



As the Crown Research Institute for our land environment and biodiversity, our role and responsibility to New Zealand is clear. This land, and everything that shares it with us, is our future. Hence our purpose is 'Science for our land and our future'.

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.

Landcare Research New Zealand Limited
(Manaaki Whenua – Landcare Research)
Annual Report 2020

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

The iridescent green *Megadromus antarcticus* ground beetle, found only in the Canterbury region. With some 6.5 million specimens, Manaaki Whenua's nationally important New Zealand Arthropod Collection (NZAC) contains the most complete coverage of terrestrial invertebrates in New Zealand.

The NZAC is a vital resource for verifying the presence or absence of species in New Zealand, making border biosecurity control decisions about possible pest incursions, and identifying the status of threatened native taonga.



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Our Land, Our Future

Tō tātou whenua, mō āpōpō

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

A word from our Chair

It is my pleasure to introduce Manaaki Whenua's 2020 Annual Report. Like all organisations, Manaaki Whenua has come through a challenging period since the beginning of 2020 and I sincerely thank all our people, our partners and shareholding government Ministers for their support. The fact that we continue to be a robust and resilient organisation with a high level of staff engagement is testament to people working together within Manaaki Whenua – alongside our fellow Crown Research Institutes (CRIs) and other partners – and our unrelenting focus on our purpose and strategy.

While our thoughts are with those countries and people suffering greatly from the pandemic, in our relatively protected Aotearoa New Zealand we can learn from our own and others' experience. Three lessons are relevant to this organisation and the role it plays for Aotearoa New Zealand. First, we are reminded once again of the vulnerability of human populations to disruption in nature. Few of us predicted the scale of disruption from a global pandemic. In contrast, many have predicted the

scale of disruption from climate change, yet the speed of mitigation, preparation and adaptation remains painfully slow. Our national response to the pandemic has given us an unprecedented and unrepeatable opportunity to invest in the science that will support the social and economic recovery required to address the climate emergency.

Second, natural capital must be sustained and enhanced if our economy is to be sustained and grow. Our dependence on ecosystem processes demands that we understand the pressures on them, their state, and how we can respond effectively. Yet, as the Parliamentary Commissioner for the Environment has pointed out in recent reports, our investment in the necessary science and capability in this country is irregular and leaves serious gaps. This poses a significant systemic risk to our recovery, and ultimately our sustainability as a successful and prosperous economy.

Third, people are central to change and response, and yet the science of people's knowledge, behaviours, and


support needs is not well covered by research investment. Māori and Pacific cultures preserve many intimate links between people and the natural environment, yet even that traditional knowledge is at risk of being lost or of not being included alongside Western science.

In the past two decades Manaaki Whenua has worked to develop research capacity relevant to all these lessons. I am pleased to reflect the value of that work in this report, and see real value being achieved when the outcomes of our science are adopted by others.

We have increased the participation of Māori and strived towards partnership to protect their interests in te Ao Māori, the natural world of Māori that sustains us all. The increasing number of Māori staff at Manaaki Whenua and of our valued links with iwi and other Māori entities will help us to fulfil our side of the partnership in repairing, restoring and protecting the natural world, which in turn will support sustainable economic development in Aotearoa New Zealand.

During 2020 we have been pleased to work with Te Pae Kahurangi (the CRI Review) team and I thank them for their clear identification of the opportunities for CRIs and the wider science system. Establishing clear goals and strategies for national science, streamlining the investment process, and nurturing the research capability and infrastructure (including facilities, collections and database) are aspirations that we share.

In closing, I would like to particularly thank our Chief Executive, Richard Gordon, who this year celebrated 25 years with Manaaki Whenua, including almost 10 as CE. Richard's deep knowledge and understanding of the strategic issues facing Aotearoa New Zealand and ability to translate this into active and empathetic leadership have been instrumental in Manaaki Whenua's success. Finally, thank you to my incredibly capable and supportive directors – your wisdom, challenge and guidance have been most appreciated.



Jane Taylor – Chair
27 November 2020



A word from our CEO

This year we have seen again that disruption and adversity often bring out the best in people. With a few days' notice our people entered 'lockdown' and had to work entirely from home, if that were possible. There was a rush of innovation and adaptation! Teams that are spread across Aotearoa New Zealand started meeting together online, much more frequently than was ever possible in person. Our people also kept in touch and supported staff living alone, or with their own challenges.

Our researchers showed adaptability. Some quickly turned their ecological modelling skills to support the national effort to model Covid-19 and advise government on its policies. Some brought together environmental, economic and social research skills to show how multiple benefits could be achieved from Covid-recovery investment in infrastructure. Others worked tirelessly across CRIs and with MBIE to ensure we were sharing and implementing best practice: for example with health, safety and well-being, or with sustaining remuneration and jobs. The CRIs have identified areas where they will collectively contribute to the recovery.

The lesson has been reinforced for us that innovation, collaboration, and adaptability are needed to address the other major challenges that have not been locked down during this pandemic: the worsening impacts of climate change, the impacts of land use, and ongoing biodiversity loss.

Another lesson from the pandemic is that everything is connected in this world. Sustainable development (what some describe as achieving a restorative economy) depends upon the environment, on people and our institutions, and their interactions. This thinking led us to take another step towards integrating the UN's Sustainable Development Goals [SDGs] with our corporate strategy, which we describe in this report. The SDGs provide a comprehensive scorecard and targets, and while we have worked with internal and external stakeholders to identify the 12 SDGs most relevant to Manaaki Whenua, we continue to work on our target-setting.

In this report we consider the value of the SDGs, and gaps in them, when addressing indigenous peoples' interests, which are fundamental to our partnering with Māori. In Te Ao Māori everything living and inanimate

is connected through whakapapa [lineage]. In Manaaki Whenua we wish to bring that philosophy to enrich our use of the SDGs. To do this with integrity we will continue to build bridges between Western science and traditional indigenous knowledge, [mātauranga Māori], and between management and tikanga [the right ways].

Manaaki Whenua has performed well this year across a range of metrics. Our staff engagement scores were very high [81% in Manaaki Whenua and 87% in Toitū Envirocare], which was pleasing given the impacts of the pandemic. We continue to focus on many areas of well-being, gender equity, cultural balance and diversity, with progress being reported in these pages. Our science revenue has been sustained in the near term despite the pandemic, but challenges lie ahead in the next 2–5 years as we navigate changes in the national science investment strategy and some of our large programmes finishing.

Our subsidiary, Toitū Envirocare, and New Zealand's Biological Heritage National Science Challenge (which we host), are performing well, and in their own ways are changing the way we link science to impact for the benefit of society. Toitū enables hundreds of organisations to be recognised for their contribution to achieving the zero-carbon future of Aotearoa New Zealand.

I wish to acknowledge on her departure the very significant role played by Dr Andrea Byrom as the inaugural Director of the Bioheritage Challenge since 2015. Dr Byrom has driven high-impact research and greatly enhanced the engagement between science and Māori, while promoting equitable collaboration between organisations and kindness between people in science.

It would be wrong to suggest that our people have come through the pandemic unaffected, or that we will return to 'normal'. This year has been a period of heightened anxiety for many and actual loss for some – of a partner's job or the ability to visit family at times of crisis. I acknowledge the difficulties our people have faced and our thoughts are with those overseas who face worse problems. Looking ahead, future research investment may be at risk while governments worldwide address financial challenges.

On the positive side, in 'building back better' our business travel habits will change, reducing carbon emissions, costs and impacts on personal well-being. Manaaki Whenua has been certified carbon neutral since 2011, and our carbon intensity continues to decline. An important contribution we have made this year with the Aotearoa Circle was to develop a pathway for more landowners to be rewarded for capturing carbon in indigenous, not-for-harvest planting and regeneration. This paves the way for decarbonisation with ecological and social benefits, which is much in demand.

In closing, I thank you, the reader, as a stakeholder taking an interest or continuing to support our work to achieve positive impact. I wish to thank all our people in Manaaki Whenua for their dedication and skills. I thank our Board of Directors and their Advisory Panels for their valued guidance; and the Senior Leadership Team and our Wider Leadership Team, who lead Manaaki Whenua through changing times and for whom our Covid-19 response is another job, done well, on top of their day-jobs.



Richard Gordon – CEO
27 November 2020



Our purpose

We are an organisation of 441 scientists, researchers, and experts supporting science who are dedicated to helping New Zealanders understand and live well with our land.

Our purpose is Science for Our Land and Our Future
- Ko te pūtaiao mō tō tātou whenua, mō āpōpō.

We want to ensure all New Zealanders have the knowledge, understanding, and tools to live in harmony with our land by enjoying its many gifts, preserving its unique diversity, and enriching it with our creativity, care, 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.

Science for Our Land and Our Future

Ko te pūtaiao mō tō tātou whenua, mō āpōpō

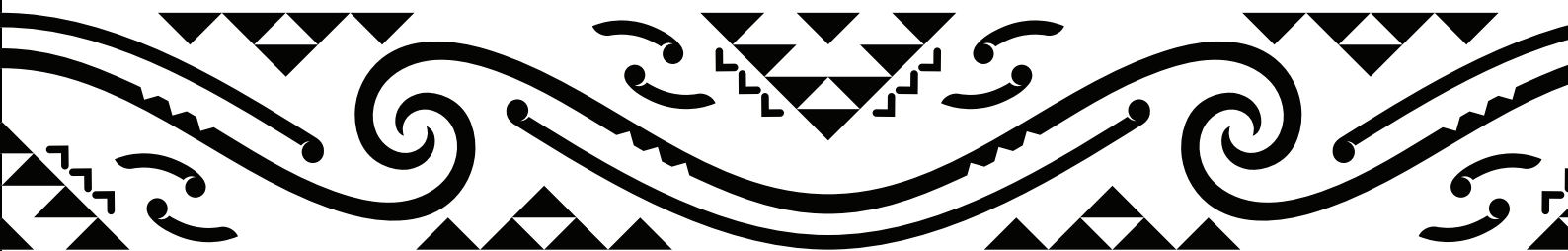


Our vision

Our vision is: Kia tupu matomato a Tāne, a Rongo, a Haumia-Tiketike - Let it be that the land and all its fruits may flourish. This vision acknowledges 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, 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.

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

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



Our values

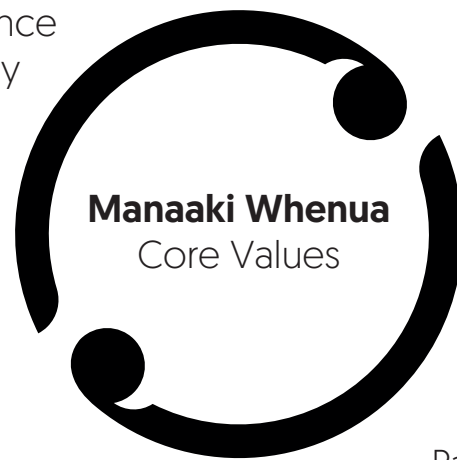
Our identity is underpinned by shared values we collectively cherish in each other. Science that delivers reflects our shared purpose, and our shared commitment to doing science and research that will result in practical solutions for New Zealand. As fascinating as much research can be, we value research 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.

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Science that delivers

Excellence
Relevance
Integrity



Caring
Partnering
Common Purpose

Manaaki Tangata

Our behaviours

A pillar of our 5-year strategy – Strategy 22 – is building an irresistible culture, a culture underpinned by our values that empowers us to create positive impacts for New Zealand's land environment. We have worked with our people to define our irresistible culture. Our five behaviours represent that culture in terms of everyday actions that we can observe and improve. They are an expression of our values in action and reflect our strategic priority to create impact through integrated and innovative research. Through the past year we have been progressing a culture programme designed to embed these five behaviours, build on our existing strengths, and develop other areas to ensure we have a resilient, empowering and ultimately irresistible culture at Manaaki Whenua.



Share freely & 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 te hē ka tika



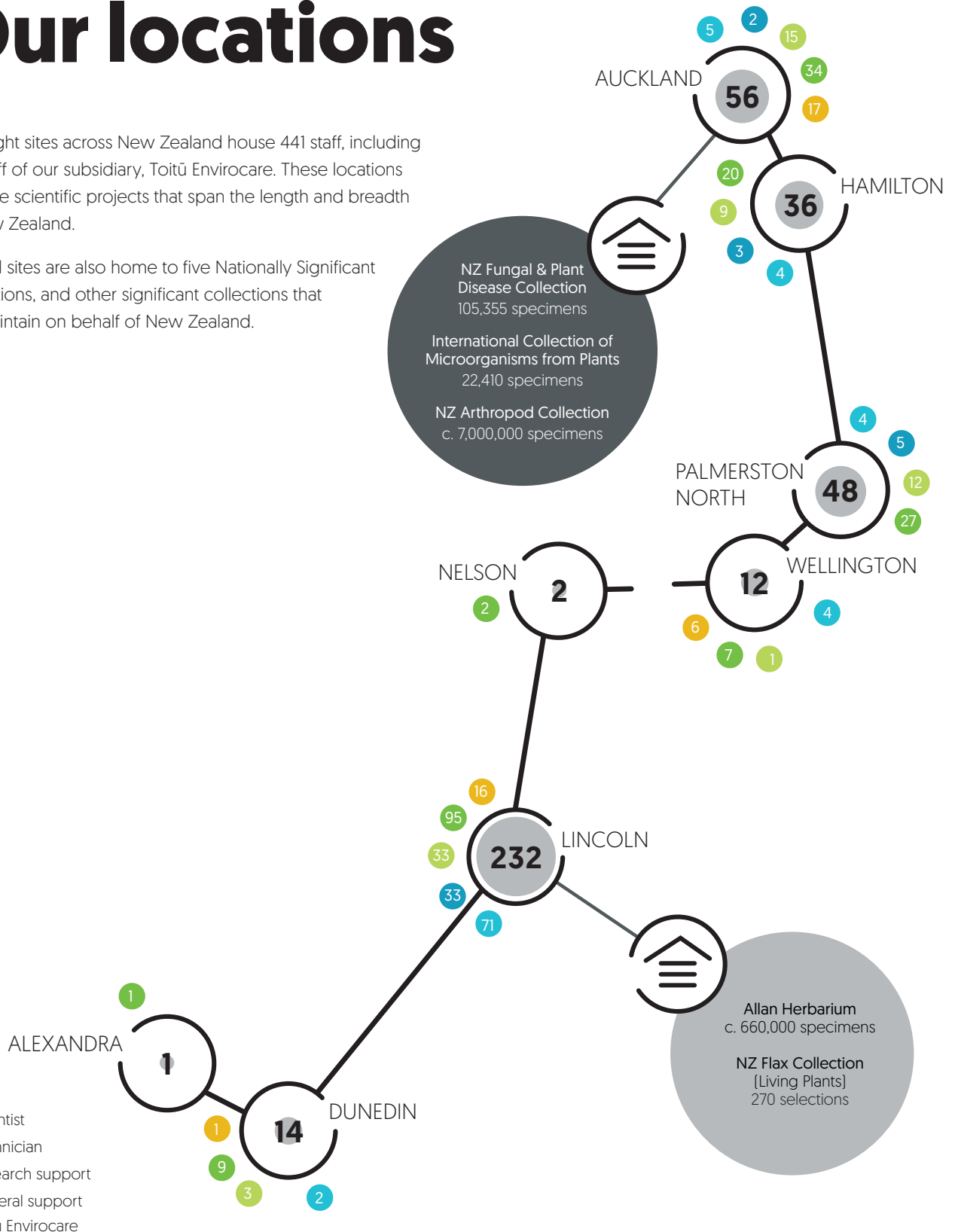
Embrace diversity

Awahi mai, awahi atu, tātou tātou e

Our locations

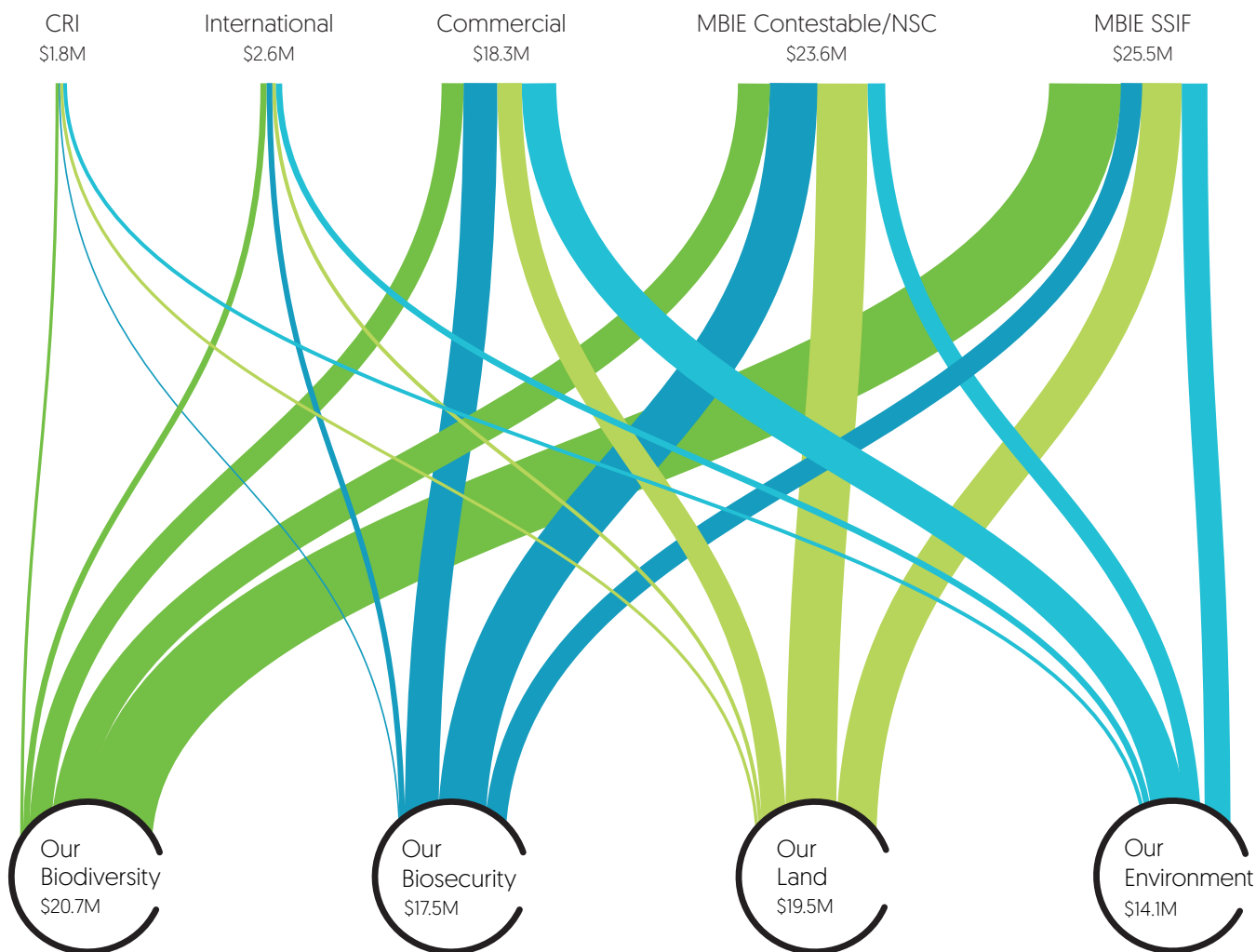
Our eight sites across New Zealand house 441 staff, including the staff of our subsidiary, Toitū Envirocare. These locations facilitate scientific projects that span the length and breadth of New Zealand.

