Bioprotection Aotearoa

Te Pū Whetū o te Taiao

Aspiring to the highest pinnacle of science

BIOPROTECTION AOTEAROA ANNUAL REPORT 2022

Ko te paetahi e

Ko te tirohanga whānui
ki te taiao o te whenua nei e

Kia mau rā e

Inamata ki te anamata

Hei oranga tonutanga e

Nō hea rawa rā e

Nō ngā hau e whā

Nō ngā tai katoa

Ngā moana, ngā motu e

KO TE KOIORA O AOTEAROA E

Hei

The First Level

The expansive look and research into
the natural world of our land

Let's hold on to

The past to head to the future

To sustain our long lasting lifeforce

From where

From the four winds

From all of the tides

The oceans and the islands

THE WELLBEING OF AOTEAROA

HOW TO FIND US

bioprotection.org.nz

twitter.com/BioprotectionNZ

facebook.com/BioProtectionNZ

instagram.com/bioprotection_nz/

linkedin.com/company/bioprotectionaotearoa

youtube.com/@bioprotectionaotearoa1898

CONTENTS

OUR STORY

HARIATA (SALLY) MCKEAN (*NGĀTI RANGINUI*)

We would like to express our deepest gratitude and acknowledgment for the life and contributions of Hariata (Sally) McKean (*Ngāti Ranginui*), an esteemed kuia who passed away in June 2022.

Sally's presence within the Ko Maru Rangahau Kāhui for Bioprotection Aotearoa was invaluable. She exemplified the qualities of a Rangatira, and her profound knowledge of te reo Māori and tikanga left a lasting impact.

Sally's dedication to bioprotection and her commitment to preserving cultural heritage will be cherished and remembered, and her legacy will continue through the mission and vision of Bioprotection Aotearoa.

Tangi kau ana te ngākau
Matapōrehu ana te iwi
I te wehenga atu o tēnei hākui
Ka tatū te ngākau i te korenga o āwhitu, i te korenga o mamae
Ka ngawari te wairua
Ka ngawari te tīnana
He hautoa, he māia, he whakatara
Ko koe tēnā
Waiho atu tō rahi, tō iwi
Hai hopo, hai tangi kau
Hanatu rā ki ōu mātua tīpuna
Ki te kāinga wairua i te rangi
E oki atu rā

Prof Amanda Black
(Tūhoe, Whakatōhea, Te Whānau ā Apanui)

FROM OUR DIRECTOR

We are in a new era where we are living with climate change. Aside from highlighting losses and damages that we are already experiencing (and that will continue), these effects are hitting the most vulnerable communities and ecosystems particularly hard.

To be effective in providing solutions, our choices need to be grounded in diverse values and world views, including scientific knowledge, Indigenous knowledge, and local knowledge. This approach reinforces the foundation of our bioprotection strategy and values.

Right now, we need our next generation of bioprotection leaders and practitioners to be brave and to co-design and co-collaborate with communities and research fellows.

It is imperative that scientific outcomes advance 'collective impact', driven by the desire to protect the mauri of Papatūānuku and her whenua, as we learn to adapt and live with climate change.

I am proud of the work we are doing and the relationships we are forging, but to ensure that our research has impact and legacy we need to have the right support in place.

Going forward, we need support for those on the ground, either working the land, or working in the laboratory to ensure that these solutions will find their way to places of need.

We can produce the tools, the methods, and the trained researchers but we need the right mechanisms in place so that collective aspirations can be realised.

Kotahi te hoe, ka ū te waka ki uta.
Paddling in unison, the waka will reach land.

FROM OUR CO-CHAIRS

Matua Henare Edwards (*Te Rawara, Te Aupouri, Ngā Puhi*)
CO-CHAIR OF THE BOARD

John Rodwell
CO-CHAIR OF THE BOARD

We are pleased to present the Co-Chairs' Report for Bioprotection Aotearoa, highlighting the considerable progress and achievements made in the past year. It is with great enthusiasm and gratitude that we reflect on our collective efforts towards building a sustainable and resilient agricultural community.

Since its establishment in July 2021, Bioprotection Aotearoa has thrived as a collaborative platform, bringing together the strengths and expertise of eleven partner organisations. We would like to express our sincere appreciation to all our partners for their unwavering support and commitment to our shared vision. Together, we have cultivated a powerful and diverse research community that is driving innovation and advancing bioprotection practices in Aotearoa New Zealand.

Throughout the last year, we have made significant strides in bridging the gap between mātauranga Māori and science, to unlock new avenues for addressing complex agricultural challenges.. This inclusive approach has enhanced our scientific endeavours and brought together researchers and communities, enabling us to tackle issues of national, cultural, and economic importance.

We are delighted to report that Bioprotection Aotearoa has successfully assembled a remarkable team of staff and early career researchers who are deeply committed to their work. Their dedication and passion have fuelled our commitment, and they are contributing to ground-breaking advancements in bioprotection. We extend our heartfelt appreciation to our researchers and community members for their invaluable contributions and enthusiasm.

Furthermore, our strategic advisory board has played a pivotal role by providing strategic oversight and guidance, ensuring the alignment of our efforts with our long-term objectives. We are immensely grateful to the board for their expertise and valuable contributions to the success of Bioprotection Aotearoa.

Looking ahead, we recognise that the challenges in the agricultural sector are dynamic and evolving. As co-chairs, we are fully committed to fostering an environment that encourages collaboration, innovation, and knowledge exchange. By nurturing partnerships and fostering multidisciplinary research, we aim to address emerging threats and develop sustainable solutions that will safeguard our landscapes and contribute to the prosperity of the agricultural community.

In conclusion, we extend our deepest gratitude to all our stakeholders – including our funding agencies, industry partners, and the wider community – for their continued support. Together, we are building a future where bioprotection is not just a necessity but a thriving and profitable pillar of Aotearoa New Zealand's agricultural landscape.

Thank you for your dedication and commitment.

Ngā manaakitanga

OUR PARTNERS

LINCOLN UNIVERSITY
TE WHARE WĀNAKA O AORAKI

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

VICTORIA UNIVERSITY OF WELLINGTON
TE HERENGA WAKA

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

agresearch
āta mātai, mātai whetū

Plant & Food Research
Rangahau Ahumāra Kai

Manaaki Whenua
Landcare Research

SCION
FORESTS PRODUCTS INNOVATION

VISION

Our communities in Aotearoa New Zealand and the Pacific are empowered with the knowledge to act as *kaitiaki* (guardians) of our *whenua* (land), supporting healthy and resilient environments where our *mokopuna* (grandchildren) can thrive.

MISSION

Bioprotection Aotearoa is a national Centre of Research Excellence, training a new generation of scientists to approach academic research in bioprotection differently.

Early career researchers are encouraged to move away from a siloed approach, and instead draw on our collective academic strengths and to value the diversity of knowledge systems, including mātauranga Māori, for the purpose of extending scientific knowledge.

Through the provision of teaching and learning, early career researchers build their skills and capabilities to deliver multidisciplinary research that supports a holistic, systems-level approach that protects productive and natural landscapes from pathogens, pests, and weeds in a warming climate.

Hosted by Lincoln University, Bioprotection Aotearoa is a collaborative partnership among seven universities and four Crown Research Institutes.

TE PŪ WHETŪ O TE TAIAO

ASPIRING TO THE HIGHEST PINNACLE OF SCIENCE

In November 2022, Bioprotection Aotearoa hosted an inaugural noho marae. Experiences and knowledge-sharing opportunities built whanaungatanga, strengthened relationships, and connections, and fostered kotahitanga for everyone in attendance.

Travelling from across Aotearoa New Zealand, members of Bioprotection Aotearoa gathered before the gates of Ōnuku Marae, Akaroa.

Over the playful sounds of the harbour and native birdsong, the *karanga* rang out – the first voice of *tangata whenua* calling our *rōpū* to begin their *whakaeke* (advancement) onto the marae.

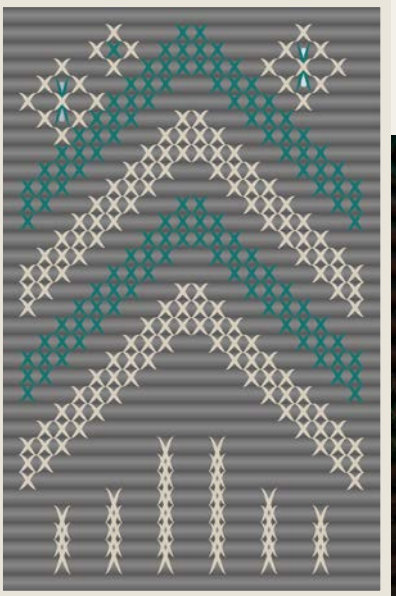
For many attendees, not only was it the first time meeting *kanohi-ki-te-kanohi* (face to face), it was also their first time on a marae.

Joining us was the Kahu Collective, a group of local weavers from Ōtautahi, who share a passion for *raranga* (weaving) and want to awaken the world to its beauty and healing properties.

Alongside our programme, many hands united to weave a tukutuku panel and fill it with our own stories. The design embodies our values as a national Centre of Research Excellence.

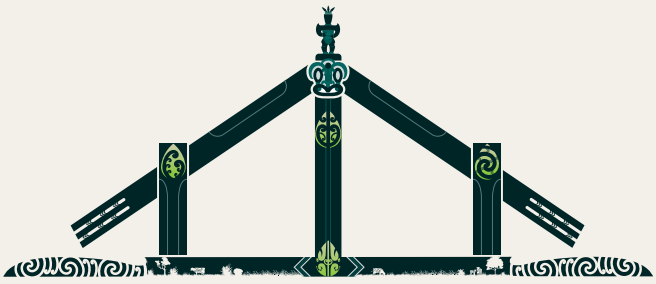
Te Pū Whetū o te Taiao – Aspiring to the highest pinnacle of science was the name gifted by our Pou Whirinaki, Huata Arahanga during the *poroporaki* (farewell speeches).

Te Pū refers to the origin point and ***whetū*** refers to the stars – the origin of the stars being the highest pinnacle to aim for.



OUR RESEARCH FRAMEWORK

Bioprotection is focused on protecting the *mauri* (life force) of Papatūānuku and her *whenua* (land). When her wellbeing is compromised, we suffer socially, culturally, environmentally, and economically. Three pillars support our research themes.



Pou 1 | Titirangi, piercer of the heavens

Bioprotection **defines** what a healthy and productive ecosystem should look like and provides a framework to assess the wellbeing of an ecosystem of any scale.

