Bioprotection Aotearoa

Ko Te Toa i a Tini

BIOPROTECTION AOTEAROA ANNUAL REPORT 2024

Ko te toa i a tini i a mano o te tangata

We possess the strength of the many. It is the bravery of a multitude of thousands of people.

– Tūwhakauika & Te Oreorehua

This edition marks the conclusion of our first tranche, our foundational phase, during which we have grown into the entity we now call Bioprotection Aotearoa. We are multidisciplinary, working towards bringing together different knowledge systems to create new insights and find solutions to safeguard Aotearoa and the Pacific from pests, weeds and diseases in a changing climate.

As we look ahead, we stand ready to build on this foundation and extend our impact into Tranche 2.

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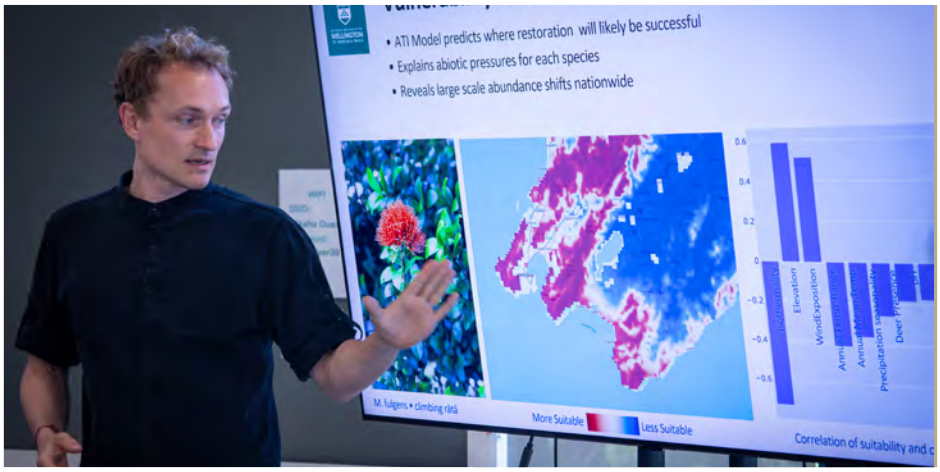

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A MESSAGE FROM OUR DIRECTOR

PERSPECTIVES ON A 20-YEAR RESEARCH JOURNEY

The year 2024 marked the end of Tranche 1 and my third year as the Director of Bioprotection Aotearoa. I'm acutely aware of how far we've come. I think it's important to look back on how the research landscape has changed during the last three years to reflect on our progress, especially since our research journey predates Bioprotection Aotearoa.

The journey of Bioprotection Aotearoa is separate from, but linked to, my own journey. Bioprotection Aotearoa was officially funded in 2021, but its previous iteration, the Bio-Protection Research Centre (BPRC), was established in 2003. BPRC's goal was to strengthen the value of New Zealand's pastoral, horticultural and forestry industries through research into next-generation bioprotection (biosecurity and biocontrol) solutions.

My first introduction to BPRC was in 2011 as a newly graduated PhD with an MBIE postdoctoral fellowship in sustainable bioprotection and Māori bioprotection, working with Melanie Mark-Shadbolt. In 2015, I led a project with Nick Waipara that was highly political, propelling me into an intense period of public exposure and engagement. It was this experience that taught me the importance of negotiating multiple viewpoints into a cohesive strategic plan. It also came at a time when the political landscape was increasingly embracing Māori heritage. It made sense that the next iteration of BPRC would need to reflect this shift.

From 2021, Bioprotection Aotearoa has been guided by a te ao Māori framework, Te Taiao-a-Rangi, which aims to unite us as a community, give direction to operations, and guide research to weave science and innovation with Indigenous knowledge. This was a transformational shift from BPRC and a much-needed refresh to bring people together, direct research for greater impact, and attract the next generation of researchers and leaders.

The three and a half years since Bioprotection Aotearoa was funded as a national Centre of Research Excellence have been challenging, but I have been lucky to have the support of my team. I'd like to thank the operations team, the deputy directors and senior researchers, and the many emerging researchers who represent the substance behind the whakataukī:

Ki te kotahi te kākaho, ka whati; ki te kāpuia, e kore e whati.
If a reed stands alone, it can be broken; if it is in a group, it cannot.

Professor Amanda Black
(*Tūhoe, Whakatōhea, Te Whānau ā Apanui*)
Director of Bioprotection Aotearoa

A MESSAGE FROM OUR BOARD CHAIRS

Seeing how quickly our climate changes and its deepening impacts on Papatūānuku, we are reminded of our mokopuna and grandchildren. What are we leaving for them? While we cannot capture every solution, Bioprotection Aotearoa offers a meaningful start grounded in research, collaboration and care for our environment.

Our research framework, Te Taiao-a-Rangi, continues to guide our community on their academic and cultural pathways. Engaging with te ao Māori through opportunities such as the noho marae (an overnight stay on a marae), is a good way to build connections and deepen understanding. This journey is not a sprint; it takes time.

Since its launch in 2021, Bioprotection Aotearoa has progressed steadily by advancing its research, strengthening partnerships, and supporting the next generation of bioprotection leaders.

Some of our early career researchers have completed their studies, published papers in high-impact journals, and taken the next steps in academia or industry.

The success of our early career researchers is a testament to the dedication of their mentors and supervisors. Without their expertise, insight and care, there would not be a next generation of bioprotection leaders.

We acknowledge and thank Lincoln University for its continued support as host for Bioprotection Aotearoa, ensuring the network is well provided for.

The future of Bioprotection Aotearoa is strong as the second tranche of research begins in 2025 with a new wave of early career researchers and a fresh suite of projects. This next phase builds on a strong foundation of research excellence, trusted relationships and shared commitment to protecting our ecosystems.

On behalf of the Board, we thank everyone for their contribution and look forward to another year of innovation and collaboration.

Henare Edwards (*Te Rawara, Te Aupouri, Ngā Puhi*), Co-chair of the Board

John Rodwell, Co-chair of the Board

COLLABORATIVE NETWORKS

Our progress is built on the relationships we have established with these communities and organisations.

- Agribusiness and Economics Research Unit (AERU)
- Brown Genomics Group
- Centro Internationale de la Papa (CIP, International Potato Centre) Lima, Perú
- Churston Farm
- Department of Conservation – Te Papa Atawhai
- Ducks Unlimited New Zealand – Wetland Care New Zealand
- Environmental Genomics Lab
- Fiji National University
- Genomics Aotearoa
- Ministry of Agriculture, Fiji
- Ministry of Primary Industries
- National Vegetation Survey Databank
- New Zealand Institute of Language, Brain and Behaviour
- Ngāruahine
- Ngāti Kahungunu ki Wairarapa
- Ngāti Tamaoho
- Ngāti Whatua Ōrākei
- National Institute of Water and Atmospheric Research (NIWA)
- Plant Pass
- Resilience to Nature's Challenges
- South Pacific Commission
- South Pacific Community
- Te Kaha 15b Ahuwhenua Trust
- Te Kaha Gold
- Te Whānau-ā-Te Ēhutu
- Te Kura Kaupapa Māori o Wairarapa
- The James Hutton Institute
- University of the South Pacific
- Waytemore Farm Ltd
- Willesden Farms
- Zasha Weinberg lab

FROM VISION TO IMPACT

OUR PURPOSE

Bioprotection Aotearoa is dedicated to safeguarding the lands of Papatūānuku, the oceans of Tangaroa, and the communities connected by the waters of Te Moananui-a-Kiwa, from biological threats. We acknowledge the interconnections of ecosystems and their pivotal role in society, culture, environment and economy.

Through an integrated approach that brings together scientific and social understanding with Indigenous knowledge, we will enhance the wellbeing of ecosystems across all scales.

By leveraging this knowledge, we develop innovative solutions to bolster ecosystem resilience and resistance. This will ensure Papatūānuku and her whenua (land), Tangaroa and his oceans, and Te Moananui-a-Kiwa and the wider Pacific can adapt and thrive for the benefit of future generations.

As a national Centre of Research Excellence, Bioprotection Aotearoa advances knowledge, develops leaders and fosters collaboration to address the urgent challenges facing our environment.

OUR IMPACT

Equity and diversity

in application and implementation of programme principles and activities.

Sustainable productive environments

contributing to, environmental, economic, cultural, and social wellbeing.

Increased public confidence

in the country's ability to manage productive ecosystems for the wellbeing of all.

Higher-earning, science-trained workforce

specialised in an Aotearoa New Zealand context.

Reduced reliance of synthetic inputs

with the development of new and fit-for-purpose solutions.

OUR PARTNERS

We are a partnership among these organisations who value bioprotection.

Lincoln University

The University of Auckland

The University of Waikato

Massey University

Victoria University of Wellington

University of Canterbury

University of Otago

AgResearch

Plant & Food Research

Manaaki Whenua Landcare Research

Scion

HOROMAKA BANKS PENINSULA

EXPLORING THE LAYERS OF RESILIENCE AND RESISTANCE IN HOROMAKA BANKS PENINSULA'S SHIFTING LANDSCAPE

Horomaka Banks Peninsula sits on the doorstep of Ōtautahi Christchurch, the South Island's largest city. A portion of research from Bioprotection Aotearoa is centred here, informed by the knowledge, landscapes and communities of the region.

Like many other parts of Aotearoa New Zealand, Horomaka Banks Peninsula has endured widespread successive waves of land-use change, transforming its landscape into a place that bears little resemblance to its ecological past. Once abundant with indigenous biodiversity that thrived within natural ecosystems, these landscapes have undergone changes with lasting impacts, including on the relationships between people and place.

According to the Christchurch City Council's Biodiversity Strategy 2008–2035, biodiversity on Horomaka Banks Peninsula reached its lowest point in the 1920s, with just one percent of the original forest cover remaining. Over time, the widespread clearing of forests, shrublands and native grasslands made way for agriculture, impacting the health of remnant native ecosystems.

Today, ecosystems such as regenerating forests and shrublands persist in pockets and fragments across privately owned land and steep, isolated hillsides. These remnants often border agricultural land or occupy transitional spaces at the edges of productive land. They also face an accelerating rate of change and disturbance from climate change.

