Wildlife Ecology & Management and Biocontrol & Molecular Ecology teams.

Around 850 people across the country registered for the event, including staff from MfE, MPI, DOC, other ministries, councils, other CRIs, universities, and many industry stakeholders – a huge increase overall from previous years. Feedback was very positive despite the disadvantage of not being able to network in person.

The webinars are available to watch again at the link below:

www *https://www.youtube.com/landcareresearch*

DNA sequencing for better identification of fungi

It is an exciting time to be a fungal taxonomist (someone who specialises in the identification and classification of fungi) according to Dr Peter Johnston, one of Manaaki Whenua's experts in the discipline.

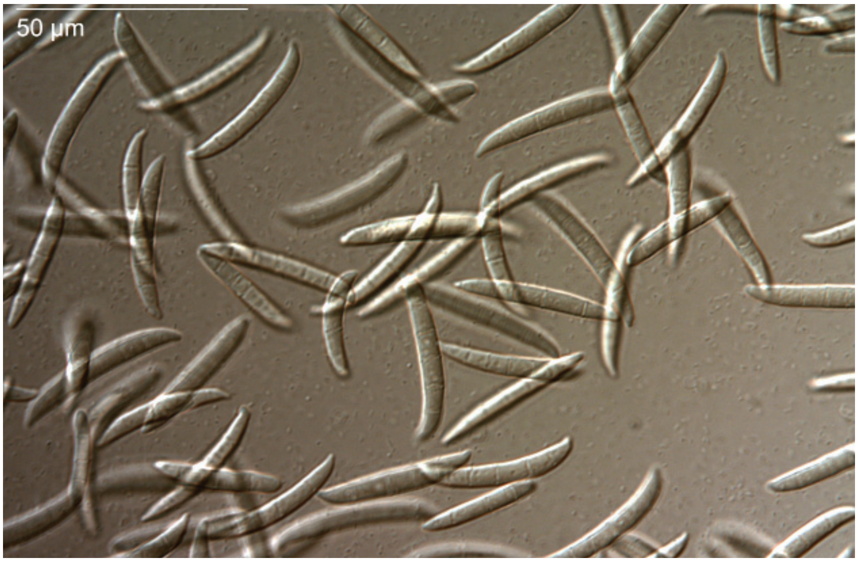
In the past, fungi were identified using morphology – what they look like. This included their shape, colour and size visible to the human eye, as well as features revealed by a microscope. Classifications were based on the characters that humans found the most useful to measure and observe. Fungi are also morphologically simple, meaning that classifications were based on only a few characters.

Now, DNA sequencing has completely changed the game. Suddenly fungal taxonomists have an almost unlimited number of characters to use to develop their classifications. Mycologists around the world are collectively developing new classifications that incorporate new knowledge about relationships provided by DNA sequences. Users of the classifications – such as plant pathologists, ecologists and biosecurity regulators – increasingly use DNA sequences rather than microscopes to identify their specimens.

One consequence of the switch from morphology to sequences is that most lists of fungal pathogens thought to be 'present in New Zealand' are based on the old, morphology-based classifications and identification methods. The question arises, can the old records be trusted? The 'present in New Zealand' lists need to be validated and accurate because they are the basis

> *Our validation work showed approximately 169 available specimens of* Phoma, Fusarium *and* Verticillium *had been misidentified.*

of managing New Zealand's biosecurity. Whether or not a species already occurs here is the vital first step in assessing biosecurity risk at the border.



A Kowhai pathogen, initially identified as Fusarium lateritium*, a benign secondary invader of stressed plant tissue. DNA analysis showed it was* F. avenaceum*, a pathogen also associated with head blight of wheat.*

Manaaki Whenua is in a key position to undertake this validation by sequencing our collections of microorganisms and fungi that support the 'present in New Zealand' statements. We have now carried out validation studies on several groups of very important soil-borne plant/crop pathogens that were notoriously difficult to identify using morphology. These include the genera *Fusarium* (which causes, among other serious diseases, fusarium wilt in many vegetable crops and crown rot in cereal crops); *Phoma* (which causes black rot and leaf spot diseases in vegetable crops); and *Verticillium* (the cause of verticillium wilt in over 350 species of vegetables, fruit trees, flowers, field crops, and shade or forest trees).