Pou 2 | Pou Tokomanawa, the heartbeat of the whare

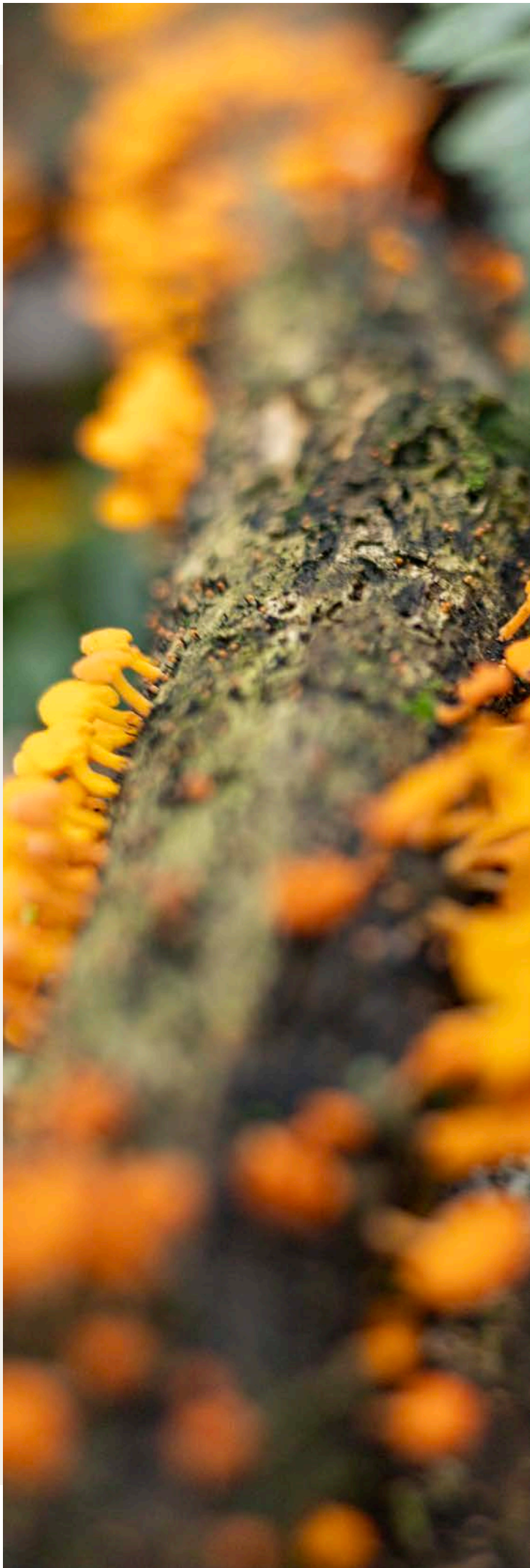
Within an ecosystem, bioprotection examines the interactions and relationships that form among organisms, identifying their collaboration network and partnerships to resist attack and **defend** themselves.

Pou 3 | Nuku-a-rangi, shifting throughout the heavens

Using this fundamental knowledge, leaders in bioprotection can leverage these mechanisms to **design** innovative solutions and tools that improve the resilience and resistance of organisms and holistically restore the overall health of an ecosystem.

Recloaking Papatūānuku

Extending across our whare is the foundation, **Recloaking Papatūānuku**. This guides our research to weave the science and innovation embedded in mātauranga Māori and Pasifika Indigenous knowledge.



OUR IMPACT

The impact of bioprotection secures the *hauora* (wellbeing) of Papatūānuku and her whenua to adapt and thrive for the benefit of future generations. Our success will ensure:

Increased public confidence in our ability to manage productive ecosystems for the wellbeing of all

The management of Aotearoa New Zealand's landscapes is informed by new ecosystem health indicators and new practices that lead to sustainable production. There is nationwide acceptance of Bioprotection Aotearoa's socioeconomic and governance models, which will lead to the adoption of best practice solutions designed to protect against emergent bioprotection threats at multiple scales.

Equity and diversity in application and implementation

Bioprotection Aotearoa authentically demonstrates Te Tiriti o Waitangi led practice, engages in strong partnership with Māori, and implements a diversity policy across all governance, management, and science teams. Te ao Māori principles are embedded in our programme, and Māori and Pasifika researchers are involved in all our bioprotection activities.

Increased export earnings from sales and licencing of new products

Aotearoa New Zealand has increased development and adoption of novel, locally sourced and socially acceptable solutions for bioprotection and reduced reliance on synthetic inputs in agriculture. Products will be marketable for export as premium products that are produced in low synthetic input environments.

Sustainable productive environments contribute to economic, environmental, cultural, and social wellbeing

Our research leads to sustainable, resilient, and productive environments by supporting the *mauri* (life-force) of our productive lands. In a warming climate, Bioprotection Aotearoa's research:

1. understands, predicts, and designs against pathogen, pest and weed threats,
2. maintains productivity with fewer synthetic inputs, using innovative, locally sourced, and socially acceptable solutions,
3. contributes to the care and protecton of Aotearoa New Zealand's landscapes, which creates a positive and sustained impact on human wellbeing.

Higher-earning technical workforce

Our early career researchers successfully graduate from Bioprotection Aotearoa, producing high-quality outputs that are inclusive, values-based and advance the understanding of indigenous cultural knowledge. They will have diverse experience and work in positions that require fluid thinking and problem-solving that draws on different knowledge spheres.

ADVANCING A COMMUNITY AND THEIR WHENUA

LEARN HOW WE ARE PARTNERING WITH MĀORI AGRIBUSINESS IN TE KAHA TO BRING ABOUT ECONOMIC STRENGTH AND RESILIENCE IN A MULTI-USE LANDSCAPE.

TE KAHA

Situated in the Bay of Plenty near Ōpōtiki, Te-Kahanui-a-Tikirākau (Te Kaha) is home to the people of Te Whānau-ā-Te Ēhutu.

The Raukūmara Ranges stretch behind Te Kaha, feeding many rivers that traverse the land and make their way toward the sea. Coastal marae dot the landscape where the sweeping sands of Maraetai Bay curve to meet the sea.

Bush, forest, sea, and rivers unite, with Whakaari/White Island puffing away on the horizon, serving as a daily reminder that life can change quickly in this part of the world.

With multiple kiwifruit orchards, maize sites, and a commercial nursery all backed by native land, it has always been the community's philosophy to give back to the soil, plants, and people within their region.

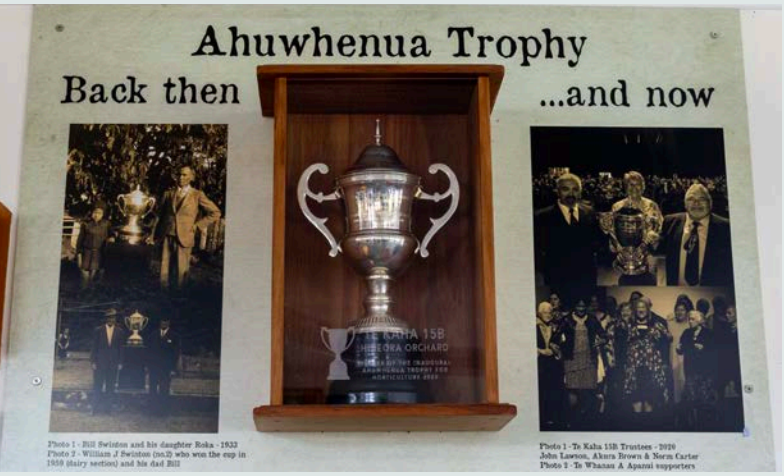
It's January. The atmosphere is alive with the joyful laughter of children and their whānau swimming underneath the bridge, where the Kereu River meets the sea.

Among them, a few adventurous souls climb a rope fastened to a tree branch that hangs over the water, while the rest eagerly observe the spectacle. With bravery and skill, they leap, manoeuvring their bodies to create a magnificent splash reminiscent of a geyser. The onlookers respond with cheers, expressing their admiration for these daring feats.

This is a place that favours the bold and the brave; the strong and the resilient.

This is also one of the many reasons Bioprotection Aotearoa has been developing a relationship with Te Kaha 15B, one of the six Ahu whenua Trusts in Te Kaha Group.

In 2020, Te Kaha 15B was bestowed the Ahuwhenua Trophy, an award that recognises outstanding achievements in Māori farming and horticulture. Proudly displayed in the local RSA, this esteemed accolade symbolises their commitment to fostering partnerships with research groups such as Bioprotection Aotearoa. Through these collaborations, Bioprotection Aotearoa undertakes multidisciplinary scientific research that aims to make a difference to the whenua and its people.



Bioprotection Aotearoa Director Prof Amanda Black, pou lead Dr Nick Waipara, and Te Kaha 15B Chairman Norm Carter all whakapapa to Te Kaha. Ron Clark, who resides in Te Kaha, is the Manager of Te Kaha Nursery. They, like many others, are passionate about what can be achieved.

THE CHALLENGE OF ECONOMIC BOOM AND BUST

Nick explains that Te Kaha is a scientifically valuable site due to its diverse use of land. Maize, kiwifruit, podocarp native bush, and mānuka/kānuka scrub sit side by side.

“Te Kaha has a long history of producing crops for export and economically fending for itself. However, it has also been the victim of boom and bust.”

He’s talking about the thriving commercial horticultural ventures that date back to when kūmara were plentiful, only to become difficult to grow when a moth pest invaded in the early 1900s. A thriving squash export trade later fell victim to a pathogen in the 1990s, then a bacterial kiwifruit vine disease (Psa-V) hit many areas of Aotearoa New Zealand, including Te Kaha, in the early 2000s.

In recent decades, maize has continued to be grown in the area, along with successful ventures into gold kiwifruit, citrus and macadamia nuts.

‘The people here have immense knowledge of cultivation,’ says Nick. ‘But when you are looking at economic production, ideally things need to be sustainable. For example, maize is a greedy crop. Perpetual maize production hammers the soil and strips it of nutrients.’

EXTREME WEATHER AND ITS IMPACT ON WHENUA AND INFRASTRUCTURE

Extreme weather also has a habit of testing the community's strength and resilience, as well as the whenua and infrastructure.

Nick explains, "The cyclones like Bola in the 1980s and now Gabrielle. Te Kaha has always had extreme weather, which inevitably shapes and reshapes the land, and often determines what economic crops do well here, as accessing domestic and international export markets relies on the road (SH35) staying open."

Remote in an already isolated region, Te Kaha relies on what can only be described as precarious access and infrastructure.

"The locals talk about how the river changed course about 30 years ago and took the road with it,' says Nick. "To a degree, that is an ongoing process. The road getting in and out has always been one way. It is coastal so subject to slipping, plus there are lots of bridges, lots of slips, and the river periodically carves out parts of the road – access is always under construction."

THE YOUNG LEAVE THE COAST, AND TEND NOT TO RETURN

Te Whānau-ā-Apanui takes pride in their self-sufficiency, but the departure of the youth in search of job opportunities elsewhere remains a concern. Norm Carter, Chairman of Te Kaha 15B, acknowledges the limited career pathways in the region, saying, “It is hard to see the young people of Te Kaha leave to seek jobs elsewhere. We have been trying to give them a leg up,” he further explains.

“We sponsor scholarships and some of our joint venture partners have given money for sponsoring education. We target Year 13 through to the second year of university. From that point, there are so many other opportunities they can try to access.”

Norm emphasises the long-term vision for the community, stating, “Our ultimate aim is to get one or two to push through to a degree so they can start to come back and work on their own land and their own blocks.”

Within Te Kaha 15B, there are success stories of advancement within the community. “At the moment we have people who used to be pickers and pruners, who were on a block earning minimum wage, who we have helped become supervisors and managers of blocks,” Norm highlights. “Now they are taking higher earning salaries into their family homes as supervisors. They are making a hell of a difference to their families plus it is money coming back into our community.”

