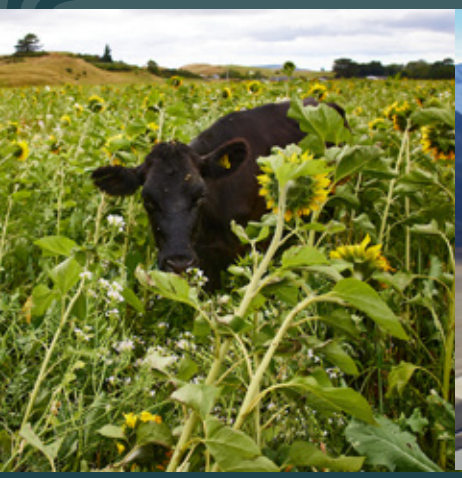
National SCIENCE Challenges

OUR LAND AND WATER

Toitū te Whenua, Toiora te Wai

Our Land and Water

Annual Report Summary



July 2022 – June 2023

10 Things Our Land and Water Learned in 2022–2023

1

Aotearoa can meet its goals for GHG emissions and water quality, and produce a nutritious diet for New Zealanders, by growing the right crops in the right place.

2

Sediment losses could increase up to 233% by the end of the century due to climate change. Without mitigation, these losses will be greatest in Northland, Gisborne and Manawatu-Wanganui.

3

The convergence of climate change, Covid-19, and systemic poverty amongst Māori has motivated kāinga to become more resilient to external shocks.

4

We will detect change in water quality over a 5 to 20-year period if we invest in more monitoring, increasing current levels by three to five times.

5

Protein harvesting from pasture has the potential to enable the reduction of stocking rates without compromising a farm's economic viability, while reducing environmental impact. generations.

6

Failure to increase environmental and social ambition in policies under development in New Zealand could result in significant reductions in market access to the EU.

7

Rural community resilience can be quantified using available data. Communities that score higher on the resilience index have higher income, higher levels of educational achievement and higher levels of employment.

8

Application of the Tīmata Method to establish ngahere (native bush) has the potential to reduce costs by $20,000 per hectare.

9

A nitrogen-loss Risk Index Tool was developed to assess the spatial risk of nitrogen loss from land through leaching and runoff, using underlying soil, climate and slope characteristics.

10

Science-only panels and close connection to officials can benefit freshwater policy development, but other factors, including implementation practicalities, moderate the influence of science-based advice.

1. https://doi.org/10.1080/03036758.2022.2137532
2. https://doi.org/10.1016/j.geomorph.2023.108607
3. https://ourlandandwater.nz/indicators-of-success
4. https://ourlandandwater.nz/detect-change
5. https://ourlandandwater.nz/pasture-humans
6. https://ourlandandwater.nz/eu-green-deal
7. https://doi.org/10.1080/00779954.2022.2154253
8. https://ourlandandwater.nz/ngahere
9. https://bit.ly/risk-index-tool
10. https://ourlandandwater.nz/npsfw-management

Our objective is to maintain and improve our land and water quality for future generations, while enhancing the value of the primary sector to New Zealand.

The Our Land and Water objective holds te ao Māori (a Māori world view) at its heart as a central unifying concept, giving effect to a vision that recognises our fundamental connection to our land and water, to which we give and receive benefits in a reciprocal way. It embraces a concept of value creation from agriculture that is much broader than growth in production or productivity.

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Page 29: Rob Suisted
Page 35: Stock image combined with screenshot of Open Country Dairy online tool
Page 28: Rob Suisted
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Executive Summary

The goal of the Our Land and Water National Science Challenge is for all New Zealanders to be proud of the quality of our land and freshwater, and for Aotearoa to be world-renowned for its sustainable food and fibre production. We are working towards an agri-food and -fibre system that enhances the vitality of te Taiao by creating mosaics of diverse land uses.

Our Land and Water is in its seventh year of operation, hosted by AgResearch and supported by 16 collaborative partner research organisations. In this financial year, Our Land and Water invested in 27 new research programmes and 22 Rural Professionals Fund special projects.

Major achievements in 2022–23 include:

The commissioning of the third and fourth rounds of Rural Professional Fund brings the number of projects supported through this contestable fund to 49, for a combined total investment of just over $3M. The projects connect rural professionals, farmers and researchers together to develop or test new and innovative ideas for improved land use and water management. Results from the second round were published in 'New Ground' in December 2022, a magazine circulated widely to rural professionals.

Launching seven new mātauranga Māori-led research programmes (collectively $4.2M), with inbuilt impact for Māori land stewards and kaitiaki of whenua and wai

Notable science findings and impacts in 2022–23 include:

Aotearoa can produce enough of the right crops in the right places to deliver a nutritious diet for New Zealanders, profitably and while also meeting current ambitions to lower greenhouse gas (GHGs) emissions and nutrient losses to water. The net cost of the required land use change would be less than <1% of the primary sector's export revenues, and potential savings for the health system would be in the order of $14B.