Our validation work has shown that approximately half of the 108 available specimens of *Verticillium* from New Zealand, about half of the 96 specimens of *Fusarium*, and about a quarter of the 268 specimens of *Phoma* had been misidentified. We found that eight species of plant pathogens, previously thought to be present in New Zealand in fact do not occur here. The previous incorrect records could have resulted in material being released at the border that contained species that would have brought new plant diseases to New Zealand.

As a further example, our work also recently enabled the accurate isolation and identification of fungi associated with grapevine trunk diseases that are already present in New Zealand.

Another consequence of using DNA sequencing to identify specimens is that non-experts in fungal morphology can identify many more species; for example, from ecological studies. A recent survey of fungi associated with the aggressive, unpalatable pasture weed giant buttercup (*Ranunculus acris*) in New Zealand found that from 140 specimens sequenced, 22 represented species never before reported as present in New Zealand.

Basic presence/absence data such as these are central to the management of biosecurity risks to New Zealand – and our fungal taxonomists are in the vanguard of this work.

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https://doi.org/10.1080/01140671.2020.1716813

Moving New Zealand beyond myrtle rust

Myrtle rust is a disease caused by an invasive pathogen that infects iconic native New Zealand trees in the Myrtaceae family. Spread by the windborne fungus *Austropuccinia psidii,* myrtle rust affects many economically and culturally important species such as pōhutukawa, mānuka, kanuka and rata, leading to tree dieback and potentially tree death. It can also affect non-native Myrtaceae such as feijoa and eucalypts.


An active myrtle rust infection.

Myrtle rust was first detected in New Zealand in March 2017 and is now found throughout the upper North Island. It has currently been recorded as far south as Greymouth.

Manaaki Whenua is coordinating research activities on myrtle rust across New Zealand as part of the MBIE 5-year multi-institute research programme "Beyond Myrtle Rust" – to ensure an effective national response to the pathogen. These activities span four main research areas:

- Pathogen dynamics: Improving understanding of how the fungus reproduces in New Zealand.
- Ecosystem impacts: Investigating broad-scale impacts of *Austropuccinia psidii* on ecosystem functions, and assessing whether environmental factors (including host plant features) might influence disease progression and consequences.
- Novel mitigation techniques: Investigating host plant resistance to myrtle rust, whether plant or microbe-mediated.
- Kaitiakitanga and Māori-led solutions: Cultural and environmental priorities are being assessed alongside disease impacts, with capacity being built and management strategies developed, ultimately producing a Te Ao Māori values framework and protection plan.

Myrtaceae in New Zealand contribute to key ecosystem processes and services, either as early successional species (kānuka, mānuka, pōhutukawa), or as a long-term 'climax' vegetation canopy species (rātā). However, in many cases, we are still unsure of the degree to which ecosystem functions are dependent on Myrtaceae. By understanding what constitutes a healthy myrtaceous ecosystem (i.e. the baseline), Manaaki Whenua researchers can predict the effects of myrtle rust to better understand impacts on forest conservation efforts, and on ecosystem functions.

The programme, which began in October 2018, has made good headway despite the COVID lockdowns. At Manaaki Whenua, we have completed analyses quantifying the functional importance of Myrtaceae in New Zealand forests to compare species- and family-level richness and abundance patterns, functional attributes, and their environmental drivers. Initial results suggest Myrtaceae is the third most important woody-plant family in New Zealand.

Manaaki Whenua researchers are now set to head into the field this summer, when myrtle rust is most virulent. They will focus on disease dynamics in the hard-hit genus *Lophomyrtus*, and improve our understanding of ecosystem functions in native and naturally re-generating stands of mānuka. This will generate valuable baseline data in advance of possible disease development in this taonga species, enabling disease impacts and future management approaches to be better assessed.

Manaaki Whenua's researchers are also involved in SSIF-funded work being run by the Bioheritage National Science Challenge on kauri dieback and myrtle rust.

