G.40 ANNUAL REPORT 2021

We present our Annual Report in two parts. Part 1 provides an overview of Manaaki Whenua, highlights of our science that show the contribution we are making towards our four ambitions for New Zealand, and an update on the progress we are making in delivering on Strategy 22, our 5-year strategy. 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: manaakiwhenua.co.nz/report

Landcare Research New Zealand Limited
(Manaaki Whenua – Landcare Research)
Annual Report 2021

Presented to the House of Representatives pursuant to Section 44 of the Public Finance Act 1989.

ISSN (print) 1172-7942
ISSN (web) 1177-9969

www.manaakiwhenua.co.nz

Contents

Our Land, Our Future 1

- About us 1
- A word from our Chairs and CEO 3
- Our locations 6
- Our investments in science impacts 7
- Collections and databases 8

Our context 10

- New Zealand's science priorities 11
- Stakeholder input 12
- Our commitment to Te Tiriti 13

Our science & ambitions for New Zealand 15

- Our Biodiversity 16
- Our Biosecurity 21
- New Zealand's Biological Heritage National Science Challenge 25
- Our Land 27
- Our Environment 32
- Toitū Envirocare: climate leadership for Aotearoa New Zealand business 37

Our strategic goals 39

- Our Strategy – Strategy 22 39
- Pillar 1 – An irresistible culture 41
- Pillar 2 – A better way of working 47
- Pillar 3 – Science for impact 52

Reference 56

- Non-financial KPIs 56
- Provisional KPIs for corporate sustainability 57
- Directory 58

Table of Innovation Stories

Restoring New Zealand birdscapes 17
Technology tracking tōrea 17
Turning the next page on predator control in New Zealand 18
A range of work in wetland biodiversity 19
He matawara o mua – Taking account of shifting ecological baselines 20
DNA sequencing for better identification of fungi 22
New biocontrol tools showing promise 22
Fake clues: using misinformation about odour to protect rare bird species 23
Updates and investment boost our national soils mapping capabilities 29
A new soil pH map for New Zealand 29
Monitoring paddock-scale changes in land use – from space 30
How one thing leads to another – building long and deep relationships in effective land management 30
Reconstructing long-term climate change 33
Our contribution to state-of-the-environment reporting for Aotearoa New Zealand 35
Changes in the rural New Zealand hazardscape 35
Regenerative agriculture – what does it mean for New Zealand? 36

Our Land, Our Future

Tō tātou whenua, mō āpōpō

About us

We are the Crown Research Institute for our land environment and biodiversity – an organisation of 444 scientists, researchers, and experts supporting science who are dedicated to helping New Zealanders understand and live well with our land.

Our purpose

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

Our role is to ensure that all New Zealanders have the knowledge, understanding, and tools to truly live in harmony with our land: enjoying its many gifts, preserving its unique diversity, and enriching it through our creativity, care, industry, and culture. 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:

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

Our vision

Kia tupu matomato a Tāne, a Rongo, a Haumia-Tiketike – Let it be that the land and all its fruits may flourish

Acknowledging the unique and special relationship that Māori have with Aotearoa and with their land and the environment, we draw on a uniquely Māori perspective of the world around us. Tāne, Rongo, and Haumia-Tiketike are tamariki (children) of Rangi, our sky father, and Papa, our earth mother. Together they hold dominion over the forests and both cultivated and uncultivated food (e.g. kūmara and fernroot) and the land-based realms they exist within. If we use the land wisely, then the domains of Tāne, Rongo, and Haumia-Tiketike will be in balance. This concept of wise land use is a core purpose of Manaaki Whenua, and inherent in kaitiakitanga (custodianship) of our natural taonga and resources for future generations.

Our values

Our identity is underpinned by shared values we collectively cherish in each other. Science that delivers reflects our shared purpose and our shared commitment to doing science and research that will result in practical solutions for New Zealand. As fascinating as much research can be, we value research relevant to New Zealand and the challenges we face as a country. Our science must be excellent, and as an independent research institute our integrity underpins our partners' trust.

‘Manaaki tangata’ means care for the people. Our diversity of skills, experiences, nationalities, and knowledge allows us to understand and solve complex problems. By partnering with other people and organisations we can expand that diversity to great effect and still share a common purpose. This unites our action, our resolve, and the impact we can have for New Zealand. Our success rests with our people, so we are driven to care for them and make sure they have an environment and support that allow them to succeed.

Our behaviours

A pillar of our 5-year strategy – Strategy 22 – is building an irresistible culture, underpinned by our values, that empowers us to create positive impacts for New Zealand’s land environment through innovative and integrated research. Within this culture, we have worked with our people to define five behaviours that express our values in action:

Share freely and often: Kia rite tonu te tohatoha

Invite input from others: Kia areare mai ōu taringa

Commit to excellence: Whāia te iti Kahurangi

Experiment to learn: Mā tē he ka tika

Embrace diversity: Awhi mai, awhi atu, tātou tātou e

A word from our Chairs and CEO

The need for Manaaki Whenua's work has never been greater. Climate change impacts, the losses of biodiversity and soils, and the pressures of land-use on water resources are increasing steadily. The land and life on land face unprecedented change, yet there is great opportunity to sustain and enhance that natural capital, and there is a growing movement of people in all sectors of society making that happen.

The Government is developing and implementing policies for water, biodiversity, climate change response, and resource management. Businesses are acting on environmental challenges to manage their risks and respond to changing consumer, community, and regulatory demands. Community groups are multiplying with environmental goals such as predator-free New Zealand. Iwi Māori are upholding their responsibility as kaitiaki (guardians) of their lands. Our research, science, and innovation help meet all those needs.

Our 2020/21 year has seen valuable outcomes from our work, despite the ongoing impacts of the global pandemic. Two of our researchers are in the team that won the 2020 Prime Minister's Science Prize for the Covid-19 modelling work that continues to inform Government's strategies. This report includes many examples of where, across the breadth of our work, our people have been innovative, collaborative, and effective.

This year has seen significant extension of soils information (S-Map) to inform land-use decisions; major contributions to national state of the environment reporting on land and biodiversity; new developments of tools for targeting and removing predators of our native species; advances in understanding soil carbon as a major carbon sink; a Mātauranga-based approach to assessing soil health; remote sensing methods to assist the development of the manuka and kanuka honey sector; and a community-focused approach to targeting flood-defence infrastructure.

We have maintained the excellence of our research. Our publication citation rate has been the highest among CRIs for 5 years, second among New Zealand research organisations (after AUT) and we are within the world's top 15 environmental research organisations. We collaborate strongly. In the 3 years to 2020, our overseas collaborations have led to 2,200 joint publications, and this year 90% of our outputs were co-authored with other organisations.

Our long history of working with Māori reached a milestone when we made a formal commitment to implementing the principles of Te Tiriti o Waitangi. Those principles are partnership, participation, and active protection of Māori interests. They will inform decisions across our business and the direction of our research. Our Māori researchers are highly respected for their experience and selfless dedication to advancing Māori aspirations.

The interruption to our work from periods of lockdown reduced of our capacity to conduct our work, but Manaaki Whenua met its target surplus of $3m (NPAT) on gross revenue of $97m. This generated our budgeted Return on Equity of 6%. We suffered a regrettable year-long delay in the opening of our major new building at Lincoln due to a construction issue beyond our control; and an IT implementation project has caused significant disruption for our staff. By the end of the year, we had implemented recovery plans for both projects and our new building will be open by the end of 2021.

Our subsidiary, Toitū Envirocare, performed exceptionally well, meeting the rapidly growing demand from New Zealand and UK organisations to measure, manage, and achieve net zero emissions. In its tenth anniversary, Toitū continues to provide practical leadership to organisations contributing to national goals.

We were very pleased to welcome Rob Phillips as the new Chair of the NZ Biological Heritage National Science Challenge, Daniel Patrick as the new Director, and Prof Shaun Ogilvie as Kaihautū Ngaitahu. Our warm thanks go to Dr James Buwalda as the Chair since the Challenge's inception in 2015, and to both Dr Andrea Byrom and Melanie Mark-Shadbolt as inaugural co-Directors.

At the time of writing, we have not yet seen the Government's green paper that sets out proposals for a reset of the research sector in New Zealand. We look forward to discussing its content and helping Government arrive at its policy decisions.

As one of seven CRIs, we have contributed to the coming debate about the future of the sector through two reports published in September 2021. These outline first, the present form and contribution of the CRIs and the collaboration between them; and second, our thinking on a future model in which the four major groups (Government, Māori, industry, and research) would jointly identify national priorities for research and then ensure strategic investment in those goals.

Through its 30-year history Manaaki Whenua has made a hugely valuable contribution to New Zealand's unique natural environment. It has done this through excellent research and close relationships across New Zealand's major sectors and community groups. New Zealand's environmental challenges and its research, science and innovation needs are increasing. Manaaki Whenua has the people, experience, and relationships to meet those needs into the future.

Our people have shown great resilience, dedication, and professionalism during the effects of the pandemic, the uncertainties of the research funding system, and the internal challenges we have faced. We thank them most warmly. We also acknowledge the dedication and efforts of our fellow directors and extend particular thanks to Professor Emily Parker and the Hon Kate Wilkinson, who finished their terms on 30 June 2021. Emily has served since 2011, ably chaired the Board's People & Culture Committee, and been a valued member of the governance group, Mana Rangatira, for the NZ Biological Heritage National Science Challenge. Both Emily and Kate brought great skills and humanity to their work on the Board.

Finally, we thank our partners and those who use our work to achieve a shared ambition that the environment should flourish, because all life depends on it.

Jane Taylor, Board Chair | *Paul Reynolds QSO, Acting Board Chair* | *Richard Gordon, CEO*

30 September 2021

On 30 June 2020 our Board Chair, Jane Taylor, ended her 7-year term as a director of Manaaki Whenua, which included 6 years as Chair. Jane led the Board and company through a period of re-focusing, growth, and development, creating an organisation that is greatly valued by its stakeholders and staff. We thank Jane most warmly for her vision, strategic leadership, and for her commitment to the people of Manaaki Whenua. Jane led with a strong commitment to delivering value for Aotearoa in terms of social, economic, and environmental well-being. She championed our responsibilities through Te Tiriti and our role in sustainable development. We are indebted to her for her tireless contribution to the success of Manaaki Whenua and the well-being of its people.

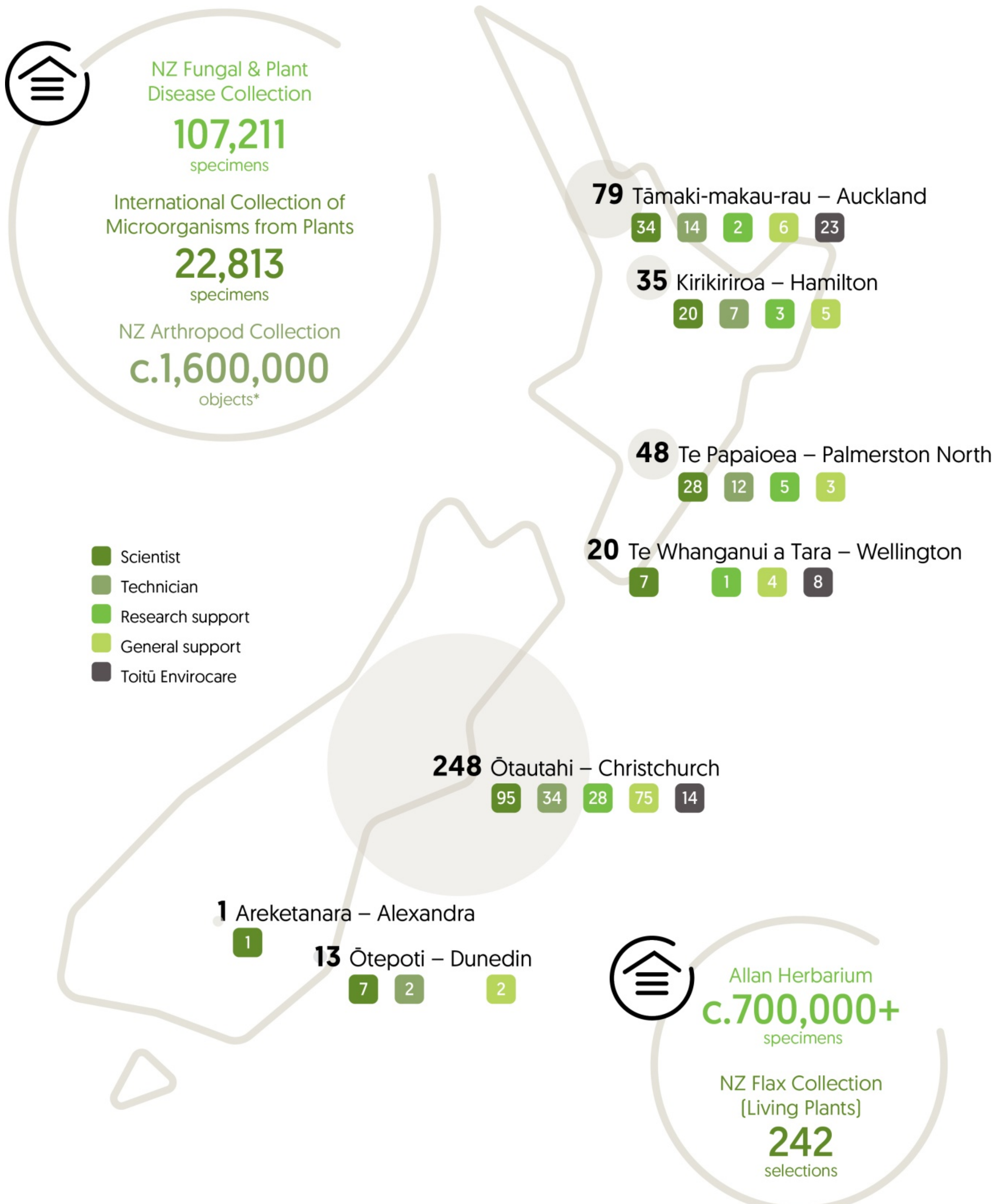
Board members: back row, left to right: John Rodwell, Prof. Caroline Saunders, Dr Paul Reynolds QSO, Justine Gilliland, Ngarimu Blair; front row, left to right. Hon. Kate Wilkinson, Prof. Emily Parker, Jane Taylor (Chair).

Our locations

Our sites across New Zealand house 444 staff and research associates, including the staff of our subsidiary, Toitū Envirocare. These locations facilitate scientific projects that span the length and breadth of New Zealand.