These patchwork landscapes are shaped not only by physical and natural forces but also by the diverse communities who live, work and care for them. This includes local hapū, independent trusts, and farmers and landowners, many of whom have been working to improve the health of the land they manage.

For example, local hapū, such as Wairewa Rūnanga, continue to strengthen the wellbeing of land and communities through initiatives such as kānuka (*Kunzea ericoides*) planting.

Similarly, Hinewai Reserve, a significant conservation project, is supporting the natural regeneration of 1,600 hectares in the south-eastern corner of Horomaka Banks Peninsula. Owned and managed by the Maurice White Native Forest Trust, the reserve's regeneration efforts benefit native flora, birds, invertebrates, and wider ecosystems.

While the Trust's philosophy is one of minimal interference, they actively remove weed species that impede the natural regeneration process. These include pines (*Pinus radiata*), old man's beard (*Clematis vitalba*), and sycamore (*Acer pseudoplatanus*), a shade-tolerant species that often lines roads across the peninsula.

Farmers and landowners across Horomaka Banks Peninsula are exploring more sustainable and innovative practices. Many landowners who have engaged with Bioprotection Aotearoa are supporting the regeneration of kānuka shrublands on their land. They have a shared commitment to support the health and resilience of the landscapes and the unique ecosystems they sustain.

Willesden Farms is one such example. Spread across 5,843 hectares, the farm combines livestock production under irrigation systems and on hill country, combined with production and carbon plantation forestry, and native regenerating biodiversity. It is working alongside biodiversity experts to strengthen its biodiversity plans, support riparian planting, and eradicate pest animals such as pigs.

Willesden Farms also supports research organisations like Bioprotection Aotearoa to develop new knowledge and techniques that will support the sustainability of their productive landscape. One area of focus is the role of soil carbon in building ecosystem resilience, an emerging field that supports both productive farming and environmental restoration.

Yet in the context of climate change, conservation land, farmland, and privately-owned land (all of which may contain fragments of remnant or regenerating native bushlands) are facing an accelerating rate of change and disturbance.

Horomaka Banks Peninsula and the communities that care for it form the backdrop to the research stories that follow. From defining and working towards ecosystem health to predicting and mitigating changes driven by climate change, our researchers have joined the community effort to strengthen the wellbeing of this whenua, the land that sustains both ecosystems and people.

REDEFINING WHAT IT MEANS TO BE A HEALTHY ECOSYSTEM

IS THERE A SINGULAR DEFINITION FOR HEALTH?

When we fall ill, we usually know what health looks like and how to recover. Whether we need medication, rest or lifestyle changes, we can return to a healthy baseline and carry on.

Like humans, ecosystems might become ‘unhealthy’ through stressors like pests, weeds and pathogens that affect their ability to function and be productive. Some ecosystems can recover on their own, while others may need human intervention. But before people can intervene and restore what is damaged, they first need to understand what a ‘healthy’ ecosystem looks like.

Ecosystem health isn’t just a scientific question; it’s a critical issue that landowners, conservationists and communities care deeply about. Developing meaningful ways to look at it helps bridge the gap between science and real-world decisions.

This research brings together a diverse team of researchers, each playing a role in exploring what underpins ecosystem health.

Context is key: there is no land without people

This research project falls under Pou Titirangi, the first pou of the research framework Te Taiao-a-Rangi. Project leader Professor Ian Dickie describes this as the 'listening pou' focused on observing, listening and understanding what is happening across a range of different ecosystems.

"Bioprotection isn't about distant natural systems, it's focused on landscapes with people. Across Horomaka you have agricultural, recreational and conservation land areas with lots of people, all sitting right next to each other," says Ian.

What's considered 'healthy' depends on land use and its purpose. An indigenous forest fragment and a kiwifruit orchard may both be thriving, but their definitions of 'health' look very different.

Comprehensive research design

The project team chose kānuka as the focal species for this research. Choosing kānuka was inspired by restoration plantings of Wairewa Rūnanga, who aspire to recloak their whenua (land) in native forest.

Kānuka, an endemic species to Aotearoa New Zealand, plays a vital role in ecological succession, helping establish new ecosystems after disturbances such as fire or abandoned grasslands and laying the foundation for the development of mature forests.

Postdoctoral Fellow Dr John Ramana, based at Manaaki Whenua – Landcare Research, spent significant time identifying kānuka forests across Horomaka. He contacted landowners to gain access to sites across a range of elevations and rainfall levels.

At 30 sites, the project team sampled around a focal kānuka tree to capture a more complete picture of ecosystem dynamics along the edges and in the interior of forest patches.

"We measured a lot of different things," John explains, including foliar damage, soil nutrients, key environmental factors, pathogen presence on leaves, the community of beneficial microbes, tree age, growth rates, and nutrient uptake.

The team had initially hoped this data could be collated into a dashboard to provide landowners with an indication of forest health. However, synthesising the data into a clear picture of ecosystem health has been more complex than expected, and the project team did not land on a simple definition of ecosystem health.

"Ecosystem 'health' can look so different depending on the context," John explains.

At the core of ecosystem health is resilience and resistance

Although the project team did not find a simple definition of ecosystem health, they believe healthy ecosystems still share a fundamental attribute. This is centred around resistance and resilience and is what Ian describes to be at the core of ecosystem health.

"It's not how fast you grow. It's not how productive you are. It's about maintaining that growth and productivity even when things get a little stressful."

Building on this idea, Ilaria La Bianca, a PhD student from the University of Canterbury, is exploring how soil ecosystems respond and function under drought or flooding stress. She is using the same kānuka sampling sites to examine the short and long-term effects of moisture stress on soil and plant dynamics.

By analysing DNA data obtained from these sites, Ilaria has identified soil microbiomes present in the ecosystem and is working to determine whether they play a role in the resistance and resilience of soil and kānuka plants.

Pathogens in plain sight

Oomycetes are a well-known group of organisms commonly found in aquatic systems and are mostly pathogenic. But across the 30 kānuka sites, the team is finding new oomycete species in abundance, which are completely undocumented in science.

"What do you do with that? We've got one of the most important tree species in Aotearoa New Zealand, that is a taonga species, and of enormous importance to local rūnanga, with a potential pathogen in its leaves that we have no idea what it is, and no idea what it's doing," says Ian.

John adds that pathogens are a normal part of ecosystems. In fact, they can play essential roles in maintaining healthy ecosystems by supporting dynamic processes. The important part, John explains, is understanding the potential toll these pathogens may have, what drives their activity, and how their populations change over time.

Very few studies have examined pathogenic oomycetes that do not appear to cause ill effects in ecosystems. Ian notes, "You tend to think, 'I'll wait until there's a problem, and then I'll go study the problem.' We're probably one of about a dozen studies that has actually looked at oomycetes in natural communities, so our work is really critical to understanding how these communities respond to the environment."

Where to from here?

With so much effort invested in defining ecosystem health, only to uncover more questions than answers, one might wonder if the pursuit was too ambitious.

“No, not at all,” John says confidently. “It’s interesting. We are reframing our focus away from defining health and instead leveraging new technologies for quick detection.”

These technologies include nanopore sequencing, which provides long DNA reads, enabling a clearer picture of what pathogens could be present. Remote sensing also has the potential to help flag areas of threat early without the need to be on the ground.

Understanding what keeps ecosystems functioning is becoming increasingly important as climate change accelerates. Bioprotection Aotearoa’s research isn’t just about reacting to threats. It’s about equipping us to protect Aotearoa New Zealand’s landscapes for generations to come.

“When we’re trying to restore an ecosystem, we can have a goal in mind, one that gives us security in the land to continue doing what we need it to do, and what it needs to do,” Ian concludes.

POU TITIRANGI

PROJECT 1.3: DEFINING HEALTHY AND PRODUCTIVE ECOSYSTEMS

JOHN RAMANA

Postdoctoral Fellow, Manaaki Whenua – Landcare Research

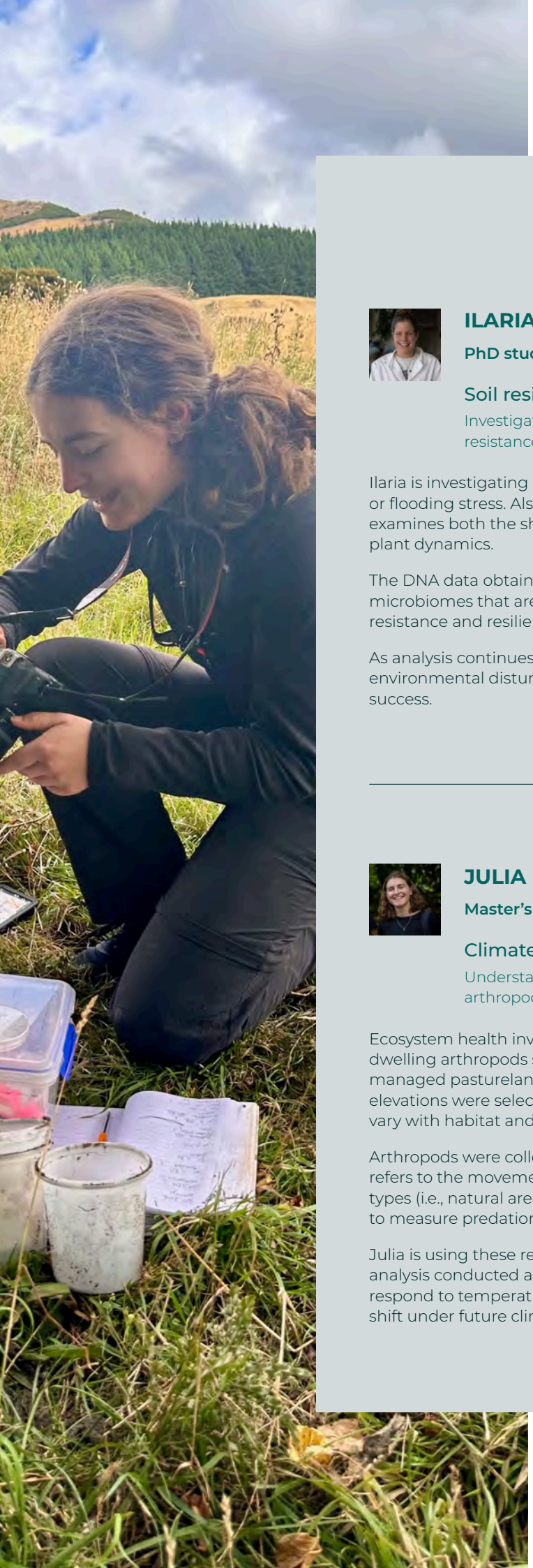
Understanding the drivers of kānuka health

Investigating the contribution of the plant microbiome to plant health and determining microbiome transferability to enhance restoration plantings

John has been investigating how ecosystems remain healthy despite the presence of pathogens and pests. His research focuses on kānuka shrublands across 30 sites on Horomaka Banks Peninsula, where he is assessing their current state of health and identifying potential threats that could impact their health in the future.

