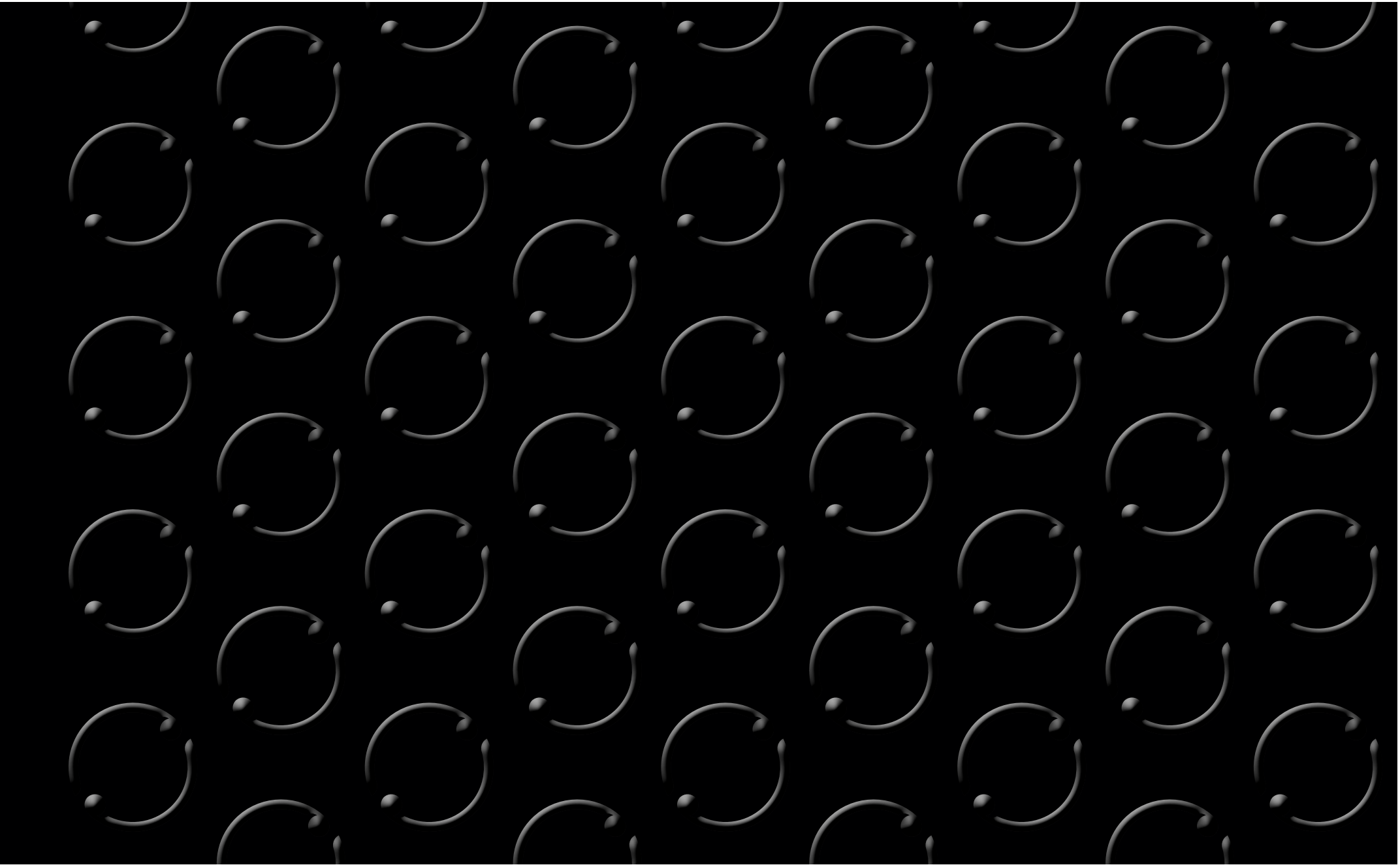


We present our Annual Report in two parts. Part 1 provides an overview of Manaaki Whenua, highlights of our science that show the contribution we are making towards our four ambitions for New Zealand, and an update on the progress we are making in delivering on Strategy 22, our 5-year strategy. In Part 2 we present our directors' report and financial statements.

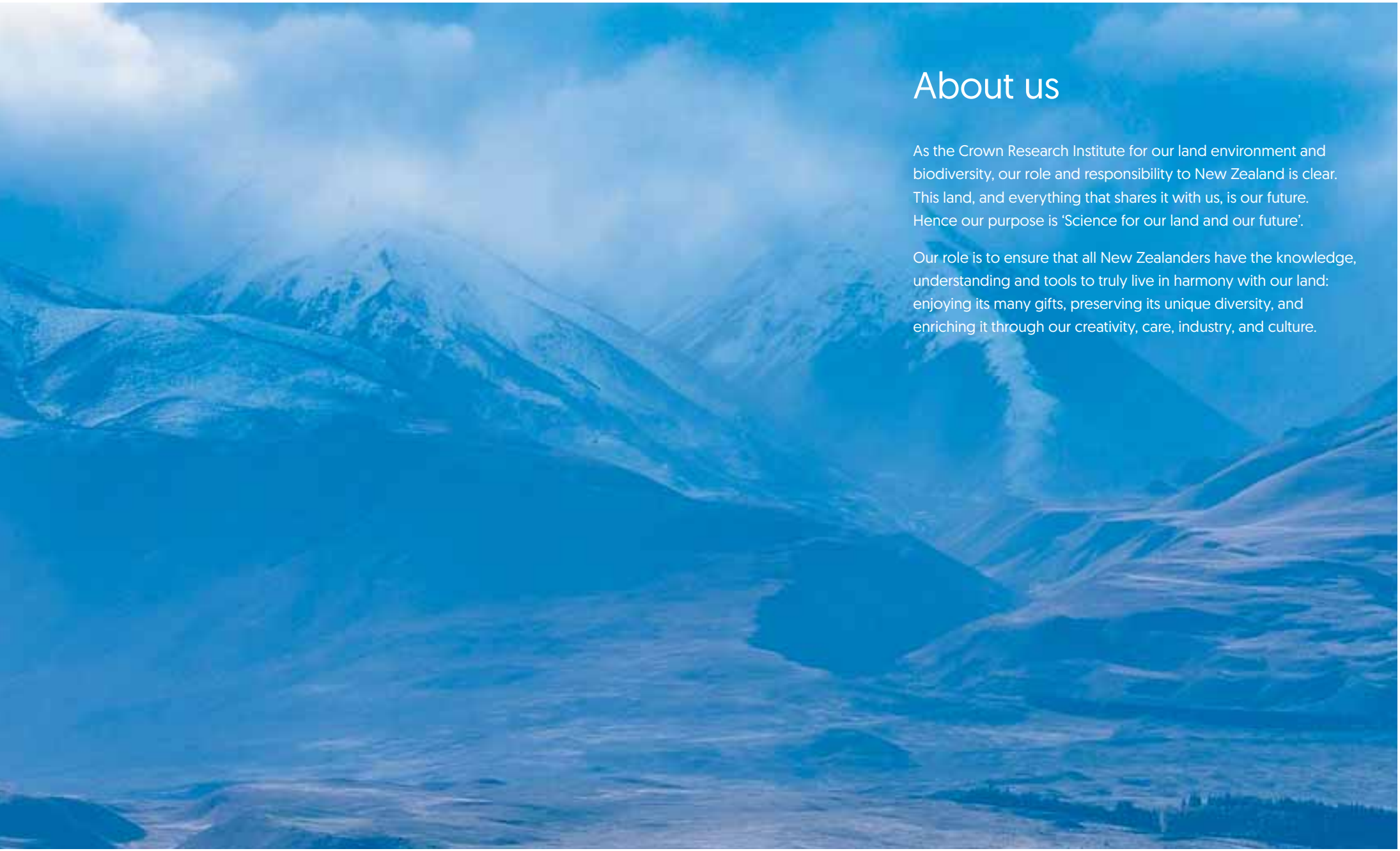
PDF versions of both Part 1 and Part 2 are available for download from the Manaaki Whenua – Landcare Research website: manaakiwhenua.co.nz/report

Contents

PART 1

Our Land, Our Future

Tō tātou whenua, mō āpōpō



About us

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.

A word from our Chair and CEO

We are pleased to present our 2019 report for Manaaki Whenua, which describes progress towards our vision that the land and all its fruits may flourish. It has been a positive year for Manaaki Whenua, with strong improvement in performance across all of our capitals. Particular highlights have been the stories of uptake and impact of our science in supporting the sustainable use of natural capital and ecosystem services; the recruitment of many excellent new staff; a very positive 26% increase in our staff engagement score; the widespread acknowledgement of our staff and science by peers and partners; and progress with our internal initiatives that are making Manaaki Whenua fit for the future. We thank our 427 people for the outstanding contributions they have made to these achievements.

This report describes how our strategy and structure have shaped our role in enabling New Zealand to achieve its ambitions for biodiversity, biosecurity, and our land and wider environment, including the country's response to climate change. Our science has informed and influenced government, primary industry, Māori and the wider public in saving our taonga (treasured) species, protecting our freshwater resources, using our soil sustainably, and both mitigating and adapting to climate change.

Our work is performed against a global backdrop of major social and environmental challenges. In the past year the Intergovernmental Panel on Climate Change and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services have published severe warnings about the likely extent and impacts of climate change and biodiversity loss. The New Zealand Government has published Environment Aotearoa 2019, a state of the environment report that paints an uncomfortable picture of our land, water, and greenhouse gas emissions. School students have been on strike and cities have declared climate emergencies. In our work, these important global issues confront us daily and more starkly.

As we consider the enormity of the challenges, we take the view that positive action – at any scale – is increasingly important in a world flooded with negative stories and polarised views. For us, this means our research, science and technology must have impact. It must inform, influence and make more effective the positive actions of our partners. We acknowledge that our science is but one contribution. Action by communities is critical to societal change when it is guided by values and peer support, informed and enabled by science and technology, bounded by regulations, and achieved through individual behaviour.

It is not surprising, therefore, that demand for our work on the social dynamics of change has grown, supported largely by the National Science Challenges, where there is a realisation of the critical role of community aspirations and pathways to societal change. New Zealand's Biological Heritage National Science Challenge, which we host, is a leading example. We are very proud of its outstanding contribution in this area and acknowledge the work of its governance, Kahui Māori and management groups in achieving a very positive review of its first 5 years' performance.

At the other end of the science spectrum our work using genomics, artificial intelligence (AI) and 'big data' has also increased as we utilise new scientific approaches to find solutions to biodiversity loss and sustainable land use. We have worked with numerous community groups and land managers to ensure these solutions help them in practical ways with their challenges and aspirations – from predator-free cities and sanctuaries, to farmers 'doing the right thing' on the land and optimising land uses.

Our recruitment of 60 additional science staff in the past 3 years has brought greater capacity, diversity, skills and international networks to Manaaki Whenua. This has been across all areas of our science. We have also increased our non-science staff to enable us to progress projects across our people and culture (enhancing well-being, safety and leadership skills) and our infrastructure (a large replacement building at Lincoln, and enhancements to system security and information technologies).

Our deepening partnerships with government, primary industry, Māori and public communities are supporting our impact as we invest in active listening, earlier engagement, co-innovation, and stewardship of scientific knowledge. We welcome a new partnership with the Ministry for the Environment (MfE) that recognises the potential for working more closely on common issues. Our partnerships in the science world are deepening through coordination provided by Science New Zealand and the National Science Challenges. We are also building long-term relationships

with overseas institutes, such as Wageningen University & Research in the Netherlands. These bring mutual benefit, especially in the career development and inspiration of our people through exchanges.

Our financial performance continues to be strong. We reached new highs with our revenue and profitability (before investment). Our retained earnings have enabled us to invest without debt in the replacement building at Lincoln for 80+ staff, which is due for occupation by the end of 2020.

CEO Richard Gordon, Chair Jane Taylor and the Hon. Dr Megan Woods, Minister of Research, Science and Innovation, break ground for the new building at our Lincoln campus.

We are on track with our Strategy 22 initiatives. Working with Māori has seen us recruiting more Māori to Manaaki Whenua, building new relationships with iwi such as Ngāti Kurī in the Far North and Māori businesses such as Parininihi ki Waitotara and Hikurangi Enterprises. Many of our people have engaged in our training to raise Treaty of Waitangi awareness and understanding of partnership, Māori tikanga (customs), and language (te reo).

Our Strategy 22 science initiatives are boosting innovation – both for new research directions such as predator control strategies, and for new product possibilities such as indigenous edible fungi. We acknowledge and appreciate the support of KiwiNet in this development. We have also continued to enhance our integrated science capacity to encompass the social, economic, and cultural complexity of environmental issues. We have lifted the public's awareness of our work through social media, and initiatives such as the award-winning stand at National Fieldays (a farm industry event), the NZ Garden Bird Survey, and outreach to schools. New programmes have started in the Pacific, bringing our weed biocontrol, biodiversity, and economic capabilities to Island Nation challenges.

Our Enviro-Mark Solutions (E-MS) business has had a record year, reflecting an increased desire by organisations to understand and manage their carbon footprints. Over the past decade E-MS has secured a market position of providing credible programmes and certification of achievements by its customers. This year it also became a certified B-Corp, leading by example in this important developmental area. We acknowledge the exceptional leadership and contribution of its CEO, Professor Ann Smith, who is stepping down from the role. E-MS is core to Manaaki Whenua's business, and its contribution to sustainable development – both now and in the future – is of huge relevance and importance.

Ultimately, what motivates Manaaki Whenua's people is making a difference by partnering for impact and providing leadership where it is needed; informing decisions despite information often being uncomfortable; and experimenting to find the best solutions that respect multiple world views. In the face of severe global challenges, we celebrate the work of our people and our partners and look forward to continuing to lead environmental science that creates impact – and value – for New Zealand.

Jane Taylor – Chair
29 August 2019

Richard Gordon – CEO
29 August 2019

He Kupu nā te Pou Whakarae rāua ko te Tumuaki

E koa ana māua kia tāpae i te pūrongo ā tau 2019 mō Manaaki Whenua. Kei roto rā te whakmārama mō te kaneke pēhea kia whaktutukihia te moemoeā “kia tupu matomato a Tāne a Rongo, a Haumia Tiketike”. He tau whaihua tēnei kua hipa atu, inā te kaha pikinga o te mahi huri noa i ō mātou rauemi katoa. Ka tika kia mātua tīpakohia ngā kōrero e whai ake nei: (1) te kuhunga o tō mātou pūtaiao hei tautoko i te whakamahinga tūroa o ngā rātonga pūnaha rauropi me te kaupapa rauemi ao tūroa; (2) te maha noa o ngā kaimahi hou tino pai rawa kua whiwhi nei mātou; (3) he pikinga tōrunga (26 ōrau) mō tō mātou kaute whakaurunga; (4) te whakamihitanga whānui a ō mātou kaimahi e ō mātou hoa rangapū, tuākana-teina pūtaiao hoki (5) te kaneke o ngā mahi ā-tari nei hei whakatikatika i a Manaaki Whenua mō āmua. Ka tika me mihi nui ki ō mātou kaimahi 430 nā rātou i whaiwāhi mai ki ēnei whakatutukihanga papai rawa.

Ka riro mā tēnei pūrongo hei whakamārama i pēhea te hanga o tō mātou rautaki, hanganga hoki me te pānga mai ki tō mātou tūranga hei whakamana i Aotearoa kia whakatinana i ōna whāinga mō te kanorau o ngā momo koiora, te tiaki pai i aua koiora, tō tātou whenua me te taiao whānui hoki, tae noa ki tō Aotearoa urupare ki te nekehanga o te āhua o ngā rangi (arā te nekehanga āhuarangi). Ko tō mātou pūtaiao kua whakamārama atu, kua whakaaweawe atu hoki ki te kāwanatanga, te ao ahumatua, ngāi Māori me te ao tūmatanui, hei rauora i ngā momo taonga koiora, hei tiaki i ngā rauemi wai Māori, hei whakamahi i te one i runga i te whakaaro mō te ao tūroa, hei whakamauru, hei urutau hoki ki ngā nekehanga āhuarangi.

Mahi ai mātou i roto i te horopaki o ngā wero o te ao whānui e pā ana ki te taiao me te hapori whānui. I te tau kua hipa i whakaputaina ētahi kupu whakatūpato tino taumaha mō te pānga whānui mai o te nekehanga āhuarangi me te ngaromanga o ngā momo koiora. Nā te Komiti Ao Whānui mō te Nekehanga Āhuarangi me te Komiti Ao Whānui mo Ngā Koiora Kanorau me ngā Rātonga Pūnaha Rauropi ēnei kupu whakatūpato. Kua whakaputaina hoki e te Kāwanatanga te Pūrongo Taiao Aotearoa 2019. Ka whakaatuhia e tēnei pūrongo he pikitia manawarau mō te whenua, te wai me ngā puhapuha hauhā. Kua tutū puehu ngā tuaira kura, ā kua whakapuakitia e ētahi taone nui he “Ohotata Āhuarangi”. I roto i tō mātou mahi ki Manaaki Whenua, he rite tonu te pānga mai o ēnei take whakahirahira o te ao whānui ki a mātou, ia rangi ia rangi. Kua nui kē atu te pānga mai o aua take i ēnei rangi.

Kei te whakaaroaro mātou mō te whakahara o ēnei wero. Heoi ki tō mātou whakaaro me mahi tonu ahakoa pēhea te tauine iti o te mahi. Me pērā ahakoa kua tāmia katoatia te ao e ngā kōrero kino, kōrero taumaha hoki me ngā tirohanga kiriweti. Mō mātou, he tohu tērā me mātua whai hua tō mātou rangahau, pūtaiao, hangarau hoki. Me whamamārama, me whakaawaawe hoki i te mahi a ō mātou hoa rangapū. Arā, nā ta hua o tā mātou mahi me whai hua nui kē atu te mahi a ō mātou hoa rangapū. E mōhio ana mātou ko tō mātou pūtaiao tētahi koha kotahi anake o te whāingaroa. He mea nui rawa hoki te mahi a ngā hāpori iti hei whakarerekē i ngā mātāpono o te hāpori whānui. Engari e tika ana kia riro mā tō mātou pūtaiao, hangarau hoki hei āwhina, hei ārahi i te haerenga. Kia noho hoki ko ngā mātāpono pai me te tautoko o ngā tauākana-teina hei āwhina. Kia tāpareparehia hoki e ngā ture, kia whakatutukihia e ngā mahi takitahi a te tangata.

Nō reira, nā whai anō kua kaha ake te hiahia mō ō mātou rangahau e pā ana ki ngā taineke o te nekehanga hāpori. Ko te rahinga o te tautoko mō tēnei momo rangahau i ahu mai i ngā Wero Pūtaiao Ā-Motu Nei. E mārama ana rātou ki te hiranga o ngā wawata o te hapori hei para i te huarahi mō te nekehanga ā-hapori nei. Hei tauira – ko te Wero Ā-Motu mō Ngā Koiora Tuku Iho (ko mātou kei te whakamanuhiri i a rātou). E tū whakahī ana mātou ki te koha mai o tēnei kaupapa, ā, me mihi ka tika ki tōna poari, Te Kāhui Māori me ngā rōpū whakahaere. Nā rātou katoa i oti pai ai te arotake mō to whakatutukihanga o tana rima tau tuatahi.

Ki tērā atu pito o te tūāwhiorangi pūtaiao ko tō mātou mahi raweke huinga ira, te hinengaro horihori me te raraunga kaitā. Kei te tipu haere tō mātou whakamahinga i ēnei kaupapa me kore ake pea ka kitea ētahi rongoā hei aukati atu i te ngaromanga o ngā momo koiora kanorau, hei āwhina hoki i te whakamahinga o te whenua i runga i te whakaaro mō te au tūroa. Kua mahi mātou i te taha o ngā rōpū hāpori me ngā kaiwhakahaere whenua maha noa hei whakatūturu ka whai āwhina rātou hei whakatutuki i ō rātou hiahia: Mai i te wawata kia whakakorengia atu ngā kīrearea i ngā taone me ngā piringa taiao, tae noa ki ngā momo āwhina mō te kaipāmu kia “tika tana mahi” i runga i te whenua, kia mākoha tana noho ki runga i te whenua.

