Bioprotection Aotearoa

Introducing Bioprotection Aotearoa

ANNUAL REPORT 2021

KARAKIA TIMATATANGA

Whakatauhā, Whakatauhā
Whakatauhā te Rangi e tu nei
Whakatauhā te Papa e takoto nei
Titia kia oho, titia kia wātea
Titia, kia whakawātea Te Taiao
Titia ki te Poho Tane Nui A Rangi
Whano, whano haramai te toki
Houmi e, hui e, Taiki e

Welcome the breath of life
The breath of life descends from the heavens
The breath of life rises from mother earth
Probe to awaken,
Probe to neutralise the environment
Probe into the realm of the great Tane
Bring hither the adze
Binding us together, lashing us together, it is done!

HOW TO FIND US

https://bioprotection.org.nz/

https://twitter.com/BioprotectionNZ

https://www.facebook.com/BioProtectionNZ

https://www.instagram.com/bioprotection_nz/

https://www.linkedin.com/company/bioprotectionaotearoa

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BIOPROTECTION AOTEAROA KAUPAPA

OUR PARTNERS

OUR KAUPAPA

MOEMOEĀ (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.

OUR MISSION

Bioprotection Aotearoa is a National Centre of Research Excellence (CoRE). Hosted by Lincoln University, the centre is a collaborative partnership between seven universities and four Crown Research Institutes: the University of Auckland, Waikato University, Massey University, Victoria University of Wellington, University of Canterbury, University of Otago, AgResearch, Plant & Food Research, Scion, and Manaaki Whenua – Landcare Research.

We exist to train future bioprotection leaders and deliver pioneering, multi-disciplinary research that addresses the environmental challenges facing Aotearoa New Zealand and the Pacific.

We draw on our collective academic strengths to develop new and innovative solutions that protect our productive and natural landscapes from pathogens, pests and weeds in a warming climate.

Our *kaupapa* (principles) is guided by a unique framework that incorporates both *mātauranga Māori* (Māori knowledge) and science. This framework, *Te Taiao-a-rangi*, supports a holistic, systems-level approach to achieving intergenerational environmental sustainability.

FROM THE DIRECTOR

Tēnā koe,

The first year of Bioprotection Aotearoa is dedicated to our people. *He whānau*, *he hāpori* - our *whare* is our people, we are a community with unique shared experiences and knowledge that bind us together. We journey together putting a face to the research and the success of our vision is wholly dependent upon the passion and dedication of our people.

2021 marked the beginning for Bioprotection Aotearoa, a new National Centre of Research Excellence. Formerly known as the Bio-Protection Research Centre, we have refocused our research to address the environmental challenges Aotearoa New Zealand is facing. Our *mahi* and our people will protect our productive lands from pests, pathogens, and weeds in a changing climate for years to come.

We also rose to the challenge to give effect to Te Tiriti o Waitangi and unity through Te Ao Māori and science. Our *kaupapa* is represented by our whare *Te Taiao-a-rangi*, a symbol that guides our holistic, systems-level approach to achieving intergenerational environmental sustainability through research and training.

Across the floor of our whare is a platform that extends out into the Pacific – *Te Moana-nui-a-kiwa*, connecting Bioprotection Aotearoa to the island nations of the Pacific. The effects of climate change have greater impact on our pacific neighbours. As such they too are part of this movement.

Our success and legacy will be determined by the strength of our community, which is why building and maintaining relationships will be the focus of the next 12 months. Embarking on a new journey is always challenging, and even more so during a pandemic. Our progress to date is a testament to the passion and professionalism of our researchers.

I am excited to lead Bioprotection Aotearoa into a new era, one that weaves together multiple sciences, mātauranga Māori, Pasifika knowledge and diverse perspectives. Our legacy will be one of enduring partnerships that create impact, and I am proud to be a part of this movement.

Whakakotahi te hāpori, hei organga ui mō te katoa

Our community strives as one for the greater wellbeing and betterment of all.

Ngā manaakitanga,

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

Prof. Amanda Black
DIRECTOR

FROM OUR CO-CHAIRS OF THE BOARD

Applying science to our environment can at times feel a bit clinical. But the reality is our environment is a living thing. It's breathing, it's alive.

Bioprotection Aotearoa marks a new era of forging a partnership with Tangata Whenua and uniting mātauranga Māori with Pasifika indigenous knowledge and Western science.

Our three *pou* were developed by some of our nation's leading researchers, and members of our Kāhui, who pulled the strands together into Te Taiao-a-rangi. The pou hold up the roof of our whare and create the environment in which we operate. This framework also brings our value systems together, helping us walk in solidarity.

As we continue to integrate into the new Bioprotection Aotearoa whare, we have the luxury of writing our own *kawa*, or what the people within our whare determine holds value and importance. Kawa creates structure and consistency and *tikanga* determines how the people within our whare carry this out. Tikanga guides our actions, operations, and activities, which will in turn determine our strategic outputs.

Our kawa and tikanga are magnified through our governance and management structures. From the top, our board, the Kāhui, and the Directorship ensure these strands permeate throughout our organisation to ensure consistency in all we do.

Papatūānuku will benefit when our knowledge systems are intertwined, seamlessly, and are absolutely supportive of each other.

He aha taku koha kia taku mokopuna? What is my gift to my grandchild?

He taiao para kore! A healthy sustainable environment.

Matua Henare Edwards

(*Te Rawara, Te Aupouri, Ngā Puhi*)

Co-chair of the board and chair of the Kāhui

Aotearoa New Zealand is one of the few developed economies in the world with such high dependence on agriculture. Yet the world of farming has changed dramatically in the last 5 years.

For farmers like myself, we are mindful of the need for science and technology to guide our farming practices with the tools and capabilities that are necessary for farmers to operate in a truly sustainable way.

Since launching in July 2021, Bioprotection Aotearoa has built a powerful team of staff and early career researchers from across eleven partner organisations. Our organisation is well supported by our host, Lincoln University. Our advisory board has the depth and expertise to provide strong strategic oversight and guidance. Our growing research community members are united in their enthusiasm and sense of purpose, as they play a pivotal role towards developing resilience in our landscapes where pathogens, pests and weeds will no longer be a problem.

The way in which Bioprotection Aotearoa brings together mātauranga Māori and conventional science to address these issues is a powerful and important thing to be doing. It creates togetherness within a wider group of society to get behind a problem of national, cultural, and economic significance.

This shift empowers us all to realise how much we have in common, how much we can learn from each other, and how much we need each other. With this strategy, our team and our research, Bioprotection Aotearoa plays a fundamental role in building a thriving and profitable agricultural community.