To gain a comprehensive understanding of each site, John centred his sampling around a focal kānuka tree, selecting trees growing across different elevation gradients and precipitation levels. This included trees growing on the edge of forest plots and those in the interior to capture a full picture of the ecosystem dynamics.

Sampling included measuring tree growth to predict the tree's ability to sustain growth over time. Using soil, root and leaf samples, John has sequenced DNA to characterise the community of microorganisms associated with kānuka. He has also mapped the community of plants that surround each tree.



ILARIA LA BIANCA

PhD student, University of Canterbury

Soil resistance and resilience

Investigating the role of the microbiome in ecosystem and plant resistance and resilience

Ilaria is investigating how soil ecosystems respond and function under drought or flooding stress. Also collecting data from the 30 kānuka sites, this research examines both the short and long-term effects of moisture stress on soil and plant dynamics.

The DNA data obtained from these sites has helped Ilaria identify the soil microbiomes that are present to determine whether they have a role in the resistance and resilience of soil and kānuka plants.

As analysis continues, Ilaria is deepening her understanding of how dynamic environmental disturbances affect soil functions and how this may affect kānuka success.

JULIA PALMER

Master's student, University of Canterbury

Climate effects on arthropod spillover

Understanding how climate affects spillover of pest-controlling arthropods from natural forest fragments to managed areas

Ecosystem health involves more than just plants and soil. Julia surveyed ground-dwelling arthropods such as beetles and spiders in native forest fragments and managed pasturelands on Horomaka Banks Peninsula. Sites across a range of elevations were selected to explore how arthropod movement and predation vary with habitat and temperature.

Arthropods were collected using pitfall traps to measure edge effects, which refers to the movement of insects across the boundary between two habitat types (i.e., natural areas and pastureland). Sentinel prey (live fly pupae), were used to measure predation pressure in the field to indicate natural pest control.

Julia is using these results to compare local edge effect patterns with a global analysis conducted across a latitudinal gradient. Understanding how arthropods respond to temperature changes can help predict how natural pest control may shift under future climate warming.

UNDERSTANDING THE SPREAD OF WEEDS

STRANGERS IN A STRANGE LANDSCAPE

It starts with something simple: an apple core, casually tossed from a moving car window. The apple core lands in the roadside gravel, where it is warmed by the sun, nestled among a tangle of weeds and grasses. In time, the seeds germinate, sending fragile roots into the soil, and green shoots upwards toward the light.

At first glance, an apple tree growing by the roadside might not seem like a problem. But this small event signifies a much larger pattern. Roads, tracks and waterways act as corridors not just for people but also for plants, pests, and pathogens.

As a result, some non-native species may have been introduced with the best of intentions or by accident, take root in landscapes they were never meant to inhabit. Some settle quietly, while others spread aggressively, outcompeting native species, altering soil microbiome and structure, and reshaping ecosystems.

Why look at weeds in Horomaka?

The mix of different land uses and ecosystems across Horomaka creates unique conditions for the introduction and spread of plant species from many different parts of the world: South Africa, Japan, Mexico and of course the United Kingdom.

“Weeds are trouble, they’re a growing problem,” says Dr Laureline Rossignaud, who completed her postdoctoral fellowship with Bioprotection Aotearoa and is now working at Manaaki Whenua – Landcare Research as a Forest Ecologist.

“Many invasive plant species have arrived in Banks Peninsula from overseas, which is why we need more research to understand which ones are establishing, and which ones might be a threat to both native plant communities and the people who live there.”

One major concern is the spread of conifer species, particularly *Pinus radiata* and *Pinus contorta*. These trees, initially planted for forestry, have started escaping from plantations. Their seeds are dispersed by wind and establish themselves far beyond the intended boundaries.

How do we define an invader?

“At the end of the day, weeds are just plants,” explains Laureline. “Even native species can be weeds if they are unwanted in a particular space. But when we talk about invasive alien weeds, they are species that have not evolved in New Zealand and have a negative impact. ’Weeds’ is just a common name.”

Weeds are a widespread problem on Horomaka, and once a particular weed species spreads, eradication becomes extremely difficult. A key focus is therefore identifying uncommon and localised weeds with the potential to become widespread across the region.

In an article for *The Spinoff* in 2022, Professor Margaret Stanley from the University of Auckland described these species as “sleeper weeds”, explaining that their small populations often persist unnoticed until the right conditions ‘activate’ them.

“Sometimes they are small, inconspicuous plants that we don’t notice until they’re widespread, and some haven’t yet found the right pollinator or environmental conditions to ‘take off’ and become invasive,” wrote Margaret.

Where do we start?

For home gardeners and land managers alike, the more you pull, the more weeds seem to fight back. The challenge of managing invasive species on a large scale requires more than just persistence.

“This is where our research comes in: it helps us to be a little more pragmatic, and instead of being overwhelmed by the number of weeds coming in, we can start prioritising those weed species for which management might have the greatest impact.”

The research supported by Bioprotection Aotearoa works to build a greater understanding of the establishment of invasive plant species and their potential for impact.

Weeds in kānuka shrublands

One of the defining landscape features of Horomaka Banks Peninsula is the kānuka shrublands, which are a nationally vulnerable native ecosystem. Our previous work included a survey of wilding conifers across Horomaka Banks Peninsula and found that kānuka shrublands are particularly vulnerable to invasions.

“This is worrying given their conservation status and the fact that the ecosystem acts as a nursery for the establishment of native forest,” explains Distinguished Professor Philip Hulme, a lead investigator for this research.

Many naturalised plant species do not commonly persist in the deep shade of the forest understory, due to their preference for light. As such, they tend to stop at the edge of forest fragments.

PhD student Friederike Espinoza is looking at how fragmentation impacts weed invasion in kānuka fragments on Horomaka. Her research explores the shade tolerance of different weed species and their ability to invade the edge and interior of kānuka fragments. She is also looking at how invasions might be impacted by moisture conditions as well as grazing by livestock.

Given the scale of weed issues across Horomaka Banks Peninsula, focusing the research of Bioprotection Aotearoa in this region is particularly valuable. The combination of its rich history, diverse use of land, long-term ecological records, and the knowledge shared by local communities offers unique insights.

The project team continues to explore how the complexity of the landscape impacts weed invasions. The plan is to investigate how roads, rivers, and tracks interact with the diversity of the landscape and whether they contribute to the spread of certain weeds.

POU NUKU-A-RANGI

PROJECT 3.2: THE ROLE OF LANDSCAPE ATTRIBUTES ON WEED INCURSIONS

LAURELINE ROSSIGNAUD

Postdoctoral Fellow, Lincoln University

Non-native plant invasions in native forests and shrublands

Exploring the effect of vegetation structure, landscape and climate on plant invasions in native shrublands

Using data from 247 mānuka (*Leptospermum scoparium*) and kānuka plots surveyed across Aotearoa New Zealand between 2009 and 2014, Laureline studied non-native species richness and ground cover in relation to vegetation structure, landscape features and climate.

Laureline found that higher native canopy richness led to lower non-native richness and ground cover. Non-native richness and ground cover increased with adjacent anthropogenic land cover, whereas native richness and ground cover showed a negative relationship. More non-native species were found in drier areas, while native richness was influenced by temperature.

This study emphasises that simply managing our shrublands is insufficient to prevent plant invasions; the landscape in which these ecosystems are found must also be considered. Further work is now examining the characteristics of the weeds that are most invasive across these ecosystems.

FRIEDERIKE ESPINOZA

PhD student, Lincoln University

Weed invasions in New Zealand shrublands

Assessing the drivers behind the establishment of alien weed species in kānuka shrubland on Horomaka Banks Peninsula

This project aims to understand the factors shaping weed invasions in kānuka shrublands, examining edge effects at kānuka and grassland boundaries.

Friederike is using surveys, field and greenhouse experiments to test whether fragmentation promotes weed invasion, how shade tolerance affects variations in sensitivity of weeds to edge effects among shade-tolerant and intolerant weed species, and how soil and light conditions influence weed establishment in kānuka fragments.

This research is contributing valuable insights to improve weed management strategies and ecosystem protection.