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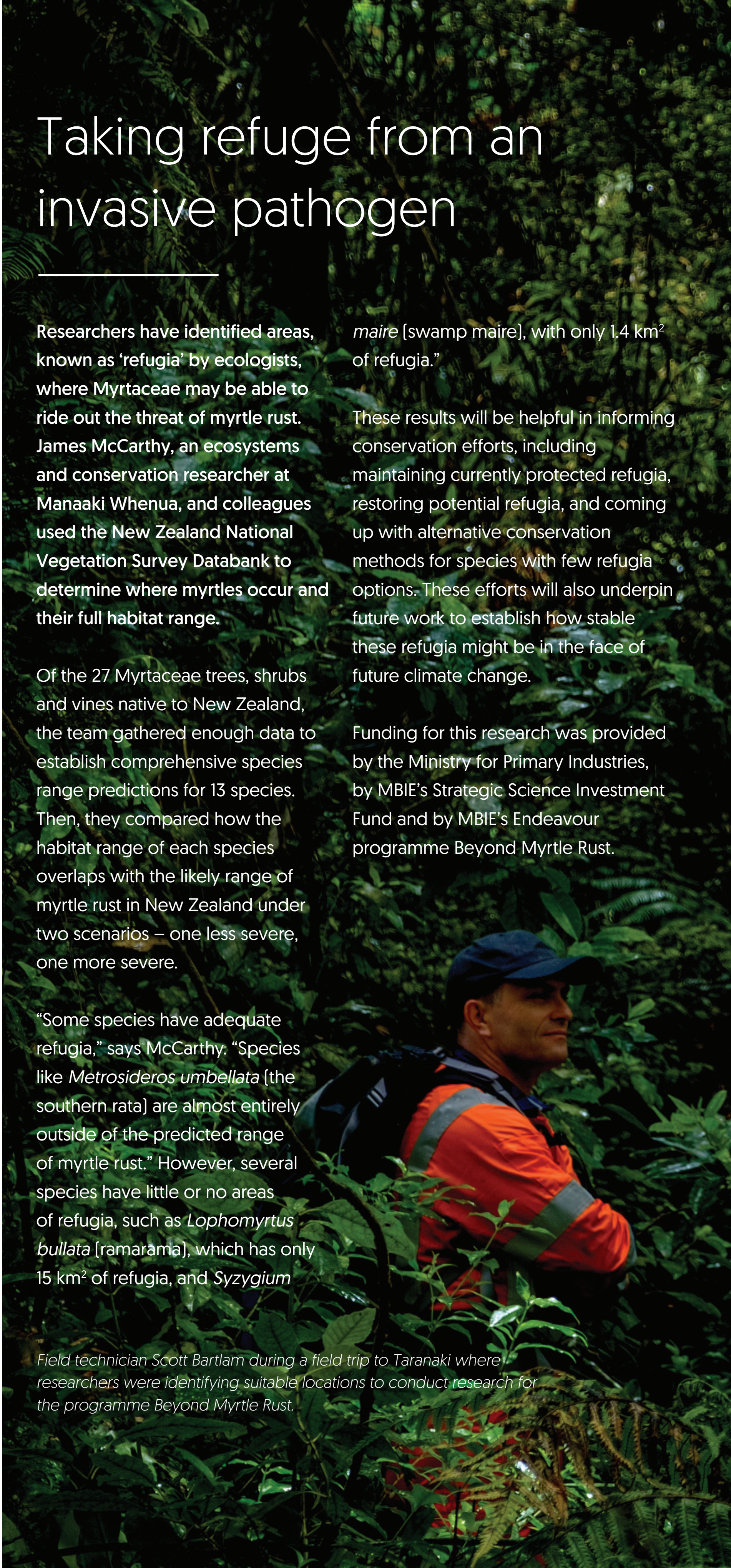
www *https://www.landcareresearch.co.nz/discover-our-research/biosecurity/ecosystem-resilience/beyond-myrtle-rust/*

www *https://bioheritage.nz/collaborations/kauri-dieback-myrtle-rust/*

Taking refuge from an invasive pathogen



Researchers have identified areas, known as 'refugia' by ecologists, where Myrtaceae may be able to ride out the threat of myrtle rust. James McCarthy, an ecosystems and conservation researcher at Manaaki Whenua, and colleagues used the New Zealand National Vegetation Survey Databank to determine where myrtles occur and their full habitat range.

Of the 27 Myrtaceae trees, shrubs and vines native to New Zealand, the team gathered enough data to establish comprehensive species range predictions for 13 species. Then, they compared how the habitat range of each species overlaps with the likely range of myrtle rust in New Zealand under two scenarios – one less severe, one more severe.

"Some species have adequate refugia," says McCarthy. "Species like *Metrosideros umbellata* (the southern rata) are almost entirely outside of the predicted range of myrtle rust." However, several species have little or no areas of refugia, such as *Lophomyrtus bullata* (ramarama), which has only 15 km^2 of refugia, and *Syzygium maire* (swamp maire), with only 1.4 km^2 of refugia."