Ono tekau ngā kaipūtaiao hou kua timata i Manaaki Whenua i te toru tau kua hipa. Nā tērā kua piki ake

tō mātou āheinga, te kanorau hoki a ō mātou kaimahi, ngā pūkenga me ngā hononga atu a Manaaki Whenua ki te ao whānui. Ko ēnei kaipūtaiao hou kua kuhu mai ki ngā wāhi katoa o tō mātou pūtaiao. Kua piki ake hoki te tokomaha a ō mātou kaimahi kore-pūtaiao hei āwhina i a mātou kia kaneke i ngā hinonga puta noa i ō mātou tāngata, i tō mātou ahurea hoki (te whakanakonako i tō mātou oranga, haumaru, me ō mātou pūkenga rangatiratanga) me tō mātou hanganga (tētahi hangatanga nui hou ki Ōtautahi me ngā whakanakonakotanga ki te haumaru o te pūnaha me ngā hangarau pārongo).

Kei te pai te haere o ngā kaupapa Rautaki 22. Ko tētahi whāinga kia mahi tahi me ngāi Māori. Nā tērā kua whiwhi mātou i ētahi kaipūtaiao Māori. Kei te whiria hoki te taura tangata ki ētahi atu iwi pērā ki Ngāti Kuri ki te Taitokerau, Parininihi ki Waitōtara me Te Hinonga Hikurangi. E hia kē ngā kaimahi kua whakangungua hei hiki i te māramatanga ki te Tiriti o Waitangi me ngā tikanga Māori, reo Māori hoki

Koa ana mātou kua timata tētahi hoa rangapūtanga ki te Manatū mō te Taiao. Kei te aro atu mātou tahi ki te pito mata kia mahi tahi i runga i ngā kaupapa taiao e pā tahi nei kia mātou tahi. Kei te kaha haere hoki ō mātou hoa rangapūtanga i roto i te ao pūtaiao. Ko Pūtaiao Aotearoa rātou ko ngā Wero Pūtaiao Ā-Motu Nei hoki kei te āwhina i a mātou kia pērā. Kei te whanake hoatanga tūturu hoki mātou ki ētahi rōpū nō rāwāhi, pērā ki te whare wānanga o Wageningen ki Hōrana. Mā ēnei momo hoatanga ka whaipainga ngā taha e rua. Ka pēnei ake mō ngā huarahi whanake kaimahi me te whakamanawa kaimahi i runga i te ara whakawhiti kaimahi.

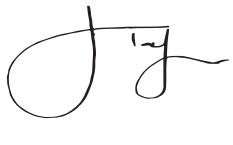
Kei te kaha tonu te hua o tō mātou mahi ā-pūtea nei. I eke mātou ki tētahi teiteitanga hou ā-pūtea nei, ā haumoni nei hoki (i mua i te whakangaotanga). Mā ngā haumoni kua pupuri nei mātou ka taea te whakangao (kore nama nei) ki te hangatanga hou ki Ōtautahi mō ngā kaimahi whitu tekau. Ko te tikanga, hei te mutunga o te tau 2020 ka whakanohoia taua hangatanga.

Ko ngā kaupapa pūtaiao o Rautaki 22 kei te whakakaha i te wairua auaha – mō te aronga rangahau hou (pērā ki ngā rautaki whakahaere kīrearea) me ngā āheinga hua hou pērā ki ngā momo hekaheka taketake ka tareka te kai. Me mihi ka tika ki a Kiwinet i roto i ēnei āhuatanga. Kua ū tonu hoki mātou kia whakanakonako i tō mātou āheinga ki te whakakotahi i ngā momo pūtaiao, kia uru mai ai te taha hāpori, ahurea, ōhanga, tae noa ki te whīwhiwhitanga o ngā kaupapa taiao. Kua hikitia te māramatanga o te tūmatanui ki tō mātou mahi mā ngā kaupapa pae pāpāho pāpori me ngā mahi pērā ki te Ngā Rangi Pāmu o te Motu (i whiwhi tohu mātou mō tō mātou mahi ki reira), te Rangahau Manu Māra me ngā kaupapa whātoro atu ki ngā kura. Kua timatahia ētahi whakaaturanga hou ki te Moana nui a Kiwa. E kawe ana mātou i tō mātou pūtaiao whakahaere ā-koiora nei i ngā otaota ki reira, me tō mātou āheinga mō te mahi kanorau koiora, mahi ōhanga hoki ki ngā wero o ngā whenua moutere.

Tino pai hoki te tau mō tō mātou umanga a Toitū. He tau inati mō rātou me kī. He whakaaturanga tēnei o te pikinga o te hiahia mō ō rātou rātonga mai i ngā rōpū e ngana ana kia mārama, kia whakahaere hoki i o rātou tapuwae hauhā. I te tekau tau kua hipa, kua whakatūngia e Toitū he tūranga mākete e taea ai e rātou te tuku whakaaturanga whaimana, tiwhikete hoki mō ōna kiritaki.

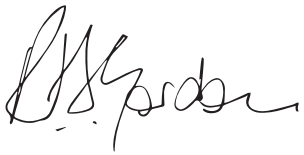
I tēnei tau hoki i whakawhiwhia ia ki te tohu B-Corp. He tohu tēnei e āhukahuka ana ki te tauira ārahitanga o Toitū i roto i tēnei wāhi whanake hiranga. Me mihi hoki ki te tino ārahitanga o te Tumuaki – Te Ahorangi Ann Smith - kei te whakwātea ia i tōna tūru. He umanga whakahirahira rawa a Toitū ki a Manaaki Whenua, me tōna koha mai ki te kaupapa whanaketanga i runga i te whakaaro mō te ao tūroa. Ināianei, ā, mō āmua hoki. Inā kē noa atu tōna nei hiranga.

Hei te mutunga o te rā, ko te mea e whakahihiko nei i ngā kaimahi o Manaaki Whenua, ko te whakaaweawe panonitanga mā te mahitahi ki ngā hoa rangapū, mā te tuku ārahitanga i ngā wā e hiahiatia ana. Ko tā mātou he whakamōhio ki ngā whakatau ahakoa he manawarau i ētahi wā. Ko tā mātou hoki he whakamātauria kia kite i ngā rongoā pai rawa e whakaute ana i ngā tirohanga o tēnā o tēnā. Kei te anga atu tātou katoa ki ētahi wero taumaha rawa mō te ao whānui. Engari ko tā mātou kia āhuareka ki te mahi a ō mātou hoa rangapū. Kei te titiro whakamua hoki mātou kia ārahi tonu mātou i ngā mahi pūtaiao whaihua mō te taiao – whai uaratanga hoki – mō Aotearoa.



Jane Taylor – Pou Whakarae

29 Hereturikōkā 2019



Richard Gordon – Tumuaki

29 Hereturikōkā 2019

Our purpose

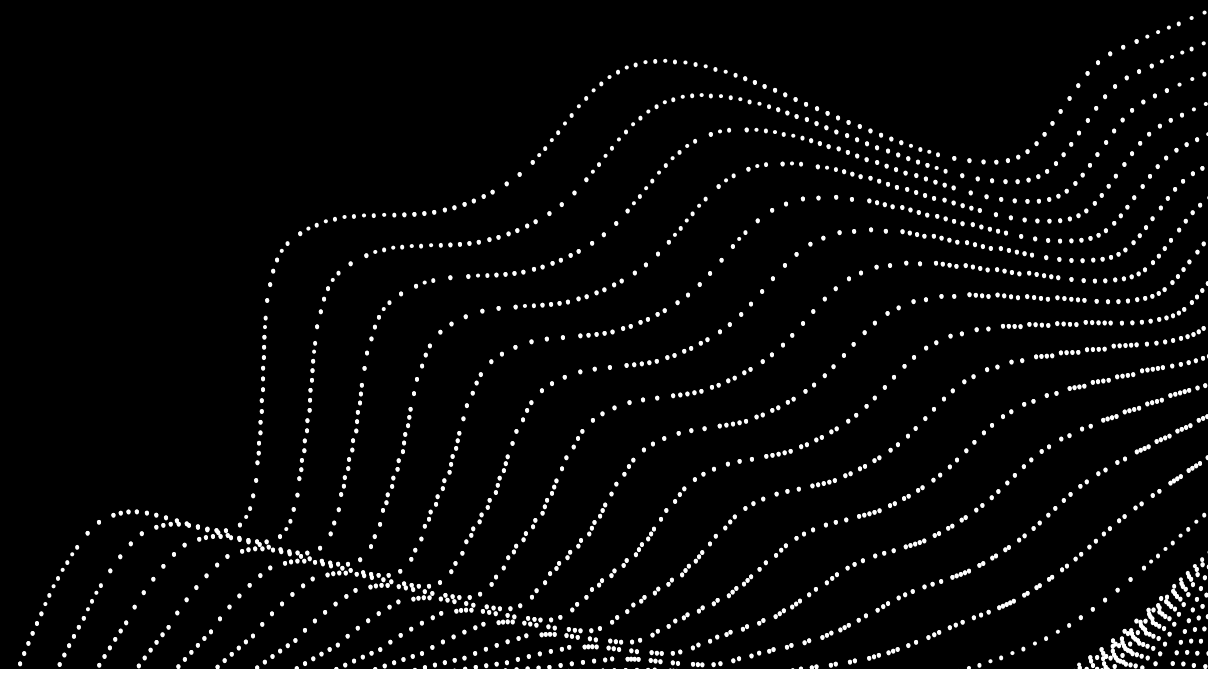
We are an organisation of 427 scientists, researchers and experts supporting science, who are dedicated to helping New Zealanders understand and live well with our land. We want to ensure all New Zealanders have the knowledge, understanding and tools to live in harmony with our land by enjoying its many 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

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

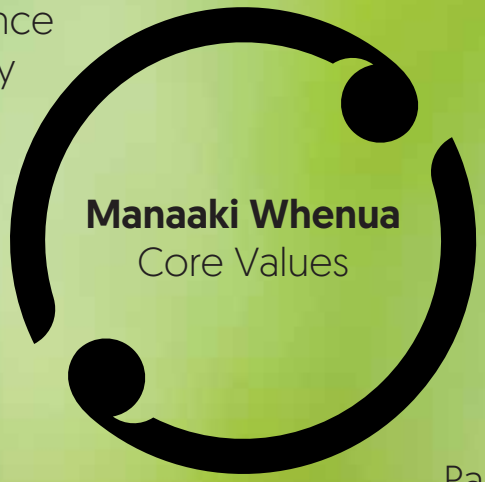
KIA TUPU MATOMATO A TĀNE, A RONGO, A HAUMIA-TIKETIKE

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

Our values

SCIENCE THAT DELIVERS

Excellence
Relevance
Integrity



Caring
Partnering
Common Purpose

MANAAKI TANGATA

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 any research can be, we value research that is relevant to New Zealand and the challenges we face as a country.
Our science must be excellent, and as an independent research institute our integrity underpins our partners' trust.

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

Our behaviours

A pillar of our 5-year strategy – Strategy 22 – is building an irresistible culture, a culture underpinned by our values that empowers us to create positive impacts for New Zealand's land environment. In the past year we have worked with our people to define our irresistible culture. Our 5 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 though integrated and innovative research. Through the next year we will be progressing a culture programme designed to embed our behaviours, build on our existing strengths, and develop other areas to ensure we have a resilient, empowering and ultimately irresistible culture at Manaaki Whenua.

Experiment to learn
Mā te hē ka tika

Share freely & often
Kia rite tonu te tohatoha

Invite input from others
Kia areare mai ōu taringa

Embrace diversity
Awhi mai, awhi atu, tātou tātou e

Commit to excellence
Whāia te iti kahurangi

Our locations

Our eight locations across New Zealand house 427 staff including the staff of our subsidiary, Enviro-Mark Solutions, and another 59 research associates. These locations facilitate science projects that span the length and breadth of New Zealand.

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

COLLECTIONS AT AUCKLAND

NZ Fungal & Plant Disease Collection
103,119 specimens

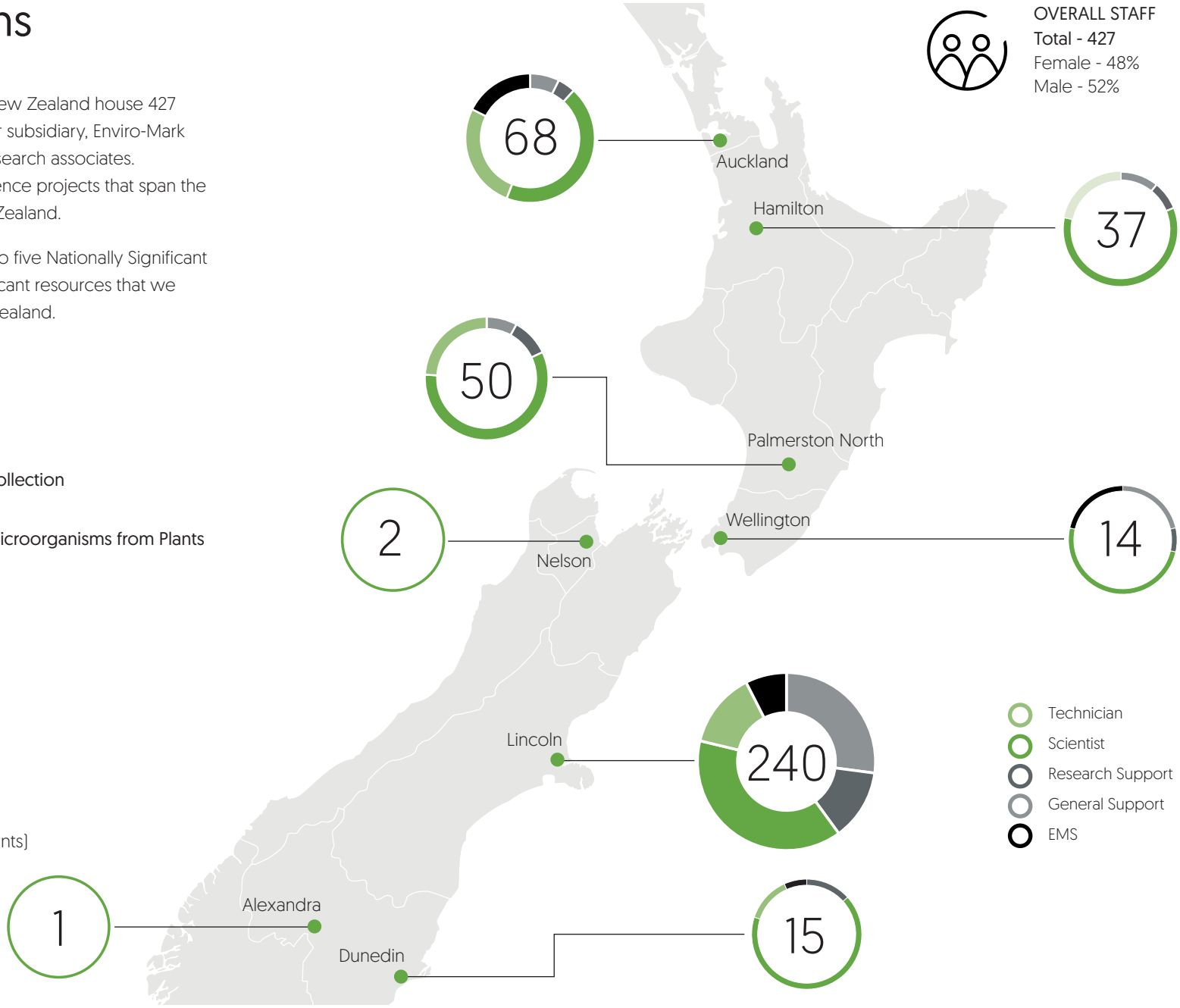
International Collection of Microorganisms from Plants
22,122 specimens

NZ Arthropod Collection
c. 7,000,000 specimens

COLLECTIONS AT LINCOLN

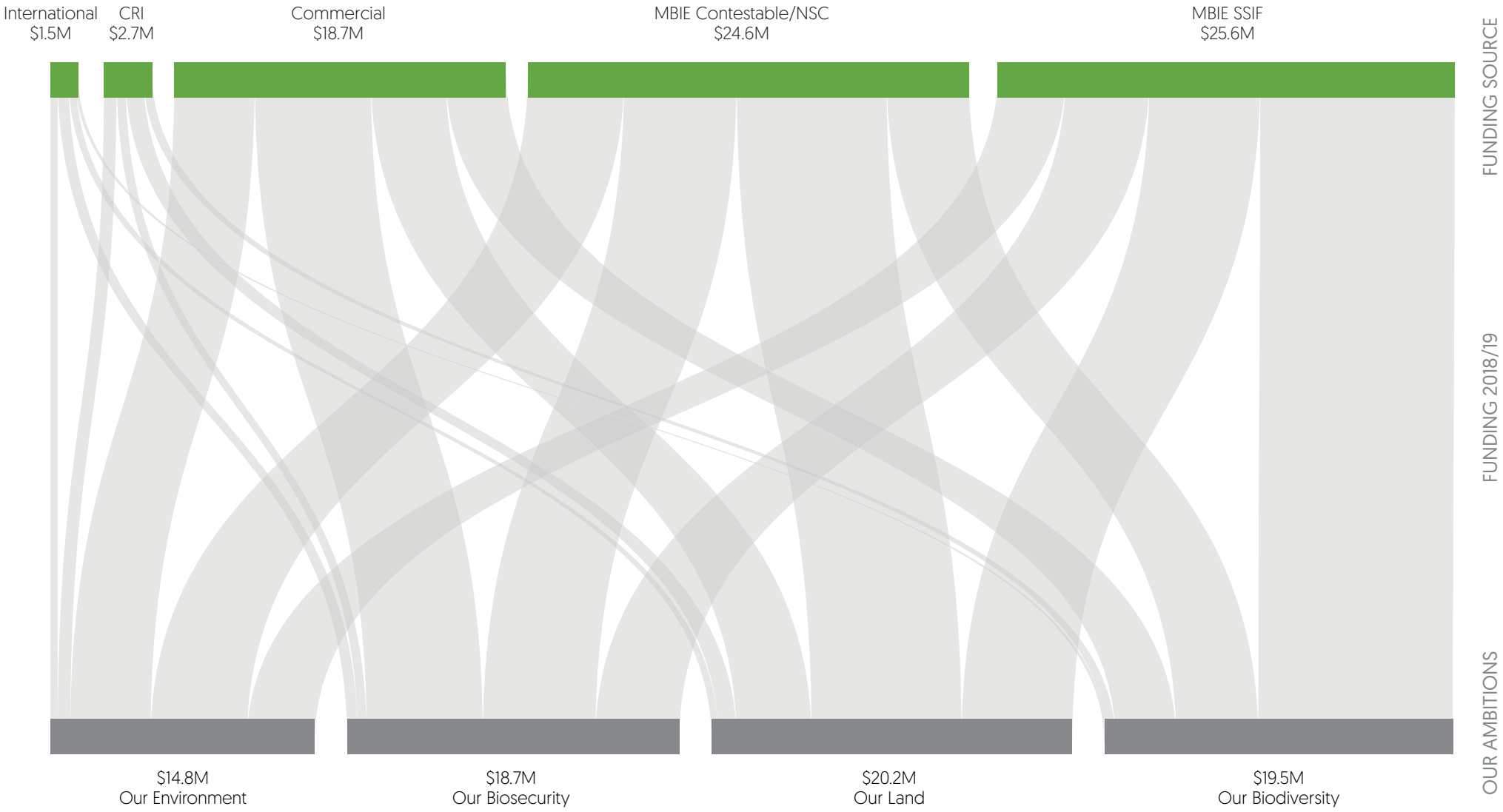
Allan Herbarium
c. 655,000 specimens

NZ Flax Collection (Living Plants)
263 selections



Our investments in science impacts

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



Our 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 that is 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.