DIANA BORSE

PhD student, University of Auckland

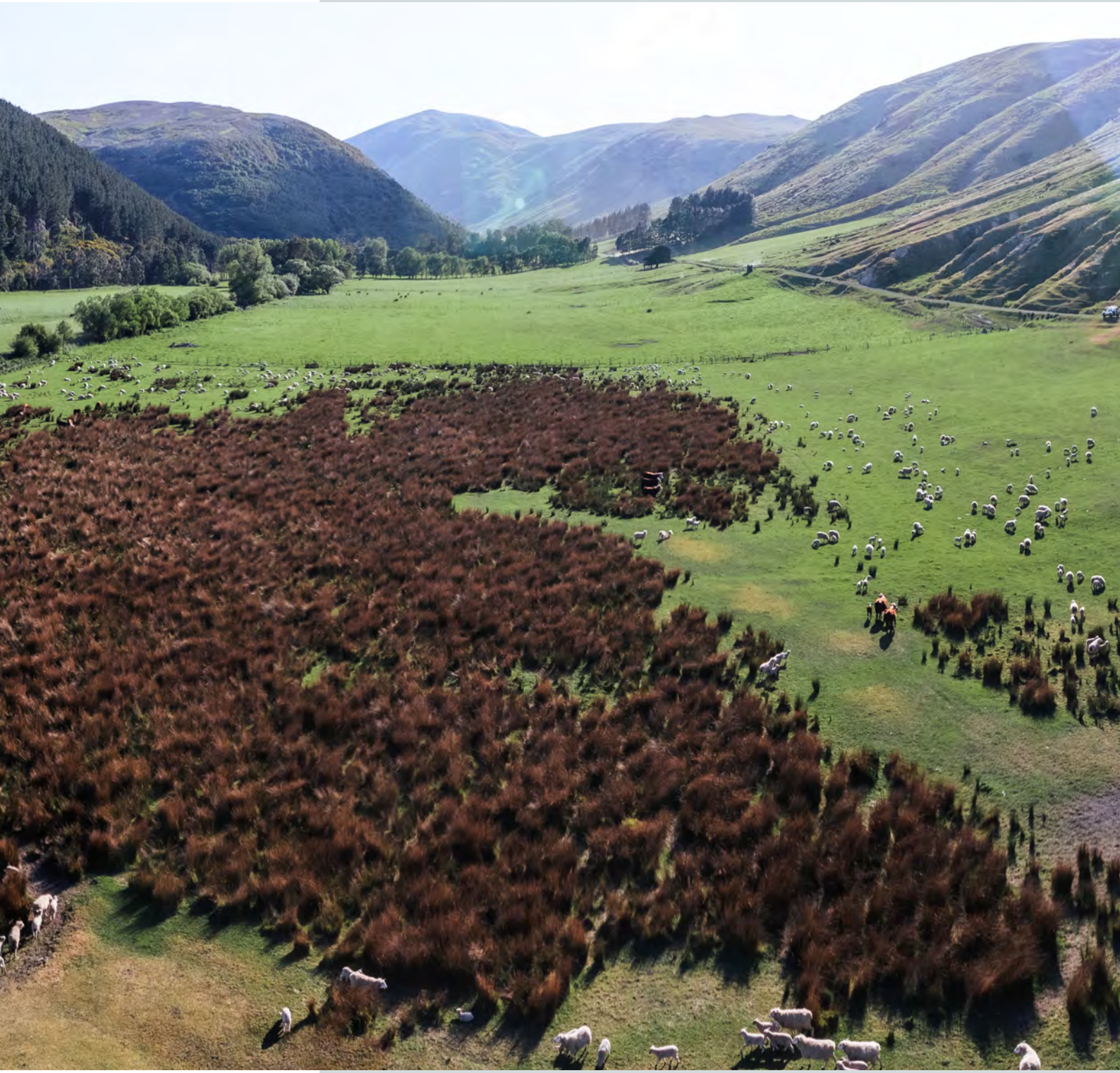
Interactions among co-occurring weeds and their impacts on native plants

Understanding how different weed combinations affect native plantings

Through field research and shade house experiments, this project aims to determine the impacts that co-occurring woody weeds have on native restoration plantings.

Weeds growing together may interact and change each other's impacts on the health of native species. This project focuses on the interactions between woolly nightshade (*Solanum mauritianum*), brush wattle (*Paraserianthes lopthantha*), and tree privet (*Ligustrum lucidum*) to determine the types of impacts they have on native plants when they co-occur.

Diana's field research aims to understand patterns of weed co-occurrence by surveying the plants growing with each of the three target weeds compared to those growing under native restoration plantings. Shade house experiments will test the impacts of the weeds on mānuka depending on the combination of weed species present. Diana will then test how mānuka is affected by the removal of different weed species.



KAITUNA VALLEY'S CARBON BANK

WHERE MICROBES MANAGE THE VALUE OF CARBON

Soil is more than just dirt. It's a thriving ecological community where carbon plays a vital role in sustaining life and ecosystem health. Microbes break down organic matter, contributing to long-term carbon storage, while also using it for energy, releasing carbon dioxide through respiration.

For this underground community, carbon is a treasured resource. The amount of carbon stored in soil reflects an ecosystem's resilience, benefiting not just plants and soil but also the atmosphere.

Throughout history, carbon has shaped ecosystems, and today, it remains a key indicator of an environment's ability to withstand and recover from change. Carbon's role in soil health and climate resilience has never been more important.

Measuring carbon wealth in Kaituna Valley

Kaituna Valley is located on the southwest side of Horomaka Banks Peninsula, extending from Te Ahu Pātiki Mount Herbert to Te Waihora Lake Ellesmere. The Kaituna River, which flows through the valley, has a rich history as an abundant source of kai (food) that teems with tuna (eels).

Despite its relatively small size, Kaituna Valley contains a diverse range of land uses. This patchwork landscape provided an ideal case study for Dr Alexa Byers, a Postdoctoral Fellow at Lincoln University.

Alexa set out to investigate whether soil carbon levels in Kaituna Valley varied according to how land was used. She hypothesised that land that was heavily used for agriculture would have lower carbon stores than native fragments of land.

“You have your pine, which has been a pine forest for over 20 years. You have native forests, which have retained native cover. And then you have your intensively used agricultural sites.”

This diverse landscape provided Alexa with a semi-controlled research setting that balanced natural variability with the consistency needed for comparisons. It offered ideal conditions for measuring carbon levels across different land uses, including remnant native forest, regenerating native bush, exotic plantation forest, dryland pasture, and irrigated pasture.

The active carbon zone

While it’s tempting to imagine that soil carbon is stored deep underground like a locked vault, the real action happens much closer to the surface. In the top 10cm of soil, microbial life rapidly cycles carbon, shaping soil health and resilience. Alexa calls this the ‘active carbon zone’, the area with the greatest carbon flux between the atmosphere and the soil.

“You might expect that less disturbed land has a soil profile that has remained relatively intact over time, providing an opportunity to accumulate more carbon, whereas land that has had its soil layers mixed up and its soil profile disturbed might have had greater carbon losses.”

Armed with samples from the top 10cm of soil across the different land uses, Alexa set out to determine how changes in land use alter the way soil microbes process carbon, ultimately influencing soil carbon levels among land uses.

Plot twist: rethinking soil carbon dynamics

When she began analysing her data, Alexa was in for a surprise. She found no significant variation in soil carbon levels among land uses.

“I thought there would be a big difference, but the carbon levels in the soil weren’t that different,” says Alexa.

To probe further, Alexa’s research methodology allowed her to analyse the DNA of microbial genes involved in soil carbon cycling. She found differences in the diversity and abundance of microbial cycling genes, suggesting potential variations in how carbon is processed across land uses.

“One of the big surprises to me was the site with the highest plant diversity, the native forest site, actually had the lowest diversity of carbon cycling genes,” Alexa explains. This was in stark contrast to her hypothesis that the site with the highest plant diversity would have the highest microbial gene diversity.

Alexa thinks her results may be due to native forests having a more stable environment with fewer disturbances in the soil over time. However, further research is needed to test this theory.

“I didn’t find what I had expected, which as a scientist, is really interesting,” Alexa reflects. “But I imagine this must be frustrating for land managers when there’s no real single or straightforward answer to this research. Still, that’s the nature of science.”

Going deep

With the understanding that land use influences the gene diversity of soil microbes and the way they cycle carbon, Alexa hopes to expand her research by sampling in other areas to see if her results can be replicated and compared.

“One thing that we didn’t look at is depth, which is really important for soil carbon, particularly when you’re measuring its levels in soil.” says Alexa.

To build on her research and assess long-term carbon storage, Alexa will sample soil at depths of 50-60cm to look for any big differences in soil carbon there.

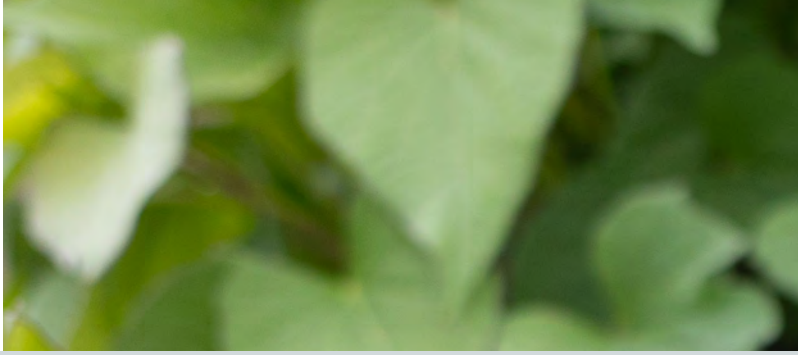
“That’s definitely an area worth exploring next, and it might help answer some of our questions about why we didn’t see any major differences,” Alexa concludes.

CULTIVATING EXCELLENCE

PEER-REVIEWED PUBLICATIONS

Our goal at Bioprotection Aotearoa is to cultivate early career researchers who produce high-quality research that is inclusive and values-based, and that advances scientific knowledge. One of the most traditional and high-value ways of disseminating research is through publication in peer-reviewed journals. Our early career researchers led and supported over a dozen publications in 2024.

The following pages offer a sample of published accomplishments from across our research community.



NILS BIRKHOLZ

Postdoctoral Fellow, Otago University

About Nils: Nils studies bacteria-fighting viruses called phages, which are being widely considered as the next step to controlling antibiotic-resistant bacteria in food production and human health.

"If we know how bacteria defend themselves against phages and what the phage response to this defence is, we are better prepared to develop treatments for human or plant diseases," says Nils.

Key publication: Birkholz, N., Kamata, K., Feussner, M. et al. Phage anti-CRISPR control by an RNA- and DNA-binding helix–turn–helix protein. *Nature* 631, 670–677 (2024). https://doi.org/10.1038/s41586-024-07644-1

About the publication: In all organisms, regulation of gene expression must be adjusted to meet the requirements of the cell. This regulation frequently involves helix–turn–helix (HTH) domain proteins. In the arms race between bacteria and bacteriophages, the rapid expression of phage genes that enable infection are then repressed by an HTH-domain-containing protein.

This paper describes how these phage proteins use multiple layers of regulation and repression to keep bacterial defences in check. Specifically, the HTH-domain-containing protein studied repressed Acr synthesis transcriptionally through DNA binding and inhibited translation of mRNAs by binding conserved RNA stem-loops and blocking ribosome access.

Given the ubiquity of HTH-domain-containing proteins, it is anticipated that many more of them elicit regulatory control by dual DNA and RNA binding. Nils hopes this finding might prompt other researchers to take another look at their role in gene regulation and build on the different aspects of this publication.