Reflecting on the impact of these transformations, he adds, “You can see the difference in their faces, you can see it in their āhua, just the way they are around other workers and how they supervise them. It has been good that way, and it filters out into the community.”

MĀORI SUCCESS INTEGRAL TO THE PARTNERSHIP BETWEEN BIOPROTECTION AOTEAROA AND TE KAHA

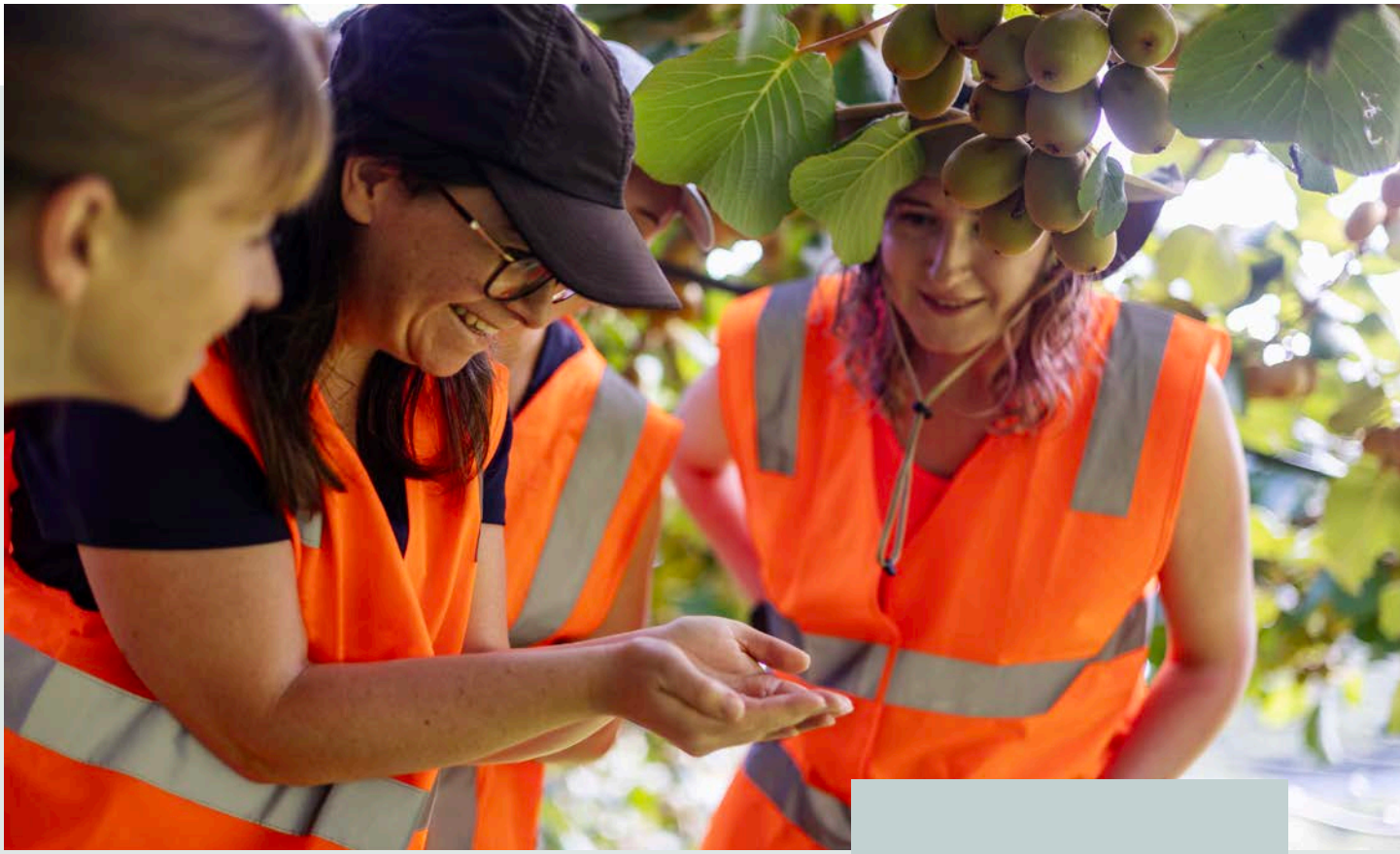
Bioprotection Aotearoa understands these challenges, with Māori success at the forefront of this partnership.

"We hui with the Te Kaha community and visit regularly so we can hear from growers, local industry representatives, and importantly, landowners and wider community. Everyone is included in discussions and planning which also ensures local knowledge over many years of successful crop production is heard and respected. Our *kaupapa* is very much grounded from te ao Māori perspectives including *whanaungatanga* and *kaitiakitanga*. We work with locals and their values to find out what they want researched and be directed towards their key priorities," explains Nick.

"In this case, economic wellbeing for the future, employment, and having opportunities for the next generation have been expressed. This is not just about money but about opportunity and building of capability through training and education initiatives as well as resilience to improve infrastructure and some of the community's other assets long term. People want to return to Te Kaha – they left for jobs years ago but very much want to come back to live."

With Bioprotection Aotearoa's involvement in Te Kaha it is hoped that opportunities in climate change, environmental issues, and scientific research will become attractive and feasible career paths that complement the more traditional horticultural roles.

Nick is careful to point out that Bioprotection Aotearoa's relationship with Te Kaha is in its infancy. "Both sides are learning from each other and growing in their understanding and importantly our kaupapa and mahi is being led by the decisions of the locals."



SOLVING REAL WORLD PROBLEMS THROUGH MULTIDISCIPLINARY RESEARCH

A cohort of Bioprotection Aotearoa postgraduate students have begun multidisciplinary research at the same sites across Te Kaha.

"In Te Kaha we look at the whole ecosystem – above ground, below ground, insects, spiders, pathogens, soil microbiomes, weeds, biosecurity. There is a whole synergy of learning. There are multiple data sets being produced with many ways of looking at things. That brings real strength to the research, and will hopefully help the resilience and sustainability of kiwifruit in Te Kaha beyond where it is now."

Much of Bioprotection Aotearoa's research will assist the Te Kaha community to transform low value crops like maize to high value gold kiwifruit. It will also help them expand onto land that is not currently used for commercial purposes.

"It's not about having all or nothing," says Nick. "It might be that we can harness beneficial activity at microbe and microbiome levels. We might be able to biologically control some of the pests and diseases or do some good returning of nutrients naturally rather than using fertilisers."

Nick believes doing more in this way will mean a reduction in costs for farmers and growers, benefiting them while also meeting the demand for minimal chemical interference in export markets.

"After all, everyone wants as little chemical interference as possible," says Nick. "And of course, this way of looking at things can only impact our water and land in a positive way. Pollution, chemical runoff, and degraded catchments from over fertilisation could be reduced. It is a whole picture."

EXPANDING HORIZONS FOR THE COMMUNITY OF TE KAHA

While kiwifruit production has been successful in Te Kaha for the past two decades, growers are keen to avoid self-reliance on a single crop. They understand that future generations will be impacted by today's land management practices, including over cropping and monoculture farming.

The Manager for Te Kaha Nursery Services, Ron Clark, has been working with industry research groups to help identify and develop alternative crop solutions suitable for the region. "This will help protect the land from overuse and excessive use of chemicals," he explains.

Ron adds that the use of chemicals weighs heavily on the minds of most people in the community. "The health of the whenua must be protected for future generations. If the world is to feed the growing masses, then the land must be nurtured and protected."

Te Kaha Nursery has set up trial areas to grow and showcase alternative crops. In some cases, a variety of growing methods are applied to enhance yield and production, as well as provide alternatives for mechanical harvesting methods.

"Although some of these may take two to three years to prove their worth, at least it is a starting point," says Ron. "We don't want to see or create a situation in Te Kaha that will enable adverse weather or climate change to degrade the value of the whenua for future generations. I would see the loss of the integrity of the whenua to be the biggest threat to the community."

AN EXCITING BEGINNING WITH SO MUCH MORE TO COME

The partnership between Bioprotection Aotearoa and Te Kaha 15B is set to address Ron's concerns, and so much more.

"Scientists are underway with their samplings," says Nick. "The results will be interesting. For example, we already suspect that regenerating native ecosystems bring benefit to the land through ecosystem services like beneficial insects and microbes that are associated with native plants. It is exciting stuff."

Te Kaha growers and landowners will have direct access to data that has come from their land and contributions. Results and findings will also be published in scientific journals and presented at conferences, but Nick is conscious that learnings should also be made public in an accessible way.

"What we are doing here in Te Kaha is so important. We are learning so much about ecosystems and multi-use landscapes. Most places we live have a mixed model of use, native plants, and primary production.

We need to use those fragmented landscapes to develop smarter ways of producing food for ourselves, producing high value crops for an export market, and contributing to our economic wellbeing – not just in Te Kaha."

Nick believes the results from Te Kaha will have ramifications for the rest of the country, especially regions facing similar issues, such as Northland and Gisborne.

Bioprotection Aotearoa has a sustainable long-term vision that extends beyond the eight years of funded research.

"We are just at the beginning," says Amanda. "In years to come it will be fascinating to follow how people from the Te Kaha community become involved. It would be great to see a young person from this community researching the values that are intrinsic to Te Whānau-ā-Apanui and the region, and how this influences the decisions made around land use and land management practices. That would be the icing on the cake."

BUILDING CAPABILITY

SEE HOW WE ARE BUILDING THE CAPABILITY OF THE NEXT GENERATION OF BIOPROTECTION LEADERS TO APPLY AN INTEGRATED APPROACH TO SOLUTION DEVELOPMENT IN A MEANINGFUL WAY.

BIOPROTECTION AOTEAROA NETWORK

Since launching in July 2021, Bioprotection Aotearoa has challenged early career researchers to step out of their comfort zones and actively engage in promoting equity, diversity, and inclusion in their work.

Creating a space for partnership and collaboration is not easy. It requires courage and a willingness to be comfortable with the uncomfortable.

"It starts with you. If you don't shift your thinking around impacts early in the piece, then greater, sustainable, meaningful science outcomes will not be realised."

– Prof Amanda Black

Nicola Sullivan, an aligned PhD student, says "It's been so refreshing coming to Bioprotection Aotearoa. I've worked in science for 15 years and the focus has always been on publishing in high-impact journals, and about prestige, with little talk about the impact for communities and how research will be used. Bioprotection Aotearoa has renewed my sense of purpose; it's re-energised me. To be able to see your work directly benefiting communities is really motivating."

Gary Steel, Pou 3.3 lead, agrees that collaboration with communities is an unusual - if not unheard of - approach for scientists. He says, "One of the ways that Bioprotection Aotearoa has changed my thinking has been the strong collaborative approach to research - not just across researchers but also communities."

Gary says this approach can be "unnerving" because the touchpoints with the community are not specified beforehand. However, he recognises benefits for both the community and researchers.