These results will be helpful in informing conservation efforts, including maintaining currently protected refugia, restoring potential refugia, and coming up with alternative conservation methods for species with few refugia options. These efforts will also underpin future work to establish how stable these refugia might be in the face of future climate change.

Funding for this research was provided by the Ministry for Primary Industries, by MBIE's Strategic Science Investment Fund and by MBIE's Endeavour programme Beyond Myrtle Rust.

Field technician Scott Bartlam during a field trip to Taranaki where researchers were identifying suitable locations to conduct research for the programme Beyond Myrtle Rust.

Biocontrol – slow and steady wins the race

As is well known, invasive non-native plant species are a threat to New Zealand's native biodiversity and ecosystems – and the list of invaders is long. Herbicides are widely used in the management of invasive plants, but they have non-target effects on native plants in treated areas and are expensive to apply (especially from the air). It is also thought that they slow down the recovery of native plant communities after treatment. Widespread aerial herbicide application also risks public disapproval linked to perceived effects on human and wider ecosystem health.

Paul Peterson and colleagues from Manaaki Whenua, Massey University and the Open Polytechnic recently published the findings from a long-term, carefully controlled study, partly funded by SSIF, comparing herbicide use with biocontrol methods for the control of invasive heather in and near Tongariro National Park. Their work was named 'Paper of the Month' for June 2020 by the Journal of Applied Ecology.

Heather (*Calluna vulgaris*) was deliberately introduced into the park from Europe in 1912, subsequently becoming the most invasive weed there, dominating over 50,000 hectares. The heather beetle (*Lochmaea suturalis*) was introduced from the UK as a biocontrol agent to control heather in 1996. This study, which began in 2007, followed the outcomes of four treatments: (a) control (insecticide spray to protect vegetation from heather beetle feeding, (b) biocontrol (to expose heather to beetle feeding only), (c) herbicide (herbicide + insecticide to protect vegetation from beetle feeding but expose it to herbicide), and (d) biocontrol + herbicide (to expose vegetation to beetle feeding and herbicide).

The herbicide-only, biocontrol-only, and herbicide + biocontrol plots all showed effective reduction in heather cover from around 50% to near zero. However, after 5 years, plots treated with herbicide also showed reductions in cover and species richness of native plant species, whereas these non-target effects were not seen in biocontrol-only plots; biocontrol agents are carefully chosen to ensure they only attack the target plants. In fact, native plant species even started to recover in biocontrol-only plots.

The authors concluded that control strategies for the management of invasive plants should more readily

*Heather beetle (*Lochmaea suturalis*) a biocontrol agent introduced in 1996 is shown to only attack its target plant heather (*Calluna vulgaris*).*

consider biocontrol methods in the future. "Where invasive non-native plant species problems are widespread and threaten indigenous plant communities over large tracts of land, as they do in New Zealand, biocontrol is likely to be more appropriate than widespread herbicide application, mechanical, grazing or burning methods."

Biocontrol is not a quick fix, however. It takes many years to select, approve, breed and release biocontrol agents, and the sector is scrupulously regulated through the Environmental Protection Authority. Nonetheless, over time Manaaki Whenua's scientists have built up considerable expertise, experience – and large reserves of patience! – to ensure the successful application of biocontrol methods to enhance New Zealand's biodiversity.

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www ***https://besjournals.onlinelibrary.wiley.com/doi/10.1111/1365-2664.13691***

More biocontrol agents in the pipeline

Just before lockdown in early 2020, Zane McGrath of Manaaki Whenua travelled to Uruguay to collect specimens of *Anastrepha australis* (the moth plant pod fly), a prospective biocontrol agent for the invasive moth plant *Araujia hortorum* (also known as *Araujia sericifera*).

Native to South America, moth plant is a serious pest plant in New Zealand. Producing up to 1,000 windborne seeds per seed pod, it is particularly invasive in northern New Zealand. The vines of moth plant smother shrubs and small trees, shading out small native plants and seedlings. *Anastrepha australis* larvae feed on immature seeds within the plant's seed pod, typically leaving no viable mature seeds to germinate.