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



Our investments in science impacts

Investment in our science, research, and technology comes from a variety of sources, including central and local government, industry, and international science collaborations. These investments power programmes across our four ambitions for New Zealand.

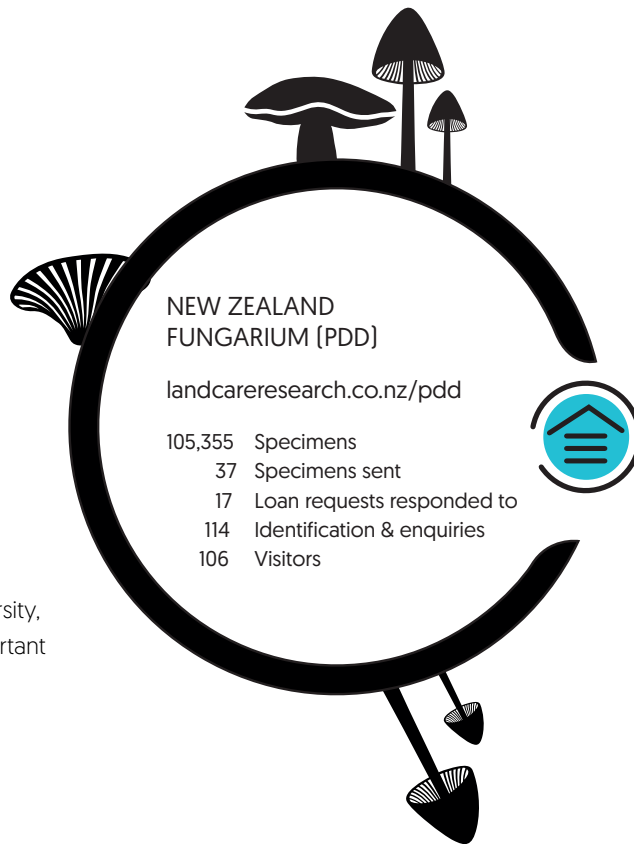


Note: this diagram shows provisional revenue amounts for 2019/20. Full audited revenue amounts are shown in Part 2 of the Annual Report.

Collections & 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.



* in scientific publications [based on Google Scholar].
^ courtesy of Google Analytics.





Nationally Significant Collection



Nationally Significant Database

NGĀ TIPU WHAKAORANGA DATABASE

maoriplantuse.landcareresearch.co.nz

114,689 Page views^
2,408 Database records
32,761 Visitors



INTERNATIONAL COLLECTION OF MICROORGANISMS FROM PLANTS (ICMP)

landcareresearch.co.nz/icmp

22,410 Cultures
154 Orders sent
1,012 Cultures sent
190 Identification & enquiries
106 Visitors
170 Specimens cited*



NATIONAL VEGETATION SURVEY DATABANK (NVS)

nvs.landcareresearch.co.nz

28,699 Page views
121,574 Plots
9,264 Datasets supplied
140 Data requests
604 Registered users
151 New datasets
1,522 Plots added



LAND RESOURCE INFORMATION SYSTEMS (LRIS)

Iris.scinfo.org.nz

158,500 Page views
7,500 Data downloads
10,927 Registered users
44,173 Visits/sessions



ALLAN HERBARIUM (CHR)

landcareresearch.co.nz/allanherbarium

c. 660,000 Specimens
2,544 Specimens sent
60 Loan requests responded to
552 Identification & enquiries
505 Visitors



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.

The science system within which we operate is increasingly complicated, with more entities focused on the 'wicked' problems the world faces. Manaaki Whenua navigates this complexity through collaboration and leadership. Like other research providers we face risks to our revenue from that complexity, and the fragmentation and lack of continuity that come with it.

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 international 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. In this Annual Report we also make explicit our contributions to the United Nations globally relevant Sustainable Development Goals.



The blue Entoloma mushroom [*Entoloma hochstetteri*], also known by the Māori name werewere-kōkako, from a story that the kōkako got its blue wattle from rubbing its cheek on the Entoloma.

New Zealand's science priorities

Manaaki Whenua supports the Government's commitment to an inclusive, sustainable, and productive New Zealand. In turn, our Minister, together with numerous government strategies and policy statements, provides us with guidance on New Zealand'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, in collaboration with appropriate organisations, iwi, agencies, and departments. These alignments are described in more detail in our annual Statement of Corporate Intent.

In 2019/20 we contributed significantly to three overarching priorities for the Government that were expressed in our shareholding Minister's Letter of Expectation, as follows.

Higher-value products from the land:

We work with other CRIs to provide farmers with the tools and knowledge they need to ensure credibility and transparency in their environmental performance; to improve the management of water, nutrients, and greenhouse gas emissions; and to explore future uses for Māori-owned land. We also contribute directly to

the maintenance of biosecurity and the preservation of our biodiversity, in both the agricultural and conservation/tourism sectors. This includes supporting the Government's Biosecurity 2025 strategy and Te Mana o te Taiao: Aotearoa New Zealand Biodiversity Strategy 2020.

A healthy environment:

We are a major contributor to the Our Land & Water National Science Challenge, our S-map (digital soil map) database supports the Overseer model for nutrient management, and nationally we lead work on understanding and preventing soil erosion.

Our social scientists have developed new knowledge, tools, and approaches, including cultural tools, to better understand how biodiversity and ecosystem services affect human well-being, and how human activities affect biodiversity and modify ecosystems, which helps land managers make more informed natural resource management decisions.

We are helping to evaluate the relevance and scientific underpinning of regenerative agriculture in New Zealand, and support the Ministry for Primary Industries' 'Fit for a Better World' and 'Te Taiao' initiatives, which have strong sustainability themes and Māori engagement.

Low-carbon economy:

We provide scientific leadership in both greenhouse gas emissions and soil carbon inventory and management, supporting New Zealand's transition to a low-carbon economy outlined in the November 2019 Climate Change Response [Zero Carbon] Amendment Act, and assisting in meeting our international obligations under the Paris Agreement.

Our subsidiary, Toitū Envirocare, is a lead contributor in our efforts towards this goal, working in a very practical way with several hundred New Zealand organisations to achieve low-carbon goals.

We also work collaboratively with the other Crown Research Institutes and the Ministry of Foreign Affairs and Trade on climate action for Pacific Island countries.

Stakeholder input

To more deeply understand the needs of partners, 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 and stakeholders. Our target is to engage more research partners in joined-up efforts of this nature.

Our Board's **Outcome Advisory Panel** (OAP) consists of senior representatives from our Treaty partners, stakeholder organisations in central and local government, iwi, the food and fibre industry, and business. The Panel is a key mechanism for ensuring our science direction is responsive to the needs of our major sector partners. The Panel meets with our Senior Leadership Team with the goal of exploring and clarifying the needs of the primary sector, and provides high-level strategic advice to our Board of Directors. This forum has proven invaluable, as discussion with a group of sector leaders allows us to explore emerging priorities, challenges, and opportunities in great detail.

During the past year two forums have been convened. The theme of the first meeting was an exploration of the UN Sustainable Development Goals (SDGs) in the context of our current work programme for both corporate and science areas. The meeting was preceded by a short-structured

interview with the OAP members to explore questions relating to both their understanding of and involvement with the SDGs. This also involved seeking their views on which SDGs they feel are most important to Manaaki Whenua. The second meeting was held on-line due to Covid-19, with the theme unsurprisingly being a discussion on the challenges and opportunities of the pandemic.

Five areas were explored, which Manaaki Whenua staff will now consider in our approach to strategic research.

1. Data/monitoring
2. Economy - the intersect of tourism, biodiversity, and provenance
3. Interconnected world - climate smart, resilient and sustainable landscapes
4. Behaviours
5. Thought leadership.

The online format enabled greater participation across the members than at a number of previous meetings. Consideration is now being given to using this and in-person meetings to greater effect for the OAP.

Outcome Advisory Panel

Rob Phillips – Environment Southland
Martin Kessick – DOC
Karen Adair – MPI
Katy Bluett – Callaghan Innovation
Jamie Tuuta – Tourism NZ
David McCall – Dairy NZ
Sam McIvor – Beef + Lamb NZ
Warwick Tauwhare-George
– Parininihi ki Waitotara
Natasha Lewis – MfE

Our **Science Advisory Panel** brings an international scientific perspective, helping us evaluate our scientific excellence, explore emerging science needs, and develop research areas, both from a New Zealand perspective and an international science sector perspective. In November 2019 this panel conducted a science review for our biodiversity and biosecurity research. They concluded that overall we are a national research leader with an international reputation, with our science quality remaining very high and delivering numerous impacts. In November 2020 they will review our land and environment research, in both cases reporting to the Board of Manaaki Whenua.

Science Advisory Panel

Prof Jason Tylianakis (Chair), University of Canterbury (NZ)
Dr Simon Lambert (Tūhoe and Ngāti Ruapani), University of Saskatchewan.
Dr Susan Hubbard, Lawrence Berkeley National Laboratory and University of California, Berkeley, USA.
Prof Brajesh Singh, University of Western Sydney, Australia.
Dr Jenny Webster-Brown (AgResearch), Director of the Our Land & Water National Science Challenge.
Prof Jan Bebbington, University of Birmingham.

Partnering for impact across research horizons

New Zealand faces many environmental issues that need an integrated research approach across scientific disciplines, world views, users, and producers of knowledge and tools. As a result, science has become more collaborative, both nationally and internationally.

In the table to the right we provide examples of the different partners we work with across three distinct research 'horizons'. Together, these make up a knowledge value chain.

Horizon 3 is fundamental, underpinning research that develops new knowledge and understanding of systems and processes.

Horizon 2 converts this fundamental knowledge into designing responses to environmental pressure, developing ways of working across groups in society, in close collaboration with partners such as policy agencies, local government, iwi, and the primary sector.

Horizon 1 consists of highly applied work and tools from research, and partners in this space tend to be practitioners – for example, conservation groups using traps, farmer advisors using S-map, and biosecurity border control using our gene sequencing for identification of pest incursions.

To ensure science for impact, we lead, bring together, contribute to, and engage with the right team for the job across the three research horizons. In many areas we work right across the complete knowledge value chain, innovating, creating knowledge with others, and then applying that knowledge.

Beyond collaboration, strategic partnerships enable us to combine our strengths with the complementary strengths of our partners.

RESEARCH HORIZON

Horizon 1

APPLIED RESEARCH



- Creating tools from research for practical action
- Valued by practitioners in everyday situations

EXAMPLES OF PARTNERS AT EACH STAGE

Treaty partners: iwi, Māori entities
Department of Conservation
Non-governmental organisations (e.g. Predator Free 2050)
Regional and local councils
Community partnerships (e.g. Cape 2 City)
Agritech businesses
MPI

EXAMPLES OF OUR RESEARCH

Biodiversity: Rats with chips (page 32), Pacific Seeds for Life (page 34)
Land: LCDB (page 44), Sharing our knowledge abroad (page 46), Building whakawhanaungatanga (page 47), GIS for Māori land managers (page 47)
Environment: National environmental reporting (page 51)

Horizon 2

DEVELOPING RESEARCH IDEAS



- Converting fundamental knowledge of ecosystems and social processes into workable, real-world solutions
- Designing responses to environmental pressures
- Developing ways of working across groups in society

Treaty partners: iwi, Māori entities
National Science Challenges
MBIE
MfE
MPI
Regional councils

Biodiversity: Fungi and the IUCN (page 33)
Biosecurity: Most-wanted predator's DNA sequenced (page 40), Beyond Myrtle Rust (page 39)
Land: S-map, Regen Ag (both page 45)
Environment: Tracking climate change awareness (page 50), Decision-making in freshwater management (page 50), A new national soil carbon monitoring system (page 52)

Horizon 3

FUNDAMENTAL RESEARCH



- Developing new knowledge
- Systems understanding
- Working from micro to national scales

Universities
Other Crown Research Institutes
National Science Challenges
International research institutes (e.g. Wageningen, Netherlands; Lawrence Berkeley National Laboratory, California; INRAE, France)

Biodiversity: Kiwi microbiome (page 35)
Biosecurity: Eradicating the last 5% (page 38)

Our alignment with an international sustainability framework

The UN Sustainable Development Goals

As a signatory to the United Nations Sustainable Development Goals (SDGs), New Zealand reports on its progress towards meeting each of the 17 goals. As the Crown Research Institute for our biodiversity and land environment, Manaaki Whenua directly contributes to this country's responses and responsibilities. Since their release in 2015 the SDGs have provided an internationally accepted and comprehensive framework for sustainable development to be used by governments and organisations. Under the 17 SDGs sit 69 targets and 247 performance indicators.

In April 2019 we engaged our subsidiary, Toitū Envirocare, to evaluate the SDGs as a framework for revising Manaaki Whenua's sustainability policy. We also wished to explore the alignment of our strategic plan (Strategy 22) with the SDGs, and consider the relevance of the SDGs to our responsibilities under Te Tiriti o Waitangi (Treaty of Waitangi) as a partner to Māori. The last of these objectives is a work-in-progress for us.

The process has included a materiality evaluation, in which 32 internal and external stakeholders rated the 17 SDGs for their relevance (or materiality) to Manaaki Whenua's activities. Our process involved surveying and interviewing members of our partner groups, and also our own people (internal stakeholders), and holding a workshop to discuss the results.

In the prioritised (material) list of 12 SDGs generated by that process, each SDG aligned to either the outcomes of our research and science, or to our culture and 'ways of working' as an organisation, or to both. In this report we describe how we contribute to delivering the 12 material SDGs and the targets relating to them in the UN's framework. Six of these SDGs relate to our science, and six to our strategy as an organisation.

We also aligned our new sustainability policy with the SDGs. For each material SDG we developed a policy commitment. Some of the SDGs' targets are more relevant to governments than to a research institute, and in these cases we decided they were out of scope for our work. Examples of these include matters of trade, social policy and financial policy.

**SUSTAINABLE
DEVELOPMENT
GOALS**

Policy and outcomes

The results of this process have enabled us to rewrite our sustainability policy and align that and our research and science outcomes to the SDG framework with some confidence. Matrix I, page 25, summarises this alignment by showing the wording of the material SDG and its relevant targets alongside our new policy commitment and the relevant Ambition. Our activities as an organisation also contribute to the SDGs through our organisational culture and the ways in which we work. Matrix II, page 56, summarises that alignment in the same way as Matrix I. Our process for target-setting includes development of Key Performance Indicators (KPIs) for our operational activities - a work in progress.

Our target-setting for research and science aggregates the goals of several hundred individual projects into a set of major outcomes (Our Ambitions) with measurable benefit for Aotearoa New Zealand. This benefit is called the 'impact of science' and it can be difficult to establish precise goals, outcomes and attribution, because achieving impact involves many people, organisations, priorities, timelines, funding and individual projects. We are working collectively with our CRI colleagues and MBIE to achieve greater clarity for the target-setting and measurement of impact, which is a challenge for science globally.

Te Ao Māori and the SDGs

Throughout this report we refer to our relationship with Māori, who are the indigenous people of Aotearoa New Zealand. As a Crown Research Institute we work with Māori as a partner and seek to uphold the principles of Te Tiriti o Waitangi (The Treaty of Waitangi). These are summarised as partnership, participation, and active protection. Each principle has special significance to the work we do and how we do it together.

We recognise synergy between the principles of SDGs and Māori thinking, such as the interwoven nature of manaaki whenua – manaaki tangata (caring for the land and the people for both to prosper). For example, our work towards SDG15 (Life on Land) has a special significance for Māori because their world-view connects people very closely to all elements of the environment.

Furthermore, SDG16 talks of promoting inclusive societies, and our work aims to help Māori engage as a partner in governance processes that determine matters related to the environment. SDG17 talks of partnership for achieving the SDGs, which resonates with the goal of partnership with Māori and also Māori themselves working closely with indigenous peoples in other countries.

However, the SDGs leave a gap for greater integration with indigenous peoples' interests, as we discuss on page 24. This aspect of our alignment with the SDGs and our interpretation of them for the benefit of Māori is work-in-progress for us. It is likely to lead to further evolution of our sustainability policy, which we will report on next year.

**Ko tā Manaaki Whenua he whakatūturu
i te Tiriti o Waitangi me ōna mātāpono
– koirā te tūāpapa e inehia ai ngā
Whāinga Toitū Whakawhanake nei.**

**Manaaki Whenua affirms the
Treaty principles as the foundation
upon which the Sustainable
Development Goals will be measured.**

Indigenous peoples and the SDGs

Indigenous peoples have struggled to see themselves reflected in the SDGs, with few of the 230 indicators mentioning indigenous interests. The SDGs' notion of well-being fails to acknowledge that, for indigenous peoples, land isn't simply a means of production; it is a fundamental expression of cultural and collective identity.

In a similar vein the UN Permanent Forum on Indigenous Peoples (the Forum) warns that the SDGs pose risks for indigenous interests – for example, where clean energy projects encroach on indigenous lands and territories. For all these reasons the Forum recommended that the SDGs should have regard to the United Nations Declaration on the Rights of Indigenous Peoples, and that any programmes implemented under them should be: “culturally sensitive and respect Indigenous Peoples’ rights to self-determination as well as collective rights in terms of land, health, education, culture and ways of living”.

So if the SDGs are, in effect, subject to indigenous rights to self-determination and collective interests in relation to environmental resources, then how should we apply them in Aotearoa New Zealand? The answer is both simple and, at the same time, complex. Let's explore a simple example.

The indigenous Māori right to self-determination is largely captured in the 1840 Tiriti o Waitangi [Treaty of Waitangi] Article II concept of tino rangatiratanga. The Courts of Law have said that this right implies a duty on the Crown, as a signatory to the Treaty, when exercising its powers, to keep in mind three 'principles' with respect to indigenous interests. These are the principles of partnership, participation and active protection.

For example, Manaaki Whenua is using the SDG's Goal #15 'Life on Land' to help set targets for indigenous biodiversity research in Aotearoa. The Treaty principles would suggest that we should do the science and research in a way that [1] engages with Māori in the spirit of partnership, [2] creates a space for genuine participation in the conversation about research, including Māori research, on indigenous biodiversity and [3] actively protects Māori interests in indigenous biodiversity.

Does Manaaki Whenua have the capacity for this Treaty-based approach? Mā te wā ka kitea – time will tell. We seek to uphold the principles of the Treaty and are committed to growing that capacity in Manaaki Whenua. This means having both more Māori researchers in Manaaki Whenua and more non-Māori staff being confident to work with Māori in observing the Treaty's principles [see relevant statistics on pages 66–67]. It also means seeing the commitment fulfilled through governance and management of Manaaki Whenua.



Holden Hohaia
GM Māori Partnerships

Our science and the SDGs

Matrix I: This table outlines the six SDGs identified as material to our research priorities.



Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.



Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Relevant targets from SDG 14 and 15

[From SDG 14]

- 14.1 Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.

[From SDG 15]

- 15.1 Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.
- 15.2 Promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally.
- 15.3 Combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.
- 15.4 Ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.
- 15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.
- 15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed.
- 15.8 Introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species.
- 15.9 Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.