SCIENCE DOESN'T FIT IN A SQUARE BOX, IT'S MUCH MORE FLUID

Summer scholar Ella Spears says that Bioprotection Aotearoa's unique approach has upended the way she thinks about science. "Before Bioprotection Aotearoa, science to me was a rigid process with a very set structure of steps that researchers could not deviate from. Since joining, I have realised science is much more fluid. It has its own mauri. It can be a messy, imperfect process, and it takes time. But Bioprotection Aotearoa also taught me how to cope with that, to persevere knowing the journey is subject to change."

Board member Jessie Chan says that Bioprotection Aotearoa has been "specific in its intent of pursuing a renewed focus on mātauranga Māori and supporting the kaitiaki of the whenua. We are showing why it is better to embrace a collective approach, with conventional science and a te ao Māori world view at the core of what we do."

Nicola says, "The questions around how we incorporate mātauranga Māori with science are going to challenge us as scientists, as we learn to incorporate different knowledge systems across our careers. Also having Māori researchers prominent in the organisation shapes our engagement in an authentic way."

THE IMPORTANCE OF TE AO MĀORI

The noho marae was a crucial activity in building the team's cultural capability and understanding of te ao Māori worldviews. Ella describes the experience as "super refreshing" to be taught by Māori in a Māori context.

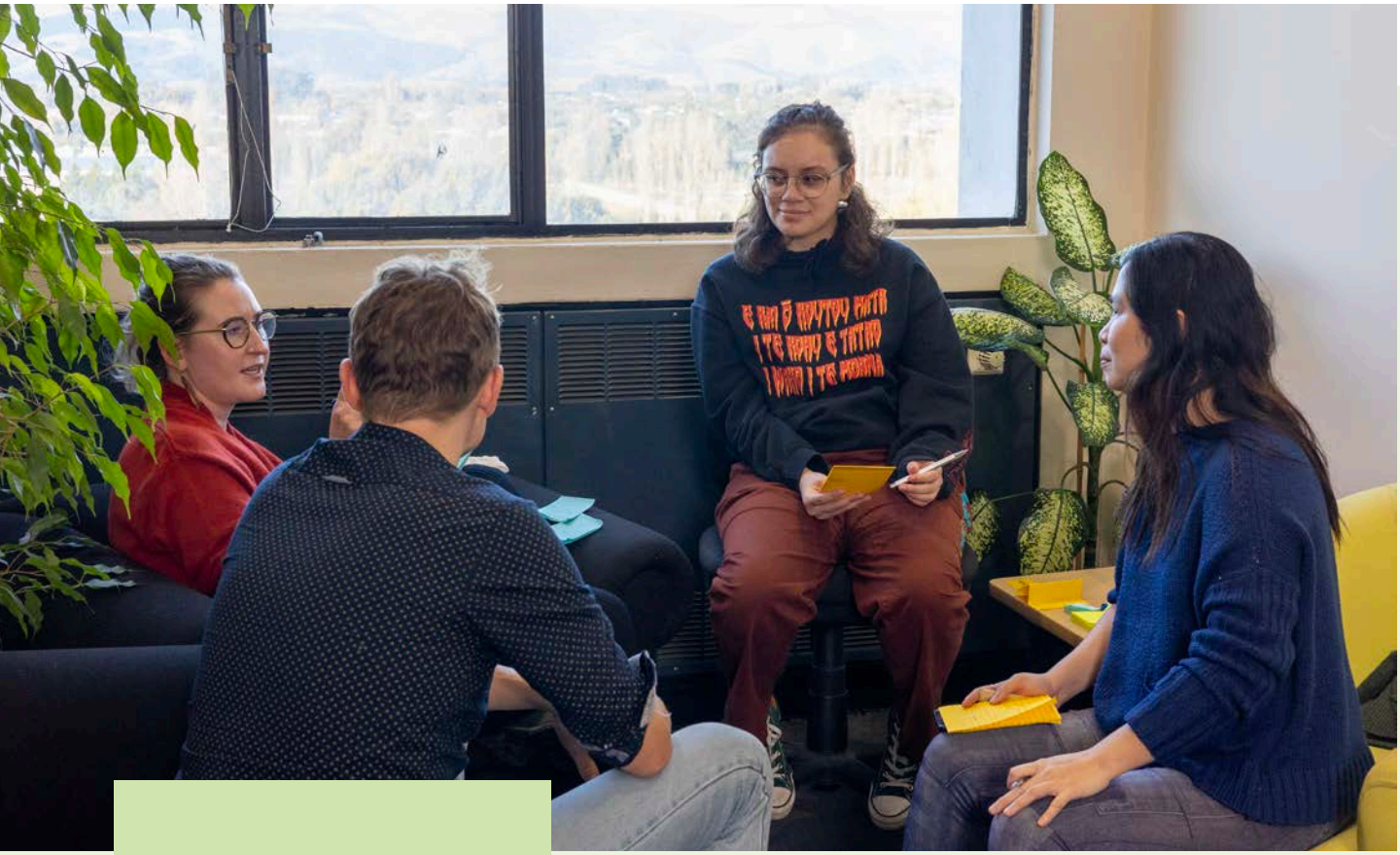
"To be on a marae with Māori was such a positive thing. It was the best thing we could have done to connect and understand the backbone of Bioprotection Aotearoa. Now I understand why we really need to have positive relationships with Māori to do research on the land or oceans. Before the noho marae, it had seemed scary, but now I'm feeling more optimistic."

Summer scholar Zsaleya Sword-Tua agrees that the noho marae was an impactful event. "Being on such sacred land, surrounded by nature, makes you pause and think: all the work we're doing is for this. I really enjoyed the storytelling that was shared about the history, about how Māori looked after the land. I felt quite privileged to be on the marae."

Bioprotection Aotearoa's focus on working collaboratively extends not just to external communities. It also permeates the way Bioprotection Aotearoa works internally, by fostering a caring and sharing environment, rather than a competitive one.

Gary believes that the incorporation of te ao Māori views has helped this collaborative spirit.

"Māori culture has a more collective way of decision making. This has started to permeate through Bioprotection Aotearoa and has shown up as a far less individual and more collective way of doing research."



SAFEGUARDING AN OPEN SPACE FOR COLLABORATION

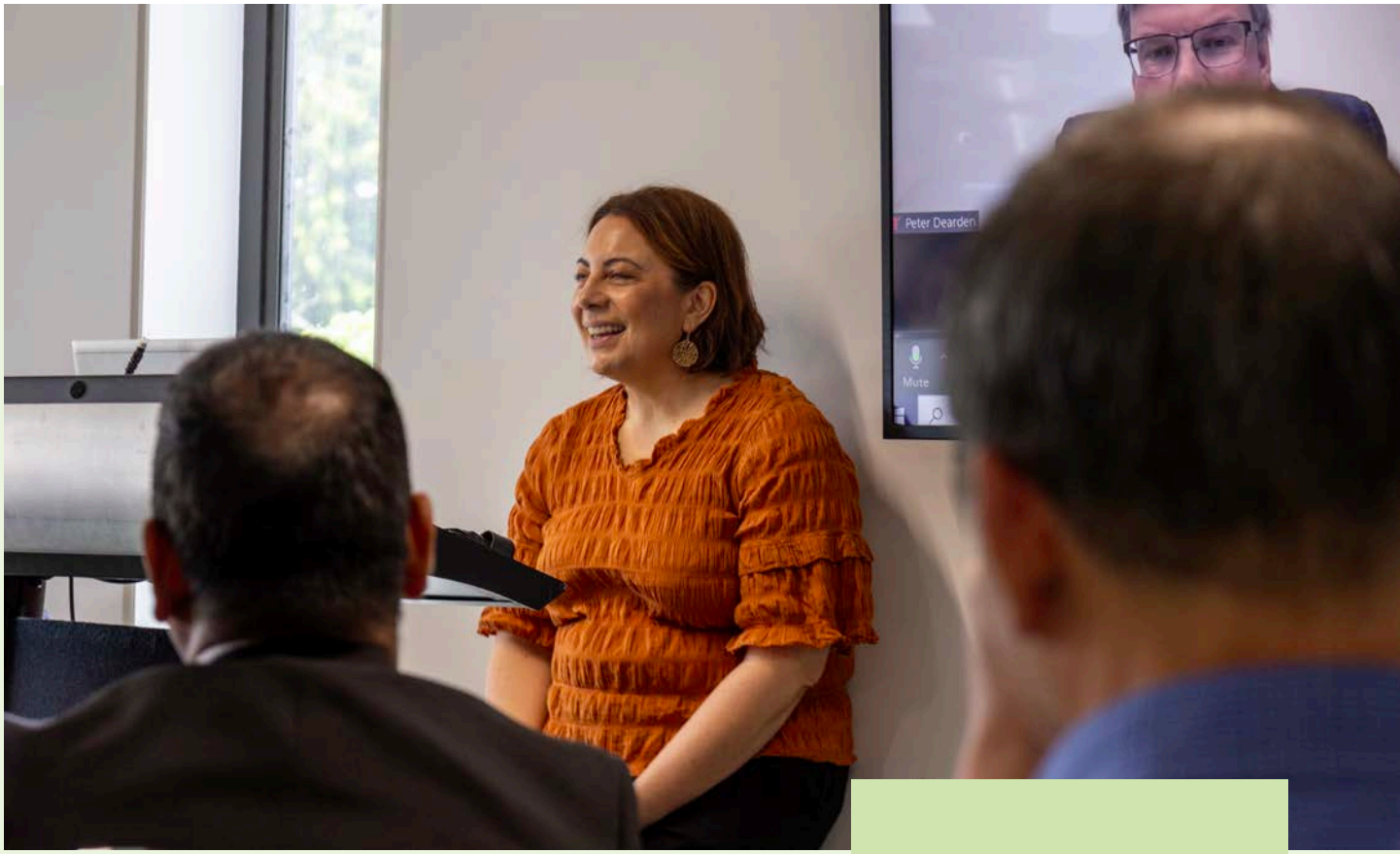
Nicola says, “Bioprotection Aotearoa is such a welcoming environment. They make you feel like you are part of a team. It is an open space, and when people are enthusiastic, this is acted on. For example, at the noho marae, we did sessions on pepeha and waiata. This made us want to learn more, so management then set up Te Reo classes. We feel listened to.”

Jessie says that the increase in collegiality has given her a renewed excitement for the shared kaupapa and vision. “This excites me personally. We have gone from the old science model of writing up projects and solving current problems to thinking about what our future landscapes look like and how we can understand these ecosystems better to improve biodiversity and productivity.”

The early career researchers network at Bioprotection Aotearoa is a unique aspect that promotes a sense of belonging and shared purpose.

Nicola says, “I really enjoyed meeting other early career researchers and having that shared focus. Because there are a lot of us working in Te Kaha, we share resources, and are often supporting each other to troubleshoot in the field. This is encouraged and fostered and is greatly beneficial for everyone.”

Ella agrees. “This is the first time I have felt part of the scientific community, and it has been the perfect place to make connections because there are so many early career researchers at a similar stage in their careers. We all understand where each other are coming from and can relate to each other. It has been the perfect environment for me between undergraduate studies and postgraduate studies. Everyone has been super supportive and genuinely interested.”