Ngā Tipu Whakaoranga Database

97,873	Page views^
2,408	Database records
15	Requests – cultural plant information (not flax)
30,365	Visitors

http://maoriplantuse.landcareresearch.co.nz

Land Resource Information Systems (LRIS) Database

271,500	Page views
4,996	Data downloads
68,200	Users
100,500	Visits

http://lris.scinfo.org.nz

National Vegetation Survey (NVS) databank Database

14,591	Page views^
109,122	Plots
2,294	Datasets supplied
55	Data requests
500	Registered users
68	New datasets
639	Plots added

http://nvs.landcareresearch.co.nz

* in scientific publications (based on Google Scholar)
^ courtesy of Google Analytics

New Zealand Flax Collection

Collection

263	Selections
24	Orders sent
97	Enquiries
112	Visitors

manaakiwhenua.co.nz/harakeke

Allan Herbarium (CHR)

Collection

c. 655,000	Specimens
1,614	Specimens sent
44	Loan requests responded to
478	Identification & enquiries
523	Visitors

manaakiwhenua.co.nz/allanherbarium

New Zealand Arthropod Collection (NZAC)

Collection

c. 7 million	Specimens
29	Loan requests responded to
548	Identification & enquiries
71	Visitors

manaakiwhenua.co.nz/nzac

New Zealand Fungarium (PDD)

Collection

103,119	Specimens
390	Specimens sent
20	Loan requests responded to
155	Identification & enquiries
188	Visitors
38	Specimens cited*

manaakiwhenua.co.nz/pdd

International Collection of Microorganisms from Plants (ICMP)

Collection

22,122	Cultures
97	Orders sent
797	Cultures sent
170	Identification & enquiries
188	Visitors
158	Specimens cited*

manaakiwhenua.co.nz/icmp

Our board

Jane Taylor
Chair

Jane is a professional director, with a strong background in both law and finance.

She holds numerous directorships and is also chair of Predator Free 2050 Ltd, a key player in achieving New Zealand's Predator Free 2050 ambition.

She was awarded the Otago Daily Times Business Leader of the Year for 2016.

Dr Paul Reynolds QSO
Deputy Chair

Paul served as Chief Executive of the Ministry for the Environment from 2008 until 2015. He holds a PhD in Biochemistry from the University of Otago and is Chair of AgResearch.

Prof. Emily Parker
Director

Emily is a Professor in Chemistry and Biochemistry at Victoria University, leading a team focused on the science and application of complex biomolecules.

John Rodwell
Director

John is an experienced director with a background in corporate finance, investment banking, and investing in agri-businesses.

Prof. Caroline Saunders
Director

Caroline has 30 years' research expertise and over 300 publications specialising in sustainable economic development.

The Honourable Kate Wilkinson
Director

Kate is a former Member of Parliament and Cabinet Minister. She was appointed Commissioner of the Environment Court in May 2015.

Ngarimu Blair
Director

Ngarimu holds a number of directorships in iwi development, rugby, the science sector, and sustainability leadership. He is currently the Deputy Chair of the Ngāti Whātua Ōrākei Trust in central Auckland.

Our leadership team

Dr Richard Gordon
CEO

Richard is passionate about good science making a positive difference for society and the environment.

He became Chief Executive in 2011 after 5 years as Science General Manager.

Dr Steve Lorimer
GM Development

Innovation, investment and commercialisation leadership.

Chris McDermott
GM Brand & Communications

Building one of New Zealand's great brands.

Nigel Thomson
GM Corporate Services

Ensuring the sustainable and efficient operation of our organisation.

Holden Hohaia
GM Māori Partnerships

Building strong and mutually valuable partnerships with Māori.

Dr Peter Millard
GM Science

Developing new research collaborations and co-leading our science portfolios.

Dr Fiona Carswell
Chief Scientist

Leading our high-performing science teams.

Kylie Hansen
GM People & Culture

Building a great culture with great people.

Graham Sevicke-Jones
GM Science and Knowledge Translation

Applying our science to environmental challenges.

Our Context

An outside perspective

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. Beyond New Zealand, our internationally respected scientists are involved in global efforts to address the many challenges posed by climate change and sustainability, and their work also offers practical solutions to New Zealand's local and regional environmental management issues.

To ensure that our science is relevant and on track, we have set up Advisory Panels that draw on external expertise: one panel of scientists and one of stakeholders from government, industry, iwi, and the primary sector.

Our Minister sets out her expectations for Crown Research Institutes annually, and we share the challenges and opportunities in our operating environment with other New Zealand and international businesses. For example, technology and the workforce are changing, and we need to adapt to new ways of working and expectations of staff, both young and old. We have unique requirements to find the right science capabilities and build our capability in Māori research. Within New Zealand and worldwide such capabilities are a finite resource and in high demand. We need to be the preferred employer.

The science system has also become more complicated, with more entities focused on the increasingly complex and 'wicked' problems the world faces. Manaaki Whenua must navigate this complexity successfully through collaboration and leadership. We see exceptional opportunities in integrating across the current science and science-user ecosystem, which is represented in our approach to partnerships.

Global priorities

A new generation of concerned citizens – from striking school students to cities declaring a climate emergency – increasingly looks to science for leadership and answers to the significant environmental challenges being faced by us all – globally, nationally and locally. These challenges are large and highly complex and will not be solved solely by scientific knowledge, but by intelligent and well-timed social interventions guided by that knowledge.

The Intergovernmental Panel on Climate Change and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services have both issued renewed and stronger warnings in the past year about the impacts of global change. They have advised that transformational change will be needed to avert these risks. Manaaki Whenua staff have contributed to both of these international groups.

As a signatory to the United Nations Sustainable Development Goals (SDGs), New Zealand reports on its progress towards meeting 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. The SDGs provide a framework not only for our science but also for our wider performance in achieving social and economic goals. We are evaluating the SDG indicators as an internationally accepted framework for target setting in our work.

Our research and science directly support the four UN SDGs that relate to the health of our biosphere: Life on Land, Life below Water, Climate Action, and Clean Water and Sanitation. Manaaki Whenua's science is increasingly supporting the ability of communities – especially indigenous Māori communities – to take part in democratic processes that influence the natural environment and address resources. As a New Zealand business, we also contribute directly to economic and social goals through our sustainable business practices, and by being a good employer providing skills development in communities.

SUSTAINABLE DEVELOPMENT GOALS

New Zealand's science priorities

In her Annual Letter of Expectations of March 2018, the Hon Dr Megan Woods, Minister of Research, Science and Innovation, highlighted several critical areas of focus for Crown Research Institutes: sustainable economic development (including increasing export value from the land), maintaining a healthy environment, and transitioning to a low carbon economy – ultimately to improve the well-being of all New Zealanders. In these areas Manaaki Whenua is adding value in the following ways.

Higher-value products from the land: We work increasingly with other Crown Research Institutes to provide farmers with the tools and knowledge they need to ensure credibility and transparency in their environmental performance; to improve 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.

A healthy environment: We are a major contributor to the Our Land & Water National Science Challenge, our S-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, to better understand how biodiversity and ecosystem services affect human well-being and how human activities affect biodiversity and modify ecosystems, to help land managers make more informed natural resource management decisions. We also aim to support regenerative agriculture with a credible scientific evidence base.

Low carbon economy: We created a new research portfolio focused on climate change mitigation and adaptation to ensure this important area has the necessary profile for us to continue providing science leadership in both greenhouse gas emissions and soil carbon inventory and management. Our subsidiary, Enviro-Mark Solutions, is a lead contributor in our efforts towards this goal. 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.

New Zealand's Well-Being Budget

The 2019 budget has become known as the 'Wellbeing Budget'. Manaaki Whenua is well placed to support the Government's priorities for well-being and the integration of production, sustainability and inclusivity. We are working with The Treasury to develop a new 'well-being monitor' index. The concept is to assess the contribution of each of the four capitals (natural, social, human, physical/financial) that influence well-being, and develop indicators to help track how these contributions are changing over time.

Getty Images

Science Advisory Panel

Our Board's Science Advisory Panel has an important role in evaluating scientific quality. The Panel meets annually to review our performance, future research directions, and capability needs to ensure our research is both excellent and relevant, and that we are taking advantage of key developments in international science. Each year the Panel is asked to concentrate on specific areas for review. These reviews take place in advance of our annual review of the Strategic Science Investment Fund (SSIF) allocation.

Our Science Advisory Panel on a field trip to Lake Areare, near Hamilton.

In 2018/19 the Panel was chaired by Professor Stephen Goldson (AgResearch) and comprised Professors Jason Tylianakis (University of Canterbury), Jan Bebbington (University of Birmingham, UK), Adam Jaffe (ex-MOTU, now in the USA), Mark Adams (Melbourne), and Andrew Campbell (Australian Centre for International Agricultural Research).

This year we held the Panel meeting in Hamilton, and the theme for the discussions was the opportunities presented by potential disruptors of our science, including: the rise of the empowered citizen; dealing with the reality of alternative facts and fake news; AI and big data; helping communities frame the question; and making choices and taking action – our capacity to care.

The recommendations of the Panel included developing a strategy to manage the increasing amount of fake news and scientific misinformation in general circulation, based on:

- emphasising the quality and integrity of our scientific research
- maintaining our leadership in research relating to māturanga Māori by ensuring staff in this area are well supported
- building our capabilities in socio-economic and cultural research and the social science disciplines in order to address the multi-faceted and contestable nature of many contemporary environmental issues
- maintaining both our unique and significant collections, and the organisation's ability to perform and publish outstanding research.

Outcome Advisory Panel

Our Board's Outcome Advisory Panel consists of senior representatives from key stakeholder organisations in central and local government, industry and business, the primary sector, and iwi, and it 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 and provides high-level strategic advice to our Board of Directors.

In December 2018 the Panel met to discuss capacity limitations, reflecting the growing importance of technology and market disruptions facing New Zealand, and the need to see how Manaaki Whenua acts in the role of investor in science. Presentations focused on critical science capacities and the long-term need for science, on building trust and authenticity in science to give sectors the information and confidence to make changes, on more mobile career pathways for scientists, and on highlighting the key areas for each sector to support science in partnership with Manaaki Whenua.

A second meeting of the Panel in June 2019 considered future land-use change driven by climate change, environmental constraints and social licence in New Zealand. We need to navigate carefully through these complex problems and sector interests, providing robust tools, techniques and measurement at a variety of spatial scales. Key points are the need to ensure that systems are considered as a whole while recognising the complexities this introduces, and the need for integrative science that connects social, biological and physical science. An increasing need is to ensure that world views are respected, and to capture the opportunities this brings.

Making Aotearoa the most liveable place in the world

A new partnership with the Ministry for the Environment

In April 2019, the senior leadership teams of the Ministry for the Environment (MfE) and Manaaki Whenua came together to explore our shared objectives for New Zealand's land environment. Vicky Robertson, Chief Executive of MfE, shared a vision for "Making Aotearoa the most liveable place in the world". Richard shared our vision – "Kia tupu matomato a Tāne, a Rongo, a Haumia-Tiketike", translated as "Let it be that the land and all its fruits may flourish". The strong alignment of these two visions was noted by both Chief Executives, an observation that set up a productive day spent exploring opportunities for deeper partnership between the organisations.

As the teams explored the strategies underpinning these two visions, we discovered many shared strategic objectives. Three key priorities for a future partnership were identified:

- capability building at the science–policy interface
- land use adaptation for a zero carbon economy
- resource management system performance.

This has formed the basis of a partnership Memorandum of Understanding signed in August 2019. A feature of the partnership will be new opportunities for staff secondment between our organisations.

For example, during the past year Anne-Gaelle Ausseil and Phil Lyver from Manaaki Whenua were seconded to MfE to join a senior science team in the production of *Environment Aotearoa 2019*, a wide-ranging strategic report from MfE and Statistics New Zealand on the state of New Zealand's environment. This report brought together the best available environmental reporting data, as well as a body of evidence from scientific literature and mātauranga Māori, to reveal the state of and trends in our native plants, animals and ecosystems.

In 2019/20 Anne-Gaelle Ausseil will be seconded part time to the Office of the Prime Minister's Chief Science Adviser through our partnership with MfE, further building expertise at the science–policy interface.

Signing our partnership Memorandum of Understanding in August 2019.

Christine Harper

Our Ambitions for New Zealand

Our Biodiversity • Our Biosecurity • Our Land • Our Environment

Four ambitious goals

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.

On the following pages we present brief highlights of our science and research impacts in support of each of our four ambitions, together with a series of more detailed 'innovation stories'.

Our Biodiversity

Our work enables New Zealand to:

- reverse the decline of native species, habitats and ecosystems
- makuru ana ngā mahinga kai (gather food from abundant and flourishing areas)
- increase the resilience of natural ecosystems.

Our biodiversity research impacts

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

Aotearoa New Zealand has a rich biodiversity, from the smallest bacteria 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 provides the scientific foundations needed to improve New Zealand's ability to protect the most threatened species and ecosystems. This ability relies on a deep understanding of ecosystem resilience, tipping points, and how various threats – from climate change to invasive species – affect native species.

To deliver on our interlinked biodiversity research priorities and improve New Zealand's biodiversity management, we collaborate with the Department of Conservation (DoC), the Ministry for Primary Industries (MPI), regional councils, iwi, wildlife sanctuaries, non-governmental and community groups, as well as businesses. We also contribute through major national initiatives such as New Zealand's Biological Heritage National Science Challenge and Predator Free 2050.

In helping New Zealanders understand and celebrate their unique biodiversity, this year we worked with DoC to communicate information on white rust affecting *Lepidium solandri* – the nationally critically threatened Maniototo peppercress – to councils and to Land Information New Zealand (LINZ). This dissemination of information allows multiple agencies to appreciate and manage the risk to this species, including how best to mitigate population loss. We have also provided DoC with a report focusing on their capacity to determine the ecological impacts of introduced Himalayan tahr in alpine and subalpine ecosystems.

Our research has also contributed to a better understanding of another threatened species – the Haast tokoeka – New Zealand's rarest kiwi subspecies, with only around 400 individuals. Our measurement of novel genetic variation within this subspecies has provided strong support for the classification of the Upper Arawhata tokoeka as a genetically distinct population. Our work is of critical value for conservation programmes intended to maintain genetic variation and maximise the evolutionary potential of Haast tokoeka in future generations, and will allow appropriate management units to be decided upon, preventing further loss of genetic diversity.

As an example of our foundational knowledge, this year we gave technical input into the third national *Bird Atlas of New Zealand* project, led by Birds New Zealand. The atlas is an essential reference tool for land managers, developers, regional councils, conservation organisations, and researchers, showing the remaining areas of greatest bird diversity and areas that may need significant habitat protection.

We also worked with organisations and iwi across the country to share scientific findings from which all New Zealanders can benefit. For example, we contributed to a 3-day wānanga at Te Hāpua, in Northland, at the invitation of the Ngāti Kurī Trust Board, to talk to Ngāti Kurī about the results from the March 2018 Bioblitz at Kapowairua and to look at developing future opportunities. Ngāti Kurī Trust Board are seeking partners to advance their strategic goals, and this relationship will enable the future development of joint opportunities. It also provides a process for benefit sharing with iwi for systematics research.

On the next pages we share a series of innovation stories that highlight key outcomes from our research into our biodiversity.

Creating pest-free sanctuaries for New Zealand

The control of introduced mammal pests for biodiversity restoration and other objectives in New Zealand is nationally critical work. One part of this work involves 'sanctuaries': sites implementing multi-species pest mammal control for biodiversity and wider ecosystem recovery objectives with substantial community involvement. Many of these sanctuaries are surrounded by pest-proof fencing.

Sanctuary projects may be created and managed by individuals, inside agencies, community groups, or as collaborations. However, sanctuary practitioners generally lack the scientific expertise to prioritise sites, determine best-practice pest control or monitoring methods, or undertake research.

For 15 years we have run annual sanctuaries workshops that have been a key conduit for Manaaki Whenua and other science into the national sanctuary network, and we have maintained a database of sanctuary attributes. In 2014 a national incorporated society known as Sanctuaries of NZ Inc. (SONZI) emerged from these annual workshops, and this year SONZI became the main workshop organiser, although Manaaki Whenua still organises the science day.

Through mutual respect and trust we have built an enormous 'commons' database of biodiversity outcome data that will yield valuable insights for years to come. Our preliminary analyses have excited practitioners to continue their (frequently voluntary) management effort, and have encouraged agencies to continue supporting them. Our comparisons of long-term biodiversity restoration trajectories under pest eradication-focused vs suppression-focused regimes will inform future strategies where and when to deploy such regimes, with the aim of achieving the ultimate goal of pest eradication on mainland New Zealand. This research is also well aligned with New Zealand's Biological Heritage National Science Challenge.

At 3,400 ha, Maungatautari, in the Waikato, is the largest predator-free ring-fenced enclosure on the New Zealand mainland – larger than all the others put together. Manaaki Whenua has a long relationship with Maungatautari, where our studies have documented long-term (10-plus years) vegetation, invertebrate and bird responses to the removal of all pest mammals, except mice.

This year our scientists have written the 2019–29 Restoration Plan for the site. A keystone of this plan will be re-establishing a population of kōkako in the sanctuary as a flagship species for further restoration. With Maungatautari free of all pest mammals except mice, the prospects for kōkako survival there are promising. However, the ringfence is designed to keep predators out, not animals in, so discussion has also been required on systems to stop kōkako climbing out of their safe haven.

We also presented at this year's Annual General Meeting of the Maungatautari Ecological Island Trust on changes in bird and invertebrate densities on the maunga since pest eradication in 2006. The audience included Trust administrators, iwi, volunteers, and funders. The research results we presented demonstrate the biodiversity gains that have been made in the area.

Our pest control work in sanctuary areas is critical to the survival of native species, including at Aldinga in Central Otago (top and above right) and at Maungatautari (right).


Suzette Howe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National collections – not just a nice-to-have

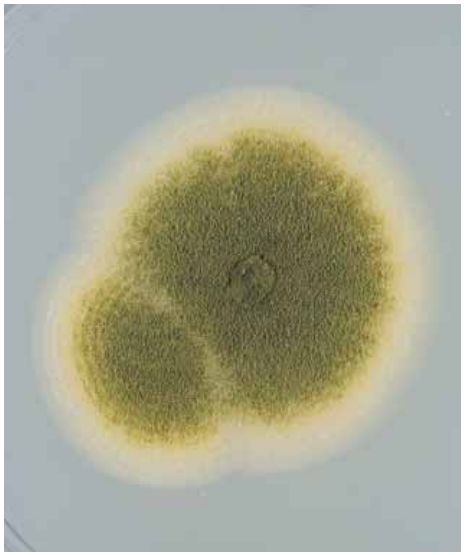
The importance of Manaaki Whenua's nationally significant collections of biota came into sharp focus this year when we worked with DoC, Auckland Zoo, and others on the challenging recent deaths of kākāpō chicks. The chicks had the respiratory disease Aspergillosis, caused by different species of the mould fungus *Aspergillus*.

In addition to our mycologists' knowledge of these fungi, our culture collection holds many isolates of *Aspergillus* that may assist with understanding why Aspergillosis is now a significant problem in kākāpō survival. Our researchers visited vets at Auckland Zoo to view affected kākāpō and to receive samples for analysis, and are involved in genomics work associated with the causal species.

Routine maintenance of the International Collection of Microorganisms from Plants (ICMP) has also led to the discovery of a new fungus record for New Zealand. This fungus, identified by DNA sequencing, is *Sarocledium terricola*. The ICMP contains over 20,000 strains of fungi and bacteria. The routine DNA sequencing of existing ICMP cultures is likely to continue to provide novel and unexpected data on New Zealand's fungal diversity.