John Rodwell
Co-chair of the board

Matua Henare Edwards
CO-CHAIR OF THE BOARD
& CHAIR OF THE KAHUI

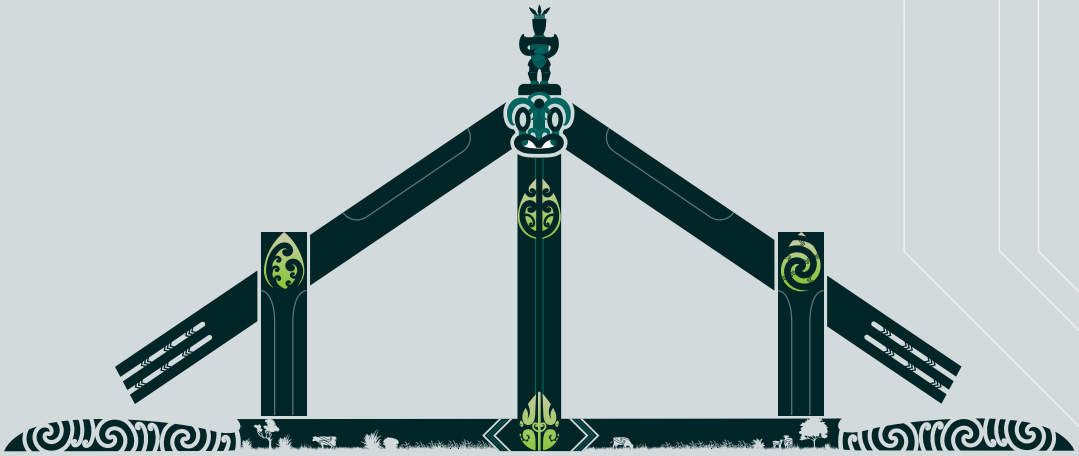
John Rodwell
CO-CHAIR OF THE BOARD

PART 01

OUR STRATEGY

PART 01

OUR STRATEGY



TE TAIAO-A-RANGI

Te Taiao-a-rangi is a framework that honours our whakapapa, unites our CoRE as a community, and gives direction to our operations and research. The roof of our whare is Ranginui, the sky father. The foundation of our whare is Papatūānuku, mother earth.

Our whare is upheld by three pou, or pillars that represent our key research themes:

- **Pou 1: Titirangi | piercer of the heavens**
  Guides our research to **define** a healthy, productive ecosystem.
- **Pou 2: Poutokomanawa | the heartbeat of the whare**
  Guides our research to **defend** against pathogens, pests, weeds and climate change.
- **Pou 3: Nuku-a-rangi | shifting throughout the heavens**
  Guides our research to **design** ecosystems that are more resilient and resistant.

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.

The roof of our whare is held up by our three pou, protecting us from any threats that may arise.

Within our whare, our people are guided by our *kawa* (protocols), unique *tikanga* (best practice) and values as a CoRE. Our whare promotes healthy people and healthy whenua, contributing to improved environmental, economic and social outcomes for future generations.

BUILDING OUR IDENTITY

Bioprotection Aotearoa is a collaborative network of people spread across Aotearoa New Zealand at seven universities and four Crown Research Institutes (CRIs). Space is often understood from a Western perspective as something that has a void, creating distance, and prevents connection. However, in Te Ao Māori, space or *wā* is perceived as something relational. It is the space between which connects people and places and this is nurtured. In our whare, wā weaves our connection, allowing our community to relate to each other, binding us together.

The level of influence that Bioprotection Aotearoa has on our society and economy will be determined by the strength of our community. This strength will be determined by our shared understanding of how our research will achieve Bioprotection Aotearoa's *moemoeā* (vision). With this in mind, we held our inaugural (virtual) hui with a goal of building connection and a shared identity.

We also explored how we will operate in a purpose-driven environment where all members feel heard, involved and empowered. We had opportunities to hear diverse perspectives during an in-depth discussion about the value of bioprotection research and what it will look like for Bioprotection Aotearoa to become a successful CoRE.

By developing a collective understanding of Bioprotection Aotearoa's identity, participants begin to conceptualise how their work will contribute toward Bioprotection Aotearoa's moemoeā.

WHO IS BIOPROTECTION AOTEAROA?

Bioprotection should not be perceived as a discipline of science, but rather a movement focused on protecting the *mauri* (life force) of Papatūānuku and her *whenua* (land). When her well-being is compromised, we suffer socially, culturally, environmentally and economically.

Bioprotection aims to understand the life forces and their relationships that exist within and among our natural and productive ecosystems. It weaves together a breadth of scientific disciplines with Māori and Pasifika indigenous knowledge to identify the mechanisms that enable ecosystems to survive and thrive against the threat of pathogens, pests and weeds in a warming climate.

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

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.

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.

The impact of bioprotection secures the *hauora* (well-being) of Papatūānuku and her whenua to adapt and thrive for the benefit of future generations.

As a National Centre of Research Excellence, Bioprotection Aotearoa advances bioprotection knowledge and understanding while training the next generation of bioprotection leaders and practitioners.

OUR UNIQUE QUALITIES

- **The diverse breadth of science disciplines**

  Bioprotection Aotearoa is a network across diverse science disciplines, collectively working to address a complex global research challenge unique to Aotearoa New Zealand. We are thought leaders, providing innovative ideas and solutions for environmental resilience. We encompass:

  - Ecology
  - Microbiology and molecular biology
  - Biochemistry
  - Mātauranga Māori
  - Economics
  - Environmental governance
  - Social sciences
  - Pasifika indigenous knowledge

- **Te Tiriti o Waitangi led practice**

  Bioprotection Aotearoa embraces equity and diversity for enhanced well-being. Guided by Te Ao Māori, Te Tiriti o Waitangi leads our practice. We value contextualised indigenous knowledge from Māori and Pasifika communities, which informs our science, research and collaborative partnerships.

- **Educating the next generation of bioprotection leaders**

  Our *whānau* foster an inclusive learning environment that *awhi* (care and nurture) our early career researchers through broad networking opportunities. We mentor our students along a pathway of educational and career success in science.

- **Community-driven**

  We are deeply connected to our communities and *te taiao*, our natural world. We are open and accessible, with a culture of valuing our people and our partnerships with communities at local, national and international levels.

OUR VALUES: TE PONO, TE TIKA ME TE AROHA

Our values as a CoRE are interdependent and grounded in *Te Pono* (truth, honesty and integrity), *Te Tika* (doing what is right, in the right way) and *Te Aroha* (respect and reciprocity).

- **Manaakitanga | respect and generosity**

  Our kawa and tikanga enable us to create a safe space within our whare where our leaders, researchers, students and *manuhiri* are welcomed, nurtured and respected. Our whare is a place to stand and be heard, a place of belonging, where everyone can share ideas, ask questions and debate. Respect and generosity are demonstrated through *mohiotanga*, communication and the sharing of information so we can serve each other to strengthen our whānau and community.

  We foster *tuakana/teina* relationships to pass on knowledge and mentor the next generation of bioprotection leaders.

- **Whanaungatanga | relationships and connection**

  He whānau, he hāpori – our whare is our people; it is also *te taiao*, the environment. Our community has a unique, shared whakapapa, history and knowledge that bind us together. Our *rōpū* (collective) paddles our *waka* (boat) together, seeking direction from our communities and te taiao.

  Our work brings together science, mātauranga Māori, Pasifika indigenous knowledge and the diverse perspectives of Aotearoa New Zealand. Our collective strengths and knowledge are woven together, making us stronger – *ka kaha tatou*.

- **Kaitiakitanga | guardianship**

  We each have a role as *kaitiaki* (guardians). Our people are the caretakers of our whare, our tāngata, our whānau, our communities and our whenua. We are deeply connected to our communities and te taiao. We work to form deep connections and valued partnerships with local iwi, Pasifika leaders, practitioners, communities, institutions, industry and international leaders in bioprotection.

  Only by working together can we protect the mauri of our landscapes and ensure well-being for future generations

OUR PRIORITIES

- **Building a treasury of bioprotection knowledge**

  As a National Centre of Research Excellence, Bioprotection Aotearoa will build a new integrated and intergenerational approach that protects the productive landscapes of Aotearoa New Zealand against the impacts of pathogens, pests and weeds in a warming climate.

  Bioprotection Aotearoa will build a treasury of knowledge that can inform future research pathways and identify and fill gaps in our current knowledge.

- **Advancement of bioprotection knowledge**

  Our breadth of understanding across Western science, mātauranga Māori and Pasifika indigenous knowledge uniquely positions Bioprotection Aotearoa to conduct world-leading research that will advance holistic fundamental knowledge in bioprotection. This will drive innovation and the development of solutions and tools designed specifically for the needs of Aotearoa New Zealand.