THE IMPACT OF DIVERSITY

Bioprotection Aotearoa is working hard to create more diversity across its advisory board, management team, researchers, and students. Having diverse role models is important for younger researchers and makes leadership more authentic.

Nicola says, “Bioprotection Aotearoa is very authentic. This comes from the top - you hear it in the way Amanda speaks, so it permeates everything.”

Gary agrees that Amanda and other leaders have been a key influence.

“They genuinely seem to care about us and genuinely embody what they are talking about. Their messages are consistent and not lip service. What they are doing is really challenging but worthwhile. We want to change the world, but it is changing ourselves that matters – building wider collaborations and the ability to work together.”

Zsaleya says, “What was cool for me is that there are a lot of strong, powerful women in leadership roles, which is really inspiring. Science can be quite male-dominated, so it’s nice to see gender roles changing to be more balanced.”

Jessie says that diversity is important because, “When we look at the world around us and future challenges, we need to change what we do and how we do it - this is the core of our research. To get a wider view of how we use our whenua better, that is better for everybody and helps us address future challenges. We cannot keep doing it the way we are. We must have more future thinking and open-mindedness at the board level.”

Ella says that the importance of diversity was reinforced at the noho marae. “There were people from so many backgrounds and experiences – that is what makes good science. Diversity makes science so much better.”

ADVANCING FUNDAMENTAL KNOWLEDGE

LEARN ABOUT HOW WE ARE IMPLEMENTING OUR RESEARCH STRATEGY, WHICH AIMS TO FORTIFY THE RESILIENCE AND RESISTANCE OF PRODUCTIVE ECOSYSTEMS AGAINST A DIVERSE ARRAY OF BIOTIC AND ABIOTIC CHALLENGES.

RESEARCH STRATEGY

Productive landscapes play a vital role in Aotearoa New Zealand's economy. However, these essential ecosystems face mounting pressures from pathogens, pests, and weeds, exacerbated by the challenges posed by a warming climate.

Bioprotection Aotearoa recognises the necessity for a fundamental change in managing these incursions.

Productive landscapes often encompass significant areas of natural and cultural value. Many of Aotearoa New Zealand's native land is found within productive farms, highlighting the intricate connectivity between native and productive land.

Managing the flow of pathogens, pests, and weeds necessitates a comprehensive strategy that acknowledges the interdependence of both ecosystem types. By adopting a holistic approach, positive outcomes in land used for food production can directly and indirectly benefit native ecosystems.

The research carried out by Bioprotection Aotearoa is gaining momentum, driven by the adoption of holistic approaches that consider the interconnectedness of ecological factors. With a growing *kete* (basket) of new knowledge founded on a multidisciplinary and culturally inclusive approach, Bioprotection Aotearoa is committed to creating a resilient and sustainable future for Aotearoa New Zealand's invaluable productive ecosystems.

POU 1

TITIRANGI

Pou Leaders:

Dr Julie Deslippe, Victoria University of Wellington, and **Prof Jason Tylianakis**, University of Canterbury

WHAT DEFINES A HEALTHY AND PRODUCTIVE ECOSYSTEM?

Researchers are making progress in understanding factors defining healthy native and productive ecosystems by studying interactions between soils, plants, microbes, pests, and stressors.

Horomaka (Banks Peninsula) is one of their primary field sites, where they are working with landowners in various land-use mosaics. Using this landscape-level generated data, they aim to develop targeted strategies to protect ecosystems from pests, weeds, and diseases.

Co-lead Prof Jason Tylianakis explains, "Our research aims to unlock the secrets of ecosystem resilience and resistance to change, across a variety of scales. Understanding how healthy ecosystems reassemble and adapt following disruption allows us to develop effective management practices for their long-term sustainability."

Another vital aspect of this research focuses on assessing the sensitivity of Phytophthora strains for abiotic stresses linked to climate change. By investigating how key plant species respond to drought and osmotic stress, researchers aim to identify vulnerabilities and develop strategies to mitigate their impact.

The project involves studying Aotearoa New Zealand strains of *Phytophthora pluvialis* and *Phytophthora cinnamomi*, broad-spectrum pathogens threatening native flora and economically important species.

Another project has been working on detecting virus movement across agroecological interfaces. By identifying indicator plants that signal the presence of viruses, this research provides a better understanding of potential risks at the interface between indigenous and agricultural landscapes.

In Pou Titirangi, researchers explore the ongoing arms race between pests and their natural enemies. Understanding these dynamics is crucial in dealing with stressors like climate change and assessing the severity of pest damage in response.

Co-lead Dr Julie Deslippe, says it has been a highlight to see the commitment across the team to share ideas and work towards the goals for Pou Titirangi.

"We have expertise in plant pathology, ecological interactions, and landscape analysis. This bridging of scales from the micro to the macro is a core strength of our approach. We are well on our way to identifying more effective strategies for managing ecosystems, including incorporating mauri as a health indicator," says Julie.

Pou 1
Titirangi
Projects 2022

POU 1.1

MULTI-SCALE INTEGRATED MEASURES OF PRODUCTIVE ECOSYSTEM HEALTH

Translating Māori concepts of *mauri* (life force) to assess ecosystem health and incorporate peoples' values. Mauri, derived from *mā* and *uri*, represents pureness passed down from the gods. It recognises the interconnections between all living things and the Earth's forces.

Principal & Associate Investigators

Prof Ian Dickie (Lead)	University of Canterbury
Dr Nick Waipara	Plant & Food Research
Prof Nick Roskruge	Massey University
Dr Kate Orwin	Manaaki Whenua Landcare Research
Dr Claudia Meisrimler	University of Canterbury
Assoc Prof Robin MacDiarmid	Plant & Food Research

Project:

Understanding the drivers of plant health

DR JOHN RAMANA

Postdoctoral Fellow

Manaaki Whenua Landcare Research

John is working to understand the characteristics of a plant microbiome that contributes to its health, even in the presence of pathogens. The project considers interactions at different spatial scales, including the plant's microbiome, neighbouring plant communities, and environmental conditions.

He is conducting his research across Horomaka (Banks Peninsula) using 30 field sites which range in elevation and rainfall. John is taking multiple physiological measurements relating to plant health and analysing the microbiome composition of leaves, roots, and soil.

This research will also investigate the transferability of microbiome traits across native tree species. The long-term goal is to tie in with restoration efforts, and to transplant healthy microbiomes to facilitate native forest regeneration. This research aims to provide valuable insights into enhancing plant health and ecosystem restoration.

Project:

The effects of abiotic stress on *Phytophthora cinnamomi* and its interaction with *Nicotiana benthamiana*

LEANN VINSON

PhD Student

University of Canterbury

Phytophthora cinnamomi is an oomycete that has a broad range of approximately 5,000 hosts, globally. This research aims to understand how climate change induced drought and salinity stress affect *Phytophthora cinnamomi* performance and its interaction with *Nicotiana benthamiana*.

To investigate the potential impacts of climate change on *Phytophthora cinnamomi*, the oomycetes are subjected to osmotic and salinity stress conditions through exposure to varying concentrations of polyethylene glycol (PEG) and sodium chloride (NaCl), respectively.

A range of *Phytophthora cinnamomi* variables, including mycelial growth, zoospore production, reactive oxygen species (ROS) levels, as well as proteomic and transcriptomic data are analysed under these stress conditions.

Additionally, Leann will expose *Phytophthora cinnamomi* to *Nicotiana benthamiana* and examine its physiological characteristics, and transcriptomic and proteomic expression of stress-related genes and proteins.

Project:

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

COLE MCARTHUR

Masters Student

Plant & Food Research

This project focuses on virus ecology, using sentinel plants as a signifier to detect virus movement across agroecological interfaces.

Cole is completing trials at two field sites, a vineyard in Marlborough and on Waiheke Island. The sites were chosen because they are agricultural areas adjacent to displaced native land and established native land.

Nine native and non-native varieties of sentinel plants were chosen and strategically planted at the field sites for a month. Samples are collected and sequenced to identify viruses and their movement.

The research addresses virus transmission between native and introduced plants, contributing to understanding disease dynamics and aiding in protective measures.

Pou 1
Titirangi
Projects 2022

POU 1.2

PROCESSES THAT PROMOTE ECOSYSTEM HEALTH ACROSS SCALES IN THE FACE OF PATHOGEN AND PEST ATTACK

Identifying interconnected ecosystem properties that contribute to overall health, including crop production, microbial communities, landscape characteristics, and environmental factors. It investigates the evolutionary factors that enhance resilience against pests both above and below ground.

Principal & Associate Investigators

Prof Jason Tylianakis (Lead)	University of Canterbury
Assoc Prof Jonathan Tonkin	University of Canterbury

Project:

Theoretical model and meta-analysis of crop–pest interactions, coevolution and metacommunity

DR HAO RAN LAI

Postdoctoral Fellow

University of Canterbury

This project is working to understand the interplay between coevolution and land use in influencing crop yield loss. Through a global survey of major food crops, we have found that some crops exhibit resistance to pests and pathogens, while others suffer significant losses from specific pests and pathogens.

Hao Ran is investigating whether this variation is related to the coevolutionary arms race between crops and pest species or influenced by land-use characteristics such as seed recycling, chemical use, and local biodiversity.

He aims to identify the relative importance of these factors to help prioritise management actions for better food security.

Pou 1
Titirangi
Projects 2022

POU 1.3

A NEW FRAMEWORK TO ASSESS ECOSYSTEM HEALTH FOR AOTEAROA NEW ZEALAND

Developing a framework for assessing risks to ecosystem health in Aotearoa New Zealand, considering unique geographical, ecological, and cultural factors.

Principal & Associate Investigators

Dr Julie Deslippe (Lead) — Victoria University of Wellington
Assoc Prof Jonathan Tonkin — University of Canterbury

Project:

Maximising wetland restoration for biodiversity and community

DR STEPHANIE TOMSCHA

Postdoctoral Fellow

Victoria University of Wellington

Stephanie is researching how wetlands might be restored to create resilience to global changes. She is using GIS to determine optimal locations for creating new wetlands in Wairarapa.

The goal is to maximise the benefits for native biodiversity and local communities by improving water quality, enhancing access to cultural resources, and promoting carbon storage.

This research focuses on identifying areas where wetlands can be restored to protect the critically threatened endemic tree species, maire tawake, or swamp maire (*Syzygium maire*), which exclusively grows in wetlands and holds cultural significance for Māori.

Stephanie's GIS models consider climatic conditions, such as temperature and humidity, along with soil moisture and type, to locate refuges for swamp maire and protect it from myrtle rust.

POU 2

POU TOKOMANAWA

DEFENDING AGAINST PATHOGENS AND PESTS

Pou Leaders:

Dr Monica Gerth, Victoria University of Wellington, and **Assoc Prof Matt Templeton**, Plant & Food Research

Pou Tokomanawa is on the hunt for new tools and approaches that can help protect productive ecosystems or agriculture from expressions of disease under different climatic conditions.

A lot of this work is conducted in the laboratory, to advance knowledge and tools that will feed into Bioprotection Aotearoa's research pipeline and be implemented by the other pou.

"It is molecular tool development. It does not sound very sexy, but you do need it," says Dr Monica Gerth, co-lead for Pou Tokomanawa.