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

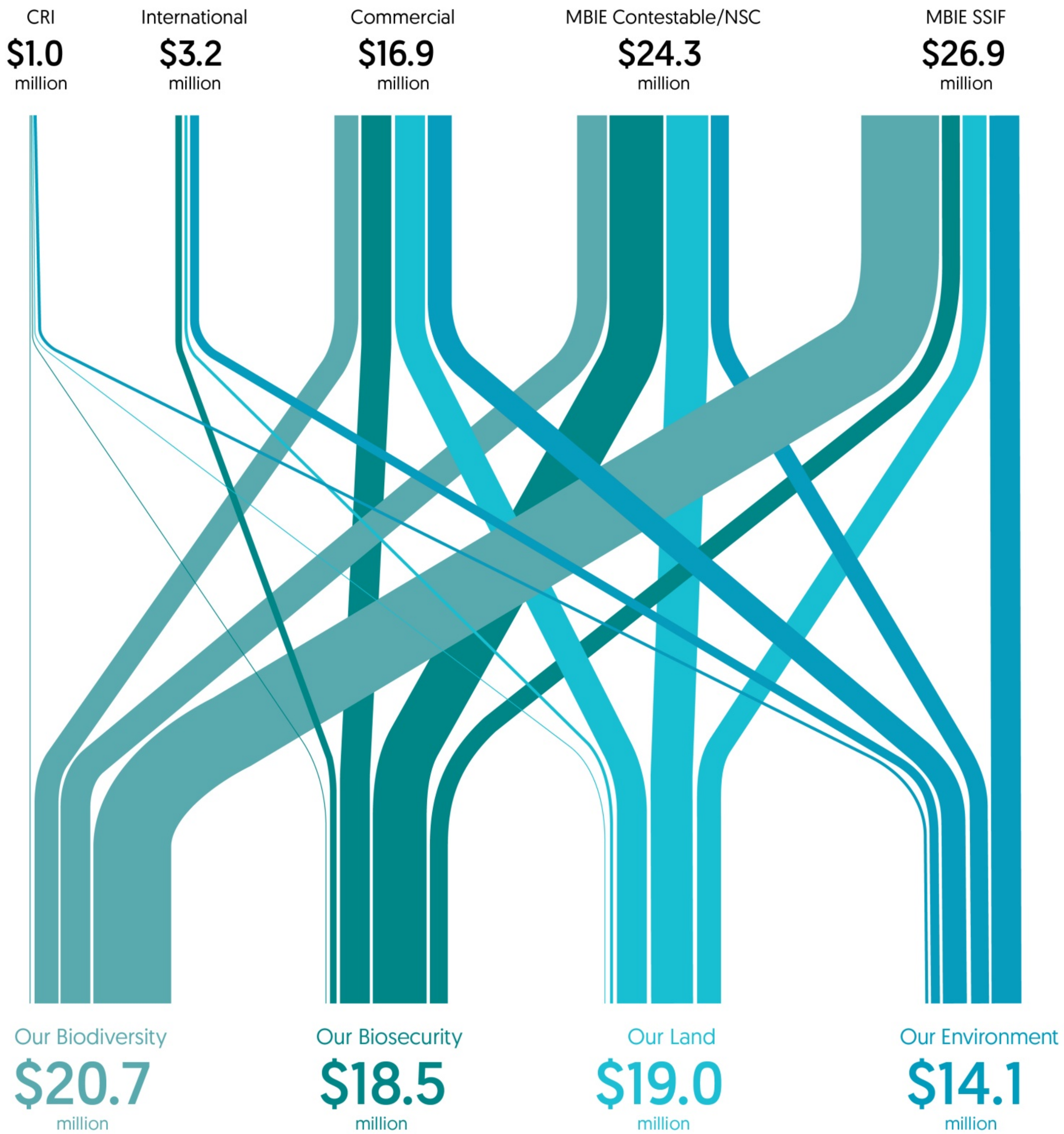
This year we bade a fond farewell to our Nelson office, owing to the retirement of key staff in that location.



*From 2020/21 the counting method for the NZAC has changed: the data show objects, not specimens.

Our investments in science 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. These investments power programmes across our four ambitions for New Zealand. The following diagram is based on science revenue information for 2020/21 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 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.

COLLECTIONS

New Zealand Fungarium (PDD)

landcareresearch.co.nz/pdd

107,211	Specimens
50	Specimens sent
13	Loan requests responded to
122	Identification & enquiries
98	Visitors

New Zealand Flax Collection

landcareresearch.co.nz/harakeke

242	Selections
29	Orders sent
240	Enquiries
220	Visitors

International Collection of Microorganisms from Plants (ICMP)

landcareresearch.co.nz/icmp

22,813	Cultures
124	Orders sent
1,106	Cultures sent
195	Identification & enquiries
98	Visitors
155	Specimens cited[1]

New Zealand Arthropod Collection (NZAC)

landcareresearch.co.nz/nzac

c. 1.6M	Objects
26	Loan requests responded to
1,142	Identification & enquiries
23	Visitors

Allan Herbarium (CHR)

landcareresearch.co.nz/allanherbarium

c. 7M	Specimens
1,072	Specimens sent
34	Loan requests responded to
652	Identification & enquiries
186	Visitors

DATABASES

National Vegetation Survey Databank (NVS)

nvs.landcareresearch.co.nz

13,790	Page views
122,497	Plots
4,150	Datasets supplied
138	Data requests
679	Registered users
53	New datasets
466	Plots added

Ngā Tipu Whakaoranga Database

maoriplantuse.landcareresearch.co.nz

135,726	Page views[2]
2,408	Database records
35,767	Visitors

Land Resource Information Systems (LRIS)

lris.scinfo.org.nz

148,698	Page views
6,803	Data downloads
11,793	Registered users
46,243	Visits/sessions

[1] in scientific publications (based on Google Scholar).

[2] courtesy of Google Analytics.

Our context

Our context begins with our Crown ownership and the expectations of our shareholding Ministers. The Government has laid out clear priorities for New Zealand that must inform our strategy and science priorities, including zero carbon and predator-free, and goals for freshwater.

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, industry, and the primary sector.

Beyond New Zealand, our internationally respected scientists are involved in global efforts to address the many challenges posed by climate change and sustainability.

New Zealand's science priorities

Manaaki Whenua supports the Government's commitment to an inclusive, sustainable, and productive New Zealand, and in turn our Minister, together with numerous Government strategies and policy statements, provides us with guidance on the Government's priorities for our land.

We take into consideration and contribute to relevant Government-wide initiatives and sector science strategies, such as the Ministry of Business, Innovation and Employment's (MBIE's) draft Research, Science and Innovation Strategy (Kei Mua Te Ao), and Te Pai Kahurangi (The CRI Review), in collaboration with appropriate organisations, iwi, agencies, and departments.

In 2020/21 we contributed significantly to the priorities for the Government that were expressed in our shareholding Minister's Letter of Expectation, supporting the Government's commitment to an inclusive, sustainable, and productive New Zealand, as this report shows. We continued to fulfil the CRIs' role of maintaining New Zealand's strategic research and science capability in biodiversity, biosecurity, soil science, land-use planning, social, economic, bioinformatic, and climate mitigation research.

We supported diversity throughout our organisation by further implementing an embedded Māori culture and realising Vision Mātauranga (see page 13). We also contributed to the future science workforce by working with universities to foster upcoming talent (see also page 50).

Specific ministerial priorities for Manaaki Whenua were:

Auckland redevelopment: We have continued to work with relevant CRIs and Government departments regarding the potential for a Biosecurity Hub at Mt Albert. Our decision-making process will be influenced by MBIE's current integrated infrastructure review, which is being completed in parallel with the CRI review.

Biosecurity: We continue to be fully compliant with the requirements of the Hazardous Substances and New Organisms Act at our containment facilities (see page 50).

Transparency and access to data: We have continued to make the data from our collections and databases accessible and available to specialist users and to the public (see page 9).

Connectedness: We have supported pan-sector initiatives, including those from the Primary Sector Council and the Aotearoa Circle, helping coordinate collective action towards New Zealand's goals of sustainability and ecosystem regeneration. We have also continued to develop partner relationships with major overseas organisations to create talent pipelines and career development opportunities for CRI staff (see page 50).

Stakeholder input

To understand the needs of partners more deeply we have established a range of forums with different target partner groups. These include an annual co-innovation workshop with primary sector and government partners, an annual iwi co-innovation workshop, and project-focused forums covering a range of audiences, including Design Thinking workshops with members of the public. Our target is to engage more research providers in joined-up efforts of this nature.

Our Board's **Outcome Advisory Panel** provides advice to help us fulfil our Statement of Core Purpose through strategic alignment and collaboration with key users of our science. 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, the food and fibre industry, and business.

The Panel meets with our Senior Leadership Team to explore and clarify the needs of the natural resources sector, and provides 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. Implementation of an engagement framework, its strategic alliances and plans, continues to progress with specific regional council and central government (Ministry for the Environment (MfE), DOC) plans now in place. This year the Panel also contributed to our Strategy 22 refresh, providing feedback on proposed goals and an over-arching and underpinning Te Tiriti framework.

Our **Science Advisory Panel** brings an international scientific perspective, helping us evaluate our scientific excellence, explore emerging science needs, and develop research areas, from both from a New Zealand perspective, and from an international science sector perspective.

This year the panel review focused on 'Our Land' and 'Our Environment', when reviewing our science excellence. Its conclusions were as follows:

> The panel finds the work in the reviewed platform to be at the high level expected of this leading CRI. There is clear evidence of breakthrough science by traditional metrics (papers in high-impact journals such as *Nature*, high citations, etc.), and evidence of impact through the development and provision of nationally critical databases and information services and through deep engagement with a growing range of stakeholders. Manaaki Whenua is internationally competitive despite existing in a national environment which requires significantly more funding to be obtained competitively than in equivalent overseas systems.

Our commitment to Te Tiriti

As a Crown Research Institute we have a responsibility to Māori, the indigenous people of Aotearoa New Zealand, as a Treaty Partner and to enacting the principles of the Treaty of Waitangi.

In 2021 Manaaki Whenua has made a formal commitment to uphold the principles of Te Tiriti and embed them in our organisation.

The principles will change the way we think about partnership and participation, about our research priorities, the way we do our research, and the skills and roles of our people. Being true to the principle of partnership means aspiring for Manaaki Whenua to be a partnership that brings together science and Mātauranga-based knowledge systems.

Our statement of commitment to te Tiriti is as follows:

> Manaaki Whenua commits to upholding the principles of the 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 & incorporations.

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.

We continue to grow our pool of Māori scientists & researchers who also hold equally strong te ao Māori perspectives, connections, and cultural skillsets across all our disciplines. In 2021 we recruited an additional experienced Māori Land Mapping Programme Manager and a Māori Cultural Capability Adviser. This complements our already strong Māori team (probably one of the strongest among the CRIs). We are also exploring new Māori co-leadership frameworks and it is anticipated this will lead to additional Māori research roles in Manaaki Whenua.

Our recently signed Tauākī Ngākau Titikaha (Statement of Commitment) presents an opportunity to reach out to hapū & iwi to signal our interest in working with our Te Tiriti partners.

Manaaki Taiao (our Māori research team) continue to be preferred providers of advice about alternative land use opportunities for Māori land decision makers. The potential for whānau/hapū/iwi to generate economic returns from indigenous plants continues to be a strong area of interest. In the last financial year, we completed feasibility assessments for 38 lands trusts in Tairāwhiti, 80 land trusts across the Bay of Plenty from Whangaparaoa in the east to Horohoro in the west and inland to Tarahore and Te Waimana. Of these, 67 proceeded to final business case stage.

We are working to embed programmes and project connections (through Vision Mātauranga projects and more broadly) that help expose our Pākehā colleagues to iwi/Māori organisations so that they gain experience and confidence in working in Māori settings to help achieve their taiao aspirations. Through Vision Mātauranga we are working the Ngāi Tahu Māori Rock Art Trust to carry out paleo-ecological studies on the vegetation at the Opihi site. Using ancient DNA, we will work alongside the local hapū/iwi to provide a 'window into the past' on the historical vegetation and taonga species present when the Opihi site was originally occupied by takata whenua. This will guide the iwi and help shape aspirations for species plant selection and habitat restoration.

We are also creating or modifying investment instruments to facilitate mātauranga Māori research and Māori leadership. Our recently endorsed Tauākī Ngākau Titikaha (Statement of Commitment) for Te Tiriti explicitly commits Manaaki Whenua to increase the proportion of SSIF-funded projects that are co-designed with Māori and under the leadership of the Manaaki Taiao (Senior Kairangahau Māori) Leadership Group. This increase will be set as a KPI in future years.

We are in ongoing discussions with the Director of Māori Research, Science & Innovation at MBIE, and others, to explore opportunities to work together to enhance Māori outcomes across the science sector.

Our science & ambitions for New Zealand

Our Biodiversity • Our Biosecurity • Our Land • Our Environment

Four ambitious goals

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.

Our four ambitions are designed to present our science and research in an approachable and meaningful way, for all New Zealanders to engage with.

Our science is aligned with the UN's Sustainable Development Goals as outlined in our 2019/20 Annual Report. The specific goals that we have identified are: 15 Life on Land (to which much of our work contributes); 2 Zero Hunger; 6 Clean Water and Sanitation; 11 Sustainable Cities and Communities; 13 Climate Action; and 16 Peace, Justice and Strong Institutions. We also contribute to 17, Partnership for the Goals.

Our Biodiversity

Our ambition is that New Zealanders know about, value, and actively care for our unique biota and ecosystems.

Knowing and understanding our unique biodiversity

We are experts in knowing what biodiversity we have, and what species we don't have and don't want in New Zealand. Our systematists and taxonomists maintain our nationally significant collections of biota and are increasingly turning to genomic methods to identify specimens, enabling rapid responses to biosecurity incursions. This work is fundamental foundational knowledge that underpins all efforts in New Zealand to protect our most threatened species and ecosystems.

Leading the recovery efforts for New Zealand's ecosystems

Aotearoa New Zealand has a rich biodiversity, from the smallest bacterium to the largest kauri tree, but it is under serious threat from pressures such as invasive species, climate change, land-use intensification and conversion, mining, and urban development. Discovering, protecting, and restoring this precious taonga requires exceptional science and infrastructure, practical policy, real-world tools and solutions, and everyone's support and participation.

Our research into ecosystem resilience provides the scientific foundations needed to improve New Zealand's ability to protect our most threatened species and ecosystems, within both Western science and mātauranga Māori frameworks. This ability relies on a deep understanding of ecosystem resilience, tipping points, and how various threats – from climate change through to invasive species – affect native species.