- **Growing resource capability**

  The provision and facilitation of teaching and learning will grow the diversity of skills, capabilities and expertise in Aotearoa New Zealand and lift the quality of research practice. Early career researchers will be mentored to value and appreciate a breadth of diverse knowledge systems to solve complex problems, empowering a new generation of bioprotection advocates and researchers to think differently.

- **Outreach to create sustainable change**

  Bioprotection Aotearoa will engage with mana whenua, experts, industry and the communities who are most affected by pathogens, pests, and weeds. Our outreach programmes will bring our bioprotection knowledge and understanding directly to end-users, empowering them to implement evidence-based tools that will protect and defend productive landscapes.

- **Influencing policies, society and the economy**

  New knowledge, understanding and outputs from Bioprotection Aotearoa will be highly respected and integrated into local and national policy. Guidelines developed by Bioprotection Aotearoa for ecosystem protection will influence environmental, social, cultural and economic change that benefits Aotearoa New Zealand.

OUR INDICATORS OF SUCCESS

- **Sustainable productive environments contribute to economic, environmental, cultural and social well-being**

  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 protection of Aotearoa New Zealand's landscapes, which creates a positive and sustained impact on human well-being.

- **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.

- **Increased public confidence in our ability to manage productive ecosystems for the well-being of all**

  The management of Aotearoa New Zealand's co-created, resilient landscapes is informed by new ecosystem health indicators and new practices that lead to sustainable production. There is nationwide acceptance of socioeconomic and governance models from Bioprotection Aotearoa, which 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 of 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.

OUR GOALS FOR 2022

- **As an organisation**

  As we execute our research plans, we will be resilient and adaptable under pandemic conditions, so we can meet or exceed our planned objectives in 2022.

- **For our people**

  We will develop agency to work towards shared goals among individuals, teams and the wider Bioprotection Aotearoa whānau.

PART 02

OUR PEOPLE

PART 02

OUR PEOPLE

In the last six months, we have been mapping out pathways in bioprotection. Our map is to be used as a guide that will lead our explorers on their individual pathways through science.

As our students begin their own journey, they are placed under the care and protection of our Bioprotection Aotearoa whānau. The factors that once prevented Māori and Pasifika students from entering science and being successful, will be mitigated so they can continue to thrive and create successful scientific careers.

Bioprotection Aotearoa continues to diversify our outreach programmes by connecting with like-minded partners and communities that have the same kaupapa. As our networks spread, bioprotection's diversity of thinkers and representation people will also grow.

UNDER THE PROTECTION OF OUR DEPUTY DIRECTORS

Peter Dearden

Deputy Director | Research and Stakeholder Engagement

University of Otago

Professor and Director of Genomics Aotearoa

Working in developmental genetics and genome sequencing for many years, Peter Dearden recognised how hard it was for students, particularly in rural areas, to learn about complex scientific topics like genetics. The lack of science labs, a shortage of science teachers, and a science curriculum that is difficult to teach all present barriers.

Peter's solution was to kit out a shipping container, turning it into a mobile science lab that can be taken into remote schools and communities across Aotearoa New Zealand. Though it was designed to teach genetics, it has evolved to support the teaching of other science subjects including astrology, biology, ecology and bioprotection.

"When you plonk a big blue box in the middle of the carpark, blocking parents' access to the school, it encourages them to interact with it. Kids are dragging parents out of the car and bringing them to have a look and see what we are doing."

Peter attributes the success of Lab in a Box to its ability to engage both children and parents, generating interest and dialogue in science.

"There is good data out there that shows if you want kids to think about science in their secondary education, you need to capture them as year 7 and 8 students," Peter says.

Peter points out that Aotearoa New Zealand's economy is based on biology, and therefore it's crucial to attract more students to bioprotection as a career pathway. In addition, climate change is one of the biggest issues facing Aotearoa New Zealand, and we need to build more capability to help find solutions to the challenges that will be associated with it.

Because Bioprotection Aotearoa pulls from a wide range of scientific disciplines, the CoRE has an opportunity to engage schools in a variety of ways and in multiple areas of the curriculum. We are especially keen to connect with children whose whānau work in agricultural settings and therefore have a vested interest in looking after the ecology of their own land.

Nick Roskruge

Deputy Director | Māori and Pasifika

Massey University

Professor of Ethnobotany and Horticulture

Nick Roskruge has a special interest in mentoring Māori and Pasifika students to progress in their careers. However, a challenge for Bioprotection Aotearoa is that not many Māori and Pasifika students have done degrees that prepare them for a career in bioprotection. This means there is currently a small cohort of Māori and Pacifika graduates that can advance in the field.

Nick says, "In the old world, pre-European times, [Māori] people identified from an early age, where their future lay. They were linked and aligned to health, or to become warriors or gardeners. It was identified based on their personality and characteristics."

Now, in a world where everyone has access to a wide range of instant information and influence from social media, choosing a career is not so straightforward.

Given there are no direct pathways into bioprotection, Bioprotection Aotearoa will need to identify people with good skills and support them to go into the field, where their learning can then be extended.

From a cultural perspective, Bioprotection Aotearoa has made a commitment to support Māori and Pasifika students using the whare model, *Te Taiao-a-rangi*. Nick says, "It's the task of the people within the whare to ensure our students can draw from the people they need to, connect from the people they need to, and hear from other people's experiences."

In an academic world, this could be considered professional development, but Māori call this whanaungatanga. When Māori researchers and Māori students come together, they each bring their own network. These networks intersect and collide beyond the scope of Bioprotection Aotearoa, and they allow students to explore many more activities and build relationships within this wider network.

Bioprotection Aotearoa is about creating a space that is interactive. Nick says, "We want these actions to become building blocks, not things that take up space and get in the way of their progress."

UNDER THE PROTECTION OF OUR DEPUTY DIRECTORS

Phillip Hulme

Deputy Director | Management and Operations

Lincoln University

Distinguished Professor of Plant Biosecurity

Phillip Hulme is a world-leading invasion biologist whose research aims to answer why some species become invasive, what their impacts might be and what we should do about them.

In addition to his work at Bioprotection Aotearoa, Phillip is a coordinating lead author at the United Nation's Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

Phillip, in partnership with over 70 other IPBES researchers from around the globe, is undertaking the first global assessment of invasive pests, weeds and pathogens. The results of this state-of-the-art review will be presented in 2023 to a plenary session of representatives from over 140 countries.

Phillip's team are specifically examining how governance, trade, urbanisation, land use, climate change and resource extraction drive biological invasions.

"It's a fascinating experience because the IPBES conceptual framework is holistic and actually quite close to where Bioprotection Aotearoa is heading," Phillip says.

Phillip believes that this strong link between Bioprotection Aotearoa and international policy means our students work in a dynamic, interdisciplinary environment that ensures they are well-placed when they graduate.

"Although our students may be based in New Zealand, they are part of a global phenomenon. When our students finish here, they will be well prepared for an international environment."

Phillip says the whole concept of bioprotection is what Aotearoa New Zealand needs. We need people who have the skills to understand the current and potential threats to the environment.

"At Bioprotection Aotearoa, we bring an additional aspect of a much broader cultural vision that is incredibly important," Phillip says. "Nowadays you cannot work in New Zealand without that broader perspective of different knowledge systems, and this is becoming true globally."