Manaaki Whenua will

Empower stakeholders to: conserve, restore and protect land-based ecosystems, soils and their services; reverse the decline of indigenous biodiversity and natural habitats; reduce the impact of invasive species; develop the sustainable use of land resources; and develop equitable policies through partnership.

Alignment with our science ambitions

OUR BIODIVERSITY, OUR BIOSECURITY & OUR LAND

Read more

More Birds in the Bush
[page 32]

Fungi and the IUCN
[page 33]

Pacific Seeds for Life
[page 34]

Kiwi microbiome
[page 35]

Eradication science
[page 38]

Beyond Myrtle Rust
[page 39]

Stoat genome sequenced
[page 40]

LCDB [page 44]

Freshwater management decision-making
[page 50]

National environmental reporting [page 51]

UN Sustainable Development Goal



End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.

Relevant targets from SDG 2

- 2.2 Double the proportion of productive land under sustainable management strategies.
- 2.5 By 2020 maintain genetic diversity and curation of seeds, cultivated plants and related wild species, and traditional knowledge, with equitable benefit sharing.

Manaaki Whenua will

Inform the development of food production systems that enhance soil, land, water, and ecosystem services, and ensure climate change adaptability, while working especially with Māori in Aotearoa New Zealand and indigenous peoples in Pacific nations.

Alignment with our science ambitions

OUR LAND

Read more

Our collections [pages 14–15]
Pacific Seeds for Life [page 34]
LCDB [page 44]
S-map [page 45]
Science for regen ag [page 45]



Ensure availability and sustainable management of water and sanitation for all.

Relevant targets from SDG 6

- 6.6 By 2020 protect and restore water-related ecosystems (indicator = extent of such systems).
- 6.b Strengthen participation of local communities in improving water management (indicator = proportion of local authority areas with operational procedures).

Manaaki Whenua will

Guide the use of land in ways that improve freshwater quality, enhance water-use efficiency, protect and restore water-based ecosystem services, and support integrated catchment-based governance and management.

Alignment with our science ambitions

OUR LAND

Read more

The BEST programme [page 47]
Freshwater management decision-making [page 50]



Ensure availability and sustainable management of water and sanitation for all.

Relevant targets from SDG 11

- 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage.
- 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels.

Manaaki Whenua will

Inform the development of integrated policies and planning that enhance resource-use efficiency, ecosystem services, climate change mitigation and adaptation, resilience to natural disasters, and inclusive governance processes, while decoupling waste from growth.

Alignment with our science ambitions

OUR ENVIRONMENT

Read more

GIS for Māori land managers [page 47]
Our Covid responses [pages 82-83]



Take urgent action to combat climate change and impacts.

Relevant targets from SDG 13

- 13.2 Integrate climate change measures into national policies, strategies and planning.
- 13.3. Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.
- 13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities.

Manaaki Whenua will

Empower organisations, sectors and the nation to measure, manage, reduce and mitigate their greenhouse gas emissions; understand climate risk and increase resilience; create opportunities, and develop policies and plans that integrate social, economic, cultural and environmental dimensions.

Alignment with our science ambitions

OUR ENVIRONMENT

Read more

Pacific Soils Portal (page 46)
Survey of Rural Decision-Makers (page 50)
Soil carbon network (page 52)
N₂O and CH₄ emissions (page 52)
Toitū (page 53)



Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable and inclusive institutions at all levels.

Relevant targets from SDG 16

- 16.7 Ensure responsive, inclusive, participatory and representative decision-making at all levels.
- 16.b Promote and enforce non-discriminatory laws and policies for sustainable development.

Manaaki Whenua will

In achieving Our Ambitions, we will support the development of responsive, inclusive, participatory and representative decision-making and governance by our stakeholders and the Treaty Partner. Māori.

Alignment with our science ambitions

OUR ENVIRONMENT

Read more

First Māori edition of *NZ Journal of Ecology* (page 34)
Connecting New Zealanders to their environmental land information (pages 44–47)
The BEST programme (page 47)
New Zealand Garden Bird Survey (page 79)

Our science ambitions for New Zealand

Delivering on our core purpose requires exceptional science and research, spanning 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 general managers and research leaders have developed a science strategy using a logic model framework. This strategy creates a direct line from a research project, right through to our four ambitions. Every year we review our seven research portfolio plans and priorities using this strategy document. By considering the needs of our end-users and New Zealand, we are able to refine our research priorities, ensuring they are fit-for-purpose.

On the following pages we present brief highlights of our science and research in support of each of our four ambitions, together with a series of more detailed 'innovation stories'. Each story also demonstrates our contribution to the UN Sustainable Development Goals.

4

Ambitious Goals

- Our Biodiversity
- Our Biosecurity
- Our Land
- Our Environment



The nationally endangered tautuku gecko (*Mokopirirakau* 'southern forest') is native to parts of the southern coasts of Otago and Southland.
Image: Samuel Purdie

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 [see pages 14-15], 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 [DOC], the Ministry for Primary Industries [MPI], 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.

RELEVANT SDGs



SDG 15: Our materiality analysis showed that our research under this science ambition is most closely aligned with UN Sustainable Development Goal 15: Life on Land.

Our contribution to this goal is to empower stakeholders to conserve, restore, and protect land-based ecosystems, soils, and their services; reverse the decline of indigenous biodiversity and natural habitats; reduce the impact of invasive species; develop the sustainable use of land resources; and develop equitable policies through partnership.



Innovation stories

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



Mycologist Dr Peter Buchanan inspects a specimen of *Hygrocybe rubrocarnosa*.

Rats with chips: how microchipped rats are helping scientists to protect our native birds

Some of the highest rat densities ever measured on the New Zealand mainland are being recorded in a study run by Manaaki Whenua at Lake Alabaster in Fiordland as part of the 5-year 'More Birds in the Bush' MBIE Endeavour research programme. The study, carried out in collaboration with DOC, is showing the remarkable ability of rats to multiply rapidly following beech seeding, such as the 'mega-mast' (mass seeding event) that occurred in 2019.

Cost-effective pest management relies on knowing where and when pest numbers are high so that management can be focused in the right place at the right time. Understanding how altitude and food availability regulate rat numbers should give conservationists the edge in protecting wildlife from rat plagues, which can lead to localised extinctions of native wildlife.

To tease out these factors, the researchers have been intensively monitoring rat population dynamics at both high and low elevations in forested areas near the lake.

Since the study began 14 months ago, 912 individual rats have been live-captured and given a microchip and a metal tag in their ear before being released. Rats at high elevation are also being fed to see whether they can survive cold temperatures when they have sufficient food.

The preliminary results have been startling. Following the beech seed mast in 2019 the population density at Lake Alabaster reached a phenomenal 17 rats per hectare. This is one of the highest rat densities ever measured on the New Zealand mainland and reflects the incredible ability of rats to multiply rapidly following beech seeding.

Although food helped sustain the rats through the autumn, during the winter the rats being fed declined as

much as the rats that were not fed. This suggests that another factor – perhaps temperature or predation by stoats – is limiting rats. Once this is known, it should be possible to create a 'weather forecast' about likely rat numbers for conservation managers, which will involve making predictions about rat numbers based on the climate and forest at a specific site. In turn, this will allow rat control to be done as effectively as possible, resulting in more birds in the bush.



Rat in a live capture trap, Lake Alabaster, Fiordland.

International recognition for New Zealand's endangered fungi

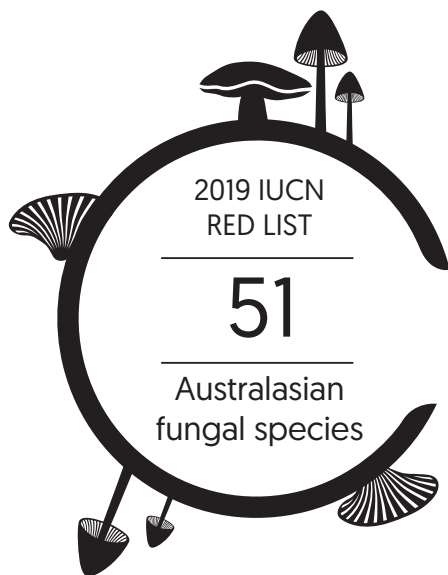
Established in 1964, the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (www.iucnredlist.org) is a critical indicator of the health of the world's biodiversity and the world's most comprehensive information source on the global conservation status of animal, fungus, and plant species.

However, until recently very few fungi had been assessed for their likely Red List status. Despite being the second largest kingdom of multicellular life, fungi were represented in the November 2009 edition of the list by only three species worldwide, along with 17,288 species of animals and plants. Dr Peter Buchanan and Dr Jerry Cooper at Manaaki Whenua have addressed this

gap for New Zealand's fungi, drawing on the expertise of staff at our nationally significant New Zealand Fungarium in Auckland.

Following an IUCN Red List workshop in July 2019 in Melbourne, 51 assessments of Australasian fungal species were finalised to IUCN Red List standards by the end of 2019, and 30 of these were from New Zealand. Of the 51, three species were formally Red Listed by IUCN as Critically Endangered, twelve as Endangered, nine as Vulnerable, and six as Near Threatened; seven were designated as Least Concern, and fourteen as Data Deficient. Progress has also been made on assessments for another 33 species – vastly increasing the knowledge and understanding of our rarest fungi.

Inclusion on the Red List doesn't confer legal protection, but the data included in each listing provide information about range, population size, habitat and ecology, use and trade, threats, and conservation actions to help inform necessary conservation and policy decisions.



Tea tree fingers (*Hypocreopsis amplexens*) – a critically endangered fungus.



Deconica baylisiana (the alpine pouch).

A research partnership gives rise to a special mātauranga Māori journal issue



NZ *Journal of Ecology* special issue cover, 'Mātauranga Māori and shaping ecological futures'.

During the year researchers at Manaaki Whenua contributed to the first special issue of the *New Zealand Journal of Ecology*, focusing on mātauranga Māori [Māori knowledge].

There is increasing recognition that mātauranga Māori and working with Māori communities enhance our understanding of ecology and provide valuable perspectives and frameworks to guide research, management, and policy development. The special issue included an editorial and 13 papers from across New Zealand, with a focus on how mātauranga Māori informs current and future research and decision-making in ecology. A key theme was discussion on what constitutes a good partnership, which is an important shift from past discussions that have focused on the requirement to partner with Māori communities.

Manaaki Whenua researchers contributed at least three papers as first authors to the journal, with Dr Priscilla Wehi as guest editor. The papers spanned hangarau pūtaiao [technological science] and the development of a mātauranga pūtaiao mobile application; use of te reo and mātauranga Māori in taxonomy; and the use of Māori species names in scientific communication and reporting. Behind the scenes, the special issue arose in part because of our partnership with the University of Auckland's Centre for Biodiversity and Biosecurity's Joint Graduate School, through which the necessary collaborations and connections between researchers were made.

Pacific Seeds for Life

In March 2020 the New Zealand and Australian governments approved funding for the Pacific Seeds for Life [PS4L] project, in partnership with the

Pacific Community [SPC] Land Resources Division. Both Australia and New Zealand are members of the SPC.

The project, which will run for 5 years, aims to build a resilient seed system – a diverse portfolio of high-quality plant genetic resources that is available at all times for farmers and growers.

This work is crucial to ensure sustainable food production in the face of natural disasters and climate change, and to improve the health of Pacific people by broadening their crop diversity.

Manaaki Whenua's role in the project is to offer technical support for the Centre for Pacific Crops and Trees, which houses the Pacific Seeds Bank for clonal crop varieties in the Pacific (yam, taro, sweet potato, banana, and breadfruit, among others). Our work includes virus-indexing their live collections to ensure they are clean before splitting and distribution to Pacific countries.



Breadfruit, one of the crop species held by the Pacific Seeds Bank.

Gut flora could hold key to kiwi survival

Brown kiwi (*Apteryx mantelli*) are highly vulnerable to extinction in the wild, with populations currently in serious decline. Even though ongoing conservation efforts such as Operation Nest Egg have increased their survival rate, the stress of captivity and the high density of chicks co-habiting still puts them at risk of disease, especially from the potentially lethal coccidia parasite.

Dr Manpreet Dhama and other Manaaki Whenua researchers are tracking over 40 birds through different life stages at the National Kiwi Hatchery Aotearoa in Rotorua by monitoring their faeces.

The aim is to build a deeper understanding of the biology and physiology of kiwi living in captivity in order to understand how the captive environment is shaping the microbial communities in the gut of the kiwi. The research will guide best practice for looking after kiwi in captive breeding programmes across Aotearoa and around the world.

The research is funded by the Strategic Science Investment Fund (SSIF), with supplementary funding from the Ornithological Society of New Zealand. The National Kiwi Hatchery is owned by Ngāi Tahu Tourism.



Dr Manpreet Dhama and colleagues at the National Kiwi Hatchery in Rotorua.



Raw materials for research into the kiwi gut microbiome.

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 spans the development of novel pest control tools, understanding predator behaviours to maximise interaction with those tools, and 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 control

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. This work 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.

Diseases, 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 are currently leading research on myrtle rust in New Zealand under the Beyond Myrtle Rust programme. We work with many other groups on border security for early detection and prevention, and to improve control methods for established invasive species.

RELEVANT SDGs



SDG 15: Our contribution to this goal is to empower stakeholders to: conserve, restore, and protect land-based ecosystems, soils and their services; reverse the decline of indigenous biodiversity and natural habitats; reduce the impact of invasive species; develop the sustainable use of land resources; and develop equitable policies through partnership.



Innovation stories

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

Science technician Morgan Coleman collects leaf fall for research being conducted on Department of Conservation land at Elsthorpe Bush, Hawke's Bay, as part of the Predator Free Hawke's Bay programme.

Eradicating the last 5%

New Zealand is a world leader in controlling and, in some areas, eradicating invasive mammalian predators. Much of that innovation has been in developing and deploying devices [e.g. traps, bait delivery], but those devices can only achieve complete eradication if all individuals in the target population interact with them – and we know that some don't.

Predator control routinely removes approximately 95% of a target population. However, New Zealand's Predator Free 2050 initiative requires scientific breakthroughs to achieve 100% eradication of rats, mustelids, and possums.

While 95% eradication typically cost \$20–\$30 per hectare, 100% costs over \$400 [e.g. pest eradication from Rangitoto and Motutapu Islands cost \$1,200 per hectare]. The prohibitive cost of eradicating the last 5% using current technology is a barrier to New Zealand achieving our Predator Free 2050 eradication goal.

As well as being hugely expensive to remove the last 5% in a pest population, survivors remaining in an area with plentiful resources are likely to breed successfully and at close to their maximum rates, meaning that they act as a source for rapid population growth and expansion. This, in turn, means that more money has to be spent on controlling them, and so the cycle of control continues.

The 5-year MBIE programme 'Eradication Science', which began in October 2019, is focused on the careful study of behaviours among pest populations to

offer solutions to these problems. The fundamental questions addressed by the programme are:

- what makes survivor individuals survive control?
- do they have predictable behavioural characteristics [why do these animals not take baits or enter traps when 95% of their species do]?
- how can we manipulate those behaviours using novel cues or combinations of cues to overcome survival behaviours?

The research now underway will enable land managers to achieve eradication cost-effectively, rather than the current paradigm of sustained [costly] predator control. Unlike sustained control, the environmental benefits of eradication continue in perpetuity. By negating the need for ongoing control, eradication will also dramatically reduce the need for repeated applications of toxins. We believe we can reduce the cost of eradication by at least 25%, as fewer control devices would be used due to increased device encounter rates, and



Ngā Manu Images

We aim to establish what enables some pest animals to survive controls.

shorter times would be needed due to increased device interaction rates.

Our collaboration with Māori and Moriori partners will ensure that our research responds to their priorities – a first for predator tools research in New Zealand – and that any approaches we develop are culturally relevant and appropriate for use on the whenua.

Beyond Myrtle Rust – complex responses needed to solve complex problems

Collaboration and communication are the key to success in solving some of our most complex environmental problems. The Beyond Myrtle Rust (BMR) programme, a 5-year effort funded by MBIE and hosted by Manaaki Whenua, is pulling together multiple experts from several institutions while working with stakeholders and iwi to tackle a disease that threatens some of our most iconic native trees.

First detected in New Zealand in 2017, the wind-blown fungal pathogen that causes myrtle rust, *Austropuccinia psidii*, is now well established here. The disease threatens many ecologically, culturally, and economically important species in the Myrtaceae family, such as pōhutukawa and mānuka.

BMR is a wide-ranging research effort to improve our understanding of the pathogen itself, examine the ecosystem impacts of myrtle rust, look for control tools, and collaborate with iwi to build capacity and facilitate Māori leadership for myrtle rust management. The programme is now in its second year



An active myrtle rust infection



Dr Mahajabean Padamsee inspects a leaf for signs of myrtle rust during a field trip to Taranaki.

and already at least 20 Manaaki Whenua staff have contributed to it. A recent site-scoping field trip to two of Auckland's regional parks – Tāwharanui and Shakespear – was a joint effort by Manaaki Whenua, Auckland University, Auckland Council, and local iwi Ngāti Manuhiri.

These efforts have been complemented by those of scientists from two other Crown Research Institutes [Plant & Food and Scion] and four New Zealand educational institutions [Auckland University, Unitec, Lincoln University, and Canterbury University]. The programme also has a research leader based at the University of Queensland and draws on scientific expertise from other collaborators in Australia, where myrtle rust has a longer history. Myrtle rust research is also taking place through the New Zealand's Biological Heritage Ngā Rākau Taketake programme [focused on kauri dieback and myrtle rust].

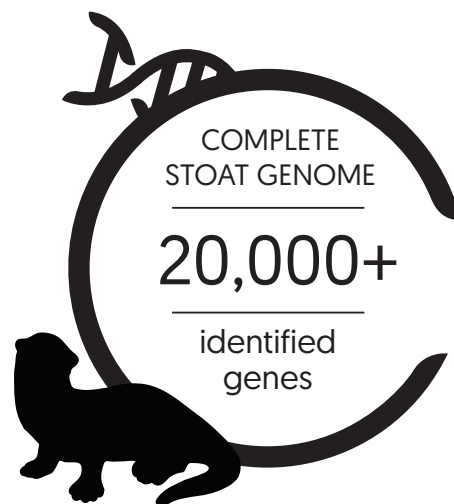
Keeping communications flowing in such a complex programme requires strong information sharing and co-planning. An advisory group, including representatives from government agencies, iwi, and industry, is kept informed and provides guidance. Regular communications with iwi ensure they have up-to-date information on the disease and programme operations in their rohe, as well as opportunities to participate directly in the programme.

Most-wanted predator's DNA sequenced

Assembled by teams of New Zealand scientists working with international collaborators, the complete genome of the stoat (*Mustela erminea*) is now available to researchers at the US-based National Center for Biotechnology Information genome database, hard on the heels of the ship rat genome.

The genome sequencing of the stoat was led by Dr Andrew Veale at Manaaki Whenua. The project was co-funded by New Zealand's Biological Heritage Science Challenge and by Predator Free 2050 as part of its Science Strategy, and involved collaboration with scientists from the Vertebrate Genome Project based at The Rockefeller Institute and the Wellcome Sanger Institute.

The assembled stoat genome is over 2.4 billion DNA bases long, with over 20,000 identified protein-coding genes. This new genome is one of the



highest-quality vertebrate genomes ever produced, with nearly gapless complete chromosomes assembled and annotated.