Restoring our most at-risk species

Our work contributes to the conservation and restoration of some of our most iconic bird species, but we are also active in research to protect many other taonga, from native lizards to native fungi. We work with many external agencies and groups to achieve these aims, including the Department of Conservation, the Ministry for Primary Industries, regional councils, iwi, wildlife sanctuaries, non-governmental and community groups, and businesses. We also contribute through major national initiatives such as New Zealand's Biological Heritage National Science Challenge and Predator Free 2050.

On the next pages we share some of our successes and science highlights for our biodiversity in 2020/21.

Dr Anne Schlesselmann measuring wing length of a tōrea chick to follow growth and assess time to fledging.

Innovation story

Restoring New Zealand birdscapes

Manaaki Whenua researchers are combining ambitious field-based research and computer modelling to derive evidence-based conservation management strategies that agencies, ecosanctuaries, and farmers can all use to help native birds thrive, in montane native forests, on farms, and in coastal harbours and estuaries.

The MBIE Endeavour-funded research programme More Birds in the Bush is developing tools to forecast both predator and native bird populations across New Zealand forests. Like a weather forecast, the research aims to help forest managers forecast not only predator levels but also the outcomes of different predator management regimes for native bird populations.

One ambitious aspect of the More Birds programme aims to determine how food availability varies across an elevational gradient and influences the nesting success of native forest birds both with and without predator management.

Between September 2020 and January 2021, Dr Anne Schlesselmann set up a large-scale field study on Mt Pirongia in the Waikato to monitor 100 nests of titipounamu and miromiro in three elevational bands. The researchers also monitored pest populations and invertebrate abundance, under contrasting predator management regimes. Nest monitoring of such small bird species in dense, mature forest is time-intensive as it requires researchers to follow female birds, that are often secretive, back to nests where they are incubating eggs.

In a complementary project, Dr Sarah Richardson has led research to map fruit production along the 900-m elevational gradient at Mt Pirongia to understand how different fruit and nectar resources become available at different places.

Together, these projects will disentangle how food production and predator management together drive populations of predators and birds along elevational gradients. Results will feed into the development of the large-scale forecasting tool, so that both predator and bird population outcomes and different management options can be evaluated.

Innovation story

Technology tracking tōrea

Tōrea are one of our 'internal migrant waders' that breed in South Island braided river valleys in spring and enjoy life on the coast in winter. Their impressive mobility makes conservation management challenging because they encounter diverse threats throughout their annual migratory cycles, including while they are on the move and in coastal wintering grounds.

A multi-year research collaboration between Manaaki Whenua, the Department of Conservation (DOC) and the Ornithological Society New Zealand (OSNZ) aims to reveal for the first time how the major predator-management programmes of Environment Canterbury, LINZ, and DOC in riverbeds contribute to national population outcomes of iconic braided river species such as tōrea.

The programme relies on GPS technology to track tagged tōrea that head to winter feeding grounds from the upper Rangitata Valley. A research team tagged 32 adult and fledgling tōrea with GPS transmitters in spring

2020. They also monitored the survival of more than 60 nests and fledglings on high country farmland and riverbeds in the upper Rangitata valley.

Complementary GPS-tagging and banding by DOC and OSNZ on wintering grounds started last June and is now rolling out across the country's harbours.

Early results show high adult and chick survival under predator trapping, as well as some remarkable spatial patterns since birds have taken flight. Already, tracks indicate some key national northward and southward flyways and the sheer extent of the North and South Island habitat network that supports wintering tōrea.

Manaaki Whenua aims to use the data to develop a spatial population model linking wintering and breeding sites of different tōrea subpopulations in different habitats and under different management regimes.

Field research for this project has been mainly funded by MBIE's Strategic Science Investment Fund, with Environment Canterbury co-funding enabling predator indexing and helping to support time-intensive fieldwork.

Innovation story

Turning the next page on predator control in New Zealand

Introductions of small mammals to New Zealand have caused catastrophic losses of indigenous biota owing to predation, browsing and competition for shared resources. Our deeply endemic bird species, highly adapted to New Zealand's pre-predator environments, are particularly vulnerable because of traits such as flightlessness, ground nesting, and highly specialised diet.

In response, numerous ecological restoration projects have been set up across New Zealand and its offshore islands. Each project has reported local predator control successes, but their collective contribution to the overall biodiversity narrative has remained unclear.

Manaaki Whenua researchers Rachelle Binny, John Innes, Andrea Byrom (NZ Biological Heritage National Science Challenge), Neil Fitzgerald, Robbie Price and Roger Pech, recently joined forces with researchers at DOC, University of Canterbury, and Te Pūnaha Matatini, to undertake a national meta-analysis of mainland restoration projects and their biodiversity outcomes. The work combined data from 27 ecosanctuaries, including projects led by community trusts, regional councils, and DOC, who contributed close to 80 biodiversity datasets surveying hundreds of species.

The research team extracted 447 biodiversity response measures, including bird counts, invertebrate counts, seedling and sapling counts, from datasets and scientific reports on 16 sanctuaries with different management approaches to pest control, ranging from ring-fenced ecosanctuaries and peninsular ecosanctuaries to unfenced pest suppression schemes and possum control programmes.

For each response measure an 'effect size' was calculated to measure the biodiversity benefit of pest control and these were then combined to give an overall measure of biodiversity benefit across multiple projects.

The results showed that there were strong benefits for native birds, invertebrates, and vegetation from all types of pest-managed restoration on the mainland. The greatest benefits came from pest control regimes that focused on eradication, such as fenced ecosanctuaries.

Within bird species, deep endemics benefited the most from pest control, with complete eradication or sustained suppression of pests to very low levels providing the best outcomes. A key finding was that after about 7 years of being pest-free, deep endemics were abundant enough to out-compete exotic bird species. There was also evidence of pest control providing some benefit to endemic invertebrates as well as birds, in particular wētā.

Knowing the long-term biodiversity benefits we get from eradication compared with suppression will be critical for designing an effective national strategy for restoration on Aotearoa's mainland.

Innovation story

A range of work in wetland biodiversity

Scientists at Manaaki Whenua are currently doing globally important research into wetlands.

Wetlands are important ecosystems for their biodiversity, cultural, and recreational values as well as their key role in carbon storage. However, wetlands are also ecosystems under threat. In New Zealand, wetlands have declined by ~90%, mostly over the past 200 years, from around 10% to just ~1% of the total land area owing to drainage and conversion to other land uses. Remaining wetlands continue to degrade from drainage, nutrient runoff from agricultural land and fire, as well as weed invasion and climate change. Ongoing losses of wetland area in New Zealand are similar to global averages of around 0.5% per year.

Current biodiversity monitoring in wetlands tends to focus on large organisms such as birds and plants, which can be relatively slow to respond to environmental change. However, Dr Jamie Wood, Dr Beverley Clarkson, and colleagues at Manaaki Whenua have been using new eDNA techniques to monitor biological change in wetlands.

The researchers sequenced microbial DNA from soil cores taken down to 4 metres below the surface in seven New Zealand wetlands, in one of the few studies globally to have studied wetland microbes at such depths. The results showed distinct changes in microbial communities with depth. In more modified or drained wetlands, types of microbes responsible for carbon dioxide emissions were more common in the upper layers.

Ultimately eDNA may provide a useful tool for monitoring real-time wetland condition, identifying when critical thresholds are being approached, and helping monitor the success of projects focused on the restoration of wetland ecosystems.

Dr Clarkson has also recently published international research aiming to pin down understanding of plant leaf traits in wetland ecosystems at a global scale. The 'leaf economics spectrum' describes leaf traits ranging from slower-growing 'conservative' species, able to survive on limited resources, to faster-growing 'acquisitive' species that do better in environments with abundant resources. The leaf economics spectrum was developed for terrestrial plants from a variety of ecosystems, however its application to wetland ecosystems remained unclear.

Using data on 365 wetland species from 151 studies worldwide, Dr Clarkson and colleagues found that wetland plants cluster at the acquisitive end of the spectrum, with lower leaf mass per area of leaf, more leaf nitrogen and phosphorus, faster photosynthetic rates, and shorter leaf lifespan than non-wetland plants. These traits allow wetland plants to be specifically adapted to the complex and adverse conditions found in wetlands, such as lower levels of light, oxygen, and nutrients. The study fills an important knowledge gap in understanding important wetland ecosystem processes and services.

He matawara o mua – Taking account of shifting ecological baselines

Global biodiversity losses due to human activities have accelerated more in the past 50 years than at any time in human history. Intertwining with this rapid decline is the loss of knowledge about past environmental conditions and species' abundance. This loss threatens how the next generation perceive the state of their environment within the scale of their lifetime – a phenomenon often referred to as shifting ecological baselines.

Ecological indicators based on western science systems are often used in monitoring and reporting to understand environmental change; however, the short timeframes in which these data are collected can often hinder understanding. Increasingly, conservation and restoration organisations are looking to Indigenous peoples to detect and track long-term change in their environments through their direct interactions with natural resource (e.g. customary harvest) or general observations during time on the land or sea.

However, the monitoring and evaluation by Indigenous peoples are often done using language concepts and ordinal scores (e.g. few, some, a lot), so these systems can also be vulnerable to how individuals perceive, experience, and remember past natural resource state.

A recent study by Manaaki Whenua and Tūhoe Tuawhenua Trust researchers set out to determine the relationships between ordinal scores and quantitative estimates (e.g. flock size) used by members of the Tuawhenua community of Ruatāhuna to gauge different forest indicators. Using this information, the researchers also investigated whether community members of different ages gauged these indicators differently.

The researchers said that while the relationships between ordinal scores and quantitative measures remained consistent across all age classes, they did observe a significant intergenerational shift in how community members understood the abundance and size of a selected group of species. This suggested individuals are influenced by the abundance or size of the species they experienced over their time.

The findings suggest the mitigation of shifting ecological baselines will be a critical aspect in how kaitiaki perceive change in their environments and determine the scale and level of action and investment required to recover those populations. This will be a particularly important issue for younger kaitiaki who have not witnessed the historical abundance, productivity, and function of past ecosystems. In this regard, kaumātua offer valuable accounts of past and current ecological thresholds.

The protection of customary harvest practices and/or the establishment of community-based environmental monitoring initiatives offer opportunities to maintain contact with species and their environments and track changes. Iwi- and hapū-led conservation and restoration initiatives stand to benefit from the accounts of kaumātua through strong intergenerational knowledge transfer mechanisms and community focused monitoring. It also gives tangata whenua an important stake in future environmental interpretation and decision-making processes, while ensuring a continued interaction with their mātauranga.

Our Biosecurity

We want New Zealand to be protected from invasive biological threats.

Landscape-scale predator control

We provide sector leadership for tools and technologies to enable landscape-scale predator control. Our research covers the spectrum from the development of novel pest control tools, through understanding predator behaviours to maximise interaction with those tools, to complex spatial modelling to guide optimal deployment of control and subsequent surveillance efforts.

We collaborate with many partners as part of our drive to help New Zealand reach its Biosecurity 2025 and Predator Free 2050 goals. We have been closely associated with the Predator Free 2050 initiative since its inception in 2016, providing underpinning and leading research and strategic guidance at all operational levels.

We also draw on the considerable experience of our social scientists in carefully building a 'social licence to operate' – a key ingredient of successful applied predator control research.

Weed biocontrol

Controlling weeds in New Zealand is a challenging and expensive task. Widespread weeds can be found in inaccessible locations and alongside native and economically important plants. Herbicides are expensive to apply, often kill desirable plants, can contaminate the environment, and need to be reapplied regularly in order to control weeds.

Our research into biocontrol methods offers a cost-effective, environmentally friendly, and permanent solution to weed control. Our research encompasses a wide range of activities, from classic field surveys to innovative molecular techniques. With state-of-the-art containment and research facilities around the country, we are able to work safely with a variety of organisms without risk to the New Zealand environment.

Pathogens and pests

Our native biodiversity and our ability to derive income both from primary industries and from our unique landscapes are constantly threatened by invasive pests and pathogens. For example, many of our most iconic New Zealand tree species in the Myrtaceae family – including rātā, pōhutakawa, kānuka and mānuka – are currently at risk from the exotic windborne pathogen myrtle rust, while our kauri trees are suffering from kauri dieback. We work with many other groups on border security for early detection and prevention, and for improving control methods for established invasive species.

We are also engaged in work to control invasive invertebrates, including assessing the potential risks and impacts, identification of species, designing surveillance programmes to detect species, and developing strategies for pest management (especially for *Vespula* wasps and ants). The ultimate aim of this research is to protect natural ecosystems and reduce economic losses for primary industries.

On the next pages we share some of our successes and science highlights for our biosecurity in 2020/21.

Innovation story

DNA sequencing for better identification of fungi

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

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

However, most lists of fungal pathogens thought to be 'present in New Zealand' are based on the old, morphology-based classifications and identification methods. The question arises, can the old records be trusted? The 'present in New Zealand' lists need to be validated and accurate because they are the basis of managing New Zealand's biosecurity. Whether or not a species already occurs here is the vital first step in assessing biosecurity risk at the border.

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

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

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

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

Innovation story

New biocontrol tools showing promise

Non-native *Vespula* wasps, the German wasp (*Vespula germanica*) and the common wasp (*V. vulgaris*), are generalist predators that attack a wide variety of arthropods, including honeybees, butterflies, flies, and spiders. They will also scavenge for protein from animal carcasses and dustbins. Where they are invasive, these wasps have detrimental effects on normal ecosystem functioning, food webs and the behaviour of native birds.

The wasps also have a significant impact on New Zealand's beekeeping industry, with wasp damage being regularly ranked as the third or fourth highest cause of colony loss in beehives. Together with their disruption of the enjoyment of the outdoors and recreational activities, and the health risks of stings, it is estimated that wasps cost New Zealand up to $130 million annually in damage and management.

Fortunately, new biocontrol tools are about to be released to control both types of wasp. The Tasman District Council, acting on behalf of the Vespula Biocontrol Action Group, applied to the Environmental Protection Agency (EPA) in September 2020 seeking permission for two new wasp biocontrol agents to be released in New Zealand – a beetle and a hoverfly, both of which parasitise the brood of the wasps within the wasp nest. The application was prepared and managed by Dr Bob Brown at Manaaki Whenua.

The process for obtaining an EPA biocontrol approval is long and painstaking and involves collaboration with many different groups. For this approval process, stakeholders included South Island iwi, Department of Conservation staff, regional councils, the QEII National Trust, the NZ Landcare Trust, the Ecological Society of NZ, Federated Farmers, the Royal Forest and Bird Protection Society of NZ, the NZ Entomological Society, the NZ Forest Owners Association, Apiculture NZ, and District Health Boards. Public submissions were also invited.

