

BIOECONOMY
SCIENCE
INSTITUTE



Manaaki Whenua
Landcare Research

2025

ANNUAL REPORT / PART ONE



We present our Annual Report in two parts. Part 1 provides an overview of Manaaki Whenua – Landcare Research, from 1 July 2025 a Group of the Bioeconomy Science Institute. It highlights our science and the contribution we are making towards creating value for New Zealand through our research, people and partnerships. In Part 2 we present our directors' report and financial statements.

PDF versions of both Part 1 and Part 2 are available for download from the Manaaki Whenua – Landcare Research website:
landcareresearch.co.nz/report



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Annual Report 2025

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Cover image: Remutaka range looking towards Lake Wairarapa.

Contents

Forming the Bioeconomy Science Institute	2	HOW WE WORK / TE ĀHUA O TĀ TĀTOU MAHI	56
Manaaki Whenua – long-term benefits for our bioeconomy	4	Putting people at the centre	57
OUR CONTEXT / TŌ TĀTOU HOROPAKI	6	Our infrastructure	60
2025: Science sector reform	6	Our impact processes	61
Government priorities for science	7	Our commitment to sustainable development	66
		Our financial resilience	67
OVERVIEW OF MANAAKI WHENUA - LANDCARE RESEARCH / TIROHANGA WHĀNUI	8	Non-financial KPIs	68
Our locations	10	Directory	69
Our investments in research impacts	11		
Collections and databases	12		
Stakeholder input	14		
OUR STRATEGIC PILLARS / Ō MĀTOU POU RAUTAKI	15		
Strategic pillar 1: Drive research impact with our partners	16		
Strategic pillar 2: Weave the principles of Te Tiriti into our fabric	17		
Strategic pillar 3 Create a sustainable environment for our research and people to thrive	18		
OUR SCIENCE / TŌ TĀTOU PŪTAIAO	20		
Our four research impacts	22		
Restoring ecosystems	24		
Capability building in data and digital technologies	32		
Managing invasive species	34		
Land resources and climate change	42		
Catalysing change	50		
Toitū Envirocare	54		

Forming the Bioeconomy Science Institute

New Zealand's science, innovation and technology system is undergoing a one-in-a-generation transformation.

It is an exciting time to be part of the New Zealand science system. While not without its challenges, the formation of the Bioeconomy Science Institute has tremendous potential to make a step-change in how New Zealand manages and optimises the use of its biological resources. Since they were formed in 1992, the Crown Research Institutes have delivered on their remit to support strategic research and economic growth. This next step will supercharge how research can and will deliver impacts for New Zealand and the world.

Since the announcement in January 2025 that four new Public Research Organisations would be formed from the Crown Research Institutes, those at the CRIs that now form the Bioeconomy Science Institute have worked tirelessly to implement the changes required. Huge effort has been and is being put into establishing the Bioeconomy Science Institute while maintaining delivery of our ongoing science and business operations.

As of 1 July, we — the Board and Transition CEO — took up the official mantle of leading the transition of the Bioeconomy Science Institute into a single functional research organisation. The hard work is still to come – aligning the suite of technologies and processes that will make us one integrated organisation that will have meaningful impact for New Zealand's bioeconomy. We have no doubt that the team is up for the challenge of building on the success of the legacy organisations to deliver something truly transformational.

Bringing together more than 2300 people, with a wide range of skills, capabilities and experiences, is not easy. But the formation of the Bioeconomy Science Institute is a genuine opportunity to change the status quo, not only by supporting New Zealand's critical bioeconomy with research for today but also in planning for the future. The collective focus on impact, not just in terms of dollars but also for the environment and communities, will see New Zealand maintain its reputation for innovation and protect the financial, physical and cultural health of our nation.

We thank Manaaki Whenua's outgoing Chair, Colin Dawson, and the outgoing Directors Dr Paul Reynolds, John Rodwell, Justine Gilliland, Marje Russ, Dr Warren Williams and Dr Andrea Byrom for their governance, advice and support of Manaaki Whenua. We would also like to acknowledge the members of the transitional governance group for initiating the merger process.

As we start our journey as the Bioeconomy Science Institute, we acknowledge Kim Wallace, previously Chair of AgResearch, Gray Baldwin, Candace Kinser and Andrew Morrison, all previously Directors at the legacy organisations, for joining our new Board. Their institutional and sector knowledge will provide a strong foundation for the new organisation in future. We are also grateful to the Group CEOs for their leadership and support as we continue on this journey to a single organisation.

To all of the staff at the Bioeconomy Science Institute – we thank you for your patience and dedication during what we know is a very unsettling time. Now more than ever the Māori proverb resonates: He aha te mea nui o te ao? He tangata, he tangata, he tangata. What is the most important thing in the world? It is people, it is people, it is people.



A handwritten signature in black ink, appearing to read 'Barry Harris'.

Barry Harris, Chair,
Bioeconomy Science Institute



A handwritten signature in black ink, appearing to read 'M. Piper'.

Mark Piper, Transition CEO,
Bioeconomy Science Institute

A word from Manaaki Whenua – Landcare Research's CEO

Manaaki Whenua – Landcare Research's science is more sought after than ever to solve difficult land management problems. As the science sector reforms take shape, our pipeline of future opportunities is healthy: we bring more than 600 revenue-generating research projects into the Bioeconomy Science Institute for the 2025/26 financial year, each of which supports improved outcomes for New Zealand's land environment and biodiversity.

We have maintained our fiscal sustainability over the past 6 years, with stable growth in both total science revenue and net revenue per researcher across all our science areas. Our sustained performance, even in economically uncertain times, is a result of our strong alignment with government and primary sector priorities for environmental research. This has been complemented by an organisation-wide drive to generate new commercial revenue in non-traditional sectors—such as banking, energy, and insurance.

Into 2026/27 we are optimistic that our new ways of working will help the Bioeconomy Science Institute to deliver science with impact for partners across New Zealand. We thank the outgoing Manaaki Whenua – Landcare Research Board for their guidance over the past years, and look forward to contributing to the success of the new organisation.



A handwritten signature in black ink, reading 'J Stevenson-Wallace'.

James Stevenson-Wallace, Group CEO,
Manaaki Whenua – Landcare Research,



Hon Dr Shane Reti, Minister for Science, Innovation and Technology (centre), unveiled the Bioeconomy Science Institute's new logo on 2 September, 2025. The event was held at the Bioeconomy Science Institute's headquarters, Tuhiraki, in Lincoln. The event was attended by Bioeconomy Science Institute chair Barry Harris (far right) and Transition Chief Executive, Mark Piper (far left), the MP for Ilam, Hamish Campbell, and the MP for Banks Peninsula, Vanessa Weenik. Photo credit: Bioeconomy Science Institute.

Manaaki Whenua – long-term benefits for our bioeconomy

Over the years, Manaaki Whenua's science has made significant contributions to New Zealand's bioeconomy.

Weed biocontrol, over the nearly 100 years it has been researched, has produced some of the largest return on investment for New Zealand of any science, as the following examples show:

- The control of the invasive weed St John's wort was recently calculated to have given a 6200:1 return on every dollar invested since the 1940s. It has saved 660,000 hectares of the country's pastoral land from being completely overrun with the weed at an estimated yearly eradication cost of \$15 million, which also illustrates the long-term nature of this science endeavour. Control of St John's wort is now completely self-sustaining.
- Control of nodding thistle using two weevils and a gall fly has resulted in an 80% decline in the weed and a benefit:cost ration of 580:1, representing a current saving of around \$28 million per year in control efforts.
- Heather was planted in Tongariro National Park (TNP) in 1912 to provide food and cover for introduced grouse. While grouse failed to establish, heather thrived and invaded more than 60,000 hectares of the Central Plateau, North Island. The introduced heather beetle *Lochmaea suturalis* was imported by Manaaki Whenua in 1992 and released into TNP in 1996. By 2021, 40,000 hectares of the heather had been damaged by the beetle, saving some \$17 million per year in control measures including herbicides.

Our work in modelling the contribution of tree shade to reducing heat stress in the national beef and milk herds shows that planting more shade trees in pastures could deliver around \$250 million added revenue in beef and milk production.

An outbreak of facial eczema in 1981 was estimated to have cost NZ \$266 million in lost production. Our fungal experts are working with Beef+Lamb, AgResearch and other industry stakeholders on novel approaches to eliminating facial eczema in ruminants – targeting a \$38 million cost saving for by the end of the programme [see page 26].

Wallabies are currently estimated to cost the country \$84 million per year in losses on productive land. Our current multi-aspect work on wallaby control includes GPS tracking, lures, monitoring and detection, genomics and better bait stations.

Underpinning New Zealand's productive land resources and developed over the past 30 years, our online soil map S-map now covers 11.8 million hectares, 44.3% of the country. Increased coverage and data improvements have been primarily focused on our most valuable soils (Land Use Categories 1-4), with 78.2% of this land now having S-map coverage. S-map now has 14,000 users across the agricultural and land management sectors, and 65,000 factsheets are downloaded each year.



Long-term biocontrol: Tongariro National Park before (left) and after (right) control of invasive heather by the heather beetle *Lochmaea suturalis* [top].

Soil contains about three times more carbon than terrestrial vegetation, and twice as much as the atmosphere. New Zealand's soil carbon stocks are high, so it is important to conserve what we have and increase it if we can. Since 2018, we have undertaken vital baseline mapping of soil carbon at 500 agricultural sites across the country. Carbon stocks in the top 30 cm of pastoral soils are about 100 t/ha. Resurveying of sites has also begun; sites are being revisited on a 4-year rolling resampling to determine any changes in soil carbon.

Our nationally significant database LRIS [Land Resource Information System <https://lris.scinfo.org.nz/>; actually a collection of datasets and databases] is an authoritative online repository of information on general land characteristics, a derivative general-purpose land evaluation [land-use capability], and a range of land and soil data and associated information resources related to environmental, climate, land management and production attributes. It began with the development of regional land resource data, particularly the New Zealand Land Resource Inventory [NZLRI], from the 1970s onward. Land and soil data were gradually consolidated into the LRIS database, which now includes a suite of web applications and online services. Users of LRIS are very broad and include scientists, local and national government policy-makers, businesses, iwi and hapū, universities, schools and the general public both in New Zealand and overseas.

Brushtail possums are maintenance hosts of bovine tuberculosis [TB] that readily transmit TB to livestock. Over more than 20 years, Manaaki Whenua has worked on wildlife host ecology, epidemiology, control strategies, TB surveillance and proof of freedom, underpinning the pest management component of the TB-Free programme

managed by OSPRI [formerly the Animal Health Board]. Operational application of our research has contributed to declines of TB in livestock from over 1,500 infected herds in 1995 to just 14 nationally in 2025.

Our social scientists undertake long-term social and sector surveys across the country, including the Survey of Rural Decision-Makers [every two years since 2013], the Environmental Perceptions Survey [since 2000], the New Zealand Colony Loss Survey for the apiary industry and MPI [since 2015], and the New Zealand Nursery Survey for the forestry and nursery sectors, for MPI. These nationwide surveys are invaluable datasets for better natural asset management. They help decision-makers to assess information to underpin choices and decisions, design and implement policy instruments, and track policy performance to enable adaptive management.

Founded in 2001 as a subsidiary of Manaaki Whenua, Toitū Envirocare [see page 54] now helps more than 900 businesses and organisations to make informed, verifiable decisions to mitigate greenhouse gas emissions and supports New Zealand's national emissions reduction commitments.

Often-cited research by John Innes and colleagues, published in 1999, identified ship rats and possums as the key contemporary causes of kōkako decline, which led to one of New Zealand's most successful conservation stories. The science behind the recovery of kōkako led to the development of 'mainland islands' by the Department of Conservation, and subsequently the community-led ecosanctuary movement.

Our science has always had impact...

Since 1998, Manaaki Whenua has produced:

- 2,559 contract reports helping people to make better-informed land management decisions.
- 6,712 published research papers cited 309,000 times. This translates to a citation impact factor of 1.42, which puts Manaaki Whenua ahead of all other CRIs in terms of citations, and also ahead of all New Zealand universities except Auckland and AUT.

... and we retain good staff!

Manaaki Whenua is a unique place to work, and has been proud to support and retain staff expertise over the long term. Nineteen of our current staff originally began their careers with the Department of Scientific and Industrial Research [DSIR], long before Manaaki Whenua was formed in 1992. Our two longest-serving recent retirees [excluding Research Associates] both worked here for 50 years each, and our two longest-serving current members of staff have both worked here since 1977. Of our current Research Associates continuing to contribute their expertise post-retirement, nine started their careers with the DSIR and the longest-serving originally joined us 54 years ago, in 1971.

Our context / Tō tātou horopaki

2025: Science sector reform

The announcement in January 2025, by the Prime Minister, of the Government's intention to proceed with the formation of four Public Research Organisations (PROs) is transforming the national science landscape.

As of 1 July 2025, Manaaki Whenua - Landcare Research was brought together with AgResearch, Plant & Food Research and Scion into a single entity – the New Zealand Institute for Bioeconomy Science Limited (Bioeconomy Science Institute).

At the same time, NIWA and GNS Science were amalgamated to form the New Zealand Institute for Earth Sciences Limited (Earth Sciences New Zealand), and the New Zealand Institute for Public Health and Forensic Science (PHF Science) was formed from ESR. A fourth PRO, the New Zealand Institute for Advanced Technology (NZIAT), has also been announced.

The new institutions continue as Crown entity companies, but with a strengthened ability to focus on delivering economic benefits to New Zealand.

This Annual Report looks back at the achievements of Manaaki Whenua since its inception in 1992, with a particular focus on the financial year 2024/25, and also forward to new ways of working as part of the Bioeconomy Science Institute.

About the Bioeconomy Science Institute

The Bioeconomy Science Institute's purpose is multi-faceted: to advance innovation in agriculture, horticulture, forestry, aquaculture, biotechnology and manufacturing; protect and enhance ecosystems from biosecurity threats and climate risks; enhance and protect our native forests; and develop new bio-based technologies and products.

Each constituent organisation of the Bioeconomy Science Institute has initially become a "group" within it. Over the 12 months from July 2025, these four organisations will be fully merged into one, and legislation to officially convert the Crown Research Institutes into PROs will be introduced to Parliament later in 2025.

Bringing more than 2,000 people together, the Bioeconomy Science Institute is New Zealand's largest research institute, supporting sectors contributing 80% of the nation's exports and more than 10% of GDP. This scale-up has created a research organisation of internationally significant size and standing.

Transition to the Primary Research Institutes

Since the merger announcement, staff at all levels of Manaaki Whenua have worked closely and constructively with colleagues from the other Crown Research Institutes to make the government's intention to create PROs a reality. The merged entity will be fully formed by the close of 2025 and the final build will continue into 2026, so it will be important to continue delivering on our stakeholders' and partners' needs and to reassure them of our continued commitment, especially those with whom we have long-run partnerships and multi-year contracts.

Our unique contribution to the Bioeconomy Science Institute

Our scientists lead research into the measurement, management and protection of terrestrial ecosystems and biodiversity, achieving sustainable use of land resources and ecosystem services, and helping industries and organisations to develop within environmental limits and meet market and community requirements. We also hold and curate nationally significant collections and databases on behalf of all New Zealanders. Much of this work is long-term, cumulative, underpinning – a foundation for New Zealand's economic prosperity.

Over time, Manaaki Whenua has achieved an exceptional reputation for excellence in land-based science, providing benchmarks against which environmental changes can be understood and therefore managed.

As the Bioeconomy Science Institute takes shape, New Zealand will continue to need this cross-sectoral science to solve growing environmental and social challenges. These challenges are complex, with large uncertainty, high stakes, and polarised views. Our role is to support and lead action with evidence-based understanding and capability, finding solutions from integrating our work with the work of others.

Our science has always been a highly collaborative undertaking, with ever more of our work undertaken in partnership with external groups – and this will continue in the Bioeconomy Science Institute. Our partners across central, local and regional government, the primary sector,

and iwi and hapū, help to shape our research priorities and are crucial in translating science into real-life impact. Manaaki Whenua's commitment to Te Tiriti will inform the Bioeconomy Science Institute's approach to strengthen partnerships with iwi and hapū.

Government priorities for science

As this Annual Report shows, in 2024/25 we significantly contributed to priorities for the Government expressed in our shareholding Minister's 2024 Letter of Expectation. It called for us to make the most efficient and effective use of our funding and resources, and required financial responsibility, in support of the Government's agenda for economic growth.

Working in the most efficient and effective way

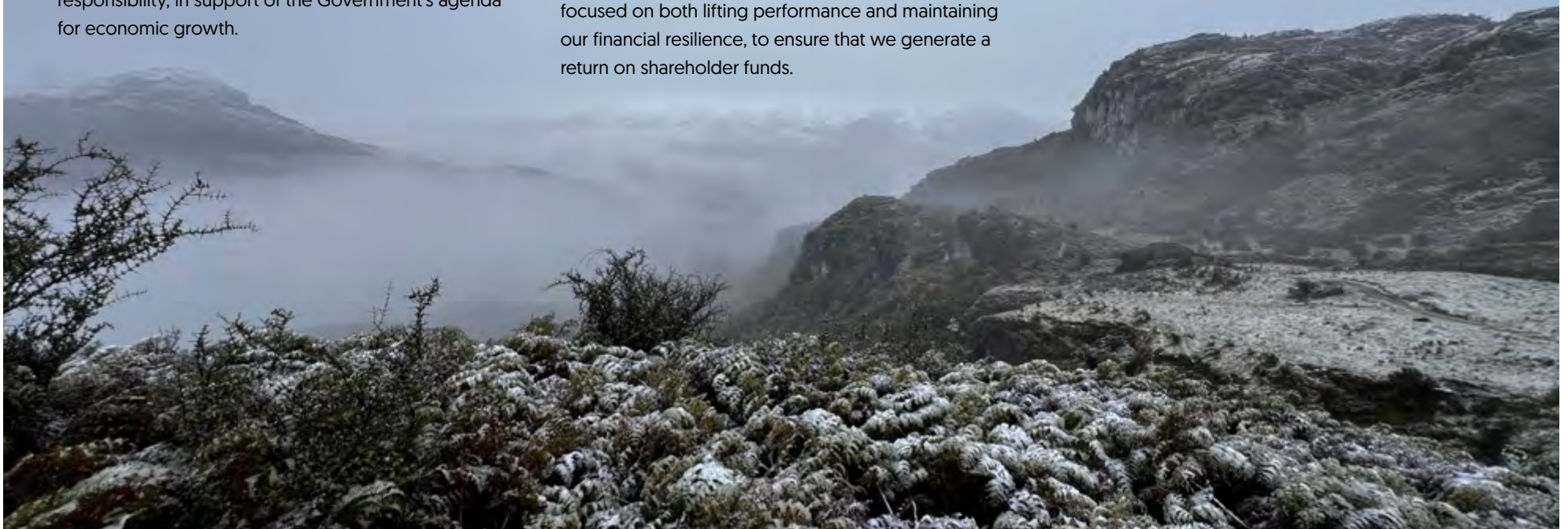
Implementing new commercial arrangements has enabled us to drive efficiency, better deploy funding and resources, and improve targeted outcomes. Embedding our impact-based assessment framework into the science we do has improved our productivity and ensured we are delivering in the most efficient manner.

Being financially responsible

We recognise the constrained fiscal environment and the need to remain financially responsible. We have an active programme of work, driven by senior leadership, focused on both lifting performance and maintaining our financial resilience, to ensure that we generate a return on shareholder funds.

We have continued to explore opportunities to work alongside markets and commercial entities to realise a return from investments made in climate and environment-positive actions, including through our subsidiary Toitū Envirocare (see page 54).

We have developed a sector-facing commercial strategy to diversify revenue and expand our client base, to improve financial resilience, and to lift the uptake of our science by the private sector.



Overview / Tirohanga whānui

Our ambition

Kia mauriora te whenua me tōna taiao [make the life-force and vitality of the land strong].

This requires a positive reciprocal relationship between people and their natural environment – between Māori iwi and their ancestral lands.

Mauriora is the Māori concept of life-force and vitality. In Māori thinking, mauriora requires the people to be connected with their ancestral lands. Māori trace their origins [whakapapa] to the land. The indivisible connection between people and their land is expressed in manaaki whenua – manaaki tangata [care for the land – care for the people]. That phrase captures the reciprocity of the relationship. In non-Māori thinking the close relationship between the land and its people has a long history and we believe our ambition statement speaks for all ethnicities.

Our purpose

Science for our land and our future – Ko te pūtaiao mō tō tātou whenua, mō āpōpō.

Agreed in 2010, our Statement of Core Purpose [SCP] is 'to drive innovation in New Zealand's management of terrestrial biodiversity and land resources to protect and enhance the terrestrial environment and grow New Zealand's prosperity'. Under the Crown's SCP for Manaaki Whenua, we are mandated to be the lead CRI provider for:

- improving the measurement, management, and protection of New Zealand's terrestrial ecosystems and biodiversity, including those in the conservation estate
- achieving the sustainable use of land resources and their ecosystem services across catchments and sectors
- improving the measurement and mitigation of greenhouse gases in the terrestrial biosphere
- increasing the ability of New Zealand industries and organisations to develop within environmental limits and meet market and community requirements.

Te Tiriti

We are committed to upholding the principles of Te Tiriti o Waitangi in all our activities. These principles are Partnership, Participation, and Active Protection of Māori interests, especially in the natural environment.

Our research impacts and outcomes

We focus on four intersecting areas of research impact [see diagram on page 22]:

- Restoring ecosystems
- Managing invasive species
- Catalysing change
- Land resources and climate change.

Delivering impact with our partners

To achieve positive impact we work alongside Māori iwi as the Tiriti partner, central and local government, business and industries, community groups, and the global research sector.

Research capability

We invest in people to achieve excellence in our research, and to strengthen capability and collaboration. We create the right teams across the spectrum of fundamental and applied science. Our research is ranked among the leading environmental research institutes globally. We maintain capability to address national emergencies, especially in biosecurity.

We aim to provide for health, safety, and well-being, for an equitable, diverse and inclusive culture, and for the future of work. Within this culture, we have worked with our people to define five behaviours that express our values in action:

Our behaviours:



Experiment to learn:
Mā tē he ka tika



Share freely and often
Kia rite tonu te tohatoha



Invite input from others:
Kia areare mai ōu taringa



Embrace diversity:
Awahi mai, awahi atu, tātou tātou e



Commit to excellence:
Whāia te iti kahurangi

Akhil Sam Son and Dr Scott Fraser doing soil augering at sunset in Northland. Image Kristin Deuss.