STUDENTS PURSUING BIOPROTECTION

Tere Porter-Rawiri

Summer Scholarship recipient

University of Otago

4th year of BSc in Indigenous Development and Genetics (University of Otago)

Originally from the small town of Waitara in Taranaki, Tere Porter-Rawiri (Te Āti Awa) has been interested in science as a way to contribute to her community since high school. But it was a professor at the University of Otago who really inspired her to think about how mātauranga Māori could work alongside Western science.

"It was literally one lecture that broadened my view," Tere says. "By incorporating tikanga and other Māori concepts, he helped me understand that Māori have been scientists for thousands of years. It's made me more confident in my identity and to feel like I do belong in this space."

Tere has just completed a summer scholarship with Bioprotection Aotearoa, investigating the DNA barcoding of mycorrhizal fungi associated with mānuka and kānuka. These fungi are important to plant survival and growth, so accurately identifying species diversity using molecular techniques will help to protect and restore these ecosystems.

Mātauranga Māori is informing Tere's research in the way she approaches science. "It's taught me to not be rigid in my thinking and to have a broader perspective," she says.

She also says that having a Māori supervisor is really important to her. "It makes it a culturally safe space and I'm able to come up with my own ideas and incorporate my own mātauranga Māori views."

"Being aware of other Māori doing science is so important. I think they've made it and so can I! When there are only a couple of Māori students in your class, there's an internal feeling that you don't belong."

She says the fact that Bioprotection Aotearoa is defining its values and ensuring Māori are represented at the highest leadership levels makes it a culturally safe space. She says, "I like that they are highlighting being holistic and inclusive, and also the focus on the environment, something I also really value."

Tere hopes to continue with her postgraduate studies after she finishes her undergraduate degree this year.

Cole McArthur

Summer Scholarship recipient and MSc student

Plant & Food Research

BSc in Cell and Molecular Biology (Victoria University), 2nd year of MSc in Biology (Auckland University)

Cole McArthur is currently finishing a summer scholarship with Bioprotection Aotearoa, investigating how 'sentinel plants' might be used as a tool to monitor the movement of viruses among host plants.

Specifically, Cole is interested in areas where agricultural land interfaces with native ecosystems. The movement of viruses from agricultural to native plants is causing severe damage to Aotearoa's biodiversity. He hopes his work will contribute to our understanding of how viruses are shared between plants and how they evolve in new ecosystems.

Cole's research project has so far identified which plant species might act as sentinels, based on their ease of use and likelihood of virus susceptibility. The sentinels will include both exotic agricultural plants and native plants.

Cole will be continuing his work with Bioprotection Aotearoa next year in a Master's degree project. He will conduct field studies to determine how the sentinel plant species selected can be used as a diagnostic tool to identify which viruses are moving between the host plants.

This area of research, known as virus ecology, is relatively new globally. Cole says, "The field is a fledgling just like Bioprotection Aotearoa. It's exciting because I get to learn a whole new set of skills in a brand new area of research."

He is also enjoying being part of the Bioprotection Aotearoa community.

"Bioprotection Aotearoa is still figuring out our identity. Every person is part of that identity and being part of that development is exciting."

"It's also motivating to be part of a community that cares about the same things as me. I'm enjoying learning about what scientists of my generation are thinking and doing that is different to what's happened previously. It feels like I can try new things out and that they will be well received."

STUDENTS PURSUING BIOPROTECTION

Alana Thurston

PhD Student

Lincoln University

BSc (Haverford College, U.S.A.), MSc Plant Protection (Lincoln University)

Originally from the US, Alana has always been really interested in science. Prior to coming to New Zealand, she studied and conducted field and lab-based research in environmental chemistry and developed an interest in plant-fungi relationships.

Alana built on this interest at the Bio-Protection Research Centre, completing a Master's degree on kauri dieback. She's now working on her PhD at Lincoln University with supervisor Professor Amanda Black, examining how soil resiliency might be improved in agricultural landscapes. This will help maintain soil productivity when climate change and land-use changes occur.

Alana has chosen a field site at Te Kaha, a small and remote town in the Bay of Plenty. A Māori collective owns and farms the site, which has both monocultures of corn and kiwifruit. The monocropping of corn has probably reduced the soil quality and productivity, which may pose difficulties when these sites are transitioned into higher value crops, such as expanding kiwifruit orchards. Alana hopes her research will help the community better understand correlations between management practices and soil resiliency.

She will start her project by characterising the diversity of microbial species in the soil as well as the contribution of microbial taxa to biogeochemical processes. She will then investigate how low-functioning soils might be made more resilient, for example by inoculating them with high-functioning soil microbial communities. Other potential solutions could include native cover cropping to provide carbon and stimulate soil activity, or organic fertilisers that could support microbial communities.

Alana is looking forward to being part of Bioprotection Aotearoa's research community, which she says will help both her career and personal growth.

"I'm especially excited about how Bioprotection Aotearoa's mātauranga Māori framework will both restructure researchers' mindsets and also determine our choice of field sites and the direct impact we're trying to make, ensuring our research is informed by and benefits Māori communities."

Simon Apang Semese

Early Career Researcher

Massey University

Bachelor of Tropical Agriculture (PNG UNRE), PGDip in Horticultural Science (Massey University), MSc in Ethnobotany (University of Goroka, PNG)

Growing up in the rural town of Wau, Morobe Province of Papua New Guinea, Simon Apang Semese had limited opportunities to learn about science and the outside world. It was only when he went to university in the city, and eventually travelled to New Zealand on an MFAT scholarship, that he appreciated the importance of science and agriculture to the world.

Simon's inspiration now is to help other young people around the Pacific have opportunities to learn science and to use that knowledge together with their traditional knowledge to help their communities flourish.

"Even when you come from a rural place or developing country, you can still make a difference in the field of science," Simon says. "Reaching out to others and inspiring them about the opportunities in science is the way forward, especially with the change in the climate and other related contemporary issues."

Simon, or Saii as he likes to be called, has spent the last six years studying and researching horticulture, ethnobotany and conservation in both New Zealand and Papua New Guinea. Here, he has worked closely with Māori communities to maintain traditional crops and protect and regenerate native flora. This has included a project on the repatriation of kumara to Aotearoa in the 1990s, which was the genesis of the Wai 262 Waitangi Tribunal claim that considered who is entitled to make or participate in decisions affecting indigenous flora and fauna.

Saii is part of the cross-pou team at Bioprotection Aotearoa and will be focusing on building capacity in bioprotection both in New Zealand and across the Pacific region. This will include educational activities and compiling baseline data of regional bioprotection research, threats and activities.

Saii is looking forward to supporting other Pasifika and Māori researchers across the three pou of Bioprotection Aotearoa. He also hopes to use his extensive regional connections to support bioprotection researchers across the Pacific.

Elizabeth Elliot Noe

Post-Doctoral Fellow

Lincoln University

BSc in Environmental Studies (Wheaton College, USA), MSc in International Nature Conservation (Lincoln University, NZ and University of Göttingen, Germany), PhD in Ecology and Social Sciences (University of Waikato)

Much of conservation biology focuses on pristine natural landscapes that only a few people get to visit, but Elizabeth Elliot Noe has always been interested in areas where conservation and people meet. She wants to promote biodiversity conversation where people are, including agricultural landscapes, where production and the protection of native species and habitats are knitted together.

Her research to date has focused on promoting biodiversity conservation and understanding human-nature relationships in landscapes heavily used and disturbed by people. Throughout her career, she has combined theories and methods from the social sciences and ecology, exploring people's worldviews, values and resulting behaviours to address conservation biology challenges.

"I have a mixed background," Elizabeth says. "I grew up in Poland, my mum is American, my dad is a Kiwi, and I've travelled a lot. I've always been interested in different worldviews and values, and how those values affect behaviours."