Research had to ensure that the new biocontrol agents are completely specific to the target organism, do not attack any other organism, and also do not harbour any diseases or parasites that could attack them. The EPA's decision to allow the new biocontrol agents was notified on 16 February 2021, some 5 years after the first science was begun – a major milestone. Next steps are for Manaaki Whenua's researchers to receive the agents into our insect containment facility for rearing and eventual release.

Other important biocontrol work over the year has included the introduction of a beetle to control moth plant near Tauranga and in Northland, and encouraging results from a trial of heather beetle in the Tongariro area.

Innovation story

Fake clues: using misinformation about odour to protect rare bird species

As part of long-running research into the behaviour of introduced mammalian predators in New Zealand and Australia, researchers from Manaaki Whenua and the University of Sydney asked whether it might be possible to manipulate predator behaviour by using misinformation. Could we use unrewarded prey odour cues to fool predators, and make them ignore real prey cues? If we could make predators less efficient at hunting, might we also make them miss real prey?

Over two nesting seasons, the researchers tested the response of cats, ferrets, and hedgehogs to false odour cues at nesting sites for three shorebird species – the banded dotterel, wrybill, and South Island pied oystercatcher. These native bird species nest on the ground on braided rivers in Canterbury, New Zealand, and are highly vulnerable to predators.

The researchers made odorous pastes from bird carcasses and feathers – and tested whether repeated exposure to these odours would affect the predators' behaviours. They set out the pastes at 300–400 points across nesting sites before the birds arrived to nest, and also during the nesting season. Predators' behaviour was then compared with that at testing sites without paste. Camera traps were used to monitor predators' interest in the paste, and to monitor the survival of nests with and without odour paste. In the second nesting season, the paste/no-paste sites were swapped to increase the reliability of the results.

All three types of predator were attracted by the paste odours, but ferrets and cats, in particular, quickly lost interest when there were no prey associated with the scent cues. Thus, when the birds arrived to nest, the predators had already altered their behaviour by ignoring bird odour, including that of the real birds.

The effects on nest survival were striking for all three bird species: compared with non-treated sites, odour treatments resulted in a 1.7-fold increase in chick production over 25–35 days and doubled or tripled the odds of successful hatching. For banded dotterel, the researchers estimate that this intervention could result in a 127% increase in the population size in 25 years of annual odour treatment. The method is best suited to small areas of vulnerable biodiversity where lethal control methods are difficult to implement.

Dr Grant Norbury preparing a camera trap, Tekapo.

New Zealand's Biological Heritage National Science Challenge

A system-wide collaboration to address the challenges of protecting our nation's unique biodiversity

National Science Challenges take a collaborative approach to solving some of New Zealand's biggest strategic issues. They are an opportunity to increase the stretch and impact of our research, and to provide an economy of scale by working with collaborators.

Manaaki Whenua is proud to host New Zealand's Biological Heritage National Science Challenge (BioHeritage Challenge) one of New Zealand's 11 National Science Challenges (NSCs). We also contribute to Our Land & Water; Deep South; Resilience to Nature's Challenges; Science for Technological Innovation; Building Better Buildings, Towns and Cities; and Sustainable Seas. Working with the NSCs allows us to increase the impact of our research across our four ambitions through effective collaboration and adding value – solving national-scale problems for the benefit of Aotearoa.

New Zealand's Biological Heritage National Science Challenge – Ngā Koiora Tuku Iho

The BioHeritage Challenge aims to reverse the decline of our biological heritage by protecting and managing biodiversity, improving biosecurity, and enhancing resilience to harmful organisms. They convene a wide range of expertise, and prioritise investments to connect, accelerate, and evaluate progress toward effective solutions to protect Aotearoa's precious environment.

BioHeritage is strategically focused on three impact areas that strongly align with Manaaki Whenua's four ambitions:

- Whakamana – empower
- Tiaki – protect
- Whakahou – restore.

The BioHeritage Challenge also leads *Ngā Rākau Taketake (NRT) – Saving Our Iconic Trees* – a four-year strategic research platform finding new solutions for management of two diseases: kauri dieback (KDB) and myrtle rust (MR).

Significant BioHeritage Challenge achievements this year have included:

> Inter- and trans-disciplinary research has been celebrated as a hallmark of the National Science Challenges, including BioHeritage. BioHeritage has been recognised for building partnerships across a range of sectors and communities, championing Te Tiriti o Waitangi-led science and principles, incorporating te ao Māori (the Māori world) view throughout its investments, and connecting multi-institutional teams – people and organisations that had not previously worked together.

Recent BioHeritage Challenge successes that Manaaki Whenua are proud to include:

- **Creating a shared, multigenerational Biodiversity Vision:** BioHeritage has collaboratively developed a 100-year bicultural vision for biodiversity restoration. This sets a national benchmark for flourishing native biodiversity and is informed by a framework that maps the targets, perspectives, and strategies of biodiversity stakeholders, including iwi, business, community, NGOs, industry, and governmental organisations.
- **Leveraging genomic data to support biological heritage management:** We used modern genetic technologies to increase understanding of Aotearoa's biological heritage, which can be applied to maintenance and enhancement of populations.

- **Allowing a better Te Tiriti partnership voice for Māori in the biological heritage space**: In the Ngā Rākau Taketake Oranga Theme, all research is Māori-led mātauranga, and the team have discovered a rongoā treatment and protocol that appears to be effective against KDB. While further validation is needed, the initial results are very exciting!

Partnering for impact: how we align with the BioHeritage NSC

Manaaki Whenua supports the BioHeritage Challenge in a variety of ways, including IT, human resources, and financial support. We endorse the BioHeritage's commitment to Te Tiriti o Waitangi partnerships, led by its Tiriti-based governance group (Mana Rangatira) and Co-Directors (Challenge Director and Kaihautū Ngātahi) along with research co-leadership practice.

The objectives of about $8 million of our SSIF research are closely aligned with the goals of the BioHeritage Challenge annually.

BioHeritage Challenge parties

Eighteen organisations formally partner to create the BioHeritage Challenge. They are: AgResearch, Auckland University of Technology, Cawthron Institute, DOC, ESR, GNS Science, Lincoln University, Massey University, MPI, NIWA, Plant & Food Research, Scion, University of Auckland, University of Canterbury, University of Otago, University of Waikato, Victoria University of Wellington, with Manaaki Whenua as the Challenge host.

Our Land

We want New Zealanders to use our land, soil, and water resources wisely

Nationally significant land management databases

There is strong demand for information and tools to support effective management of our land resources. By drawing on and enhancing the value of our Nationally Significant Databases such as S-map (mapping New Zealand's soils) and the Land Cover Database (LCDB), our research grows the availability of authoritative information on New Zealand's land-based resources.

Manaaki Whenua's work to describe our land and soils directly informs land management policy and regulation set by government agencies and councils, and enables landowners and iwi to make sustainable land management choices. For example, soil information from S-map is widely used to support decisions on nutrient, effluent, and irrigation management; crop production and suitability; modelling of hydrology, ecosystem services, and climate change impact; as well as land valuation, education, and land planning.

Remote sensing

We are national leaders in remote-sensing techniques for effective land management. Our online mapping tools and resources, backed by powerful Geographical Information Systems (GIS) software and expertise, are available both for specialist technical users and for anyone interested in mapping our environment and land resources. We are also actively involved in research to improve these tools, such as cloud clearing for sharper topographical mapping.

Soil and ecosystem health

Soils underpin and are inextricably linked to the ecosystems they support. Robust soil health is critical to ecosystem health in all natural and farmed ecosystems.

We undertake fundamental soil and ecosystem science for New Zealand, joining the dots across a wide range of disciplines, including soil physics and chemistry, ecosystem modelling, and understanding te ao Māori perspectives and concepts of soil health.

Our work in soil and ecosystem health aims to find sustainable ways to balance land and ecosystem use, using information and tools to support the effective management of our land resources.

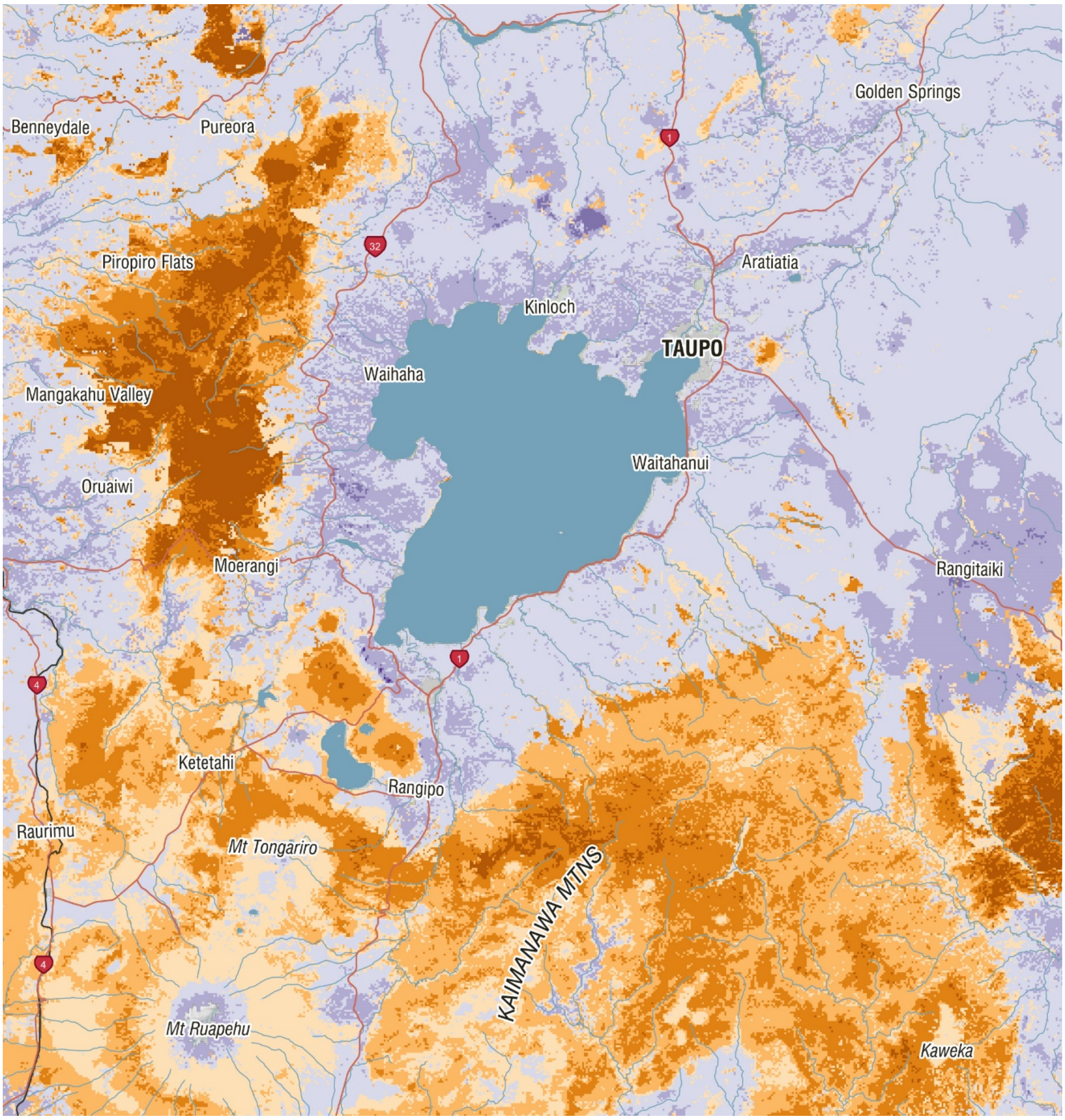
Sediment and erosion control

We undertake a diversity of research and consultancy projects, including fundamental understanding of soil 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.

We are involved in many research projects to measure and manage soil erosion, including building fundamental understanding of erosion processes in New Zealand, and the study of landscape dynamics and responses to environmental change.

We are highly skilled in erosion and sediment modelling – what causes erosion and where the resulting sediment ends up – through which we develop tools for the control and mitigation of soil and land degradation.

On the next pages we share some of our successes and science highlights for our land in 2019/20.



New maps show soil pH for New Zealand at a variety of depths.

Innovation story

Updates and investment boost our national soils mapping capabilities

S-map Online, a tool developed and updated by Manaaki Whenua, provides the best available soil resource data for New Zealand and, in doing so, underpins the Government's roadmap for the food and fibres sector, *Fit for a Better World*.

S-map is extensively used, with over 33,000 soil information sheets downloaded over the last year from the S-map Online website. It is used by rural consultants, councils, landowners, and others for crop/pasture management, nutrient budgeting, erosion control, irrigation management, drought resilience, and land valuation.

In August 2020 S-map had a significant nationwide update, especially to its soil hydrology information, as part of an MBIE-funded Endeavour science programme running from 2016 to 2021, which has focused on the science that underpins S-map to enable continual improvement in soil information for New Zealand.

The main changes to S-map, which users are now seeing online, are:

- increased coverage of New Zealand. With an additional 5,000 km^2 of soil data, S-map now covers 36.6% of New Zealand, including 67.3% of the 'multiple use land' in the country
- a new model for estimating soil hydrological properties (including available water), based on a vastly increased amount of background laboratory data. The update to S-map has increased the number of samples in the model from 1339 (over 313 sites) to 4641 (over 684 sites)
- three new national maps of soil chemistry attributes (carbon, pH, P retention)
- two new tools that help land managers and consultants find the S-map soil type that best matches on-farm field observations.

New Government investment in S-map announced in December 2020 will allow significant co-investment partnerships with regional councils, enabling a real step-change in understanding the unique soil types and spatial variation in one of New Zealand's key strategic natural assets. Active soil mapping is now underway in Waikato, Bay of Plenty, Hawke's Bay, Horizons, Wellington, Tasman, Marlborough, and Canterbury regions, aiming to add approximately 1.5 million hectares of land to S-map over the next 5 years.

Innovation story

A new soil pH map for New Zealand

Soil pH indicates the relative acidity or alkalinity of a soil, and significantly influences various soil functions, soil quality and fertility. Considered a 'master variable' in soil science, pH affects soil in almost every way – its physical structure, patterns of carbon, nitrogen, and phosphorus cycling, its biological activity and regulation, the bioavailability and mobility of nutrients, and the uptake of trace elements such as cadmium. Understanding soil pH is critical for farmers, for the fertiliser industry, for soil ecology, for land-use classification, and for effective land management.