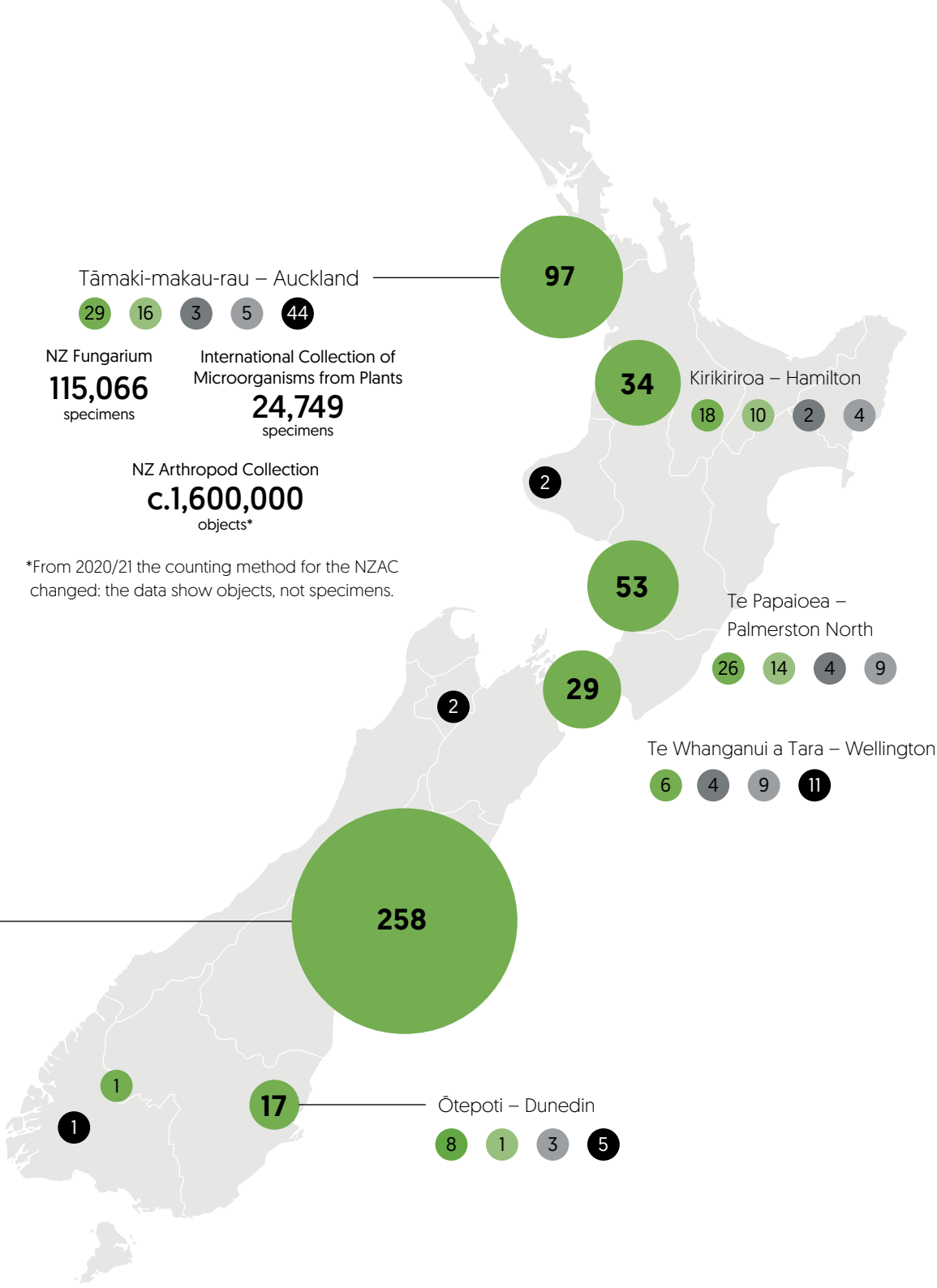
Our locations

Our sites across New Zealand house 494 staff and research associates, including the staff of our subsidiary, Toitū Envirocare. These locations facilitate scientific projects that span the length and breadth of the country.

Several sites are also home to five Nationally Significant Collections, and other significant collections that we maintain on behalf of New Zealand.

- Scientist
- Technician
- Research Support
- General Support
- Toitū Envirocare

Note: Some of our staff work remotely; we have accounted for their locations at the nearest site.



Our investments in research impacts

Investment in our science, research, and technology comes from a variety of sources, including central and local government in New Zealand, industry, and international science collaborations. The following diagram is based on provisional science revenue information for 2024/25 rather than on audited information.



Collections and databases

Manaaki Whenua is the custodian of almost a third of New Zealand's Nationally Significant Databases and Collections. These include biological resources (e.g. reference species collections), cultural knowledge, and soil and land resources. They are important scientific, cultural, and historical public good assets.

These collections provide base knowledge critical to improving the conservation of New Zealand's land-based biodiversity, including species of importance to Māori. They also provide important reference collections for identifying biosecurity risks.

In addition to our collections, we maintain a number of online databases and tools (many of which are nationally significant) that provide detailed information about our land, soils, biodiversity, biosecurity, and environment. These are available for use by our scientists and researchers, and for many other scientists, researchers, postgraduate students, government departments, regional councils, and industries across New Zealand and around the world.

Tāngata whenua also have an important connection to Manaaki Whenua's collections and databases. This is based on the relationship that tāngata whenua have with their land, and extends to include anything collected, sampled or measured from, that land. This connection is informed by the principles of Te Tiriti o Waitangi, the WAI262 claim and indigenous data sovereignty. See the selected highlights below for some examples of progress in building these connections.

Te Tiriti o Waitangi increasingly informs how we approach and engage with our Māori partners and set our research agendas. Manaaki Whenua's Statement of Commitment to Te Tiriti has been in place now for 4 years, during which time a strong theme of Māori data governance has begun to emerge. This is in part due to the momentum that has been created over this period by the Te Tiriti Partnership Group [page 18]. However, external drivers are also at play, influencing the direction of impact, including the recent report of Te Kāhui Raraunga on Māori data governance, as well as an increasingly Te Tiriti informed authorising environment.

Manaaki Whenua continues to forge a path that builds bicultural capability for its people, and both supports and encourages reflection on our Te Tiriti commitment throughout the breadth of research.

Digitising our collections is further extending their reach and usability, including for Māori interests, and our work over the year in attaching biocultural labels and notices where possible places us at the forefront of international progress in supporting indigenous rights and interests over the nationally significant databases and collections that we maintain.

Selected highlights

In a recent presentation at the 2024 Fungi Colloquium, Manaaki Whenua's Biota of NZ information system was described as the most powerful resource for fungi of its kind in the world. Free to use, it includes all fungal species, and their hosts reported from New Zealand, provides up-to-date names and classification for the fungi, an opinion about biostatus (e.g. is it really here? is it exotic or indigenous?), and contains links to the information sources supporting those statements. In addition to being an essential tool for managing biosecurity, the information on Biota of NZ has been used to ask questions like 'what is the impact of exotic fungal pathogens on native plants?', and 'how has increasing levels of trade impacted the rates of introduction of new fungal pathogens?' Biota of NZ also holds information on bacteria, land invertebrates and plants, including seed plants, ferns and allies, mosses, liverworts, hornworts, lichens, and some algae. Biota of NZ is constantly updated by experts and users can subscribe to any notifications of changes to taxonomic data.

Noted for its limestone cliffs and coral reefs, relatively little is known about the indigenous and naturalised plants of Niue, a beautiful and solitary small island in the South Pacific. Manaaki Whenua botanist Dr Peter Heenan has made a special botanical discovery on the tiny island nation of Niue, by identifying three new flora species. These represent new naturalised records of *Erigeron bellioides* DC. (Asteraceae) and *Psidium cattleianum*

Sabine [Myrtaceae]. *Crepidomanes saxifragoides* [C.Presl]
P.S.Green [Hymenophyllaceae] is also an addition to the indigenous flora.

Over 650 specimens of fungi, held at the Royal Botanic Gardens, Kew, in London, were returned to the New Zealand Fungarium – Te Kohinga Hekaheka o Aotearoa this year. The fungi formed the private collection of Dr Greta Stevenson [1911 – 1990], a New Zealand botanist and mycologist renowned for describing many new species of Agaricales [gilled mushrooms]. She and the collection moved to England where she completed her taxonomic work and prepared a five-part series on the Agaricales of New Zealand, published between 1962 and 1964. These invaluable specimens will now be catalogued and used for research and for species revisions.

Staff at the New Zealand Arthropod Collection, led by entomologist Dr Aaron Harmer with contributions from Dr Darren Ward and Dr Leanne Elder, have created two new semi-automated imaging tools for quickly capturing label images of pinned insect specimens for digitisation. Known as the Raked Pinned Insect Imaging Device [RAPIID], the hardware for these image systems is modular and customisable to user needs. The team has also developed a scaled-down version, RAPIIDlite, and software to run the devices, allowing them to be used by non-experts and volunteers. Initial testing shows that these tools make the imaging process around four times quicker, as well as standardising the processes and reducing error rates.

Collections data for 2024/25

New Zealand Fungarium [PDD]

landcareresearch.co.nz/pdd

115,066	Specimens
1,677	Accessions
1,850	Objects sent or received in 42 transactions

New Zealand Flax Collection

landcareresearch.co.nz/harakeke

253	Selections
311	Plants gifted through 44 transactions
141	Visitors

International Collection of Microorganisms from Plants [ICMP]

landcareresearch.co.nz/icmp

24,479	Cultures
144	Orders sent
809	Cultures sent

New Zealand Arthropod Collection [NZAC]

landcareresearch.co.nz/nzac

c. 1.6M	Objects
25	Loans
1,372	Identification & enquiries

Allan Herbarium [CHR]

landcareresearch.co.nz/allanherbarium

c. 817,000	Objects
1,323	Specimens sent
337	Identification & enquiries
294	Visitors

Databases

National Vegetation Survey Databank [NVS]

nvs.landcareresearch.co.nz

132	New datasets
1,438	Plots added
3,920	Datasets downloaded or distributed

Ngā Rauropi Whakaoranga

[Māori plant names database]

rauopiwakaoranga.landcareresearch.co.nz

2,408	Database records
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Land Resource Information Systems

[LRIS] Portal

Iris.scinfo.org.nz

787,969	Page views across all portal services
202,902	Total users
18,515	Registered users



Stakeholder input

Manaaki Whenua's partner base is very broad, as the natural environment touches every part of society. With a broad partner base comes a diversity of needs; but our partners have many shared interests. Our partners' interests in biodiversity, land, and water have remained consistent. Within the past decade, action on climate change has become a major theme.

To ensure our science stays relevant and on track to meet local, regional, and national needs, we adopt co-design principles wherever possible, including two Advisory Panels that draw on external expertise: one panel of scientists and one of stakeholders from government, iwi and industry. Our Board's Outcome Advisory Panel (OAP) provides advice to help us fulfil our Statement of Core Purpose through strategic alignment and collaboration with key users of our science, and to provide insights and advice into diversification of our customer base. Membership of the panel spans the breadth of our major sectors, partners and research interests and consists of senior representatives from key stakeholder organisations in central and local government, iwi, and the food and fibre, energy, tourism and finance sectors.

The Panel meets bimonthly with representatives of our Senior Leadership Team (SLT) and annually with the Board and SLT to explore and clarify the needs of Māori enterprise, Central and local government, and Industry. The OAP provides an opportunity to explore the challenges that they are facing and providing high-level strategic advice to our Board of Directors. We continue to improve Māori input, connectivity, and our understanding of the needs of Māori,

industry, and government. Effective engagement, strategic alliances and plans continue to progress with specific regional councils and central government entities (MfE, MPI, DOC) and industry.

This year the Panel commented on the tough economic conditions and the degree of pragmatism regarding environmental improvements in most sectors. They did talk about how carbon markets were driving land managers to consider the mix of activities that improve land resilience and how Manaaki Whenua might support this alongside regional-type spatial conservation planning indicating the least-damaging places for economic or infrastructure development. They also emphasized the strong influence of international markets in setting domestic environmental expectations – these persist almost regardless of domestic regulation. Again, we were challenged on how we could support New Zealand industries in meeting these market expectations.

Our Science Advisory Panel (SAP) brings an international scientific perspective, helping us evaluate our scientific excellence, explore emerging science needs, and develop research areas. In the 2024/25 financial year we undertook a review of science excellence for our soils, land-use, and climate change research. The SAP included members from overseas. The Panel made four substantive recommendations, which Manaaki Whenua has agreed to adopt.

The recommendations were as follows:

Recommendation 1: Manaaki Whenua should foster all possible opportunities for researchers to achieve and maintain excellence in their field, and to retain and build critical research capabilities, particularly in social science, soil science and mātauranga Māori.

Recommendation 2: Manaaki Whenua should maintain their current emphasis on achieving impact and include this as a measure of the quality of the research. Recognising that impact will take longer to achieve in the face of recent and proposed environmental and societal policy changes, Manaaki Whenua can build capability in impact creation by investing in research communication and engagement across a range of audiences.

Recommendation 3: When working with Māori and/or mātauranga, Manaaki Whenua should consistently include Māori research and engagement from the start of the process.

Recommendation 4: Manaaki Whenua should consider how they perceive and value researcher-led collaboration with other research entities in New Zealand and internationally. We recommend that Manaaki Whenua develop and implement strategies to encourage and support national and international collaborations. The latter is particularly important to rebuild connections impacted by COVID, to keep Manaaki Whenua's researchers connected into international research and to extend impact beyond New Zealand.

Our strategic pillars

Te Āpōpōtanga, our internal organisational strategy, was established in 2021. It describes our approach to creating value for New Zealand through our research, people and partnerships.

As shown on page 8, Te Āpōpōtanga established our ambition: *Kia mauriora te whenua me tona taiao* – the life-force and vitality of the land is strong.

Through Te Āpōpōtanga, our science continues to focus on our core purpose, leading research into environmental issues, opportunities and solutions, improving the measurement, management and protection of terrestrial ecosystems and biodiversity, achieving sustainable use of land resources and ecosystem services, and helping industries and organisations to develop within environmental limits and meet market and community requirements.

Te Āpōpōtanga has served us well for nearly 5 years. It has proved adaptable to meet new and emerging challenges and has been a useful framework for our long-term thinking as an organisation. It has enabled us to pivot quickly to develop new opportunities and to meet our shareholder's expectations.

As we move into the Bioeconomy Science Institute, the main pillars of Te Āpōpōtanga remain relevant to us and to the Bioeconomy Science Institute's success. We bring a successful, high-performing workforce, with strong, deeply embedded and collaborative values, to the Institute.

Since its adoption, Te Āpōpōtanga has focused on three strategic pillars:

Strategic pillar 1

Drive research impact with our partners

Together with our partners we will prioritise New Zealand's needs from research (now and in the future) and develop strategic investment pathways. Research impact will be accelerated through user-centred developments. We will leverage data and digital technologies where they add value.

Strategic pillar 2

Weave the principles of Te Tiriti into our fabric

The Tiriti principles will guide Manaaki Whenua to a balanced state of partnership; in finding inspiration and value while engaging science and mātauranga; in influencing our strategic leadership towards equitable outcomes; and in growing both the number of Māori in the organisation and our networks among iwi and hapū.

Strategic pillar 3

Create a sustainable environment for our research and people to thrive

We will ensure our people have the right environment and personal development in which to work to their greatest potential, so that Manaaki Whenua fulfils its national role and sustains and grows its national and global impact.



Senior researcher Dr Sam McNally undertaking research into carbon cycling in rural landscapes.

Drive research impact with our partners

This strategic pillar sets the core direction for Manaaki Whenua, supported by strategic pillars 2 and 3.

Our research has impact when it is valued and used by our partners and contributes to meaningful, positive change for society and the environment. New Zealand's environmental issues are broad, but our research resources are limited, so it is essential we work on the major priorities and accelerate the impact of that work in partnership.

We leverage data and digital technologies where they add value.

Our current priority initiatives within this pillar are:

1.1: Impact management planning

Manaaki Whenua has used the Impact Planning and Evaluation Network (iPEN) impact creation cycle to conceptualise how impact from science is generated. While in reality this is more an iterative than a linear process, the cycle presents the key stages and activities required.

We are actively managing for impact, exploring opportunities to work alongside markets and commercial entities to realise a return from investments they make in climate and environment-positive actions.

Implementing new commercial arrangements will help us to drive efficiency, better deploy existing funding and resources, and improve targeted outcomes.

Progress in 2024/25

During the past year we ran a multi-sector-facing commercial pursuit process across each of our main areas of research, aiming to diversify our sources of revenue, improve our financial resilience and lift uptake of our solutions. We pursued opportunities outside of our traditional areas of activity, including the energy, tourism, and finance/insurance sectors.

1.2: Data and digital transformation

To an increasing extent, all our science is digital science. Our vision here is for Manaaki Whenua to embrace and leverage the disruptive power of digital technology in pursuit of high-impact research. We enable Manaaki Whenua researchers to undertake increasingly complex, transdisciplinary research across a wide diversity of research questions. Advanced eResearch tools and techniques not only power novel approaches to research, but also enable us to build solutions that address the real-world problems faced by those who manage New Zealand's land environment.

Examples of progress in 2024/25

We have continued to build and support a highly capable team of data scientists, software engineers and developers. We have backed this with an eResearch support team to ensure access to digital science tools and techniques. We are increasingly harnessing the power of big data and deep learning to help solve complex environmental problems.

Generative Artificial Intelligence (GenAI) is advancing rapidly, particularly in areas such as Retrieval-Augmented Generation (RAG) and applied reasoning. These developments offer new ways to increase the value of our digital resources.

We have two signature projects underway. The first is a pilot tool, SoilInsights, which is helping scientists manage and retrieve intergenerational knowledge from our extensive digital library of soil science research. This collection spans more than 40 years of findings and includes early New Zealand soil information from 1920 to 1960. This is a largely untapped resource. The pilot is exploring how to unlock decades of valuable pre-database insights that remain hidden but are still highly relevant today.

The second project is examining how GenAI technologies can be used to create personalised AI agents with deep institutional and domain knowledge. The aim is to replicate the experience of interacting with the original scientist, enabling a wider range of people to access and benefit from the expertise of internationally recognised, long-standing specialists in their fields.

Weave the principles of Te Tiriti into our fabric

This pillar recognises that Māori, iwi, hapū and whānau are key partners for Manaaki Whenua as we seek to deliver on our ambition: Kia mauriora te whenua me tōna taiao. Māori have a growing influence and indigenous body knowledge over land use and biodiversity outcomes. The Māori economy is on the rise, making Māori significant potential investors both economically and environmentally. As kaitiaki [guardians] of the whenua [land] and taiao [environment], Māori are key partners as we prioritise our research and drive impact for New Zealand.

Our commitment to Te Tiriti

Manaaki Whenua's tauākī ngākau titikaha [statement of commitment] to Te Tiriti was signed on 30 June 2021.

"Manaaki Whenua commits to upholding the principles of Te Tiriti o Waitangi as defined by the courts and the Waitangi Tribunal, and reaffirmed by Te Arawhiti [The Office for Crown Māori Relations] and Cabinet Office guidelines of October 2019. These can be fairly summarised as the Treaty principles of: [1] Partnership, [2] Participation and [3] Active Protection when working with iwi and Māori interests. Manaaki Whenua will incorporate these principles into our aspirations, strategy and our working practices to inform and guide us in our engagement with iwi entities and Māori land trusts and incorporations."

"E ngākau titikaha ana a Manaaki Whenua kia whakamarangahia ngā mātāpono o te Tiriti o Waitangi. Kua tautuhia ēnei mātāpono e ngā kōti me te Rōpū Whakamana i te Tiriti, ā, kua whakatūturingia e Te Arawhiti me ngā aratohu nā Te Tari o te Rūnanga o te Kāwanatanga i whakaputa i te marama o Whiringa ā Nuku 2019. Hei

whakarāpopoto, ko ēnei ngā mātāpono e whai ake nei: [1] ko te rangapūtanga, [2] ko te whai wāhitanga, [3] ko te āta manaaki inā e mahi tahi nei tātou ki ngā whaipānga a te iwi, a te Māori anō hoki. E mea ana a Manaaki Whenua kia whai wāhi mai ēnei mātāpono ki ō tātou wawata, rautaki, tukanga mahi hoki hei whakamārama, hei ārahi hoki i a tātou i te wā e whakarato nei tātou i tō tatou whāinga roa."

The Treaty principles apply across Manaaki Whenua and not just to our research. Our goal is to reflect the spirit of partnership enshrined in Te Tiriti, support Māori in playing an active and equal role as a partner across Manaaki Whenua, and ensure active protection of Māori interests and equitable outcomes for Māori in our work. In being true to the principle of partnership.

Manaaki Whenua has aspired to be a partnership between cultures, each bringing their own, equally valued, knowledge system.

Moving forward we will apply the principles in how we engage with iwi 'at place' and where our science is relevant to Māori. We will reach out and seek to connect early on to co-design projects and we will approach our relationship with iwi in the spirit of partnership.

Our current priority initiatives within this pillar are:

2.1: Building our capacity to partner with Māori

Manaaki Whenua continues to build capacity to partner with Māori, whether that be with iwi, hapū, rūnanga or Māori businesses. Acknowledging differences in Māori priorities – which range from the well-being of people and the environment to ensuring economic growth –

contributes to determining where we should be building capability, thereby ensuring we are giving effect to our commitment to weave the principles of Te Tiriti o Waitangi into our fabric.

Progress in 2024/25

Our bicultural competency programme Kia Maia continues to provide resources, training and encouragement to staff to develop the competencies and skills to deliver on our Tiriti commitment and to engage with Māori. Initiatives include access to online te reo training, Tiriti workshops, advice on tikanga [customs] and – for tangata tiriti, non-Māori, how to prepare to arrive as guests [manuhiri] in knowledge processes, whether supporting or doing research.

The Poipoia Kia Rere intern programme forms part of our commitment to build pathways into Manaaki Whenua for kairangahau Māori, creating new pathways for these tauria [students] to see a future in science and at Crown Research Institutes more broadly. Interns work on a wide range of research, including Māori-centred projects in environmental science, mātauranga-informed monitoring, and restoration ecology. The programme is explicitly designed to scaffold technical skills, cultural confidence and professional belonging. It is complemented by Manaaki Whenua's broader commitment to leadership development, including senior Māori roles that provide students with visible role models and pathways into permanent employment. This year 3 Poipoia Kia Rere interns were supported by Manaaki Whenua supervisors across the motu – the projects covered the dispersal of piirairaka [fantail], seed banks, and work at Te Kohinga Hekaheka [the Fungarium].

2.2: Partnership in the collections and databases

Manaaki Whenua's collections and databases Te Tiriti Partnership Group, Te Rōpū Rangapūtanga Tiriti, was established to oversee the implementation of a comprehensive strategic plan for our collections and databases, and to advise us on how best to connect hapū and iwi to the taonga we hold on their behalf as their Te Tiriti partner. The group embodies a structural commitment to enabling Māori access to and governance over scientific knowledge systems. This group is dedicated to ensuring that Māori can reconnect with institutional collections and datasets, particularly those relating to biodiversity, soils, and environmental heritage. These resources are critical for contemporary planning, environmental monitoring, and cultural revitalisation. The Kaitūhonohono (connector) role facilitates the operationalising of relationship-based governance of the collections, ensuring that the held data and knowledge systems are not just technically accessible but relationally accountable.

Progress in 2024/25

The Collections protocol has been further developed during the year to provide ethical guidelines for the collection, care, and management of biological specimens and taonga, ensuring alignment with Te Tiriti o Waitangi and Māori cultural values. It reflects a commitment to respectful partnerships with Māori, recognising their role as key stakeholders and integrating mātauranga and tikanga Māori into collection practices. Emphasising the principle of "Connect before you Collect", it advocates engaging with Māori communities and kaitiaki before collecting, to prevent intergenerational harm and uphold cultural significance. The protocol supports scientific standards while protecting Māori heritage through partnership, participation, and active protection.