Whitiwhiti Ora/Land Use Opportunities research generated a 'Data Supermarket', a comprehensive online storehouse of information about a diverse range of crops and their growth requirements now and in a climate-changed future. The open-access, searchable Data Supermarket was featured on 1News Breakfast and in our new Digital Toolshed webinar series in May 2023.

With all research funding now fully invested, Our Land and Water has pivoted to creating optimum impact from research outputs and this will continue to be the priority through 2023–24. The integrative, practical nature of Our Land and Water research outputs is drawing interest from regional councils and policy setters, as well as primary industry-focussed organisations and societies. The inclusion of stakeholders, consultants, Māori agribusiness professionals and catchment groups within research teams is also facilitating the uptake and immediate impact of research in case study catchments.

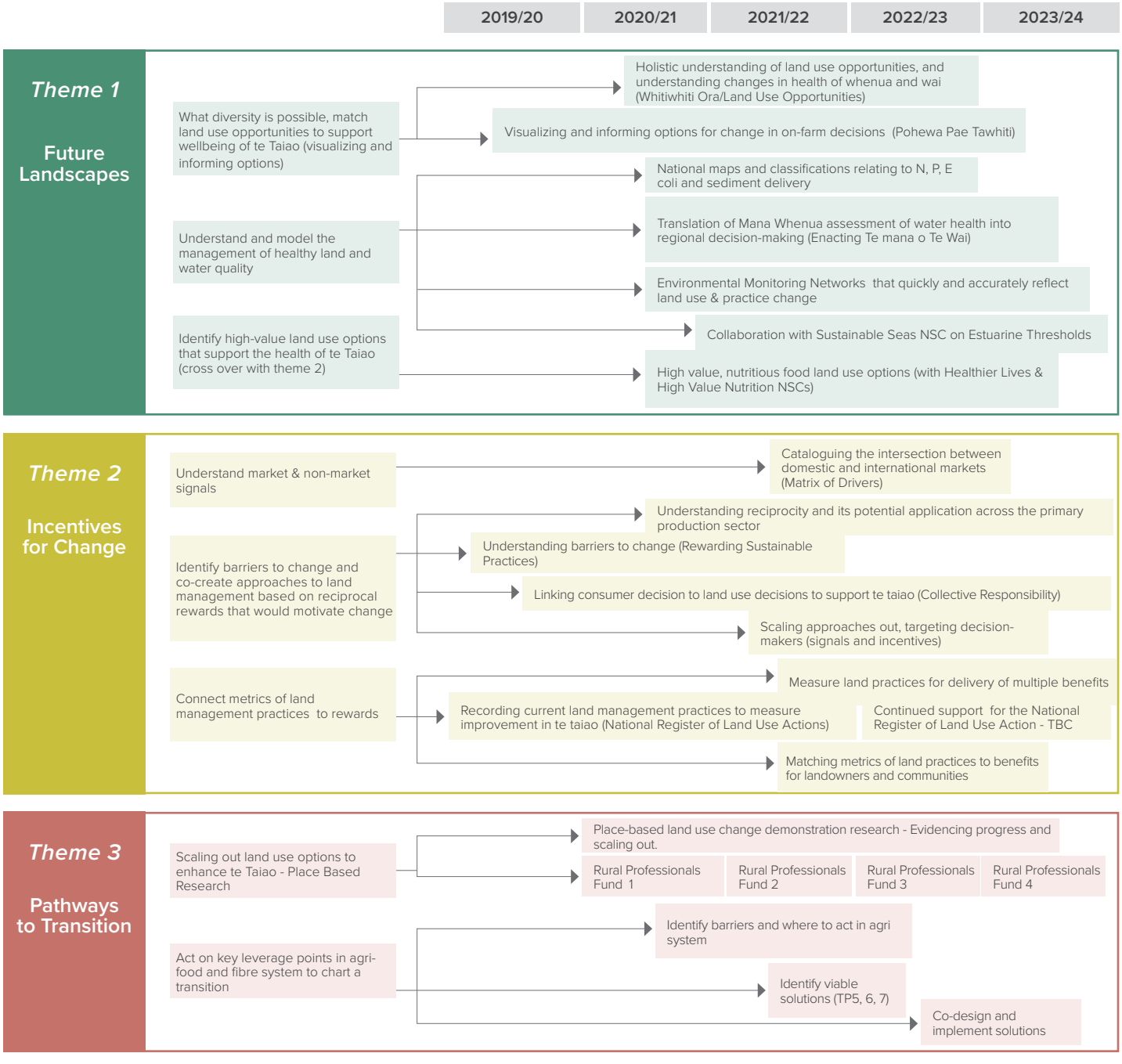
Minor unspent funds in research or operations budgets (e.g., due to staffing changes or Covid-19 impacts) are being channelled into strategic support for impact extension and developing stakeholder capabilities in the application of Our Land and Water tools. Trusted writers and communications consultants, including Māori communications specialists, are being retained on contract through to June 2024, to increase Our Land and Water's communications capacity. A final symposium is being planned for May 2024 to further deliver knowledge and innovation to end-users and stakeholders.