Elizabeth joined Bioprotection Aotearoa as a Post-Doctoral Fellow at Lincoln University in January. Her research will investigate the relationship that New Zealand dairy farmers have with their land, to develop ways of encouraging and supporting pro-biodiversity farm management. The goal is to develop partnerships with farmers to conserve biodiversity in rural New Zealand.

Elizabeth says, "I'm excited to be part of Bioprotection Aotearoa because it includes such a large group of researchers from very different fields. I'll get to meet and work with people from psychology, economics, public policy, ecology and other disciplines. This is also a really exciting opportunity for students just starting their careers."

Nils Birkholz

Post-Doctoral Fellow

University Of Otago

BSc and MSc in Biology (Technische Universität Braunschweig), PhD Molecular Microbiology (University of Otago)

Nils Birkholz is a molecular microbiologist interested in the interactions between bacteria and their viral predators, bacteriophages. He will be involved in Poutokomanawa and is aiming to identify and characterise new defence systems in the plant pathogen *Pectobacterium*.

These bacteria cause diseases such as soft rot in potatoes and other crops, so they are economically important to Aotearoa New Zealand. His goal is to potentially harness these systems for innovative bioprotection strategies.

Nils says, "There's been a recent explosion in the discovery of new defence systems in bacteria that were not known before. This makes us think that other defence systems may be present in the genomes of bacteria that could be interesting and useful for developing new technologies for bioprotection."

Although his research is still in the early stages, Nils has so far catalogued a large collection of New Zealand *Pectobacterium* strains from Lincoln and Plant & Food Research, which will be used for the identification and testing of phage defence systems.

Nils is looking forward to having more interactions this year with researchers across the Bioprotection Aotearoa network.

"The exciting thing about bioprotection is researchers from so many disciplines are working on the same problems. It's interesting to see how researchers from other fields tackle the same problems and how we form synergies to get better at solving them."

PART 03

OUR RESEARCH

PART 03

OUR RESEARCH

Productive landscapes occupy almost 50% of Aotearoa New Zealand's land area and are the engine room of the economy. However, our productive landscapes are under significant stress from established pathogens, pests, and weeds and will face an array of additional threats in this warming climate.

Reactive responses to tackle individual invasions as they arise are no longer sufficient, nor is it sustainable. Bioprotection Aotearoa adopts a fundamental shift in thinking, where our research focuses on strategies that aim to increase the resilience and resistance of productive ecosystems against a broad cross-section of abiotic and biotic threats.

The key to the success of our research is that it spans biophysical and socioeconomic sciences within a framework that explicitly adopts cultural values into all aspects of research. Our research is unified under an indigenous values framework, *Taiao*.

The term Taiao can be used to describe environmental health, however, the meaning is far more holistic than a series of biophysical measurements. Taiao intimately links the value of ecosystem health with the wellbeing of people and, as human activity is at the root of our ecological problems, recognises that it must also be at the heart of the solutions.

This is especially true for productive landscapes that also hold significant areas of natural and or cultural value. 50% of Aotearoa New Zealand's native area is within productive farms. This high connectivity between native and productive land means that the flow of pathogens, pests, and weeds between the two must be understood and managed using a holistic approach, and positive outcomes for land used in food production will have direct and indirect benefits for our native ecosystems.

POU 1 – TITIRANGI

WHAT DEFINES A HEALTHY AND PRODUCTIVE ECOSYSTEM?

The health of our plant-based productive ecosystems emerges from interactions among plant communities, microbes in and on plants, external stressors, and the broader landscape context at a variety of spatial scales.

Knowing what defines the health of a productive ecosystem is crucial to understanding how to protect them; how to undermine the persistence of undesirable components such as pests, weeds and diseases; and how to monitor whether sustainable ecosystem productivity is improving.

In essence, a healthy ecosystem is one that is relatively resistant to change and can also reassemble/reorganise following disruption – meaning it is also resilient to change.

POU LEADERS:

Dr. Julie Deslippe
Victoria University of Wellington

Prof. Jason Tylianakis
University of Canterbury

PROJECT 1.1: MULTI-SCALE INTEGRATORS OF ECOSYSTEM HEALTH

This project will translate Māori expressions of *mauri* (life force) for assessing ecosystem health including peoples' values.

The word mauri is a combination of mā and uri, meaning pureness passed down from the gods. Each living thing has a mauri that relates to, and interacts with, the Earth's forces. Underpinning the Māori economy and their investment in managed primary production is the recognition and prioritisation of *oneone* (soil) health to sustain *whenua* (land) and *taonga* (cultural treasures).

Māori define soil health holistically, stressing interconnections and strong links to sustaining life, food production and human well-being. Māori conceptual models and definitions tend to locate Māori at the centre of ecosystems and regard a healthy soil as one "capable of supporting, maintaining, and enhancing life and well-being". This provides the foundation for the development of Māori soil indicators that guide the management of soil health.

This project aims to develop multi-scale networks of disease incidence and impact. It will also help us understand above- and below-ground drivers of health in the face of pathogens, pests and climate change.

So far, we have assembled the project team, completed the project's experimental design and selected our primary research sites in collaboration with iwi/hapū and land-owners.

Principal & Associate Investigators

Prof. Ian Dickie	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	University of Auckland

Post-Doctoral Fellows

Dr. John Ramana	Manaaki Whenua - Landcare Research

Post-Graduate Students

Megan Tan* (PhD)	University of Canterbury
Merlyn Robson (PhD)	University of Auckland
Leann Vinson (PhD)	University of Canterbury
Cole McArthur (MSc)	Plant & Food Research

*Aligned

PROJECT 1.2: PROCESSES THAT PROMOTE ECOSYSTEM HEALTH ACROSS SCALES IN THE FACE OF PATHOGEN AND PEST ATTACK

This project aims to identify the linked properties of ecosystems that allow them to remain healthy, in terms of crop production, microbial communities, landscape properties and environmental setting. It will determine the evolutionary drivers of resilience to pests, both above- and below-ground.

Ecosystem health emerges from interactions among plant communities, microbes in and on plant tissue and soil (the phytobiome), external stressors, and the broader ecosystem context at increasing scales. For example, soil biota profoundly influences plant performance and resistance to disease. Conversely, above-ground biota can influence soil mutualists, pathogens and pests.

The relative role of these factors in driving individual plant health are poorly understood, and the effects can differ according to the plant and microbial taxa involved. This uncertainty makes it difficult to manage ecosystems towards enhanced health and bioprotection outcomes.

Principal & Associate Investigators

Prof. Jason Tylianakis	University of Canterbury
Dr. Jonathan Tonkin	University of Canterbury

Post-Doctoral Fellows

Dr. Hao Ran Lai	University of Canterbury

PROJECT 1.3: A NEW FRAMEWORK TO ASSESS ECOSYSTEM HEALTH FOR AOTEAROA NEW ZEALAND

This project aims to develop a novel framework for assessing risks to ecosystem health. It will account for feedback from processes that arise due to the unique geography, ecology and culture of Aotearoa New Zealand.

The health of Aotearoa New Zealand's productive ecosystems – including their ability to withstand pathogens, pests and weeds in a changing climate – depends on drivers that operate across a range of scales from individual pest and weed incursions to national policies.

These drivers interact across landscape mosaics, often in complex and unanticipated ways, to affect a range of local health outcomes on productive land. Farm managers are typically charged with optimising economic yield within legislated requirements. The practices they adopt as a result (e.g., the development of herbicide-resistant weeds) can affect the surrounding landscape.

Decision-support tools used in Aotearoa New Zealand are typically focused on local outcomes, and do not explicitly account for how decisions feedback to impact ecosystem outcomes across the landscape and time. We urgently need tools that allow explicit consideration of these interactions and risks, which is what this project will focus on.