In response to a growing need for better soil pH information, Pierre Roudier and colleagues at Manaaki Whenua have developed a new method to digitally map soil pH at high resolution (100 m) across New Zealand. The work was supported by SSIF funding from MBIE.

To create the new maps, soil pH information for New Zealand was collated from a wide range of datasets, including soil surveys, soil quality programmes, wetland monitoring programmes, and soil biodiversity research programmes. The main dataset was the National Soil Data Repository, which contributed around half of the 12,000 soil sampling points.

The complete dataset was then processed through data augmentation, a statistical technique that is also used in machine learning. The process created a much larger and more robust master dataset for a soil pH model to be calibrated, including richer information about depth variations. Comparison with existing soil pH maps showed that this new digital soil mapping method significantly out-performed existing soil pH information for the country. It is now available in LRIS alongside the original data layers, as well as on S-map.

Innovation story

Monitoring paddock-scale changes in land use – from space

Winter grazing of forage crops is a key land-use practice in southern New Zealand, providing important feed for livestock. In recent national research, Manaaki Whenua's scientists identified Southland as the region with the most winter-forage cropping in hill country, as a percentage of all hill-country agricultural land. This practice has been identified as risky if not managed well, especially on slopes of 7 degrees or more, potentially resulting in soil degradation and nutrient losses. However, the extent of repeat cropping of winter-grazed forage crops is a knowledge gap.

In new research, we used an existing time series of winter-forage maps, derived from satellite imagery, to identify how often paddocks are re-used for winter forage. The work built on a series of evaluations for Environment Southland Regional Council and a nationwide exercise for MfE to assess the potential impacts and policy implications of the 2016 Southland Water and Land Plan. Principal funding was provided by MBIE under the Advanced Remote Sensing Aotearoa programme.

We examined maps derived from satellite images of the Gore-Mataura area, Southland, for the winters of 2013, 2014, 2017, and 2018. Within the 32 km × 32 km study site (67,618 ha), 8,925 ha were classed with high certainty as winter forage in one or more of the source maps. These winter-forage crops were generally grown on well-drained Brown soils (63%), followed by Pallic and Gley soils.

Although the study was limited by its pilot scale and by differences in mapping methods of the source maps, valuable data on repeat cropping were derived. This new knowledge will be useful when designing and developing best management practices across different soil types, for regional policymaking and for future monitoring.

Innovation story

How one thing leads to another – building long and deep relationships in effective land management

Manaaki Taiao is a rōpū (group) made up of Manaaki Whenua Kairangahau Māori (Māori researchers) working on Māori-led research projects within a range of science portfolios. 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 – our enduring relationship with the Te Awahohonu Forest Trust, Northern Hawke's Bay, is an excellent example.

Dr Nikki Harcourt, a senior researcher in the Manaaki Taiao group, was initially approached by the Trust to provide a Kaupapa Māori land use opportunities assessment for their Tarawera C9 block, based on word of mouth about Manaaki Taiao's reputation in the land assessment space. Tarawera C9 comprises some 10,000 ha of pristine indigenous forest with both lowland podocarp and high-altitude beech, as well as another 15,000 ha of plantation pine, areas of reversion scrub, bordered by five rivers, and has very high biodiversity.

Further alignment of MWLR capabilities with Trust aspirations has led to the initiation of studies on āwheto (kumara caterpillar), huhu, and social research.

In the spirit of reciprocity, we have created a summer internship for Floyd Walker, one of the Trust's uri (descendants), who is working with Dr Eva Biggs and Dr Claudia Lange on the āwheto project. Dr Harcourt is supporting their rongoā wānanga, having worked with Pa (Rob) McGowan to provide the Trust with advice; together they will be present at the rongoā wānanga in March 2021.

The Trust's long-term aspiration is to develop a research hub and wellness retreat, and they are excited about the potential to explore an enduring relationship with Manaaki Whenua. It is also really important for us to be able to whakamana back to the Trust. The core purpose of our Manaaki Taiao rōpū is to empower kaitiaki, and we acknowledge that our partners are not a repository of information and resources for us to mine. We are proud to empower our Māori partners by sharing our knowledge and co-developing new knowledge in ways that are truly useful for them.

Our Environment

We want New Zealand to be an environmentally informed nation, taking action together

Climate change adaptation and mitigation

Our scientists are working to ensure that New Zealand has strategies to manage the risks and respond to the opportunities that climate change offers for the environment, the economy, and society.

Unlike in most developed countries, half of New Zealand's greenhouse gas emissions are methane and nitrous oxide resulting from agricultural practices. A number of inter-related research programmes focus on reducing land-based greenhouse gas emissions.

Carbon measurement and management

Manaaki Whenua leads New Zealand in both carbon measurement and management, providing underpinning research into national carbon stocks and changes over time, and services to help organisations reduce their carbon footprint.

Toitū Envirocare Ltd, a wholly owned subsidiary of Manaaki Whenua since its creation in the early 2000s, is a market leader in certified programmes for organisations to reduce their carbon footprint and enhance environmental performance (see page 37).

Sustainable society and policy

Our work in this area complements our biophysical science by focusing on the social, cultural, and economic processes and information needed to improve policy performance and to convert knowledge and tools into action on the ground. We underpin this work with several major nationwide surveys, such as our Survey of Rural Decision Makers.

Developing effective policy entails designing, undertaking, and evaluating engagement processes and strategies; understanding preferences, values, and governance processes for natural asset management; assessing information to underpin choices and decisions; designing policy instruments and their implementation; and tracking policy performance to enable adaptive management. Our research group is the largest social science group with this specific expertise in New Zealand.

The research they do spans urban, rural, and conservation landscapes and catchments, the full range of ecosystem services and natural resources, and a wide array of stakeholders – central and local government, industry, NGOs, and community and Māori organisations.

On the next pages we share some of our successes and science highlights for our environment in 2020/21.

Reconstructing long-term climate change

Long-term palaeoecological and climate reconstructions provide baseline information to show how species and ecosystems have responded to climate change and human activities in the past. These palaeo-archives are increasingly being used to help inform conservation management plans and policies and to increase our understanding of the long-term impact of humans and the degree to which ecological changes today differ from natural disturbance and climate changes in the past.

Dr Janet Wilmshurst, from Manaaki Whenua's Long-Term Ecology Lab, has recently been involved in a number of international collaborations to study long-term palaeoecological records, resulting in three *Science* publications this year.

The first study, led by colleague Associate Professor Damien Fordham at the University of Adelaide, provided a review of how palaeoecological records can offer new prospects for benchmarking and maintaining future biodiversity.

The team found approximately 40% of terrestrial ecosystems are projected to have experienced shifts in temperature during the past 21,000 years that are similar in pace and magnitude to regional-scale future forecasts. The records reveal that terrestrial biodiversity will experience significant changes in response to future global warming, including wide-scale species declines that will threaten the goods and services ecosystems provide to humanity.

Identifying what causes some species to be more sensitive than others to climate-driven change in the past can lead to improving early-warning systems signalling population collapse, extinction or ecosystem shifts as a result of climate change, which helps safeguard biodiversity into the future.

In the second study, Dr Wilmshurst and Research Associate Matt McGlone formed part of a major international collaboration between 31 scientists from 7 different fields of research (geochronology, climate modelling, atmospheric chemistry, solar physics, anthropology, palaeontology, and genetics) that examined the impact of the last reversal of the Earth's magnetic poles.

The work was based on a study of radiocarbon (carbon-14) in the tree rings of New Zealand kauri (*Agathis australis*) logs found preserved in Northland peat bogs for more than 40,000 years. The age of the trees happened to cover a key period of Earth's history when one of the most dramatic reversals of the magnetic poles occurred 42,000–41,000 years ago, known as the Laschamps Excursion after the French village where it was discovered.

Although the Laschamps Excursion has been recognised in palaeo-archives from around the world, until now it had not been clear whether such magnetic changes had any impacts on climate and life on the planet. Analysis of the ancient kauri tree rings revealed a prolonged spike in atmospheric radiocarbon levels, caused by a surge of cosmic radiation as the Earth's magnetic field weakened and the poles switched, providing a way of precisely linking widely separated records of environmental change from around the world.

The team found that changes in magnetic and incoming radiation patterns caused substantial changes in atmospheric ozone concentration and circulation, electrical storms in the tropics, abrupt changes in tropical Pacific rain belts and Southern Ocean westerly winds, arctic air to chill North America, and ice sheets and glaciers to advance. These synchronous global climate shifts occurred at the same time as major environmental changes, extinction events, and transformations in the archaeological record.

With some indication that the Earth's magnetic field could be relatively close to another, similar flip, having weakened c. 9% in the past 170 years, this research illuminates some of the possible environmental consequences of such an event.

The third multinational collaboration, again including Dr Wilmshurst, was led by Dr Sandra Nogue from the University of Southampton, and sheds new light on the impact of humans on Earth's island biodiversity.

The team studied long-term pollen records dating back 5000 years, extracted from sediments on 27 islands around the world, including from New Zealand. By analysing all these fossil pollen data, they were able to build up an understanding of the composition of each island's vegetation and how it changed over time.

Globally, islands provide the ideal environment to measure human impact using fossil pollen analysis as most were settled in the past 3,000 years when climates were similar to the present day. Knowing when people arrived on an island means that scientists can study how the composition of its ecosystem changed in the years before and after.

The findings suggested that the rate of change in an ecosystem's plant-life increases significantly during the years following human settlement, with the most dramatic changes occurring in locations settled in the past 1,500 years. The most rapid changes occurred in islands that were settled more recently – such as the Galápagos, first inhabited in the 16th Century. Islands where humans arrived more than 1,500 years ago, such as Fiji and New Caledonia, saw a slower rate of change, probably because the land-use practices, technology, and introduced species brought in by the later settlers were more transformative and far reaching than those of the earlier settlers.

In New Zealand, and on many other islands, the legacy of human impact almost always surpasses the natural impact of earthquakes, volcanic eruptions, and extreme weather events, and the resulting vegetation changes are often irreversible.

The results of these three *Science* papers illustrate how reference periods in Earth's history serve as important natural laboratories for understanding biodiversity responses to climate and anthropogenic change.

42,000-year-old kauri log from Northland (note truck for scale). Photo: Nelson Parker

Innovation story

Our contribution to state-of-the-environment reporting for Aotearoa New Zealand

Since 2015, research organisations across New Zealand have contributed to a growing national cache of environmental reporting data under the requirements of the 2015 Environmental Reporting Act. Scientists at Manaaki Whenua have acted as science leads for much of this work, offering expertise and strategic direction on the comprehensive Environment Aotearoa 2015 and 2019 reports, as well as individual domain reports including Our Land 2018, Our Freshwater 2020, and Our Atmosphere and Climate 2020.

Released on 15 April this year, the latest interim report, *Our Land 2021*, drew heavily on Manaaki Whenua's expertise and information, including that of Dr Nina Koele, who was seconded to MfE to 'hold the pen' for the project, Dr Anne-Gaelle Ausseil, and Garth Harmsworth of the senior science and matauranga team, and Drs Bryan Stevenson and John Drewry who peer-reviewed the report.

The report is the first in the series to respond to the Parliamentary Commissioner for the Environment's recommendation to take a theme-based approach to state-of-the-environment reporting, and it also aligns with the 'DPSIR' model (**D**rivers of change, **P**ressures on the environment, **S**tate of the environment, **I**mpacts of that state, and society's **R**esponses), used for public policy overseas.

As a result, Our Land 2021 focuses on dynamic land-use issues rather than static land indicators. It explores the pressures on land, the Māori perspective, the interaction with climate, links to public well-being and wider aspects of the environment.

The report's environmental indicators are at a formative stage in this new approach, but each is given a full explanation and trend analysis on the Statistics NZ website. As part of this work, Dr Sam Carrick and others at Manaaki Whenua updated and created new data for environmental indicators in soil quality and land fragmentation.

Looking ahead, Manaaki Whenua's scientists are aiming to contribute to the MfE's Environment Aotearoa 2022, and are looking into the feasibility of new indicators that will be needed to assess impacts and meaningful linkages between the environment and human well-being. Fit-for-purpose indicators, which need to be transparent, reproducible, and traceable, all require robust supporting data.

We are working to identify these indicators in conjunction with MfE, using a framework based on ecosystem services (ES) and Nature's Contribution to People (NCP), an approach favoured by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). Initial work has proposed that indicators are split into 'supply' indicators, which represent an ecosystem's capacity to supply the service, and 'benefit' indicators, which refer to the service's contribution to well-being. Next steps include wider discussion of this framework and building indicators with the participation of a larger group of stakeholders.

Innovation story

Changes in the rural New Zealand hazardscape

New Zealand is a highly dynamic, multihazard environment, including coastal, riverine, and seismic landscape hazards. Manaaki Whenua's social scientists, including Dr Nick Cradock-Henry, are currently building a wide body of knowledge about the importance of co-creating knowledge about disaster response, allowing effective knowledge sharing across New Zealand's locally devolved and complex disaster management response systems. Co-creation of knowledge about hazards pre-event is known to be of value if it includes both scientifically credible information and processes that support practitioner contributions to solutions.

Our most recent research has found, for example, that farm-level flood resilience can be enhanced through farm-level response and recovery plans, and we also monitored the capacity to absorb shocks and prepare for future uncertainty among Marlborough winegrowers and the wider wine-production industry following the 2016 Kaikoura earthquake.

We have also begun developing applied approaches to support adaptation planning and decision making, starting with Hawke's Bay. A 'pathways planning' approach is one method: it creates a framework to support decision-making in the face of deep uncertainty, importantly adding in a participatory element, engaging with diverse values and conflicting objectives, and opening up conversations to identify ideas that participants might pioneer and test in preparation for change – for example, climate change. A new project for the Ministry for Primary Industries is now applying the approach in Marlborough, Northland, and Canterbury.

Through co-created knowledge, policy makers, practitioners, and researchers can enhance resilience, via learning and pre-event preparedness, identifying their vulnerabilities to natural hazards early.

Innovation story

Regenerative agriculture – what does it mean for New Zealand?

Regenerative agriculture has been proposed as a solution for some of New Zealand's most acute challenges. Advocates suggest it can improve the health of our waterways, reduce topsoil loss, offer resilience to drought, add value to primary exports, and improve the pervasive well-being crisis among rural farming communities.

With a groundswell of farmers transitioning to regenerative agriculture in New Zealand, there is an urgent need for clarity about what regenerative agriculture is in New Zealand and for scientific testing of its claimed benefits.