"We are in the middle of spreading out in all directions. You try ten different things, in hopes that one makes it out into the field."

One piece of work that has been released is the first fully assembled Phytophthora genome. Partially funded by Bioprotection Aotearoa, this research project was led by Professor Rosie Bradshaw from Massey University.

Monica says this work is a really big deal. "It is as foundational as you can be and makes other research so much easier around trying to understand the biology of how pathogens are infecting their hosts."

The impact of this research is worldwide, as it can be used as a reference genome for other Phytophthora species that impact both agriculture and native ecosystems around the world. Monica adds, "It's such an important resource for Bioprotection Aotearoa and all our students."

There is a hive of activity across the labs that form the team within Pou Tokomanawa. Researchers, including early career researchers, and aligned students, connect regularly to discuss projects, share their wins and hurdles, and seek support and guidance from each other.

"This network across labs is creating larger connections between projects," Monica says. "The boundaries between projects are more fluid than it looks on paper, which we never predicted or planned."

Though it is early days, Monica believes these connections will have downstream effects that will benefit Bioprotection Aotearoa overall.

Pou 2
Tokomanawa
Projects 2022

POU 2.1

THE MECHANISMS FOR MICROBIOTA-MEDIATED PROTECTION

Exploring how plant ecosystems' microbiome contributes to disease control outcomes. We aim to uncover the genetic and chemical basis of these interactions, focusing on discovering new indigenous taxa and functions for bioprotection in Aotearoa New Zealand.

Principal & Associate Investigators

Dr Monica Gerth (Lead)	Victoria University of Wellington
Dr Carl Mesarich	Massey University
Dr Nicola Day	Victoria University of Wellington
Dr Nick Waipara	Plant & Food Research

Project:

Understanding the role of fungal effector proteins in antagonistic fungus–microbe interactions

KARA PENDAVINGH

PhD Student

Massey University

Kara seeks to understand the role of secreted effector proteins from the apple scab (*Venturia inaequalis*; Vi) and tomato leaf mould (*Fulvia fulva*; Ff) fungi in interactions with other microorganisms.

Using transcriptomic and metagenomic analyses, Kara aims to better understand the influence that Vi effector proteins have on the apple phyllosphere and leaf litter microbiota during transition from biotrophic to saprophytic growth and sexual reproduction.

Kara's research also aims to produce and purify several candidate antimicrobial effector proteins from Vi and Ff and to characterise their roles in mediating antagonistic microbe–microbe interactions.

In addition to providing information on how fungal pathogens manipulate the microbiota of their plant hosts and environment, this research will hopefully lead to the identification of fungal antimicrobial effector proteins that can be trialed for the control of pathogens associated with plants with economic, horticultural/agricultural, and cultural significance to Aotearoa New Zealand.

Project:

The bacteria that colonise kiwifruit vine leaves

POLINA IDLECHIK

PhD Student

Victoria University of Wellington

Bacteria colonise many habitats including soil, plants, water, and the human gut. Although it's common to hear about disease-causing bacteria, most bacterial species are neutral or even beneficial for their host.

Te Kaha is the field site for this project, which will look at what bacteria are present on the leaves of kiwifruit plants and identify the possible beneficial impacts they have on the plant health.

Polina will also explore whether native plants that border the orchard help to create a more beneficial bacterial community for plants.

Project:

Using bioinformatics to help us solve the puzzle

LETICIA CASTRO

Research Fellow

Victoria University of Wellington

Leticia is working to create a microbial genomic bioinformatics support space, which will provide our scientists with the necessary tools and processes for analysing biological data.

By enhancing the computational skills of Bioprotection Aotearoa researchers, this initiative will boost their confidence and enable them to fully explore the intricate nature of the data they generate both in the field and the laboratory.

Leticia, as a research technician, will ensure comprehensive involvement in all aspects of the researchers' projects, facilitating a hands-on approach that will contribute to a clearer understanding of the various components involved.

Pou 2
Tokomanawa
Projects 2022

POU 2.2

GENETIC AND GENOMIC APPROACHES TO PEST AND PATHOGEN CONTROL

Enhancing biocontrol agents by manipulating their microbiome or the pests' microbiome. This manipulation will increase virus virulence or introduce specific pandemic-causing microbes in target pests.

Principal & Associate Investigators

Prof Peter Dearden (Lead)	University of Otago
Dr Mark Hurst	AgResearch
Dr Nick Waipara	Plant & Food Research
Prof Murray Cox	Massey University

Project:

Genetic and genomic approaches to pest and pathogen control

DR SARAH INWOOD

Postdoctoral Fellow

University of Otago

This project is studying and manipulating the microbiome of biocontrol agents and pests in Aotearoa New Zealand to understand their impacts on insect parasitism. By analysing samples from across the country, Sarah will examine the microbiomes of the Argentine stem weevil (ASW) and its biocontrol agent, *Microctonus hyperodae*, comparing contemporary and historical samples.

Sarah aims to understand why biocontrol effectiveness against ASW has declined and to develop methods to enhance biocontrol. Additionally, she will investigate and manipulate the microbiome of the Varroa mite, a parasite of honeybees that transmits viruses and negatively affects honeybee populations.

The goal is to uncover the role of the microbiome in biocontrol decline and to develop tools for microbiome manipulation to improve pest control strategies.

Pou 2
Tokomanawa
Projects 2022

POU 2.3

HARNESSING NATURAL DEFENCE SYSTEMS IN THE BIOPROTECTION BATTLE

Characterising natural microbial defence systems for pest/pathogen research and bioprotection.

Principal & Associate Investigators

Prof Peter Fineran (Lead)	University of Otago
Assoc Prof Paul Gardner	University of Otago
Dr Simon Jackson	University of Otago
Dr Rob Fagerlund	University of Otago

Project:

Fighting crop pathogens with viruses

DR NILS BIRKHOLZ

Postdoctoral Fellow

University of Otago

Nils is focusing on the intricate interactions between bacteria and phages. By studying bacterial strains from the Pectobacterium genus, which are known to cause significant agricultural losses, Nils aims to identify and characterise new defence systems employed by bacteria against phage infections.

This research has potential implications for developing treatments for human and plant diseases. Additionally, the utilisation of phages as a potential solution for pest control in agriculture could be very useful, particularly in countries like Aotearoa New Zealand that are heavily reliant on agriculture.

Overall, this research contributes to advancing our fundamental understanding of bacterial immunity and exploring innovative approaches for disease management and agricultural sustainability.

POU 2.4

EXPLORING THE MOLECULAR BASIS OF HOST SPECIFICITY

Developing tools and approaches for ecosystem-wide disease protection by studying pathogen–host interactions.

Principal & Associate Investigators

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

Project:

Unveiling the molecular secrets of kauri dieback: shedding light on *Phytophthora agathidicida* genome and effector genes

DR MELISSA GUO

Postdoctoral Fellow

Massey University

Melissa's research has made a substantial contribution to understanding the kauri dieback pathogen, *Phytophthora agathidicida*, at the molecular level. She has performed all the laboratory work that led to a chromosome-level assembly of the *Phytophthora agathidicida* genome sequence – a world first for any Phytophthora pathogen.

To determine expression of *Phytophthora agathidicida* genes during plant infection, Melissa developed a hydroponic system for sampling from roots and leaves of the model host plant *Nicotiana benthamiana*. She discovered *Phytophthora agathidicida* effector genes that are duplicated and silenced or mutated, suggesting mechanisms for adaptation. One effector appears to be a key suppressor of plant defence. Melissa helped forge a collaboration with an international Phytophthora research group to study this in more detail.

Melissa has published a journal article on the genome of *Phytophthora agathidicida* based on Bioprotection Aotearoa work and three as co-author on prior work or aligned collaborative projects.

Project:

Investigating the relationship between Phytophthora species and kauri dieback

TAYLAH DAGG

Masters Student

Massey University

Taylah is investigating the relationship between the pathogen that causes kauri-dieback, *Phytophthora agathidicida*, and two other *Phytophthora* species, *Phytophthora multivora* and *Phytophthora cinnamomi*.

She is working to understand if these pathogens interact with each other and contribute to the devastating disease known as kauri dieback. Her research focuses on the proteins secreted by the pathogens and how these influence their interactions.

Initial experiments on agar plates showed unexpected results, with colonies of the same species actively avoiding each other. Taylah is now analysing the secreted proteins using liquid chromatography-mass spectrometry.

Additionally, *Nicotiana benthamiana*, plants will be used to investigate the impact of the pathogens on plant growth and disease formation.

Project:

Insight into the effectomes of *Phytophthora cinnamomi* isolates by comparative genomics

ALEXANDRA COX

Masters Student

University of Canterbury

This project is investigating the effectome of *Phytophthora cinnamomi*, a pathogenic oomycete that causes devastating dieback and root rot diseases in a wide range of host plants.

Through comparative genomics and genome annotation using long sequence reads and reference genomes, Alexandra seeks to identify and annotate the effector proteins encoded in the *Phytophthora cinnamomi* genome.

These effector proteins play a crucial role in establishing a niche within the host's tissues, and they contribute to the pathogen's pathogenicity.

Given the constant co-evolutionary dynamics between *Phytophthora cinnamomi* and its plant hosts, understanding the effectome will provide valuable insights into the pathogen's adaptation and the development of counter measures, particularly in vulnerable Aotearoa New Zealand plant species.

POU 3

NUKU-A-RANGI

DESIGNING RESISTANT AND RESILIENT PRODUCTIVE ECOSYSTEMS

Pou Leaders:

Prof Leo Condron, Lincoln University, and **Dr Steve Wakelin**, Scion

Historically Aotearoa New Zealand has approached a pest, disease or weed incursion on a case-by-case basis. If there is a detrimental risk to the social, economic, cultural, and environmental health and wellbeing of Aotearoa New Zealand, there is a surge in investment towards scientific research that will help generate long-term solutions to control and manage these issues.

Co-lead Dr Steve Wakelin says Aotearoa New Zealand is playing whack-a-mole, a reactive approach that is no longer fit for purpose. “It has got to a stage where these incursions are popping up faster than we can effectively react to them. If we keep doing this, we are setting ourselves and future generations up for failure.”

Pou Nuku-a-Rangi aims to disrupt this reactive approach and redirect the focus of research towards finding ways to build resilience, a pre-emptive approach.

Researchers from this pou have been gathering data that build a picture around current environmental conditions and management practices across productive and native landscapes.

“Resilience is not just about the plants, the soils, or the microbes. It comes right from the decisions around land use, communities, and governance,” says Steve.

Resilience as Steve describes, is made up of many layers, including:

- resilience of desired plants
- microbes and pathogens
- soils and carbon
- communities, people, governance, and decisions

“When these principles behind resilience in ecosystems are put together, a virtuous system of resistance emerges. It will support people at a governance level to make better decisions that support an intergenerational model of resilience,” says Steve.

Researchers from this pou have been gathering data that build a picture around current environmental conditions and management practices across productive and native landscapes.

Emerging data and knowledge-gathering processes are working to support the next phase of research, which will identify management practices that can alter the ecosystem trajectory toward an enduring, disease and weed -suppressive state.