The underpinning data provided by the genome will be invaluable in helping to achieve predator-free status for New Zealand; for example, by enabling the development of stoat-specific toxins.



The stoat (*Mustela erminea*) is one of New Zealand's 'most wanted' pest predators.

National Science Challenges

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 economy of scale by working with collaborators.

Manaaki Whenua is proud to host one of New Zealand's 11 National Science Challenges (NSCs), New Zealand's Biological Heritage (BioHeritage). 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 strategy is focused on three impacts that have strong alignment with Manaaki Whenua's four ambitions:



National
SCIENCE
Challenges

- Whakamana – Empower
- Tiaki – Protect
- Whakahou – Restore

How Manaaki Whenua has contributed to BioHeritage Challenge successes

Inter- and trans-disciplinary research have been celebrated as a hallmark of the National Science Challenges, including BioHeritage. The Challenge has been recognised for building partnerships across a range of sectors and communities, championing a Māori world view throughout its investments, and connecting multi-institutional teams – people and organisations that had not previously worked together.

Challenge successes that Manaaki Whenua has been proud to lead or contribute to include:

- sequencing the genome of the invasive stoat – a global first in partnership with DOC and Predator Free 2050 Limited, which will pave the way for future genomic approaches to the control of invasive mammals [see also page 40]
- investigating the susceptibility of native flora to myrtle rust through the Ngā Rākau Taketake surge investment, in partnership with Plant & Food Research and Scion – urgent and fundamental research aimed at saving our taonga rākau (trees) [see also page 39]
- building biocultural indicators for Aotearoa, in partnership with Tūhoe Tuawhenua Trust, that contribute to our understanding of trends in ecosystem health and conservation
- developing a deeper understanding of how climate change impacts can exacerbate conservation threats in

island systems, in partnership with seven other research providers as part of a consortium established under the BioHeritage NSC umbrella.

Partnering for impact: how we align with the BioHeritage NSC

Manaaki Whenua supports the BioHeritage NSC in a variety of ways, including IT, human resources, and financial support. We endorse the Challenge embracing more formal Treaty partnerships with the merging of its Governance Group and Kāhui Māori into a single governance entity (Mana Rangatira), and through the appointment of a Director Māori.

We align around \$8 million of SSIF funding to the BioHeritage Challenge annually.

BioHeritage Challenge parties

Eighteen organisations have signed a Collaboration Agreement for 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 Database, the Land Resource Information System (LRIS), our research increases the availability of authoritative information on New Zealand's land-based resources.

Although we still have some way to go to fully map our diverse soils and landscapes and understand how they function, 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 impacts; as well as land valuation, education, and land planning.

Remote sensing

We are national leaders in remote-sensing techniques for characterising and monitoring New Zealand's unique land ecosystems. 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 automated cloud clearing techniques to create national coverage mosaics of satellite imagery. This is a significant step forward for regularly cloud-affected countries such as Aotearoa.

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.

RELEVANT SDGs



SDG 2: Our contribution to this goal is to support the development of food production systems that enhance soil, land, water, and ecosystem services, and ensure climate change adaptability, while working especially with Māori in Aotearoa New Zealand and indigenous peoples in Pacific nations.

SDG 6: Our contribution to this goal is to guide the use of land in ways that improve freshwater quality, enhance water-use efficiency, protect and restore water-based ecosystem services, and support integrated catchment-based governance and management.

SDG 15: Our contribution to this goal is to empower stakeholders to: conserve, restore, and protect land-based ecosystems, soils and their services; reverse the decline of indigenous biodiversity and natural habitats; reduce the impact of invasive species; develop the sustainable use of land resources; and develop equitable policies through partnership.

Innovation stories

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



Research technicians collecting soil cores in the rain at Ashley Dene farm, Lincoln, Canterbury.

Land Cover Database v5 launched in 2020

In the past 6 years more than half a million hectares of New Zealand's land cover has changed, according to the latest version of New Zealand's Land Cover Database (LCDB, version 5), launched in January 2020. Researchers say it is one of the biggest shifts in land cover since the first Land Cover Database – a digital map and multi-temporal thematic classification of New Zealand's land cover – was released nearly 20 years ago.

Land cover describes the extent of vegetation, built environments, water bodies, and bare natural surfaces across New Zealand. Measuring the composition of land cover and its changes is crucial to help decision-makers understand the pressures that different land uses are placing on our land and waterways, along with the implications for biodiversity and the functioning of ecosystems.

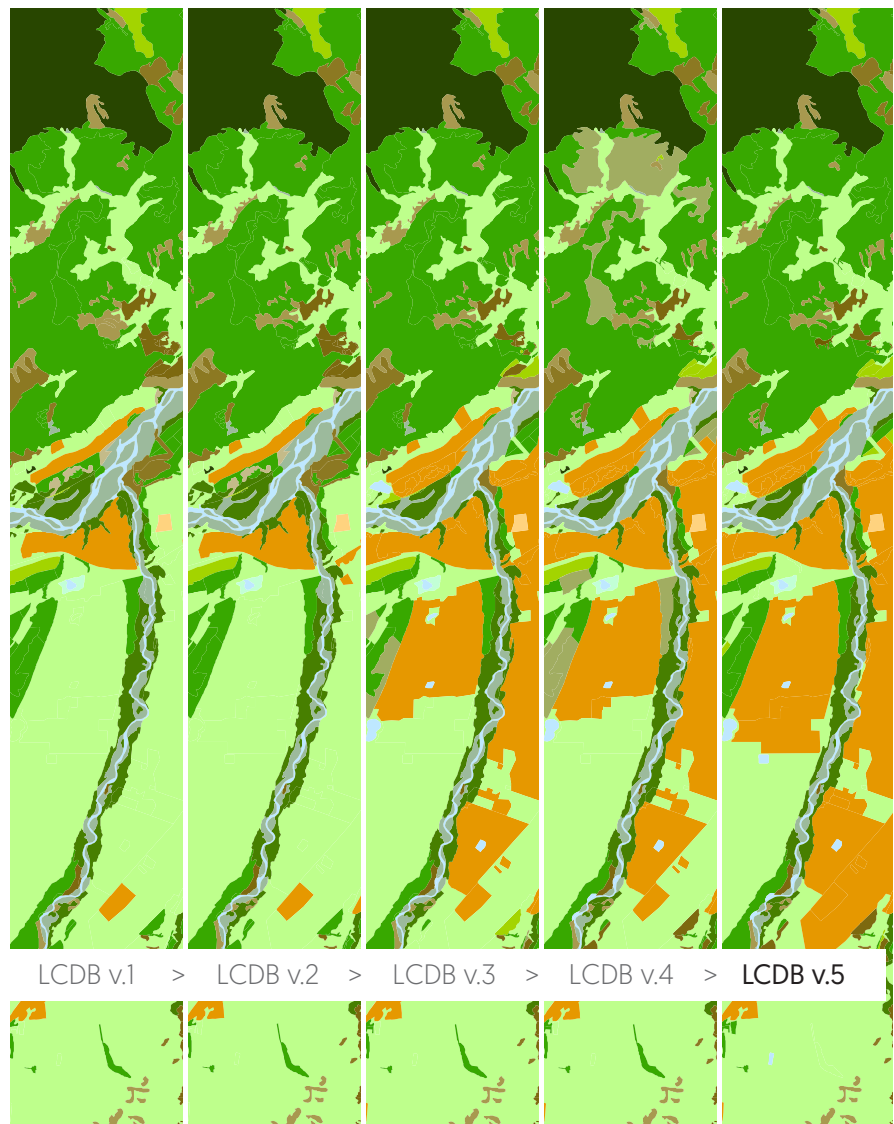
Progressive improvements in land-cover mapping have been made with each new version of the LCDB. One changing land-cover concern is the ongoing decline in wetlands. Preliminary results show that wetlands – New Zealand's most depleted and threatened ecosystem – have continued to reduce over the past 6 years, with only 220,000 hectares remaining.

Other preliminary results show that growth in the country's built-up area appears to be at a rate of one to three thousand hectares per year, of which 65–75% is on high-producing pastoral land and 8–10% on cropland, orcharding, and other land covers.

The LCDB is used for a surprising number of applications, from international and national reporting of the state of the environment, through to the production of better maps, and management and monitoring of land cover and land use. For example, it has been used to

monitor vegetation changes in catchments, and to decide the amount of bait needed in an area of land for predator control.

<https://iris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/>



Progressive changes in land-cover mapping are shown with each new version of the LCDB.

Regen ag: does the science stack up for New Zealand?

Regenerative agriculture (regen ag), a term first coined in the 1970s, applies an adaptive ecological approach to agricultural landscape management, with a focus on ecosystem health. However, little research has been done to show whether, or how, regen ag delivers on claimed environmental, economic or social benefits, particularly in a New Zealand context.

To address this knowledge gap, soil ecologist Dr Gwen Grelet is leading a pilot project funded through MBIE's Strategic Science Investment Fund and MPI, baselining the ecosystem performance of conventionally managed and regeneratively run farms in New Zealand, across roughly 20 indicators.

The project includes both dairy and drystock pastoral farms in the south of New Zealand. Here, flooding and cold temperatures create substantial challenges, especially for winter feeding, which is one of the motivations for transitioning to regenerative management.

The indicators include visual soil assessments, soil moisture and water infiltration, aggregate stability (how well the soil holds together), soil carbon and nitrogen stocks to a depth of 1 metre, and various indicators of ecosystem biodiversity, including plants, insects, soil invertebrates, and soil microbes. Some farms have also agreed to participate in an assessment of economic metrics (profitability and business resilience).

The pilot is a collaboration between Manaaki Whenua scientists and external

collaborators such as Quorum Sense, BakerAg, 5th Business Agri, Plant & Food Research, and AgResearch.

A linked project, funded by Our Land & Water National Science Challenge, SSIF and the NEXT Foundation, in partnership with MPI, is a survey of New Zealand farmers, industry, government, and scientists. It will uncover any questions they have about regenerative agriculture, identify the main principles and objectives of regenerative farming systems in New Zealand (dairy, drystock, arable and viticulture/horticulture), and show how these differ from similar systems overseas.

The survey work will also develop a framework for building a scientific evidence base specific to regenerative agriculture in New Zealand across all high-priority environmental, economic, and social outcomes, so that future research can quickly fill the evidence gaps.

The work is particularly timely given global and national uncertainties over the economic effects of Covid-19, and the need to enhance New Zealand's agricultural resilience in global marketplaces increasingly dominated by environmentally and ethically minded consumers.

S-map goes from strength to strength

Over the past 15 years S-map has transformed soil survey in New Zealand, from a mix of hard-copy soil maps and bulletins and a few regional endeavours based on old-fashioned informatics tools such as spreadsheets, into a robust, nationally consistent information system supplying soil information to a wide



Dr Kara Allen collecting topsoil samples.

range of clients and users. In 2016 we were awarded a 5-year MBIE Endeavour programme, which allowed us to invest in the scientific methods underpinning S-map.

An additional 1.98 million hectares have been added to S-map in the past 5 years. Over 5,700 unique soil types have now been identified, which are mapped in 16,000 different soil map units, each with its own unique combination of soils, and different soil layers to 1 metre depth. We have also significantly expanded the representativeness of soil reference sites across New Zealand; for example, by moving from 313 sites with soil water storage measurements to over 700 sites. This is a substantial public investment (about \$10,000 per site), so we have invested to secure the

data for future scientists in the National Soil Data Repository, which is one of New Zealand's nationally significant intergenerational databases.

S-map data are very widely used. They are in demand from scientists for erosion, crop production, attenuation pathways, irrigation, and other hydrological research. S-map data are now extensively used in farm environmental planning, monitoring, and reporting: 64,000 web requests for soil information from the OverseerFM nutrient budget tool have been made over the past 12 months. S-map geospatial data are supplied directly to an expanding list of clients, including fertiliser companies, a dairy company, most regional councils, and banks. S-map data are also a critical input in the NZ Water Model (NIWA), the NZ Drought Index (NIWA), IrriCalc (Aqualinc), and the OverseerFM nutrient budget tool. All these tools provide information to public organisations and private end-users across New Zealand.

Sharing our knowledge abroad

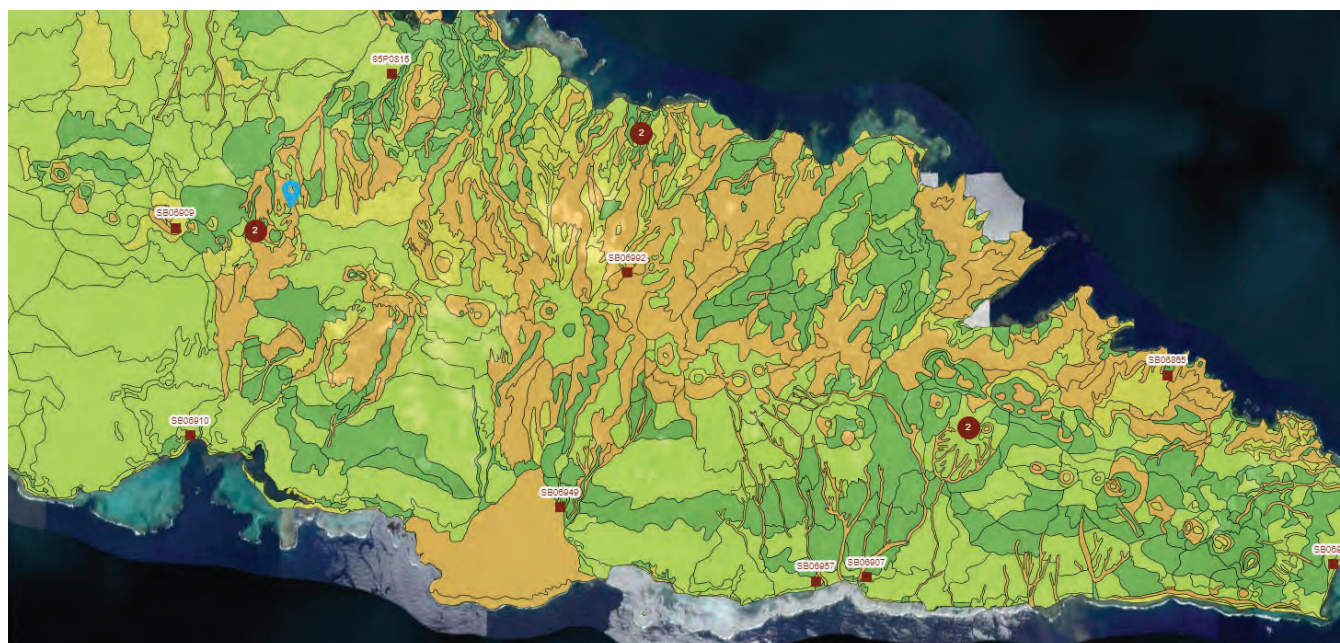
For decades, soil scientists from Manaaki Whenua have been visiting Pacific Island countries and territories (PICTs) to collect soil samples and map soil patterns. This work is vital to help decision-makers improve their soils knowledge and land-management practices.

As new online tools have been developed, researchers have also been championing the concept of an online Pacific soils tool. The Pacific Soils Portal, launched in 2020, has been developed by Manaaki Whenua in collaboration with CSIRO Agriculture and Food, the Secretariat of the Pacific Communities Land Resources Division, and PICT Agriculture Departments. It brings together soil data, dating back to the 1960s, for five Pacific countries – Fiji, Samoa, Tonga, Kiribati, and Tuvalu.

The portal currently covers, and will also link to, the New Zealand and Australian portals to showcase and compare soils across the entire South Pacific. It will also align with activities under the Food and Agriculture Organization's Global Soil Partnership.

The portal is funded by the Australian Centre for International Agricultural Research (ACIAR), and can be viewed on computers, tablets, and smartphones.

<https://psp.landcareresearch.co.nz/>



Soil mapping of Samoa as shown on the Pacific Soils Portal.

Building whakawhanaungatanga in Waikato and the Bay of Plenty

For Māori, elements of ecosystems and their linkages form the basis of whakapapa (ancestry) and kaitiakitanga (guardianship/management) principles, and are crucial to taonga, traditions, health, and well-being. Over time, the development and intensification of land has resulted in degraded ecosystem services and loss of biodiversity for tangata whenua and iwi.

In September 2019 a 6-year collaborative research programme, Biodiversity and Ecosystem Services for Resource Management (BEST), led by Manaaki Whenua, came to an end. The programme set out to avoid further degradation of New Zealand's ecosystem services by helping land managers make better-informed natural resource management decisions.

As part of the BEST programme, we undertook two flagship initiatives that used participatory community processes and the concept of ecosystem services to underpin decisions at a catchment/local level. The first, in the Rangitāiki catchment in the Bay of Plenty, looked at the potential impact of land-use intensification on the catchment. The second, in the Mangapiko catchment in the Waikato, used the same conceptual framing to develop an ecological restoration plan for the catchment that considered the various uses, needs, and aspirations of the whole community.

Researchers worked with tangata whenua to hear about their whakapapa, history, and relationship with their catchment, along with aspirations for their awa, repo, and whenua. Iwi involvement in the processes and their knowledge were invaluable to the

researchers, but also to the community participants during discussions on the impacts of land-use intensification in the Rangitāiki catchment and the restoration options for the Mangapiko catchment.

The discussions with tangata whenua were crucial for building whakawhanaungatanga (relationships), exploring issues, and discussing scenarios for alternative land uses or for options to restore the landscape.

Tangata whenua brought a unique perspective on rongoā (medicines), healing springs/waters, and mahinga kai (food gathering) that others did not have, and their oral history about the catchment gave a greater depth of understanding of and appreciation for the surrounding landscape and the interconnections between the land, water, and people of the catchment.

In the Mangapiko catchment, as iwi, hapū and most importantly kaitiaki of their place, they were able to articulate what had changed for them and help identify how restoration efforts could be used to enhance the spiritual and physical health of the catchment.

Within the catchment, restoration efforts led by local farmers and the Waikato Regional Council have started that rehabilitation journey. Alternative methods have been tested for willow removal and native planting developed to meet community needs. Wetlands have been protected and reconnected to native remnants, and sediment traps are being used to reduce sediment loss into the stream – all underpinned by the participatory, collaborative strengths of the BEST programme.

GIS for Māori land managers

Iwi and conservation groups throughout the country can now track and plan the conservation progress of native taonga species in their rohe thanks to a new free software package developed by Manaaki Whenua.

The software contains publicly available mapping data to allow users to visualise and track the success of conservation efforts for specific species such as kiwi. The software can show where particular species live, and the changing environment and sub-species distributions across a large landscape or region, or at an iwi-specific scale.

The project is the first of its kind and was created by Manaaki Whenua in conjunction with the national kiwi protection organisation Kiwis for Kiwi, as a direct response to feedback from conservation groups asking for a low-level introduction to geospatial visualisation tools for monitoring and planning conservation progress.

With the package, users can access all basic GIS maps in one place and look at geospatial layers of land cover, vegetation, rivers and other information at a specific scale. They can visually track their conservation efforts, see environmental or species changes, and map out where they should focus future endeavours to achieve conservation goals.

www.landcareresearch.co.nz/tools-and-resources/databases/visualisation-package

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.

This year we have made significant progress in the measurement of New Zealand's soil carbon inventory, beginning the first phase of a new nationwide baseline soil carbon measurement study.