As an example of our painstaking classification work, this year also saw the publication of the second and third volumes of a flora of New Zealand's liverworts – the culmination of over 30 years' work by Manaaki Whenua's David Glenny that required the collection and classification of over 14,000 specimens. In New Zealand we have the richest liverwort flora in the world for the size of our country, and it is quite different from other places. Currently, 653 species of liverworts and hornworts are known from New Zealand (including *Heteroscyphus cuneistipulus*, lower right) and their national and international importance have only recently begun to be understood. They help intercept rainfall in native forests, decreasing rainfall run-off and helping stabilise our soils. The chemical make-up of some liverworts may have important biological activities (for example, anti-bacterial or anti-microbial properties), which merit further research.

manaakiwhenua.co.nz/collections
manaakiwhenua.co.nz/lichen-flora



Our national collections enable swift laboratory identification of samples (such as Aspergillus*, top right), and are an internationally significant research resource.*

Restoration of cultural harvest at Te Waihora

During the year researchers have worked collaboratively with Ngāi Tahu to investigate customary management reforms, with a focus on wetlands, but more specifically black swan (Kakīnui) populations across the South Island. Black swan eggs (Hua Kakīnui) were collected as part of an annual harvest at Te Waihora (Lake Ellesmere), and also as research manipulations. For this, researchers accompanied tangata tiaki to monitor swan breeding responses to egg removal, and cygnet survival and movements. The programme supports the operationalisation of Ngāi Tahu mana motuhake over a significant mahinga kai, and contributes to the co-production of knowledge between the two groups.

Mark Herse

Craig Pauling (Ngāi Tahu tangata tiaki) collects black swan eggs as part of an annual harvest and research manipulation (right). Remaining eggs in the nests are labelled for future monitoring (below).

Mark Herse

Our Biosecurity

Our work enables New Zealand to:

- better respond to biosecurity threats
- reduce pest, weed and disease impacts
- kia tiakina ngā taonga tuku iho (better protect treasured species).

Our biosecurity research impacts

We want New Zealand to be protected from invasive biological threats. Our native biodiversity and our ability to derive income both from primary industries and from our unique landscapes are constantly threatened by invasive weeds, pests and diseases.

Manaaki Whenua collaborates with many partners as part of our drive to help New Zealand reach its Biosecurity 2025 and Predator Free 2050 goals. Our research focuses on border security for early detection and prevention, and improving control methods for established invasive species.

This work is not confined to pest mammals: our science also contributes to the understanding and management of plant, algal and fungal incursions into our natural ecosystems.

This year we have worked on a wide range of research projects for landscape-scale predator control, aiming to rid New Zealand of its most damaging introduced predators – rats, stoats and possums. We recognise the need to gain social licence for new and emerging control methods, and this requires effective engagement with New Zealand communities.

As an example, we are part of the working group leading the development of a predator-free initiative based around Moehau on the Coromandel Peninsula. We are the only science provider in the group, and our involvement indicates both our reputation nationally in the Predator Free 2050 research area and our trusted relationship with the Pare Hauraki iwi collective, who are key stakeholders in the project.

We also informed the Waitaki Wallaby Liaison Group, comprising Environment Canterbury, LINZ, DoC, Federated Farmers, and individual landowners, on improving the detection of Bennett's wallabies. This is important, as confirming that a pest population has been eradicated can lead to significant cost savings for management agencies.

We prepared the science behind several successful applications for biocontrol agents, including a gall mite to curb the pest plant old man's beard: Horizons Regional Council applied to the Environmental Protection Authority (EPA) to introduce the gall mite on behalf of the National Biocontrol Collective, comprising 14 regional councils and DoC. The formation of galls helps to reduce the lateral spread of old man's beard, and as a flow-on effect potentially thins the canopy coverage and reduces shading of the undergrowth. The EPA's decision-making committee noted the environmental benefit of reducing herbicide usage if biocontrol proved effective.

Elsewhere in the country we were able to release 1,500 to 2,000 Honshu white admiral butterfly larvae at two sites in Greymouth as part of a new project to stop the spread of the invasive weed Japanese honeysuckle.

Greymouth is a key South Island site where the weed is a problem. Manaaki Whenua researchers Hugh Gourlay and Murray Dawson visited Paroa and Greymouth Schools to teach students about biocontrol agents. The visits were done for the Guardians of Paroa Taramakau Coastal Area Trust through MBIE Curious Minds funding.

The researchers also visited schools in Canterbury and Auckland over the year as part of the Great Weeds Hunt Aotearoa, raising awareness in receptive minds of pest plants such as Spartina and purple loosestrife, whose eradication aligns with priorities and control initiatives underway by DoC and regional councils.

We are also involved in more traditional monitoring of biosecurity incursions, providing high-quality molecular identification of several either deliberately mislabelled or otherwise disguised shipments of seed material that have been intercepted by Biosecurity New Zealand. We are the only provider of this service in New Zealand.

On the next pages we share a series of innovation stories that highlight key outcomes from our research into our biosecurity.

Progress towards Predator-Free New Zealand

Manaaki Whenua has conducted pest management research for decades, but its landscape-scale predator control research really began in Hawke's Bay in 2014, working with the Poutiri Ao ō Tāne project, and later the Cape to City project, led by Hawke's Bay Regional Council and DoC with mana whenua and community groups. These projects led the charge, and others have since emerged under the more ambitious Predator Free programme, a $28 million package announced by the Government in 2016 to eradicate rats, possums and stoats from the mainland by 2050.

Pablo Garcia-Diaz

Capturing and collaring mustelids in the Taranaki region.

Predator Free 2050 Ltd was established to leverage and distribute these funds to groups who could demonstrate local eradication and landscape-scale suppression of predators, and to enable them to obtain additional funding to achieve their goals. Exemplar predator control sites have been set up across the country to establish the feasibility of large-scale eradication of pest predators. Groups on Waiheke Island, and in Hawke's Bay, Taranaki, Wellington and Dunedin are formal partners in the programme. The work is multi-agency, multi-stranded and long term.

In Taranaki, for example, scientists from Manaaki Whenua's Wildlife Ecology and Management Team are collaborating with the Taranaki Regional Council, DoC, and the Taranaki Mounga Project on a research project to investigate how invasive mustelids (ferrets, stoats, and weasels) move around the landscape.

The project is part of Towards Predator Free Taranaki, which is New Zealand's largest rural predator removal scheme. It is a rural operation covering around 270,000 ha between New Plymouth and Egmont National park and involves the help of hundreds of rural residents who are keen on trapping mustelids to protect native wildlife.

Earlier in the year, Pablo Garcia-Diaz, Chris Niebuhr, and Oscar Pollard travelled to Taranaki to capture and collar mustelids. Their main objective was to understand whether mustelids living in the vast ring-plains of Taranaki can move into Egmont National Park, where the Taranaki Mounga environmental restoration programme is taking place. The field data will be combined with computer models to assess the movements of predators across the landscape over time.

In other linked work, we used a new simulation tool, TrapSim, to check whether a planned 14,000 ha trapping programme in the Taranaki ring-plain was likely to achieve its goals prior to its roll-out. Using our novel modelling, we were able to give the programme managers confidence in their proposed trap network design.

Towards Predator-Free Taranaki is supported by $11.7 million from Predator Free 2050 Ltd. It is being delivered around Mt Taranaki in different stages, and involves residents, community groups, DoC, the Taranaki Mounga Project, the NEXT Foundation, Manaaki Whenua, schools, iwi and the three district councils in the region.

manaakiwhenua.co.nz/kararehe-kino

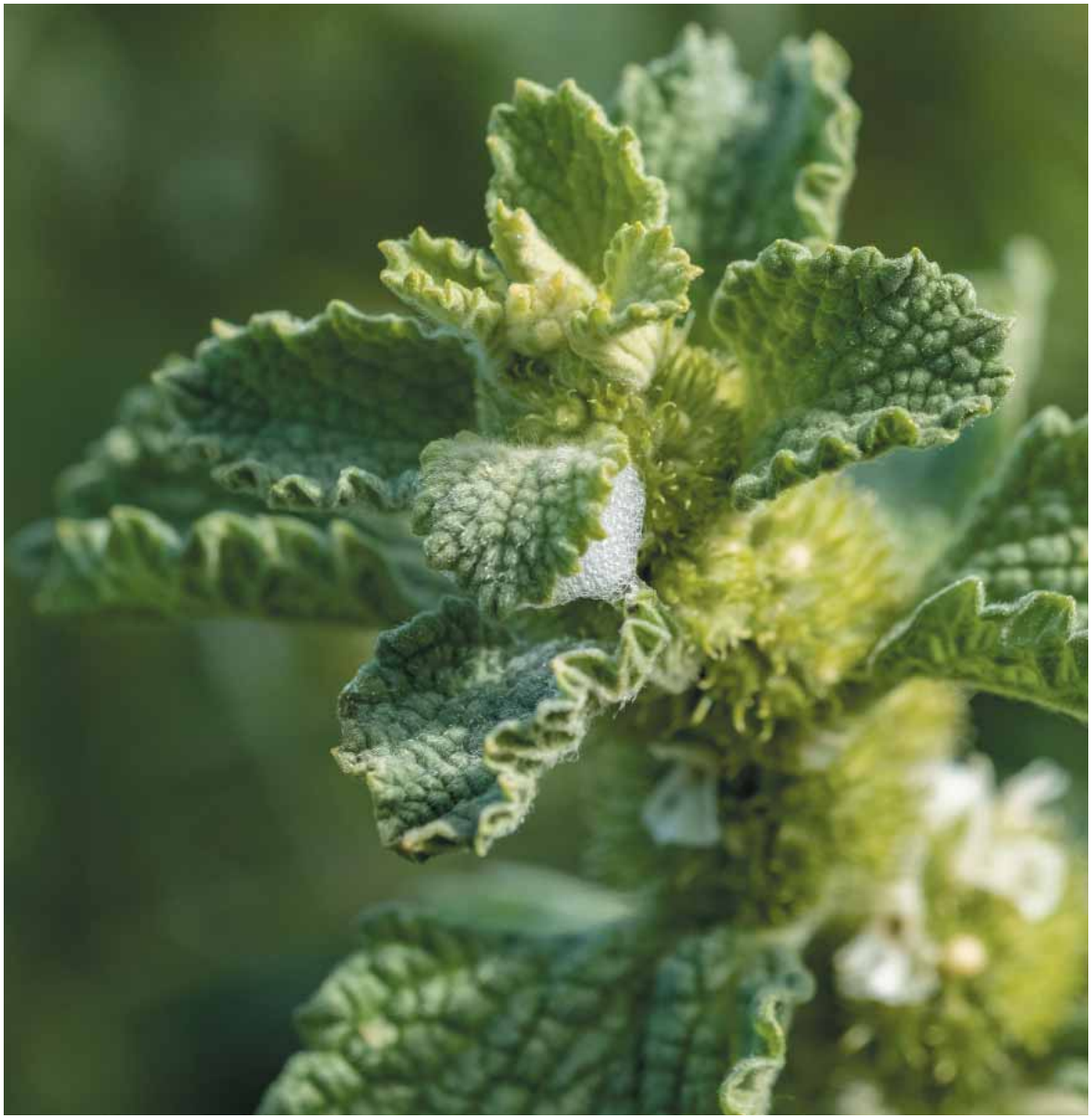
Biocontrol approved for invasive horehound weed

Horehound (*Marrubium vulgare*) is a small, perennial shrub that looks like mint. It is native to temperate parts of Eurasia, Europe, the Middle East and the Mediterranean region, including North Africa. It was first recorded as naturalised in New Zealand in 1867, and had been classified as a weed by 1902. It is also an acknowledged weed in Australia, southern USA and South America.

Horehound is not palatable to stock, and taints the meat of animals that are forced to graze on it. The weed displaces preferred forage plants, reducing pasture productivity. Horehound also produces hooked burrs (seed capsules) that stick to the wool of sheep, and this downgrades the quality of the fleece. Horehound is most abundant in Canterbury and Otago, but it has become an increasing problem on dryland farms across the country. It is now recognised as one of the worst weeds in lucerne crops. Negative economic impacts to farmers may be as high as $29–39 million annually.

The Horehound Biocontrol Group is a collective of landowners supported by a grant from the Sustainable Farming Fund. Manaaki Whenua is the science provider to the group. The application to introduce two moths as biological control agents for horehound was approved by the Environmental Protection Authority in December 2018. Larvae of the horehound plume moth (*Wheeleria spilodactylus*) attack the above-ground vegetation, and larvae of the horehound clearwing moth (*Chamaesphecia mysiniformis*) attack the roots.

manaakiwhenua.co.nz/horehound



We are now using two moth species in the biological control of the invasive weed horehound.

A toolbox of novel technologies for predator control

Affordable monitoring and control techniques for pest predators are essential to the future success of Predator Free NZ, and for wildlife management in general. Researchers at Manaaki Whenua are currently working on a wide range of projects to extend the tools available for pest control.

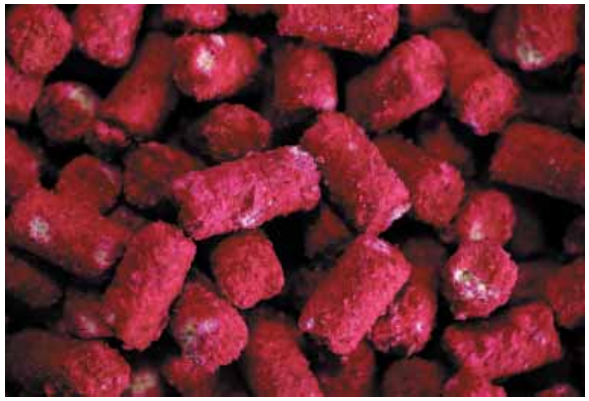
Over the past decade, Manaaki Whenua's Brian Hopkins and his colleagues have been researching species-selective toxins. They have identified a rat-specific toxin, now being tested in field trials. The active component is specific to *Rattus* species. The team are now working to adapt the bait formulation to be as effective in ship rats as it is in Norway rats, so that both species can be targeted using one bait product.

During his PhD research project, Manaaki Whenua scientist Patrick Garvey discovered that the scent of large predators (e.g. the feral cat *Felis catus* or ferret *Mustela furo*) is a powerful attractant for smaller predators (e.g. stoat, *Mustela erminea*). A non-toxic, natural lure suitable for use in all environments has been developed from this project, and is already being used by a small number of conservation groups across the North Island. It has been achieving great results in increasing stoat capture rates at four conservation project trials. Patrick has also started a research project to develop a 'super lure' for stoats and weasels – a synthetic lure that performs as well as or better than the natural scent.

We are also using machine learning to develop software that will automatically identify animals in camera trap images, reducing the time spent and the cost of image processing by an order of magnitude. Researcher Al Glen has been working with Dr Greg Falzon from the University of New England in Australia on image recognition software that identifies animal species from trail camera images. The software needs thousands of images of a species to learn to recognise it reliably, but with continuing refinements accuracy is expected to exceed 95%.

manaakiwhenua.co.nz/kararehe-kino

Ngā Manu Images



Our work aims to expand the range of tools in the predator control toolbox, including lures, species-specific toxins and accurate machine recognition.

Our Land

Our work enables New Zealand to:

- use land more sustainably
- he whenua koiora (better use resources for intergenerational well-being)
- better protect and restore land and soil resources
- reduce the impact of land use on freshwater resources.

Our land research impacts

We want New Zealanders to use our land, soil and water resources wisely. Some of our most important natural resources have reached critical environmental thresholds because of unsustainable land use. Finding a healthy way to balance land and ecosystem use is critical to our future prosperity, using information and tools to support effective management of our land resources.

Our role is to improve knowledge of how the land responds to human pressures, understand the potential limits to land-use intensification and other development, and discover what drives natural resource management decisions. This will improve the primary sector's economic and environmental performance, and will support the provision of wider ecosystem services.

By drawing on and enhancing the value of our Nationally Significant Databases such as S-map and the Land Cover Database (LCDB), our research grows 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.

From setting new policies and regulations or managing nutrient loads, to increasing the utility of the nutrient budgets produced via Overseer™, high-quality, accurate soil data are critical. Getting it right is key to both protecting freshwater quality and ensuring primary sector production is not unnecessarily restricted.

Left: Somerton Station farmer Steven Bierema took part in research undertaken by the MBIE Programme 'Maximising the Value of Irrigation' on his arable farm in Canterbury.

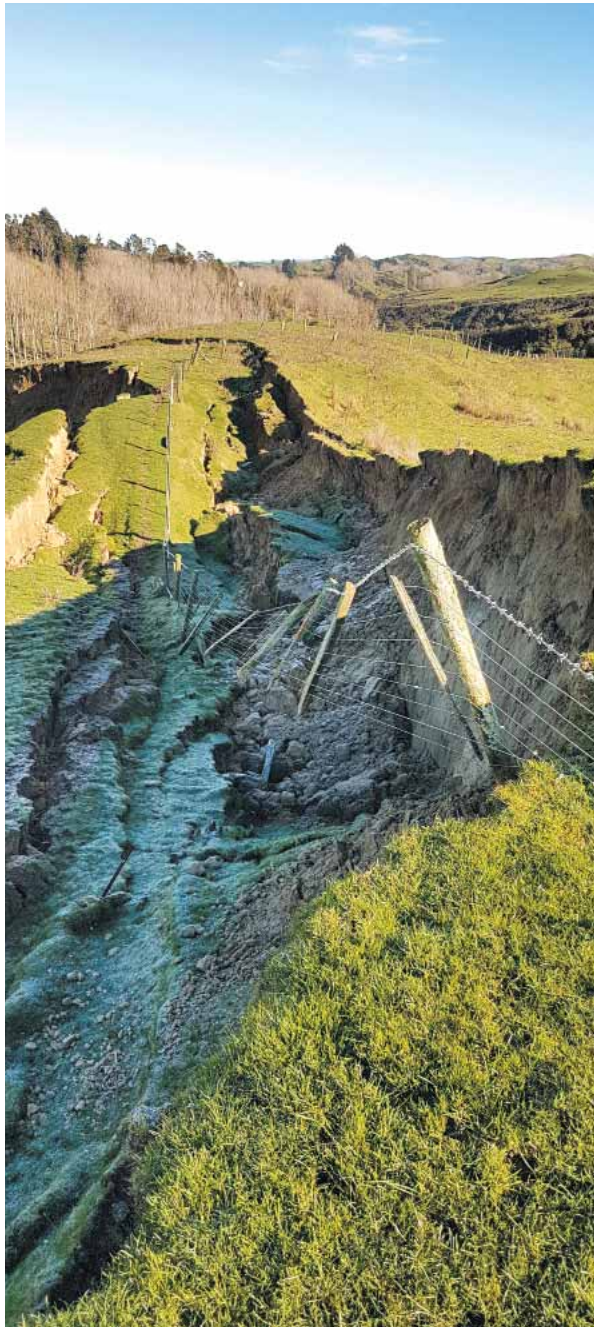
The latest S-map Online update of our national soils has just been completed, taking the overall S-map coverage to 33% of New Zealand. In the past year, 0.82 million ha of soil-mapping data were added to S-map in seven different regions. In this latest update, the Port Hills from Gebbies Pass to Godley Head were mapped from legacy data. All the productive land of the Hawke's Bay region has now been entered in S-map, including a lot of new mapping. S-map Online has very high and growing usage, with over 14,100 registered users and between 15 and 18 users using the site every hour during the working day (Monday–Friday). These users visited over 48,000 times this year, downloading 33,000 fact sheets.

As with land management decisions, national policies on freshwater management rely on robust definitions of different habitats and where they occur. Wetlands are challenging to define because they are dynamic. We have developed a method to accurately and consistently map and define wetlands on a scale relevant to regional councils. This will help inform national policy (for example the National Policy Statement for Indigenous Biodiversity, and the National Policy Statement for Freshwater Management).

This year we have also made significant progress in mapping our nation's land resources using advanced remote-sensing techniques; for example, by providing a national map to show the amount and persistence of all New Zealand hill country agricultural bare ground over a typical winter. We used our paddock boundary mapping methodology on time series Sentinel-2 satellite imagery to identify agricultural land and divide hill country paddocks from flat land paddocks, and to identify and map those hill country pasture and winter forage crop paddocks that were heavily grazed over the winter of 2018/19.

We have also made discoveries in the field that will have important implications for our productive sector as we transition to a lower carbon economy; for example, discovering that adding carbon to soil can lead to reduced nitrate leaching, thanks to lysimeter experiments with collaborators from Lincoln University.