Produced in February 2020, a new white paper set out 17 priority research topics and introduced 11 principles for regenerative farming in New Zealand. The white paper, led by Manaaki Whenua's Dr Gwen Grelet, was the result of intensive collaboration and consultation with more than 200 people from June to November 2020. Collaborators included farmers and growers, researchers, primary industry bodies, banks, retailers, non-governmental organisations, government departments, large corporates, consultants, marketers, overseas researchers, and educators.

The project was funded by the Our Land and Water National Science Challenge, the NEXT Foundation and Manaaki Whenua.

Toitū Envirocare: climate leadership for Aotearoa New Zealand business

For most businesses in Aotearoa New Zealand, the challenge of operating successfully during a global pandemic has been significant. Increasingly, however, business has also recognised the opportunity, importance and indeed necessity to take positive climate action for the future of the planet and this growing sentiment has resulted in a very strong performance for Toitū Envirocare over 2020/21.

Toitū verified over 9 million tonnes of CO_2e (up 25% on 2020) and offset over 194 000 tonnes of CO_2e (up 60% on 2020), in partnership with 417 clients in their carbon programmes (up 35% on 2020). Toitū also has 139 clients working on their environmental impacts through the Toitū Enviromark programme, and another 80 working on non-programme environmental initiatives, including verification only, science-based targets and carbon credits.

In July 2020, the Toitū Board and management set out an ambitious 5-year strategic plan with the overall objective being to catalyse action for a zero-carbon future and lead the way for Aotearoa New Zealand business to achieve net zero by 2050. Key areas of strategic focus have been:

Expanding Toitū's reach

While the demand for carbon programmes is coming from across all business there has been a particular focus on supporting the public sector, primary sector, food and beverage as well as manufacturing and professional services, including financial where the Finance Sector Amendment Bill has driven increased demand for Toitū's services in line with the requirement to meet new mandatory reporting deadlines from FY2023.

Toitū also launched a number of new programmes including carbonzero farm, Carbon Assess (for SMEs and supply chain reporting) and sustainability strategy development. Through the sustainability strategy development workshops, Toitū has informed and educated a number of executive and board members on climate risks and opportunities, what net zero means and what climate leadership in Aotearoa looks like.

Education and advocacy

A strong focus for Toitū has been the fostering of sustainability knowledge and capability across Aotearoa New Zealand business. Toitū has organised both online and in-person information and education events (over 2,000 industry representatives) as well as participating in numerous external events across all sectors with key Toitū people involved as expert speakers, leaders of panel discussions and subject matter expert panel members. External communications have been focused primarily on the business audience, with the launch of new farm and SME measurement products, publishing a wide range of client success stories – Lake Hāwea Station, Summerset Group, solarZero, and promoting their annual 'Top Carbon Reducers'.

Building the ecosystem

Partnering across the sector has seen Toitū involved in national and international forums relating to carbon claims, offsetting and carbon neutrality, participation in working groups to improve the modelling of wastewater emissions in the NZ context, and development of a position regarding acceptance of renewable electricity certificate by our programmes.

Other technical developments included the reaccreditation of both carbonreduce and carbonzero programmes, strong progress towards updating of programmes to align with updated measurement, verification and accreditation standards, and streamlining of product certification processes to provide improved client experience and allow for the increased demand for product carbon footprints.

Making action easy

With continued strong growth in client numbers, internal processes such invoicing, and audit scheduling have been improved. Investment has been made in standardisation and automation to support scaling the business. The Toitū emanage software platform has been enhanced to support the new version of the ISO 14064 standard. This is important for clients wanting to measure the emissions throughout their value chain.

Our client base

Toitū continues to build strong relationships with existing and new clients, from large New Zealand corporates such as Fonterra, Westpac, ANZ, The Warehouse Ltd, Fisher & Paykel Healthcare through to public sector organisations including Climate Change Commission, MBIE, Accident Compensation Corporation, Ministry of Transport, MPI, Ministry of Social Development, Ministry of Justice, and Fire and Emergency. Significant new private sector clients included Precinct Properties, Fulton Hogan, Silver Fern Farms (product), Proctor and Gamble (product), Discovery NZ, and Macpac NZ. Toitū's international licence partner Achilles has also seen strong growth in demand for carbonreduce and are now offering carbonzero, with its first carbonzero clients certified this year.

Our people

To deliver this significant increase in business Toitū has increased permanent staffing numbers across the country from 40 in 2020 to 49 in 2021. While this increase has been across all functions of the business and especially in Client Delivery and in Auckland, Toitū continues to have a strong presence in both Christchurch and Wellington.

The outlook for the coming 12 months, COVID allowing, continues to be positive for Toitū Envirocare with increasing numbers of businesses seeing sustainability as critical to not only the planet's long-term future but to that of their business. For many, sustainability now means taking on a far wider commitment than simply carbon reduction and Toitū is well positioned to lead and support this more ambitious thinking and ultimately action in the business community.

Our strategic goals

Our Strategy – Strategy 22

Strategy 22 was developed in 2017 as a 5-year strategy to guide key investment within the organisation to 2022. Our strategy rests on **three main pillars** to support how we deliver impactful science – an irresistible culture, a better way of working, and science for impact. As the 5-year period comes to a close, we are now engaged in a refresh of Strategy 22, building on its success and involving our staff in its further development.

Our activities as an organisation contribute to meeting the 12 material UN Sustainable Development goals that we identified in the 2019/20 Annual Report. Six of the goals were identified as material to our organisational activities: 3 Good Health and Well-being; 5 Gender Equality; 8 Decent Work and Economic Growth; 10 Reduced Inequalities; 12 Responsible Consumption and Production; and 13 Climate Action.

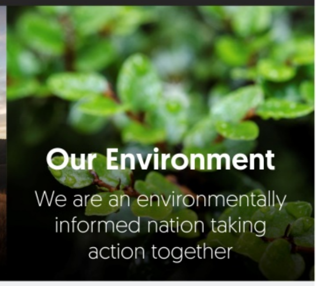
Science for our land and our future

Ko te pūtaiao mō tō tātou whenua, mō āpōpō

OUR STORY

Kia tupu matomato a Tāne, a Rongo, a Haumia-Tiketike

Let it be that the land and all its fruits may flourish



OUR PATHWAY TO IMPACT

Through our science, research and partnership, we will enable New Zealand to realise its goals for our land environment

Science **Activity** › Science **Outcome** › Science **Impact**

OUR STRATEGY

01. An irresistible culture

Our unique culture embraces mātauranga Māori as a complementary world view, and values leadership, diversity, and partnership as powerful tools for creating positive impacts for our land.

02. A better way of working

Our business is built on an efficient, sustainable and scalable operating model that ensures we can realise the greatest possible impact for New Zealand from every dollar invested.

03. Science for impact

Our research is highly valued as it delivers real world outcomes for NZ. Integrated and innovative science brings together multi-disciplinary teams, partners and the public to respond to the land environment issues that face all New Zealanders

OUR WAY

Experiment to learn
Mā te hē ka tika

Share freely & often
Kia rite tonu te tohatoha

Invite input from others
Kia areare mai ōu taringa

Embrace diversity
Awhi mai, awhi atu, tātou tātou e

Commit to excellence
Whāia te iti kahurangi

Pillar 1 – An irresistible culture

There are two key goal areas within this strategy pillar: Our People, and Science Working with Mātauranga Māori

Goal 1 – Our people

Manaaki Whenua derives its value from its people. It is the unique combination of our 444 researchers, scientists, technicians, science support staff, and corporate staff that powers our impact for New Zealand. Manaaki Whenua aspires under our Strategy to be an employer of choice, attracting and retaining exceptional talent.

100% committed to health, safety, and well-being

Our goal is that everyone is 100% committed to health, safety, and well-being. We continuously seek to mitigate risks inherent in our work in laboratories, on our sites, and in our fieldwork in remote locations.

We have continued to support the health and well-being of our employees through our Manaaki Tangata well-being programme, providing a monthly focus on different well-being themes.

Harassment and bullying prevention

Manaaki Whenua has a zero tolerance for bullying and harassment of any kind. We regularly review processes in place to ensure we are providing a safe work environment for all people working for and with Manaaki Whenua.

Safe and healthy environment

Manaaki Whenua achieved external certification against the AS/NZS 4801 health and safety standards in 2018. Further external audits in 2019 and 2020 highlighted the progress that has been made in our health and safety practices. We achieved re-certification in our 2021 audit against the new ISO 45001 standards.

A great place to work – being an employer of choice

Our culture of empowerment comes from diverse talents, great leadership, and communication. We bring together the best teams from within and beyond our organisations and provide our staff with opportunities for career and leadership development skills enhancement, external interaction in our sector. Flexible working is a key component of 'our way' of working, enabling working arrangements to meet people's diverse circumstances and encouraged collaboration in different ways.

Our goal of being an employer of choice for the world's best talent is focused on creating an environment of support and opportunity for our people.

We achieved an 86% response rate to this year's Employee Experience Survey. Our engagement index was 76% (and 83% in Toitū Envirocare). These engagement scores help us understand the overall experience for our people at Manaaki Whenua.

A diverse and inclusive work community

With the establishment of our Diversity & Inclusion group we are exploring ways to ensure that Manaaki Whenua is an inclusive workplace. We have run workshops and internal events to raise awareness and increase understanding of different cultures and backgrounds. Existing programmes in the Public Sector, such as Papa Pounamu, are guiding our initiatives and areas of focus. We also have a regular bicultural training programme to build our capability including noho marae, Treaty awareness training, and te reo, which is offered to all our staff.

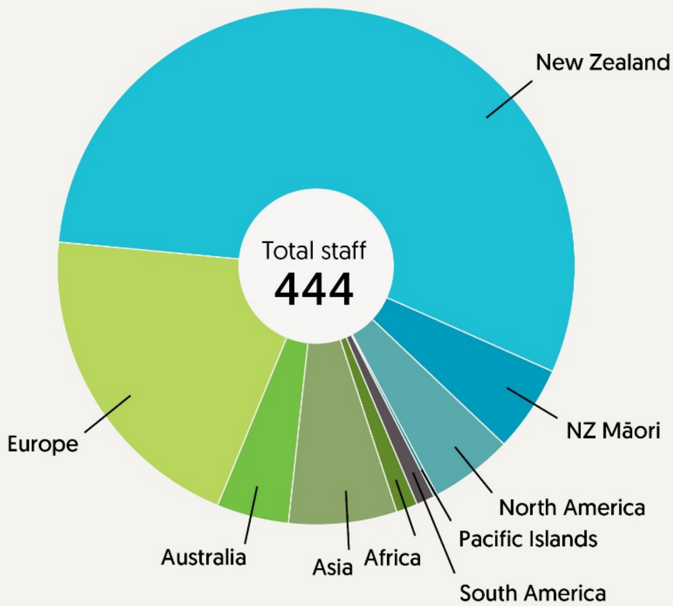
During 2020/21 approximately 100 staff attended ‘bite-sized’ Te Tiriti sessions, with an additional eight staff attending a more detailed Te Tiriti training course. In May 2021 we employed a Māori Capability Facilitator who ran sessions with staff to discuss bicultural needs/ideas for training in 2021/22. We also placed two tauira (Māori students) into summer internships.

Gender equality

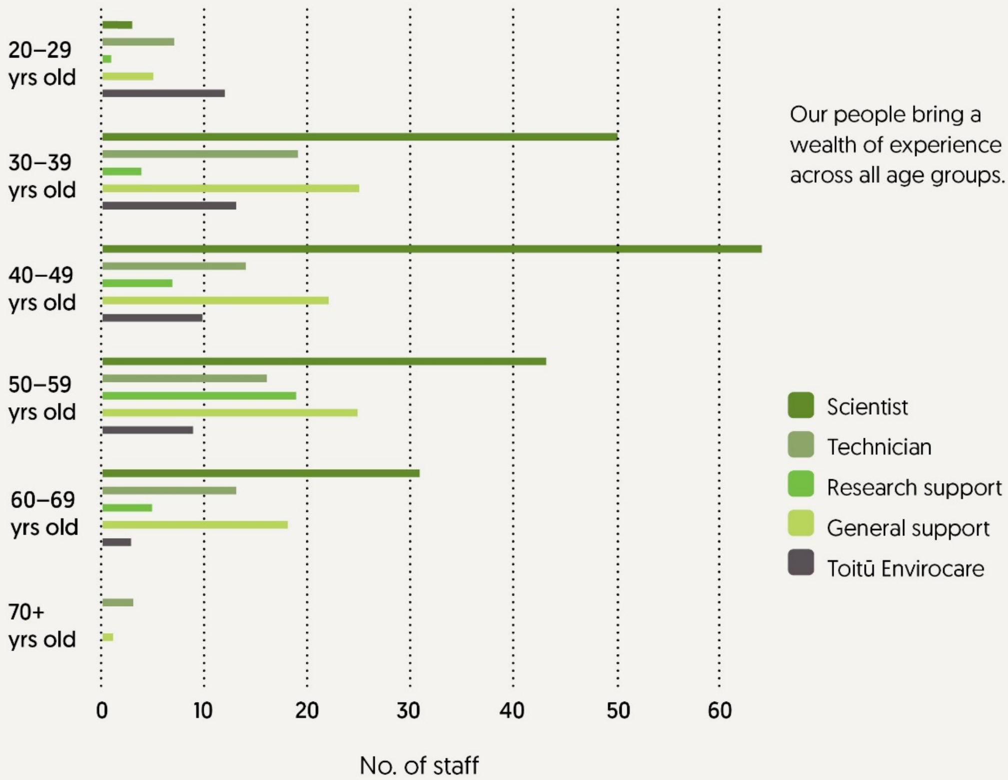
Manaaki Whenua and its employees are committed to taking proactive steps to achieve a working environment for all workers that is free from bias and discrimination in employment and pay practices, and in which all can achieve their full potential. We have developed a Gender Pay Gap action plan focusing on activity to address the underrepresentation of women in leadership roles.

STAFF OVERVIEW

Ethnicity



Age distribution

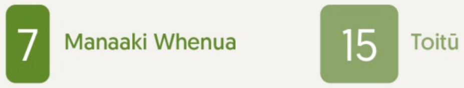


Our people bring a wealth of experience across all age groups.