Toitū Envirocare Ltd, a wholly owned subsidiary of Manaaki Whenua since its creation in 2001, is a market leader in certified programmes for organisations to reduce their carbon footprint and enhance environmental performance [see page 53].

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. We underpin this work with several major nationwide surveys, such as our Survey of Rural Decision Makers [see page 50].

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 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.

RELEVANT SDGs



SDG 11: Our contribution to this goal is to support the development of integrated policies and planning that enhance resource-use efficiency, ecosystem services, climate change mitigation and adaptation, resilience to natural disasters, and inclusive governance processes, while decoupling waste from growth.

SDG 13: Our contribution to this goal is to empower organisations, sectors, and the nation to measure, manage, reduce, and mitigate their greenhouse gas emissions; understand climate risk and increase resilience; and develop policies and plans that integrate social, economic, cultural, and environmental dimensions.

SDG 16: In achieving all four of Our Ambitions, our contribution to SDG 16 is to support the development of responsive, inclusive, participatory, and representative decision-making and governance by our stakeholders and the Treaty Partner, Māori.



Dr John Hunt and Dr Scott Graham set up equipment for climate data collection at Ashley Dene farm.

Innovation stories

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

Tracking climate change awareness among rural decision-makers

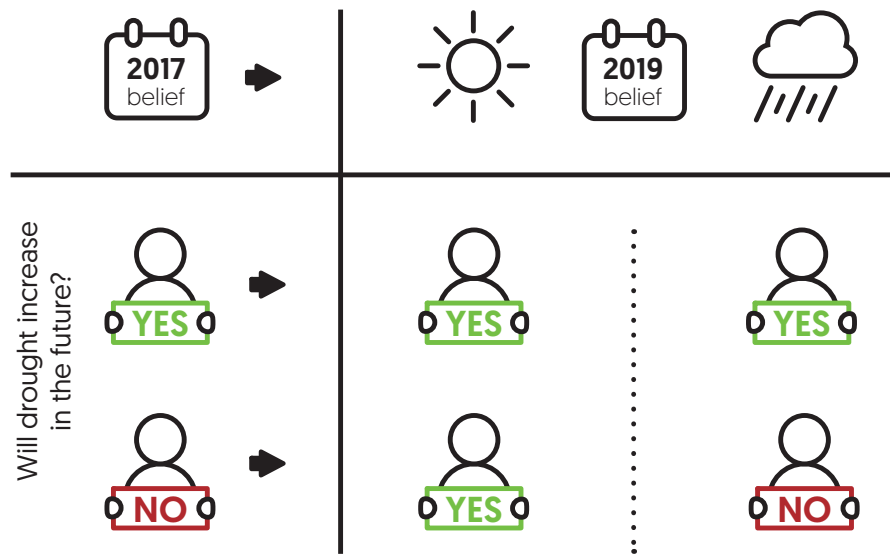
Over the coming decades changes in climate are likely to have serious effects on New Zealand's productive land environments. The Intergovernmental Panel on Climate Change (IPCC) projects a 0.8°C increase in temperature by 2040 for New Zealand, as well as more extreme rainfall events and increased drought severity.

The latest results of the biennial Survey of Rural Decision Makers (SRDM), run by scientists at Manaaki Whenua, show that farmers are more aware than ever of the risks of climate change on their activities.

The SRDM is now the largest and longest-running survey of decision-making in the primary sector in New Zealand. Results from the SRDM have become conventional wisdom in policymaking circles. It also has a sizeable panel component, enabling longitudinal analysis of policy. With between 3,000 and 5,000 farmers, foresters, growers, and lifestyle block owners from Cape Reinga to Bluff taking part in each wave, the survey records current practice and future planning across the breadth of the primary sector.

Most respondents to the latest survey believe climate change is already affecting New Zealand, and roughly three-quarters anticipate that the frequency or intensity of drought, heat waves, flooding, and storms will increase in the future.

Encouragingly, most farmers, foresters, and growers have introduced management practices to mitigate



Changes in expectations of droughts increasing in the future are dependent on experiences of recent dry or wet weather.

climate change effects, such as changing stock rates, planting native trees, increasing feed reserves, changing stock breeds, investing in infrastructure to stop flooding, and increasing water storage. Of note, most farmers would rather plant indigenous trees, but feel that the poor rate of return is a barrier.

In work linked to the survey, our scientists investigated the drivers behind this increased awareness of climate issues, using experience of drought as an example of a climate change event. This work showed that farmers most strongly refer to the past 5 to 10 years rather than the longer historical record when evaluating a drought's intensity. This may create future problems, because if, for example, an area experiences a few 'good' years amid a prolonged drought, people are less likely to adapt to the overall change. This is an important finding for effective policymaking: policies and guidance for farmers that rely on increasing perceptions of risk to spur them to act may overestimate how much risk farmers actually perceive.

Decision-making in freshwater management – a social learning approach

Scientists have long recognised that one of their biggest challenges is how to translate their recommendations into lasting management and behaviour changes among stakeholders. Individuals or people working in organisations may not be able to make changes easily, owing to a combination of norms and institutional routines they work within. After initial enthusiasm for change, these people can quickly become disillusioned if they feel they are 'going it alone' when community commitment to change is essential.

Social learning – a relatively new approach to this issue – aims to develop understanding and action to achieve change among groups of stakeholders. Working at the community or sectoral

level rather than at the individual level, social learning co-creates knowledge through combined reflection and negotiation, building trust and enabling science to be more effectively translated into action. Good facilitation by a multi-disciplinary project team is vital to support open conversations. Care must also be taken to ensure different knowledge systems are all appreciated and used within the wider process, including knowledge from science, local experience, and mātauranga.

Researchers at Manaaki Whenua and AgResearch recently published a paper on the power of social learning in freshwater management in two catchments: one in the Wairau Valley (Marlborough) and one in Mangatarere (Wairarapa). For both catchments, a representative collaborative group was formed, and then four or five facilitated workshops were led by a dedicated project team. The workshops allowed each group to understand the ways in which they value their river in order to develop future water-use scenarios and create useful indicator sets to assess progress in their agreed direction. The research aimed to discover how best to design social learning processes to enable community participation and navigate issues related to institutional structures. The research was part of the 'Wheel of Water' programme led by Aqualinc Research.

Andrew Fenemor, who led the Wairau case study, comments that this research, and ongoing work on collaborative and integrated decision-making, has been influential in the design of regional council planning processes for freshwater. For example, the Takaka Freshwater and Land Advisory Group (FLAG) used these approaches to recommend water allocation and

water-quality limits and land-use policy to manage water bodies – including the renowned Te Waikoropupū Springs – in Tasman District. The research has also been influential in the Government's 'Essential Freshwater 2019–20' work programme aiming to reverse the decline in lowland water quality nationally.

National environmental reporting – our science behind the headline reports

The recent increase in environmental regulations in New Zealand, including the *National Policy Statements for Freshwater Management* (2013, 2017, 2019) and the recent *National Policy Statement for Highly Productive Land*, is increasing demand for monitoring and assessing the impacts of land use on our resources. The Environmental Reporting Act 2015 also requires the Ministry for the Environment (MfE) to report on the state of New Zealand's environment once every 4 years, with domain reports for one of the air, land, freshwater, marine, and climate domains produced every 6 months.

Manaaki Whenua staff Dr Anne-Gaelle Ausseil and Dr John Dymond have worked closely with MfE as science leads for two major reports (*Environment Aotearoa 2015* and *Our Land 2018*), and provided ongoing scientific advice through a Senior Science Mātauranga Team (SSMT) for *Environment Aotearoa 2019*, *Our Freshwater 2020* and upcoming atmosphere and land domain reports. These reports combine the best environmental data and evidence from

the scientific literature and mātauranga Māori (with additional contributions in SSMT from Garth Harmsworth, Phil Lyver, and Shaun Awatere) to reveal the state of, and trends in, our soils, native plants, animals, and ecosystems.

Our work has created foundational data sets for soil quality indicators, pre-human vegetation, soil erosion, biodiversity information (including rare ecosystems), wetland mapping, and modelling of land-use pressures. Transparency, reproducibility, and traceability are the main principles required to produce indicators – all of which need robust supporting data.

Our wetland mapping has shown that New Zealand has lost 90% of its original wetland extent, providing a benchmark for the Environment Court. Our analysis of urbanisation and lifestyle block expansion showed that there is a risk of land being locked out of primary production for residential use, a finding that has led to the proposed National Policy Statement on Highly Productive Land to protect our finite resources.

In partnership with MfE and the Prime Minister's Chief Science Advisor, we are providing a framework for measuring, reporting, and monitoring natural capital through indicators. This work is fundamental to Treasury's well-being framework and will aid with investment and budget priorities to assess their impacts and dependencies on our natural resources.

Other projects with MfE have included an improvement of land-use change information in the Land Use and Carbon Analysis System (LUCAS). LUCAS is a project to measure and monitor the carbon stocks of New Zealand's forests and soils. This information is required for New Zealand's reporting

requirements under the Kyoto Protocol and the United Nations Framework Convention on Climate Change, and has helped to improve the accuracy of our greenhouse gas emissions reporting. Manaaki Whenua has also facilitated the inclusion of land indicators as Tier 1 Statistics NZ indicators for environmental reporting, contributed to the National Environmental Monitoring Standards on Soil Health and Trace Elements, and supported the future development of *Land, Air, Water, Aotearoa* to include land data and analyses.

We have also made important contributions to the Aotearoa Circle partnership, which brings together leaders from the public and private sectors to investigate and report on our natural resources, including being instrumental in the development of its *2020 Biodiversity Native Forests Report*.

A new national soil carbon monitoring system for agricultural land

Every year, under the United Nations Framework Convention on Climate Change and the Paris Agreement, New Zealand is obliged to report its national human-produced (anthropogenic) greenhouse gas emissions and removals. With average soil carbon stocks in New Zealand's agricultural soils estimated at about 100 tonnes per hectare in the top 30 cm, changes in soil carbon could make a significant contribution to our national carbon footprint.

However, there are few direct measurements of soil carbon change available, and the data we have are largely based on unrepresentative

historical soil survey sampling sites of agricultural land. To provide the necessary data, Manaaki Whenua has begun the first phase of a new nationwide baseline soil carbon measurement study.

The overall plan is to monitor changes in soil carbon at 500 sites across the country within each of five broad land-use classes: cropland, horticulture, dairy pasture, flat-rolling drystock pasture, and hill-country drystock pasture. Sites will be revisited on a 4-year rolling resampling to determine any change in soil carbon. The system is designed to be able to detect a change of about 2 tonnes of carbon per hectare within each of the five classes.

This national benchmarking is being complemented by work to enable farmers to determine soil carbon and carbon changes on their individual farms. Interest from farmers is recognition of the importance of soil carbon for overall soil health and the potential for soil carbon to offset greenhouse gas emissions. Our scientists are currently working with consultants and farmers to create user-friendly, on-farm soil carbon measurement systems.

The national soil carbon monitoring project is a collaboration between Manaaki Whenua and the University of Waikato, and is funded by the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) and MPI. Funding for the initial statistical design phase came from MPI via the Global Research Alliance on Greenhouse Gases.

N₂O and CH₄ emissions: measurement and mitigation

A renewed New Zealand Government focus on climate change in the past 3 years has sought to identify future research needs to address gaps in greenhouse gas monitoring and mitigation, thereby improving New Zealand's national inventory for international reporting and mitigation technologies to meet proposed emission targets.

We have worked in partnership with NzOnet (New Zealanders involved in nitrous oxide emissions) researchers with a key focus on developing country-specific emission factors from emissions measured to account for New Zealand soils, climate, and management practices. We collected emissions data from grazed pasture soils, followed the IPCC guidelines, and used our process-based research understanding of biological nitrogen transformations and soil and climatic factors regulating emissions to improve the New Zealand agricultural greenhouse gas inventory.

These subsequent improvements in nitrous oxide emission factors have resulted in significant reductions in New Zealand nitrous oxide inventory estimates and avoided overestimation of emissions. We have also been able to develop a method for the national inventory that could more accurately estimate nitrous oxide emissions from hill country, which will be incorporated in the national inventory from 2020.

Business climate action grows with Toitū Envirocare's success

Toitū Envirocare has had a transformative year. In November 2019 Enviro-Mark Solutions rebranded as Toitū Envirocare, a move designed to align its purpose with its programmes, and to position the company for increased growth and profile. 'Toitū' means to actively sustain, and is an acknowledgement of the company's roots in the care for our land, and New Zealand. More than a name, it is a commitment to care for the life of our place, our people and future, and an invitation to share in collective change for our environment and economy. The company's flagship programmes were also renamed Toitū carbonzero and Toitū carbonreduce, as part of a streamlined suite with recognisable marks of environmental action.

Toitū's influence and achievements grew throughout the financial year, despite the impacts of the Covid-19 global pandemic. During 2019/20 Toitū:

Expanded the impact of the carbon programmes, Toitū carbonreduce and carbonzero

Toitū verified over 4 million tonnes of CO₂e and offset over 121,700 tonnes of CO₂e, in partnership with 303 clients in our carbon programmes. Toitū also has 149 clients working on their environmental impacts through the Toitū Enviromark programme, and

another 49 working on non-programme environmental initiatives.

Built valuable relationships with key partners

Toitū secured key industry clients, including Westpac New Zealand, ASB, and AMP Wealth Management. These additions to the collective, along with many other new members, is a strong signal that sustainability and climate action are becoming mainstream in business operations and strategy.

Grew demand for product carbon footprinting

Toitū has seen increasing interest in carbon certification for products. This financial year Lion launched their Toitū carbonzero-certified The Fermentist Kiwi Pale Ale, and Toitū worked on the Fonterra and Foodstuffs North Island collaboration of Toitū carbonzero certified Simply Milk (officially launched in 2020/21).

Continued to play a role in New Zealand's goal to reduce emissions in the agricultural sector

The previous financial year saw the initial development of the Toitū Farm Carbon Certification programme. This year Toitū deepened their relationship with key sector collaborators on this project, including Beef + Lamb, OverseerFM,

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AsureQuality, and Pāmu, and involved more farmers in the development and testing of the programme. The expected launch is in early 2020/21.

Rapidly adapted to new ways of working

Toitū was able to pivot business processes in response to changing client needs and operational rules under the Covid-19 lockdown.

Toitū Envirocare welcomed a new Chief Executive, Becky Lloyd, in November 2019. Since starting, Becky has focused on ensuring Toitū's expertise, backed by Manaaki Whenua science, is at the forefront of carbon conversations within New Zealand, streamlining business processes and delivering new product offerings.

Toitū remains Manaaki Whenua's commercial influencer of carbon management, environmental management, and sustainability. Through the Toitū collective, Manaaki Whenua furthers the impact of its science.

Our strategic goals

Strategy 22 was developed in 2017 as a 5-year strategy to guide key investment within the organisation to 2022. Our strategy rests upon three main pillars, with nine underpinning goals, to support how we deliver impactful science.

An irresistible culture

Our people

Our culture of empowerment comes from diverse talents, great leadership and communication. We bring together best teams and provide staff with career development. Everyone is 100% committed to health, safety and well-being.

Science working with mātauranga Māori

Our work and impacts are enriched when we build understanding between scientific and Māori worldviews. Mātauranga Māori stands alongside our science in providing insights into our land and our future for all New Zealanders.

A better way of working

Our infrastructure

Our Collections and ICT support excellent research. Our sites provide great working environments, support our partnerships and are a base of interaction with New Zealanders.

Our sustainability

We invest wisely to deliver our strategy including financial resilience. We set challenging Sustainable Development Goals that reflect our vision.

Our partners

Our partnerships are enduring and are based on trust and mutual support. Through long-term partnership we increase our capacity and achieve our ambitions.

Science for impact

Innovative & challenging

We are tackling greater science challenges with greater rewards for New Zealand. We actively seek and support innovation.

Strategic & integrated

We work at longer and larger scales and on more complex problems, integrating across disciplines and stakeholders.

Valued & trusted

We are responsive to the needs of our clients and partners. We produce whole solutions with and for them. Our advice is trusted.

Engaged with all New Zealanders

We have a strong identity and we engage citizens in our research and speak with authority.



A flowering *Pennantia baylisiana*, also known as the kaikōmako, endemic to Manawa Tāwhi / Three Kings Islands, where only one wild plant is known to exist.

Our strategic goals and the SDGs

Our activities as an organisation contribute to meeting seven material UN Sustainable Development Goals identified through a stakeholder engagement process [see page 22]. The following pages show the wording of each SDG and its targets relevant to our business, our policy commitment and the Strategy 22 pillar to which it relates. Our Science for Impact pillar is largely about how we do our research and science, which contributes to the SDGs as shown on pages 25–27.

UN Sustainable Development Goal



Ensure healthy lives and promote well-being for all at all ages.

Relevant targets from SDG 3

Targets for SDG 3 are health sector targets that do not relate to our business, but our commitment is related to the title of this SDG.

Our goal is to:

Empower our people to commit themselves 100% to health, safety, and well-being while leading with our own responsibilities as their employer.

Our strategic goal

Our people: Health, safety and well-being

Read more

Health & safety [page 62]



Achieve gender equality and empower all women and girls.

Relevant targets from SDG 5

- 5.1 Eliminate all forms of discrimination against women.
- 5.5 Ensure women's full and effective participation and equal opportunities at all levels of decision-making.

Our goal is to:

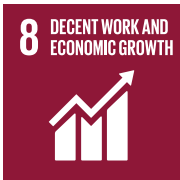
Ensure gender equity in participation, leadership opportunities, conditions and reward in all aspects of our work, using enabling technologies, where appropriate.

Our strategic goal

Our people: Gender equality

Read more

A representative workforce [page 63]



Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all.

Relevant targets from SDG 8

- 8.1 Sustain economic growth.
- 8.2 Greater productivity through diversification and innovation.
- 8.4 Decouple economic growth from environmental degradation.
- 8.5. Achieve full and productive employment and decent work for all, including those with disabilities.
- 8.8 Protect labour rights and promote safe and secure working environments for all workers.

Our goal is to:

Maintain sustainable economic performance that supports innovation, entrepreneurship, job creation, staff development, fulfilling roles, and advancement opportunities with fair remuneration.

Our strategic goal

Our sustainability: sustainable economic growth
Our people: an irresistible culture

Read more

Commercialisation & innovation
(pages 71, 76–77)



Reduce inequality within and among countries.

Relevant targets from SDG 10

- 10.1 Achieve and sustain income growth of the bottom 40% of the population at a rate higher than the national average.
- 10.2 Empower the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.
- 10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices.

Our goal is to:

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.

Our strategic goal

Our people: diversity and inclusion

Read more

Remuneration
(page 65)
Embracing Diversity
(page 65)
Māori staff development
(pages 66–67)



Ensure sustainable consumption and production patterns.

Relevant targets from SDG 12

- 12.1 Implement 10-year framework of programmes for sustainable consumption, production and use of natural resources.
- 12.5 Substantially reduce waste generation through prevention, reduction, recycling and reuse.
- 12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.
- 12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products.

Our goal is to:

Measure and manage our own consumption and outputs to sustain and restore natural resources, reduce waste and emissions using ecologically restorative practices to maintain our net zero position while we progressively decarbonise; and foster a circular bio-economy, while through our procurement and services encouraging other organisations to adopt sustainable practices.

Our strategic goal

Our infrastructure: Sustainable investment in facilities and systems
Our sustainability: Procurement

Read more

Our sustainability
(page 70)



Take urgent action to combat climate change and impacts.