On the next pages we share a series of innovation stories that highlight key outcomes from our research into our land.



Andrew Neverman

Science to manage soil erosion

New Zealand is losing 192 million tonnes of soil each year due to erosion – the equivalent of more than 7 million dump-truck loads.

According to MfE's *Environment Aotearoa 2019* report, almost half (44%) of this loss is from pastoral land. This erosion has been accelerated by the loss of native vegetation but is primarily caused by significant weather events, where heavy rain causes slips, slumps and stream-bank collapse that send massive amounts of fertile soil and sediment into waterways, streams and rivers.

This land-based erosion and transfer of sediment is a huge problem for New Zealand. It doesn't just reduce land productivity: it also affects water quality. Too much sediment in rivers, lakes and coastal environments can smother freshwater and marine habitats. It can also hamper the growth of aquatic plants and animals, and increases the risk of flooding in towns and cities.

As significant weather events continue to increase, so does the amount of erosion, triggering the urgent need for research to understand how to best target erosion control to slow the damage and improve water quality. One of these projects is a new, collaborative, 5-year MBIE-funded programme Smarter Targeting of Erosion Control (STEC), led by Manaaki Whenua, which has the task of exploring cost-effective ways of targeting erosion control and improving water quality, discovering where erosion occurs, sediment volume, what type of sediment is produced, and by which processes.

"Year to year there is large variability in storm events," says Manaaki Whenua geomorphologist Dr Hugh Smith. 'We have severe storm events like the one in 2004 in the Manawatū River, where huge quantities of sediment are generated and flow down the river, and there are massive impacts from landsliding and flooding. Then in other years we have extended low rainfall periods with no major storms and less sediment, but the water quality is still quite troubling.'

Current erosion modelling tools model annual average sediment loads over entire catchments, but through STEC new data will be collected and used to build new models, sampling in four river catchments across New Zealand. These are the Manawatū, for new and continuing data collection; the Whanganui, to look into impacts from the 2018 storm and legacy sediments; and the Oreti in Southland and Wairoa near Auckland, to research bank erosion and sediment fingerprinting methods in collaboration with NIWA's Managing Mud programme.

The models will indicate how sediment, and in particular fine silt, moves through catchments, and how erosion and sediment transport can be targeted and mitigated cost-effectively to help strategically minimise erosion effects. Erosion mitigation research will also be conducted on farms to learn more about effective erosion techniques.

STEC is led by Dr Chris Phillips and Dr Hugh Smith from Manaaki Whenua, in collaboration with NIWA, Massey University, Waikato University, and an international research network. The programme partners with Whanganui iwi (Tamaupoko Community group) and Rangitāne o Manawatū.

Smarter remote sensing for effective land management

Satellite photography has long been a useful tool in land management, enabling landscape comparisons over time that show the large-scale effects of historical land-use decisions. Modern remote-sensing techniques use all parts of the light spectrum and are very high resolution, and the data sets are updated every 5 days as satellites pass overhead. However, perfectly cloudless skies are rare, and even wisps of high cloud can distort and hide important details on an image.

Manaaki Whenua's James Shepherd and Jan Zorner have implemented a full cloud-clearing method for satellite images on one of New Zealand eScience's high-performance computers in Wellington. The new method, run on the supercomputer known as Mahuika, is a big step forward in remote sensing, enabling scientists to efficiently clean and prepare large archives of satellite imagery, removing clouds and their shadows to create sharp topographical mosaics.

The cleaned images allow analysis of landscape and vegetation changes over relatively short time scales, including patterns of crop flowering and growth, soil erosion and forest health. These data are an underpinning resource to enable other researchers to measure and manage New Zealand's land resources, including the environmental impacts of land use.

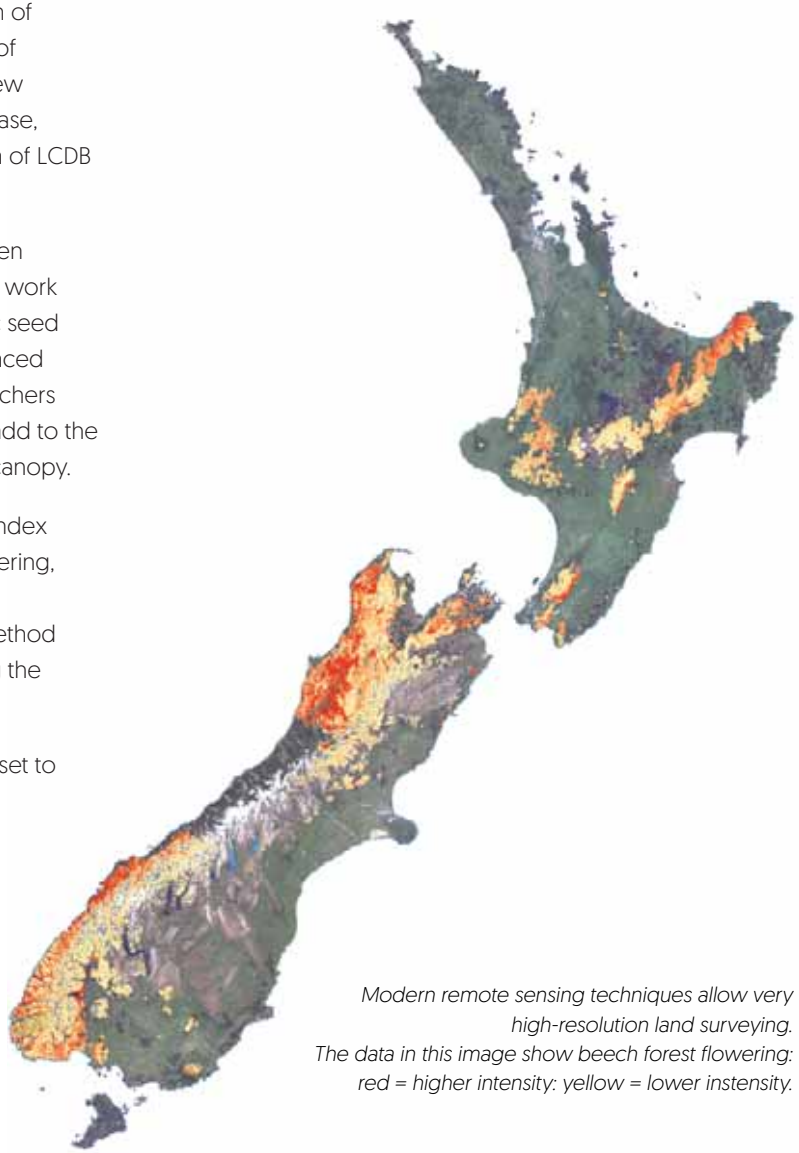
The cloud-clearing method is especially significant for the Advanced Remote Sensing of Aotearoa programme, which is dependent on these methods to produce improved maps of vegetation through the analysis of time-sequenced data.

A new proposal submitted to MfE has been funded to allow our remote-sensing team to complete the fifth version of the New Zealand Land Cover Database (LCDB). The LCDB is a digital map and multi-temporal thematic classification of New Zealand's land cover, with 33 mainland classes of landscape (35 including the Chatham Islands). The new information will be a significant addition to the database, which has not been updated since the fourth version of LCDB was released in 2014.

This year a new remote-sensing method has also been developed to identify when beech trees flower. This work is especially useful to predict the likelihood of prolific seed seasons known as beech masts. As part of the Advanced Remote Sensing of Aotearoa programme, our researchers have found that in the visible spectrum, red flowers add to the green leaves to produce a distinct yellowing of the canopy.

The degree of yellowing can be assessed from the index (red-green) and used to estimate the density of flowering, which can then be further related to seedfall density. Combining this technique with the cloud-clearing method allows patterns of forest canopy behaviour, including the unusual beech mast signal, to be seen clearly.

DoC has provided their national beech seedfall data set to enable these relationships to be investigated fully. If the relationships are strong, it may be possible to produce a national map predicting autumn seedfall for DoC. This could be a major strategic step forward in national pest control work, over and above traditional methods of estimating and predicting beech mast and subsequent rodent increases, especially in very remote areas of the country that are almost impossible to sample or measure on the ground.



Modern remote sensing techniques allow very high-resolution land surveying. The data in this image show beech forest flowering: red = higher intensity: yellow = lower instensity.

Maximising value from irrigation

Major technical advances in irrigation systems over the past two decades have given farmers and growers the ability to apply specific amounts of water to a paddock or block of land. However, different types of soil and pieces of land within a block or paddock require different amounts of water, and too much water can easily be applied, causing water wastage, nutrient loss and leaching.

In 2013 the MBIE-funded collaborative programme Maximising the Value of Irrigation (MVI), led by Manaaki Whenua, with Plant & Food Research and the Foundation for Arable Research (FAR), took on the challenge of creating new irrigation scheduling and management systems at the paddock scale. That programme is now drawing to a close, and the results are a step-change in irrigation management.

One group of MVI researchers used high-resolution sensor mapping and in-field soil and crop sensor monitoring systems to assist with precision irrigation, leading to water savings of between 9% and 30% when irrigation was varied according to the different soils at the site.

The sensor mapping system was trialled on six farms, where researchers processed the survey data into 'management zones' to record the main soil differences. The soil variability was then tested through physical soil sampling to measure how much water each soil zone could hold.

The team designed, built and used wireless sensor networks for near real-time monitoring at irrigation sites and sent this information via a smartphone app to the participating farmers to inform them of precise irrigation schedules and to monitor daily crop water usage.

Alongside the soil moisture research, another group of MVI researchers used remote-sensing methods to create a technique for monitoring daily crop water usage, to help calculate how much water a crop is using each day at the paddock scale.

MVI is applied science at its sharpest. The new irrigation scheduling and measurement systems developed as part of the programme will enable New Zealand's farmers to make effective irrigation decisions to improve productivity, reduce costs, and lessen the negative environmental impacts of overwatering.

Bit.ly/max-irrigation

Long-term research from a rain shelter site (left and top) is enabling precise irrigation scheduling at the paddock scale (above).

Our work in the Honey Landscape project aims for real impact for Māori agribusiness.

The Honey Landscape

The mānuka honey industry is booming – but how many hives can the landscape sustain?

Scientists and Māori agribusiness have teamed up to learn more about mānuka DNA variation, beehive stocking rates, and honey bee food resources in a 5-year project that sets out to answer these questions and best maximise this opportunity.

Dr Gary Houliston is leading the Manaaki Whenua component of The Honey Landscape project, which aims to create a comprehensive model of New Zealand's native honey landscape, blending science and tikanga Maori. Researchers have been working with Māori landowners to collect leaf samples from natural mānuka stands, extract the DNA, and analyse the data.

Bit.ly/honey-landscape

Our Environment

Our work enables New Zealand to:

- kia tautokohia te kaupapa kaitiakitanga (better enable kaitiakitanga – guardianship – to be practised)
- make better-informed environmental decisions
- be more inclusive and effective in environmental policy, planning and governance
- better adapt to climate change and mitigate its impacts
- be a more resilient society and economy.

Our environment research impacts

We want New Zealand to be an environmentally informed nation, taking action together. As New Zealanders we are proud of our clean, green image and aspire to lead the world by our example. This is tempered by an increasing awareness of just how fragile our environment is.

To make real improvements we need reliable data and indicators, and decision-making processes that account for the complexity and uncertainty surrounding our environment, along with practical action. New Zealand's economic development can only be sustained if industries and businesses operate within complex environmental limits.

The work done by Manaaki Whenua is increasingly designed to support policy makers, Māori, business, and community groups to be a part of making decisions on the future uses of and values relating to our environment, locally, regionally and nationally. We must balance the needs of multiple and diverse stakeholders, including national and local government, the private sector, Māori and local communities in making these decisions.

As a local example, this year we worked with community members in the Mangapiko catchment to develop a biodiversity restoration strategy for the catchment. As part of this strategy we have worked with Waikato Regional Council to modify the approach to riparian willow and poplar planting to match the aspirations of the catchment community and to ensure the trees better survive the conditions in the catchment.

At a larger scale, we assisted Southland Regional Council to understand the fate of its region's wetlands, using remote-sensing images of three parts of the region from 1990 to 2012. Of the 32,814 ha of wetlands initially present, 3,452 ha were lost, and a further 3,943 were assessed as being at risk by the end of the time series. Most of the changes occurred on the Southland Plains as a result of conversion to other land uses. Wetland loss is associated with a decline in ecosystem services, including reduced capacity to regulate water quality, mitigate flooding, perform carbon cycling, or provide habitat for threatened and game species. Our findings have informed Southland Regional Council of the need to promote sustainable wetland management in agricultural environments.

As a country, New Zealand will meet its international greenhouse gas obligations and targets through a mix of domestic emissions reductions, the removal of carbon dioxide by forests, and participation in international carbon markets. To achieve this, we will need a robust inventory of net emissions and carbon storage at a national scale, and appropriate mitigation tools.

With soil carbon measurement increasingly centre-stage in farm emissions management, our research in this area is vital to understand our national contributions to climate change and to discover ways in which our farming and natural systems can mitigate the effects of climate change through careful management and adaptation.

As part of this work we chaired a technical advisory group for the Livestock Environmental Assessment and Performance Partnership (LEAP) of the Food and Agriculture Organisation (FAO) of the United Nations. The group, comprising 37 researchers from 27 different countries, has worked over 18 months (including two face-to-face meetings) to draft a report for LEAP entitled *Guidelines for Measuring and Modelling Soil Carbon Stocks and Stock Changes in Livestock Production Systems.* These guidelines aim to give a harmonised, international approach for estimating soil organic carbon (SOC) and SOC changes in livestock production systems. The guidelines have been peer-reviewed by experts and offered for public consultation, and they will soon be disseminated by the FAO for individual countries to adopt.

We also improved the accuracy of measuring nitrous oxide emissions from hill land. In partnership with AgResearch, we analysed the data from existing New Zealand hill country nitrous oxide measurements to show that dairy-grazed, low-slope hill land exhibits emission factor values similar to those from previous New Zealand studies on beef-grazed low slopes.

On the next pages we share a series of innovation stories that highlight key outcomes from our research into our environment.

Manaaki Whenua a key contributor at IPBES and to Environment Aotearoa 2019

The plight of global biodiversity made headline news around the world in May 2019 when the United Nations Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) met in Paris, France, and issued their first Global Assessment.

Modelled on the older, more familiar and remarkably successful Intergovernmental Panel on Climate Change (IPCC), the IPBES provides a global overview of the status of and trends in biodiversity and ecosystem services – the ways in which ecosystems support human societies.

With representatives from 132 governments, May's IPBES meeting brought together 145 science experts from 50 countries and based its findings on the review of more than 15,000 scientific publications.

Having been appointed as a coordinating lead author at the sixth IPBES plenary session in Medellin, Colombia, Manaaki Whenua's Anne-Gaelle Ausseil was part of the official New Zealand delegation in Paris, a team that also included Nicola Toki and Elaine Wright from DoC, and Adam Opzeeland from the Ministry for Primary Industries.

The scientific research was distilled into a 1,500-page document, which was then further refined into a 40-page *Summary for Policy Makers*, a digestible scientific tract to support policy makers concerned with the status and condition of biodiversity around the world.

Anne-Gaelle also assisted an MfE senior science team to contribute to *Environment Aotearoa 2019*, an important report on the state of our environment.

Nicola Toki

Above: The New Zealand delegation at IPBES 2019 comprised, from left, Anne-Gaelle Ausseil from Manaaki Whenua, Adam Opzeeland from MPI, Elaine Wright and Nicola Toki from DoC.

ipbes
Science and Policy for People and Nature

Measuring and managing soil carbon – fundamental field science for New Zealand

The carbon contained within soils is critical for soil health and ecosystem functions, such as the maintenance of soil structural stability, root growth, air/water movement, and nutrient cycling. It plays an important part in the control of rainwater run-off and soil erosion, and is a vital food source for soil biota. Soils with higher carbon are generally more resilient to climatic extremes of intense rainfall and drought.

Current models of soil carbon storage predict that soil respiration processes, which contribute significantly to the cycling of carbon between the biosphere and the atmosphere, will increase as the climate warms, thereby releasing more carbon to the atmosphere. Alteration of soil respiration processes could have a big impact on atmospheric CO_2 concentrations.

To test the relationship between soil respiration and climate warming, we used different carbon isotopes in soils to measure the rate of turnover of soil organic matter *in situ* over time. We studied soils under crops and compared them with soils with no roots present (in root exclusion plots).

This work has shown that root respiration processes increase in response to climatic warming, with associated increases in carbon release, but that the turnover of carbon contained within the soil itself remains very stable – an important challenge to current modelling assumptions of how soils will respond to a warming climate.

In other work, in collaboration with Lincoln University, Plant & Food Research, Scion and the University of Canterbury, our researchers have been using unique paddock-scale facilities to measure carbon and water inputs and losses and leaching losses from large lysimeters, and have been able to calculate annual gains and losses in carbon, water and nitrogen.

Results in the first year showed that irrigated lucerne was carbon-neutral. In the second and third years carbon losses exceeded carbon uptake, resulting in losses of up to 3% of total soil carbon. In the fourth year the irrigated site continued to lose soil carbon while there was a small net gain at a non-irrigated site.

The findings highlight the need for alternative cutting or grazing management to avoid carbon losses, at least during the years following establishment of the crop regime.

Nitrogen leaching losses also occurred both with and without irrigation, but they were much greater at the irrigated site, indicating that irrigating with effluent is not a good management practice for lucerne on stony soils.

David Whitehead and colleagues at Manaaki Whenua also published a paper on management practices to reduce losses or increase soil carbon stocks in temperate grazed grasslands, using New Zealand as a case study. The paper, in the journal *Agriculture, Ecosystems & Environment*, synthesised 8 years of research findings from the New Zealand Agricultural Greenhouse Gas Research Centre Soil Carbon programme. There is now firm evidence that soil carbon stocks under grazed grasslands on flat sites are decreasing, and changes to management practices are needed to slow or reverse this trend.

manaakiwhenua.co.nz/soil-carbon

Precision fieldwork in real-world locations is essential to ensure sustainable management on-farm. Manaaki Whenua's John Hunt and Scott Graham monitor data collection equipment at Ashley Dene in Springston.

The Lake Snow Toolbox: environmental monitoring of slime in our iconic lakes

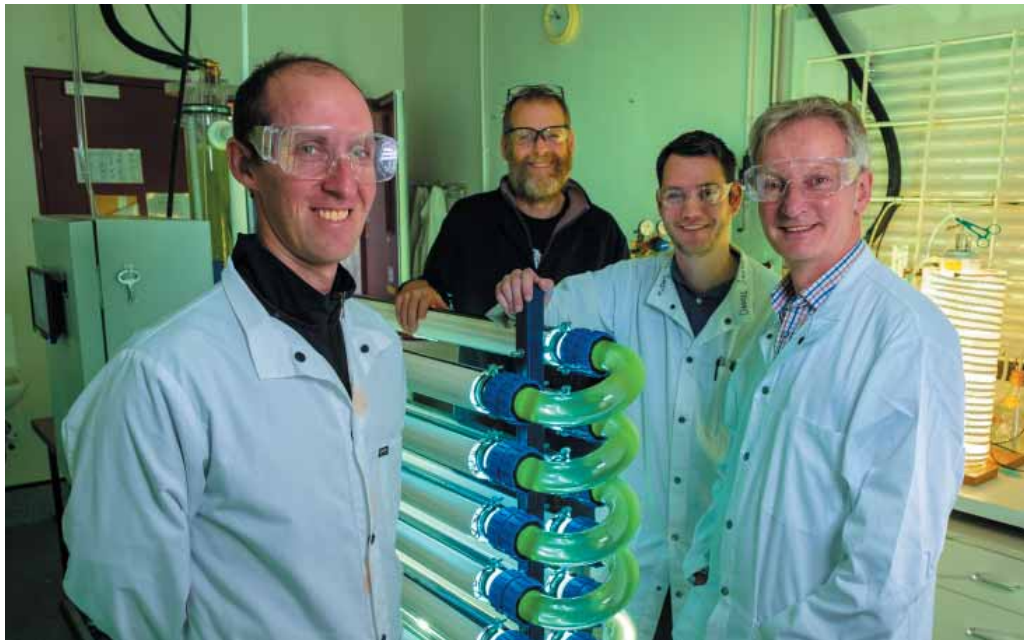
Lake snow is produced by a microscopic alga, *Lindavia intermedia*, and is becoming a major problem in Central Otago and Lake Wānaka. The reason why lake snow, also known as lake snot, is growing in lakes in these regions is unclear.