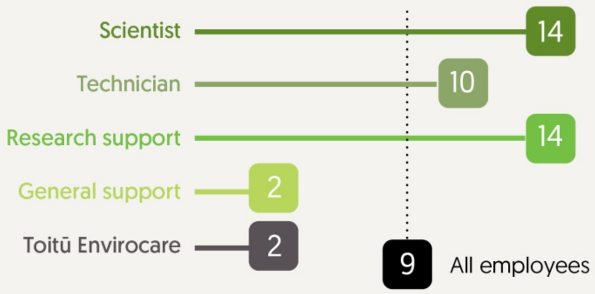
STAFF OVERVIEW CONTINUED

Overall gender distribution*

Annual turnover (%)



Average years' tenure



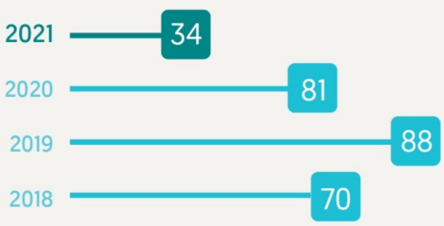
Employee retention metrics are a useful snapshot of staff satisfaction and help to judge future staffing requirements.

Overall engagement (%)

Our staff engagement survey results show a pleasingly high level of overall staff engagement.

HEALTH AND SAFETY

Near misses



Lost-time injuries

Reporting of lost time to injuries and near misses, so we can learn from them, is an important part of our Safety Differently culture.

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

Goal 2 – Science working with Mātauranga Māori

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.

We are committed to the development of our bicultural capability. Our ability to engage Māori in every part of our research is a key to our success. Building an understanding of and empathy for Māori culture is a key part of our Diversity and Inclusion Strategy.

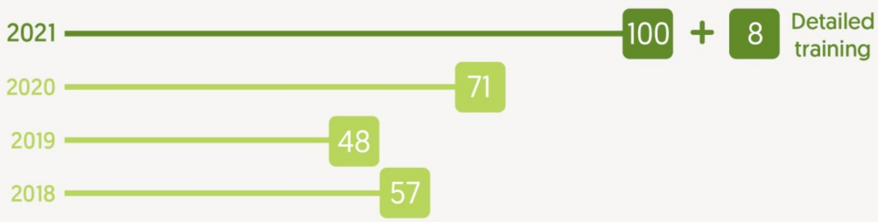
Partnership with Māori

Manaaki Whenua has developed enduring partnerships with selected iwi, groups of iwi, Māori trusts/incorporations, and Māori organisations (see also page 13). 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.

NUMBER OF WORKSHOPS

Treaty workshops

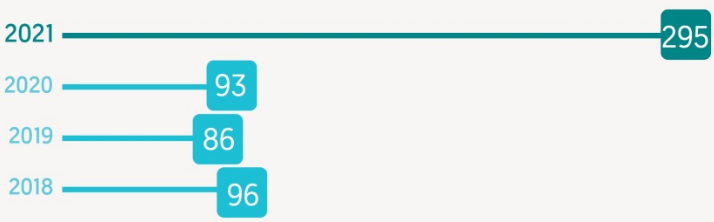


Cultural awareness workshops

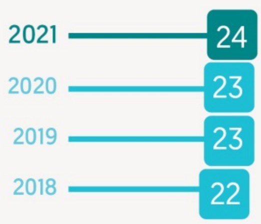
In 2019/20 and 2020/21 some of our bicultural training activities were impacted by Covid-19.

VISION MĀTAURANGA PROJECTS

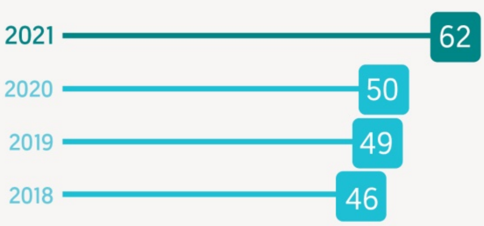
Research specifically relevant to Māori



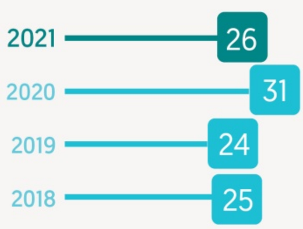
Kaupapa Māori



Research involving Māori



Māori-centred research



Pillar 2 – A better way of working

The second pillar of our strategy focuses on the systems, processes and infrastructure that underpin our ability to create impact through our research. Our business needs to be built on an efficient, sustainable, and scalable operating model that ensures we can realise the greatest possible impact for New Zealand for every dollar invested in Manaaki Whenua.

Goal 3 – Our sustainability

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.

Our commitment to sustainable development goals

In 2020 we identified which UN Sustainable Development Goals are most relevant to Manaaki Whenua's research impacts and to how we operate as an organisation. From within and outside Manaaki Whenua, 38 people contributed to selecting 12 of the 17 SDGs. We then used those 12 goals as the framework for a new Sustainability Policy, launched to the organisation in mid-2021, and are working towards setting our own targets.

Our experience of target-setting for the SDGs has been that targets and KPIs are more readily set in the management of our operations, which is under our control, than in the impact of our research, where we are dependent on the actions of others. Progress in defining operational targets and KPIs is shown in the table on page 57 in this document's Reference section.

Last year we reported that the SDGs did not specifically address indigenous peoples' rights in relation to land and the impacts on their land of matters covered by the SDGs, for example responsible production (SDG12). Indigenous peoples' rights are covered by the UN Declaration of the Rights of Indigenous Peoples (UNDRIP), to which New Zealand is a signatory. We now address this matter within our commitment to the principles of Te Tiriti, which are **partnership**, **participation,** and the **active protection** of Māori interests in their lands (see page 13).

Our commitment to sustainable operations

In the past year we have revised our corporate sustainability policy. The process began with a 'materiality assessment' and included feedback from our stakeholders and staff. The scope of the policy includes the activities of Manaaki Whenua: of our people (staff) in the course of their work; our relationships with investors, clients, partners, and suppliers; and the impact we achieve now and into the future through our work and partnerships.

Sustainable procurement and operations

As a Crown Research Institute we access several All of Government (AoG) and syndicated contracts. Several of these have sustainable procurement practices, as required by the Government's broad 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.

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 include moving our car fleet to electric vehicles, sustainable travel procurement and making progress towards sustainable energy use in our buildings. As the infographic on page 49 shows, our overall greenhouse gas emissions have been considerably reduced during the pandemic, and as the table on page 57 shows, we aim to maintain progress in this area in future years.

We have been certified to the ISO14001 standard since 1998, meaning that we maintain systems to document and manage our environmental impacts. We have been certified carbon-neutral since 2011, meaning that we measure and manage our greenhouse gas emissions and pay to offset those emissions that we have not been able to eliminate. We maintain carbonzero certification through our subsidiary, Toitū Envirocare, which purchases certified carbon credits on our behalf, and with whom we have worked to explore how the UN's Sustainable Development Goals can be used for reporting on our sustainability.

Other initiatives we have undertaken in the 2020/21 year include:

- Installed stage one 'readiness' infrastructure for photovoltaic solar panels on our new building at the Lincoln site, with planned installation at end of this calendar year.
- Progressed our vehicle replacement plan to achieve the Government's target of all light vehicles in the Government fleet to be emissions-free by 2025/26. This year we replaced two hybrid cars with fully electric vehicles, replaced all our SUVs with plug-in hybrid SUVs, and installed EV charging infrastructure at the Auckland and Lincoln sites.
- Participated in the newly formed CRI Sustainability Network, with a focus on decarbonisation.

Sustainable business

As a research institute our ability to deliver on our purpose and deliver impact for New Zealand is dependent on our ability to continue to support the science talent required. We have an established commercialisation pathway – the Accelerate Programme. The programme has a dual focus on people and projects. We seek to stimulate and develop the impact and entrepreneurial awareness of our researchers by exposing them to training and mentorship opportunities, and we identify and accelerate projects where new products or services can be created. Under this programme, work has continued on our selective rat toxin commercialisation and on a native fungi production system.

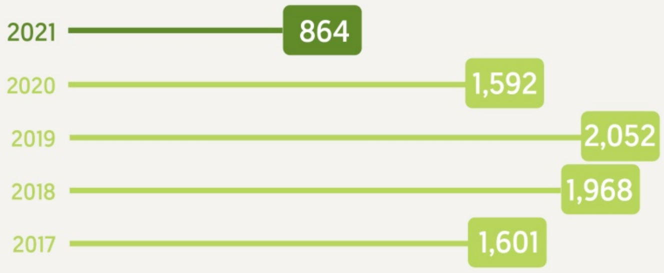
The Kiwi Innovation Network (KiwiNet) is a New Zealand network of public research organisations working together to transform scientific discoveries into marketable products and services. KiwiNet acts as a channel for collaboration, empowering people by helping them access the tools, connections, investment, and support they need to commercialise research. It runs an Emerging Innovator Programme, open to early career researchers based at universities and Crown Research Institutes across New Zealand.

Christopher Smith, one of our Kiwinet emerging innovators from 2019, has been selected as a finalist for the Kiwinet Awards in the Breakthrough Innovator Category. We have also had two new Kiwinet Emerging innovators this year, Julia Allwood and Kishor Kumar, who are working on projects related to the application of DNA sequencing technology and the application of sensor technologies to soil data gathering.

Manaaki Whenua is a partner in KiwiNet, along with Plant & Food Research, Callaghan Innovation, AgResearch, Otago Innovation, Lincoln University, University of Canterbury, Viclink, WaikatoLink, AUT Enterprises Ltd, Cawthron Institute, Environmental Science & Research, NIWA, Scion, GNS Science, and the Malaghan Institute.

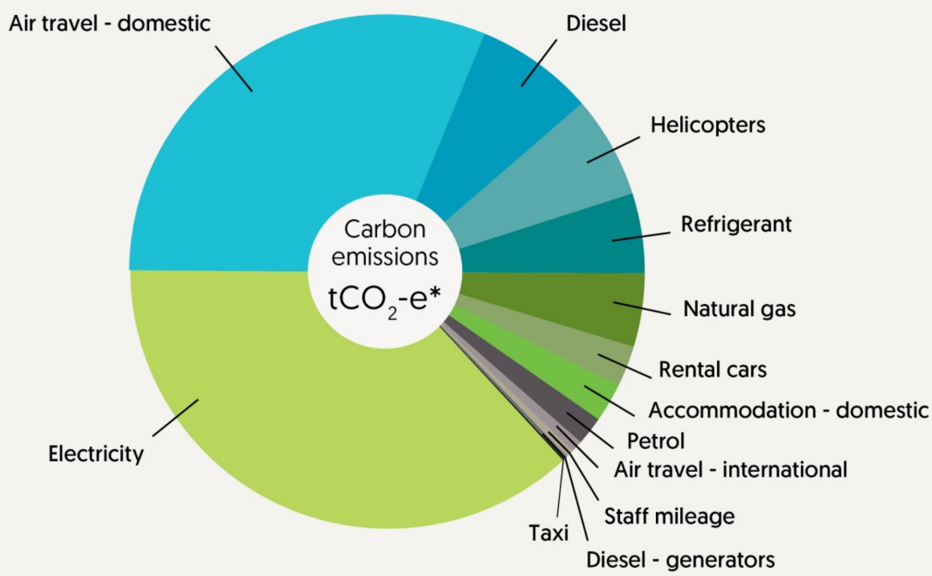
CARBON EMISSIONS

Total emissions (tCO_2-e)*



Partly because of Covid, in 2020 and 2021 our carbon emissions were reduced.

Activity (year to June 21)



Certifcation

Carbonzero certification

2011–present

ISO 14001 certification

1998–present

TOITŪ CARBON ZERO ISO 14064-1 ORGANISATION

* tCO_2-e = tonnes carbon dioxide equivalent.

Goal 4 – Our infrastructure

Our goal is that our collections and databases, property, equipment, and IT infrastructure support excellent research; and that our sites provide great working environments, support our partnerships, and are a base of interaction with New Zealanders.

This year we have focused on enhancing the security of our IT infrastructure. Our Te Rauhitanga project at the Lincoln site continues and is expected to be opened in early 2022.

All 12 of our Transitional and Containment Facilities have had their continuing conformance with MPI's requirements under the Biosecurity Act and HSNO Act confirmed by returning acceptable results from every verification inspection conducted at the facilities during 2020/21.

Goal 5 – Our partners

Manaaki Whenua has been a consistent supporter of a partnership approach to achieve strategic goals for New Zealand. From the Outcome-Based Initiatives (OBIs) of the early 2000s, through the Platforms of the early 2010s, to the National Science Challenges (NSCs) since 2015, we have been active in supporting system alignment.

Partnership is also central to our Strategy 22. 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.

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

This year we were active participants in a number of joint CRI initiatives, including workforce planning, capability and development, developing enduring partnerships and co-innovation with Māori, the CRI Impact Planning and Evaluation Network (IPEN) project to increase impact, and the cross-CRI National Environmental Data Centre (NEDC). We are also leading an initiative with the regional government sector to assist in the implementation of the Regional Council Research Science and Technology Strategy (RS&T) as they tackle implementation of the National Policy Statement for Freshwater Management (NPS FM) and other legislative drivers and environmental issues.

With other CRIs we continued to explore how we can better work together to grow capability and maximise returns on SSIF investment. We were active participants in the joint CRI initiatives 'Workforce planning, capability and development' and 'Developing enduring partnerships and co-innovation with Māori', and the CRI Impact Planning and Evaluation Network (IPEN) project to increase impact. We have been active in the recently formed joint CRI/Callaghan Innovation Covid Recovery Taskforce. This taskforce is looking at 'shovel ready' science to assist in New Zealand's economic and social recovery.

Manaaki Whenua co-leads two of the identified projects and participates in the other four. Part of this involves the cross-CRI national environmental data centre (NEDC), which will provide better visibility and access to CRI environmental data via web access. We have also recently been active in the joint CRI resilient agriculture-themed collaboration with four other CRIs looking at the opportunities to partner with Māori agribusiness and an integrated approach to resilient agriculture. Regenerative agriculture is an initial focus and builds on the collaborative project that developed the white paper on regenerative agriculture with Our Land & Water National Science Challenge. We are leading a current initiative with the regional government sector with a focus on assisting in the implementation of the Regional Council Research Science and Technology Strategy (RS&T) as they tackle implementation of the National Policy Statement for Freshwater Management and other legislative drivers and environmental issues.

At present, six of our staff members are employed part-time by the University of Auckland to co-supervise the next generation of biodiversity and biosecurity scientists. We also have five staff members in adjunct roles with the University of Canterbury and Lincoln University under the auspices of the Joint Postgraduate School in Food Transitions, while many of our staff have other supervisory and teaching input within the university system.

Additionally, this year we renewed our partnership MOU with DOC, and developed a focus plan and an improved engagement plan.

International partnerships

Science is also an international endeavour. We reach out to and share expertise, staff, and data with many organisations across the globe.