He Whakaputanga Hua – The Value of the Biological Collection and Information System to Māori celebrates the national and global significance of the biological collections and information systems. Filmed in Lincoln and Tāmaki in 2024-25, the film highlights how these resources enrich understanding of New Zealand's unique biodiversity and contribute to sustainability. As the Collections evolve into a dynamic, living taonga, they foster reconnection between iwi, hapū, and Māori with their whenua, taonga species, and ancestral knowledge—integrating whakapapa and Mātauranga Māori. Featuring pūrākau from tangata whenua and insights from our tangata Tiriti scientists, the film and accompanying handouts aim to inspire future engagement, highlighting benefits and will be shared across social media, the website, and with key stakeholders.

2.3: Partnering with Maori for impact

Manaaki Whenua is focused on an end-user-centred approach and engaging deliberately with Māori business. This initiative will help guide how we respond to the end-users of the science and become proactive in discussing, planning, and implementing pathways to address aspirations and priorities that affect all Māori, with the benefits overflowing to New Zealand.

Progress in 2024/25

Kaihautū Dr Nikki Harcourt was announced as a joint winner in the Te Tohu Tūhura (Charter a Course for Impact through Partnering with Māori) category at the annual Science New Zealand Awards in March 2025. Nikki collaborated with Hikurangi Bioactives Limited leads Dr Damian Skinner and Manu Caddie, on a programme of research to support the ongoing development of a market for kānuka products in New Zealand. From an ao Māori perspective, kānuka is an important taonga species, with mātauranga Māori knowledge about the ways of observing and living with these species being handed down through the generations. Perhaps one of the most valuable outcomes

from the partnership was the creation of the Māori Kānuka collective, Hā Kānuka, which has actively shared insights and learnings with other Māori entities from across the motu.

In partnership with Ngatirua hapū, Dr Warwick Allen and colleagues conducted the first systematic survey of vegetation and bird communities in Mangāōnui Forest, Te Tai Tokerau. Data from 108 plots were combined with satellite imagery, LiDAR, and climate/topography models to map forest types, biodiversity patterns, and taonga species distributions. The results were shared at a wānanga at Taupāō Marae and will inform Ngatirua's long-term kaitiakitanga and forest management planning. Funded by Ngā Rākau Taketake and the Vision Mātauranga Capability Fund, this work supports iwi-led conservation and enhances understanding of indigenous ecosystems. See also page 29 for another example of plot surveying for local mana whenua and landowners.

During the year we received a request for scientific advice from kaitiaki in Tauranga, wanting to look at the potential of proven methods stemming from mātauranga of contaminant absorption using fungi as a bio-remediation material. Following a successful Vision Mātauranga Capability Fund funding proposal, kaihautū Ani Kaunamu is now working alongside Ngāti Kuku at Whareroa Marae to co-develop a project about the effects of industrial contaminants on the soil and the whenua, based on this initial request.

Create a sustainable environment for our research and people to thrive

This pillar focuses on ensuring that our operating model, processes and systems are optimised to support efficient, high-impact research delivery.

Our current priority initiatives within this pillar are:

3.1. Mahi Tahī

The Mahi Tahī (Working Together) programme is primarily an investment in future efficiency and sustainability. Its main objective is to release 60 hours of researcher time per FTE each year through better processes, systems, and task allocation, while also lifting staff well-being and strengthening key organisational platforms.

Progress in 2024/25

The programme moved from design to delivery at the start of FY25, adopting a tranche-based approach. Tranche 1, Idea to Project, was delivered mid-year and established a single, end-to-end pathway that guides an idea from inception through scratch budgeting, approvals, and proposal development. This clear route has already improved efficiencies reduced the amount of rework for researchers.

Tranche 2, Project to Output, is well advanced and will be delivered in two drops scheduled for July and August 2025. This work standardises project initiation so every bid is captured consistently, clarifies role accountabilities, introduces a new resource-forecasting tool, tightens procurement controls, and will deliver upgraded enterprise reporting.

With Manaaki Whenua's research operations transitioning into the Bioeconomy Science Institute, the programme is now focused on completing the end-to-end lifecycle redesign and embedding its process and system improvement methods into business-as-usual practice.

3.2 Future of work

Equipping our people for the future of work is a critical priority for Manaaki Whenua.

Progress in 2024/25

For many years Manaaki Whenua operated under a matrix structure that cross-referenced science capability with project management and business support functions. In September 2023, a decision was made to review the matrix structure to see whether it was still fit-for-purpose to deliver science with impact. The work was part of the organisation's strategic response to emerging government signals about financial responsibility and efficiency. Five staff advisory groups worked in detail to inform a wide-ranging matrix review, looking at workflows, business development and research delivery.

The review report made 120 recommendations to better support research delivery. After further extensive staff consultation, in November 2024 final decisions on a revised science capability framework were made, replacing the matrix structure with a business unit structure.

Four new science impact areas were established: Restoring Ecosystems, Managing Invasive Species, Catalysing Change, Land Resources and Climate Change. Science team leaders, team coordinators, research priority area leaders and capability leaders were mapped across these impact areas. The new operating structure took effect in early 2025.

Our people are equipped to work alongside and with emerging technologies such as generative AI and other AI-based technologies (including machine learning and deep learning). These technologies are developing fast and are rapidly changing the ways our people work. Advice and organisational policies on responsible best-practice AI use are being developed both on the science and support sides of the business.

Our science

Tō tātou pūtaiao

Delivering on our core purpose, to fix the complex environmental problems facing New Zealand, requires exceptional science and research integrating a wide array of scientific disciplines.

Manaaki Whenua acknowledges mātauranga Māori (New Zealand indigenous knowledge) as a world view complementary to Western science. We believe that our work and impacts are enriched when we build understanding between scientific and Māori world views. Mātauranga Māori stands alongside our science in providing insights into our land and our future for all New Zealanders.

Innovation stories can be found on the Manaaki Whenua website:
landcareresearch.co.nz/innovation-stories



Field Technician Emily Lawrence restocking wallaby traps and resetting trail cameras in South Canterbury.



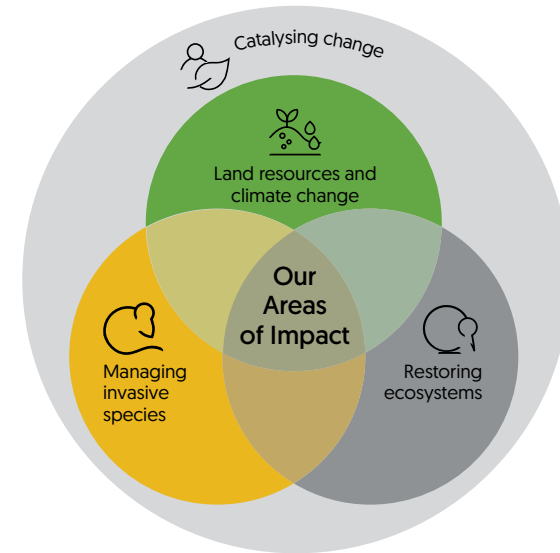


Our four research impacts

Our four areas of research impact are designed to present our science and research in an approachable and meaningful way, for all people in New Zealand to engage with.

Much of our research work is focused where these four areas of research impact overlap. This integration is important to many of our partners, who must address issues collectively and not in isolation. Our partners address not only the integration of land, water, and biodiversity, but also the integration of social, economic, and cultural dimensions.

Our research in these four areas has 12 research outcomes, which are needed by our partners.



Our 12 research outcomes



1. Critical knowledge of the wealth, state, and trends in our biodiversity, soils, and lands informs natural resource decision-making

Our environmental data resources and foundational knowledge provide fundamental information for New Zealand's economy, environmental management, environmental recovery, and social development. Our data are used by policy makers and land managers across the country and further afield in the Pacific region to underpin wise choices and decisions about land use.



2. Hapū and iwi act confidently as kaitiaki of their whenua using science and mātauranga Māori

In a post-Treaty of Waitangi settlement landscape, iwi, hapū, and whānau are repositioning themselves to enable active kaitiakitanga, from the bottom up and the top down. Across Manaaki Whenua, but particularly through our Manaaki Taiao rūpū [group] of kairangahau Māori [Māori researchers], we work with iwi, hapū, and communities to develop strategic planning, policy, and monitoring tools informed by mātauranga Māori and science to support kaitiakitanga. Over time we are building strategic partnerships with our Māori partners for mutual benefit.



3. Māori land trusts and incorporations achieve their aspirations for their land

Following Treaty settlements, Māori entities are increasingly important landholders in New Zealand. We aim to provide tools and enhance capabilities in partnership with Māori land trusts and other incorporations to support their management decisions.



4. Ecological restoration is guided by knowledge of past and present ecosystems

Our research provides baseline information to show how species and ecosystems respond to environmental changes and human activities, and to help inform conservation management plans and policies.



5. Land use, soils, and erosion are managed to improve freshwater quality

We undertake a diversity of research and consultancy projects, including fundamental understanding of erosion processes, landscape dynamics and response in a changing environment, erosion and sediment modelling, and tools for the control and mitigation of soil and land degradation.



6. Productive lands are regenerative at the landscape scale

We support the productive sector to make effective decisions to improve productivity, reduce costs, and operate sustainably as part of the drive towards a sustainable food and fibre sector.



7. Risk and harm from invasive organisms are mitigated

Our native biodiversity and our ability to derive income both from primary industries and from our unique landscapes are constantly threatened by invasive weeds, pests, and diseases. Our work enables New Zealand to better respond to biosecurity threats, reduce pest, weed, and disease impacts, and better protect our native taonga. Our collections are a critical component of biosecurity responses,



8. Biosecurity tools are available with social licence

We design and develop socially acceptable biosecurity tools for wildlife management, and for the control of invasive plant species. Our collections are vital to the development of these tools.



9. Communities and regulators have adaptation pathways for climate change

We have built significant expertise, capability, and capacity and positioned ourselves as one of the leading science providers in New Zealand for climate risk, resilience, and adaptation research, with a growing international profile through high-impact publications and collaborations. Working with a wide range of stakeholders, we have developed new tools, frameworks, and processes to support adaptation planning, risk and resilience assessment, monitoring, and evaluation frameworks.



10. Greenhouse gas emissions and removals are managed to mitigate climate change

Sustainable land management to create climate-smart landscapes is an essential part of ensuring New Zealand reaches its climate emission targets. Our science enables the right decisions to be made and the right policies to be put forward to manage our greenhouse gas emissions now and in the future.



11. Environmental decisions are underpinned by advanced geospatial information

Mapping and regular monitoring of land cover and land use are critical to understanding environmental state, health, and pressures. Our nationally significant digital databases of land use are the authoritative information source for this work.



12. National environmental outcomes are improved by integrating social practice theory, policy tools, and economics.

Our team of social and economic scientists is the largest in the Southern Hemisphere dedicated to researching the human dimensions of environmental management.

Progress in 2024/25

The following pages showcase the innovative science we undertook in 2024/25, taking each research impact area in turn.

Restoring ecosystems

We are New Zealand's lead agency for ecosystem research. Natural ecosystems underpin the bioeconomy, which is of course is the economy: 13 of the country's top 20 export commodities – more than 70 per cent of our entire export earnings – depend on natural resources. And 70% of our export value is derived from economies with mandatory climate or sustainability-related disclosures in force or proposed. Land-based science that enables the restoration of ecosystems is not a luxury: it's the protection of prosperity in systems increasingly vulnerable to external economic and climate-related shocks.

New Zealand's unique indigenous biodiversity faces ongoing pressure from multiple threats. We investigate how species and ecosystems respond to environmental changes and human activities, helping to inform biodiversity management plans and policies. Our science drives innovative solutions that guide management decisions and enhance long-term environmental and economic prosperity.

Our research provides insights into past ecosystems and deepens our understanding of how they function today, knowledge that is vital for reversing ecosystem degradation. We have unparalleled capability nationally to generate, synthesise and interpret data from the past and the present to help model and inform future predictions, boosting New Zealand's resilience to climate-related and economic shocks.

We undertake research across varying spatial scales [national, regional, local site-based] and varying time scales [present day, decadal, centennial, to millennial] and integrate these to enable informed and resilient land management.

The Nationally Significant Collections and Databases that we host on behalf of New Zealand are an archive and a critical benchmark in safeguarding New Zealand's exports to global markets. Understanding what is here already makes it possible to track change, identify new threats, and avoid potential costs to producers, the Ministry for Primary Industries (MPI), and indeed New Zealand's reputation and its environment. The collections and databases, unlocked through the expertise of the researchers that work with them, enable the preservation and management of biosecurity and biodiversity, the discovery of new applications for biological materials, and directly support the resilience of our environment and bioeconomy.

Selected highlights

Recent work led by Dr Alex Boast and Dr Janet Wilmshurst from the Long-Term Ecology Laboratory has expanded the potential sites for future kākāpō population recovery. Ancient DNA and pollen analyses of preserved kākāpō coprolites (droppings) revealed that the birds were historically eating almost twice the range of plants they are known to consume at present, including seeds and leaves of southern beech as well as nutrient-rich beech mistletoes, and therefore their dietary range and habitat was much wider than it is today. The Department of Conservation (DOC) has found this information especially valuable as they search for new sites to relocate kākāpō, enabling them to consider a broader range of suitable locations.

As part of the MBIE Endeavour-funded project More Birds in the Bush, our researchers have compiled observed demographics of native forest birds under different management and temperature gradients in forests. Their literature review resulted in demographics recorded for 26 species, with 5,582 nests monitored and 10,023 adults followed. In total, this represented a staggering amount of fieldwork by hundreds of people from community groups, students, agencies and researchers from different organisations. Importantly, the analysis showed that across the bird community invasive predator management increases nest survival but not adult survival. Invasive predator suppression and eradication therefore reduces impact on precious native avifauna, and ideally should be targeted to coincide with the vulnerable period of nesting.

Our palaeoecological scientists joined with international researchers to show that the last historical refuges of moa are the same places that much of our unique biodiversity (such as takahe and great spotted kiwi) is relegated to today. These insights emphasise the importance of protecting remote and minimally impacted regions, which continue to serve as vital sanctuaries for these species.



Senior Technician [Ecology] Paul Robbins (left) and Kevin Hare of the Rongowhakaata Iwi Trust establishing a permanent forest monitoring plot in Rākaukākā Forest.

Conservation ecologist Neil Fitzgerald is working with the Department of Conservation and Massey University to better understand the threats to long-tailed cuckoo/koekoeā. Koekoeā breed only in the forests of New Zealand. Here, they lay their eggs almost exclusively in the nests of pōpokotea (whitehead) in the North Island, and mohua (yellowhead) and pīpī (brown creeper) in the South Island – three closely related endemic forest birds. In late summer and autumn koekoeā migrate up to 6,000 km to islands scattered across the Pacific. The researchers aim to track koekoeā to better understand their movements and their relationships with these host species, and have enlisted the help of citizen scientists to look out for accidentally killed specimens to help establish migration patterns.

Avicennia marina australasica is our only mangrove tree. Known as manawa in te reo Māori, it is a small, native subspecies of the Australian grey mangrove. Mangroves are found in only a very small area of the country, but like mangrove forests around the world, they are home to unique biodiversity both in the water and on land, act as a buffer against coastal erosion and storm surges, stabilise soil and capture carbon. Until recently there was no globally accurate picture of mangrove extent or the many benefits they provide to people. A new report by the UN Environment Programme, involving Manaaki Whenua senior researcher in landscape ecology Dr Dan Richards among many co-authors from around the world, focused on analysing changes in mangrove carbon stocks over two decades. The combined results showed that net stocks of mangrove carbon have stabilised to some extent. From 1996 to 2020, only around 3.4% of the global mangrove carbon stocks were lost. This is much better news than was expected, although this still amounts to a substantial 139 megatonnes of carbon.

Innovation stories

Major step forward in understanding Facial Eczema in livestock

Facial eczema (FE) is a disease of livestock that causes liver damage, lowered production, skin irritation and peeling, and sometimes death. It is caused by a toxin (sporidesmin) produced primarily by the spores of a fungus growing in the dead litter at the base of pasture in warm moist conditions. Sporidesmin, when ingested by cattle, damages the liver and bile ducts. The damaged liver cannot get rid of a breakdown product of chlorophyll, which builds up in the blood causing sensitivity to sunlight, which in turn causes inflammation of the skin. FE has cost New Zealand's economy an estimated \$332 million annually.

Now, a significant breakthrough in understanding FE in livestock has brought New Zealand closer to reducing the disease's devastating impacts.

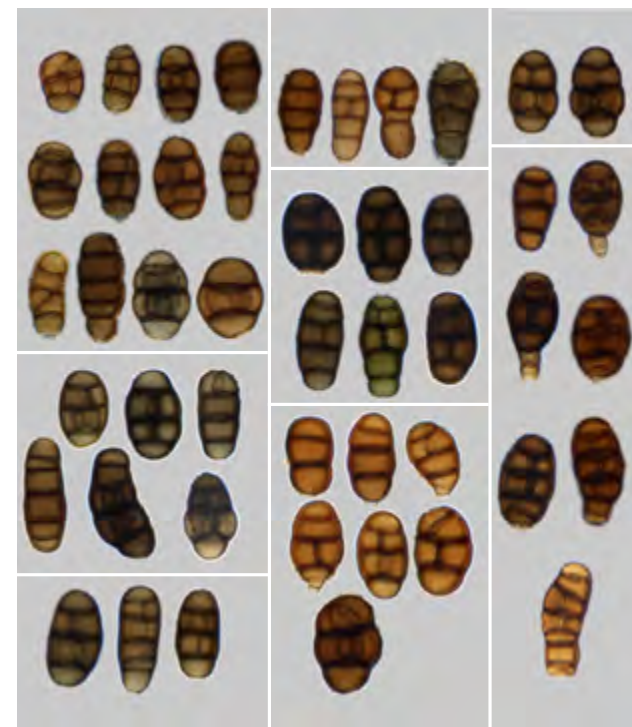
Until recently, sporidesmin, the toxin responsible for FE, was thought to be made by the fungus *Pseudopithomyces chartarum* (formerly *Pithomyces chartarum*).

Earlier this year, a consortium of researchers from AgResearch, Manaaki Whenua, Beef + Lamb New Zealand (B+LNZ) and the Livestock Improvement Corporation were able to show that in fact few *Pse. chartarum* strains appear capable of making sporidesmin, and a new species, *Pseudopithomyces toxicarius*, is the primary sporidesmin producer. *Pse. toxicarius* resembles *Pse. chartarum* closely and is easily misidentified.

The research reclassified the fungus using global data, which was made possible through the ICMP fungal collection, including a critical 1958 specimen. Providing

a clearer understanding of the disease's causes will also enable better tracing of where it has spread, as well as paving the way for more effective control strategies.

Dr Bevan Weir, a senior scientist at Manaaki Whenua and an expert on fungi, was a lead researcher in the identification process. "This breakthrough is the result of years of hard work and dedication from our research teams and the farming community," says Bevan. "Identifying *Pseudopithomyces toxicarius* as the primary cause of Facial Eczema is a critical step forward and a testament to the commitment of everyone involved."



This composite photograph shows how similar conidia/spores of different species of *Pseudopithomyces* are.

FE risk is currently assessed on-farm using spore counting methods, but because of the above problems of misidentification, the counts may have included non-toxic spores, leading to inaccurate risk assessments. However, the researchers urge farmers to still keep monitoring and participating in studies like the B+LNZ Sheep Poo study, because spore counting remains an important tool for farmers to understand and manage FE risk in their regions.

With a clearer understanding of the fungus that produces sporidesmin, researchers are now better equipped to develop tools and diagnostics that will help eliminate the effects of FE on New Zealand's farming industry. The work also showcases the long-term value of New Zealand's scientific collections in guiding future management and control.

Are birds always on the menu for rats in New Zealand's beech forests?

A recently published study has shown that native birds are always on the menu for invasive rats in New Zealand's beech forests, regardless of how much other food might be available. The study delved into the DNA inside rat stomachs and showed that one in five rats in a remote Fiordland forest had been eating birds.

The research – a collaboration between researchers at Manaaki Whenua – Landcare Research and the Department of Conservation [DOC] – aimed to understand how rat diet may change over different years. Ship rats have a field day during beech “megamasts” (mass seeding events), when the flood of extra food in the forest leads to a population spike. These increased numbers of rats spell trouble for our native birds, but a crucial question remained – is it just the extra rats that are the problem, or are birds also a bigger part of the rat diet when the seed runs out?



Birds are on the menu for rats in beech forests.

“Answering this question is important to enable the best timing of predator control efforts for bird conservation,” explains lead researcher Dr Jo Carpenter. “If rats do end up eating birds more often when beech seed runs out and they begin to starve, that suggests pest control should be timed just before that happens. However, if they eat birds at a similar rate all the time, that suggests we need to always be keeping their numbers down.”

But, until now it's been very difficult to tell exactly what rats eat, partly because they chew their food up so

finely. The researchers got around this problem by using genetic techniques to illuminate the “ghosts of past meals” by screening the DNA of over 200 rat stomachs. These stomachs came from rats trapped at Lake Alabaster in Fiordland over three years following the megamast of 2019.

The results were sobering – the rats were eating 15 different native and introduced bird species (with a particular fondness for native silvereyes and introduced blackbirds), as well as 40 different plant species (mostly silver beech and broadleaf species, but also mosses and orchids). The proportion of rats consuming birds was surprisingly high – nearly one in five rats overall had bird DNA in their stomachs, with more birds eaten at lower altitudes where birds are more abundant. However, this proportion didn't change over the three years – one in five rats ate birds all the time, suggesting that most rats did not switch to eating more birds when the beech seed bonanza finished.

“We were surprised by how frequently the ship rats were eating birds,” comments co-author Dr John Innes, “because most other studies have found birds are only an occasional part of ship rat diet. However, those studies have all had to pick through rat stomachs to find tiny fragments of eggshell or feathers, so it could be that bird consumption was under-estimated.”

So what does this mean for conservationists? “Our findings suggest that it's the sheer number of rats in a mast year that are the problem for our native birds, rather than those rats also eating birds more frequently than usual,” explains co-author Dr James Griffiths, a science advisor at DOC. “This means it's critical for rats to be kept at low densities where possible, while also timing that control to best protect birds when they are particularly vulnerable, such as during nesting.”



Gallacea scleroderma, Arthurs Pass.

Ancient poo proves moa were key dispersers of colourful truffle-like fungi

In a curious case of finding something unexpected whilst looking for something else, Manaaki Whenua's palaeoecologists have discovered that ancient moa were fond of fungi, particularly colourful truffle-like species that mimic fruit. This discovery, in turn, has helped to advance our understanding of present-day and likely future native forest resilience.

The story begins with two ancient bird coprolites – fossilised poo – collected several years ago from dry caves in two remote locations in New Zealand's South Island beech forests. Coprolites can be carefully picked apart and analysed for DNA and microscopic remains to find out what species of birds deposited them and what they ate. Studying ancient bird coprolites helps to reconstruct what

ecological roles extinct birds used to play in shaping New Zealand's ecosystems before they died out.