"Our discovery of a new mechanism of gene regulation is especially interesting for fundamental research."

FRANCA BUELOW

Postdoctoral Fellow, University of Canterbury/Lincoln University

About Franca: Franca's postdoc covered a variety of projects, which gave her avenues to combine disciplines (political science, linguistics, literature, psychology, and behavioural science) to explore many perspectives on decisions and decision-making.

"This postdoc allowed me to meaningfully integrate the different passions that I have," says Franca.

Key publication: Buelow, F. A., Delsault, L., & Brower, A. (2024). How does collaborative freshwater governance affect legitimacy? Comparative analysis of 14 cases of collaboration in Aotearoa New Zealand between 2009 and 2017. *Policy Studies*, 1–24. https://doi.org/10.1080/01442872.2024.2321898

About the publication: Franca and her co-authors built on political science studies of legitimacy (i.e., the normative justification of authority) to explore decision-making arrangements within collaborative freshwater governance. They conducted qualitative coding of 14 cases of freshwater collaboration, assessing texts using a qualitative, comparative method informed by literature on collaborative governance and legitimacy.

They found that while engaging citizens in collaborative decision-making of a contested issue such as freshwater can lead to better outcomes, shifting from a top-down to a collaborative governance style can negatively impact perceptions of legitimacy. This is illustrated in the analysis of their cases: they did not see an improvement in community confidence in the legitimacy, fairness and effectiveness of environmental management over time, despite major investments in collaborative decision-making in Aotearoa. The research highlights the need for improved legal structures around collaborative decision-making, as merely applying participatory approaches without changing governing structures can undermine legitimacy and erode trust in the process.

ALEXA BYERS

Postdoctoral Fellow, Lincoln University

About Alexa: Alexa is investigating the soil health of natural and productive ecosystems to understand the response of soil microbes to threats such as pathogen invasion, human disturbance and climate change.

Key publication: Byers, A., Condron, L.M., Wakelin, S., & Black, A. (2024). Land use intensity is a major driver of soil microbial and carbon cycling across an agricultural landscape. *Soil Biology and Biochemistry*, 196:109508. https://doi.org/10.1016/j.soilbio.2024.109508

About the publication: Soils act as vital reservoirs for carbon, but when soil microbes break down the organic matter around them, then respire, they release carbon into the atmosphere as a gas. Using metagenomic DNA sequencing and phospholipid fatty acid analysis, Alexa and her colleagues investigated differences in the activity, diversity and function of the soil microbiome associated with five land uses: remnant native forest, regenerating native bush, exotic plantation forest, dryland pasture, and irrigated pasture. Pronounced differences in the soil microbiome were associated with each land use, including the diversity and abundance of microbial carbon and nitrogen cycling genes. Notably, intensive agricultural soils had a higher diversity and abundance of microbial carbon-degrading genes. This suggests that intensive agricultural land may be less capable of storing carbon.

Alexa says this research may be useful in supporting the development of sustainable management practices that promote the persistence of soil carbon across agricultural landscapes, such as the protection of remnant native forest fragments.

“This research isn’t about assigning land uses into good or bad categories,” says Alexa, “but it’s important to be aware of the potential consequences of human activity on the soil.”

ELIZABETH ELLIOT NOE

Postdoctoral Fellow, Lincoln University

About Elizabeth: Elizabeth researches the values and priorities of farmers in relation to biodiversity on farms.

Key publication: Noe, E.E., Stolte, O., Buelow, F., & Wreford, A. (2024). "It all depends on what you value": Value hierarchies as barriers to native biodiversity on dairy farms. *Journal of Rural Studies*, 111:103411. https://doi.org/10.1016/j.jrurstud.2024.103411

About the publication: Much of Aotearoa New Zealand's native biodiversity resides on farmed land. Protecting and enhancing this biodiversity largely relies on farmers voluntarily adopting biodiversity-supporting farming practices, making the value farmers place on biodiversity crucial for its protection.

In this study, Elizabeth set out to understand whether or how biodiversity fits within farmers' perspectives of dairy farming. A suite of on-farm interviews revealed a range of perspectives on what it meant to be a "good farmer" and whether biodiversity was valued as part of "good" farming.

Productivity was the primary value shared by the dairy farmers Elizabeth interviewed. However, they also valued the health of the animals, aesthetics the health of the land, and a balance between work and life. These values tempered the maximisation of productivity and profitability, with some farmers devoting time and resources to native plantings for the sake of land health, aesthetics, or animal health (i.e., shade).

Still, many farmers found biodiversity-aligned efforts to be a trade-off, or a "waste" of productive land. Unless a positive connection between native biodiversity and economic productivity can be made, efforts to increase biodiversity will likely continue to depend on landowners' value hierarchies.

Objectively, this publication is a particularly good read. It's written in a balanced, understandable way and delivers value to those interested in Aotearoa New Zealand's farming sector.

SARAH INWOOD

Postdoctoral Fellow, Otago University

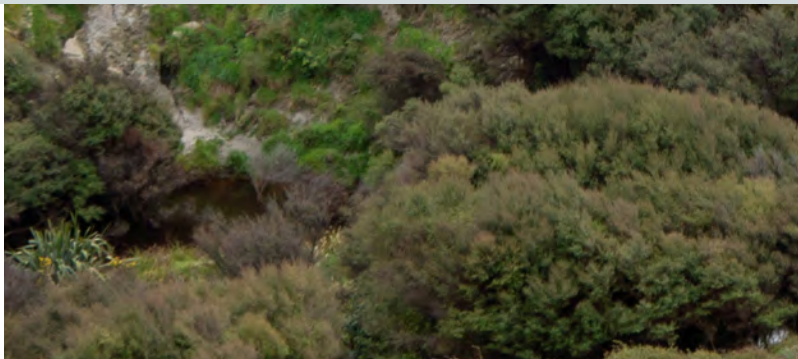
About Sarah: Sarah is a postdoctoral fellow at the University of Otago. She is interested in historically overlooked factors, like viruses and bacteria, that may be impacting the efficacy of biocontrol agents.

Key publication: Inwood, S.N., Harrop, T.W.R., Shields, M.W. et al. (2024). Immune system modulation & virus transmission during parasitism identified by multi-species transcriptomics of a declining insect biocontrol system. *BMC Genomics* 25, 311. https://doi.org/10.1186/s12864-024-10215-3

About the publication: The Argentine stem weevil (*Listronotus bonariensis*), a significant pasture pest in Aotearoa New Zealand, is primarily controlled by *Microctonus hyperodae*, a parasitoid wasp used as a biocontrol agent. Although the wasp was initially successful at providing effective biocontrol, its parasitism rates have dropped. In this study, Sarah and her colleagues performed a multi-species transcriptomic analysis to investigate the transcriptomic response of the Argentine stem weevil to parasitism by the wasp and vice versa, looking for evidence that the weevil may have evolved resistance to the wasp.

This publication adds to our current understanding of how the wasp acts on the host weevil, and how the weevil responds on a molecular level. For example, transcriptomic response of the Argentine stem weevil did show modulation of its innate immune system, flight muscle components, and lipid and glucose metabolism.

The multi-species approach also revealed continued expression of venom components in parasitised weevils, as well as the transmission of an exogenous novel DNA virus, *Microctonus hyperodae* filamentous virus (MhFV), to weevils during parasitism. Although no solid evidence for or against evolved resistance was found, the study nevertheless expands our understanding of interactions between the wasp and the Argentine stem weevil.



LAURELINE ROSSIGNAUD

Postdoctoral Fellow, Lincoln University

About Laureline: Laureline Rossignaud is a Forest Ecology Researcher at Manaaki Whenua – Landcare Research. She completed this publication as a Bioprotection Aotearoa postdoctoral fellow at Lincoln University.

Key publication: Rossignaud, L. and Hulme, P.E. (2024). Low richness of invasive non-native plants in New Zealand indigenous forests may not reflect low impact. *Diversity and Distributions*, 31: e13965. https://doi.org/10.1111/ddi.13965

About the publication: Some habitats are more vulnerable to plant invasions than others. Knowing which habitats are particularly vulnerable is essential for designing efficient management programmes. In this study, Laureline and co-author Phil Hulme used generalised additive models to assess trends in richness and cover of non-native plants in 839 permanent 20 x 20 m plots spread across New Zealand's indigenous forests and shrublands. They found that 35% of the plots had at least one non-native species.

Mānuka-kānuka shrubland exhibited generally higher non-native richness and cover than broadleaved-podocarp forest. Non-native "naturalised" species had lower cover than invasive species but greater overall richness. This pattern was mainly related to non-native woody species, like trees. Once established, trees can reach greater cover than herbaceous species even when richness is low.

Relatively few non-native plant species were found in forest habitats, while indigenous shrubland and early successional forests showed higher vulnerability to plant invasion. Woody species, which are overrepresented among invasive species, had higher cover than herbaceous species and were less limited by native canopy cover. The findings highlight the threat posed by non-native woody species and the need for targeted management programmes.

BEYOND RESEARCH

CONNECTING COMMUNITIES, BUILDING CAPACITY AND DEEPENING IMPACT

NOHO MARAE 2024

A moment to connect and refocus

Given the relentless pace of research, it's easy for scientists to get caught up in the details and lose sight of our cultural and social environment. The noho marae at Pūkaha National Wildlife Centre provided a rare opportunity to step back and reflect. These overnight stays on a marae support participants to reconnect with each other and the purpose behind Bioprotection Aotearoa.

Over three days, early career researchers, scientists and community members came together to discuss the progression of our research, revisit insights, and explore new ways to apply our research in real-world contexts.

Te Kawau Mārō serves as Bioprotection Aotearoa New Zealand's Māori advisory group, guiding the integration of mātauranga Māori and ensuring research aligns with Te Tiriti o Waitangi principles.

Members of this advisory group, include Sam Luddon (representing *Ngāti Kahungunu ki Wairarapa*) and Matetu Herewini (representing *Te Whānau ā Apanui*), and conservationist and bushman, Hamiora Gibson (*Ngāti Mutunga*), also known as Sam the Trap Man. They contributed to discussions with insights that placed our research in a broader context and beyond traditional research silos.

This depth and authenticity grounded conversations among diverse voices and experiences. It serves as a reminder of why the research of Bioprotection Aotearoa matters, and who it is for.