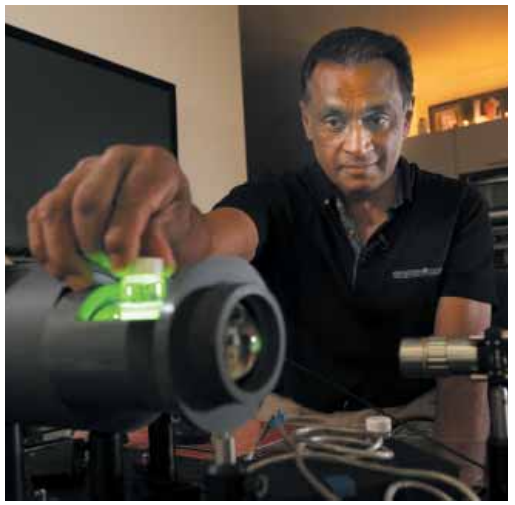
Lake snow can cause serious problems for homes and businesses, clogging municipal water infrastructure, water filters and boat engines, accumulating on fishing gear, and coating boat hulls and wetsuits. Regional councils increasingly need a cheap and reliable way to monitor and manage lake snow in areas increasingly economically dependent on tourists and recreational water users.

Until now this monitoring has been done using Raman spectroscopy, a technique to determine what molecules are present in a sample of a substance by studying the vibrational patterns of those molecules; for instance, when stimulated by laser light. However, most Raman spectroscopes are laboratory machines, unsuited to use in the field or aboard a boat.

Our researchers have developed a cost-effective, robust, laser-based Raman spectroscope that can be used in the field. It sends a laser beam into a water sample to identify instantly whether or not lake snow is present. The work builds on previous research done at Manaaki Whenua to extract DNA from the alga for genome sequencing and species identification, enabling us to identify the organism accurately.

manaakiwhenua.co.nz/lake-snow





Top: Manaaki Whenua phycologist Phil Novis (left) with University of Canterbury staff in the university's CAPE algal lab. Above: Scientist Jagath Ekanayake with the lake snow detector. Right: lake snow sample collection in Lake Wanaka.

New from Enviro-Mark Solutions – on-farm carbon footprinting for certification

You can't manage what you don't measure. Knowing a farm's carbon footprint will help farmers to find ways to reduce carbon, be more efficient, and respond to market demand for environmentally responsible, transparently sourced food products. Measuring and reducing a farm's carbon footprint will also give farmers a head start in meeting compliance and regulatory requirements.

Enviro-Mark Solutions, in partnership with Beef + Lamb, Dairy NZ, AsureQuality and Overseer Ltd, is developing an online carbon footprinting tool that will enable farmers to calculate their farm's carbon emissions, including emissions that occur beyond the farm gate.

The tool provides a first step on the path to a certified farm carbon footprint, under Enviro-Mark Solutions' internationally recognised programmes in accordance with ISO-14064-1:2018.

Achieving certification under these programmes requires members to measure, reduce, and in some circumstances offset any remaining emissions by purchasing internationally-recognised carbon credits. Certification follows an independent audit to verify the accuracy of the footprint, and measures put in place to reduce emissions.

www *enviro-mark.com*

ENVIRO-MARK SOLUTIONS

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Profitability. Sustainability. Competitiveness.

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Overseer

A good year for Enviro-Mark Solutions

Enviro-Mark Solutions has achieved significant milestones over the past financial year that reflect its performance and build its local and international reputation for credible, science-based environmental certification:

- Significant growth across flagship programmes carboNZero, CEMARS, and Enviro-Mark.
- The carbon programmes collectively completed 226 audits and certifications across regions; verified the measurements of 3.3 million tonnes of carbon dioxide equivalent (CO_2e), and 549,000 tonnes of CO_2e reductions against a base year.
- Through the carboNZero programme 110,000 tonnes of CO_2e emissions were offset.
- Engaged with the primary sector to develop a carbon footprint tool and carbon certification programme tailored for farms.
- Worked with the New Zealand Green Building Council to develop a shared standard on carboNZero certified building operations.
- Named as New Zealand and Australia's first and only CDP-accredited Science Based Targets provider. The Enviro-Mark Solutions organisational science-based target was also approved by the Science Based Target Institute – at the time only the third in New Zealand.
- Named as the only New Zealand member of the International Emissions Trading Association (IETA) and accredited to the International Carbon Reduction and Offset Alliance (ICROA). In the context of national and international uncertainty on carbon credits, this positions Enviro-Mark Solutions to have a voice in the next generation of voluntary carbon credit development.
- Certification as a B-Corp, one of a global network of companies assessed as reaching the highest standards of social, environmental and community performance.
- Enviro-Mark Solutions won and delivered the contract to update the MfE Voluntary Guidance on Greenhouse Gas Reporting. They also delivered a major update to the guidance including both a Detailed and Quick Guide, many new emissions factors in a variety of formats, and an example inventory and workbook.

Enviro-Mark Solutions is in the process of recruiting a new Chief Executive, after Professor Ann Smith

Prof Ann Smith (centre) attends the presentation of CEMARS certification to Te Papa. Also pictured is James Shaw, Minister for Climate Change, and Paula Faiva, Climate Change Manager, Tokelau Climate Change Unit, Government of Tokelau.

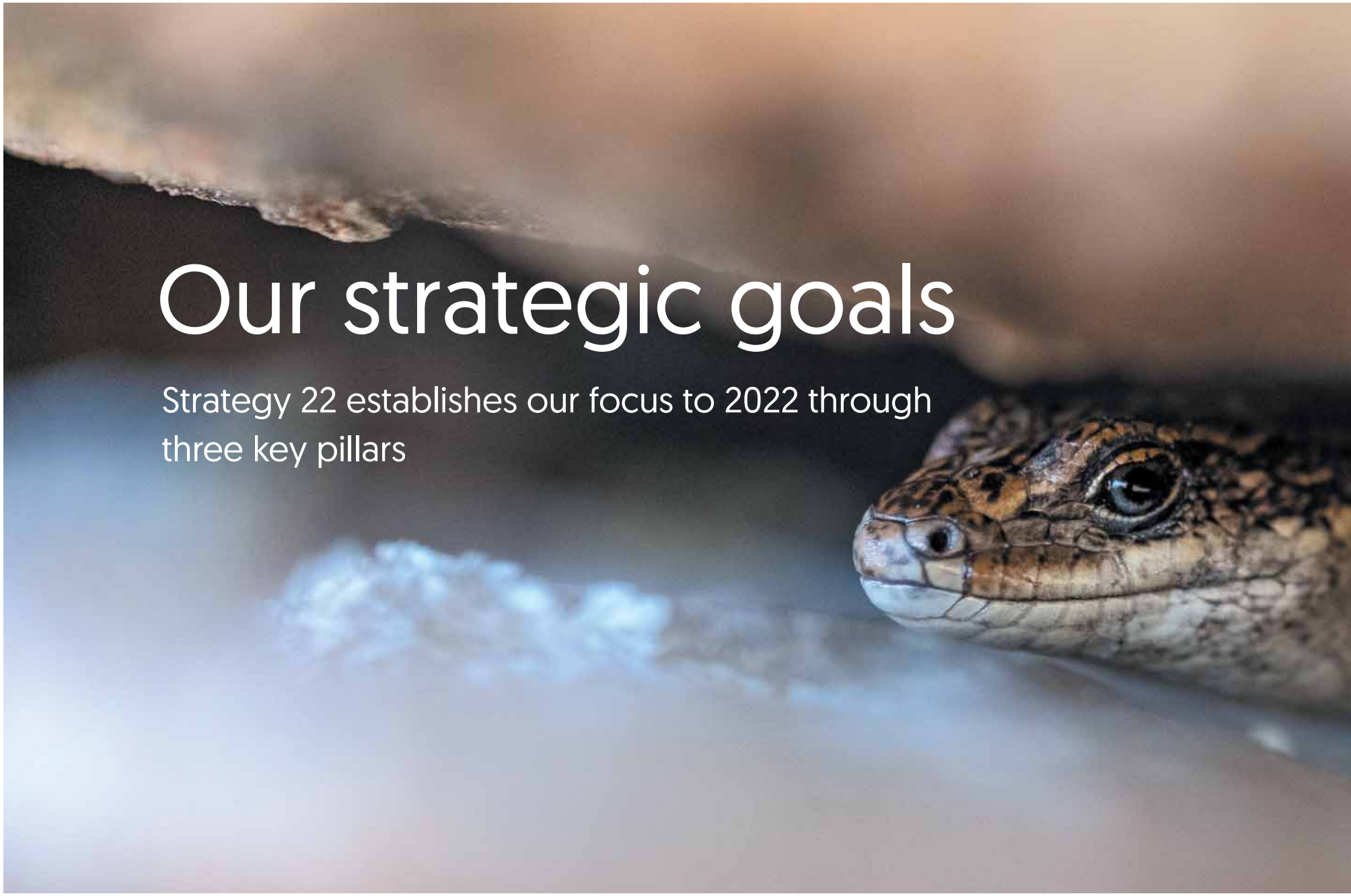
announced her intention to step down to take up the role of Chief Science Advisor. Professor Smith joined Manaaki Whenua in 2003 and was technical lead for the Enviro-Mark Solutions programmes before being named Chief Executive in 2012. Under her leadership, Enviro-Mark Solutions' reputation for credibility, integrity, and product development has been recognised internationally. Professor Smith has driven key stakeholder partnerships in New Zealand and overseas, and become a sought-after expert on carbon emissions policy, reduction, mitigation and certification. In 2019, she was named the first New Zealand Fellow of the Institute of Environmental Management and Assessment (IEMA).

Enviro-Mark Solutions is a significant example of Manaaki Whenua employing a commercialisation strategy to create greater impact from our science.

www *enviro-mark.com*

carboNZero Cert TM

Top and bottom right: attendees at the EMS Excellence Awards, which recognised achievement in carbon reduction and environmental management systems. Top left: Technical Account Manager Shannon Ball and Marketing Executive Ashish Kundalkar present CEMARS certification to Kathmandu.
All photos supplied by Enviro-Mark Solutions.



Our strategic goals

Strategy 22 establishes our focus to 2022 through three key pillars

01 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.

02 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.

03 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.

An irresistible culture

There are two key goal areas within this strategy pillar:
Our people, and science working with mātauranga Māori.

Our people

Manaaki Whenua derives its value from its people. It is the unique combination of our 427 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.

Our culture of empowerment comes from diverse talents, great leadership, and communication. We bring together best teams from within and beyond our organisations and provide our staff with career development.

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

Ensuring the safety of our people, including those who have been undertaking work on behalf of or for Manaaki Whenua, has been a key area of focus, especially with the increased number of contractors undertaking work at our sites. We have supported the health and well-being of our employees through involving them in Improvement Circles and providing a monthly focus on a different well-being theme. 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.

A learning work culture:
Manaaki Whenua recognises that by providing a learning culture we enable our people to deliver excellence. To strengthen this in practice, one of five desirable behaviours is Experiment to Learn, encouraging staff to be bold, take action, and learn.

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

We embrace diversity and, with the establishment of our Diversity and Inclusion group, we explore ways to ensure Manaaki Whenua is an inclusive workplace. The Senior Leadership Team completed unconscious bias training, and regular bicultural training (Noho Marae, Treaty Awareness, and Te Reo) is offered to all our staff.

We continue to grow our research capability, investing in key areas to best support our ambitions, the National Science challenges, and Strategic Science Investment Fund (SSIF) objectives that include Vision Mātauranga.

We are committed to being a good employer, and our People Strategy – Ko Tātou Tēnei – outlines the initiatives we are undertaking to achieve this. The achievement of Manaaki Whenua and its subsidiaries against the seven key elements of being a good employer are:

Leadership, accountability and culture:
We achieved a 78% response rate to this year's Employee Engagement Survey. Our engagement index increased from 70% to 88% from last year's survey with significant gains at all sites, in all teams, and in all categories.

Significant improvements in engagement were seen in the key areas of: confidence in the organisation's direction and senior leaders; staff feeling that they are valued and involved; and staff feeling informed as part of an ongoing dialogue.

We recognise the importance of effective leadership and have supported our leaders in developing their coaching capability. We have also identified our next group of future leaders within Manaaki Whenua and are committed to their development. We regularly review our remuneration levels to ensure they are competitive with relevant markets and benchmarks.

Our leadership programme this year focused on an in-house coaching development programme that included workshops, seminars and practical coaching opportunities. The Senior Leadership Team also participated in the practical coaching to be able to be an effective role model. We also invested in our leaders of the future by identifying five people across Manaaki Whenua with the motivation and ambition to be our future leaders, and we are working with them on individual career plans.

The Diversity and Inclusion group is leading on the development of a Diversity and Inclusion policy that is an extension of our current Equal Employment Opportunities policy. Through our new policy we not only recognise that we are a Treaty partner and the importance of biculturalism but we also value the diversity of the cultures of all our people.

Recruitment, selection and induction:
To achieve our aspiration to be an employer of choice, attracting exceptional talent, we aim to provide an excellent culture – often described by staff as a family – with opportunities for career development, skills enhancement, external interaction in our sector, and flexible working arrangements.

Capability is important and we have focused on strategic hiring decisions that ensure we can meet future research and business needs. Our sourcing and selection policies and procedures are fair and transparent. Our induction process for all new staff provides key information on the organisation and ensures they are aware of their responsibilities.

Employee development, promotion and exit:
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 available training opportunities. The performance appraisal and development programme was updated this year with input by staff, and includes development plans monitored by the training coordinator.

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

Flexibility and work design:
Manaaki Whenua encourages a healthy work-life balance and provides flexible working arrangements supported by phones and laptops to improve staff mobility. We offer part-time, variable hours and teleworking arrangements as appropriate.

Remuneration, recognition, and conditions:
We undertake an annual remuneration review that provides opportunity to reflect and adjust our recruitment and retention strategies as necessary. Manaaki Whenua has an equitable, transparent, and gender-neutral remuneration system that ensures all individuals and groups have fair employment opportunities and conditions.

As part of monitoring our remuneration, we benchmark our remuneration medians against the CRI, science and general market sectors. Manaaki Whenua also provides performance bonuses to recognise exceptional individual contributions.

Harassment and bullying prevention: Manaaki Whenua has a zero tolerance of bullying and harassment of any kind. We have reviewed and update our Bullying and Harassment policy as well as introducing a code of conduct. Employees were made aware of these policies as part of Pink Shirt events at each site. New employees are made aware of these policies as part of their induction. We have developed a set of behaviours that outline Our Way, the expectations of our actions that reflect the culture we are building.

Safe and healthy environment:
Manaaki Whenua achieved external certification against the AS/NZS 4801 H&S standards in 2018. A further external audit in 2019 highlighted the progress that had been made in our health and safety practices. We are also developing a learning culture of Safety Differently, involving our people in the development of our practices.

Pleasing results were received in the Employee Experience Survey when 98% agreed that 'I understand my Health and Safety responsibilities', 97% agreed that 'This organisation is committed to the Health and Safety of its people' (+11, compared with 2018) and

EMPLOYEE TURNOVER
Manaaki Whenua – **6.9%**
EMS - **14.7%**

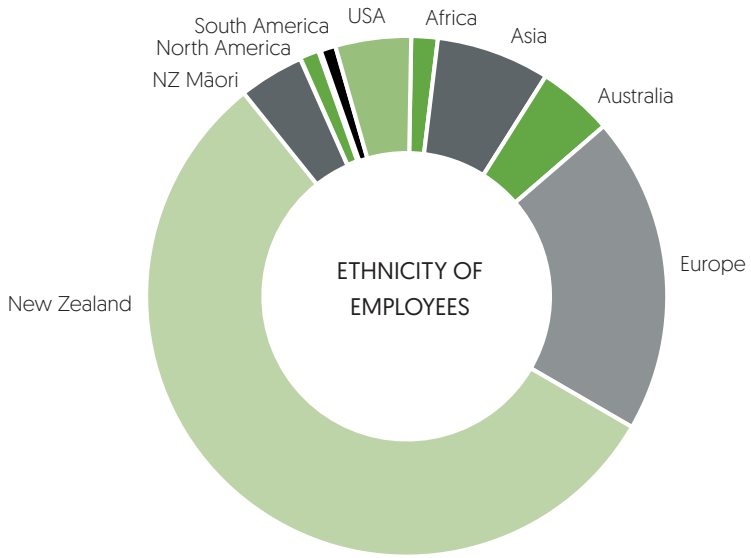
HEALTH & SAFETY
Lost time to injuries – **2**

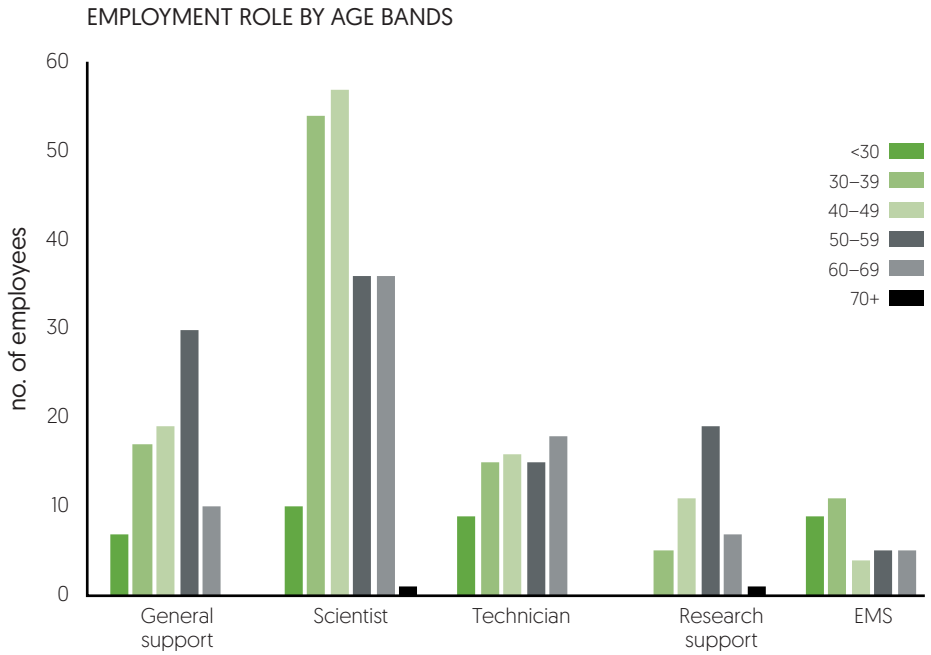
HEALTH & SAFETY
Near-miss reports lodged – **46**

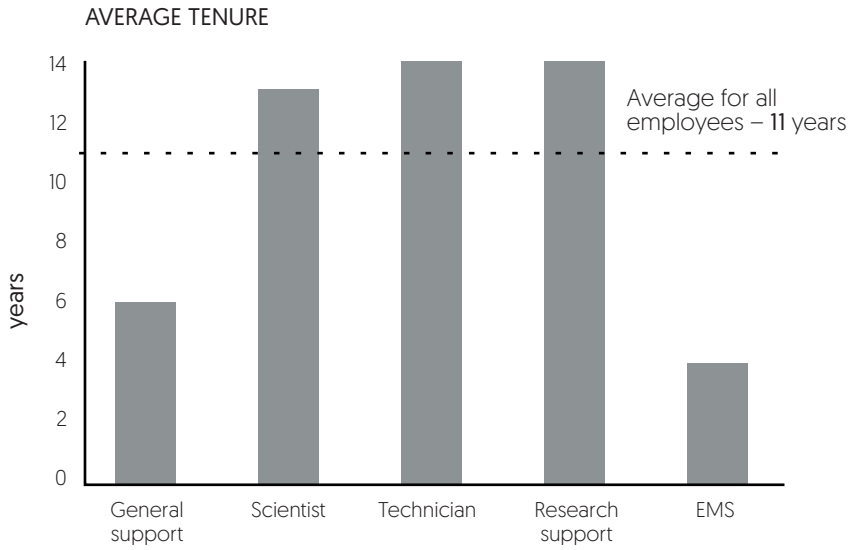
97% also agreed that 'Risks to my Health and Safety at work are reduced as far as is reasonably practicable'.