Initially included in a study of kākāpō droppings, the ancient poo turned out to be from the upland moa. Weighing less than 50 kg, this species was one of the smaller members of at least nine species of moa [the larger members reaching over 3 m tall and 250 kg in weight]. This guild of birds was flightless, herbivorous and ground-dwelling, and all went extinct around 600 years ago.

Rather than put the coprolites back in the specimen box, the scientists took the opportunity to fully analyse them, with some surprising results.

Truffle-like fungi have fruiting bodies that never fully open and lack a way to eject their spores. Whereas other fungi do this by wind, the truffle-like fungi rely on animals to consume them and disperse their spores. Overseas such fungi – including “true” truffles – are generally drab, strong-smelling and highly appealing to mammals. By contrast, those in Aotearoa New Zealand are often brightly coloured and look much like fallen berries on the forest floor.

It is likely that these fungi depended on fruit-eating birds for their dispersal, yet there is little evidence that any present-day native birds eat them. Ecologists have long debated that their original dispersers must be extinct birds, but this has not been demonstrated before.

Previous work on coprolites has already shown that the extinct moa ate brightly coloured fruits and other plant matter, but the new analyses revealed that moa were indeed consuming these colourful truffle-like fungal species. This finding adds weight to the idea that these fungi had evolved specifically to be attractive to fruit-eating birds. Moa would have been good at dispersing the

fungal spores, too. Comparison with their distant cousin the ostrich, which retains food for some 36 hours after eating it, shows that moa could have carried spores in their gut over long distances.

But given the large birds are extinct, what if anything is now driving the dispersion on which these fungi once depended? What will eventually happen to the evolutionary anachronisms – species that rely on other species to establish and thrive that are no longer there? Further how is this loss likely to affect current native forest resilience and its capacity to regenerate and expand?

It's unlikely that remaining species of herbivorous ground dwelling birds, such as weka, can make up for the loss of moa in dispersing these fungi. In turn, this may be having knock-on on overall forest resilience. Forest species such as New Zealand beeches have evolved symbiotic relationships with native fungi such as the ones detected in the moa poo, to benefit their regeneration and resilience, so fewer or less widespread native fungi in the mix may decrease forest resilience overall.

Are non-native mammals such as possum or deer able to take the place of the moa? No: scent-driven mammals are not so interested in non-odorous, fruity fungi that evolved to catch a ground dwelling bird's eye, and native fungal spores also don't survive so well in the mammal gut. Instead, non-native mammals tend to disperse non-native fungi, which in turn promotes symbiotic relationships with non-native forest species, at the expense of native ones, with possible flow-on effects on native forest resilience.

The long-term consequences of moa loss on the overall health of native ecosystems are still very much unfolding, some 600 years down the track.

Te Tairāwhiti forest fragments: protecting precious pieces of biodiversity

The danger of losing lowland native forests and taonga species in Te Tairāwhiti / Gisborne, due to climate change and an increase in extreme weather events such as Cyclone Gabrielle, has sparked new partnerships between local kaitiaki and Manaaki Whenua scientists.

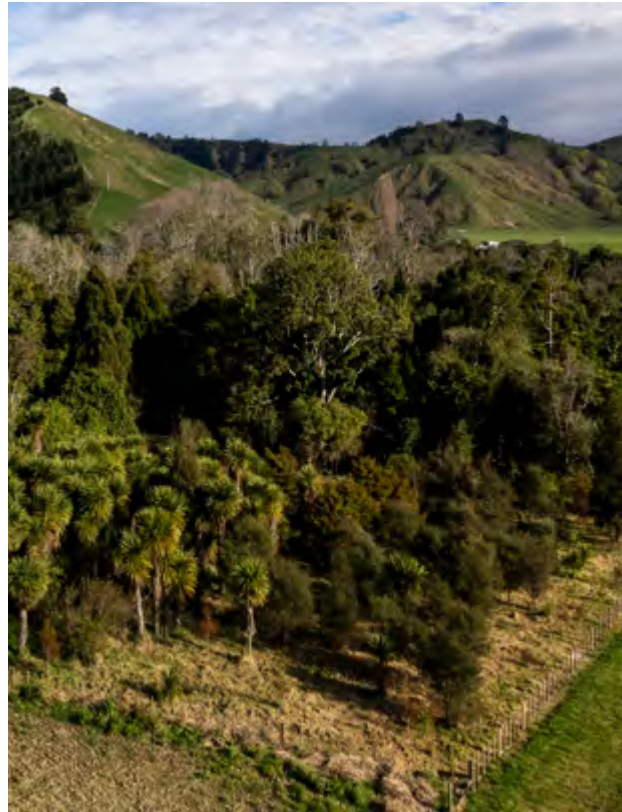
The goal is simple – to understand forest fragments and protect the region's precious biodiversity.

Manaaki Whenua Plant Community Ecologist Dr Warwick Allen and Senior Technician Plant Ecology Paula Godfrey (Ngapuhi, Ngāti Whatua o Kaipara, Ngāti Whakāue) recently led a team who partnered with local mana whenua and landowners to establish 41 permanent monitoring plots in 19 floodplain forest fragments between Wairoa and Whareponga.

Forest fragments, small patches of precious native forest, have their own unique threats and management needs because of their small size, isolation from other forests, and the range of activities that occur on the land around them.

Extreme weather events have caused disturbance in North Island lowland forests for millennia, such that many of their plant species could be considered 'flood-adapted', like the towering kahikatea (*Dacrycarpus dacrydioides*), sub-tropical pukatea (*Laurelia novae-zelandiae*), and nationally vulnerable heart-leaved kohuhu (*Pittosporum obcordatum*).

However, the natural process of forest regeneration after these weather events now faces pressures such as increased sediment deposition (a result of historical clearance of native forest for pasture and plantation forest), browsing by stock and feral animals, and invasive weeds.



The Rākaukā Forest in Manatūke, Tairāwhiti, is managed by the Rongowhakaata Iwi Trust. It was affected by Cyclone Bola in 1988 and Cyclone Gabrielle in 2023.

"Without management to mitigate these pressures, regeneration may be disrupted or prevented entirely, meaning that we are in danger of losing the few lowland forest fragments that remain in Te Tairāwhiti," says Warwick.

The team aimed to quantify damage to lowland forests from Cyclone Gabrielle and assess whether management practices such as fencing and weed control promote regeneration after disturbance from extreme weather events.

"It was confronting to see how the cyclone had impacted some of the forest fragments. Many trees were dead or dying in some of the worst-affected areas," says Warwick.

"However, at other sites I was left feeling hopeful by the presence of a diverse and healthy understory with various sizes of seedlings and saplings, suggesting that regeneration is possible with appropriate management."

The monitoring sites were chosen through discussion with local ecologists and kaitiaki, including Malcolm Rutherford (QEII National Trust), Don McLean (Gisborne District Council), Mere Tamanui (Te Aitanga Hauiti), Damian Whaanga (Rongowhakaata Iwi Trust), and Margaret Ngarimu and Jade Gibson (Whareponga).

At each forest fragment, the team established up to three permanent 20 x 20 metre monitoring plots. In each plot, they measured cyclone damage (sediment depth, flood height, and tree survival), characterised the plant community (plant species identity and percent cover), and quantified potential for forest regeneration (seed bank composition, seedling and sapling counts, browsing mammal signs).

Warwick and Paula worked closely with mana whenua, landowners, and engaged with local kura (schools) to establish the monitoring sites.

The team spent a day with Rongowhakaata Iwi Trust at Rakaukaka Forest in Manutuke (near Gisborne), where they provided training in the permanent plot method. The land has felt the impacts of multiple cyclones and is facing pressures from surrounding land use, including sediment deposition and invasive weeds.

Mere Tamanui (Te Aitanga a Hauiti) has links to many projects throughout the region and helped facilitate access to sites in Ūawa / Tolaga Bay. She said the devastation Cyclone Gabrielle caused to their whenua was staggering.

“It was like a blanket of sediment suffocated our vulnerable taonga species, with 80- to 100-year-old freshwater mussels ploughed up by turbidity and dumped on riverbanks. The cyclone deposited over two foot of sediment in some areas and shifted our saltwater wedge due to the riverbed build-up,” says Mere. “This project has given us tools and skills to gather information to help validate our natural observations and provide a record of impacts and recovery in the face of climate change,” she says.



Overspray from paddock to neighbouring reserve, Medbury, Canterbury. Image: Warren Chin.

Warwick and the team hope to release initial results from the monitoring later this year, as well as supporting iwi and other groups to expand on the monitoring. “We aim to resurvey the plots in 5-10 years to evaluate long-term impacts and post-cyclone recovery and regeneration. A key benefit of permanent monitoring plots is that they allow us to assess change over time.”

In the meantime, Warwick suggests landowners look to fence and manage weeds in any remaining lowland forest fragments to prevent stock and animal access and promote regeneration.

Losing our edges: why reserves need to be bigger

Native shrublands were once common across the Canterbury Plains, but over time, conversion of land to other uses including irrigated pasture have contributed to their gradual decline. Now, a new study by scientists at Manaaki Whenua has found that spillover of nutrients and water from adjacent intensive agriculture is facilitating invasions by exotic plants into reserves set up to protect the last remnants of these native shrublands.

Writing in the *New Zealand Journal of Ecology*, the scientists describe how nitrogen enrichment, likely from irrigated animal effluent, is detectable 10 m inside reserve boundary fences. Their study has observed increases in exotic herbs and grasses, along with declines in native species, up to 40 m in from irrigated boundaries.

“These distances are significant as some of these reserves are only 100 m across, meaning that more than 60% of these reserves can be affected,” says coauthor Dr Gretchen Brownstein.

The researchers looked at changes in plant composition with increasing distances from irrigated and unirrigated reserve boundaries, and also monitored changes in soil nitrogen and its chemical forms to better understand the sources of nutrient spillover. Exotic plant species that specialise in disturbed habitats like roadsides were the primary invasive species, rather than pasture species.

The reserves had a long history of low intensity agriculture prior to being gazetted as reserves, but still contained significant and diverse populations of native species back in the 1970s. Since then, the researchers found that they have lost more than half their endemic species while experiencing a surge in exotic species.

Co-author Dr Adrian Monks notes: “This loss of species is likely due to a combination of factors, including random extinctions that afflict small populations, lack of ecological connections to other fragments to allow replenishment of species, and competition with invasive plant species. Two separate fires spreading from a neighbouring property have also destroyed around 70% of the shrubland in the 50 ha Medbury Scientific Reserve, the largest of these protected areas.”

The ongoing effects of more intensive land use adjacent to the reserves could be managed with better rules around buffers. “Irrigation and effluent buffers around these reserves would help to limit further degradation of these reserves,” says Gretchen. However, the study highlights the larger problem of establishing representative reserves that are too small.

“While it is too late to set aside larger blocks on the Canterbury plains, there are lessons for areas such as the Mackenzie Basin, which still have large areas of indigenous dryland vegetation that are at risk from irrigation, renewable

energy schemes and wilding conifers” says Adrian. “The Mackenzie Basin is at a similar level of intensive development to the Canterbury plains when the shrubland reserves were established more than 50 years ago. To maintain viable indigenous populations in that landscape will require protection of blocks in the 100s of ha to avoid past mistakes in reserve design made on the plains.”

Where the wild things are

In 2002, landscape ecologist Dr Eric Sanderson and colleagues at the Wildlife Conservation Society Institute and Columbia University, New York, wrote an influential paper introducing the Human Footprint Map, a global measure of human pressures on the environment. One of the original aims of the paper was to find and document the “last of the wild” – the most pristine, most natural areas remaining on the planet. They also identified the wildest 1% of each biome [the “seeds of wilderness”].

Since then, the Human Footprint Map has been revised and upgraded several times, increasing its capacity to map global threats to biodiversity and to assist with conservation planning and research. It has been used to understand losses of intact ecosystems, changes in species extinction risks, and to quantify the contribution of Indigenous lands with low human pressure to terrestrial mammal conservation.

However, the map resolution is quite coarse [minimum size 1 km²] and it also uses a map projection – the Mollweide projection – which is good for showing global patterns but distorts the appearance of mid-latitude countries such as New Zealand.

To make the map more useable in a national and regional New Zealand context, Dr Olivia Burge and Richard Law

at Manaaki Whenua – Landcare Research, with Sandy Wakefield at the University of Canterbury, added a new map layer to create a New Zealand human pressure index. The new layer is at higher resolution (100 m), which matches other national-scale datasets, and also uses the same map projection as official topographical maps. It includes eight components of human pressures: built environments, cropland, navigable waterways, pasture, population density, rail, roads, and visible night lights, comparing data for 2012 and 2018.

The local layer revealed that 28% of New Zealand’s terrestrial area can be classified as “wilderness” while 60% is “highly modified” by human pressures. This is consistent with the global wilderness estimate of 28% in 2018, although much wilderness elsewhere is tundra and boreal forests/taiga, neither of which is found in New Zealand. By contrast, temperate broadleaf and mixed forests dominate New Zealand’s wilderness areas, which also have more montane grasslands and shrublands, temperate grasslands, savannahs, and shrublands than the global average. Total human pressures on the environment between 2012 and 2018 remained much the same, following the pattern shown by other higher-income countries.

To test the usefulness of the new human pressure layer to support conservation-based land-use planning, the researchers then investigated specifically whether it could explain or predict the survival of freshwater wetlands in New Zealand. Wetland conservation and loss are critical in the face of the increasing frequency of extreme climate events and the services wetlands provide in terms of flood mitigation.

Between 2012 and 2018, 1,681 ha of wetlands were lost nationwide. The mapping showed that the biggest pressure on all wetlands was proximity to roads, but the better



Human Pressure Index map [2018]. Blue areas = lower pressure.

resolution of the new human pressure map layer revealed that the lost wetlands were additionally within 100 m of land recently converted to pasture. This is a useful finding, because it shows the power of the new layer, even given limited time-series data, to differentiate between pressures on the environment and to predict likely patterns of habitat disappearance if those pressures are not mitigated – both essential tools for effective conservation management.

Capability building in data and digital technologies

Always an early adopter of technology, in 1996 Manaaki Whenua joined the World Wide Web. In that year, our remotely sensed image of Mt Ruapehu erupting was featured as NASA's "Observation of the Week". By 1997 our World Wide Web site was being accessed more than 1,300 times a day and more than 5,300 online maps were being generated by visitors each year from our GIS data.

Manaaki Whenua's work in AI spans deep learning, computer vision, machine learning, and increasingly, generative AI. These methods are integrated into a wide range of environmental research, such as land cover classification, invasive species detection, and remote sensing for vegetation and urban change, land-use change modelling and stakeholder translation, and river sediment detection and mapping. We also are piloting Large Language Model (GenAI) techniques for knowledge extraction from legacy and disparate science data sources. These approaches offer the possibility of unlocking previously hidden value and insights from sources that are otherwise hard to discover and synthesise.

We are constantly improving our use of AI technologies as we integrate these new components with our remote sensing, LiDAR, land-use modelling systems for landowners and decision-makers, and other data streams. In parallel, we make direct investments to building internal capability, including upskilling researchers and technical teams.

Our focus is on adoption, adaption, and customising of technologies to create novel insights, rather than developing the underlying technology from scratch. This applied approach enables us to embed AI into real-world science workflows that serve national and regional stakeholders and partners.

In many applied settings, deep learning models surface hidden assumptions which are useful to explore. In doing so, these tools are not only analytical enablers but also catalysts for shaping future modes of science delivery that is more iterative, insight-led, and co-designed.

Our direct investment in deep learning and AI capabilities across all our research areas and database holdings amounts to approximately \$405K per year over the past 3 years.

Examples of progress in 2024/25

Land surface classification and land use detection advancements powered by deep learning algorithms have led to improved baselines for change detection, land use reporting for international commitments, for instance the LUCAS New Zealand Land Use Map (LUM), and as support for direct decision-making by landowners and regional authorities. The LUM allows user groups to monitor the impact of land use changes across a range of land management practices, supporting economic and environmental outcomes for New Zealand's bioeconomy.

Supporting mammalian pest species eradication, our researchers have used deep learning for the detection of wild pigs, supporting targeted pest control across larger landscapes. Wild pig management delivers improved outcomes across the environment, economy, human health, and for native species by reducing the negative impacts of these animals. Protecting agricultural land and resources from pig damage, and reduced pressures on native species and at-risk ecosystems such as wetlands, leads to improved outcomes and benefits across these areas.

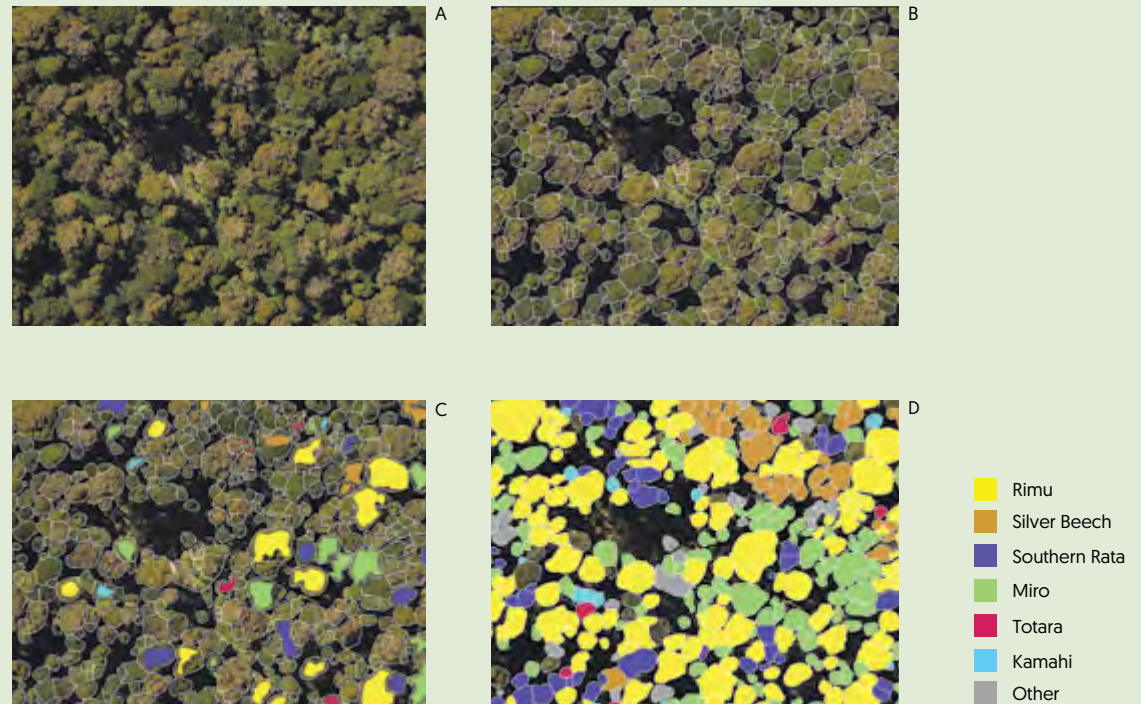
CASE STUDY:

Big data and deep learning at Manaaki Whenua

Remote sensing tools show promise for measuring forest carbon stocks and forest health at large scales. Working with the Department of Conservation (DoC), our geospatial and remote sensing team has developed cutting-edge technology for mapping indigenous tree species, applying machine learning to high resolution imagery to map tree crowns.

Acquired using aircraft flying high-resolution aerial photography, each image [A] has an incredible 2 cm pixel resolution. The tree crowns are outlined [B] and deep learning is used to copy training examples [C] for determining tree species. A complete map of tree crowns by species is then produced [D]. The technology is now being used to map individual tree species over large areas of indigenous forest.

Anchor Island is a predator-free sanctuary at the mouth of Dusky Sound, and a haven for the critically endangered kākāpō. Over one million indigenous trees have been mapped on Anchor Island, of which 160,000 have been identified as rimu, a preferred food source for kākāpō. DoC is using this information to determine the carrying capacity for kākāpō, to guide future conservation management on the island and – as the bird population recovers – on the mainland too.



A: Tree crowns at 2 cm pixel resolution. B: Crowns outlined by AI. C: Deep learning used to copy training examples for species identification. D: Complete map produced.

Managing invasive species

The estimated cost of invasive species to our primary sector is around \$4.3 billion in production losses per year with many millions of dollars in additional control costs. We contribute to national biosecurity outcomes through providing capability and confidence in assessing biological threats and using control tools – especially at landscape scales – for weeds, pests, predators, and diseases.

Vertebrate pest management

We have national leadership expertise in vertebrate pest management, social science, policy development, monitoring, surveillance and detection of pest animals across landscapes, and the management of diseases of, and vectored by, wildlife.

This science falls into five main categories:

1. Fundamental pest ecology, behaviour and genomics.
2. Eradication methods and strategies at landscape scales.
3. Prevention of reinvasion.
4. Detection of pests at very low densities.
5. Social licence to operate.

Invasive plant management

We also work to reduce the environmental, economic and social impacts of invasive plants by researching how best to manage them. We have a strong focus on developing biocontrol programmes for introduced weeds, and we are internationally acknowledged as a world leader in weed biocontrol.

Manaaki Whenua and its predecessor the DSIR have provided government ministries and research stations of Pacific Island countries (Vanuatu, Samoa, Tonga, Fiji, the Cook Islands, and Niue) with climate-resilient agriculture and sustainable land-use support for over 50 years. We are one of three partners in the Managing Invasive Species for Climate Change Adaptation in the Pacific programme (MISCCAP), working across Pacific countries to enhance future food security and resilience to climate change.

Selected highlights

Toxoplasmosis, caused by the intestinal parasite *Toxoplasma gondii*, has been confirmed as a cause of death of endangered Hector's dolphins and critically endangered Maui dolphins. *T. gondii* reproduces only in cats. The egg-like oocysts of the parasite spread from cat faeces into the environment, and can travel via surface water run-off to the sea. Toxoplasmosis also causes abortions in infected sheep, goats and pigs, and vaccinations and lamb losses can be a significant cost to the farming sector. The parasite can also affect humans, and if a pregnant woman gets infected via contact with cat faeces, birth defects are possible. Researchers from Manaaki Whenua have modelled the potential spread of toxoplasmosis by feral cats on farmland, and are currently modelling the transmission of toxoplasmosis by feral cats in the catchment area affecting the Maui dolphins to support the DOC-led toxoplasmosis management programme.

The Environmental Protection Authority (EPA) approved the release of the rust fungus *Uromyces pencanus* as a biological control agent for the weed Chilean needle grass (*Nassella neesiana*, CNG) in July 2024. The rust fungus was released in Marlborough on 7 October and there are further planned releases to come in Canterbury – both areas with significant CNG infestation. Our weeds biocontrol scientists hope that this will eventually be a game-changer for farmers against CNG, which has sharp seeds with a corkscrew-like awn that can penetrate the hides of livestock, cause blindness in stock, compete for nutrients from pasture, and adversely affect farm production.



Possum preying on eggs. Image: Ngā Manu Images.

Xylella fastidiosa (Xf) is one of the most important plant biosecurity threats to New Zealand. It affects more than 500 plant species, including economically important agricultural crops such as grapevines, summerfruit, citrus and olive, but it is not currently known to be present in New Zealand. As part of the Better Border Biosecurity (B3) collaboration, researchers at Manaaki Whenua screened collections of New Zealand indigenous plants in arboreta and botanical gardens overseas for plant pathogens from the *Xylella* genus. This work is helping scientists to assess the risk of Xf to New Zealand's indigenous flora and the potential spillover to agricultural crops. As a result of the study, MPI has updated its list of indigenous plant species that are confirmed hosts of Xf.