Pou 3
Nuku-a-Rangi
Projects 2022

POU 3.1

CREATING HEALTHY, DISEASE-RESISTANT, AND CLIMATE-RESILIENT SOILS

Working to understand the interaction among crop species, genetics, management factors, and climatic conditions with ecosystem genomes in expressing disease-suppressive functionality.

Principal & Associate Investigators

Dr Steve Wakelin (Lead)	Scion
Prof Leo Condron	Lincoln University
Prof Eirian Jones	Lincoln University
Prof Amanda Black	Lincoln University
Prof Nick Roskruge	Massey University

Project:

Quantifying the resilience of soil carbon across an agricultural land use mosaic

DR ALEXA BYERS

Postdoctoral Fellow

Lincoln University

Alexa is looking at the impacts of land-use change on soil microbial function and soil carbon resilience. Soil carbon supports a range of essential ecosystem functions and is tightly linked with the ability of ecosystems to withstand abiotic and biotic stress.

Intensive land-use change can impact the functioning of soil ecosystems, which in turn influences the resilience of soils to withstand the impacts of climate change. As soil microorganisms drive both the decomposition of and formation of soil carbon, studying their response to land-use change is essential to provide ecologically meaningful assessments of soil carbon.

Alexa is comparing five different land uses across Horomaka (Banks Peninsula) including pasture, pine, native forest, and regenerating kānuka (*Kunzea ericoides*) scrub.

Project:

Role of mycorrhizae on resilient agricultural systems

FIONNUALA (FINN) BULMAN

PhD Student

Lincoln University

Finn is working towards advancing our understanding of how land use shapes soil and root communities of arbuscular mycorrhizal fungi and what impact this has on plant resilience.

Arbuscular mycorrhizal fungi are found inside plant roots and have a key role in ecosystem functioning, impacting both soil health and plant fitness.

This project will characterise the spatiotemporal dynamics (changes across space and over time) of arbuscular mycorrhizal fungi in agricultural and native ecosystems in Te Kaha to assess how the previous mycorrhization status of land use alters future interactions of plants with root symbionts.

Through this work, Finn hopes to highlight ways that land management is affecting the structure of soil fungal communities and how this may impact plant resilience in a changing climate.

Project:

Exploring multi-functional soil resistance and resilience in agricultural mosaic landscapes

ALANA THURSTON

PhD Student

Lincoln University

Soils are vulnerable to disturbances, which can impact their health and function. Soil microbes are responsible for many key soil functions, and this project is helping us understand how soil microbial communities are impacted by disturbances, and how they might be able to recover over time.

Alana is collecting soil from maize and kiwifruit sites across Te Kaha to determine the chemical and physical properties of the soil, the size and activity of the microbial population, and the diversity of the microbial population across different seasons.

After a baseline has been established, these soils will be used in experiments to monitor how they recover over time, after being disturbed by simulated climate change impacts such as drought and heatwaves.

Pou 3
Nuku-a-Rangi
Projects 2022

POU 3.2

DESIGNING FUTURE FORESTRY: NATIVE NURSERIES OR INVADER INCUBATORS?

Determining the impact of landscape attributes, plantation characteristics, and species traits on native and non-native plant species richness and abundance in farm and community forest plantings.

Principal & Associate Investigators

Dist Prof Philip Hulme (lead)	Lincoln University
Prof Margaret Stanley	University of Auckland
Assoc Prof Jonathan Tonkin	University of Canterbury
Dr Julie Deslippe	Victoria University of Wellington

Project:

Factors influencing non-native plant invasions in native shrublands of Aotearoa New Zealand

DR LAURELINE ROSSIGNAUD

Postdoctoral Fellow

Lincoln University

Laureline is investigating how vegetation structure, landscape features, and climate affect non-native plant invasions in native shrublands across Aotearoa New Zealand.

Initial research utilised data from 247 mānuka/kānuka plots surveyed from 2009 to 2014, looking at non-native species richness and ground cover in relation to vegetation structure, landscape features, and climate.

The findings revealed 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 of non-native species were found in dryer areas, while native richness was influenced by temperature.

This study emphasises that simply managing our shrublands is insufficient to prevent plant invasions, but also requires a consideration of the landscape in which these ecosystems are found.

Further work is now examining the characteristics of the weeds that are most invasive across these ecosystems.

Project:

The impacts of co-occurring weeds on restoration plantings

DIANA BORSE

PhD Student

University of Auckland

This project focuses on the impacts of co-occurring woody weeds on native plants used in restoration plantings. The target weeds are woolly nightshade (*Solanum mauritianum*), brush wattle (*Paraserianthes lopthantha*), and tree privet (*Ligustrum lucidum*).

Diana is conducting field research by surveying what plants are growing with each of the three target weeds compared to the plants that grow under native species.

Additionally, Diana has designed a shade house experiment testing the impacts of the weeds on the growth of mānuka (*Leptospermum scoparium*) depending on the species they are growing alongside.

Pou 3
Nuku-a-Rangi
Projects 2022

POU 3.3

CREATING EFFECTIVE GOVERNANCE MODELS THAT LEAD TO RESILIENT ECOSYSTEMS

Examining social influences on healthy ecosystems and investigating their implications for pro-environmental behaviours and wellbeing in Aotearoa New Zealand.

Principal & Associate Investigators

Assoc Prof Gary Steel (Lead)	Lincoln University
Prof Anita Wreford	Lincoln University
Prof Ann Brower	University of Canterbury

Project:

Factors influencing non-native biodiversity on Aotearoa New Zealand dairy farms

DR ELIZABETH ELLIOT NOE

Postdoctoral Fellow

Lincoln University

Elizabeth is exploring the relationship Aotearoa New Zealand dairy farmers have with their land, to find ways of encouraging and supporting pro-biodiversity farm management practices. Elizabeth has interviewed 20 dairy farmers across Waikato and Canterbury.

She argues that incorporating care for native biodiversity into what it means to be a good farmer is vital for the transformation of agricultural landscapes.

The next stage of this research will explore the multiple challenges facing the dairy industry in Aotearoa New Zealand.

Project:

(Dis-)Incentives for adaptation intentions in farming

DR FRANCA BUELOW

Postdoctoral Fellow

University of Canterbury

Adaptation by farmers and other land managers is critical to ensure resilience in the face of ongoing climate variability and environmental change. However, there remains an adaptation deficit among agricultural producers.

This project is advancing our understanding of how environmental changes are addressed in Aotearoa New Zealand's farming, and why. It focuses on the drivers of individual-level decision-making in relation to environmental change, such as climate change stressors and biodiversity risks.

The information from this study will help highlight implications for adaptation decision-making and behaviours under conditions of uncertainty.

Project:

Supporting marae, hapū, and iwi in biosecurity management

JADE GIBSON

(*Ngāti Porou, Te Aitanga a Mate*)

Masters Student

University of Canterbury

This project was initially proposed to examine the role of marae and hapū in addressing biosecurity threats, specifically myrtle rust and pest species. However, it quickly shifted focus to investigate Jade's own role in supporting marae, hapū, and iwi in biosecurity management.

Over a period of six months, Jade resided on her marae, engaging with the *hau kainga* (hosts), strengthening her connection to the whenua, and fostering relationships with whānau and the wider community. The detrimental impact of myrtle rust and invasive pests like possums and stoats on the *ngāhere* (forest) at Whareponga necessitated collaborative efforts with whānau to explore effective management strategies.

This project will provide valuable perspectives on Māori-led research with a focus on biosecurity within marae and hapū settings, by demonstrating how true kaupapa Māori research can be conducted.

RECLOAKING PAPATŪĀNUKU

RECLOAKING PAPATŪĀNUKU

Pou Leaders:

Prof Nick Roskruge (*Te Atiawa, Ngāti Tama*), Massey University, and **Dr Nick Waipara** (*Rongawhakaata and Ngāti Ruapani ki Turanga*), Plant & Food Research

The point of difference with this pou is that it contributes to – and extends across – all pou, establishing a dynamic network among them. This interconnectedness strengthens the relationship, partnership, and continuing collaboration among pou, projects and researchers as part of the overall research plan for Bioprotection Aotearoa.

Pou co-lead Dr Nick Waipara says, "This is a holistic programme, that is te ao Māori driven and brings a different dimension in everything we do. It brings us together."

Embedding indigenous worldviews into research can take different courses, from positioning indigenous researchers to lead projects, to collaborating with Māori agribusiness, and partnering with Māori champions to weave mātauranga into the research. All approaches ensure the indigenous voice is being championed with equitable outcomes.

"You can't force it pragmatically to fit standard research agendas. It has to come naturally," says Nick. "The intent is to have that indigenous lens from the start, or indigenous people in it."

There is no magic formula as to how this occurs in practice. It starts with a conversation, exploring how to create better outcomes for communities. "This is the vision and mission of Bioprotection Aotearoa," says Nick. "It's planting the seeds to begin this conscious thought process earlier in project planning, to think deeper, and build authentic connections with communities our researchers partner with."

In Te Kaha, Nick has played a pivotal role in establishing the partnership between Māori agribusiness Te Kaha Gold and Bioprotection Aotearoa. However, as research projects began, more work was required to build community connections and gather the right permissions for land access. Early career researchers were positioned to make introductions with landowners, land managers and other key stakeholders within the community.

"Our early career researchers thought they were just being pragmatic about getting the right access and the right permissions. But what they have done is a critical piece of research as well," says Nick. "Social scientists would be over the moon about what was done and how it was mapped. They call this stakeholder mapping."

Nick believes that without Recloaking Papatūānuku, cross-pou multidisciplinary conversations to embed indigenous world views would not be happening, and this is an intended outcome of this pou.

In addition, Recloaking Papatūānuku has its own indigenous-led projects underway, including a PhD project led by a student from Papua New Guinea, and a Māori postdoctoral research project that will help advance knowledge around the mauri of soil and indigenous plant health.


MAIRE TAWAKI
Syzygium maire
SWAMP MAIRE
12m. A smooth barked tree with a spreading canopy, favouring very wet ground. Swamp draining has killed many fine specimen. The glossy leaves often bear dark marks and blisters. The brilliant red berries contain one seed each.

RECLOAKING PAPATŪĀNUKU

AN INDIGENOUS SOCIO-ECOLOGICAL RESEARCH THEME

Recloaking Papatūānuku is an indigenous socio-ecological research theme that promotes native biodiversity and works to maintain Aotearoa New Zealand's whenua. Defining the links between humanity and the natural world, it aims to resolve the value of mauri across ecosystems, and show how ecosystem resilience underpins community wellbeing.

Principal & Associate Investigators

Prof Nick Roskruge (Co-lead)	Massey University
Dr Nick Waipara (Co-lead)	Plant & Food Research
Aroha Mead	Independent

Project:

Molecular characterisation of traditional kūmara (*Ipomoea batatas*) and taewa (*Solanum tuboresum*) to protect food security

SIMON APANG SEMESE

PhD Student

Massey University

The challenges of population growth, urbanisation, and climate change highlight the importance of food security. Mainstream food production prioritises high-yield crop varieties for mass production, often neglecting the significance of traditional food in indigenous societies and their role in food security.