Zane worked with Soledad Jorge Delgado at Universidad de la República, Uruguay, and Soledad Villamil at Universidad Nacional del Sol, Argentina. With all the paperwork in place, including a collection permit approved by the Uruguayan government and an import permit from MPI, in February 2020 around 80 pupae were brought back to Manaaki Whenua's Beever Plant Pathogen Containment Facility at Tamaki, Auckland, for careful assessment.

Ahead of this work, in December 2019 another biocontrol agent for moth plant was fully approved and released at sites in the Bay of Plenty and Northland. One hundred and fifty adult moth plant beetles (*Freudeita cupripennis*) were released at Matapihi, near Tauranga. Shane Hona (Bay of Plenty Regional Council) and Hayden Henry, a representative of Ngāi Tukairangi Resource Management Authority, released the beetles onto a moth plant infestation smothering harakeke/New Zealand flax (*Phormium tenax*). The second release, also of 150 adult beetles, took place in the Awanui area near the Sweetwater Lakes in Northland, overseen by Jenny Dymock (Northland Regional Council). This project was funded by the National Biocontrol Collective.

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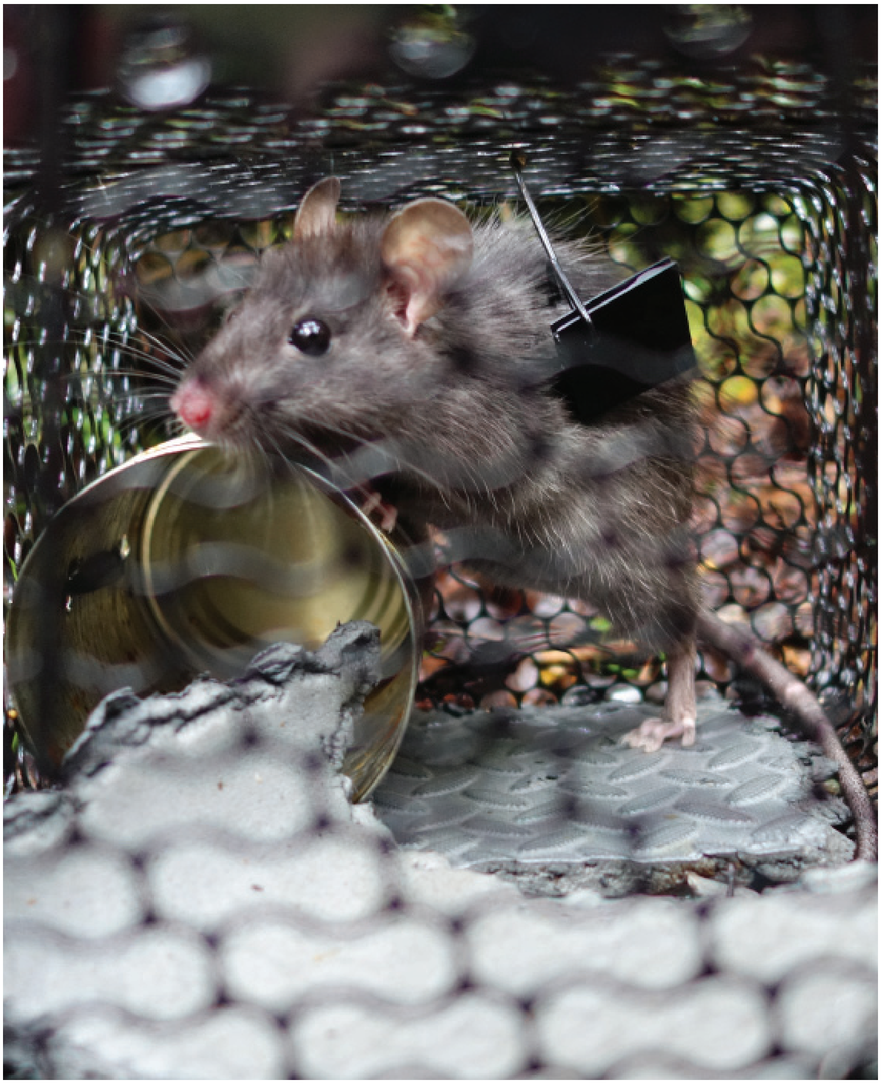
www ***www.youtube.com/watch?v=-mb3meB5Mcc***

Freudeita cupripennis, *the moth plant beetle.*

Rats with chips: how radio-collared rats are helping scientists to protect our native birds

Some of the highest rat densities ever measured on the New Zealand mainland are being recorded in a study run by Manaaki Whenua at Lake Alabaster in Fiordland, as part of the 5-year 'More Birds in the Bush' MBIE Endeavour research programme. The study, carried out in collaboration with DOC, is showing the remarkable ability of rats to multiply rapidly following beech seeding, such as the 'mega-mast' (mass seeding event) that occurred in 2019.