The pandemic impacted our ability to implement the staff exchanges that we had begun to plan. However, with INRAE (France) we instigated and signed a pan-CRI agreement to develop research exchanges and co-develop research. This was the first time all the CRIs had engaged together in relationship with an international research organisation.

With Wageningen (WUR, Netherlands) we held online workshops to develop new research directions; and with the Lawrence Berkeley National Laboratory (Earth and Environmental Sciences, California) we held online workshops, developed new research directions, and were grateful to include their Director, Prof. Susan Hubbard, in our international Science Advisory Panel's review of science excellence in November 2020.

In the period 2018–2020, 2,200 of our research publications were co-authored with overseas researchers.

Pillar 3 – Science for impact

We want to broaden our science impact through novel ways of doing, thinking, and understanding. This strategic pillar focuses on how we encourage and support our researchers to respond to the land and environmental issues that face all New Zealanders.

Goal 6 – Innovative & challenging

Our first goal under this pillar is to develop initiatives that will ensure we tackle greater scientific challenges with greater rewards for New Zealand.

Outside Thinking and Brilliant Writing

Outside Thinking and Brilliant Writing is designed to give researchers time to develop new thinking and novel ideas through collaborating both internally and externally, to provide significant mentoring to early-career scientists in writing and critical thinking, and to gain fresh inputs and to challenge our thinking. In 2020/21 we funded two initiatives, each for $150,000, as below. Both projects were funded for a second year due to Covid-related delays:

Weed dynamics

A new collaboration with groups in New Zealand, Australia, and the USA was formed to re-evaluate weed dynamics through understanding the ecological and management implications of multiple simultaneous invasions. The team used global plant functional trait databases to predict how co-invasion exacerbates the ecosystem impacts of individual weed species. They have drafted a synthesis paper for the journal *Frontiers in Ecology*, outlining a new research agenda for the next 5–10 years that has global (not just national) significance for weed management.

Soil carbon

This new collaboration with the universities of Wageningen (Netherlands), Toulouse (France) and Manchester (UK) re-evaluated the dynamic nature of soil organic carbon for sequestration and ecosystem function. Senior and emerging researchers collaborated through online workshops to develop a novel complex systems approach to understand the factors controlling soil carbon stabilisation and sequestration. The team also drafted a paper for the journal *Global Change Biology.*

The Science Den

The Science Den is an initiative to support the development of innovative and challenging ideas. The scheme is all about the ideas themselves, not running projects or doing the actual research, because truly innovative research isn't possible without really good ideas in the first place. No ideas are out of scope. Risk-taking is encouraged, and failure is celebrated alongside success if we learn from it and try again. During 2020/21 we funded the development of nine ideas:

- novel use of bacteria as a fundamental niche study system
- exploiting Allee effects to achieve predator eradication
- how to deter kea from eating 1080 bait
- breeding huhu in captivity
- using herbarium specimens for quantifying declines in insect pollinator populations.
- soil microbes to combat climate change

- using pomace to enhance compositing of raw material for microbial transformation to value-added products
- data ontology
- biochar: adding value to wilding pine control.

Goal 7 – Strategic & Integrated Research

Increasingly we work on longer and larger scales and more complex problems, integrating across disciplines and stakeholders. To tackle complex, real-world issues such as climate change, risks and hazards, biodiversity and pests, and land and water management, integration is an increasingly important characteristic of effective research. Our Climate Change Adaptation and Mitigation research portfolio, which has been developed further this year, has a wholly integrated approach.

Research can be integrated in several ways. What we mean by integration at Manaaki Whenua is research that attempts to solve larger-scale problems and therefore requires multiple skill-sets, but also a more externally driven understanding of the issues than a research community might arrive at itself. The varying contributions of expertise could include knowledge, understanding of a problem, concepts, frameworks, data, methods, skills, and interpretations. To assist with this work, in 2020/21 we completed a maturity assessment for our information strategy and then a blueprint for implementation to meet our organisational data management needs. For engagement we developed an online platform on SharePoint to help researchers engage with stakeholders. using the right approaches relevant to their projects.

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.

In accordance with the Platform Plan, 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. Across publications from all New Zealand CRIs in the past 5 years we rank number one in citation impact (InCites category normalised citation ranking) at 1.67 (2016–20) and second only to Auckland University of Technology when universities are included. Our average Scimago journal ranking (citations per document over 2 years) is currently 4.0. For our 298 publications from 2020 we already have an InCites citation impact of 1.81, higher than any other CRI or university. This puts us in the top 13% of all research institutes globally that published more than 50 papers during 2020.

Goal 8 – Valued & Trusted

We continue to work closely with our major central and local government stakeholders to develop the evidence base for conservation, biosecurity, land management policy, legislation, and regulation. During 2020/21 we engaged with major stakeholders, setting research agendas to deliver outcomes and impacts while developing a scientific culture (a right team approach) whereby individuals work to their strengths.

Increasingly, we have employed deeper partnership approaches, such as secondments, to better understand the specific needs and priorities of those who will be using our advice and tools. In 2020/21 five staff were seconded in a range of tenures to Government agencies (to MfE to produce the land domain report, to PCE to assist with Weeds investigation, to DOC to advance biodiversity monitoring) and a social enterprise (to Toha to develop the Regenerative Agriculture standards against which investment will be assessed).

We also regularly provide our key stakeholders with up-to-date briefings, both in person and online. This year, building on an initiative begun in the first Covid lockdown, we continued to promote and hold our LINK seminar series online. Attendance at these webinars was another significant step-up from in-person attendance, with a total audience of 5,533, more than double the number of attendees from 2019–20 (2,509).

Goal 9 – Engaged with all New Zealanders

As we face complex challenges like climate change, biodiversity loss, and land-use intensification, Manaaki Whenua has a responsibility to support the conversation and understanding of these problems with robust, science-backed information. 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 the execution of this strategic goal area, supporting the wider organisation to engage through marketing, communication, and digital platforms. In September 2020 our digital team launched a new website designed to support both the more technical needs of our research partners, while helping a less technical audience engage with our research. They also continued to develop our social media community, particularly on LinkedIn (a 97% increase in interactions this year) and Instagram. Our marketing team led another highly successful campaign in support of the New Zealand Garden Bird Survey, resulting in very good levels of participation (over 6,000 surveys submitted). The 2019/20 survey campaign also won a Gold Award at the 2021 PR Institute of New Zealand annual awards, in the Marketing Communication category.

SCIENCE DEN

2019: 7

2021: 9

$15,000 per idea

ONLINE

LinkOnline seminars

Live session attendees 3,559 and Later views 1,974 = Total audience 5,533 across 17 Seminars

Manaaki Whenua social media

Facebook likes

9,182

119 AVERAGE engagements per Facebook post[3]

25% INCREASE in Instagram followers

NZ Garden bird survey

Facebook Group members[3]

6,632

Instagram likes[3]

2,368

New Zealand GARDEN BIRD SURVEY

JOURNAL PUBLICATIONS

4 Average journal citation score of MWLR articles[1]

348 Papers published[2]

[1] Scimago journal ranking.

[2] Web of Science 2011–2021, for financial year 2020/21.

[3] Sprout Social media management tool.

Reference

Non-financial KPIs

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

Strategy goal area

KPI	FY18	FY19	FY20	FY21
Our people				
1. Employee engagement index	70%	88%	81%	76%
2. Employee turnover	8.5%	6.9%	4.5%	7.05%
3. Health & safety (near misses)	34	46	31	34
4. Health & safety (lost-time injuries)	0	2	1	5
5. Average tenure (years)	13	11	8	8.48
Science working with mātauranga Māori				
1. Research relevant to Māori	96	89	93	295
2. Research involving Māori	46	49	50	62
3. Māori-centred research	25	24	31	26
4. Kaupapa Māori	22	23	23	24
Our sustainability				
1. Tonnes CO_2 per $m revenue*	26.38	27.11	18.95	9.77
2. Certified total tonnes CO_2-e	1968.19	2051.63	1591.78	864.47
Strategic & integrated				
1. Impact of scientific publications (mean citation score)	3.1	3.9	4.2	4.0
Engaged with all New Zealanders				
1. Facebook likes	5686	8758	9206	9182
2. Participants in Garden Bird Survey	4376	3082	7800	6632
3. Interactions per Facebook post	92	126	143	119

*This table shows a provisional revenue amount for 2020/21.

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

Provisional KPIs for corporate sustainability

UN SDG	Our goal statement	Our provisional target/s
3. Good Health and Well-being	**We will:** Empower our people to commit themselves 100% to health, safety and well-being while executing our own responsibilities as their employer.	1. Every staff member feels that MWLR cares about their well-being 2. Every staff member believes MWLR is committed to the health and safety of its people 3. Implement relevant actions from the 2022 HSE Operational Plan by 30 July 2022
5. Gender Equality	**We will:** Ensure gender equity in participation, leadership opportunities, conditions and reward in all aspects of our work, using enabling technologies where appropriate.	4. Gender pay gap of less than 4% within each pay grade 5. Gender leadership representation of 40% female, 40% male, 20% any gender identity 6. Implement relevant actions from the 2022 Gender Equity Action Plan by 30 July 2022
8. Decent Work and Economic Growth	**We will:** Achieve sustainable economic performance that supports innovation, entrepreneurship, job creation, staff development, fulfilling roles and advancement opportunities with fair remuneration.	7. Financial sustainability to ensure ability to invest in the medium/long term, and provide fair remuneration 8. Every staff member feels their role is satisfying
10. Reduced Inequality	**We will:** Enhance the inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status and sustain income growth for our lower earners.	9. Every staff member feels included at MWLR 10. Implement relevant actions from the 2022 Equity Diversity and Inclusion Action Plan by 30 July 2022 *Also refer to targets 1, 4, 5, 6 and 8.*
12. Responsible Consumption and Production	**We will:** Measure and manage our own consumption and outputs to sustain and restore natural resources, reduce waste and emissions, and foster a circular bio-economy, while through our procurement and services encourage other to adopt sustainable practices.	11. Annual reduction in: – total waste to landfill – total water consumption 12. All procurement processes recognise and prioritise suppliers' sustainability and ethical sourcing practices *See Climate Action for GHG targets*
13. Climate Action	**We will:** Measure, reduce, and mitigate our greenhouse gas emissions; understand climate risk to our business and increase our resilience.	13. Neutral net carbon emissions (offset by certified high quality – Carbonzero – credits) 14. Reduction of gross emissions per $m revenue 15. Retain at least half of the reduction in flying kms achieved during Covid-19 per $m revenue
17. Partnerships to achieve the Goals	**We will:** Partner nationally and globally to build capacity, enhance knowledge- and data-sharing and access to science and technology, and enhance the Global Partnership for Sustainable Development.	*Māori* 16. All partnerships with Māori organisations are based on Te Tiriti principles 17. Year on year an additional 10% of staff feel they are equipped to work in partnership with Māori groups *End-users* 18. Partnership/engagement plans for major stakeholders are in place by 30 June 2022 *Science partners* 19. ≥ 55% of papers are co-authored with other NZ institutes AND ≥ 60% of papers are c o-authored with international institutes *International development* 20. Develop a strategy to enable MWLR to transfer knowledge and technology to developing countries and grow their capacity, enabling their sustainable development by 30 June 2022

Directory

DIRECTORS

Jane Taylor (Chair)*
Dr Paul Reynolds QSO
(Deputy Chair)
Ngarimu Blair
Prof Emily Parker*
John Rodwell
Prof Caroline Saunders
Hon Kate Wilkinson*
Justine Gilliland

** To 30 June 2021.*

REGISTERED OFFICE

Canterbury Agriculture & Science Centre
54 Gerald Street
PO Box 69040
Lincoln 7640
New Zealand
PH: +64 3 321 9999
FAX: +64 3 321 9998
www.landcareresearch.co.nz
NZBN Number: 9429038990496

SENIOR LEADERSHIP

Dr Richard Gordon	Chief Executive
Dr Fiona Carswell	Chief Scientist
Kylie Hansen	General Manager, People & Culture
Holden Hohaia	General Manager, Māori Development
Dr Steve Lorimer	General Manager, Development
Chris McDermott	General Manager, Brand & Communications
Dr Peter Millard	General Manager, Science
Graham Sevicke-Jones	General Manager, Science and Knowledge Translation
Nigel Thomson	General Manager, Corporate Services
Becky Lloyd	Chief Executive, Toitū Envirocare
Daniel Patrick	Director, NZ Biological Heritage National Science Challenge
Melanie Mark-Shadbolt*	Kaihautū Ngātahi, NZ Biological Heritage National Science Challenge

**To 30 June 2021.*

ALEXANDRA
43 Dunstan Road
PO Box 282
Alexandra 9340
Ph: +64 3 440 2930

AUCKLAND
231 Morrin Rd,
St Johns
Private Bag 92170
Auckland 1142
Ph: +64 9 574 4100

DUNEDIN
764 Cumberland Street
Private Bag 1930
Dunedin 9054
Ph: +64 3 470 7200

HAMILTON
Gate 10
Silverdale Road
Private Bag 3127
Hamilton 3240
Ph: +64 7 859 3700

LINCOLN
54 Gerald Street
PO Box 69040
Lincoln 7640
Ph: +64 3 321 9999

PALMERSTON NORTH
Riddet Road
Massey University Campus
Private Bag 11052
Palmerston North 4442
Ph: +64 6 353 4800

WELLINGTON
Level 6
17 Whitmore Street
PO Box 10345
Wellington 6143
Ph: +64 4 382 6649

TOITŪ ENVIROCARE
AUCKLAND
Suite 9, Level 2
20 Augustus Tce Parnell
PO Box 137182
Parnell 1151, Auckland
Ph: +64 9 574 4230 or: +64 3 321 9804

LINCOLN
PO Box 69040
Lincoln 7640
Ph: +0800 366 275

BANKERS
ANZ Bank New Zealand Limited

AUDITORS
Audit New Zealand on behalf of the Auditor-General

SOLICITORS
Buddle Findlay

Science New Zealand

Science working for New Zealand

The eight members of Science New Zealand proudly work individually and collectively alongside the rest of government to create a more prosperous, sustainable and innovative New Zealand.

4,000+	50+	6,000+	40+
smart and passionate people	sites nationwide	science projects every year	nationally significant databases and collections

sciencenewzealand.org

CallaghanInnovation
New Zealand's Innovation Agency

Manaaki Whenua
Landcare Research

agresearch
āta mātai, mātai whetū

NIWA
Taihoro Nukurangi

GNS SCIENCE
TE PŪ AO

scion

Plant & Food™ Research
Rangahau Ahumāra Kai

E/S/R
Science for Communities

newzealand.govt.nz