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 has a position description clarifying individual responsibilities for health and safety.

There has been a significant focus on the well-being of our people, with monthly initiatives including practising kindness, physical fitness, eating well, money matters, and resilience. There are also three improvement groups working through initiatives to address those themes identified as having an impact on the well-being of our staff.







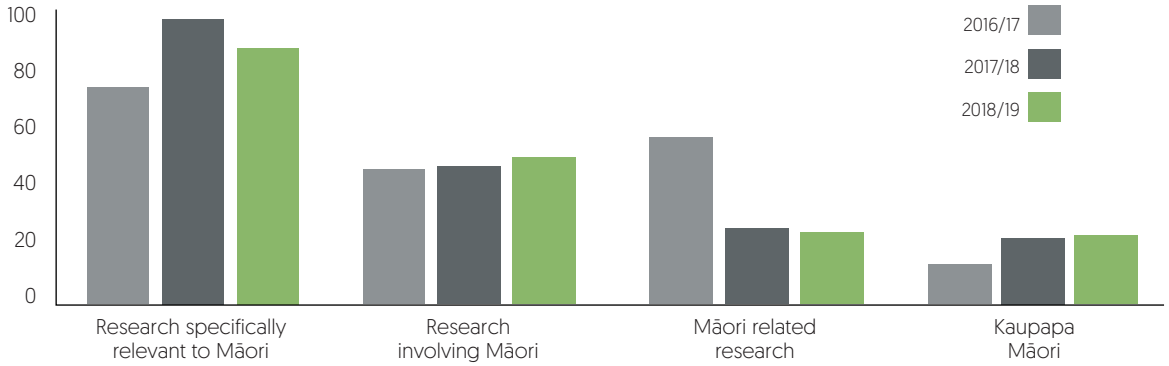
Science for Matauranga Māori

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

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

We seek to understand and respond proactively to the needs of our Māori partners, including novel approaches, e.g. through secondments and new commercial models. We increasingly co-design our science and research programmes with our Māori partners. We build on and add value to the platforms, tools, and technologies of our Māori partners to grow joint intellectual property beneficial to New Zealand. Our people have the skills and characteristics to engage well, deliver value, and support our Māori partners.

VISION MĀTAURANGA PROJECTS



Right: flax weaver Alice Spittle (Ngāi Tāhu) at Manaaki Whenua's pā harakeke. Below: a Lunchtime Kōrero Kūmara function at Lincoln, led by Dr Nick Roskruge, senior lecturer on Māori horticulture. Below right: a hangi at our Hamilton site.

Saving a species – the rescue of *Pennantia baylisiana*

Pennantia baylisiana, a tree better known as the 'Three Kings Kaikōmako,' is one of the world's rarest plant species. It is so rare that only one known wild tree is left, which grows on a steep rocky slope on Manawa Tawhi (Great Island), one of the Three Kings Islands off the coast of Cape Reinga, New Zealand.

The island is a part of the Ngāti Kurī iwi rohe. The lone tree was visited in December 1945 by Professor Geoff Baylis, and found to be a female, which does not produce any seed. Professor Baylis brought back a cutting to Auckland and nurtured it to maturity at the Department of Scientific and Industrial Research (DSIR).

Forty years later, Dr Ross Beever, a scientist from Manaaki Whenua, found a way to produce ripe seeds from the cutting-grown tree without fertilisation.

The resulting seedlings grew into healthy young plants in a Manaaki Whenua laboratory. The new plants were found to be more fertile than their mother and were carefully grown-on to produce more seedlings.

This year, Manaaki Whenua were able to return 140 saplings to Ngāti Kurī so they can plant, grow, and protect their taonga in their own region.

In June 2019, the young trees were planted at various locations around the town of Ngātaki – enabling the descendants of the original tree, still regarded as one of the world's rarest plants, to be reunited with Ngāti Kurī in the far north of the country.

manaakiwhenua.co.nz/kaikomako

Left: Pre-schoolers help to plant kaikōmako on Waiora Marae in June 2019.

Manaaki Tangata – a well-being programme for our people

Manaaki Tangata, caring for each other, is one of the key values of Manaaki Whenua. The well-being of all our people is a priority, and as an employer we wish to cherish, conserve, and sustain our people by embedding well-being into everyday operating practices, which enable employees to be proactive and Manaaki Whenua to be responsive to health and well-being needs.

The Manaaki Whenua well-being approach is underpinned by the principles of three models of health and well-being relevant to an Aotearoa New Zealand context: Te Whare Tapa Whā, PERMA, and the Five Ways to Well-being. All three represent a holistic view of well-being that is culturally appropriate for both tangata whenua and our wider multicultural workforce, and acknowledge that well-being is not one thing but many practices.

In 2018, Manaaki Whenua contracted a psychologist to facilitate a Participatory Solutions Inquiry into Well-being, whereby the organisation developed its own insights/solutions for well-being issues. Manaaki Whenua's People & Culture Business Partners were trained to undertake an 'appreciative enquiry' style of interview, during which 45% of all employees were interviewed. The process uncovered real experiences of what work is like at Manaaki Whenua and identified opportunities to improve personal well-being for staff. Overall, fifteen different themes were identified. Since September 2018, three different improvement circle groups, made up of employees and Senior Leadership Team members, have been formed to generate improvement ideas and to implement solutions.

In 2019, an internal well-being programme was launched as a trial under the name of Manaaki Tangata. The primary focus of Manaaki Tangata is employee well-being, with each month dedicated to a different well-being theme. Each theme is carefully selected based on the four dimensions of the Te Whare Tapa Whā model, with consideration given to both PERMA and the Five Ways to Well-being. The twelve monthly themes also ensure something will resonate with everybody as we recognise well-being is not one but many things. We are also ensuring, in the context of the Te Whare Tapa Whā model, that we have the right whenua (land/roots) in place to promote employee resilience and well-being.

NOHO MARAE VISITS
Koukourārata Marae – **21** staff

TREATY OF WAITANGI WORKSHOPS
Lincoln – **21** staff
Auckland – **12** staff

CULTURAL AWARENESS WORKSHOPS
Lincoln – **30** staff
Auckland – **18** staff

Left: Holden Hohaia, General Manager – Māori Partnerships. Right: Manaaki Whenua staff attend the Noho Marae at Koukourārata, Banks Peninsula on 15-16 May 2019.

The role of the Treaty of Waitangi at Manaaki Whenua – a discussion piece

As a Crown Research Institute, Manaaki Whenua acknowledges and supports the important role of the Treaty of Waitangi in shaping how we engage with iwi and Māori landowners. Broadly speaking, we see the Treaty as encouraging us to observe three key principles – partnership, protection, and active participation – when we engage with iwi & Māori land owners.

The way in which we apply these principles to engagement will depend to some extent on whether we are working with iwi or Māori land trusts or incorporations (who administer multiple-owner Māori land subject to the Māori Land Act 1993).

Both groups are absolutely important Treaty partners but they have different interests. The latter have specific legal rights and interests over a block of land to which they hold legal title. (Incidentally they also often face certain challenges with their land, since most of it is steep, challenging hill country, blocks are fragmented, there are usually lots of absentee owners, it's difficult to get finance... the list goes on).

However, iwi have a much broader range of interests both as landowners (e.g. they'll often own ex-Crown forests returned in a Treaty settlement) but also as mana whenua whose interests must be taken into account as iwi under various pieces of legislation such as the Resource Management Act 1990 and the Conservation Act 1987. These interests will cover an entire tribal rohe, i.e. catchments including waterways, conservation blocks, Council reserves, etc., and the iwi interests will extend to include taonga species, indeed *all* indigenous species that may be present in that rohe, no matter what the legal ownership status of the land on which that species might be found.

So what does all this mean for how we engage? Well, one thing is for sure, we need to be open and transparent. If we're talking to a Māori land block owner we should probably also be talking to the iwi (sometimes there'll be more than one) within whose tribal rohe that Māori land block is located. Why? Because the interests of those two groups are almost always intertwined.

Moreover, what happens on a Māori land block at the top of a catchment can have huge implications for broader iwi kaitakitanga of the tribal rohe further down the catchment.

Food for thought indeed!

Holden Hohaia

Te Kohinga Harakeke O Aotearoa/The National New Zealand Flax Collection at the Lincoln site has been used this year to help Māori rangatahi reconnect with their taonga.

A better way of working

This pillar focuses on the systems, processes, and infrastructure that enable us to realise the greatest possible impact for New Zealand.

Our infrastructure

Our goal is that our collections and databases, property, equipment, and IT infrastructure support excellent research; and that our sites provide great working environments, support our partnerships and are a base of interaction with New Zealanders. In the past year we have been able to make significant investment in key infrastructure for Manaaki Whenua, for example:

- The $15m redevelopment of our Lincoln campus (Te Rauhītanga, left)
- A new leased office for the Wellington-based team and partners
- An IT programme moving our core desktop environment to the cloud
- The early phases of a core systems replacement project targeting our financial and project management systems
- $8.2 million of SSIF funding directly contributing to the maintenance and generation of value from our collections and databases.

Our sustainability

Sustainable Business: Our contribution to the future of New Zealand is underpinned by a sustainable business model that balances social, economic, and environmental impacts. As a CRI, 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.

We have developed our commercialisation strategy – the Accelerate Programme. The goal of this work is to ensure we are using all relevant models to create impact from our research and science. We've seen some excellent progress for our rodent-specific toxin project, and through partnership with a commercial entity we plan to launch a commercial product with relevance to New Zealand's Predator Free goals, the wider Pacific Region, and beyond.

Sustainable Development: Our contribution to sustainable development is two-fold. The major part is the impact of our research and science, in which we work with other organisations to achieve sustainable development goals for New Zealand. Our business operations make up the other part of our contribution. Our annual reporting integrates our performance on both parts.

This year we started to explore the United Nations Sustainable Development Goals (SDGs) as an internationally accepted framework that could help set performance targets. The first part of this work considers the role that the SDGs and their underlying targets and indicators should have in contributing to our research priorities. The second part considers the goals that are most material to our corporate operations. External engagement on materiality will start with stakeholder interviews later this calendar year.

Our partners

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

During the year our focus has been on developing partnerships across linkages in the science value chain from capability to impact. A new relationship with Wageningen Environmental Research (part of Wageningen University & Research) in The Netherlands will support skills and career development, staff exchanges and developing joint programmes. Wageningen UR is a global leader in agricultural and environmental research.

Across the link between science and policy we formalised a new way of working with the Ministry for the Environment that will support alignment of our expertise, activities, and resources to get greater impact for our shared outcomes. Co-innovation and co-investment in programmes, staff secondments, and mutual capability-building will be valuable outcomes of this new relationship.

Linking science and its commercial application, we are partnering with the state-owned enterprise Orillion to develop predator-control technologies. A major driver is the national goal of eliminating four major mammalian predators by 2050. Beyond New Zealand, demand exists for similar technologies, in agriculture and conservation, and our work with Orillion will target both New Zealand and international opportunities.

National Science Challenges

National Science Challenges take a collaborative approach to solving some of New Zealand's biggest issues. They are an opportunity to increase the stretch and impact of our research, and to provide an economy of scale for working with collaborators. Manaaki Whenua is proud to host one of New Zealand's 11 National Science Challenges, New Zealand's Biological Heritage (NZBH). 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, and to MBIE's Unlocking Curious Minds. Working with the NSCs allows us to increase the impact we can deliver across our four ambitions through effective collaboration.

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

NZBH Challenge successes

Inter- and trans-disciplinary research have been celebrated as a hallmark of the National Science Challenges, including NZBH. This 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 – individuals and organisations that had not previously worked together.

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

- a deeper understanding of how the public will respond to emerging pest control technologies, with these insights informing regional and national government policies and decision-making for landscape-scale pest control
- sequencing the genome of the invasive German wasp – a global first that will pave the way for future genomic approaches to the control of invasive invertebrates
- the development of a 'virtual data hub' for environmental DNA (eDNA), which will enable groundbreaking insights into the state of our biological heritage across land and freshwater domains – benefiting both primary industries and the conservation sector
- Māori-led projects that demonstrate how te ao Māori and kaupapa Māori approaches can create significant national impact for Aotearoa.

A new 2019–2024 strategy for NZBH: partnering for impact

In June 2019 the NZBH Challenge completed its first tranche (5 years of funding) and is moving into Tranche 2 from 2019 to 2024. The mid-way review in 2018 strongly endorsed the Challenge's proposed 2019–2024 strategy, which aims to transform the way we conduct science and research in Aotearoa. The Challenge has embraced a Treaty partnership approach, 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.

The new strategy is focused on three impacts that have a strong alignment with our four ambitions:

- whakamana – empower
- tiaki – protect
- whakahou – restore.

NEW ZEALAND'S BIOLOGICAL HERITAGE

Ngā Koiora Tuku Iho

National SCIENCE Challenges

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

NZBH Challenge parties

Eighteen organisations have signed a Collaboration Agreement for the NZBH Challenge: 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.

www.bioheritage.nz

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. It runs an Emerging Innovator Programme, open to early career researchers based at universities and Crown Research Institutes across New Zealand.

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

Scientists identified as KiwiNet Emerging Innovators at Manaaki Whenua this year include:

- Chris Smith, who has successfully cultivated three New Zealand native mushroom species historically eaten by Māori using prepared wood-based growth media in controlled conditions. The project is looking at the potential to produce these fungi as a gourmet food for high-end restaurants.
- Patrick Garvey, who is exploring a natural lure to attract stoats and weasels to traps, based on observation that stoats are attracted to the odour of ferrets. The project has concentrated on isolating the chemical compounds responsible for this attraction (see also page 36).
- Matteo Poggio, who has completed his Emerging Innovator Programme on rapid spectroscopic (infra-red) methods for soil analyses to provide highly accurate and cost-effective estimations of selected soil attributes, bypassing time-consuming and expensive traditional analytical techniques. Models for chemical and physical soil properties have been developed and tested.

Bevan Weir

Emerging Innovators Matteo Poggio (above), Chris Smith (top right) and Patrick Garvey (right).

Te Rauhītanga

This year has seen significant progress made with our Lincoln redevelopment programme, known internally as Te Rauhītanga – The Gathering Place.

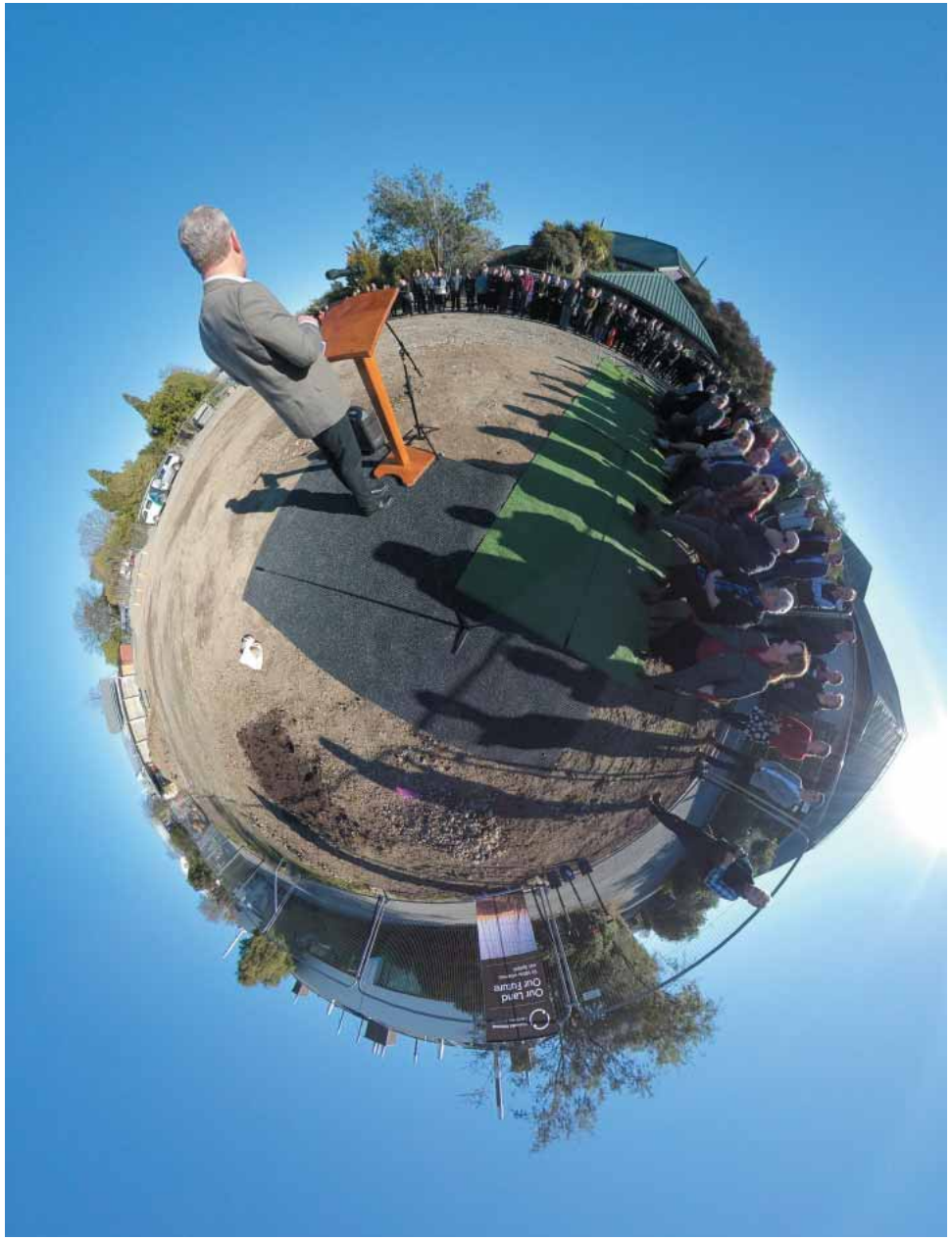
The programme began with a need to replace the Godley building at our Lincoln campus, but also presented an opportunity to pioneer new ways of working that power exceptional science, better integration, external collaboration, and a stronger, united culture.

The past year has seen the demolition of the old Godley building, and the design of our new building finalised. The new build features a two-storey office wing and a 'main street' that will link the existing Fleming building to the new office wing.

This year the programme enters the most exciting phase – the construction of the new building – both on time and on budget. As well as the physical monitoring and construction progress, the programme team is exploring and implementing key technology to support future ways of working, and working with our people to develop the cultural and behavioural changes required to support our strategy.

Within the design of the new building will be a set of experiences to help visitors to Manaaki Whenua better understand our science. The interactive experiences will be centred around each of our four ambitions.

The construction programme will see us open our new building in late 2020.



A 360-degree camera picture of our CEO Richard Gordon addressing guests at a site blessing and ground-breaking ceremony for the new building at the Lincoln site.

Our carbon footprint

Given the focus of our business on 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 ISO14001 standard since 1998, meaning that we maintain systems to document and manage our environmental impacts. We have been certified carbon-neutral since 2011, meaning that we measure and manage our greenhouse gas emissions and pay to offset those emissions that we have not been able to eliminate. We maintain carboNZero certification through our subsidiary Enviro-Mark Solutions, which purchases certified carbon credits on our behalf.

We report on operational environmental indicators including air travel, vehicle travel, HFC refrigerant loss, other energy use and emissions.