Rat in a live capture trap.

Understanding how altitude and food availability regulate rat numbers should give conservationists the edge in protecting wildlife from rat plagues, which can lead to localised extinctions of native wildlife. To tease out these factors, the researchers have been intensively monitoring rat population dynamics at both high and low elevations in forested areas near the lake.

Since the study began 14 months ago, 912 individual rats have been live-captured and given a microchip and a metal tag in their ear before being released. Rats at high elevation are also being fed to see whether they can survive cold temperatures when they have sufficient food.

"Rats are generally less common in cold, high-altitude forests across New Zealand than in warm, lowland forests," says study lead Dr Jo Carpenter, a postdoctoral researcher at Manaaki Whenua. "But it's not clear whether that's because rats can't handle cold temperatures, or because there is typically less food there, especially in winter."

"If it's temperature that normally limits rats from living up high, and not food, we might expect to see high-elevation forests supporting more rats as the climate warms," says Manaaki Whenua researcher Dr Adrian Monks. "This could have devastating consequences for some of our native birds, which currently use these colder environments as refugia from pests."

The study also has direct implications for pest control. Cost-effective pest management relies on knowing where and when pest numbers are high so that management can be focused in the right place at the right time.
The preliminary results have been startling. Following the beech seed mast in 2019 the population density at Lake Alabaster reached a phenomenal 17 rats per hectare. These are some of the highest rat densities ever measured on the New Zealand mainland and reflect the incredible ability of rats to multiply rapidly following beech seeding.

Rat being fitted with a radio transmitter collar.

Although food helped sustain the rats through the autumn, during the winter the rats being fed declined as much as the rats that were not fed. This suggests that another factor – perhaps temperature or predation by stoats – is limiting rats. Once this is known, it should be possible to create a 'weather forecast' about likely rat numbers for conservation managers, which will involve making predictions about rat numbers based on the climate and forest at a site. In turn, this will allow rat control to be done as effectively as possible, resulting in more birds in the bush.

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Heli-access only to the remote Lake Alabaster fieldwork site.

Are we winning against wildings?

Invasion by wilding pines is arguably New Zealand's most serious and intractable weed problem. Wildings have profound impacts on our treasured landscapes and native plants, ecosystem services, economy, and cultural values.

However, up until 4 years ago we still had key gaps in our knowledge of how wilding pines spread, how they affect ecosystems, and how to better control them. In 2017 the MBIE Endeavour-funded programme 'Winning Against Wildings' started to address these key knowledge gaps and help achieve large-scale gains in the control of wildings.

Research technician Rowan Buxton from Manaaki Whenua locates seedlings of wilding pines to remeasure at the Molesworth Station near Hanmer.

Our research in the 'Winning Against Wildings' programme aims to resolve where, and when, management can minimise the spread and negative impacts of wildings, while minimising costs and adverse environmental effects. We combine research on invasion dynamics and management interventions to ensure that management efforts slow or reverse wilding pine invasion.

The programme brings together collaborators from Manaaki Whenua, Scion, the University of Canterbury, Lincoln University, and overseas. We also work closely with on-the-ground operations and across government to stop the accelerating impacts of wildings across New Zealand. Our collective goal is to see the National Wilding Conifer Management Strategy succeed: wildings have been controlled or are contained nationally by 2030.

We are now over 3 years into the research programme and have made much progress to help manage wildings. We have:

- designed, built and deployed a new, low-cost apparatus that enables rapid measurement of seed dispersal potential, to improve estimates of wilding spread risk
- completed trials to improve wilding control methods, such as lower-dose herbicides for aerial spraying, and new precision methods to control scattered wildings using aerial drones – many of these improvements in wilding control tools are now in good-practice guides and are widely used by land managers to help make control effective, cheaper and safer
- developed new simulation models to predict wind movement and behaviour in complex terrain, which will improve our understanding of how topography and plantation design influence wilding spread risk to prevent future wilding invasions from planted sources.