Māori cultivated root crops long before Europeans arrived in Aotearoa New Zealand, but many traditional varieties, especially kūmara, have been lost despite preservation efforts, exacerbating crop diversity decline. Genetic erosion of traditional crops requires urgent action.

This project aims to characterise kūmara and taewa accessions, considering cultural factors, for future conservation. The identified accessions will be preserved at the International Centre for Potato in Peru. The developed methodology holds potential for other crops, contributing to preserving traditional crop diversity and global food security.

Project:

Integrating mātauranga and science to enhance maire tawake resilience

DR HANAREIA EHAU-TAUMAUNU

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

Postdoctoral Fellow

Plant & Food Research

Hanareia is supporting the use of mātauranga with science to enhance the resilience and survival of maire tawake in Aotearoa New Zealand.

Maire tawake or waiwaka (*Syzygium maire*) is a taonga plant species that is 'threatened-nationally critical' due to land clearing, swamp draining, and more recently the incursion of myrtle rust.

Hanareia will use metagenomic sequencing to provide insight into the maire tawake leaf microbial community, the contribution of the surrounding trees to the microbial community, and how this may mitigate the impacts of myrtle rust.

The whakapapa of maire tawake will be described through mātauranga to make connections between the plant species and the leaf microbes to find innovative disease protective solutions. Research will also be conducted in controlled environments to look at the protective effects of microbial communities against myrtle rust.

ORGANISATIONAL STRUCTURE

TAUMATA | STRATEGIC ADVISORY BOARD

Co-Chair

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

Co-Chair

John Rodwell

Board members

Prof Jim Morton | Lincoln University

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

Prof Richard Blaikie | University of Otago

Adjunct Assoc Prof James Ataria (*Rongomaiwahine, Ngāti Kahungunu, Raukawa*) | Tuaropaki Trust/ Cawthron

Jessie Chan | Rural Co

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

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

KĀHUI MĀORI

Chair

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

Kāhui members

Prof Nick Roskruge (*Te Atiawa, Ngāti Tama*) | Massey University

Dr Nick Waipara (*Rongawhakaata, Ngāti Ruapani ki Turanga*) | Plant and Food Research

Prof Amanda Black (*Tuhoe, Whakatōhea, Te Whānau ā Apanui*) | Lincoln University

Adjunct Assoc Prof James Ataria (*Rongomaiwahine, Ngāti Kahungunu, Raukawa*) | Tuaropaki Trust/ Cawthron

Whaea Sally McKean (*Ngāti Ranginui*) | Independent

Prof Shaun Ogilvie (*Te Arawa* (*Ngāti Whakahemo*), *Ngāti Awa* (*Ngāti Pukeko*)) | University of Canterbury

KAIWHIRIWHIRI | DIRECTORSHIP

Director

Prof Amanda Black (*Tuhoe, Whakatōhea, Te Whānau ā Apanui*) | Lincoln University

Deputy Directors

Prof Nick Roskruge (*Te Atiawa, Ngāti Tama*) | Massey University

Distinguished Prof Philip Hulme | Lincoln University

Prof Peter Dearden | University of Otago

OPERATIONS

Operations Managers

Dr Andrew Holyoake | Lincoln University

Katrina Hall | Lincoln University

Financial Manager

Claire Tee | Lincoln University

Contracts Manager

Dr Michelle Boyle | Lincoln University

Exec. Assistant to Director

Elena Johnson | Lincoln University

Communications Manager

Zohar Marshall | Lincoln University

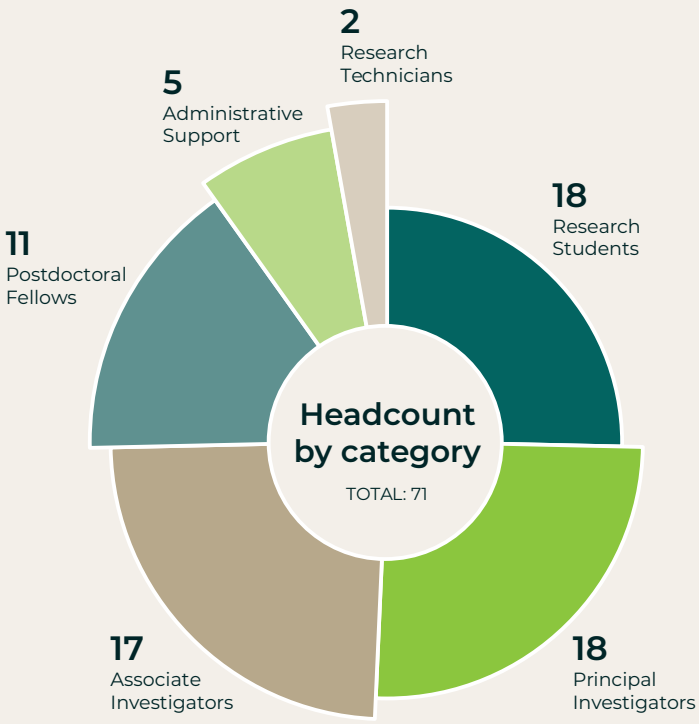
Research and Outreach Co-ordinator

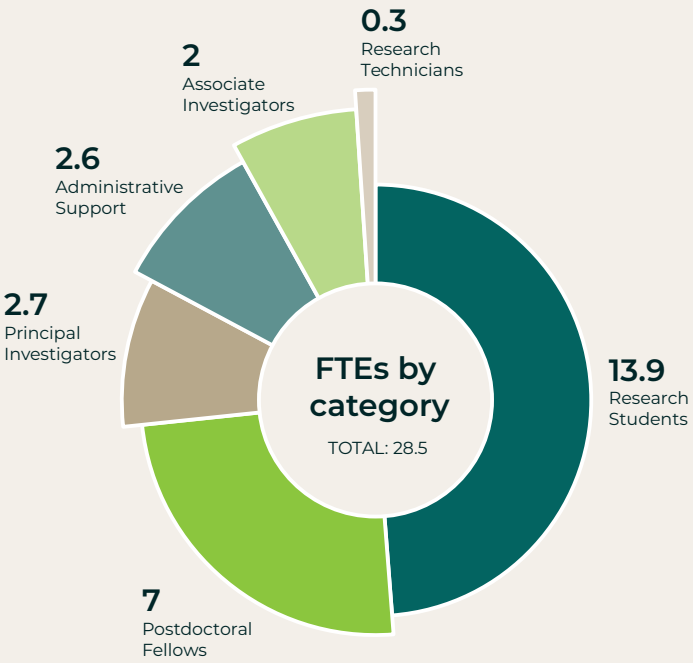
Meikura Arahanga (*Ngāpuhi, Hauraki, Tainui, Tuhoe, Ngāti Rongomai, Ngāti Kahungunu, Ngāti Tuwharetoa, Te Ati Haunui-a-Pāpārangi, Ngāi Tahu, Waitaha, Ngāti Māmoe*) | Lincoln University

OUR CAPABILITY DEVELOPMENT

UNDERGRADUATE SUMMER SCHOLAR RECIPIENTS

Ciel Baumann | University of Canterbury
Oscar Bellett | University of Canterbury
Haig Bishop | University of Canterbury
Tara Curtis | University of Canterbury
Liadan Dickie | University of Canterbury
Matt Oxenham | Lincoln University
Bella Perham | University of Auckland
Pearl Ruston | Victoria University of Wellington
Zsaleya Sword-Tua | University of Otago
Ella Spears | University of Auckland





12 Doctoral Degree

6 Masters Degree

7 Conference presentations

139 Journal articles

Scan the QR code for a full list of Bioprotection Aotearoa outputs for 2022

FINANCIALS

CATEGORY	TOTAL $ '000
TEC CoRE Funding	4,300
Surplus/(Deficit) carried forward	992
Total CoRE Funding	**5,292**
Salaries & salary-related costs	1,726
Total Salaries & Salary-related costs	**1,726**
Overheads	1,569
Project Costs	384
Travel	60
Postgraduate students	462
Equipment depreciation/rental	0
Subcontractor(s) specified	132
Total Other Costs	**2,606**
Total Expenditure	**4,332**
Net Surplus/(Deficit)	**959**

ACKNOWLEDGEMENTS – HEI MIHI KI NGĀ KAIWHAKARITE

"*Mā whero mā pango ka oti ai te mahi.*"
Unity: through red (chiefs) and black (the tribe)
the work will be done.

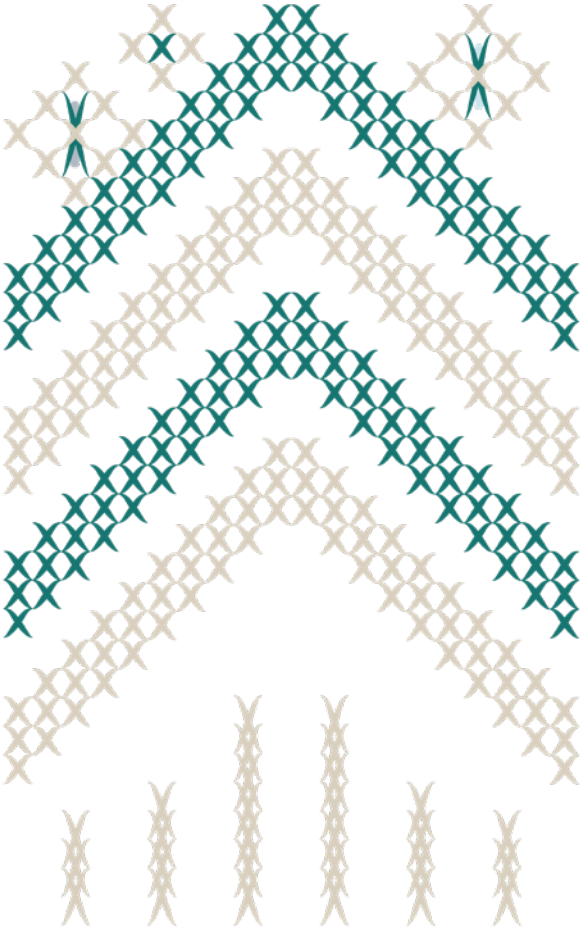
This annual report was prepared by the Bioprotection Aotearoa whānau.

Produced by Zohar Marshall, with additional written support by Dr Laura Sessions and Katherine Cottier and graphic design by Donna Gibson.

Additional assistance was provided by Prof Amanda Black, Meikura Arahanga, Elena Johnson, Angela Milner, and Matt Pearce.

Printing by Spectrum Print.

Photo credit (page 67): Myrtle Rust image supplied by The New Zealand Institute for Plant & Food Research Ltd.



If you have any enquiries or would like a copy of this report, please contact:

Communications Manager
Email: bioprotection@lincoln.ac.nz

Bioprotection Aotearoa
PO Box 85084
Lincoln University
Lincoln 7647
New Zealand

Email: bioprotection@lincoln.ac.nz

bioprotection.org.nz

Bioprotection Aotearoa
PO Box 85084
Lincoln University
Lincoln 7647
New Zealand

bioprotection.org.nz

ISSN 2815-8148 (Print)
ISSN 2815-8156 (Online)