Principal & Associate Investigators

Dr. Julie Deslippe	Victoria University of Wellington
Dr. Jonathan Tonkin	University of Canterbury

Post-Doctoral Fellows

Dr. Stephanie Tomscha	Victoria University of Wellington

POU 2 – POUTOKOMANAWA

DEFENDING AGAINST PATHOGENS AND PESTS

Crop loss from pathogens and pests is an increasing threat to agricultural production in Aotearoa New Zealand and abroad. Similarly, our native forests are under threat from current (and future) incursions, often due to migration from adjoining productive systems.

Progress has been made both to control these pathosystems, and to manage productive systems sustainably as their biology/ecology shifts in response to biological incursions. However, we still lack the knowledge and tools to effectively and economically control most existing pathogens and pests, let alone new threats that might be associated with a changing climate.

In Aotearoa New Zealand, we have unique biological, climatological and sociological settings. We therefore need to develop new approaches specific to our socio-ecological setting and our bioprotection needs.

We will take a holistic approach, seeking the mechanisms that will drive pathogen/pest defence, including microbiota-mediated protection and genetic and genomic approaches to pathogen and pest control.

POU LEADERS:

Dr. Monica Gerth
Victoria University of Wellington

Assoc. Prof. Matt Templeton
Plant & Food Research

PROJECT 2.1: THE MECHANISMS FOR MICROBIOTA-MEDIATED PROTECTION

This project will determine how the microbiome of productive plant ecosystems contributes to disease control outcomes. We will also determine the genetic and chemical basis of these interactions, with a particular focus on the discovery of novel and indigenous taxa and functions that can be harnessed for bioprotection outcomes for Aotearoa New Zealand.

It is increasingly evident that the microbiota of plants (phytobiome) plays a crucial role in plant disease dynamics and that agricultural practices can directly impact the microbiota and/or alter its protective benefits. We have a limited understanding of the underpinning mechanisms (changes in microbial community membership and function) that support these protective benefits.

In particular, our ability to understand and predict interactions among microorganisms, and between the plant and its microbiome, is limited because of a lack of fundamental knowledge that links the key taxa involved, their associated genetic and physiological mechanisms, and the ecology of interactions leading to disease expression or suppression. This is particularly important information for Pou 1 (Titirangi) and Pou 3 (Nuku-a-rangi).

Our team has identified potential field sites and established a plan for microbiota sampling. We have also connected with mana whenua to establish access to field sites for microbiota sampling in the Bay of Plenty. We've also begun optimising extraction methodologies in the lab to mine genomes for genes that encode potential antimicrobial compounds.

Principal & Associate Investigators

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

Post-Graduate Students

Polina Idelchik (PhD)	Victoria University of Wellington
Sarah Andreassend*	Victoria University of Wellington
Josie Mainwaring*	Victoria University of Wellington
Monica Summers*	Victoria University of Wellington
Samuel Rodda*	Victoria University of Wellington

*Aligned (independently funded)

PROJECT 2.2: GENETIC AND GENOMIC APPROACHES TO PEST AND PATHOGEN CONTROL

This project tests the hypothesis that we can enhance current biocontrol agents by manipulating the microbiome of biocontrol agents or pests. This manipulation will accentuate the virulence of transmitted viruses and/or deliver microbes that cause specific pandemics in target pest populations.

Biocontrol can be an effective and environmentally friendly method of pest species suppression. However, recent Bio-Protection Research Centre research identified situations where biocontrol fails, as a result of rapid evolution in targeted pest species or the development of resistance to pesticides.

This raises the question: are there ways we could exploit the search capabilities of natural enemies, especially parasitoids or predators, to deliver more effective pest control rather than just suppression?

The introduction of Varroa mite into New Zealand is a good example; this mite selects for, and vectors, virulent strains of honeybee viruses. As a consequence, commercial honeybee populations now rely on human-delivered miticide treatments for survival. Consistent with this, a growing literature shows that modifying the microbiota of pests can usefully alter their physiology. Such enhanced biocontrol agents can then be used in resilient landscape design (Pou 3).

Our team is assessing the microbiome and virome associated with Argentine stem weevil and its parasitoid control agent *Microctonus hyperodae* from multiple New Zealand locations. In addition, by examining historic samples, we have identified a novel virus infecting this species.

Principal & Associate Investigators

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

Post-Doctoral Fellows

Dr. Sarah Inwood	University of Otago

PROJECT 2.3: HARNESSING NATURAL DEFENCE SYSTEMS IN THE BIOPROTECTION BATTLE

This project aims to discover and characterise natural microbial defence systems with the potential to be used to explore pest/pathogen biology and address bioprotection challenges.

Molecular technologies derived from bacterial defence systems (e.g. restriction enzymes and CRISPR) have a proven track record in yielding powerful technologies. CRISPR-Cas can be programmed to recognise – and can modify – specific sequences, making them adaptable to study pest biology, as diagnostics, and sequence-specific biocontrol agents to eliminate particular bacteria. Bacteria also have a multitude of other defence systems and many new ones are being discovered. Aotearoa New Zealand microorganisms are likely to harbour novel defence systems that can be applied for innovative research and bioprotection strategies. This work will benefit from sequencing data and insight from project 1.2 and other projects where microorganisms are studied.

We are combining bioinformatic and experimental approaches to discover and study defence systems from bacteria. This work will reveal the potential of any of these systems for future development as tools for bioprotection research and their possible influence on biocontrol approaches that rely on targeted bacterial killing by bacteriophages (viruses that infect bacteria). We will also work with Aroha Mead (*Recloaking Papatūanuku* team) to explore Māori views and best practice for biodiscovery work and access and benefit sharing.

We have uncovered that some bacteria contain multiple defence systems that can antagonise each other (Birkholz et al., 2022 *NAR*). We have also further developed bioinformatic approaches for the detection of known phage defence systems in bacterial genomes (Payne et al., 2021 NAR). We have identified new potential defence systems for further testing and are exploring the biotechnological potential of other systems we are studying.

Principal & Associate Investigators

Prof. Peter Fineran	University of Otago
Assoc. Prof Paul Gardner	University of Otago
Dr. Simon Jackson	University of Otago
Dr. Rob Fagerlund	University of Otago

Post-Doctoral Fellows

Dr. Nils Birkholz	University of Otago

Post-Graduate Students

Leighton Payne*	University of Otago
Hazel Sisson*	University of Otago
Shaharn Cameron*	University of Otago
Megan McLeod*	University of Otago

*Aligned (independently funded)

PROJECT 2.4: EXPLORING THE MOLECULAR BASIS OF HOST SPECIFICITY

Through a deeper understanding of pathogen-host interactions, this project will generate new tools, technologies and approaches for protecting whole ecosystems from disease. The project builds, in part, on the National Science Project (Ngā Rakau Taketake), which generated a new high quality genome sequence and chromosome level assembly for the kauri dieback pathogen *Phytophthora agathidicida*.

The team will create gene models from this new genome sequence that will be evaluated to determine their potential roles in kauri dieback. The discovery that *P. agathidicida* can complete its life cycle in the model plant *Nicotiana benthamiana* provides an excellent model pathosystem in which to do this evaluation. We are planning a proteomics experiment to determine what proteins are secreted into the apoplast by the pathogen and the host.

Project 2.4 also focuses on *Phytophthora cinnamomi*, a broad-ranging pathogen that is often found in kauri forests. The first stage of this work is to assess genetic diversity in isolates obtained from different hosts. To achieve this, we have obtained a set of isolates from the Scion collection, checked the identity of the isolates, and are now preparing DNA for genome sequencing. Proteomics analysis of this species in *N. benthamiana* will follow in 2022, enabling comparative studies with *P. agathidicida*.