Project Yellow was initiated in 2014 as a collaborative biosecurity initiative to preserve the Central North Island Desert Road tussock-lands from invasive species such as broom, gorse, and yellow tree lupin. Using remote sensing technology, a breakthrough in the legume control effort has been achieved: Paul Peterson and Dr James Shepherd working together with external colleagues, including Horizons council staff, have used high-resolution imagery and data analytics to transform how invasive legumes are managed across the Central Plateau. With remote sensing now helping guide decisions and fostering efficient strategies, Project Yellow is well-positioned to meet its 2025 goal of significantly reducing invasive legume populations.

Innovation stories

AI mapping of invasive tree species in Rarotonga

Rarotonga, the largest of the Cook Islands, is well-known for its crystal-clear lagoons, sandy beaches and unique biodiversity. However, invasive weeds introduced into Pacific Islands like Rarotonga pose a serious threat to native biodiversity, ecosystems, primary production, and human health.

Manaaki Whenua's Biocontrol and Molecular Ecology Senior Technician Paul Peterson and colleagues have partnered with local government and environmental organisations in Niue and Rarotonga (Cook Islands) as part of a larger Ministry of Foreign Affairs and Trade (MFAT) funded project to develop natural enemies for key invasive weeds in the Pacific and to help countries to introduce and establish them.

During August 2023, Paul and his team travelled to Rarotonga to map African tulip tree (*Spathodea campanulata*) and falcataria (*Falcataria moluccana*).

The African tulip tree is a large, destructive, invasive tree that is widespread throughout the Pacific region and considered one of the 100 worst invasive species in the world. Falcataria is also a large invasive tree which is spreading quickly on some Pacific Islands.

"We wanted to accurately map these two species using a multi-scale, multi-spectral approach so we started by commissioning satellite and aeroplane imagery over the entire island (70 sq km) and collecting a range of drone imagery over five smaller areas across the island," says Paul.

African tulip tree [*Spathodea campanulata*].



Manaaki Whenua Remote Sensing Researcher Dr Andrew McMillan was with Paul in Rarotonga, and says the team tested various remote sensing techniques with the aim of developing practical solutions for Pacific Islands wanting to monitor their own weed control projects.

“The best method we found was to use an artificial intelligence model to map the weeds in 10 cm resolution aeroplane imagery at the island-scale using training data from drone imagery of the smaller areas to identify the weeds,” says Andrew.

As far as the team is aware, the project is the first time a detailed multi-scale approach has been used to accurately map invasive weeds over a large area.

The map the team produced showed that there are approximately 10,500 flowering African tulip trees [22,000 in total because only 48% were flowering], and 12,000 falcataria trees on Rarotonga – covering 8.3% of the entire island.

When the team presented these findings in Rarotonga at a recent conference, locals were shocked at the extent of the invasion. “They knew that the weed invasion was bad but seeing the map really highlighted the true extent of the distribution and spread,” says Paul. Due to his work on these projects, Paul was awarded the Dave Galloway Innovation Award at a recent New Zealand Biosecurity Institute conference.

Here, there and everywhere: Vanuatu welcomes the beetles

Another milestone for Pacific weed biocontrol was passed in November 2024, with Vanuatu receiving the pico beetle (*Leptinotarsa undecimlineata*) to tackle the spread of the invasive weed prickly solanum (*Solanum torvum*), known

as pico weed in Vanuatu. This release follows another successful release – the hibiscus bur lace bug (*Haedus vicarius*) in July 2024, and is part of ongoing efforts to restoring pasture lands overrun by invasive weeds in Vanuatu.

Prickly solanum is a thorny shrub or small tree with broad, hairy leaves. It overtops most herbs, grasses, and shrubs, limiting the growth of other species. The weed produces attractive berries that are rapidly dispersed by birds. It has long posed a serious problem for farmers, particularly in cattle-grazing regions, where its thorny structure and toxicity make it unsuitable as fodder. The plant’s rapid spread has forced some farmers to reduce livestock numbers or abandon parts of their grazing land.

The pico beetle, native to Jamaica, is the first natural enemy ever released globally to target prickly solanum. Both the adult beetles and their larvae feed on the leaves, effectively stripping the plant and allowing pasture to regenerate. Our researchers have spent 5 years studying the beetle and determining its suitability to deploy. “This release is of great significance for Vanuatu, where it was recently estimated that 34 percent of grazing land is lost to weeds. The most important pasture weed is prickly solanum, which was ranked the worst, or second worst weed on 81 percent of farms,” says Dr Quentin Paynter, who leads the Vanuatu Weeds Programme. “The release of the pico beetle will mean a natural enemy has now been released for three of the four worst pasture weeds in Vanuatu.”

This release builds on previous introductions, including the nail grass psyllid (*Heteropsylla spinulosa*), and the hibiscus bur lace bug, which was released on Efate in July 2024, Santo in November 2024, and Malekula in April 2025 to combat the invasive hibiscus bur (*Urena lobata*) shrub. The pico beetle was also released on Malekula in April. Work



Arnaud Cartier [right] working with the Vanuatu Biosecurity team to release pico beetles in Vanuatu.

on wild peanut (*Senna* spp.) is still in progress. Follow-up monitoring at the release sites on Efate and Santo, reports some promising results particularly for the pico beetle.

Further follow-up surveys are planned for November 2025 to assess the level of establishment. If successful, the project could serve as a model for other Pacific nations facing similar challenges, strengthening the region's resilience through sustainable biocontrol solutions.

Psyllid answer: a new biocontrol weapon for Tuvalu

In April 2024, as part of Manaaki Whenua's Natural Enemies - Natural Solutions (NENS) programme, Tuvalu released its first-ever natural enemy on the atoll of Funafuti to control their number one weed, *Leucaena leucocephala* (known locally as tamalini). Once touted as the 'miracle tree', *Leucaena* can quickly outcompete and replace other vegetation, forming dense, impenetrable thickets, impacting nutrient cycling and soil chemistry and disrupting natural successional processes. It quickly colonises disturbed ground, meaning it is expected to be an increasing problem under more turbulent weather systems brought about by climate change.

A sap-sucking psyllid, *Heteropsylla cubana*, is known as a major pest of *Leucaena* in agroforestry and is expected to help control *Leucaena* in Tuvalu.

With a land area of only 5.6 square kilometres and a population of just 1,184 residents, improving the islands' resilience to invasive plants is paramount. Touching down in Funafuti on November 25 2024, the psyllids had flown 3,180 km, but the journey wasn't over yet. Vaitupu doesn't have an airstrip, so the trip had to be coordinated with the timing of the inter-island boat that was leaving to pick up the Funafuti children that go to boarding school in Vaitupu.

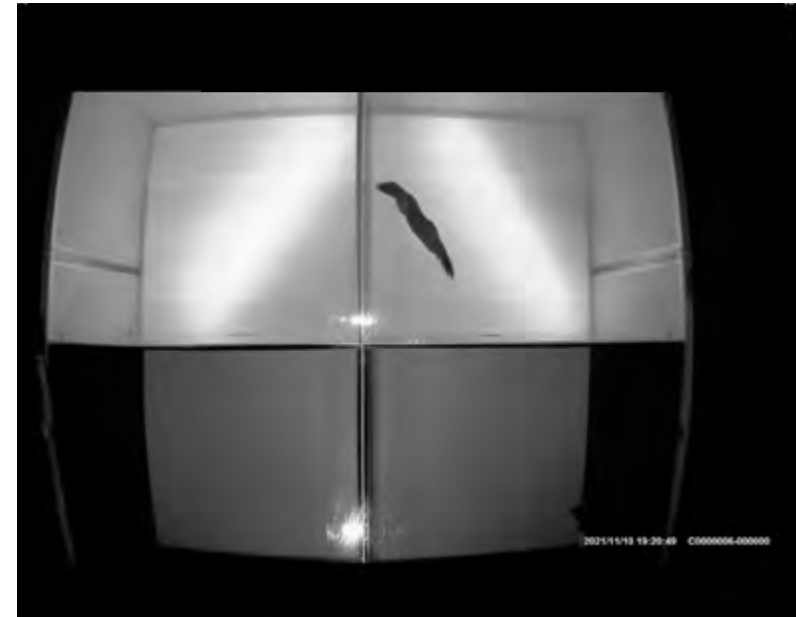
On 28 November, the team handed over the psyllids to staff at the Department of Agriculture to make the last leg of their journey, a 6-hour boat ride from Funafuti to Vaitupu, where they would be released. The release was a success, and the team hopes this will give the island another tool to help in their fight against climate change.

Fortune favours the timid: how a better understanding of stoat behaviour will help predator control

It's well-known that New Zealand's native ecosystems are under threat from introduced pest predators such as rats, cats, possums and stoats. Trapping efforts, such as those undertaken by Predator Free NZ groups, are effective up to a point – but it is very difficult to achieve 100% eradication of these predators, especially across large, remote areas.

One of the aims of the 5-year MBIE Endeavour research programme Eradication Science, led by Manaaki Whenua, is to evaluate the current toolkit of control technologies from the perspective of the pest. New knowledge is needed on why some pest animals evade or fail to interact with physical traps or baits, and to devise ways to make them more enticing.

As part of the research, Dr Patrick Garvey and Dr Kyla Johnstone, working with Dr Catherine Price at the University of Sydney, tested the responses of wild-caught stoats to three types of stoat trap. The traps were disabled so they could be triggered without harming the animals, and the stoats' behaviour was filmed each night using infrared cameras. This enabled the intrinsic behaviours of the stoats to be assessed across different trap encounters. The research complied with all relevant animal welfare and ethics requirements.



Infrared video stills taken during personality testing of stoats.

In a rewriting of the phrase “fortune favours the brave”, the researchers found that fortune favours the shyer, more cautious, less active, and less risk-prone stoats – known as “recalcitrant” animals in pest-control circles – that are less likely to interact with all types of traps. Shy female stoats, and female stoats generally, were more cautious and less likely to interact with the traps than male stoats. This finding is known from field trapping, where successful capture is strongly skewed towards males. Often, all it takes for an area to be repopulated is the survival of females that evade trapping. Almost all adult female stoats are pregnant throughout the year, so understanding sex biases in trap capture is essential to achieve eradications.

By contrast, “neophile” stoats – those attracted to risk and novelty – were more likely to approach and then trigger a trap. Enclosed box traps were the most effective, but neophile stoats were also attracted to tunnel traps. Stoats tended to interact least with head-up traps.

Is the answer to deploy more traps, to ensure that the more cautious individuals will be more likely to encounter devices? Not necessarily, say the researchers, since stoats that encountered a trap for the first time and failed to trigger it were quite likely to avoid all traps in the future – trap shyness is a persistent problem for predator control. Although some trap types performed well, no single design covered all personality traits, suggesting that less “scary” trap designs, plus more effective baits and lures, are what is needed.

Compounding the problem of trap shyness, the researchers suspect that they have actually underestimated recalcitrance in the wild. By definition, all the stoats in the study had the characteristics of risk-taking neophiles, since they had already been caught in a trap for the study. This suggests that trapping the most recalcitrant animals might

be even more difficult than this study suggests, which itself is an important finding in planning future pest control efforts.

The researchers conclude that increasing the likelihood of engagement with a trap during a first encounter, and improving the susceptibility of the animal to triggering that trap, is fundamental to increasing capture success in future predator management programmes. Next steps for the Eradication Science programme involve the development and deployment of novel lures to do just that.

Hiding in plain sight – an undetected population of wallabies in New Zealand

Wallabies are a significant invasive pest in New Zealand, causing damage to pasture, woodland and native plant communities, and are subject to a national eradication programme.

They have been present in New Zealand since around 1870, when the then-Governor Sir George Grey introduced at least four species to his menagerie on Kawau Island in the Hauraki Gulf. The two smallest species, the dama wallaby (*Notamacropus eugenii*) and the parma wallaby (*N. parma*), are very difficult to tell apart. Parma wallabies have a broader diet than dama, and therefore may be more of a threat to native biodiversity.

Dama wallabies established themselves in the North Island around the Bay of Plenty after being additionally released there in 1912, while the parma wallabies were thought to have remained on the island.

Funded by the Tipu Matoro National Wallaby Eradication Programme, research was carried out to look at the extent of wallaby populations across the Bay of Plenty. Scientists

at Manaaki Whenua, led by Dr Andrew Veale, undertook a landscape genomics study of dama wallabies.

Ears of wallabies were collected from dead animals culled in control operations, roadkill, and found bodies in the Bay of Plenty – 173 samples altogether, plus two further samples from Taranaki and four from Wellington. DNA was extracted using standard methods, sequenced, and mapped to the recently completed dama wallaby genome that Andrew contributed towards assembling. This genomic sequencing and analyses were in collaboration with colleagues at AgResearch.



Infrared camera trap capturing how wallabies interact with bait feeders, South Canterbury.

Surprisingly, the work confirmed that parma wallabies have been living essentially undetected on the mainland. This is likely due to their solitary behaviour, preference for dense scrub and forested areas, and visual similarity to the dama species.

Misidentifications of species are most common in groups such as plants and invertebrates, where identification can be a challenge even for experts. It is very rare to misidentify something as large as a wallaby – especially in a country well-attuned to the problems caused by invasive plant and animal species.

Nonetheless, the fact that a population of large animals has gone undetected for at least 30 years (and potentially for over a century), hidden amongst a morphologically similar species, highlights the continued need for monitoring of invasive species including genomic species identification. As the researchers comment, “if wallabies can go unnoticed, how many invasive insects are being missed?”

TrapSim Plus: a new tool for predator control

Funded in part by the BioHeritage National Science Challenge, in late 2024 scientists at Manaaki Whenua and the University of Canterbury launched a free, user-friendly online application, TrapSim Plus, to help people to plan better, more cost-effective predator control.

The user-friendly simulation tool is designed for use by many different groups, from landowners and land managers to trapping groups, community predator-control groups, mainland sanctuaries, forest regeneration projects, conservation organisations and schools. It allows users to compare scenarios in planning and designing ground-based predator suppression and control.

TrapSim Plus is the culmination of four years of collaboration between wildlife scientists and social scientists.

By simulating real-world situations to show the likely outcomes from different control methods and levels of effort, users can work out the cost and benefits of each approach, says project leader Dr Chris Jones of Manaaki Whenua. “We know that all predator control initiatives nationwide, with limited resources, face the challenge of choosing which control methods and how much effort to use.”

“One of the advantages of TrapSim Plus is that users can compare different regimes, such as combinations of devices, taking into account factors such as the type of predator targeted, the level of previous control and the duration of the programme. The model adds scientific rigour to any decision about how to best invest resources to maximise the effectiveness of predator control.”

Another advantage is that while science underpins the model, users don't need to be scientists or know about wildlife modelling to use TrapSim Plus, says Chris. “The online practical tool is easy to use, and it can be used by non- experts for local, community projects as well as larger-scale operations to compare the relative costs and effectiveness of different predator control programmes.”

TrapSim Plus shows the cost to achieve a specific project goal, and can also be used by predator control projects or funders to estimate what is realistically achievable given the level of funding available. The model can rank each option, show how much effort is required to control target species, and the feasibility and cost-effectiveness of each option.



Resetting a camera trap in the field.

“The tool isn’t designed to predict the exact number of individual predators remaining after a control programme,” says Chris, “but it does help understand a system and gives insight when comparing the relative effectiveness of approaches, which ultimately helps guide managers and communities in their decision-making.”

Herding cats – the science of deterrence

New Zealand has among the highest per capita ownership of domestic cats [*Felis catus*] in the world, with an estimated 1.2 million nationwide. Some 41% of households own at least one cat.

Cats are a major ecological problem worldwide – they are opportunistic broad-spectrum predators that contribute globally to biodiversity loss. In New Zealand, household, stray and feral cats prey on rabbits and hares, rats and mice, but they also take bats, lizards, birds and bird eggs, wētā and other insects.

But cat management to enhance ecological outcomes is controversial, especially any form of lethal management, because cats are highly valued as companion animals. As a result, a halo of biological and social research is needed, including non-lethal approaches to reduce cat impacts on native biodiversity, as well as the careful development of public support [also known as “social licence”] for such approaches.

To address this, as part of an MBIE-funded Smart Idea research programme, scientists at Manaaki Whenua have tested whether sound cues can deter cats from specific locations. The researchers played sounds of human voices, dogs and cats to test whether these induced fleeing and avoidance behaviours in cats and kept them from exploiting areas where food was placed. The first part of

the trial used cats in an enclosure, and the second part of the trial was done in an open suburban area, where cat activity was recorded using trail cameras.

In the enclosure trial, human playbacks protected the greatest proportion of food patches, were more likely to reduce time cats spent feeding, and induced more fleeing responses and spatial avoidance than competitor dog and cat playbacks. Cat and dog playbacks were effective in protecting food patches but induced fewer fleeing and avoidance responses. In the open area trial, cat and human playbacks were effective, and these are promising for further testing. The researchers are currently integrating playbacks into a management tool to repel cats from areas where they are not wanted but lethal control is not feasible.

Additionally, work has been done at Manaaki Whenua to establish cat owners’ willingness to adopt new cat control measures. Keeping cats indoors at night is an often-cited solution to the problem of cat predation on native species, but is it a realistic suggestion to make? A survey of 2,000 cat owners across the country suggests not – at least, not yet: cat owners will mostly or always keep their pets indoors at night only if they have high interest in cat welfare and a strongly favourable attitude towards keeping cats inside. The survey also showed that concern for cat welfare must be built-in to any cat control solutions. Owners were unlikely to keep cats inside in the long term if promotional material focused solely on the harm that cats do to wildlife, but they might be more prepared to do this if cat-friendly, inexpensive, practical, and easily maintained devices are available that enable cats to be kept inside.

Similarly, whether cat owners put collars on their cats depended on their attitude towards protecting wildlife from cats and their beliefs about the effectiveness of protective devices. If protective devices such as bibs



Feral cats are widespread throughout the country, and a significant predator of native birds.

attached to collars are effective, or their effectiveness can be improved, they may offer an inexpensive and practical alternative to keeping cats indoors at night. A campaign promoting the use of these devices would need to offer persuasive evidence that they work and are safe for cats to wear – again, highlighting the importance of cat welfare in the public mind.

Land resources and climate change

One of the greatest challenges facing regional and national agencies, and the food and fibre sector, is the integrated management of land and water to provide sustainable production, while protecting downstream ecosystems and supporting diverse community and iwi values.

Around \$56bn of agricultural sector export value depends on the top 15 cm of soil. Our work provides understanding of soils, capability to manage the effects of land use, and confidence to deploy mitigation approaches. Our current capabilities include:

- Soil mapping and land capability assessment, including digital soil modelling.
- S-map Online – an ongoing project to map the nation's economically critical soil resources – is one of our most important and widely used online outputs.
- Soil health, biology and toxicity assessment and management.
- Soil erosion, and sediment processes and management, including sediment fingerprinting and landslide modelling.
- Soil carbon, nitrogen and trace element cycling, including contaminant loss.
- Soil water storage and movement.
- Soil chemistry and physics laboratories, including in-field sensing technologies.
- Management of the Land Resource Information System which is a nationally significant soil data repository, and web portals for soil and land environment information.

Our climate change research focuses on understanding New Zealand's emissions balance, supporting mitigation, and enabling adaptation and resilience to climate change, including understanding of carbon stocks in our indigenous forests and in the soil.

We design and support pathways for carbon sequestration and for businesses and communities to take meaningful climate action. Our Toitū Envirocare subsidiary has enabled hundreds of organisations to plan and achieve certification of their emissions management.

We undertake research in:

- Measurement of carbon storage and cycling in soils and indigenous vegetation.
- Simultaneous measurement and modelling of all greenhouse gas emissions/removals from terrestrial ecosystems.

- Integrated modelling to determine spatial configurations of land-use and management that will lead to climate-smart landscapes.
- Mātauranga Māori informed advice on climate change adaptation and mitigation to lead government agencies and hapū/iwi.

Selected highlights

Manaaki Whenua's experts in soil contaminants were recently asked by Greater Wellington Regional Council to analyse and interpret data on pesticide residues at 100 non-urban State of the Environment soil quality monitoring sites. Sites sampled included dairy, drystock, perennial horticulture, arable cropping, vegetable cropping, lifestyle, plantation forestry and indigenous vegetation. Soil samples collected between 2020 and 2024 were analysed for pesticide residues including organochlorines, non-organochlorines and glyphosate by Hill Laboratories andASUREQuality. Our role was to collate the data, identify "nominal concentrations of concern" (NCOCs), and to advise on ongoing sampling. Pesticide residues were present in 70 of the 100 samples across all land-uses, but only 12 sites across all land uses had any residues above NCOC. Consistent with general patterns of pesticide use in New Zealand, these sites were confined to arable, vegetable and perennial horticulture. Overall, pesticide concentrations were judged unlikely to cause any negative environmental impacts. This work will enable the council to decide whether further monitoring or research is needed to understand the implications of pesticide use in land management.

Manaaki Whenua's researchers have been working to improve emissions accounting for Organic Soils (funded by Ministry for Primary Industries) and estimating the potential additional contribution that could be coming from peaty mineral soils (mineral soils that include a peaty layer), as part of the Maximising Carbon in Soils programme funded by the Ministry for the Environment. Preliminary estimates demonstrate these peaty mineral soils may be contributing emissions of 1.0 to 2.4 megatonnes of CO₂ equivalents per year to New Zealand's GHG emissions, large enough to require reporting to the UN Framework Convention on Climate Change as a significant source of emissions. We are working on



Moana Oceania Soil Judging Competition 2024, Rotorua. Image Kristin Deuss.

potential mitigation actions to reduce emissions from Organic Soils through multiple collaborations including with the University of Waikato and Waikato Regional Council and Irish partners who face similar issues. Future mitigation research is being planned in collaboration with New Zealand's Ag Emissions Centre.

When snow on the Southern Alps turned from white to red in the summer of 2019/20, ash from Australia's bushfires was blamed. But Marsden-funded researchers studying the event, including Manaaki Whenua's Dr Phil Novis, now say the real culprit was desert dust storms that sent massive amounts of red dust across the Tasman Sea. Using geochemical fingerprinting, the researchers analysed samples of the dust from the Fox, Franz Josef, and Tasman glaciers and pinpointed its origin as south-east Australia where it was stirred up by desert dust storms. The Southern Alps may well see more of these massive dust dumps in coming years as the climate warms, says Phil. "Climate change is expected to result in increased desertification and dry conditions in many areas so these storms – as well as wildfires that can be driven by similar weather patterns – are likely to occur more often."

SedNetNZ is a soil erosion model developed by Manaaki Whenua that predicts the generation and transport of sediment through river networks, based on representation of hillslope and channel processes at the sub-catchment scale. It is used by nine of New Zealand's 11 regional councils, whose land and water managers find it invaluable to model sediment loads, to calculate reductions in load required to reach freshwater targets, and to set freshwater objectives. With regional LiDAR data now widely available in New Zealand, a new, high-resolution LiDAR-based version of SedNetNZ was completed in June 2024, and

was then applied in the Hawke's Bay region as part of a partnership project with the Hawke's Bay Regional Council. Incorporation of the LiDAR data has allowed improved erosion and sediment model parameterisation and predictive performance, and can also produce higher resolution layers for selected erosion processes – for example, showing at a finer scale than previously possible which areas of land are most susceptible to shallow landslides. This information can then be used by land managers to better target tree planting in areas of pastoral land most affected by slope instability. Recognising its use in supporting better land and water planning, the upgraded LiDAR-based model is now being applied in a project with Waikato Regional Council [see also page 48 for more on LiDAR].