OUTREACH PROGRAMME

Protecting the forests, learning from the environment

Students from Te Kura Kaupapa Māori ō Wairarapa embarked on a journey to understand the health of Aotearoa New Zealand's forests and the role we all play in their protection from harmful incursions.

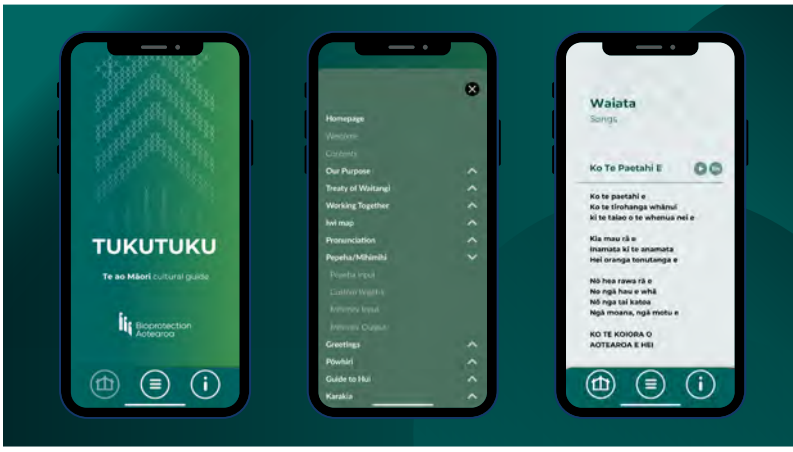
Near the school is Fensham Reserve, a home to wetlands and the endangered native species maire tawake (*Syzygium maire*). Outreach Coordinator Meikura Arahanga and several early career researchers from Bioprotection Aotearoa guided students through the wetlands, exploring the signs of a thriving ecosystem.

They discussed biosecurity threats affecting the wetland, including myrtle rust, which has been identified in their region. They also explored the impact of *Phytophthora agathidicida* on kauri, learned essential hygiene measures to prevent disease spread, and used tools like iNaturalist to document and monitor ecosystem health.

Two students extended their learning during a trip to Glenfern Sanctuary on Aotea Great Barrier Island, where they witnessed firsthand the devastating impact of *Phytophthora agathidicida* on kauri.

They met with local kaumātua Rodney Ngawaka (*Ngātiwai Nui Tonu*) to learn about the whakapapa of Aotea and how to assess kauri health, reinforcing the importance of biosecurity and indigenous knowledge systems. This experience highlighted that protecting our indigenous forests starts with each of us. Through knowledge and action, we can all contribute to the wellbeing of the whenua (land).

The work of Bioprotection Aotearoa extends beyond research in the lab and in the field. As a Centre of Research Excellence, our efforts connect with people, place and the environment, where knowledge meets action and values drive our contribution.



BIOPROTECTION AOTEAROA IN THE MEDIA

Sharing knowledge, expanding conversations

Over the past year, Bioprotection Aotearoa's research and insights have reached a broad audience through a diverse range of media. From scientific publications to mainstream news, and from industry features to community-focused stories, our work has contributed to conversations about ecosystem resilience and emerging bioprotection challenges.

Beyond traditional media, we've also focused on sharing perspectives through our own blog series, offering deeper insights into the research, people and collaborations shaping our work. These posts have allowed us to highlight the voices behind the science, providing context and connection beyond the headlines.

Each article, interview and feature has played a role in ensuring that bioprotection is not just an academic conversation but a discussion that involves communities, practitioners and decision-makers.

TUKUTUKU MOBILE APP

A starting point for cultural discovery

For many of our members, the noho marae may have been their first experience on the grounds of a marae, participating in a pōwhiri, the welcoming ceremony, and preparing their mihimihi, a personal introduction.

The unknown can be nerve-wracking, but the hospitality of mana whenua and the process of whakawhanaungatanga (building relationships) can quickly diffuse any uncertainties, bringing our members one step closer to understanding the unique cultural legacy of Aotearoa.

The Tukutuku app, developed by Kiwa Digital, is a resource to support our members in continuing their cultural journey.

PhD student Friederike Espinoza is from Germany and is amazed by the features it offers. "I use it to learn new words in te reo Māori, pronunciation, find greetings, and access a variety of other insights into Māori traditions and culture."

The app provides customisable templates to prepare a mihimihi, and access to karakia (prayers or incantations) and waiata (songs), encouraging continued cultural growth and practice.

Kara Pendavingh, a Postgraduate Fellow from Australia, shares, "As an outsider to Aotearoa, I really struggle with place names. So the Tukutuku app is a great help, especially the Mahere Iwi section!"

The goal is to stay grounded in the lessons, growing in confidence with every step forward.

OUR PROJECTS AND EXPERTISE

POU 1 TITIRANGI

Defining a healthy and productive ecosystem

POU 1.1 RESEARCHERS AND SPECIALISTS

Professor Ian Dickie (Lead), University of Canterbury
Dr Nick Waipara, (*Rongawhakaata* and *Ngāti Ruapani ki Tūranga)*, Plant & Food Research
Professor Nick Roskruge, (*Te Ātiawa*, *Ngāti Tama)*, Massey University
Dr Kate Orwin, Manaaki Whenua – Landcare Research
Dr Claudia Meisrimler, University of Canterbury
Associate Professor Robin MacDiarmid, University of Auckland

UNDERSTANDING THE DRIVERS OF PLANT HEALTH

Dr John Ramana

Investigating the contribution of the plant microbiome to plant health and determining microbiome transferability to enhance restoration plantings.

Postdoctoral Fellow at Manaaki Whenua – Landcare Research

COMPLETED

THE POTENTIAL FOR PLANT PATHOGEN SPILLOVER IN AOTEAROA NEW ZEALAND

Megan Tan

Observing how fungi are shared between native plant species and how this may lead to spillover events.

Master's student, University of Canterbury

COMPLETED

THE IMPACT OF THE MICROBIOME ON PLANT RESISTANCE AND RESILIENCE

Ilaria La Bianca

Investigating the role of the microbiome in ecosystem and plant resistance and resilience.

PhD student at University of Canterbury

IN PROGRESS

DETECTING VIRUS MOVEMENT WITH SENTINEL PLANTS

Cole McArthur

The development of a toolkit using sentinel plants to detect virus movement across agroecological interfaces.

Master's student, Plant & Food Research

COMPLETED

UNDERSTANDING *PHYTOPHTHORA CINNAMOMI* FROM WITHIN

Leann Vinson

Using systems biology to quantify and qualify transcriptomic and proteomic changes within *Phytophthora cinnamomi* infection and survival mechanisms during the exposure to drought stress.

PhD student, University of Canterbury

COMPLETED

POU 1.1 TRANCHE 1 OUTCOMES

The project team established a network of 60 research plots in 30 kānuka sites across Horomaka Banks Peninsula, spanning gradients of elevation and precipitation. Data collected from these sites have revealed a high vulnerability of Horomaka to climate-change induced pathogen incursions as well as the resilience of soil function to disturbance.

POU 1.2 RESEARCHERS AND SPECIALISTS

Professor Jason Tylianakis (Lead), University of Canterbury

Associate Professor Jonathan Tonkin, University of Canterbury

A GLOBAL ANALYSIS OF CROP–PEST INTERACTIONS

Dr Hao Ran Lai

Investigating why some crops exhibit greater resistance to specific pests, by identifying the underlying biological and anthropogenic factors that contribute to enhanced food security.

Postdoctoral Fellow, University of Canterbury

IN PROGRESS

ECO-EVO DYNAMICS OF A PEST-PARASITOID COMMUNITY

Li Wang

Investigating how biological control of pests by parasitoids will respond to climate change in the long term.

PhD student, University of Canterbury

IN PROGRESS

CLIMATE EFFECTS ON ARTHROPOD SPILLOVER

Julia Palmer

Understanding how climate affects the spillover of pest-controlling arthropods from natural forest fragments to managed areas.

Master's student, University of Canterbury

COMPLETED

POU 1.2 TRANCHE 1 OUTCOMES

These projects have deepened our understanding of how climate change, land use, and ecological interactions influence pest control and crop resilience. Together, they've provided critical insights into supporting sustainable food systems by revealing how beneficial species move, adapt and impact agricultural ecosystems under changing environmental conditions.

POU 1.3 RESEARCHERS AND SPECIALISTS

Dr Julie Deslippe (Lead), Victoria University of Wellington
Associate Professor Jonathan Tonkin, University of Canterbury

BUILDING MODELS TO GUIDE CONSERVATION OF AN ENDANGERED WETLAND TREE

Dr Sarah Herbert

Building spatially explicit models to guide conservation of a critically endangered wetland tree in mixed-use landscapes.

Postdoctoral Fellow, Victoria University of Wellington

IN PROGRESS

PREDICTING THE STATE OF AOTEAROA NEW ZEALAND'S FORESTS IN THE 22ND CENTURY

Ilya Shabanov

Understanding and predicting where, why and how forests react to climate change.

PhD student, Victoria University of Wellington

IN PROGRESS

MAXIMISING WETLAND RESTORATION FOR BIODIVERSITY AND COMMUNITY

Dr Stephanie Tomscha

Researching how wetlands might be restored to create resilience to global changes and using GIS to determine optimal locations for creating new wetlands in the Wairarapa.

Postdoctoral Fellow, Victoria University of Wellington

COMPLETED

MĀTAURANGA MĀORI AND DIVERSITY OF FUNGI IN WETLAND FORESTS

Tere Porter-Rawiri
(*Te Ātiawa, Taranaki, Ngāti Mutunga*)

The importance of fungi to tangata whenua in Wairarapa and using mātauranga Māori about fungi to characterise fungal community diversity in restored, unrestored, and conserved wetland forests.

Master's student, Victoria University of Wellington

IN PROGRESS

WETLANDS: WHERE DOES THE NITROGEN GO?

Pearl Ruston

Understanding how ecological restoration affects the partitioning of nitrogen among plant and soil pools in unrestored, restored and conserved wetland forests.

Master's student, Victoria University of Wellington

IN PROGRESS

POU 1.3 TRANCHE 1 OUTCOMES

The project team integrated diverse insights to identify contexts and locations that promote ecosystem health and sustainable production. Focusing on forests, pastures and wetlands, the team examined how landscapes are changing under pressures like land-use change, climate change and emergent plant diseases (e.g., myrtle rust).