Principal & Associate Investigators

Prof. Rosie Bradshaw	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

Post-Doctoral Fellows

Dr. Melissa Guo	Massey University

Post-Graduate Students

Taylah Dagg (MSc)	Massey University
Alexandra Cox (MSc)	University of Canterbury

PART 03

POU 3 – NUKU-A-RANGI

DESIGNING RESISTANT AND RESILIENT PRODUCTIVE ECOSYSTEMS

This research stream takes a holistic approach to bioprotection that explicitly embodies connectedness within and among components of ecosystems.

We propose that degradation of productive ecosystem health can be buffered by incorporating design principles that ensure connectivity among components is maintained while minimising opportunities for pathogens, pests and weeds to move within and between ecosystems.

In this way, we will investigate the biophysical components that lead to resilience against pathogens, pests and weeds.

Moreover, we have little understanding and a lack of quantitative analysis of what social and cultural factors drive the behavioural policy changes needed to achieve and maintain such ecosystem health.

We will develop effective social, economic and governance strategies for the maintenance of healthy ecosystems, within the unique environmental, economic and sociocultural context of Aotearoa New Zealand. This builds on international evidence that flexible strategies will be required to handle challenges associated with future uncertainty, particularly those associated with climate change.

POU LEADERS:

Prof. Leo Condron
Lincoln University

Dr. Steve Wakelin
Scion

PROJECT 3.1: HOW CAN WE CREATE HEALTHY, DISEASE-RESISTANT AND CLIMATE-RESILIENT SOILS?

This project will determine how crop species, genetics, management factors and climatic conditions interact with ecosystem genomes (the plant and microbiome) to express disease-suppressive functionality.

Managing agro-ecosystems towards disease-suppressive states is an opportunity to sustainably maintain production and reduce dependence on chemical and other inputs. As an ecosystem metaphenome, general disease suppression confers immunity/protection to a range of plants from a variety of pathosystems and is enduring over time. The role of microbial membership and functions or processes within these communities has been defined for disease-suppressive soils.

The team will also test the plant-supported heritability of plant rhizosphere microbiomes and traits over time. Using novel, mixed or cover species to manage the assemblage of microbial communities may provide new soil microbiome management tools.

Finally, the project team plan to determine the relative importance of different farm management practices on disease-suppressive soil metaphenome, and elucidate links between management practices, soil microbial biomass, and groups of beneficial and pathogenic taxa.

The research challenge is to understand how environmental conditions and management practices affect disease suppression in ecosystems, and then to apply this knowledge to management practices that can alter the ecosystem trajectory towards an enduring, disease-suppressive state.

Principal & Associate Investigators

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

Post-Doctoral Fellows

Dr. Alexa Byers	Lincoln University

Post-Graduate Students

Alana Thurston (PhD)	Lincoln University
Fionnuala Bulman (PhD	Lincoln University
Caterina Campese* (PhD)	Lincoln University

*Aligned

PROJECT 3.2: DESIGNING FUTURE FORESTRY: NATIVE NURSERIES OR INVADER INCUBATORS?

Project 3.2 aims to determine the role of landscape attributes (e.g., surrounding land-use heterogeneity, distance to urban or forest land-use), ecosystem characteristics (e.g., size, age, perimeter to edge ratio), and species traits (e.g., shade tolerance, growth rate) on woody weed incursion in mānuka and kānuka shrublands.

The research will undertake surveys of weed occurrence in a wide range of mānuka and kānuka shrublands across Aotearoa New Zealand and relate them to the landscapes in which they are found. These surveys will be complemented by sowing experiments to introduce non-native plant species into the edges and centres of the shrublands to assess the resilience to invasion by different species. It aims to take a hierarchical approach to identify what makes an ecosystem resilient or vulnerable to weed incursion at different spatial scales.

We have already begun the analyses of national surveys of weed invasion in several hundred manuka/kanuka shrublands across New Zealand and linked these to historical data to provide a unique perspective of invasion over time and space. Potential field sites for experiments have begun to be identified.

This project links closely to project 1.1 where the health of mānuka and kānuka shrublands is being investigated and also Recloaking Papatūānuku: mānuka me te kānuka.

Principal & Associate Investigators

Prof. Philip Hulme	Lincoln University
Prof. Margaret Stanley	University of Auckland
Dr. Jonathan Tonkin	University of Canterbury

Post-Doctoral Fellows

Dr. Laureline Rossignaud	Lincoln University

Post-Graduate Students

Emily Jones (PhD)	Lincoln University
Diane Borse (PhD)	University of Auckland

PROJECT 3.3: CREATING EFFECTIVE GOVERNANCE MODELS THAT LEAD TO RESILIENT ECOSYSTEMS

This project will examine the social influences on models of healthy ecosystems. We will determine key social, economic and governance implications and influences on pro-environmental behaviours and well-being in Aotearoa New Zealand. We will also investigate perceptions and responses to biosecurity challenges and countermeasures identified by work in the other Pou.

The well-being of New Zealanders is inextricably linked to local and global environmental outcomes. New socioeconomic and governance models are needed to enable the changes required to achieve desired outcomes for Aotearoa New Zealand, while contributing to positive climate change adaptations.

We will study the human dimension of meeting bioprotection challenges in the Anthropocene. We will achieve this through transdisciplinary research across all Pou, exploring the relationship between laboratory, field and social sciences, in a range of productive landscapes, including humans acting together and alone.

The project team have started to explore one governance pathway to drive behavioural change, Farm Environment Plans, which so far is proving useful. The team have also identified a co-governance pathway – Myrtle Rust on the East Coast of the North Island – with a postgraduate scholar beginning a research project there in 2022.

Principal & Associate Investigators

Prof. Ann Brower	University of Canterbury
Prof. Paul Dalziel	Lincoln University
Prof. Caroline Saunders	Lincoln University
Prof. Anita Wreford	Lincoln University
Dr. Gary Steel	Lincoln University

Post-Doctoral Fellows

Dr. Franca Buelow	University of Canterbury
Dr. Elizabeth Elliot Noe	Lincoln University

Post-Graduate Students

Jade Gibson (MSc)	University of Canterbury

PART 02

RECLOAKING PAPATŪĀNUKU

MĀNUKA ME TE KĀNUKA

Building on Pou 1, the mauri of ecosystems represent their life-force and are integral to their health. Mauri connects our natural world, from soils and productive ecosystems to humans and communities.

Traditional land managers and custodians, or *kaitiaki*, used indigenous knowledge of Aotearoa New Zealand's natural ecosystems (flora, fauna and soils) to support and grow mauri and recognise the connections and reciprocity between the health of the land and the people it supports.

This research will define the links between humans and the natural world. It will resolve the value of mauri across ecosystems and demonstrate how ecosystem restoration forms the basis of the well-being of communities.

We will explore mānuka (*L. scoparium*) and kānuka (*K. ericoides*; *Kunzea* spp.), as an indigenous (Māori and Pasifika) socio-ecological restoration model, providing positive impacts for native biodiversity as well as restorative soil practices for productive landscapes. These native *taonga* (treasured) species are studied across all three research Pou.

Mānuka and kānuka are widespread throughout Aotearoa-New Zealand, and they are part of the Myrtaceae, or myrtle family, which is widespread throughout Australasia and the Pacific. Mānuka and kānuka are often present around forest margins and act as a "window" to ecosystem health.