Manaaki Whenua and Callaghan Innovation are digging into artificial intelligence to develop a tool to help scientists uncover a treasure trove of soil research insights. The AI tool, named SoilInsights, will help Manaaki Whenua scientists seeking to access its extensive digital library, enabling them to ask, and get answers to, research questions from 40 years of unseen soil data and reports. The project team expects to have the first version of a pilot focusing on public-facing research outputs ready by the end of this year. They are working closely with soil data experts and other data scientists from Manaaki Whenua to help guide and improve the tool's development.

New Zealand is internationally recognised as having a high diversity of soil types, with our online soil mapping tool S-map identifying 4,844 soil siblings (types) in the 11 million hectares of the country mapped so far. This represents around 73% of the country's multiple-use land, in Land Use Capability classes 1 to 4. S-map Online continues to be



Drs John Hunt (left) and Phil Novis conducting field experiments at Canyon Lake in the Southern Alps.

widely used, with over 13,000 active users downloading 65,000 soil fact sheets, which is additional to the direct use of S-map data within end-user tools of organisations such as fertiliser companies, banks, councils and the Overseer nutrient budgeting tool. Through a funding collaboration between the Ministry for Primary Industries, the Ministry for the Environment, and 12 regional councils, in August 2024 Manaaki Whenua completed an extra 507,000 ha of new soil mapping coverage across some of the country's best food-producing land. A further 363,000 ha of legacy mapping was replaced with a new soil survey. The partnership is on track to deliver a further 700,000 hectares of new mapping over the next year.

The Pacific Soils Portal has had an upgrade: Vanuatu has become the sixth island nation to be covered by this popular service, with Vanuatu's national soil dataset now saved from potential loss, and readily available for use. The Pacific Soil Portal is a collaboration between Pacific Island nations, Manaaki Whenua, Australia's Centre for International Agricultural Research [ACIAR], and the Commonwealth Scientific and Industrial Research [CSIRO]. The portal is a major initiative of the Pacific Soil Partnership, and through partnering with the Pacific Community's Land Resources Division, was endorsed by the Heads of Government Departments from 23 Pacific Island Countries and Territories [PICTs] at the regional meeting of the Pacific Heads of Agriculture and Forestry Services.

In contracted work for the Parliamentary Commissioner for the Environment [PCE] we recently provided an assessment of the impact of primary sector activities on New Zealand's soil, and implications for the ongoing productive capacity and sustainability of this resource. This is part of the PCE's wider investigation into the environmental pressures

associated with the extraction, processing, use, and disposal of natural resources. We also contributed to a workshop at the Wasteminz conference on sustainable management of surplus soils with contaminated land practitioners and central and local government consulted as to the best ways to manage soils that are disturbed through land development processes.

To increase agricultural water-use efficiency and manage storm water generation more efficiently on-farm, it is essential to understand soil water infiltration rates in farm catchments. The ideal infiltrometer is simple, portable, and ready for use by research personnel, consultants, and farmers anywhere, with or without mobile phone coverage. As part of an MBIE research programme to develop smarter tools to maximise the value of irrigation, soil scientists Veronica Penny and Dr Jagath Ekanayake at Manaaki Whenua designed a cost-effective, farmer-friendly infiltrometer to meet these user requirements. It fits easily in a backpack, uses a built-in touch screen to activate, and displays infiltration rates without having to edit or enter details. It's also smartphone-compatible via Bluetooth, allowing time-series data to be downloaded to the phone or emailed to the user once in cellphone range.

Thanks in part to experts in soil contamination from Manaaki Whenua, New Zealand now has its first ever *Geochemical Atlas*, providing a baseline of concentrations of elements in our near-surface soil. Manaaki Whenua senior researchers Dr Jo Cavanagh and Dr Pierre Roudier worked with a team from GNS Science and the University of Auckland to measure the concentrations of 65 different elements in our soils, with analysis drawn from more than 800 samples taken from within the top 20 cm of soil. The atlas presents the results using maps, showing the changes

in concentration in each element across the country from Cape Reinga to Rakiura Stewart Island.

Innovation stories

Small tree patches: big impact on carbon storage in New Zealand grasslands

Small tree patches, each less than one hectare in size, play a big part in carbon storage and sequestration, biodiversity support, and climate adaptation.

Manaaki Whenua Senior Researcher Dr Daniel Richards and colleagues used high-resolution satellite data to map over 1.6 million small tree patches across 188,000 hectares of New Zealand's grasslands. The researchers estimated the above ground carbon stock stored in these patches to be between 11.6 and 29.3 million metric tonnes, with annual sequestration of up to 0.8 million tonnes of carbon.

Small tree patches sequester carbon equivalent to 2.9–7.8% of New Zealand's agricultural emissions. The market value of carbon sequestered by these patches could reach NZ\$237.6 million annually, underscoring their economic potential.

Despite their contributions, current policies exclude small tree patches from regulatory carbon markets like the Emissions Trading Scheme [ETS]. Researchers agree that the next step would be to age the patches to determine the "additionality" required by carbon markets.

"Small tree patches are often overlooked, yet they provide vital functions and cultural benefits, particularly within the Māori worldview of kaitiakitanga" says Dr Nikki Harcourt, who was involved in the study.



A mixed indigenous-dominated tree patch in Waikato delineated from grazed paddock by a fence. Image: S.Graham.

“Including these patches of trees in climate policies could significantly enhance carbon sequestration efforts while supporting biodiversity and cultural heritage.” says Dr Richards.

The study calls for policy adjustments to protect and incentivise the establishment of small tree patches. These include revising afforestation incentives and integrating these patches into emissions reduction frameworks.

“By doing so, New Zealand can align its environmental and economic goals with indigenous values and global climate targets.” This research highlights the importance of rethinking grassland management and leveraging the potential of small-scale natural solutions to combat climate change.

Calculating carbon emissions from peat fires

Huge amounts of carbon were lost in recent human-caused fires at two of New Zealand’s most important wetlands – the Kaimaumu-Motutangi wetland in Northland and the Awarua wetland in Southland.

Working with scientists at Manaaki Whenua and supported by local iwi, in particular Ngāi Takoto and Awarua Runaka, in October 2024 the Department of Conservation published the first detailed study on carbon emissions from these peatland fires.

Peatlands are a type of wetland with an incredible ability to store carbon in peat, built up over tens of thousands of years. However, peat wetland soils are highly flammable when water levels are low, which can occur during extended dry periods and be exacerbated by drainage of surrounding agricultural land. In Kaimaumu the burnt area was over 2,900 hectares, and at Awarua it was 980 hectares. The fires also caused a loss of most of the above ground vegetation.

Estimated carbon emissions from the 2022 fires were large, with more than 500,000 tonnes of carbon dioxide emissions from Kaimaumu and more than 100,000 tonnes from Awarua. If these losses had to be paid for, the estimated cost would have been about NZ\$32-\$36 million based on current carbon markets.

Manaaki Whenua senior researcher Dr Jack Pronger says the loss of carbon due to the two fires represents about 5% of New Zealand’s annual reduction target for the 2026-2030 period relative to the previous emissions budget – and that this is likely to be a conservative estimate of the total loss.

Researchers at Manaaki Whenua, the Department of Conservation, Waikato Regional Council and the University of Waikato are currently determining whether it is possible to determine carbon losses from the more recent Whangamarino wetland fire that occurred in October 2024.

Soil carbon: which on-farm interventions does the science support?

The world’s soils have been calculated to contain 1,700 gigatonnes of organic carbon to a depth of 1 metre, which



View of Kaimaumu wetland a few months after the 2022 fire, showing some regrowth of vegetation.

is more than the mass of carbon in the atmosphere and vegetation combined. Because of this, there's been a lot of interest in how soil carbon stocks could help to mitigate global greenhouse gas emissions as well as improve productivity, perhaps the best-known being the "4 per mille" initiative from the Paris Climate Accord of 2015, which set a modest-sounding aim to increase soil carbon stocks by 0.4% annually. However, it is now accepted that achieving this across the globe is not realistic.

New Zealand is fortunate to have relatively high existing carbon stocks. In grazed grassland soils, which comprise about 55% of the national land area, there's an estimated 106 tonnes of carbon per hectare to a soil depth of 30 centimetres. Even so, some of New Zealand's soils may have the potential to store more carbon. Maintaining existing carbon stocks and reducing the likelihood of future losses may be our best bet, but until now there have been scant data on which land management practices might achieve the best soil carbon outcomes for New Zealand's productive soils, and it's been similarly unclear how changes to management practices could contribute to mitigating New Zealand's national agricultural greenhouse emissions.

To address this knowledge gap, researchers at Manaaki Whenua and collaborators from several other organisations led by Dr David Whitehead have for the first time assessed and quantified the most promising approaches to reduce soil carbon losses or increase soil carbon stocks in New Zealand's productive grassland soils. The assessment collated all known data on nine different on-farm interventions, after which the researchers estimated the land area of New Zealand where these interventions could be realistically implemented, and calculated the potential effect of each on mitigating overall national agricultural greenhouse gas emissions.

The nine interventions were classed into three groups as follows:

Increasing carbon inputs to soil

- planting deep-rooting and diverse species in grasslands
- reducing forage cropping (which reduces carbon in paddocks where the forage is grown)
- deferred grazing, which allows biomass to build up prior to grazing.

Soil carbon protection

- water table management to reduce emissions from drained organic soils
- reducing cropping on drained organic soils
- full inversion tillage grassland renewal
- addition of active clay minerals to enhance the ability of a soil to store carbon
- enhanced rock weathering for capture of atmospheric carbon

Integrated systems

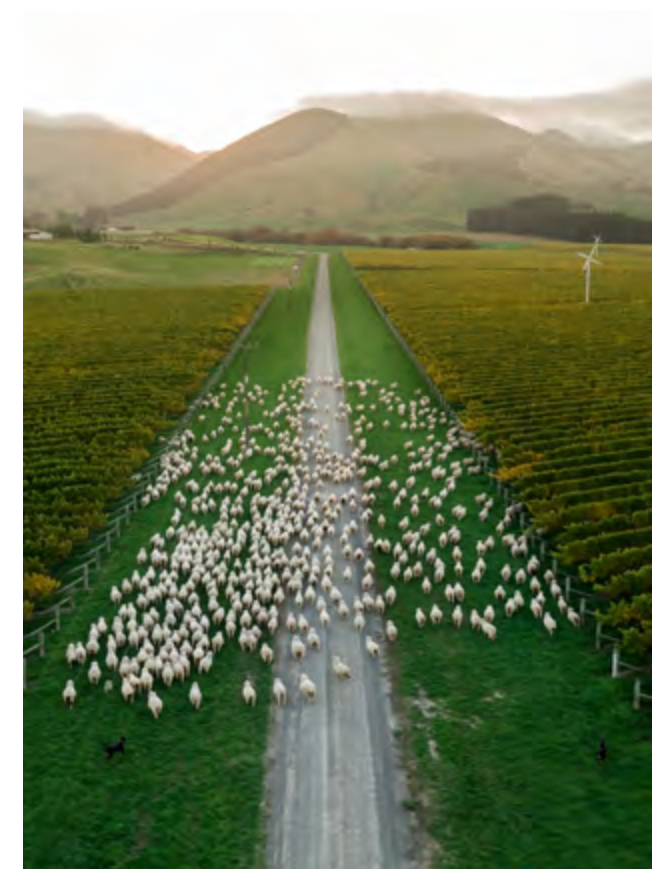
- establishment of tree clusters integrated into grassland and agroforestry.

These nine interventions were chosen based on their suitability to be incorporated into existing grassland management practices and the capability of capturing any resulting changes in soil carbon stocks in the national inventory. Data to confirm changes in carbon stocks from these interventions is scarce in New Zealand, so confidence in the effectiveness of each intervention was scored from "likely" to "possible" or "uncertain".

Overall, the potential contribution of each intervention to mitigating national agricultural greenhouse gas emissions was small, ranging from less than 1% to around 2.5% over 20 years. These contributions are less than planting trees but do allow the land to continue to be used for agricultural production. The most compelling intervention – and the one with the only "likely" confidence score – was raising

water tables to reduce carbon loss from drained organic soils. Further research is required to determine how raising water tables could be best achieved and the size of the benefits under New Zealand's unique conditions.

The researchers conclude that reducing further soil carbon losses and achieving modest increases in soil carbon stocks are possible but will require economic and political incentives that encourage the integration of multiple interventions at the farm scale.



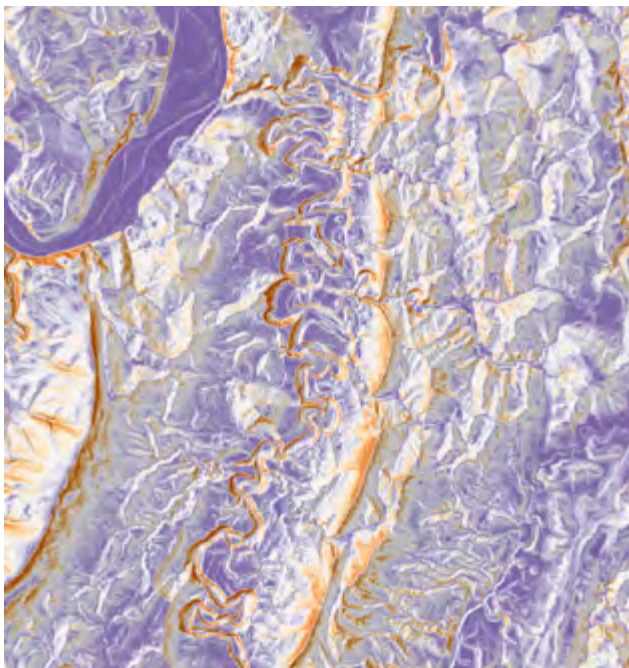
Grazed grasslands cover about 55% of the national land area.

LiDAR project a 'real step-change' for Hawke's Bay land management

Hawke's Bay Regional Council (HBRC) and researchers from Manaaki Whenua have worked on a ground-breaking project using LiDAR to enhance their understanding of the region's landscape.

Manaaki Whenua programme lead Dr Sam Carrick says this initiative marks a significant step forward in helping the region manage land resources, address erosion, and improve environmental strategies.

The project, a result of a longstanding partnership with HBRC, leverages the power of LiDAR (Light Detection and Ranging) to produce high-resolution, regional maps of land and vegetation information.



Highly detailed LiDAR topographic map.

Digital elevation models (DEMs) provide an unprecedented level of detail about the region's topography, enabling more accurate assessments of erosion and sediment loads in rivers. Manaaki Whenua researcher Dr Hugh Smith says one key aspect of the project involved upgrading existing models with the new LiDAR data. "This update enhances the accuracy of predictions related to rainfall-triggered landslides, allowing for more targeted and effective tree planting initiatives. The high-resolution topographic data from LiDAR has also been integrated into the SedNetNZ model, which estimates erosion rates and suspended sediment loads in rivers.

"This model is crucial for evaluating various land management scenarios and understanding the impacts of climate change," says Hugh.

The project's success extends beyond scientific advancements with the collaboration between scientists and policymakers at HBRC fostering a deeper understanding of the practical applications of these models says HBRC senior land scientist Ashton Eaves. "By working together, both groups have developed tools and products that are immediately useful for the council's decision-making processes."

Another researcher in the Manaaki Whenua team, pedometrician Dr Nathan Odgers says one of the innovative applications of the new LiDAR data is in analysing the slope of the land. "Slope plays a critical role in water movement and erosion risk.

The detailed slope data, now available at 5-metre intervals instead of the previous 25-metre intervals, enhances the accuracy of land use capability assessments and assists in implementing recent intensive winter grazing rules."

The project also focused on producing high-resolution vegetation class layers and fine-scale canopy structure information. "We applied our state-of-the-art software workflows leveraging recent developments in computer vision and deep learning to process raw point cloud data and turned it into a comprehensive and detailed spatial catalogue of vegetation features comprising forests, shelter belts, exotic [pine] forests, fields, and individual trees. This layer also vastly surpasses the spatial detail of previous large-scale land cover products such as the Land Cover Database of New Zealand", explains Manaaki Whenua researcher Dr Jan Schindler.

The purpose of this work was not only to generate one-off data products, but to create baseline methods and data sets which can be updated and refined in the future and used for change detection." Jan adds.

Former HBRC science manager, Anna Madarasz-Smith says the collaboration has proven mutually beneficial, allowing scientists and policymakers to develop practical solutions that directly address the region's environmental challenges. "The partnership with Hawke's Bay Regional Council highlights the importance of combining scientific expertise with local knowledge to achieve impactful results," she says.

Springtail safari: a field-based reassessment of agrichemical guidelines

Soil fauna are an essential component of virtually all terrestrial ecosystems. They are usually categorised by size into microfauna (2 to 200 μm), mesofauna (200 to 2,000 μm) and macrofauna (over 2,000 μm). The most dominant microfauna are nematodes, with springtails and mites the most dominant mesofauna and earthworms the best-known macrofauna, but macrofauna also include ants, beetles, millipedes and many other taxa. Soil fauna

support ecosystem functions by directly contributing to decomposition and nutrient cycling, and indirectly through activities such as altering soil structure.

However, there is little robust field-based information about the abundance and diversity of soil fauna in New Zealand, or about the effects of common agrichemicals on them. These knowledge gaps have the potential to hamper management decisions in the productive sector – as the following example shows.

In 2023, the New Zealand Environmental Protection Authority (EPA) updated its assessment of hydrogen cyanamide, a plant growth regulator widely used by the kiwifruit industry for the promotion of bud growth. Hydrogen cyanamide is applied as a spray once a year over August to September. The reassessment identified a high in-field risk for springtails [*Folsomia candida*, of the class Collembola], based in part on lab data that suggested hydrogen cyanamide could cause chronic toxicity effects in springtails.

However, lab-based work does not fully take account of environmental factors such as the likely more rapid degradation of hydrogen cyanamide in the field, and additional interception associated with soil surface coverings such as litter or grass. With better data urgently needed, the kiwifruit industry asked scientists at Manaaki Whenua to assess the potential effects of hydrogen cyanamide spray on Collembola and other soil fauna in a kiwifruit orchard.

A field trial was undertaken in August – September 2023 at a conventionally managed green (Hayward) kiwifruit orchard in Te Puke, Bay of Plenty. Sampling for soil invertebrates and soil chemistry was undertaken three

times: pre-spray, within 24 hours of spraying, and 6 weeks post-spray. Control plots were covered with plastic sheets during the spraying. Funding for the study was provided by New Zealand Kiwifruit Growers Incorporated and by Zespri.

The most obvious finding was a marked increase in Collembola abundance, and other soil fauna, at 6 weeks post-spray, which was attributed to seasonal variation. Critically, there were no significant differences in total Collembola abundance or type, or other soil fauna including mites (Acariformes) and ants (Formicidae), between control and treatment plots at any time-point during the study – suggesting that hydrogen cyanamide did not have any effect on soil fauna in this field study. There was minimal variation in most soil characteristics between individual plots, between control and treatment plots, and over time. Soil chemistry was generally within established soil quality target values.

These preliminary field results suggested that the in-field risk of hydrogen cyanamide for soil organisms was lower than the EPA had thought. These new findings were submitted to the EPA and presented to the EPA decision-making committee for the reassessment in February 2024, which subsequently concluded that with controls in place, the risks to in-field soil organisms from the application of hydrogen cyanamide to orchards are indeed negligible.

This type of field study is important for assessing the impacts of agrichemicals in other horticultural and agricultural systems, including better understanding of the wider potential effects of different management practices.



Sampling for soil invertebrates using a split-corer.



Collembola are plentiful in New Zealand soils.

Catalysing change

Our team of social and economic scientists is the largest in the Southern Hemisphere dedicated to researching the human dimensions of environmental management, helping people to make better environmental decisions.

Our researchers focus on how people value natural resources, how they want these resources managed, what moves them to take action, and how people are affected by policy and management decisions about these resources.

We know that meaningful change in behaviours and systems, can be achieved more easily if decisions are participatory, and the views and expectations of stakeholders are integrated and co-developed into policy or management outcomes.

It takes time and care to build social and cultural licence to operate – and our research provides the tools to make this achievable.

Our research spans rural, conservation, and urban landscapes, and the full range of ecosystem services viewed from both Western science and indigenous knowledge systems.

Selected highlights

Manaaki Whenua ecologists Cecilia Arienti and Dr Dean Anderson were recent co-authors, with researchers from the University of Auckland, Simon Fraser University in British Columbia, Canada, and communications consultant Waitangi Wood, on an important research paper that proposes a mechanism for scientists, environmental managers and indigenous land stewards to securely store data on the web while protecting the data sovereignty of indigenous peoples.

The resulting approach protects data that is shared online with sovereign data owners via public-key encryption and tamper-free blockchain notarisation (for example, about the specific location of taonga species) but also permits sharing an anonymised, less accurate dataset with less privileged users (for example, a “geomasked” or “obfuscated”, but still useful, version of the taonga location data). One important aspect of the approach is that no third party is needed to manage security or access to the data: the information remains in the direct control of the people to which it belongs. The proposed application was designed for protecting and sharing data pertaining to Biodiversity Management Areas stewarded by Māori iwi and hapu, but is applicable globally in the context of indigenous data sovereignty.

Aucklanders were able to see the growth of mould in real time thanks to an innovative advertising campaign made possible by Manaaki Whenua researchers. Senior mycologist Dr Bevan Weir worked with technician Diana Lee to create several giant agar plates measuring a metre in diameter that were affixed to billboards around the city as part of a campaign to highlight the costs and extent of household food waste. The plates were inoculated with a mould fungus like that found in blue cheese and people were able to see the mould growing across the plates.



Community engagement in science at Know Your Place environment + art, Lyttelton, November 2024.

Innovation stories

Moving the Middle using agents of change

Led by Manaaki Whenua, the 5-year Endeavour research programme Moving the Middle [2021–2026] aims to give rural land managers greater confidence to improve their environmental performance voluntarily. While many farmers are willing to make the changes needed to protect the environment and sustain their businesses, others are overwhelmed by information overload and the complexity of the multiple systems and pressures they face.

Providing more information, tools or technologies will not bring about the scale of change required. To empower real change, our research looks at the often-ignored human dimension of the systems affecting farmers and growers (e.g. financial, market, policy, societal/community) to identify places in these systems to intervene (leverage points) that will reduce pressures coming from these interacting systems.

Moving the Middle is researching a wide range of different agents of pro-environmental change on land. We are particularly interested in potentially powerful change agents, such as artists, who have not been well-researched for their role in influencing what happens on the land. Our research investigates what such agents do and how it might ultimately lead to pro-environmental impact.