We targeted a 15% emissions reduction in the 5 years to 2021. Following a period of declining emissions, this year our emissions from air travel and vehicle travel rose significantly, but our energy use decreased by 4%.

The increase reflects the challenge we face in encouraging our people to be well connected with the users of our science and our science collaborators, both in New Zealand and overseas. New entities in the science system have increased the demand for collaboration meetings, which mean staff travelling by air. Video technology does not yet substitute for face-to-face in workshops where new groups of people come together to develop new relationships and collaboration priorities.

Our goal is to reduce such travel while not compromising our business needs. We will advocate for the whole science sector to challenge its dependence on air travel for meetings.

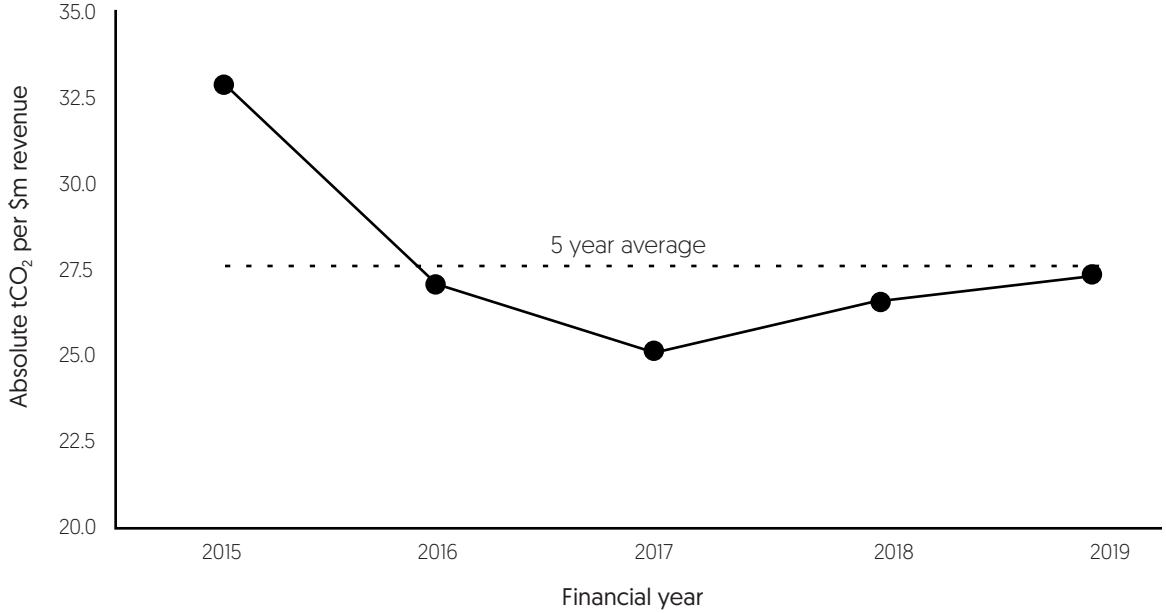
5 YEAR AVERAGE
Absolute tCO_2 – **1,819**
Revenue ($m) – **66.29**

tCO_2 per $m – **27.44**

2019
Absolute tCO_2 – **2,168**
Revenue ($m) – **79.97**

tCO_2 per $m – **27.11**

CARBON EMISSIONS PER MILLION DOLLARS OF REVENUE OVER 5 YEARS



Science for impact

Our focus in this strategic pillar is on delivering science and research that will create real-world impact for New Zealand.

By traditional academic measures of science impact, the quality of our research continues to be high. Between 2015 and 2018 Manaaki Whenua's science citation impact factor (calculated from the number of times a science paper is referred to by others) was 1.71, second only to Auckland University of Technology within New Zealand's science and university research (see also page 70).

By contrast, measuring impact in terms of societal change and benefit is more difficult because of the long timescales and complex attribution processes that can be involved. Nonetheless, we are concerned 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.

Innovative & challenging

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

Outside Thinking and Brilliant Writing are schemes to identify and fund innovative ideas we wish to test and refine through collaboration with other groups, nationally and internationally, followed by writing a synthesis paper to set the research agenda in the chosen areas for the next 5–10 years in a global context. The schemes have provided significant mentoring to early-career scientists in writing and critical thinking.

This year we identified and funded two Outside Thinking opportunities, each backed up by Brilliant Writing:

1. Innovative behavioural approaches to managing mammalian pests: eradicating the last survivors. Recent research, both in New Zealand and overseas, suggests that some species' behaviour may be managed at the landscape scale using novel applications of sensory cues. This behavioural modification approach has applications both for managing pests and for conserving rare or threatened species. Our initiative has, for the first time internationally, brought together experts in animal behaviour and wildlife management to develop a new synthesis of the two fields.
2. Indigenous Rights and Governance. New Zealand is arguably further ahead than many other nations in the evolution of indigenous rights and governance regimes. With indigenous rights and governance being a high-profile topic in many parts of the world we have a strategic opportunity to assess New Zealand's progress and to demonstrate and extend our research profile into the global arena. We aim to raise the academic profile of our Māori-focused governance research to be leaders in the field domestically and to build global partnerships with other leading academics to demonstrate emerging international leadership.

The Science Den is another 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.

Strategic & integrated research

Increasingly, we work on longer and larger scales and more complex problems, integrating across disciplines and stakeholders. For tackling complex real-world issues such as climate change, risks and hazards, biodiversity and pests, 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 therefore requires multiple skill-sets but also a more externally driven understanding of the issues than a research community may arrive at by itself. The varying contributions of expertise might include knowledge, understanding of a problem, concepts, frameworks, data, methods, skills, and interpretations.

Over the past year there have also been some great examples of integrated research happening across the organisation. For instance, Nick Cradock-Henry led a MPI-funded project on earthquake resilience in the wine industry, working with other researchers, the wine industry, the local community, Marlborough District Council, and the Ministry for Civil Defence and Emergency Management. All contributed different forms of expertise.

The study found three characteristics were associated with resilience in the face of the impacts of the 2016 Kaikoura-Marlborough-Hurunui earthquake: resistance, a measure of impact; latitude, or the degree to which the system is able to adapt and respond; and precariousness, the 'closeness to the edge' of the system.

The results also demonstrated the ways in which markets, organisational structure, and the physical environment influenced the degree to which industry was affected by the quake.

The assessment framework developed an approach that can also be used to identify system-critical vulnerabilities to a range of stressors, including high-impact weather, climate change, and market shocks.

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 science excellence.

Scimago Journal ranking

In the past year the average journal ranking of Manaaki Whenua articles was up from the 5-year average of 3.1, reaching 3.6 in 2018. This was mostly due to an increased number of articles in journals with a Scimago Journal ranking above 5.0.

Web of Science 2011–2018

Average citations per paper in 2018 have continued to increase over previous years to 18.22 (2016=11.4, 2017=13.3).

Valued & trusted

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 those 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 continue to work closely with our major central and local government stakeholders to develop the evidence base for conservation, biosecurity, and land management policy, legislation, and regulation. Increasingly, we have employed deeper partnership approaches, such as secondments, to better understand the specific needs and priorities of those who will be using our advice and tools.

In 2019 we held our 100th LINK seminar for inter-agency information sharing in Wellington. Regular LINK seminars cover science developments of interest to many third parties, including ministries and other government and non-government organisations.

Engaged with all New Zealanders

Researchers around the globe are increasingly realising that achieving impact through science requires the engagement and even participation of the public. This is no different in New Zealand, and indeed our Government has asked CRIs to lead the conversation with the New Zealand public on such key issues as climate change, biodiversity loss, and land use.

Digital technologies and communications channels provide us with the potential to reach all New Zealanders. Social media platforms provide us with a way of taking our stories to our existing and new audiences. In the past financial year, we focused on growing our social media audiences.

This focus has already seen significant gains both in our regular audience, and in our ability to reach a broader audience with relevant content. On Facebook we have seen a growth in our followers of over 50%, from 5,686 at the end of financial year 2018 to 8,758[1] and counting. Engagement with our Facebook content has increased from 92 interactions per post in financial year 2018 to 126 in financial year 2019. Instagram presence, a relatively new channel for us, almost doubled in the year to June 2019, from 1125 followers to 2101.[1]

Our most popular Facebook content for the 2018/19 year was a set of simplified, bilingual bird identification images. These reached 78,209 people,[2] and were shared 528 times[2] (manaakiwhenua.co.nz/bird-id). To support the NZ Garden Bird Survey, we run a targeted Facebook page and group. These continue to grow, with the group now having 2,988 followers[1] and 4,195 members.

[1] Sprout Social media management tool.
[2] Facebook Insights.

A toolkit for integrated science

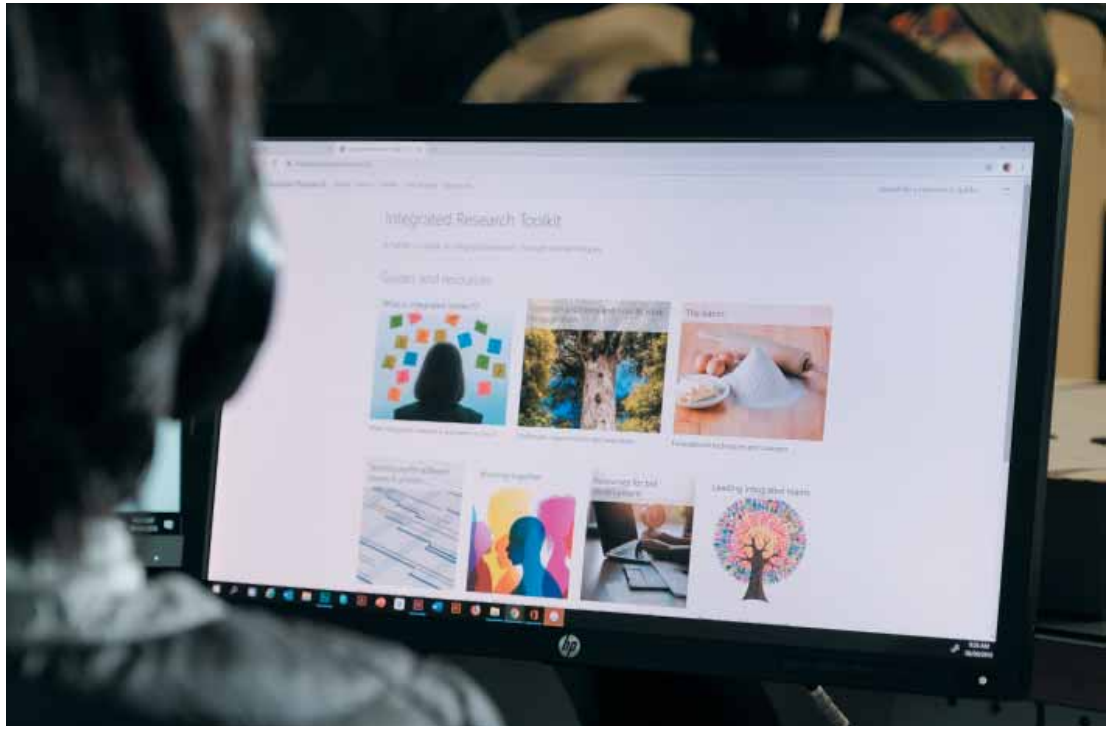
As a part of the implementation of our Integrated and Strategic Science goal we have interviewed staff and identified a number of opportunities, successful actions, barriers, and risks for integrative research. We focused on research that requires integration between biophysical and social science disciplines, and beyond the sciences to integrate Māori, stakeholder, and end-user knowledges and perspectives.

Approximately 65% of respondents felt that working more broadly with others in the organisation and with those outside the organisation would enhance the impact of their research. The interviews further supported the appetite for more transdisciplinary work.

Based on this work, and the expertise that exists within the company, Manaaki Whenua has been developing an integrated research toolkit. This toolkit, the i3 interface, which means **Integration x Innovation x Implementation**, contains a curated set of tools, approaches, information, case studies, and guides for integrated research. The interface has been iteratively tested with a group of researchers from across the company. The i3 interface was launched at a roadshow at the Manaaki Whenua campuses in late August and early September 2019.

i3

Innovative
Integrated
Implemented



Success for the CRIs at Fieldays

One of the challenges we share with the other CRIs is how we make our science relevant and useful to all New Zealanders. How do we give the public a deeper understanding of the questions we are working to answer, and show them the tools that will help shape our response to the huge environmental issues we face today?

This year, four of the CRIs – AgResearch, ESR, Scion, and Manaaki Whenua – decided to experiment with a collaborative stand at National Fieldays. Under the heading 'Science growing the future of New Zealand', our shared stand presented some of the broad science we thought most relevant to a Fieldays audience.

For Manaaki Whenua this was also a chance to experiment with some of the insights we had gathered at a recent Design Thinking sprint focused on engaging New Zealanders with our science. One key insight was that engagement with the environment starts with getting your hands dirty. Our stand invited visitors to interact with an augmented reality sandpit that illustrated how carbon exists in our soils across New Zealand's landscape. By manipulating the sand directly, visitors could get a basic understanding of some of the science that is known about soil carbon. More importantly, it started a deeper conversation about land use and land-use decisions, and how our science was working to inform the decisions that landowners can make.

This overall experiment in engaging the public with CRI science was well received, with our shared stand winning both the Supreme Site award and the award for best indoor agribusiness site.

Fieldays Site Award
Supreme Site
2019 Winner

Fieldays Site Award
Best Agribusiness Indoor Site
2019 Winner

We partnered with AgResearch, ESR and Scion to create a collaborative and interactive stand in the 'Science Alley' at Fieldays in June 2019. Our augmented reality sandpit (opposite page) attracted all ages to the stand, and we were pleased to win two awards including the Supreme Site award.

Summary of financial performance

SUMMARY TABLE OF GROUP FINANCIAL PERFORMANCE INDICATORS

	2017	2018	**2019**	2020
	Achieved	Achieved	**Achieved**	Target
Revenue, $M	65.0	77.7	**85.5**	93.6
EBIT, $M	4.8	6.3	**3.7**	2.4
NPAT, $M	3.7	4.9	**3.0**	2.1
Total assets, $M	62.6	68.7	**72.2**	74.9
Return on equity	10.4%	12.4%	**7.0%**	4.7%

Financial Performance

Total Revenue for the year of $85.5m was $7.8m up on the previous year. This reflects a strong year with demand for our science expertise continuing to increase through both delivery of Endeavour MBIE contestable research and non-MBIE funding from central and local government clients. Net Profit after tax at $3.0m reflects that we are investing in the organisation.

The reported NZ IFRS profit includes the significant one-off costs of $0.7m (net of tax) which have been incurred and expensed related to the demolition associated with the Lincoln Redevelopment (see page 66).

As a CRI we do not seek to maximise profit beyond what is needed for financial resilience, which is agreed in advance with our government owners. This year we invested $3.2m in projects specifically aligned to our strategy.

Our balance sheet and cashflows enable us to continue investing in the organisation, which will contribute to making Manaaki Whenua a more sustainable and future-proofed organisation.

Glossary

CEMARS	Certified Emissions Measurement and Reduction Scheme
CO_2e	Carbon Dioxide Equivalent
CRI	Crown Research Institute
DoC	Department of Conservation
eDNA	Environmental DNA
FAO	Food and Agriculture Organisation of the United Nations
ICMP	International Collection of Microorganisms for Plants
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
MBIE	Ministry of Business, Innovation and Employment
MfE	Ministry for the Environment
MPI	Ministry for Primary Industries
NIWA	The National Institute of Water and Atmospheric Research
NSC	National Science Challenge
NZBH	New Zealand's Biological Heritage
PDD	New Zealand Fungarium
PERMA	A well-being model comprising Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment
SCP	Statement of Core Purpose
SDGs	United Nations Sustainable Development Goals
S-map	Digital soil map for New Zealand
SOC	Soil Organic Carbon
SSIF	Strategic Science Investment Fund

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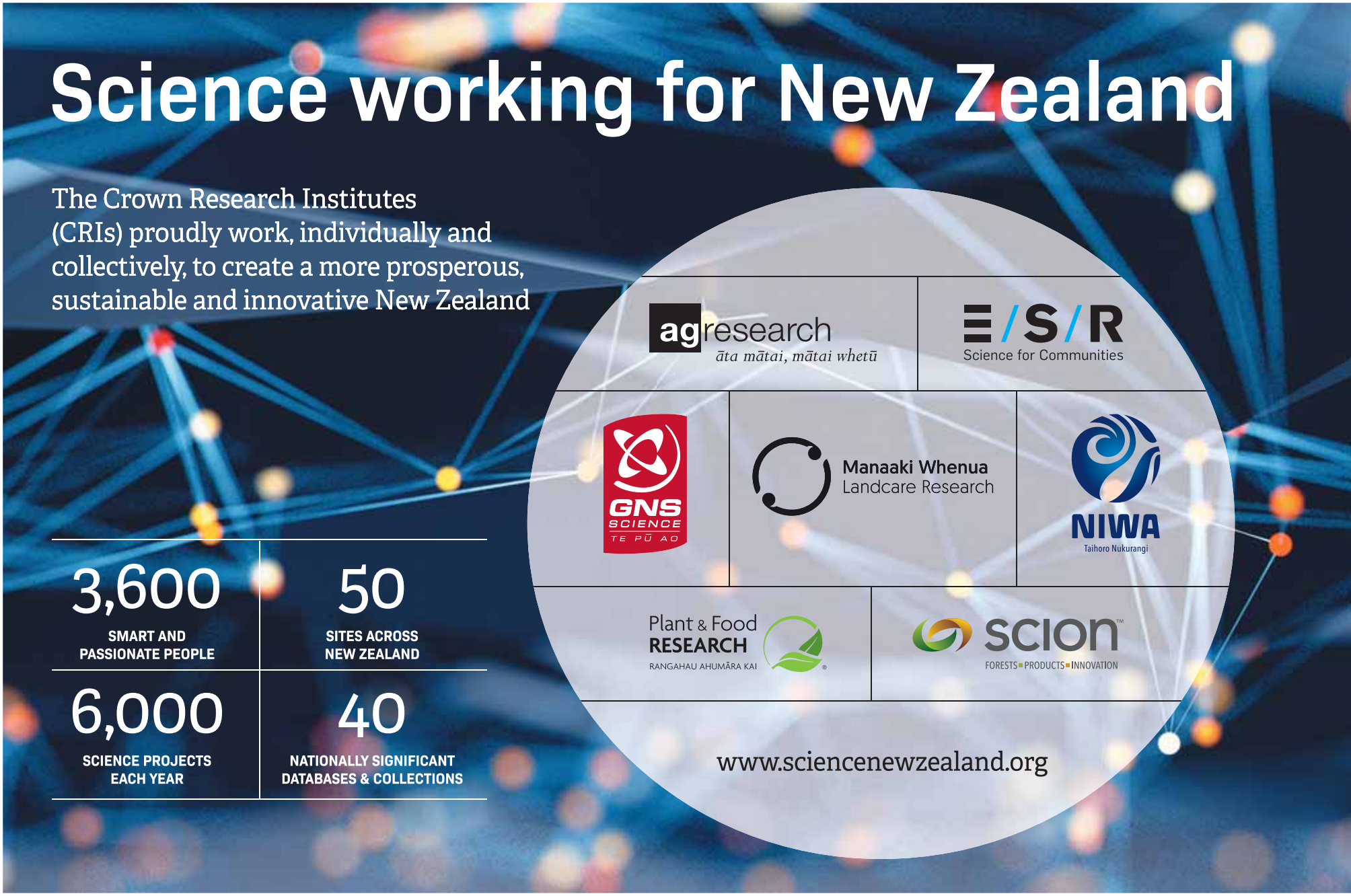
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E/S/R
Science for Communities
GNS SCIENCE
TE PŪ AO
Manaaki Whenua
Landcare Research
NIWA
Taihoro Nukurangi
Plant & Food
RESEARCH
RANGAHAU AHUMĀRA KAI
SCION
FORESTS PRODUCTS INNOVATION
3,600
SMART AND PASSIONATE PEOPLE
50
SITES ACROSS NEW ZEALAND
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