Relevant targets from SDG 13

- 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters.

Our goal is to:

Measure, reduce, and mitigate our greenhouse gas emissions using ecologically restorative practices to maintain our net zero position while we progressively decarbonise; understand climate risk to our business and increase our resilience; and develop relevant policies and plans that integrate social, economic, cultural, and environmental dimensions.

Our strategic goal

Our sustainability: Carbonzero

Read more

Our carbon footprint
(page 71)



Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Relevant targets from SDG 17

- 17.6 Enhance North–South, South–South and triangular regional and international cooperation on, and access to, science, technology and innovation, and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism.
- 17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries.
- 17.9 Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the Sustainable Development Goals, including through North–South, South–South and triangular cooperation.
- 17.16 Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries.
- 17.19 Build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries.

Our goal is to:

Partner locally and nationally with Māori, regionally with Pacific Island peoples, and globally with research and other organisations to build capacity, enhance knowledge and data-sharing, and access to science and technology, and enhance the Global Partnership for Sustainable Development.

Our strategic goal

Science working with mātauranga Māori

Our partners: New Zealand and international partnerships for global impact

Read more

Pacific Seeds Project
(page 34)

Pacific Soils Portal
(page 46)

Science working with
mātauranga Māori
(page 66)

An irresistible culture

Strategy 22 - Pillar 1

Manaaki Whenua derives its value from its people. It is the unique combination of our 441 researchers, scientists, technicians, science support staff, and corporate staff that powers our impact for New Zealand. Manaaki Whenua has an aspiration under our Strategy to be an employer of choice, attracting and retaining exceptional talent.

There are two key goal areas within this strategy pillar:

Goal 1: Our people

Our culture of empowerment comes from diverse talents, great leadership, and communication. We bring together the best teams and provide staff with career development. Everyone is 100% committed to health, safety and well-being.

Goal 2: Science working with mātauranga Māori

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.

RELEVANT SDGs



SDG 3: Manaaki Whenua will empower our people to commit themselves 100% to health, safety and well-being while leading with our own responsibilities as their employer.

SDG 5: Manaaki Whenua will ensure gender equity in participation, leadership opportunities, conditions and reward in all aspects of our work, using enabling technologies where appropriate.

SDG 8: Manaaki Whenua will maintain sustainable economic performance that supports innovation, entrepreneurship, job creation, staff development, fulfilling roles and advancement opportunities with fair remuneration.

SDG 10: Manaaki Whenua 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.



Palaeoecologists Dr Michelle McKeown and Dr Jamie Wood check a wetland sediment core sample taken from the Amoeboid Bog on the Kepler Track, Fiordland.

Our Strategy 22 Goal

Our people

1

100% committed to health, safety and well-being

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

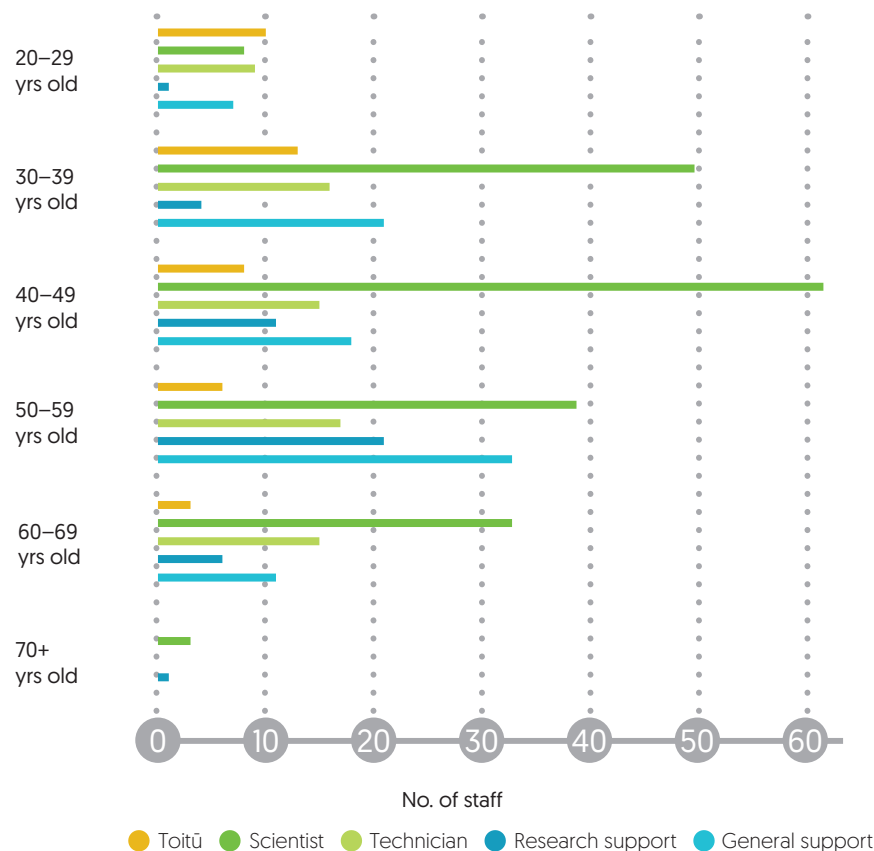
We have continued to support the health and well-being of our employees through our Manaaki Tangata well-being programme, providing a monthly focus on different well-being themes. We regularly audit (internally and externally) our systems and processes to ensure compliance with regulations and best practice, looking for opportunities to further enhance the way we work.

Adopting a 'Safety Differently' culture, with the fundamental principle of learning, is key to our Health, Safety & Environment approach. We recognise the importance of supporting the well-being of our people to achieve this. We have invested in various Health, Safety & Environment initiatives, including improving our contract management processes, emergency response training for our leaders, upskilling staff on 'Safety Differently', and health checks.



STAFF AGE DISTRIBUTION

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



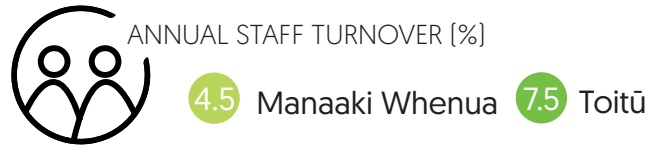
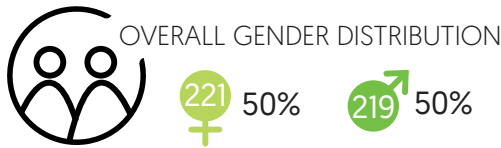
Harassment and bullying prevention

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. We regularly celebrate Pink Shirt Day and use this opportunity to remind people of our expectations for conduct and the processes in place to raise any concerns relating to how they are being treated at the workplace. New employees are made aware of these policies and processes as part of their induction. A recently developed set of behaviours

outline 'Our Way' – our expectations of our staff that reflect the culture we are building.

A safe and healthy environment

Manaaki Whenua regularly reviews its Emergency Planning and Response process, and this enabled us to be prepared and respond effectively to the Covid-19 pandemic during 2020. Keeping our people safe and ensuring our workplaces did not become a source of infection was our key priority. Through establishing our Crisis Management Team, we were able to make effective decisions and delivered clear and timely communication.



We also undertook regular pulse surveys of our staff to ensure we had an accurate picture of how our people were feeling and to review the effectiveness of our response. We saw the number of our staff working remotely increase during this period, and for some people we expect this to become their new way of working. Ensuring they have a safe remote work environment is our priority.

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 are preparing for a recertification audit in 2021 that will be against the new ISO 45001 standards.

In the Employee Experience Survey, four of our five top-scoring questions related to Health and Safety:

- 96% agreed that 'I understand my Health and Safety responsibilities'
- 95% agreed that 'This organisation is committed to the Health and Safety of its people'
- 93% agreed that 'Risks to my Health and Safety at work are reduced as far as is reasonably practicable'
- 92% agreed that 'I feel safe at work'.

A strong focus is placed on staff receiving the appropriate Health and Safety training, equipment, and supervision for the roles they perform, ensuring they are safe at work. Every employee's position description contains individual responsibilities for Health and Safety.

There has been a significant focus on the well-being of our people through our Manaaki Tangata Programme, with monthly initiatives including summer

health, practising kindness, physical health, and eating well. The importance of the well-being of our people during Covid-19 has been a high priority, and we focused on regular check-ins with our people, social connection (both virtually and in person), and providing a wealth of resources to support individual well-being, including webinars.

Gender equality

Manaaki Whenua encourages values consistent with the concept of Manaaki Tangata by providing an effective process for the identification and elimination of all aspects of policies, procedures and other institutional barriers that cause or perpetuate inequality in respect of any person or group of persons. The organisation provides employees with equality of opportunity in the workplace (e.g. in access to, consideration for, and encouragement in recruitment, selection, promotion, conditions of employment, training and career development) regardless of differences among our staff, and aims to treat diversity as an asset to Manaaki Whenua.

Annually, we produce our Pay Equity report, aligned to the Ministry for Women's Organisational Gender Pay Gap guidelines, which analyses our data for any gender and/or ethnic pay gaps. Through this process we have identified the opportunity to support our female and Māori staff in progressing to more senior positions within Manaaki Whenua. This will be a key area of focus in our action plan for 2020/21.



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



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 career development. 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 a 75% response rate to this year's Employee Engagement Survey. Our engagement index was 81% (and 87% in Toitū Envirocare), which is pleasing given the current environment we are operating in. The survey highlighted the opportunity to strengthen the development of the bicultural capability of our staff through a greater understanding of Māori cultural concepts, confidence in giving their mihi, and enabling committed relationships with iwi and Māori organisations. These engagement scores help us understand the overall experience for our people at Manaaki Whenua.



Dr Sam Carrick, a scientific speed-dater [see page 79]

Leadership development

We have continued to develop the current cohort of future leaders within Manaaki Whenua, supporting their individual career plans and providing practical coaching workshops. For the first time we brought together our

science leaders to enable consistency of practice and common understanding of expectations.

Recruitment, selection and induction

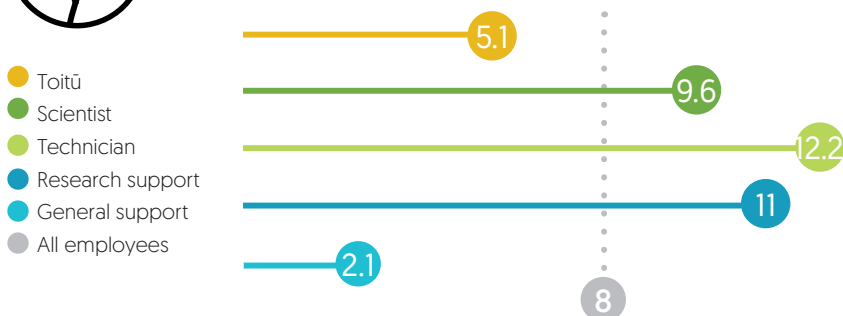
To achieve our aspiration to be an employer of choice attracting exceptional talent, we take pride in providing an excellent culture, with opportunities for career development, skills enhancement, external interaction in our sector, and flexible working arrangements to meet people's diverse circumstances.

Capability is important, and we have focused on strategic hiring decisions that ensure we can meet future research and business needs. We have sourcing and selection policies and procedures that are fair and transparent. Our induction process is thorough and includes an



STAFF AVERAGE YEARS' TENURE

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





OVERALL STAFF ENGAGEMENT [%]

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



orientation for all new staff, ensuring staff are aware of their responsibilities and key information on the organisation.

Flexibility and work design

Manaaki Whenua encourages a healthy work-life balance and provides flexible working arrangements, supported by portable devices to improve staff mobility and technology to enable effective virtual collaboration. We have embraced flexible working and built on our experiences through the Covid-19 alert levels to continue to support different ways of working. We offer part-time, variable hours, and teleworking arrangements as appropriate.

Remuneration, recognition, and conditions

We undertake an annual remuneration review, which provides the opportunity to reflect and adjust our recruitment and retention strategies. Manaaki Whenua continues to review and develop its people processes to achieve equitable, transparent systems that are free from bias and ensure all individuals and groups have fair employment opportunities and conditions.

As part of monitoring our remuneration, we benchmark our remuneration medians against the Crown Research Institute, science and general market sectors.

This year Manaaki Whenua launched its inaugural Annual Awards programme to recognise excellent contributions made

by key staff over the last year. These awards sit alongside our Reward and Recognition framework and provide the opportunity to celebrate talent across Manaaki Whenua. The awards were presented in July 2020 while connecting together for Matariki.

Employee development, promotion and moving on

Each year, including during our performance appraisal and development programme, employees have a number of opportunities to discuss their career aims and aspirations, personal development, and the training opportunities available. We have supported the development of our people leaders' capability in managing the performance of our people. Our performance appraisal and development programme enable regular conversations during the year,

including identifying development opportunities.

We ensure that our people have regular opportunities to give feedback throughout the employment life cycle, including through an exit survey when leaving Manaaki Whenua. These feedback opportunities enable valuable information to continually improve our workplace.

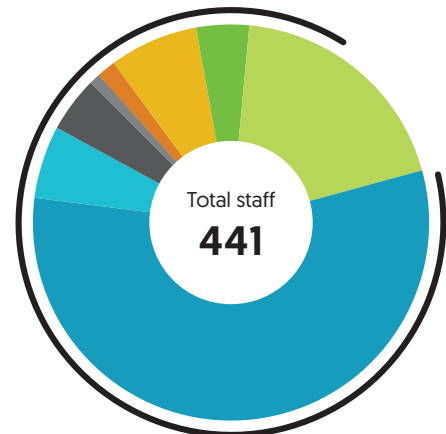
A diverse and inclusive work community

We 'Embrace Diversity' [one of our desired behaviours], and 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 with Deaf Aotearoa and Rainbow Youth, as well as a number of internal events, to raise awareness and increase understanding of different cultures and backgrounds. We also have a regular bicultural training programme, including noho marae, Treaty awareness training, and te reo, which is offered to all of our staff, including our Board of Directors.



OVERALL STAFF ETHNICITY

- Africa
- Asia
- Australia
- Europe
- New Zealand
- North America
- NZ Māori
- South America



**Our
Strategy
22 Goal**

**Science
working with
Mātauranga
Māori**

2

Manaaki Whenua acknowledges mātauranga Māori (indigenous knowledge of the Māori people) 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.

Bicultural capability

We are steadily developing our bicultural capability. Our ability to engage Māori in every part of our research is a key to meeting their aspirations. Building an understanding of and empathy for Māori culture is part of our Diversity and Inclusion Strategy.

Our Senior Leadership Team have undertaken training to increase their understanding of Wai 262 and to discuss the implications for the work we do.

Partnership with Māori

Manaaki Whenua has developed enduring relationships with selected iwi, groups of iwi, Māori trusts/ incorporations, and Māori organisations. These support and contribute to our Māori partners' aspirations. We engage regularly with these groups in the spirit of partnership, as expressed in the principles of Te Tiriti o Waitangi (the Treaty, see also pages 23–24).

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 goal is to ensure our people have the skills and characteristics to ensure participation, deliver value, and support our Māori partners. Our challenge is scale: our Māori staff are heavily committed to developing such relationships, so we need these skills to be in our non-Māori staff.



Kairangahau Kiri Reihana.

Work with Māori entities in 2019/20

We have worked with Hikurangi Bioactives Limited Partnership (HBLP) and the Waiapū Kānuka Landowners Collective to help build a thriving kānuka business in Ruatōria. This 18-month project has produced a landowner resource, the *Kānuka Handbook*, and we are working alongside HBLP with several large Māori entities from across the motu (including Parininihi ki Waitotara, Ngāti Maru, Ngāi Tahu, Ngā Rauru, and Aniwa Station) to form a national kānuka entity for Māori kānuka producers, with support from New Zealand Trade & Enterprise, Callaghan, and lawyers AJ Park.

We have also co-developed a proposal to bring together a diverse contingent of large Māori entities across the motu (including HBLP, Te Rūnanga o Ngāti Porou, Ngāti Toro, Prime Holdings, and the Ngāti Kuri Trust Board), to create a national taskforce focused on unlocking the potential of marginal land through a kaupapa Māori lens. This initiative builds on a longstanding relationship with these partners.

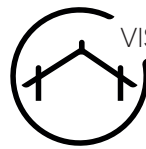
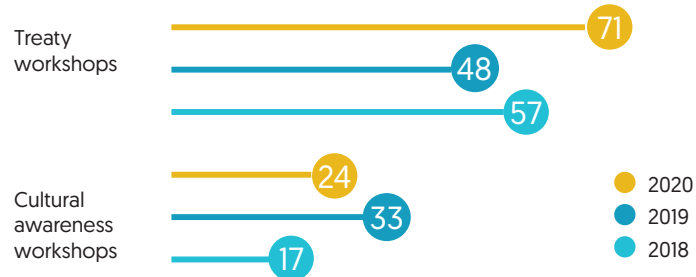
Through working with Te Awahohonu Forest Trust (in northern Hawke's Bay) to understand their aspirations for future land-use opportunities, we have established an ongoing relationship. We have also secured Vision Mātauranga Capability Fund Connect funding, enabling us to work with the Trust on critical research to support their knowledge about their āwheto resources.

Other examples of our work with and for Māori entities are described on pages 34 and 47.

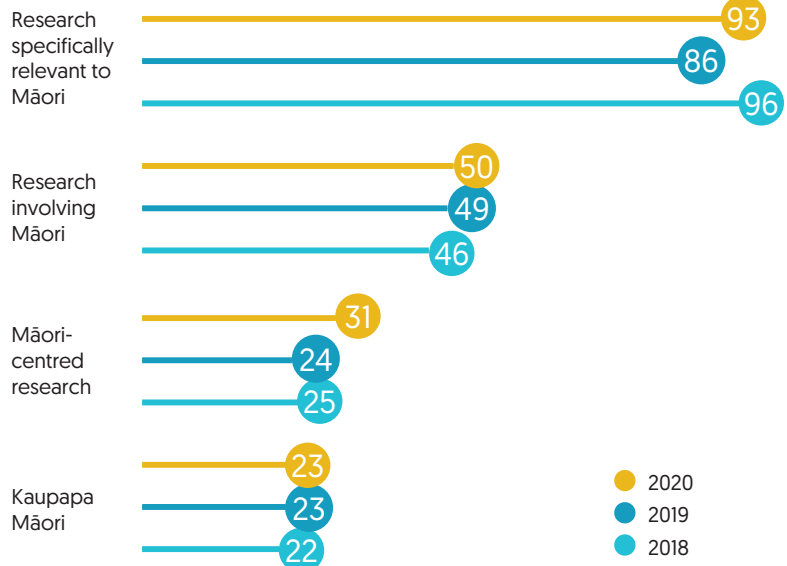


NUMBER OF WORKSHOPS

Each year we report on our bicultural staff training activities. In 2019/20 some of these activities were impacted by Covid-19.



VISION MĀTAURANGA PROJECTS



A better way of working

Strategy 22 - Pillar 2

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.

There are three key goal areas within this strategy pillar:

Goal 3: Our infrastructure

Our collections and information and computing infrastructure support excellent research. Our sites provide great working environments, support our partnerships, and are a base of interaction with New Zealanders.

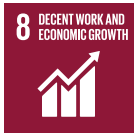
Goal 4: Our sustainability

We invest wisely to deliver our strategy, including financial resilience. We set challenging Sustainable Development Goals that reflect our vision.