As part of the Agents of Change research area, the art event *Know Your Place* was run from 20 November to 1 December 2024 in various locations around Lyttelton and its harbour. *Know Your Place* was a key test of the influence that artists may have as agents of change, and also a chance to research how experiencing art might lead to pro-environmental change. Events during

that time included a (literally immersive) underwater sound experience, displays of original art and sculpture, exhibitions, a harbour cruise and foreshore clean-up, speakers, and even themed restaurant menus. Researchers were present at the events, distinguishable by their blue t-shirts, so people could identify and engage with them.

Also acting as agents of change, schools and their teachers play an important role in building foundational skills that will support pro-environmental activity throughout life. Three schools have been studied, each with strong and distinct relationships with the land: Hauraki Plains College, a state high school situated in an agricultural area, with many students from farming backgrounds; Climate Action Campus, a satellite school that students visit a few hours per week to spend time outdoors, building confidence to take tangible actions in the face of climate change; and Pūhoro Science, Technology, Engineering, Maths, and Mātauranga (STEMM) Academy, a virtual high school/academy that seeks to enable and inspire rangatahi Māori to pursue STEMM careers.

Several unifying themes emerged from the research: The more supportive a school's wider community is of pro-environmental attitudes and action, the more likely such attitudes and skills will be developed in the school.

Critical thinking skills are important foundational skills and are nurtured in schools, but this has been equated to taking a 'balanced view' of issues. Considering both sides may inadvertently justify environmentally damaging behaviours, by framing them as just one of two equal sides of an argument.

Schools whose mission or values align with pro-environmental action find it easier to nurture pro-environmental attitudes and action in their students.

Such schools, like the Climate Action Campus, should be encouraged or supported to succeed (e.g. funded) and to work with mainstream state schools to amplify their impact, creating room in the curriculum for what is currently seen as extra-curricular activity.

Young students will take time to progress into the workforce, so the impact of school initiatives is long-term, although their potential impact is high. Other interventions (outside schools) with more immediate effects are also needed to achieve pro-environmental impacts on land.

Hive talking: fewer winter losses in 2024 for the nation's beekeepers

Conducted annually since 2015, the New Zealand Colony Loss Survey is based on the survey of beekeepers developed by the international COLOSS honey bee research association.

Survey topics include the number and nature of over-winter colony losses, queen health and performance, indicators of diseases and parasites, treatment of Varroa, supplemental feeding, and colony management. Because the challenges facing New Zealand beekeepers differ from those facing beekeepers in the northern hemisphere, the survey also includes questions that are specific to the New Zealand context, e.g. apiary crowding, predation by wasps, and nectar flow from native trees.

In 2024, we surveyed 2,828 beekeepers, who collectively had 153,856 colonies. We estimate that 10.8% of New Zealand's colonies were lost during winter 2024. This means 57,800 colonies died over winter, from a total of 535,185. It is the second year in a row where winter loss rates have fallen, and reverses a long trend of increases. Loss rates were lower this year because varroa did not kill as many



Understanding bee health is vital to our apiary industry.

hives. Only 4.6% of all colonies died from varroa during winter 2024 compared to 6.4% during the previous winter.

Commercial beekeepers (those with more than 50 colonies) represent approximately 10% of all registered beekeepers and manage approximately 94% of all registered colonies. However, the majority of beekeepers are non-commercial (1–49 colonies). About 10% of registered beekeepers do not currently keep any bees, although most plan to return to beekeeping.

Non-commercial beekeepers said the main reason they lost colonies to varroa during winter was that they had applied varroa treatment at the wrong time. The main problem commercial beekeepers had with varroa was reinvasion of their hives. Even though beekeepers generally considered their varroa treatments were effective, 19% of non-commercial and 16% of commercial beekeepers said they lost colonies over winter because the products they used were ineffective. If a product had failed, most beekeepers said they did not report it to anyone (e.g. authorities or manufacturers).

Questions about beekeeper perceptions of biosecurity were new in the 2024 survey. Most beekeepers were at least somewhat confident that they could identify the signs of European foulbrood or small hive beetle. However, beekeepers were less certain that they could identify the signs of tracheal mites or tropilaelaps mites. Overall, beekeepers had some confidence that the biosecurity system (described as a collaborative effort in which every New Zealander has a role to play) could detect exotic pests and diseases, but beekeepers were much less confident that these exotic pests and diseases could be eradicated.

Pollination was an important activity for commercial beekeepers. More than 102,000 colonies were used for commercial pollination during the 2023/24 season, with each colony pollinating an average of 1.5 commercial crops.

Strategic, tactical, complex and simple: a four-way schema for measuring on-farm change

In the face of climate and other environmental change, as well as regulatory and economic changes, farmers are always under pressure to redesign and improve their systems and to adopt new practices. Some change in practice (e.g. doing something completely different to existing practice) are more complex than others which are simple enhancements of existing ways. And some changes are strategic because they involve changing outputs to make better use of critical inputs while others are tactical because they involve finding other inputs that can substitute for critical inputs. An input is critical if access to it is crucial to the viability of the farm (e.g. pastures are a critical input for a livestock operation).

To test this four-way schema to measure on-farm change, our researchers surveyed a sample of New Zealand dairy and drystock (sheep/beef cattle) farms on the type of

change entailed in adopting four practices commonly recommended to reduce the damaging effects of livestock agriculture on water quality and biodiversity. The four practices were: fencing of streams to exclude livestock, fencing of wet areas (wetlands) to exclude livestock, the use of cover crops to reduce nutrient losses following winter grazing, and the creation of ungrazed laneway buffers to prevent nutrient emissions.

As might be expected, the researchers found that more farmers adopted simpler practices than adopted more complex ones. Adopting a practice that entails strategic or tactical change was far less common than adopting a practice that does not.

It's been common in research, and when designing policy extension programmes, to resort to "personality type" arguments when discussing the likelihood of farmers adopting change on farm. Some farmers are inherently innovative, and others are not, it's said. But this framework suggests that "early adopters" are able to adopt a practice quicker than others because they only have to make a simple change to their farm system, whereas for those who lag behind, adopting the same practice may entail a complex, or even a tactical or strategic change. These kinds of changes are more costly, more difficult and so take much more time to consider and implement. The early adopters are not necessarily so-called "leading" practitioners or "innovative" farmers.

The researchers conclude that if the likely magnitude of the impacts of change is not adequately understood, the role of other determinants, such as personality, is likely to be overstated. They also conclude that those that adopt a practice later because it is a complex change are unlikely to be able to learn much from the experiences of early adopters for whom the change is simple.

Toitū Envirocare: Responding to evolving political, economic and market contexts

As a subsidiary of Manaaki Whenua – Landcare Research, Toitū Envirocare has been leading positive change for over 23 years through science-based carbon and environmental programmes. Toitū's enduring purpose is to help organisations shift their impact on the climate and environment from negative to positive, at pace.

This includes enabling businesses to make strategic decisions to mitigate their GHG emissions and adapt to climate change impacts. These business-led decisions are vital in helping New Zealand achieve its national emissions reduction commitments.

Throughout the US and UK, there has been a movement towards simplification and reduction of climate related reporting, which continues to be a trend here in New Zealand. Despite this, Carbon and Energy Professionals New Zealand reported that while 16% of the 4,000 companies surveyed were relaxing climate targets in 2024, 37% were tightening them, with the other 48% maintaining their ambitions.

This continued support for sustainability action, despite the economic and geopolitical headwinds, is reflected in the steady demand for Toitū Advisory, Verification Services, High Quality New Zealand Carbon Credits, Climate Impact and Enviromark Programmes.

Strategic reset for an evolving landscape

A new Toitū CEO, Aisha Daji Punga, was appointed in February 2025, and has led a strategic reset, having engaged with clients, team members and stakeholders across the country to establish an insight base to inform the organisation's future direction. The strategic reset focused on how Toitū can 1) optimise environmental impact 2) unlock profit and potential for its clients and owner and 3) enable the future for the broader sector. The strategic reset resulted in an organisation redesign which was implemented in June 2025.

The year also saw the appointment of Kirsty Campbell as Board Chair and the addition of three new Board members - Justine Gilliland (Manaaki Whenua - Landcare Research Board member), Kevin Bowler and Teresa Pollard.

Optimising environmental impact:

Resulting from the strategic reset, the organisation has sought to prioritise high-emission sectors, clients of scale and influential industry partnerships. A concerted drive was undertaken to elevate Toitū's thought leadership, science credentials and brand presence to increase value and credibility for Toitū clients. A new strategic partnership with the Aotearoa Circle was established alongside existing strategic relationships with the Sustainable Business Council and the Climate Leaders Coalition.

Toitū's current client base is 918, of which 779 are on the Climate Impact and EnviroMark programmes in the 2024/25 financial year. In total, 1,005 certifications have now been issued across Climate Impact, EnviroMark, and Non-Programme. The total volume of emissions certified or verified during the year was 60.2 million tonnes CO₂e, and Toitū's clients cancelled 108k tonnes of high-quality offsets.

Unlocking profit and potential:

The financial year 2025 focused on ensuring a fit for purpose business model to withstand the current economic and political headwinds, whilst setting Toitū up to take advantage of future market growth opportunities. Focus was placed on retention strategies utilising Verification and Measure product options to support clients under budgetary constraints. Reduction in operating costs, improvements in revenue assurance processes, enhancements in systems and processes were also undertaken.

High-quality NZ Carbon Credits were re-introduced to the market in March 2025 to meet client demand, maintain carbon credit integrity and mitigate the decline in carbon credit sales from the prior year. Life Cycle Assessments and bespoke advisory projects contributed to growth outside of core programmes. This resulted in an overall profitable trading position, with growth in Advisory Services, Enviromark Programmes, Measure and Audit Services this year compared to the previous year.

Enabling the future

The strategic reset helps us evolve Toitū's capability and credentials for the future. This included the establishment of a Nature strategy to meet the evolving environmental sustainability landscape. An Independence and Impartiality Framework was established and reviewed by the external Advisory Panel. Toitū successfully achieved international reaccreditation for the next 4 years with JASANZ for its ISO Climate Impact Certification programmes.

The development of a Toitū Real Climate Credentials, Real Business Impact, digital brand campaign was undertaken during the year. Investment has been allocated in the 2025/26 financial year's budget for the development of Toitū's technology platform to meet the needs of Scope 3 and Value Chain inventory management and API integrations.



How we work

Te āhua o tā tātou mahi

Our goal is to create an environment that allows the right people to come together and create high impact research that meets New Zealand's needs. That means supporting our own people, but also supporting a high level of collaboration and integration across the research sector and the wider community that relies on and uses our research and solutions.



Anna Zrinyi-Morgan of DoC (left) and Manaaki Whenua researcher Dr Jo Carpenter at Farewell Spit carrying out a lizard survey prior to a proposed invasive mammal eradication.

Putting people at the centre

The diagram shows four interlinked strategic aspects of how we work. Our overarching priority is development of our people and culture, which also puts our people at the centre of everything we do. We are also committed to ensuring our financial resilience, developing impact processes for our science, and continually improving our support systems and infrastructure.



Organisation design

Following a review of our internal matrix structure, we reviewed our science roles and accountabilities to reset how management and leadership roles were configured, and how responsibilities were distributed across Tier 2, Tier 3 and Tier 4 managers. The end-state was a deliberately designed structure that specified the unique expectations of each position and how these positions fit together to create a culture where we are partner focused and looking for solutions to create impact.

The review also provided an opportunity to create career progression pathways for our Technicians, Researchers, Kairangahau and for individuals who wish to pursue people

and/or research leadership opportunities. This reset also saw our science leadership gender profile increase to 50.59% female representation, and 37 employees were also internally promoted to a leadership role [Tier 2 – Tier 4], demonstrating our career pathway opportunities.

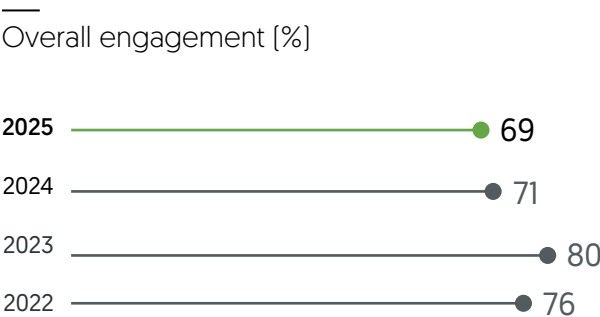
Leadership development

Focusing on our new science leadership team, an in-person training day was held to bring together 90 science leaders across management tiers 1-4. The day provided an opportunity for connection, gaining a true understanding of each of the new positions, and how they work together, expectations of the new group structure, our leadership approach, and considering our current environment how to navigate and support our people through change.

Employee Experience survey results

This survey helps us understand the overall experience for our people at Manaaki Whenua. We intend that our culture, values and behaviours underpin our staff’s senses of belonging/connection/whanau and help to create an inclusive workplace, in which everyone can bring their whole selves to work.

At 69%, the 2025 Employee Experience Survey reported a reasonable level of staff engagement given the uncertainty of our current environment.

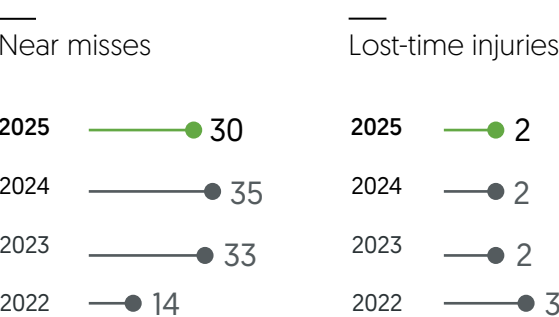


Enabling safe science

Our goal remains that everyone is 100% committed to health, safety, and well-being. The most recent staff survey shows that 94% of our people agree or strongly agree that Manaaki Whenua actively strives towards this goal. In 2024/25, we introduced new Psychological Safety questions, with 80% of our people agreeing or strongly agreeing that, in their teams, they feel safe to ask questions, make mistakes, voice opinions, and raise concerns.

The health, safety, and well-being culture at Manaaki Whenua is not the result of a few individuals, but of the collective passion and professionalism shown in all our work, whether in the field, in laboratories, or through construction and redevelopment projects.

This year, we continued to focus on reducing the risks inherent in our work in laboratories, on our sites, and in the field. This included providing input and support for change management initiatives, ensuring that new hazards were not introduced and that risk potential did not increase during times of change. We have strengthened our collaboration with Health and Safety teams across other CRIs in preparation for the formation of the BSI, with Manaaki Whenua well-placed to contribute to the development of BSI health and safety systems and processes.



The National Laboratory Manager and National HSE Manager have rolled out new Spill Kit Practical Training, building on last year's work in Hazardous Substances training and refresher resources. The Spill Kit Training was tailored to its audience (with site-specific and lab-specific versions), which also provided an opportunity to review and refresh our Respiratory Protection Programme, including updated fit testing, refreshed equipment, and updated user training.

We recently completed our annual TELARC ISO 45001 and ISO 14001 re-certification assessments and identified clear pathways for the future under the BSI model. We also consulted on, updated, and deployed our Health, Safety and Well-being Policy.

Manaaki Tangata – our well-being programme for staff – is themed monthly and also covers diversity and inclusion aspects. The wide-ranging calendar for 2024/25 comprised months dedicated to a variety of well-being themes: self-care, financial wellbeing, mental health awareness, Pasifika, kindness, holiday session wellness, workplace wellbeing, support through change sustainability, safety and health at work, belonging and inclusion, and winter wellness.

Creating an equitable culture

Our science role reset has assisted us in closing our vertical median pay gap, with more women now holding Hay Grade 17 and above positions. At June 2024 the gap was 19.4% and it has dropped to 17.2%. We acknowledge more work is required here, but with the development of our new career progression framework, the introduction of career development plans, our tier 4 people leaders having a higher FTE dedicated to leadership, and our refreshed remuneration policy, we are optimistic we will continue to see a downward trend.

Manaaki Whenua also looks at its gender pay gaps across similar pay grades (horizontal pay gap) and there is no evidence of gender pay gap across like-for-like roles.

Our Māori staff currently have a median pay gap in their favour of 0.4% compared with non-Māori.

Building a diverse and inclusive work culture

Our Diversity & Inclusion group of staff is made up of representatives across our teams and sites, raising awareness and building knowledge of diversity, enabling us to better understand the needs of our stakeholders and people and respond effectively to them.

In recent months Kia Māia, the Māori cultural development programme at Manaaki Whenua, has partnered with Kia Manawanui, the equivalent at AgResearch, to offer 90-minute workshops with Anton Mathews on a range of ao Māori aspects. This will continue for the second half of 2025, with the offerings open to all within the BSI. Te reo Māori has continued to be offered to our staff, and Tiriti training has been undertaken with an external provider.

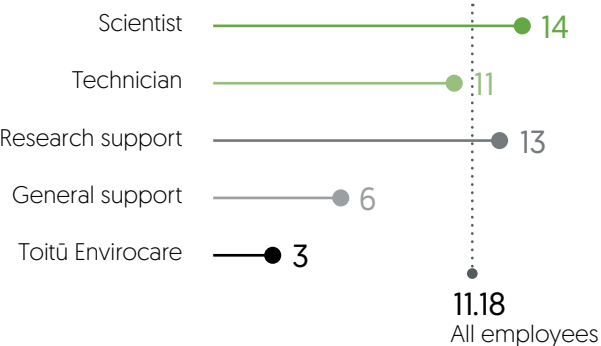
We continue to partner with Māori communities and enable capability development from within. At our Lincoln campus, senior researchers have worked with Lincoln High School to deliver a programme for students. Our Māori internship programme is well-established, and this year will offer Māori-centred and Kaupapa Māori aligned projects.

Overall gender distribution**

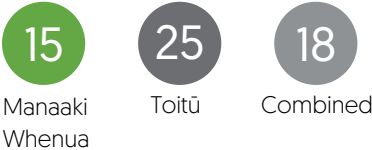


None of our staff identified as genders other than male or female.
*excluding Toitū

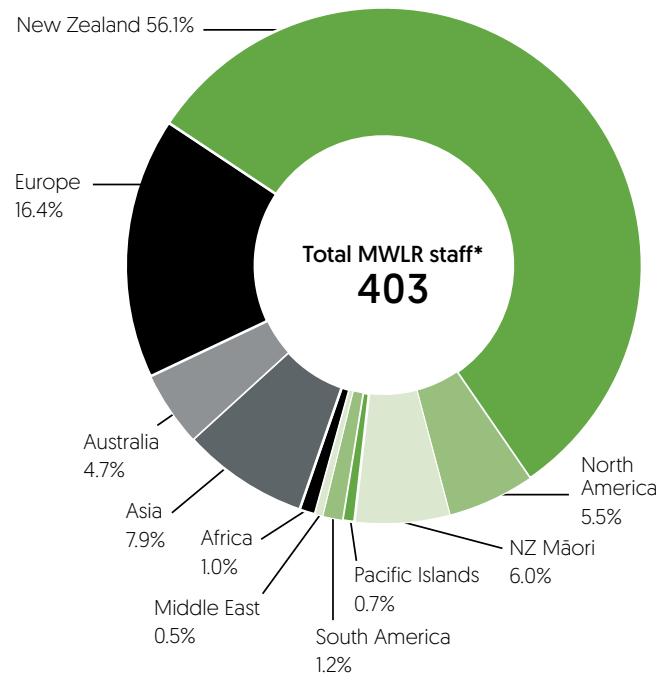
Average years' tenure



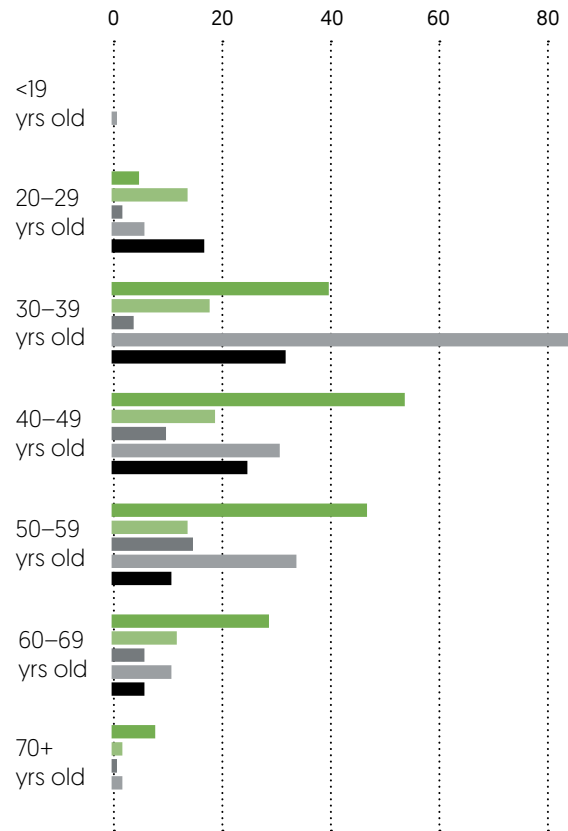
Annual turnover [%]



Origin of our staff



Age distribution



Bioeconomy Science Institute staff at a volunteer planting day, Lincoln. Image: Craig Robertson.

Our infrastructure

Our goal is that our facilities, property, equipment, and infrastructure support excellent research; and that our sites provide great working environments.

Selected highlights for 2024/25

A successful TELARC audit

A surveillance assessment of our ISO45001 (health & safety) and ISO14001 (environmental management) certification took place in May 2025, run by TELARC, New Zealand’s leading business certifier. Manaaki Whenua holds the highest possible (Gold) SiteWise accreditation status for the 2024/25 period. This achievement reflects the collective effort of everyone at Manaaki Whenua, as it is through our record-keeping, behaviours, actions, and systems that we have successfully secured this distinction. The report noted “The management systems were seen to be continually improving, responsive to changes in internal and external context and have processes to determine the needs of interested parties.”

ISO 14001 certification
1998–present



Biolab XR – Molecular Containment Lab Project

Construction started on the Biolab project at the Lincoln campus in February 2025. As of July 2025, the foundations have been cast, the steel structure erected, and the building envelope enclosed. Progress continues on budget and to programme for delivery by the end of November 2025.

Other infrastructure

Further key infrastructure upgrades were undertaken in 2025 to improve energy efficiency and operational resilience across sites.

At Lincoln, works included the replacement of flat roofing on the Herbarium and Fleming buildings, alongside the installation of a new chiller and heat pump for the Herbarium. A new energy-efficient chiller was also added to the Invertebrate Containment Facility. Additionally, electrically resistive heating systems across the Fleming buildings were replaced with modern split air conditioning units to enhance energy performance.

At the Hamilton site, the existing chiller plant was replaced with a more energy-efficient unit.

Auckland’s Tāmaki site saw upgrades to the HVAC system and alterations to the ethanol store to meet compliance regulations.



The Biolab XR molecular containment lab at Lincoln takes shape during 2024/25.

Our impact processes

We identify groups of partners, and we formalise partnerships to bring together complementary skills, align planning, and build trust within and beyond the science sector, into government and industry.

Our emphasis is strongly on integration – across organisations, disciplines, and issues.

We have continued to support the Impact Planning and Evaluation Network (iPEN), a joint initiative between the seven CRIs that aims to create greater impact for research. Over the past year iPEN has developed resources and methods, related in part to our own work in i3 to hone the impact creation cycle and to develop a community of best practice

Partnering nationally and internationally for greater impact

Our pathway to science impact depends on working with local, regional, and central government, the New Zealand science sector including universities, industry and businesses, landowners and growers, and Māori entities. As in previous years, this year we have developed new partnerships across linkages in the science value chain.