POU 2 TOKOMANAWA

Defending against pathogens and pests

POU 2.1 RESEARCHERS AND SPECIALISTS

Associate Professor Monica Gerth (Lead), Victoria University of Wellington
Associate Professor Carl Mesarich, Massey University
Dr Nicola Day, Victoria University of Wellington

UNVEILING THE MOLECULAR SECRETS OF KAURI DIEBACK

Dr Yanan (Melissa) Guo

The world's first *Phytophthora* chromosome level-assembly that led to the discovery of the genome and effector genes of *Phytophthora agathidicida*.

Postdoctoral Fellow, Massey University

COMPLETED

UNDERSTANDING THE ANTAGONISTIC FUNGUS–MICROBE INTERACTIONS OF APPLE SCAB

Kara Pendavingh

Understanding apple scab fungus interactions with leaf phyllosphere microbiota, and the role of *Venturia inaequalis* secreted effector proteins in these interactions.

PhD student, Massey University

IN PROGRESS

INTERACTIONS BETWEEN BACTERIA ON KIWI FRUIT LEAVES

Polina Idelchick

Exploring interactions between kiwi leaf colonising bacteria and their potential role in the pathogen resistance of the plant.

PhD student, Victoria University of Wellington

IN PROGRESS

POU 2.1 TRANCHE 1 OUTCOMES

This research investigated the role of plant microbiomes in protecting crops from diseases. The research aimed to identify beneficial microorganisms and understand their protective mechanisms. A key focus was exploring how the surrounding environment influences crop microbiomes. This research contributes to developing natural, sustainable methods for crop protection, potentially reducing reliance on chemical pesticides and improving agricultural productivity.

POU 2.2 RESEARCHERS AND SPECIALISTS

Professor Peter Dearden (Lead), University of Otago
Associate Professor Mark Hurst, AgResearch
Professor Murray Cox, Independent
Dr Nick Waipara, (*Rongawhakaata* and *Ngāti Ruapani ki Tūranga*), Plant & Food Research

GENETIC AND GENOMIC APPROACHES TO PEST AND PATHOGEN CONTROL

Dr Sarah Inwood

Gaining insights into the microbiome of biocontrol agents and pests, focusing on the Argentine stem weevil and the Varroa mite.

Postdoctoral Fellow, University of Otago

COMPLETED

POU 2.2 TRANCHE 1 OUTCOMES

This project carried out fundamental research leading to novel approaches to pest control for the two pests, the Argentine stem weevil and the Varroa mite. Specifically, the team aimed to modify the microbiome of the two pests. We first developed an understanding of what the microbiome of these species contains, and how it relates to the biology of these species. This led to a series of publications and the discovery of a novel virus. The team then developed microinjection technologies for these species. Attempts to modify the microbiome were successful, but the effects on viral transmission were not spectacular.

POU 2.3 RESEARCHERS AND SPECIALISTS

Professor Peter Fineran (Lead), University of Otago
Associate Professor Paul Gardner, University of Otago
Dr Simon Jackson, University of Otago
Dr Rob Fagerlund, University of Otago

FIGHTING CROP PATHOGENS WITH VIRUSES

Dr Nils Birkholz

Investigation of the bacterium *Pectobacterium* and the viruses (bacteriophages) that infect it to learn about the defences and counter-defences involved in this microscopic warfare.

Postdoctoral Fellow, University of Otago

COMPLETED

POU 2.3 TRANCHE 1 OUTCOMES

The team aimed to harness natural defence systems in the bioprotection battle. For example, we developed CRISPR-based genetic tools for gene knockdowns across kingdoms, established proof-of-concept molecular detection systems based on CRISPR-Cas systems, and screened a microbial collection for new defence systems, discovering phage-like tailocin elements that specifically kill bacterial pathogens of potato. All of the new systems and components we have characterised may provide future tools with biotechnological utility.

POU 2.4 RESEARCHERS AND SPECIALISTS

Professor Rosie Bradshaw (Lead), Massey University
Associate Professor Matt Templeton, Plant & Food Research
Dr Rebecca McDougal, Scion
Associate Professor Carl Mesarich, Massey University
Dr Claudia Meisrimler, University of Canterbury
Associate Professor Monica Gerth, Victoria University of Wellington

EFFECTOR PROTEINS IN *PHYTOPHTHORA AGATHIDICIDA*, A KAURI DIEBACK STUDY

Dr Mariana Tarallo

Understanding the molecular basis of pathogen-host interaction, through the functional analysis of effector proteins in the kauri dieback pathogen, *Phytophthora agathidicida*.

Postdoctoral Fellow, Massey University

IN PROGRESS

EXPLORING THE RELATIONSHIP BETWEEN *PHYTOPHTHORA* SPECIES AND KAURI DIEBACK

Taylah Dagg

Determining whether secreted proteins of the kauri dieback pathogen, *Phytophthora agathidicida*, influence the growth of *Phytophthora* species that co-occur in the soil surrounding diseased trees.

Master's student, Massey University

COMPLETED

INSIGHT INTO THE EFFECTOMES OF AOTEAROA *PHYTOPHTHORA CINNAMOMI* ISOLATES BY COMPARATIVE GENOMICS

Alexandra Cox

The use of comparative genomics and genome annotation to determine the effector proteins of *Phytophthora cinnamomi*.

Master's student at University of Canterbury

COMPLETED

POU 2.4 TRANCHE 1 OUTCOMES

This research carried out fundamental research leading to novel approaches to pest management. The team focused on effector proteins from broad host-range pathogen *Phytophthora cinnamomi* (*Pc*) and kauri dieback pathogen *Phytophthora agathidicida* (*Pa*). The data gathered suggests that *Phytophthora* effectors interact with each other and thus impact disease outcomes in the forest. *Phytophthora* effectors also trigger immunity or defence in hosts, slowing infection. However, these responses differ between gymnosperm and angiosperm hosts.

POU 3
NUKU-A-RANGI

Designing resistant and resilient productive ecosystems

POU 3.1 RESEARCHERS AND SPECIALISTS

Dr Steve Wakelin (Lead), Scion

Professor Eirian Jones, Lincoln University

Professor Amanda Black, (*Tūhoe*, *Whakatōhea*, *Te Whānau ā Apanui*), Lincoln University

Professor Leo Condron, Lincoln University

Professor Nick Roskruge, (*Te Ātiawa, Ngāti Tama*), Massey University

MICROBIAL COMMUNITIES AND THEIR RELATIONSHIPS TO SOIL RESISTANCE AND RESILIENCE

Alana Thurston

Investigating soil microbial communities in an agricultural landscape to understand their role in soil function and resilience to climate change.

PhD student, Lincoln University

IN PROGRESS

MYCORRHIZAL FUNGI IN RESILIENT PLANT-SOIL ECOSYSTEMS

Fionnuala Bulman

Investigating the impact of land management on arbuscular mycorrhizal fungi and the role these fungi play in plant resilience to rising temperatures.

PhD student, Lincoln University

IN PROGRESS

ENHANCING RESILIENCE OF SOIL CARBON ACROSS AGRICULTURAL LANDSCAPES

Dr Alexa Byers

Quantifying the impacts of land-use change on soil carbon cycling across an agricultural land use mosaic.

Postdoctoral Fellow, Lincoln University

COMPLETED

POU 3.1 TRANCHE 1 OUTCOMES

We aimed to investigate and quantify the impacts of land use and management on soil microbial diversity and function across diverse agroecosystems. The project team found that: (1) Diversity and abundance of soil microbial carbon degradation genes increased with land-use intensity. (2) Land-use affected the diversity of arbuscular mycorrhizal fungi in plant roots and soils. (3) Contrasting crop systems (kiwifruit, maize) influence fungal and bacterial community structures, which have implications on the capacity of soils to resist and recover from disturbances.

POU 3.2 RESEARCHERS AND SPECIALISTS

Distinguished Professor Philip Hulme (Lead), Lincoln University
Professor Margaret Stanley, University of Auckland

THE INTERACTIONS OF CO-OCCURRING WEEDS AND THEIR IMPACTS ON NATIVE PLANTS

Diana Borse

Investigating the impacts that co-occurring woody weeds have on native restoration plantings.

PhD student, University of Auckland

IN PROGRESS

WEED INVASIONS IN NEW ZEALAND SHRUBLANDS

Friederike Espinoza

Assessing the drivers behind failure and success of establishment of alien weed species in kānuka shrubland on Banks Peninsula.

PhD student, Lincoln University

IN PROGRESS

NON-NATIVE PLANT INVASIONS IN NATIVE FORESTS AND SHRUBLANDS

Dr Laureline Rossignaud

Exploring species richness and ground cover of non-native plants across Aotearoa and providing valuable insights on plant invasions in native forests and shrublands.

Postdoctoral Fellow, Lincoln University

COMPLETED

POU 3.2 TRANCHE 1 OUTCOMES

The objectives of this research was to gather empirical data on the impacts of multiple weeds on mānuka early successional ecosystems, which are highly vulnerable to weed invasion. While managers are often dealing with multiple weeds at a site, almost all global research on weed impacts to date has been conducted on single weed species. The research into an allelopathic weed (woolly nightshade), a nitrogen-fixing weed (brush wattle), and a shade-tolerant weed (tree privet) yielded tangible recommendations for prioritising weed management.

POU 3.3 RESEARCHERS AND SPECIALISTS

Dr Gary Steel (Lead), Lincoln University
Professor Ann Brower, University of Canterbury
Professor Paul Dalziel, Lincoln University
Professor Caroline Saunders, Lincoln University
Professor Anita Wreford, Lincoln University

SUPPORTING MARAE, HAPŪ, AND IWI IN BIOSECURITY MANAGEMENT

Jade Gibson
(*Ngāti Porou, Te Aitanga a Mate*)

Addressing critical biosecurity threats within Māori community settings, particularly focusing on marae, hapū, and iwi.

Master's student, University of Canterbury

COMPLETED

(DIS-)INCENTIVES FOR ADAPTATION INTENTIONS IN FARMING

Dr Franca Buelow

Investigating the environmental challenges that farming faces in Aotearoa and inferences into adaptation decision-making and behaviours.