Next we will put these findings into practice. Our close links with the National Wilding Conifer Control Programme and the NZ Wilding Conifer Group ensure we will make more progress in tackling the national wilding pine problem together.

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Celebrating our achievements

Bruce Warburton has been appointed a member of the Game Animal Council by Hon Eugenie Sage, Minister of Conservation. The Council was established to represent the interests of the hunting sector and improve the management of hunting resources while contributing to positive conservation outcomes. The Council draws together people from many disciplines, and Bruce contributes his many years' of experience of research in pest management as well as an in-depth knowledge of hunting. Bruce is well placed to make a significant contribution to the work of the Council.

Bruce Warburton

Nikki Harcourt has been appointed the Te Ao Māori Lead of the Our Land & Water National Science Challenge's Whitiwhiti Ora: Land Use Opportunities programme. She is leading the re-scoping of the programme, now centred around te ao Māori concepts and perspectives.

Nikki Harcourt

Chris Phillips has been appointed to the One Billion Trees (1BT) Strategic Science Advisory Group. Te Uru Rākau established the Group to provide independent peer review of research proposals submitted to the 1BT Partnership Fund and to recommend to the 1BT panel what science should be supported. The Group includes representatives from CRIs and other research institutes; as well as the forestry industry with a focus on smaller non-corporate entities, the New Zealand Farm Forestry Association, and those specialising in non-radiata/indigenous planting.

Chris Phillips

Zhi-Qiang Zhang has been invited to join the Strategic Advisory Committee of the Institute of Zoology (IOZ), Chinese Academy of Sciences. This honour is in recognition of Zhi-Qiang's international standing in the field of systematics, biodiversity and biosecurity, and of his existing collaborative relationship with the Institute. IOZ is substantial, with 420 staff including 75 professors plus 530 postgraduate students and 113 postdocs.

Zhi-Qiang Zhang

Getting offset, not offside, about native forests

Fiona Carswell – Chief Scientist

September 2020 saw the publication of *Native Forests: Resetting the Balance*, a report by the Aotearoa Circle that explores ways in which we can accelerate the regeneration of native biodiversity at scale while optimising the use of New Zealand's land assets.

There is little to argue with here: "Protecting and enhancing the biodiversity of New Zealand is central to supporting our unique natural environment, which is fundamental to our very existence, our culture, our way of living, international brand and key sectors of our economy." There is broad consensus on this – from primary industry, from government ministries and agencies, from the science sector, and from iwi.

But what is our collective best shot, given climate change, accelerating biodiversity decline, and business and economic drivers that largely favour land-use intensification? The report offers one audacious but attainable solution: to plant or regenerate native forests as carbon sinks across as much of the country as possible.

Audacious, because economic short-termism must be replaced by longer-term mindsets informed by environmental priorities. Attainable, because the economic payoffs of natives vs exotics are already costed in the report to be greater over the longer term, and because New Zealand has the space and the natural resources to enable the switch to be made. As Manaaki Whenua's Land Resources Inventory shows, there is plenty of agriculturally marginal land across the country that could support native forests.

Planting, or regenerating, native forests instead of exotic timber is estimated by the report to provide $6,677 per hectare of monetised ecosystem services, including carbon sequestration, biodiversity and freshwater benefits, and social and cultural benefits. This is more than is estimated can be derived from exotic forestry [$6,092 per hectare], even taking into consideration the value of the harvested exotic timber.

Encouragingly, there is already strong support within the primary sector for the planting of natives. Native forests are considered a gold standard for afforestation projects, and their offsets are sought after by businesses to help them create value-laden products; Fonterra's carbon-neutral Simply Milk, certified by Toitū Envirocare, is a good example. Manaaki Whenua's most recent Survey of Rural Decision Makers also found that those who intend to plant trees in the near future on their land disproportionately plan to plant native trees, often citing guardianship or kaitiakitanga as the primary reason.

Work is underway across New Zealand at a variety of scales to support native planting, from the national One Billion Trees project to local council initiatives. Adjustments are being made to the Emissions Trading Scheme, and policy levers are being created to enable greater parity between native and exotic options.

The outlook – for our biodiversity and our social and cultural well-being, as much as for our economic progress – will depend on those levers being pulled. It remains an audacious step to take.

www https://www.theaotearoacircle.nz/news/2020/8/26/workstream-updates

Fuscospora cliffortioides, *mountain beech.*