Partnership with Māori

Manaaki Whenua has developed enduring partnerships with selected iwi, groups of iwi, Māori trusts/incorporations, and Māori organisations. These partnerships support and contribute to our partners' aspirations. We engage regularly with these groups in the spirit of partnership, as expressed in the principles of the Treaty of Waitangi.

We seek to understand and respond proactively to the needs of our Māori partners, including novel approaches (e.g. through secondments and new commercial models). We increasingly co-design our science and research programmes with our Māori partners. We build on and add value to the platforms, tools, and technologies of our Māori partners to grow joint intellectual property that is beneficial to New Zealand.

Our people have the skills and characteristics to engage well, deliver value, and support our Māori partners.

Reaching critical mass at Ngāi Tahu Hui-ā-Iwi 2024

In November 2024, kaimahi from our Manaaki Taiao team travelled to Kaikōura to attend Hui-ā-iwi, showcasing our research to 2,000 Ngāi Tahu whānau. The biannual event, this year hosted by Te Rūnanga o Kaikōura, is a chance for Ngāi Tahu whānau, hapū and iwi to congregate and hear updates from Te Rūnanga o Ngāi Tahu, celebrate with Kapa Haka, kai, and kōrero, and learn about different businesses at market stalls. Our team's tech-savvy stall included showcasing our QGIS and geospatial mapping LiDAR work to whānau, as well as collateral related to our Pest Management and Rongoa Bioactive capability.

A Virtual Reality experience and a predator stamp activity were created for tamariki. We also had flyers for whānau, highlighting our ability to partner with mana whenua on pest control projects, and helping them to understand more about the plants on their whenua. Many constructive conversations were had with whānau, and we look forward to following up with these potential new partners.



Hui-ā-Iwi, Kaikōura, in November 2024.

Vision Mātauranga Projects

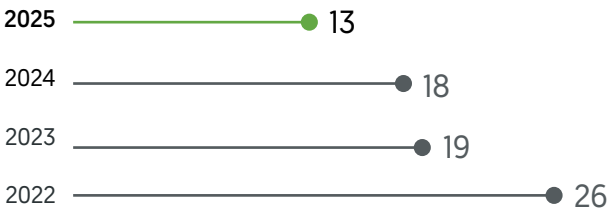
Research specifically relevant to Māori



Research involving Māori



Kaupapa Māori



Wānanga with mana whenua at Ngatirua, Taupo Bay.

Māori-centred research



Partnering nationally and internationally for greater impact

Our pathway to science impact depends on working with local, regional, and national government, the New Zealand science sector (including universities and the National Science Challenges), the primary sector, and Māori entities. As in previous years, this year we have developed new partnerships across linkages in the science value chain.

National partnerships

We have continued to support Cyclone Gabrielle recovery and response. The emergency platform on Extreme Weather Ecological Impact Assessment (funded by the Strategic Science Investment Fund) delivered to plan with the Cyclone Recovery Advisory Group, including research leads (from NIWA and MWLR) and representatives from Hawke's Bay Regional Council, Auckland Council, DOC, and the Ministry for the Environment.

We delivered against the following objectives:

- identified changes in the extent and condition of vegetation cover
- assessed impacts on naturally uncommon ecosystems
- examined the impacts on, and recovery of, freshwater fish and macroinvertebrates (led by NIWA)
- determined damage to conservation infrastructure (ecosanctuaries)
- assessed impacts on threatened and taonga species populations.

We also ran a field day and produced an infographic to ensure the results could be picked up across the country for disaster preparedness.

Local and regional partnerships

We led two major programmes of work – one being the application of improved models of erosion susceptibility to enable land use planning at regional scale (Horizons, Waikato, Tairāwhiti). The other is the completion of S-map mapping of agricultural soils for Taranaki, Northland, Manawatu, Waikato, Marlborough, Tasman, Otago and Southland regions. S-map coverage reached 11 million ha, or 73% of the multiple-use land (Land Use Capability classes 1 to 4). The S-map collaboration is a true partnership between MPI, regional or unitary councils and Manaaki Whenua.

Ministry for the Environment (MfE)

We worked with MfE on the sixth version of the Land Cover Database, an online classification of New Zealand's 33 main land cover classes used extensively by land-use planners and policy makers. Version 6 includes significant updates and uses significant advancements through leveraging AI and other automations for mapping. As usual we supported MfE with many of the indicators required for the three-yearly *Our Environment* report released in April 2025.

Department of Conservation (DOC)

Our long-standing close work with DOC harmonises our research interests in biodiversity and tools for achieving Predator Free goals. We hosted the data and platform for DOC's Tier 1 Biodiversity Monitoring Services 2024-25, and we are continuing to work with DOC across terrestrial biodiversity priorities, including National Vegetation Survey biodiversity monitoring. We continue to innovate on biodiversity data that can be inferred from remote sensing – this financial year we made major advances with DOC in being able to discern individual species. We also partnered on toxoplasmosis and potential routes of transmission.

Te Uru Rākau

We have begun new projects this year with Te Uru Rākau - the New Zealand Forest Service. We are contributing to their research programme on 'Maximising carbon sequestration' to measure carbon sequestration in regenerating indigenous forests and to advance data from remotely-sensed indigenous forests.

Food and Fibres sector

We work closely with the food and fibre sector to develop pathways for our work programmes. Examples of our work include:

- Organisations such as fertiliser companies, banks, councils and users of the Overseer nutrient budgeting tool, all rely on S-map. The dataset continues to be developed with specific focus on improving the soil mapping coverage across some of the country's best food-producing land.
- Through our research on soil water infiltration rates in farm catchments we have provided farmers the knowledge to increase agricultural water-use efficiency and manage storm water generation more efficiently on-farm.
- Our research has provided farmers the knowledge to begin to understand and account for the estimated 106 tonnes of carbon, per hectare, across our grazed grasslands. Building on this, we have identified nine interventions that farmers can undertake to mitigate soil carbon losses from their farms.

International partnerships

We are proud to have been awarded a new contract by MFAT in April 2025 for a regional Pacific partnership with Samoa, Tonga, Fiji, Vanuatu, Cook Islands, and Niue. We will support Pacific-based peer-to-peer networks across countries with links to regional and international science organisations and networks. Under the partnership, we



Dr Peter Heenan teaching the next generation of lichenologists on Niue.

will work alongside Pacific Island countries' Ministries of Agriculture and Environment, as well as agricultural research organisations, to strengthen their capacity for climate resilient:

- land-use science, data analysis, and decision-making tools: building PICs data collection and analytical capacity to enable more accurate and effective climate resilient soils, seeds, and land-use-management assessments, and decision-making;
- on-farm trials for soils, crops, and indigenous plants: undertaking harvest, cultivation, and on-farm research to trial more climate resilient soils, crops, and culturally and commercially significant indigenous plants;
- provincial seed storage and distribution: developing provincial seed centres to improve seed storage and distribution capacity to farmers across Vanuatu – to support food security after cyclones and other climate-change induced disasters; and
- agriculture and land-use lab infrastructure and associated processes: filling infrastructure, systems, and skills gaps for labs that determine climate-resilient seeds/soils/ crop/plant traits and protect against climate-induced pests and diseases.

Creating science with impact

Matawhānui | Visionary Science

Led by our Principal Researchers, the Matawhānui | Visionary Science programme, internal to Manaaki Whenua, facilitates idea development and funding opportunities for leading-edge, potentially high-reward strategic science. It is funded via SSIF. It aims to be of interest to researchers at all career stages. The initiative supports researchers' scientific aspirations through three funding opportunities.

1) Māramatanga te kupu | Outside Thinking, Brilliant Writing

Purpose: To invest in early thinking for high-risk, potentially high-reward new science ideas.

Untangling the functional response of ground and aerial hunters towards deer and other invasive ungulate prey – a project continued from the previous year – Dr Graham Hickling.

2) Whakarau whakaaro | Germinating ideas

Purpose: To deepen an existing idea and/or foster collaboration.

Several research projects were funded under this initiative in 2024/25:

Clémence Vannier, Dan Richards, Alan Heays, and Alex Herzig used GenAI with a climate-smart landscapes agent-based model to advance decision-making simulations, a novelty for socio-environmental decisions.

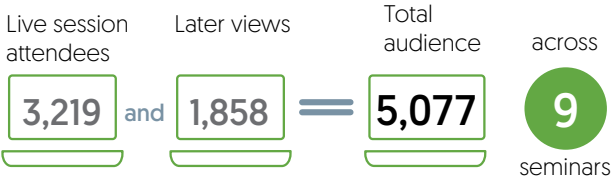
Drs Phil Novis, Manpreet Dhami, and Ana Podolyan harnessed enzymatics and genomics to deliver monitoring tools for pristine deepwater lakes.

Drs Al Glen and Patrick Garvey ran a project to alter the feeding behaviour of feral cats so they prey less on threatened native species and more on invasive prey such as rabbits and rodents.

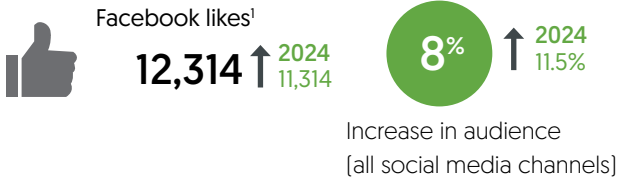
Dr Mateus Detoni's research produced a reference for researchers and decision makers to support conservation, biosecurity, and biocontrol strategies for social wasps across the Pacific region, and to enhance citizen science opportunities to record social wasps.

Online engagement

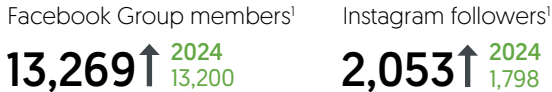
LinkOnline seminars



Manaaki Whenua social media

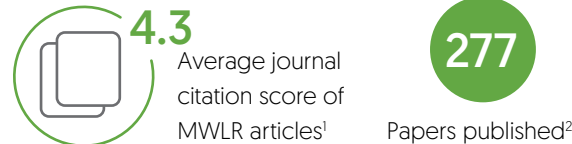


NZ Garden Bird Survey



¹ Meta Business Suite and Buffer social media management tool.

Journal publications



¹ SCImago journal ranking.

² Web of Science 2011–2025, for the financial year 2024/25, 50.5% [140] of these 277 papers were collaborations with international institutes.

3) Purapura taiao | Seed funding

Purpose: To invest in early thinking for high-risk, potentially high-reward new science ideas.

Three projects were funded in 2024/25:

Can obligate insect endosymbionts thrive outside their hosts? – Drs Claudia Lange with Connor Watson.

Establishing a new approach methodologies (NAM) platform for multiple applications, including toxicology and pest management – Dr Louis Tremblay.

Is our research being used by other scientists?

Our science adds to global knowledge and understanding of the natural world. Scientific knowledge is advanced by researchers building on each other's knowledge. A measure of this process is scientists citing other scientists' work in their publications in journals. The journals themselves are ranked by the level of citation of the articles they publish. Both are measures of scientific excellence.

Manaaki Whenua aspires to be in the top 15% of research institutes globally for citation impact of publications, thereby maintaining and building on our internationally and domestically recognised excellence in science.

According to the InCites database, a tool based on the Clarivate Web of Science, overall publications from New Zealand between 2019-2024 have a citation impact of 1.15. Over this time period, we had 23,136 citations with an overall citation impact of 1.44, second only to ESR among the CRIs. The work of our researchers was most often cited in papers on mycology, ecology, environmental science and biodiversity/conservation. In 2024/25, 50.5% (140) of

our 277 published papers had international collaborators. Our average SCImago journal ranking [citations per document over 2 years] is currently 4.3, up from 4.2 in 2023/24.

Is our research valued and trusted by all New Zealanders?

Engaging government, industry, Māori, other scientists, and the New Zealand public with our research, supports new partnerships for impact, helps develop social licence, educates, and helps shape our approach to these problems as we understand and incorporate the values of New Zealanders into our research. Our Brand and Communications team leads this strategic goal area, supporting the wider organisation to engage through marketing, communication, and digital platforms.

This year we continued to build on the success of our online seminars. Over the past year, we have held nine Link Online webinars seen by more than 5,000 people.

Registrations for these webinars come from a wide variety of our key stakeholders, particularly in local government, central government ministries such as DoC, MPI, MfE, Māori organisations, the primary sector, and other CRIs. The most popular for the year were two webinars hosted by Dr Shaun Awatere and colleagues, the first on climate change adaptation and Māori, and the second on the Huringa Āhuarangi, Huringa Oranga (Changing environment, changing well-being) research programme, and a webinar on use of generative AI for district council land-use planning decisions, presented by David Worden.

Across our social media channels (includes Facebook, LinkedIn, Instagram, YouTube, BlueSky) our audience continued to grow, with a total audience reach across all

channels of 54,688 people. Our best-performing channel was YouTube, with a 19% growth in followers to 3,298. We also saw strong growth in our LinkedIn audience, now over 12,000 including many people and organisations across the science, agricultural and professional sectors.

The New Zealand Garden Bird Survey continued to perform strongly in 2025. Taking part in New Zealand's longest-running citizen science project, the public added a further 5,800 surveys to this valuable dataset, which helps researchers track how our garden birds are faring.

In May 2025 we ran a *Fungus of the Year* promotion to coincide with the annual New Zealand Fungal Foray, held this year in the forests near Urenui, Taranaki. An online form was developed to enable public voting among 12 fungal "contestants". A very impressive total of 4,167 people took part, and the winner was *te matakupenga*/the basket fungus.

In June 2025 we were proud to feature our soil science on a set of NZ Post stamps. We worked with NZ Post to design the set, including First Day Covers and accompanying information on soil science – helping us to extend the public reach of our research.



Our commitment to sustainable development

Our contribution to the future of New Zealand is underpinned by a sustainable business model that balances social, economic, and environmental impacts. As a Crown Research Institute, we are expected to be self-sufficient and financially sustainable. With the permission of our shareholding Ministers, our surplus is reinvested in our science and infrastructure.

Sustainable procurement

We access several All of Government (AoG) and syndicated contracts. Several of these have sustainable procurement practices, as required by the Government's broader outcomes, which are built into them. Our own Procurement Policy notes we 'Require sustainably produced goods and services wherever possible having regard to economic, environmental and social impacts over their life cycle'.

We work to ISO 20400 standards for sustainable procurement wherever possible.

Taking action to combat climate change

Given the focus of our business on the sustainable use of natural resources, it is especially important that we manage our operational activities to minimise any adverse impacts on the environment and our communities. The scope of these activities includes moving our car fleet to electric vehicles, sustainable procurement with focus on whole of life impacts of goods and services to support our operations, and making progress towards sustainable energy use in our buildings.

We have been certified to the ISO14001 standard since 1998. Our successful TELARC audit in May 2025 requires that we maintain systems to document and manage our environmental impacts.

We have been certified carbon-neutral since 2011, which means we measure and manage our greenhouse gas emissions and pay to offset the emissions that we have not been able to eliminate. We maintain carbon zero certification through our subsidiary, Toitū Envirocare Limited, which purchases certified carbon credits on our behalf.

In alignment with our fleet optimisation plan, we have replaced three of our older diesel utility vehicles with new hybrid utility vehicles, and removed the last hybrid SUVs replacing these with full electric cars. Our investment in vehicle charging infrastructure across our sites continues with installations at Hamilton, Palmerston North, and Dunedin to support the electrification of our fleet.

We have installed photovoltaic solar panels on our Hamilton building to help meet baseload requirements and continue to benefit from the photovoltaic solar array at our largest Lincoln site. Much focus has been given to optimising our energy use and efficiency nationally, including investment in replacement plant, with EECA-funded audits at our two largest sites affirming our good practices whilst identifying some further opportunities.



Electric vehicles make up a significant part of our fleet, helping us to lower our greenhouse gas emissions. Image: Craig Robertson.

Our financial resilience

To fulfil our role as part of the Bioeconomy Science Institute, we need financial strength to build and maintain critical research capability for New Zealand, to fund research infrastructure (buildings and technology), and to invest in the research ideas and opportunities agreed with our partners. Our financial resilience is therefore crucial to achieving our ambition.

Looking ahead we are confident in securing funding from our usual partners and utilisation of our science staff time is high. Our revenue diversification work into new sectors has begun to pay dividends and we will continue to drive opportunities through this work. This growth has offset the reduction in funding we experienced when the New Zealand's Biological Heritage National Science Challenge was wound up in June 2024, the effects of fiscal restraints from the central government sector, and the ending of several Endeavour programmes.

Into 2026/27 we are expecting to continue this performance and are optimistic that our new science structure will deliver improved revenue and margin, ensuring Manaaki Whenua is well placed to join the Bioeconomy Science Institute as it delivers science with impact for partners across New Zealand.

Our financial performance for 2024/25 is outlined in Part 2 of this Annual Report.

Our tCO₂e emissions

Manaaki Whenua's greenhouse gas emissions for 2024/25 were 21% below target. This is a great achievement, reflecting our strong focus on energy and refrigerant management, including targeted investment in mechanical upgrades, enhanced monitoring and scheduling initiatives, the establishment of an energy management group, and greater rigour in data entry processes.

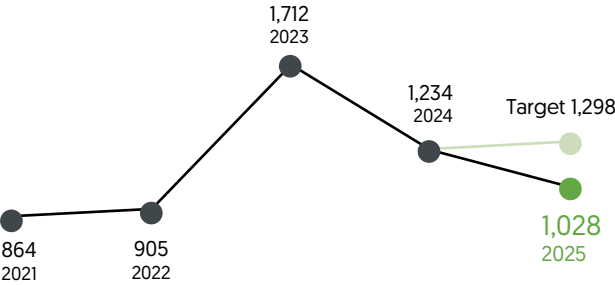
In 2024/25 our total emissions were 1,027.58 t CO₂e – subject to an audit by Toitū in August 2025. Our overall emissions were 21% lower than the 1297.6 t CO₂e target, our business travel and direct emissions were both 25% below target, and our energy emissions were 22% lower than target.

It is proposed that budgeted funds are used to purchase carbon offsets to neutralise these emissions, enabling Manaaki Whenua to achieve carbon neutral certification for the 14th consecutive year.

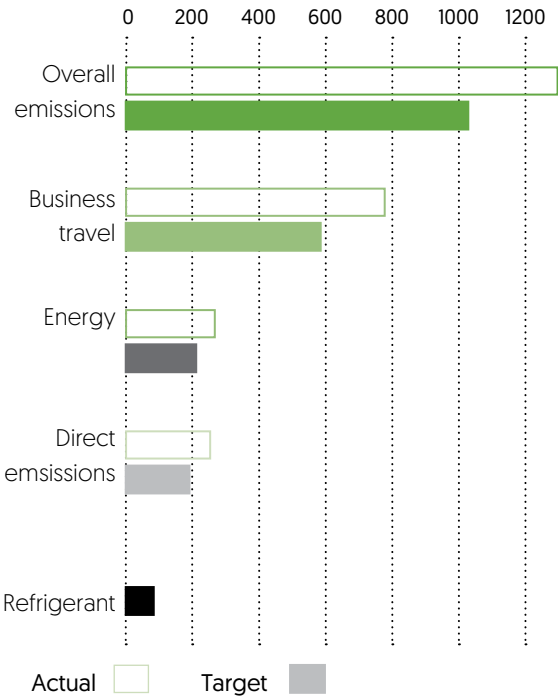
Carbon zero certification 2011–present



Total emissions [tCO₂e]



Emissions by sector [tCO₂e]



Non-financial KPIs

Here we provide an overview of selected non-financial performance metrics. Our full audited financial statements and other performance information are detailed in Part 2 of our Annual Report.

KPI	FY20	FY21	FY22	FY23	FY24	FY25
How we work						
1. Employee engagement index	81%	75%	76%	78%	72%	69%
2. Employee turnover	4.5%	7.05%	8.33%	10.02%	13%	15%
3. Health & safety (near misses)	31	34	14	33	35	30
4. Health & safety (lost-time injuries)	1	5	3	2	2	2
5. Average tenure (years)	8	8.48	11	10	10.5	11.18
Science working with mātauranga Māori						
1. Research with no specific Māori component	490	233	64	18	19	14
2. Research relevant to Māori	93	295	491	490	564	594
3. Research involving Māori	50	62	95	108	93	83
4. Māori-centred research	31	26	48	50	40	37
5. Kaupapa Māori	23	24	26	19	18	13
Our sustainability						
1. Tonnes CO ₂ per \$m revenue*	19.0	10.1	10.8	17.5	10.43	10.53
2. Total tonnes CO ₂ e*	1,593	896	905	1,712	1,234.0	1,027.58
Our impact processes						
1. Impact of scientific publications (mean citation score)	4.2	4.0	5.2	4.2	4.2	4.3
2. Facebook likes	9,206	9,182	9,679	10,839	13,497	14,218
3. Participants in Garden Bird Survey	7,800	6,632	6,234	6,237	7,933	5,800
4. Interactions per social media post	143	119	187	93	**64	97

*This row shows provisional amounts for 2024/25.

Full audited amounts are shown in Part 2 of the Annual Report.

**Facebook only.

Directory

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www.landcareresearch.co.nz
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Dunedin 9054

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WELLINGTON TE WHANGANUI A TARA

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Wellington 6143

BIOECONOMY SCIENCE INSTITUTE

DIRECTORS [from 1 July, 2025]

Barry Harris, Chair
Gray Baldwin
Candace Kinser
Andrew Morrison
Kim Wallace

TRANSITION CHIEF EXECUTIVE OFFICER

Mark Piper

REGISTERED OFFICE

Tuhiraki
19 Ellesmere Junction Road
Lincoln 7608

BANKERS

ANZ Bank New Zealand Limited

AUDITORS

Deloitte Limited on behalf
of the Auditor-General

SOLICITORS

Buddle Findlay

MANAAKI WHENUA – LANDCARE RESEARCH

CHIEF EXECUTIVE OFFICER [to 30 JUNE, 2025]

James Stevenson-Wallace

DIRECTORS [to 30 June, 2025]

Colin Dawson, chair
John Rodwell
Justine Gilliland
Marje Russ
Dr Warren Williams
Dr Andrea Byrom
Gray Baldwin

SENIOR LEADERSHIP

Richard Eglinton
Chief Operating Officer

Dr Lucy Baragwanath
Science Group Manager, Restoring Ecosystems

Dr Fiona Carswell
Science Group Manager, Catalysing Change

Dr Nancy Garrity
General Manager, Māori Partnerships

Dr Chris Jones, Science Group Manager,
Managing Invasive Species

Dr Fraser Morgan, Science Group Manager,
Land Resources & Climate Change

Chris McDermott
Chief Information Officer

Aisha Daji Punga
Chief Executive, Toitū Envirocare

We're building something new

On 1 July 2025, AgResearch, Manaaki Whenua – Landcare Research, Plant & Food Research and Scion came together to form the Bioeconomy Science Institute. Now, we are more than 2,200 people working to support the growth and resilience of the bioeconomy in New Zealand and beyond.

Together, our world-class science will advance innovation in agriculture, horticulture, forestry, aquaculture, biotechnology and manufacturing; protect and enhance ecosystems from biosecurity threats and climate risks; and develop new bio-based technologies and products.