Mānuka and kānuka are economically important to Māori and the whole of Aotearoa New Zealand, particularly in the thriving honey industry. Other benefits from these plants include derivation of bioactive plant compounds, native forestry, cultural harvest, ecotourism, and carbon.

POU LEADERS:

Prof. Nick Roskruge
Massey University

Dr. Nick Waipara
Plant & Food Research

PROJECT RECLOAKING PAPATŪĀNUKU

This research will:

1. translate expressions of mauri into measures of degraded and healthy productive ecosystems, linking to Pou 1
2. co-develop tools and approaches that enhance resilience and protect productive landscapes managed by Māori and Pasifika communities within Aotearoa-New Zealand and beyond, linking to Pou 2
3. restore balance in our productive soil ecosystems through the use of indigenous microbiomes associated with the mānuka me te kānuka system, linking to Pou 3.

We plan to operationalise the value of intergenerational land-management practices and the mātauranga of mānuka me te kānuka and its associated beneficial bioactive properties in mainstream productive sector management. This will support iwi/hapū and other productive land managers to achieve intergenerational benefits through changes in land-use practices.

Given the increase in land under Māori stewardship, this project will enable the transition of land uses based on long-term value and outcomes for the benefit of Aotearoa New Zealand and beyond.

Principal & Associate Investigators

Prof. Nick Roskruge	Massey University
Dr. Nick Waipara	Plant & Food Research
Aroha Mead	Independent

Early Career Researcher

Simon Apang Semese	Massey University

PART 04

OUR STATEMENT OF WORKS


OVERSIZE

PART 04

ORGANISATIONAL STRUCTURE

TAUMATA | STRATEGIC ADVISORY BOARD

Matua Henare Edwards (Co-Chair)
John Rodwell (Co-Chair)
Adjunct Assoc. Prof. James Ataria | Tuaropaki Trust/ Cawthron
Prof. Richard Blaikie | University of Otago
Jessie Chan | Rural Co
Prof. Jim Morton | Lincoln University
Stacey Whitiora | Plant & Food Research

KĀHUI MĀORI

Matua Henare Edwards (Chair)
Adjunct Assoc. Prof. James Ataria | Tuaropaki Trust/ Cawthron
Prof. Amanda Black (Director) | Lincoln University
Whaea Sally McKean | Independent
Prof. Shaun Ogilvie | University of Canterbury
Prof. Nick Roskruge (Deputy Director) | Massey University
Dr. Nick Waipara (Principal Investigator) | Plant & Food Research

KAIWHIRIWHIRI | DIRECTORSHIP

Director

Prof. Amanda Black | Lincoln University

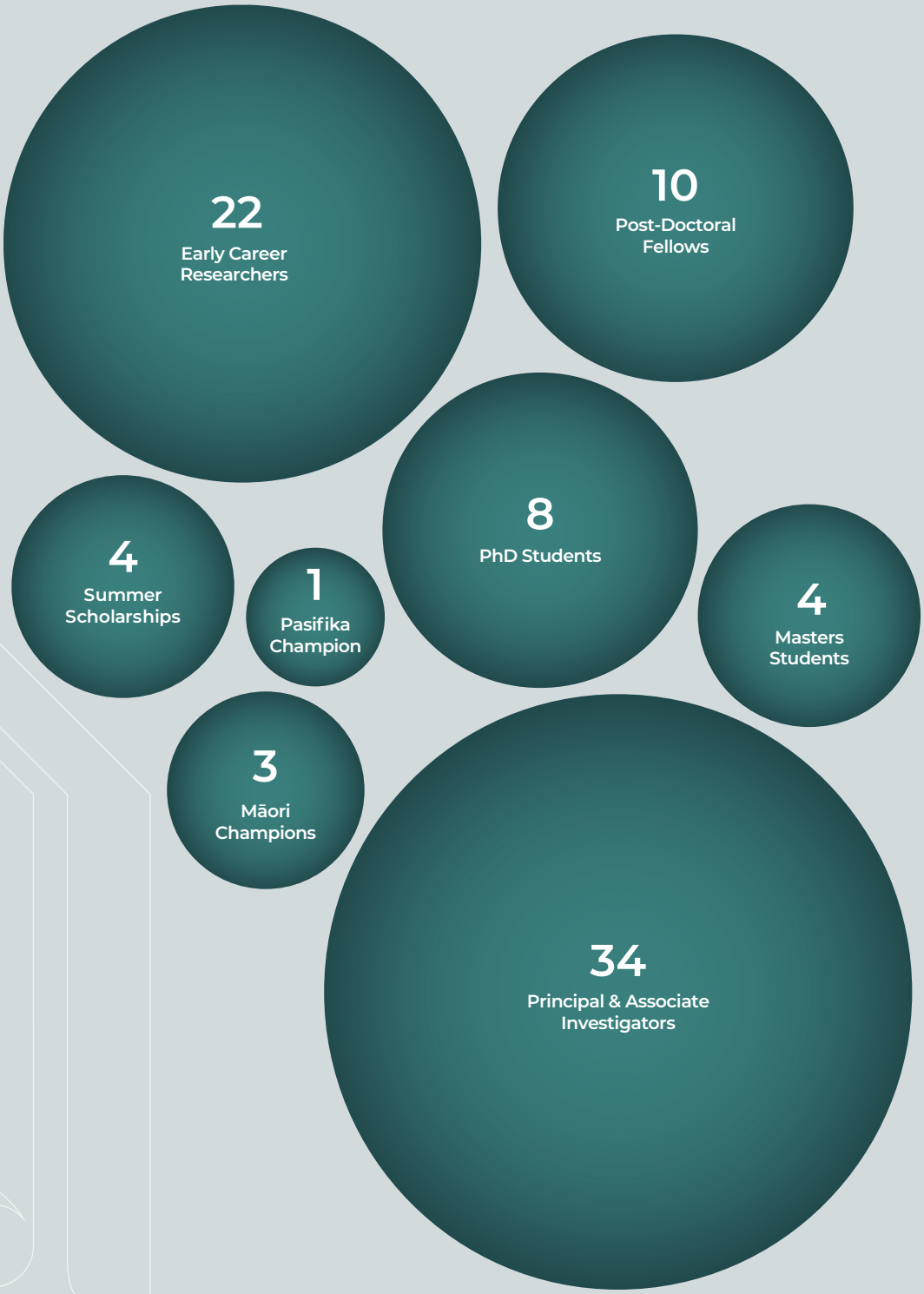
Deputy Directors

Prof. Peter Dearden | University of Otago
Distinguished Prof. Phillip Hulme | Lincoln University
Prof. Nick Roskruge | Massey University

OPERATIONS

Meikura Arahanga (Research and Outreach Co-ordinator) | Lincoln University
Dr. Michelle Boyle (Contracts Manager) | Lincoln University
Dr. Andrew Holyoake (Operations Manager) | Lincoln University
Elena Johnson (Exec. Assistant to Director) | Lincoln University
Zohar Marshall (Communications Manager) | Lincoln University
Claire Tee (Financial Manager) | Lincoln University

OUR CAPABILITY DEVELOPMENT



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PART 04

FINANCIALS

CATEGORY	TOTAL $ '000
TEC CoRE Funding	2150
Surplus/(Deficit) carried forward	0
Total CoRE Funding	**2150**
Salaries & salary-related costs	344
Total Salaries & Salary-related costs	**344**
Overheads	326
Project Costs	299
Travel	1
Postgraduate students	149
Equipment depreciation/rental	0
Subcontractor(s) specified	40
Total Other Costs	**815**
Total Expenditure	**1158**
Net Surplus/(Deficit)	**992**

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"Mā whero mā pango ka oti ai te mahi."

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