Postdoctoral Fellow, University of Canterbury

COMPLETED

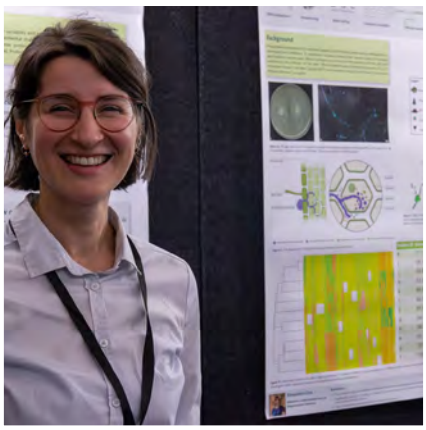
PROMOTING NATIVE BIODIVERSITY ON AOTEAROA NEW ZEALAND DAIRY FARMS

Dr Elizabeth Elliot Noe

Investigating the possibilities, practicalities and tensions of caring for native biodiversity for those who manage rural landscapes.

Postdoctoral Fellow, Lincoln University

COMPLETED



POU 3.3 TRANCHE 1 OUTCOMES

These projects collectively explored governance in bioprotection and environmental systems. Together, they advanced Aotearoa New Zealand's environmental resilience and kaitiakitanga.

The outcomes include empowering Indigenous communities in biosecurity, promoting biodiversity on farms, enabling systemic responses to climate change, and driving policy change to remove barriers to climate adaptation.

RECLOAKING PAPATŪĀNUKU

An Indigenous socio-ecological research theme that promotes native biodiversity

RECLOAKING PAPATŪĀNUKU RESEARCHERS AND SPECIALISTS

Professor Nick Roskruge (Co-Lead), (*Te Ātiawa*, *Ngāti Tama*), Massey University

Dr Nick Waipara (Co-Lead), (*Rongawhakaata* and *Ngāti Ruapani ki Tūranga*), Plant & Food Research

Aroha Mead, (*Ngāti Awa*, *Ngāti Porou*, *Ngāti Tūwharetoa*, *Tuhourangi* and *Ngāi Tūhoe*), Independent

CHARACTERISATION OF TRADITIONAL KŪMARA AND TAEWA IN AOTEAROA AS AN INSURANCE POLICY FOR FOOD SECURITY

Simon (Apang) Semese

Prioritising crop diversity, global food security, and unique characterisation of kūmara and taewa accessions to create a formal, culturally inclusive collection.

PhD student, Massey University

IN PROGRESS

INTEGRATING MĀTAURANGA AND SCIENCE TO ENHANCE MAIRE TAWAKE RESILIENCE

Dr Hanareia Ehau-Taumaunu

(*Ngāti Uepōhatu, Ngāti Porou, Te Ātiawa, Te Whānau-a-Āpanui, Ngāpuhi*)

Integrating mātauranga and science, this project will link whakapapa of maire tawake and microbial communities to produce holistic disease protective solutions.

Postdoctoral Fellow, Plant & Food Research

IN PROGRESS

RECLOAKING PAPATŪĀNUKU TRANCHE 1 OUTCOMES

These projects supported the use of mātauranga with science to enhance the resilience and survival of maire tawake, a key target of conservation and restoration efforts; and characterise kūmara (*Ipomoea batatas*) and taewa (*Solanum tuboresum*) accessions, inclusive of cultural, morphological, and molecular characterisation. A holistic understanding of these taonga species is relevant to food security, conservation, ethnobotany and protection from disease.

SUMMER SCHOLARS 2024–2025

GOVERNING GENETIC TECHNOLOGIES
Learning from the past 30 years
Sophia Bernau, University of Canterbury

PHYTOPHTHORA PLUVIALIS
The pathogen behind serious tree diseases
Bree Drinkwater, University of Canterbury

PESTS IN THE SPOTLIGHT
How Aotearoa's media portrays biosecurity
Dan Moskovitz, Victoria University of Wellington

***PHYTOPHTHORA AGATHIDICIDA* DETECTION METHODS**
Riley Macdonald, University of Otago

SOIL MICROBES AND CARBON
Protocols for measuring soil carbon and microbes
Madeleine Ford, University of Otago

ORGANISATIONAL STRUCTURE

TAUMATA, STRATEGIC ADVISORY BOARD

Co-Chairs

Matua Henare Edwards (*Te Rawara, Te Aupouri, Ngā Puhi*), Independent Representative

John Rodwell , Independent Representative

Board members

Adjunct Associate Professor James Ataria, (*Rongomaiwahine*, *Ngāti Kahungunu*, *Raukawa*), Independent Representative, Tuaropaki Trust/ Cawthron

Professor Richard Blaikie, Partner Representative, University of Otago

Professor Chad Hewitt, Host Representative, Lincoln University,

Tana Luke, (*Ngāti Rārua*, *Ngāi Tahu*, *Te Rarawa*), Independent Representative, Fonterra

Stacey Whitiora, (*Ngāti Mahuta ki te Hauāuru*, *Waikato*), Partner Representative, Plant & Food Research

Observing member

Aleise Puketapu (*Te Ātiawa*, *Waikato-Tainui*), Tahuri Whenua

KAIWHIRIWHIRI, DIRECTORSHIP

Director

Professor Amanda Black (*Tūhoe, Whakatōhea, Te Whānau ā Apanui*), Lincoln University

Deputy Directors

Professor Nick Roskruge (*Te Ātiawa, Ngāti Tama*), Massey University

Distinguished Professor Philip Hulme, Lincoln University

Professor Peter Dearden, University of Otago

OPERATIONS

Research Centre Manager

Fiona Newcombe, Lincoln University

Executive Assistant to the Director

Elena Johnson, Lincoln University

Research and Outreach Co-ordinator

Meikura Arahanga (*Ngāpuhi, Pare Hauraki, Tainui, Tuhoe, Ngāti Rongomai, Ngāti Kahungunu, Ngāti Tuwharetoa, Te Ati Haunui-a-Pāpārangi, Ngāi Tahu, Waitaha, Ngāti Māmoe*), Lincoln University

Communications and Engagement Manager

Zohar Marshall, Lincoln University

Project and Events Co-ordinator

Anna Tier, Lincoln University

OPERATIONS SUPPORT

Pou Whirinaki

Huata Arahanga (*Ngārauru-kii-tahi*)

Science Communicators

Stacey Bryan

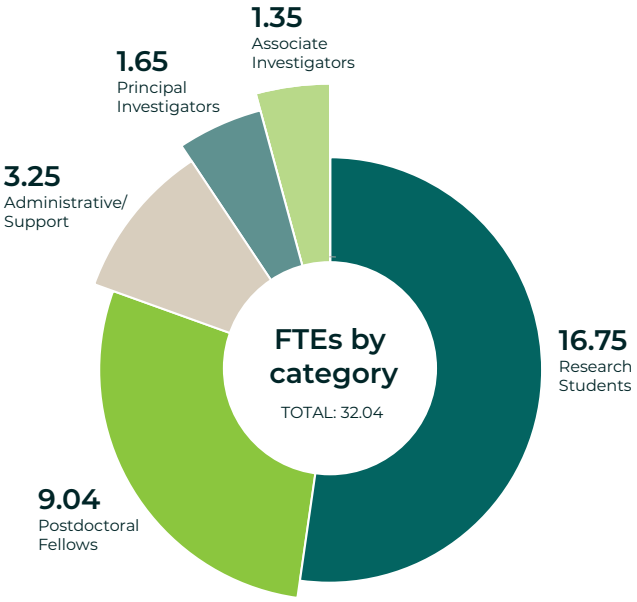
Jenny Leonard

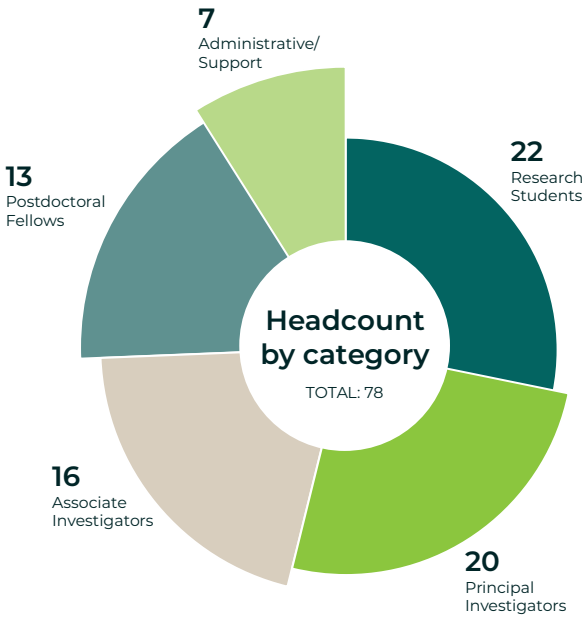
Communications Intern

Sara Lobdell, University of Canterbury

OUR PERFORMANCE

CAPABILITY DEVELOPMENT





13 Doctoral Degrees

4 Masters Degrees

5 Other Levels

41 Conference Presentations

4 Book Chapters

77 Journal Articles

Scan the QR code for a full list of Bioprotection Aotearoa outputs for 2024

FINANCIALS

CATEGORY	TOTAL $ '000
TEC CoRE Funding	4,300
Surplus/(Deficit) carried forward	1,316
Total CoRE Funding	**5,616**
Salaries & salary-related costs	1,591
Total Salaries & Salary-related costs	**1,591**
Overheads	1,272
Project Costs	624
Travel	108
Postgraduate students	489
Equipment depreciation/rental	-
Subcontractor(s) specified	224
Total Other Costs	**2,717**
Total Expenditure	**4,308**
Net Surplus/(Deficit)	**1,308**

ACKNOWLEDGEMENTS

This annual report was prepared by the Bioprotection Aotearoa whānau.

Produced by Zohar Marshall, with additional written support by Jenny Leonard, editing support by Dr Laura Sessions and graphic design by Donna Gibson.

Additional assistance was provided by Professor Amanda Black, Fiona Newcombe, Meikura Arahanga, Huata Arahanga, Elena Johnson, Anna Tier and Matt Pearce.

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If you have any enquiries or would like a copy of this report, please email: bioprotection@lincoln.ac.nz

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