Goal 5: Our partners

Our partnerships are enduring and are based on trust and mutual support. Through long-term partnership we increase our capacity and achieve our ambitions.

RELEVANT SDGs



SDG 8: Manaaki Whenua will maintain sustainable economic performance that supports innovation, entrepreneurship, job creation, staff development, fulfilling roles, and advancement opportunities with fair remuneration.

SDG 12: Manaaki Whenua 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, and through our procurement and services will encourage other organisations to adopt sustainable practices.

SDG 13: Manaaki Whenua will measure, reduce, and mitigate our greenhouse gas emissions using ecologically restorative practices to maintain our net zero position while we progressively decarbonise; understand climate risk to our business and increase our resilience; and develop relevant policies and plans that integrate social, economic, cultural, and environmental dimensions.

SDG 17: Manaaki Whenua will partner locally and nationally with Māori, regionally with Pacific Island peoples, and globally with research and other organisations to build capacity, enhance knowledge- and data-sharing and access to science and technology, and enhance the Global Partnership for Sustainable Development.



Rainwater from the office wing of our Te Rauhitanga building is channelled into a rain garden. We will harvest water from the main office roof for use in the building.

Our Strategy 22 Goal

Our sustainability

3

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 operations

Sustainability is a characteristic of an organisation's strategy and activities that relates to the impacts of the organisation on the social, cultural, economic, and environmental elements valued by society. At Manaaki Whenua our overall commitment to sustainability is reflected in our vision statement, 'Kia tupu matomato a Tāne, a Rongo, a Haumia-Tiketike – let it be that the land and all its fruits may flourish', and in our core values [Manaaki tangata and Science that delivers]. Our vision statement and values also reflect our partnership with Māori, who have their own philosophy of sustainability in mana, tapu and mauri, and in whakapapa and tikanga.

Our sustainability policy establishes the commitments we make in those areas that are considered important [material]

by internal and external stakeholders. 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. We used the UN SDGs as a framework. The revision is ongoing as we integrate Māori interests.

The scope of the policy includes the activities of Manaaki Whenua: 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. Our scope excludes Toitū Envirocare and New Zealand's Biological Heritage National Science Challenge, which have their own policies.

Sustainable procurement

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.

Life-cycle pricing is included as part of pricing evaluations, where applicable. Environmentally appropriate disposal of packaging is required. Replacement items are to be disposed of through donations to volunteer organisations, if possible, such as replacement desks in our Auckland office. IT equipment is sent to various e-waste organisations.



PAPER CONSUMPTION

4.85% 
reduction

Ethical sourcing practices and supply chain management have been included in various procurements, such as our branded clothing initiative and the audio-visual equipment for our Lincoln rebuild project, Te Rauhitanga.

In that project, locally sourced, sustainable, and environmentally responsible products have been used wherever possible. This includes certified sustainable timber with a certified chain of custody for all cladding, framing, and joinery; low volatile organic compound (VOC) levels in paints, adhesives and underlays; and water-efficient tapware.

Orders for office consumables are consolidated to reduce transportation impacts, and environmental products are highlighted in the online catalogue. Our supplier provides a quarterly report on our environmental and New Zealand-made products to see where improvements can be made. We now source KiwiCopy photocopying paper made using certified fibre from sustainably managed plantations and forest operations, from a carbon-neutral-certified supplier. Over the past year, and in part due to Covid-19, we have seen significant reduction in use of consumables such as paper as our staff have adapted to a more digital work environment.

Coffee is now a more expensive category than paper, and Utz certified coffee beans are available from our supplier, as are Fair Trade tearoom consumables.

Taking action to combat climate change

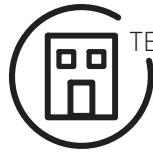
Given the focus of our business on the sustainable use of natural resources, it is especially important that we manage our operational activities to minimise any adverse impacts on the environment and our communities.

We have been certified to the ISO 14001 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 yet been able to eliminate. We maintain carbonzero certification through our subsidiary, Toitū Envirocare, which purchases certified carbon credits on our behalf. We have co-led an Aotearoa Circle project aiming to make more indigenous not-for-harvest forest carbon credits available to meet the demand for them from Aotearoa New Zealand businesses like ours.



Carbonzero certification
2011–present

ISO 14001 certification
1998–present



TE RAUHĪTANGA: LINCOLN REBUILD PROJECT



Waste construction material recycled



Godley building is solar-ready



30,000 L rainwater collection tank

The organisation is making progress in replacing our car fleet with electric vehicles by moving to hybrids in the first instance, and when feasible to an electric vehicle car fleet. Our challenge here is the range often required by vehicles being used off-road in remote locations. Off-road vehicles will be considered once our health and safety considerations can be met. A further challenge has been our ongoing use of refrigerants and the leakage into the atmosphere. We are seeking equipment to monitor and avoid such losses.

Sustainable energy options are part of the contract evaluation process, and wherever possible improvements are made to current energy sources. For example, in 2019 we removed coal as a source of heat in Lincoln. In line with Manaaki Whenua's national solar initiative, the roof of the new Godley building has been future-proofed to hold photovoltaic panels.

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 Acceleration Programme – which

looks to identify and develop both projects and people. This year we have continued to make progress in the commercialisation of a rodent-specific toxin, native mushroom species, and predator lure chemicals.

Two more staff have entered KiwiNet's Emerging Innovator programme this year, which explores pathways to commercialisation and a focus on market understanding.

KiwiNet – successful innovation funding for some of our young scientists

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 to access the tools, connections, investment, and support they need to commercialise research.

We are using KiwiNet to drive innovation opportunities for our researchers. Manaaki Whenua is a partner in KiwiNet, along with all six other CRIs, Callaghan Innovation, Otago Innovation, Lincoln University, University of Canterbury, Wellington Univentures, WaikatoLink, AUT Enterprises Ltd, Cawthron Institute, and the Malaghan Institute.

Our Strategy 22 Goal

Our infrastructure

4

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 for interaction with New Zealanders.

Te Rauhitanga – the gathering place

Through our Te Rauhitanga programme we are pioneering new ways of working that power exceptional science, better integration, and a stronger, united culture. As part of this programme we

have designed our new building at the Lincoln site to bring our research to life for our partners, stakeholders, and the community.

Highlights of the build include:

- Acoustics carefully designed to ensure that the open office environment supports different work styles.
- ‘Main Street’ – a space that joins three buildings together (Fleming, the new Godley office building and the Allan Herbarium) creating a nexus for our campus.
- A visitor experience designed to support hosting our partners and members of the community, connecting these visitors to our research through interactive experiences.
- New collaboration spaces and flexible project spaces.
- Sustainable, solar-ready design including rainwater harvesting, use of recycled materials and above-code insulation.

Palmerston North Improvement Project

The Palmerston North Improvement Project was developed after staff workshops and engagement sessions to determine how to modernise and make the best use of the space available in the Palmerston North office. The different aspects of the project included bathroom and lighting upgrades, repairing skylights, improved reception, seminar and meeting rooms, toilets and showers, and a furniture upgrade.

In-house technology transformation

In 2019/20 we continued our work on Te Tūāpapa – a project to improve science delivery through improved planning and delivery of science projects, better people and time management, and robust and controlled financial processes, all of which enable greater scientific impact.



A view of the new Lincoln office; Te Rauhitanga – the gathering place.

As part of Te Tūāpapa, this year we replaced the ageing InfoCentre financial management program with a new finance and project management tool, NetSuite, customised to encompass science, support, and process functions via accurate, trended, financial data. We also upgraded much of our information technology infrastructure, including a significant rollout of better online working capabilities during the Covid-19 lockdown, and moving our in-house data server storage, to more secure and better-supported offsite data centre locations.

Our
Strategy
22 Goal

Our
partners

5

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 research Platforms of the early 2010s, to the National Science Challenges (NSCs) since 2015, we have been active in supporting system alignment within New Zealand science.

Partnership is also central to our Strategy. We formalise relationships that bring together complementary skills, align planning, leverage investment and build trust within and beyond the science sector, into government and industry. Our emphasis is strongly on integration – across organisations, research disciplines, and issues. These

relationships also create opportunities for staff secondments and personal development.

As in previous years, this year we have developed new partnerships across linkages in the science value chain.

Partnering nationally 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.

Food and fibre

In June 2020 we signed a partnership agreement with Farmlands Co-operative and AgResearch to effect change within the food and fibre sector across a series of projects. The partnership will help to connect our science with farmers, for mutual benefit. It will help to ensure we are conducting the right science so that farmers get the information they need to be competitive and sustainable.

Pest control

This year we have also continued to collaborate with Orillion, a state-owned enterprise producing pest control products, to jointly develop a novel selective toxin for rat control. The relationship has been extended to include the New Zealand government's G2G programme to support opportunities for this project to bring benefit to South-East Asian food production areas by reducing crop and seed losses.

International partnership

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

INRAE

In June 2020, Science New Zealand (the combined Crown Research Institutes) signed a memorandum of understanding with the French National Institute for Agriculture, Food and Environment (INRAE). The agreement recognises the common scope and purpose of the organisations and encourages exchange programmes and collaborative projects. This was the first time the CRIs had acted together to form a collaboration with an overseas institute. It builds on several decades of research collaboration between individual CRIs and the French at a project level. A key focus is to foster opportunities for collaboration among early-stage researchers including staff exchanges for career development. All parties look forward to easing travel restrictions caused by the global pandemic.

Science for impact

Strategy 22 – Pillar 3

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.

There are four key goal areas within this strategy pillar:

Goal 6: Innovative & challenging

We are tackling greater science challenges with greater rewards for New Zealand. We actively seek and support innovation.

Goal 7: Strategic & integrated

We work on longer and larger scales and more complex problems, integrating across disciplines and stakeholders.

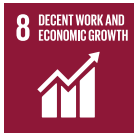
Goal 8: Valued & trusted

We are responsive to the needs of our clients and partners. We produce whole solutions with and for them. Our advice is trusted.

Goal 9: Engaged with all New Zealanders

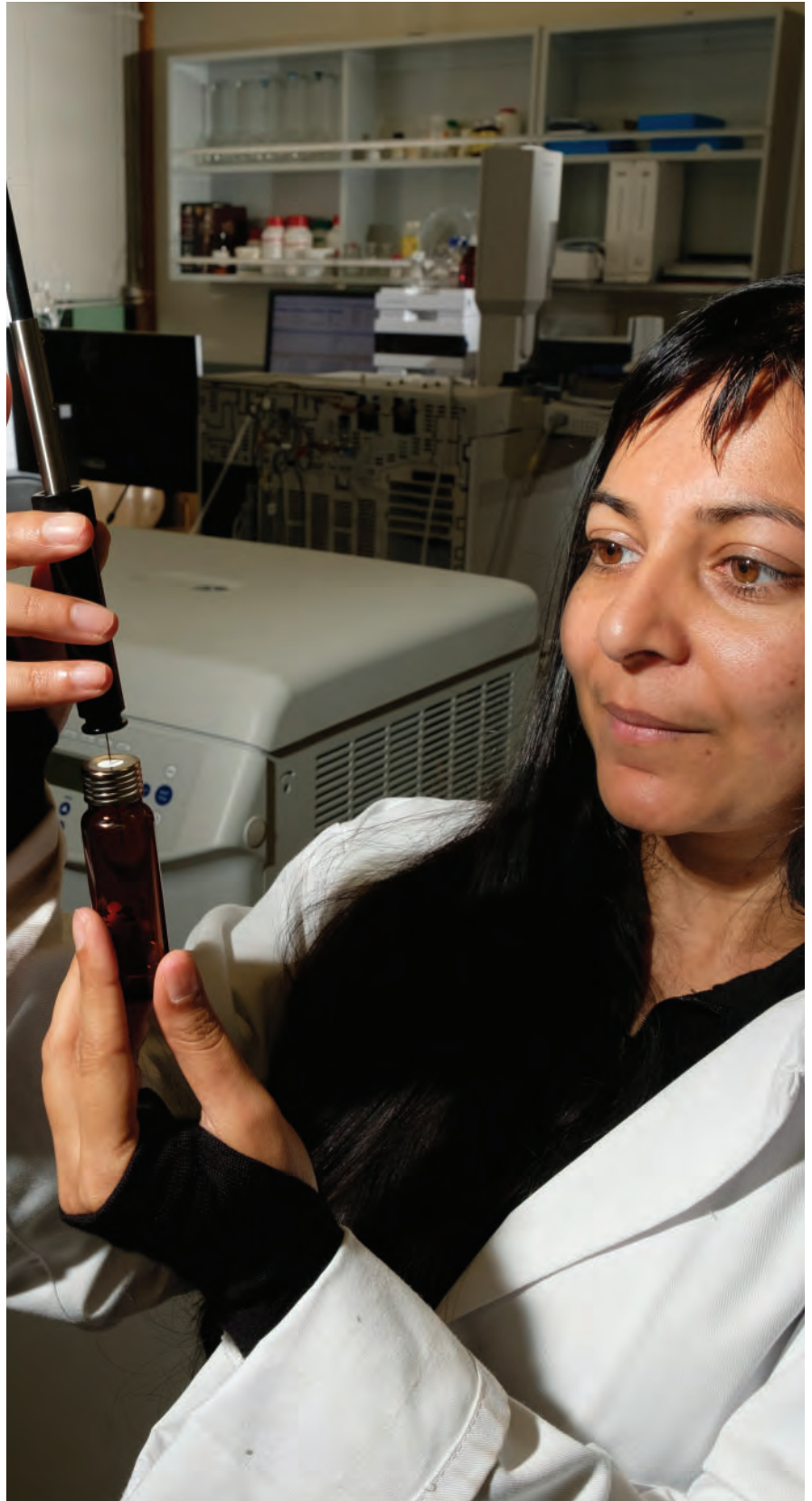
We have a strong identity and we engage citizens in our research and speak with authority.

RELEVANT SDG



SDG 8: Manaaki Whenua will achieve sustainable economic performance that supports innovation, entrepreneurship, job creation, staff development, fulfilling roles, and advancement opportunities with fair remuneration.

In addition to SDG 8, our science contributes to the UN SDGs through our outcomes and ambitions [see pages 28–52].



Dr Manpreet Dhama in the lab.

Our Strategy 22 Goal

Innovative & challenging

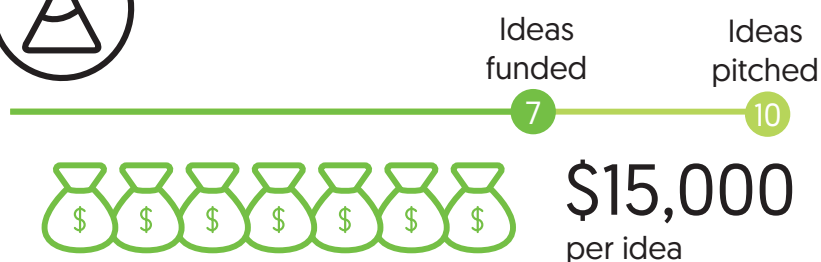
6

Our focus is on delivering science and research that will create real-world impact for New Zealand. Measuring impact in terms of societal change and benefit is made difficult by the long timescales and complex attribution process that can be involved.

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



SCIENCE DEN



The Science Den

The Science Den is an example of an internal innovation fund with a novel governance model, in which staff with innovative ideas can pitch for up to \$15,000 in funding to develop their idea through a prototype phase. In 2019/20 we saw 10 ideas pitched to the Science Den. Ideas covered topics from the very applied to the very conceptual. Of these projects, seven were funded:

- Weka as a natural rodent control
- Developing a novel nitrate sensor
- What makes *Phytophthora* pathogenic?
- Bacteria as a niche study system
- Grape waste for microbial bio-transformations
- Exploiting Allee effects with pheromone decoys
- Silicate weathering for mitigation of CO₂

Bacteria as a niche study system

At the end of January 2020, Dr Tom Etherington and Dr Phil Novis pitched an innovative idea to Manaaki Whenua's Science Den about better modelling of the fundamental niche of a species, which was given the green light by the Den panel.

The fundamental niche of a species is the environmental conditions under which a population will grow. Modelling the fundamental niche forms the basis of most invasive species risk assessments. However, there is scant empirical evidence available, and a disappointing lack of data about fundamental niches and their shapes. Therefore, niche models may be relying on assumptions about niche shapes that may be incorrect, which would mean that invasive species risk assessments are also incorrect.

The researchers proposed the novel use of bacteria as a fundamental niche study system. Bacteria grow quickly and their environments can be controlled. Rapid findings from studies in bacteria may then be transferable to invasive species modelling, including wilding pines and vertebrate predators.

The researchers have now run many proof-of-concept experiments to measure how bacteria population growth rates vary across temperature and pH gradients. As of the end of the reporting year they are moving on to more complex modelling of niche shapes, adding other dimensions relating to the space in which an organism can live, including how the niche shape might change when a competing species is introduced.

Outside Thinking & Brilliant Writing

Outside Thinking and Brilliant Writing is an initiative designed to give researchers time to develop new thinking and novel ideas, through collaborating with others both internally and externally to gain a fresh input and challenge our thinking. The initiative has:

- sought to develop novel research agendas
- involved external researchers we had not collaborated with before, who have complementary (but different) research experience to our staff
- committed us to writing a synthesis paper for a top refereed journal outlining a new research agenda for the next 5–10 years that has global (not just national) significance
- provided significant mentoring to early-career scientists in writing and critical thinking.

We identified and funded two opportunities in 2018/19. The first was 'Multiple invasive weeds', and the second was 'Stabilisation of soil carbon'. Both were affected by Covid-19 but we made good progress via powerful online conversations.



¹Scimago journal ranking.

² Web of Science 2011–2020, for financial year 2019/20.

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.

By traditional, academic measures of science impact, the quality of our research continues to be high. In the past year Manaaki Whenua's average science journal impact citation score [calculated from the number of times a science paper is referred to by others] was 4.2, up from 3.9 in 2018/19.

Our Strategy 22 Goal

Strategic & integrated research



Increasingly we work on longer and larger scales and more complex problems, integrating across disciplines and stakeholders. In order 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.

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 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.

Our organisational response to Covid-19 included an audit of how our work is integrated across research portfolios and by science ambition. In ongoing development of our integrated research toolkit [i3], we engaged staff in an intersect mapping exercise, identifying areas of strategic strength and areas in which linkages should be developed. This work has been especially powerful between our research portfolios and has increased the desire for research priority areas to collaborate further.

**Our
Strategy
22 Goal**

**Valued &
trusted**

8



LINKONLINE SEMINARS

Live session
attendees

1,546

Later
views

963

Total
audience

2,509



11
Seminars

We are responsive to the needs of our clients and partners. We produce whole solutions with and for them. Our advice needs to be trusted.

Excellent research is not enough to address New Zealand's environmental challenges. A growing focus for Manaaki Whenua is to deliver user-ready solutions and advice that respond to the needs of our users, who must respond to these challenges – often with some urgency. A priority goal is that the solutions and advice we develop are valued and trusted because they meet users' priorities and expectations.

To achieve this, we work closely with our major central and local government stakeholders to develop the evidence base for conservation, biosecurity, land management policy, legislation, and regulation. Increasingly, we employ deeper partnership approaches, such as secondments, to better understand the specific needs and priorities of users of our advice and tools.

We also regularly provide our key stakeholders with up-to-date briefings, both in person and online. This year, due in part to the restrictions on in-person information sharing caused by Covid-19, we improved our webinar capabilities and ran our LINK seminar series online. Online attendance was a significant step-up from in-person attendance.

**Our
Strategy
22 Goal**

**Engaged
with all New
Zealanders**

9

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 to 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.

This year we established a benchmark measure of engagement for our key audiences. We received 1,158 responses to a survey of the New Zealand public,

including 279 responses from Māori, and 274 responses from stakeholders. Results show that levels of awareness of Manaaki Whenua within the general public are still relatively low [24%], though significantly higher among Māori [32%]. Stakeholders' results indicate good recognition of our new brand and high levels of trust in the organisation. The survey presents us with many other insights that will guide our engagement initiatives over this and future years.

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 the past year our digital team delivered 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 grow our social media community. Our marketing team led a highly successful campaign in support of the New Zealand Garden Bird Survey, resulting in record levels of participation (over 7,800 surveys submitted). Our communications team led a shift in strategy towards an empowerment model for science communication. They also launched

Pūtaiao, a quarterly magazine including research highlights from across Manaaki Whenua.

Scientists try speed dating with journalists

In March this year a group of journalists and a number of our soil and land-use scientists tried a novel form of 'getting to know you'.

Chaperoned by Sarah O'Connell from Agribusiness Group and matchmade by Dr Sam Carrick and Federated Farmers, the 'speed-dating' event was a chance for primary sector journalists to meet our scientists, including Dr Paul Mudge, Veronica Penny, and Dr David Whitehead, to hear about their work in person, and to work on their 'elevator-pitch' lines.

Each scientist provided a one-to-two-page brief of key points, then a 10-minute presentation about their current work. This was then wrapped up with a rotational 'speed-dating' session for the journalists to ask each scientist in more detail about specific aspects of the work that interested them.

The journalists got access to good stories, the scientists got access to journalistic expertise in appropriate rural sector publications, and the face-to-face format forged good connections.

For Sam it was an approach that worked well. "Seeing the interest from the rural journalists was really encouraging. Often in our projects we have extension deliverables, but individually this can take a lot of work. The aim of this trial initiative was to create a collaborative forum where we each only had to chip in a little bit of work."



¹ Sprout Social media management tool.

² Facebook Insights.

* launched in April 2020.

The 2020 New Zealand Garden Bird Survey

The annual New Zealand Garden Bird Survey has been run by Manaaki Whenua for the past 14 years as a piece of citizen science aimed at estimating changes in native and introduced bird species in New Zealand. The survey, which runs for 2 weeks in June/July each year, has historically had around 3,000 participants. The results of each survey have informed an annual *State of New Zealand's Garden Birds* report, which has gained good media attention.

This year the survey was given additional attention, with the aim of expanding our experience of participatory citizen science, to enable more data to be collected and to increase our engagement with the public.

With a very limited budget but lots of creative ideas, the survey was widely promoted in national gardening and

NZ GARDEN BIRD SURVEY

6,064

Facebook Group members¹

480

Instagram followers^{1,*}

conservation magazines, on radio, on TVNZ, by newsletter, by video, and on social media, as well as on the Manaaki Whenua website.

To support the Garden Bird Survey, we run a targeted Facebook page and group. These continue to grow, with the group now having 4,306 followers (an increase of 44%)¹ and 6,064 members (up 45%)². A new Garden Bird Survey Instagram channel already has 480 followers.¹

Our 2020 media campaign was estimated to have reached 1.9 million people, who made over 750,000 page impressions and 73,000 video views on Facebook, as well as 33,000 visits to our website. Overall, 7,800 garden bird surveys were completed by citizen scientists this year – a record number and well over double the previous year, which will enable considerably richer data analysis for 2020 reporting. Further work is now planned to capitalise on this success with additional promotion in schools – aiming to engage a new generation of citizen scientists.



MANAAKI WENUA SOCIAL MEDIA

9,206

Facebook likes

143

Average engagements per Facebook post¹

30%

Increase in Instagram followers

Our response to Covid-19

Our vision and strategic purpose, and our contributions to New Zealand's science priorities, have been sharpened by the pandemic. We have all learnt that the unthinkable can happen, with devastating consequences. Our approaches to evaluating risk and being prepared were severely tested. Lockdown has forced us into a world of greater online connectedness and the need to manage disruption, alongside people's health and well-being. But there have been many positives, including the ability of our people in the CRIs to immediately switch the focus of their research to the needs of national emergency. During the national lockdown in the last quarter of 2019/20, although we were largely unable to carry out our fieldwork as planned, our science contributed significantly to our national economic recovery and well-being.

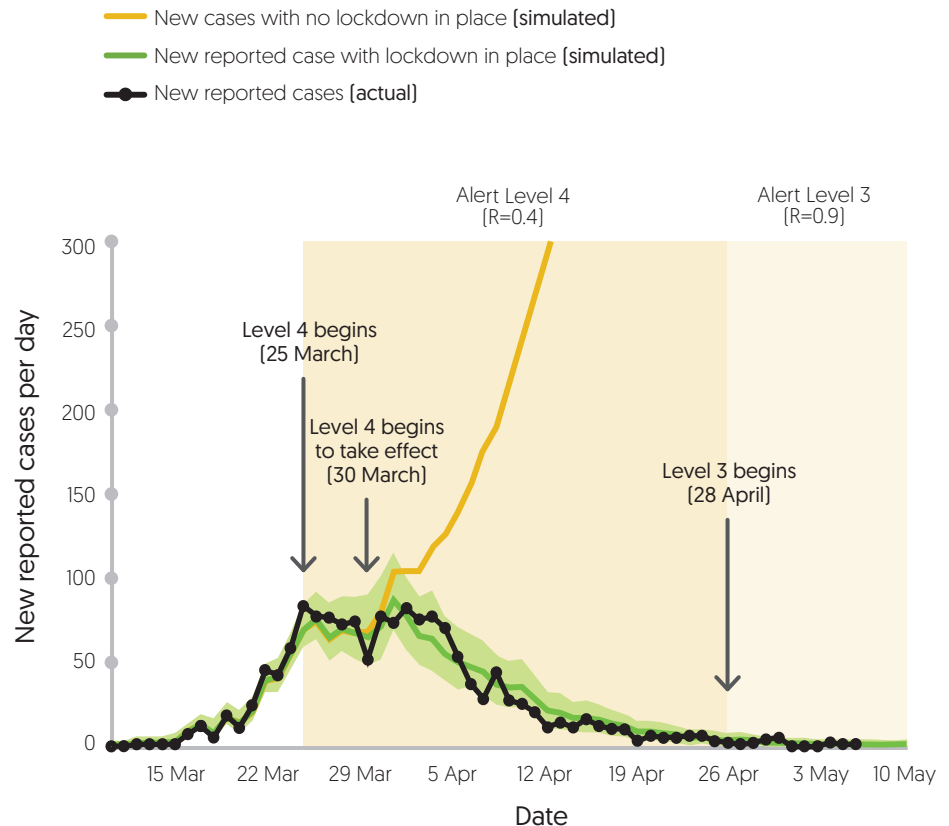


A tūi [*Prothemadera novaeseelandiae*] feeding on kōwhai flowers. Image: Rochelle Vanstone

Supporting New Zealand with Covid-related research

A stochastic model for Covid-19 spread and the effects of Alert Level 4 in New Zealand

During the Covid-19 lockdown, Dr Rachele Binny and Dr Audrey Lustig applied their predator-modelling skills to the spread of the disease, working with mathematicians and modellers at the University of Canterbury, the University of Auckland, and Te Pūnaha Matatini: the Centre for Complex Systems and Networks, on a paper to understand the likely success of New Zealand's Level 4 lockdown. The paper showed that the early Level 4 response had a significant effect on new case numbers, and that rapid case isolation, whether as a result of contact tracing, rapid testing or otherwise, can lead to containment and possibly even elimination when combined with strong population-wide controls.



Simulations of the model suggest Alert Level 4 controls had a significant effect on new case numbers.

Mapping multiple deprivation in New Zealand – a Covid contribution to policy formation

Flooding is New Zealand's most frequent and costly natural hazard, and its incidence is predicted to increase with climate change. It therefore has the potential to magnify the economic, social, and health-related effects of other deprivations, including the Covid pandemic. During the Covid lockdown period, scientists at Manaaki Whenua used the Economic and Social Vulnerability Index [ESVI] as a proof of concept to map areas of likely multiple deprivation. We looked at flooding risk as a compounding risk factor.

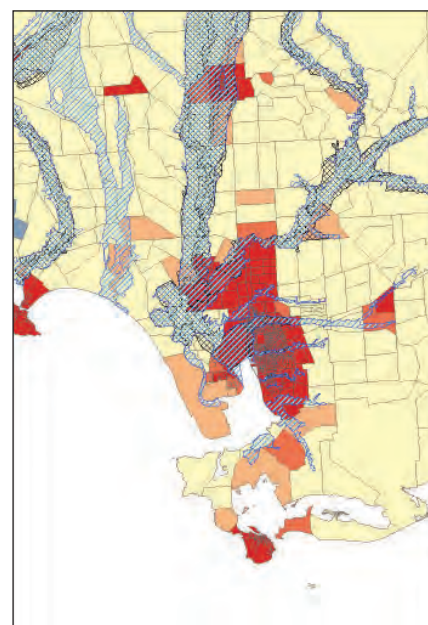
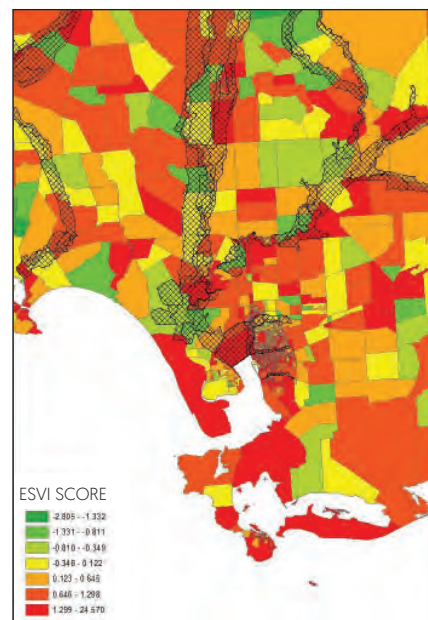
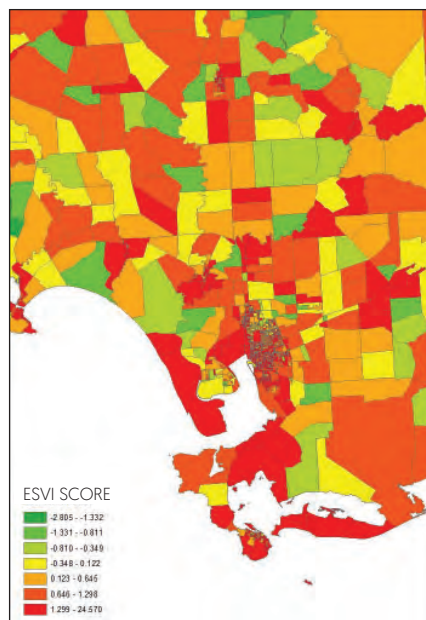
We mapped all of New Zealand and highlighted parts of Southland, the West Coast, Waikato, and the Bay of Plenty to illustrate potential ESVI 'hot spots' and 'cold spots' around New Zealand. The maps show that many of the communities most affected by the Covid pandemic are also vulnerable to climate change and water-related hazards due to their location and proximity to rivers, coastal margins, and floodplains.

Identifying areas likely to be most affected by pandemic-induced social and economic impacts and facing flood hazards enables economic recovery to be better targeted. It may also be possible to 'build back better' in ways appropriate to the needs of the people who live there; for example, by using green infrastructure to reduce the volume of stormwater that flows into streams and rivers. We recommend that

recovery investors in both government and the private sector consider similar approaches to maximise the wider social benefits of their investment.

The work, which formed the basis of a policy brief to government, was

funded via Strategic Science Investment Funding provided by MBIE. Two national Science Challenges, Resilience to Nature's Challenges and the Deep South, contributed to some of the data layers.



Overlapping maps of social vulnerability (top left), flood hazards (top right), and flood schemes (lower left) produce potential 'hot spots' of multiple deprivation (lower right).

Covid operational impact

Lowering our carbon emissions – an opportunity from lockdown

A constant in science is the need to interact with other scientists. However, international travel, in particular, is costly in terms of emissions.

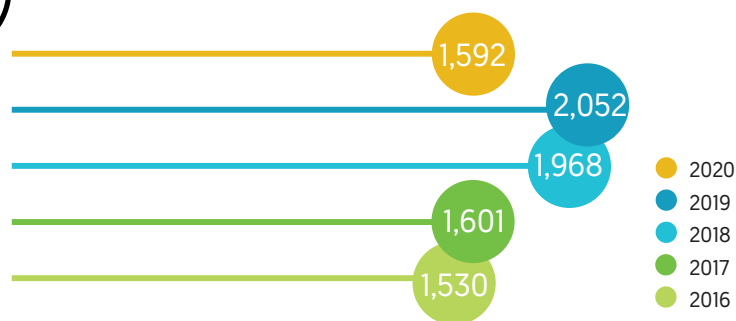
Like others during lockdown, Manaaki Whenua sacrificed national and international travel and visits by overseas scientists, and replaced them with online events and workshops. This change will continue as we take a lead in changing the travel culture through our 'Why Fly?' initiative with Science New Zealand. But the culture change needs to be managed carefully so as not to put our scientists at a disadvantage. New Zealand's scientists maintain their credibility and skills by working with other science leaders, nationally and globally. While we can employ new ways of working virtually, we still need to meet face-to-face at times, especially at the start of projects.

We are now beginning a process within the organisation to understand and consolidate what we have learned during lockdown, with a view to designing a low-carbon way of working, including more webinars, online tools, and training. This is an aspiration we want other New Zealand businesses and organisations to share, many of which are members of our Toitū Envirocare carbon management programmes.



TOTAL CARBON EMISSIONS [tCO₂-e]*

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

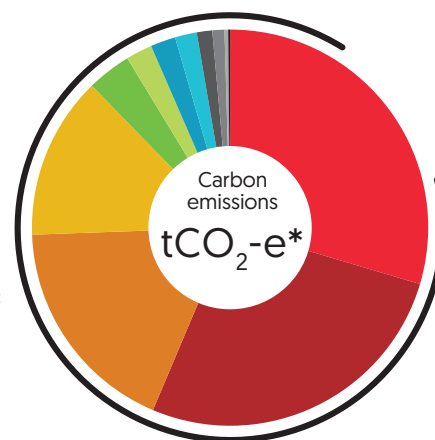


* tCO₂-e = tonnes carbon dioxide equivalent.



CARBON EMISSIONS – ACTIVITY (IN YEAR TO JUNE 2020)

- Air travel – international
- Air travel – domestic
- Electricity
- Refrigerant
- Diesel – power
- Helicopter
- Natural gas
- Rental car
- Accommodation – domestic
- Petrol
- Taxi
- Diesel – vehicles



* tCO₂-e = tonnes carbon dioxide equivalent.

Beyond Covid – designing our future

The challenge to Manaaki Whenua created by the pandemic is to provide scientific knowledge and services for New Zealand to operate in a new, economically challenged world.

During the initial stages of the pandemic the Government sent strong signals about the role of research, science, and innovation in the recovery, and its intention to provide stable investment, both for jobs and for impact. Nonetheless, all Crown Research Institutes embarked upon similar processes of organisational assessment to better understand the future of their research and business development.

In May 2020 Manaaki Whenua established three 'Future of...' workstreams to explore our post-Covid responses. The workstreams were designed with an initial lifespan of 6 months. Much of this work was already in the pipeline as part of an update of Strategy 22, but the pandemic brought it forward.

The **Future of Work** workstream concentrates on the changing nature of working styles and infrastructure, using design thinking methods to envisage how working patterns and norms might change. This recognises generational shifts in expectation and the need to balance the convenience of working remotely with the needs of building workplace community.

The **Future of Business** workstream builds on the initial work of better integrating our business development with our research portfolios and our engagement framework, to enable business and research agility. It aims to optimise our funding opportunities and better integrate our research activities, both across the organisation and between Crown Research Institutes.

The **Future of Research** workstream will improve our understanding of internal and external integration requirements to meet Covid recovery needs and better position our science for the future. It will provide feedback for strategic science development to ensure that we can partner, collaborate, and co-design in response to a post-Covid world.

Impact on our organisation in 2019/20

Culture, health, safety and well-being

Our staff were supported throughout the pandemic lockdown period, including flexible working arrangements, the chance to borrow office furniture and IT equipment from work ahead of lockdown, and technology upgrades to enable effective collaboration online across all our sites. Regular updates were sent to all staff by a dedicated Covid-19 team, including updates from senior leadership.

Financial performance

The effects of Covid-19 on our financial performance are described in Part 2 of this Annual Report.



The living room of Manaaki Whenua scientist Dr Jagath Ekanayake was transformed into a temporary laboratory during the Level 4 lockdown as he built and tested a soil sensor network.

Summary of KPIs

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

Non-financial KPIs

Strategy goal area	KPI	FY18	FY19	FY20
Our People	1. Employee engagement index	70%	88%	81%
	2. Employee turnover	8.5%	6.9%	4.5%
	3. Health & safety (near misses)	34	46	31
	4. Health & safety (lost-time injuries)	0	2	1
	5. Average tenure (years)	13	11	8
Science working with mātauranga Māori	1. Research relevant to Māori	96	89	93
	2. Research involving Māori	46	49	50
	3. Māori-centred research	25	24	31
	4. Kaupapa Māori	22	23	23
Our sustainability	1. Tonnes CO ₂ per \$m revenue*	26.38	27.11	18.95
	2. Certified total tonnes CO ₂ -e	1968.19	2051.63	1591.78
Strategic & integrated	1. Impact of scientific publications (mean citation score)	3.1	3.9	4.2
Engaged with all NZers	1. Facebook likes	5686	8758	9206
	2. Participants in Garden Bird Survey	4376	3082	7800
	3. Interactions per social media post	92	126	143
Our infrastructure	Currently we have no established non-financial KPIs to report against these strategy areas.			
Our partners	These are a work in progress.			
Innovative & challenging				
Valued & trusted				

*This table shows a provisional revenue amount for 2019/20. Full audited revenue amounts are shown in Part 2 of the Annual Report.

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Becky Lloyd

Dr Andrea Byrom*

Melanie Mark-Shadbolt

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Chief Scientist
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General Manager,
Māori Development
General Manager, Development
General Manager,
Brand & Communications
General Manager, Science
General Manager,
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* Daniel Patrick (from 14 Dec 2020)

BANKERS

ANZ Bank New Zealand Limited

AUDITORS

Audit New Zealand on behalf
of the Auditor-General

SOLICITORS

Buddle Findlay



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+

smart and
passionate people

50+

sites
nationwide

6,000+

science projects
every year

40+

nationally
significant databases
and collections

sciencenewzealand.org

CallaghanInnovation
New Zealand's Innovation Agency



Manaaki Whenua
Landcare Research

agresearch
āta mātai, mātai whetū



NIWA
Tāhoro Mōkūrangī



**GNS
SCIENCE**
TE PŪ AO

scion



**Plant & Food
Research**
Rangahau Ahumāra Kai

E/S/R
Science for Communities