Our Research Structure

Having been in operation for seven years, 2022–23 is the fourth and penultimate year of the second phase of funding (2019–2024) for the Our Land and Water National Science Challenge.

There are three research themes designed to collectively deliver the objective for our Challenge. Over 70% of Our Land and Water's total Phase 2 investment ($69M) is for research under these themes.

The investment initially budgeted for these research themes in Our Land and Water's Phase 2 Strategic Plan ($49.5M) has now been 99% invested, across 55 research programmes, working groups and think pieces.



Our Impact Goals

FUTURE LANDSCAPES

Flagship Concept:

Providing tools for land stewards to assess diverse land use options, to identify the best land use to support the vitality of te Taiao.

Theme Impact by 2024:

Decisions on land-use change and management practises can be made with confidence that they will lead to improvement in te Taiao.

Theme Impact by 2030:

The vitality of te Taiao is improving in response to our decisions as land stewards.

INCENTIVES FOR CHANGE

Flagship Concept:

Identifying rewards, signals and approaches that motivate beneficial behaviours and reciprocal relationships in the agri-food and fibre system.

Theme Impact by 2024:

New incentive approaches and value chains are motivating people and organisations to make "better decisions for te Taiao.

Theme Impact by 2030:

People and organisations in the agri-food and fibre system feel rewarded for prioritising the vitality of te Taiao.

PATHWAYS TO TRANSITION

Flagship Concept:

Working with land stewards/ organisations in the agri-food and fibre system to design new options and pathways to achieve future landscapes.

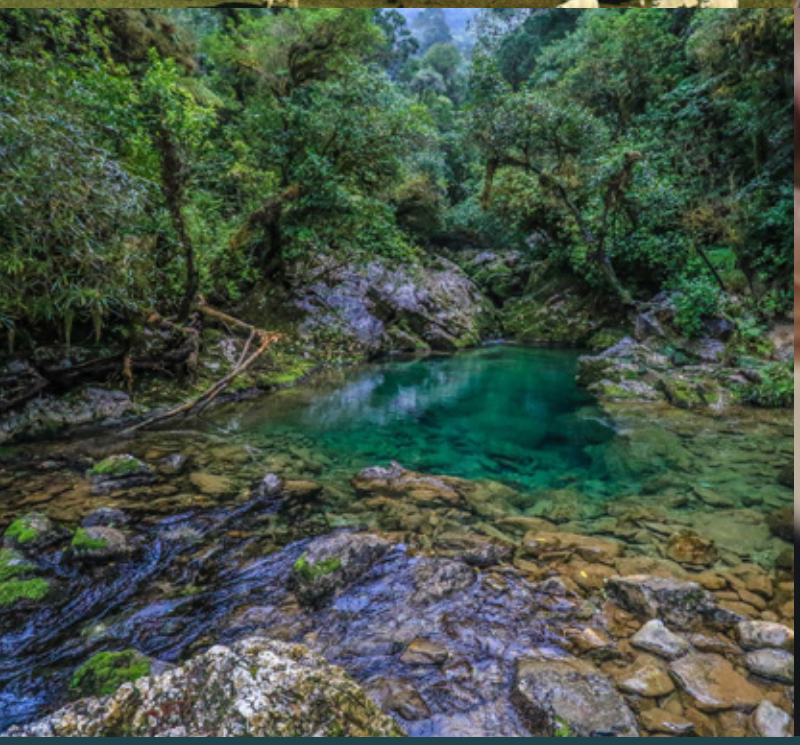
Theme Impact by 2024:

New options and pathways to enhance te Taiao are being explored by land stewards and organisations in the agri-food and fibre system.

Theme Impact by 2030:

The agri-food & fibre system is reconfiguring to enable resilient, healthy and prosperous land uses that improve the vitality of te Taiao.

Highlights and Achievements



FUTURE LANDSCAPES

Future Landscapes research informs decisions on land use change and management practises, so that such decisions can be made with confidence that they will lead to improvements in te Taiao. The impact of this research will be to increase the vitality of te Taiao in response to these decisions.

Research from the Whitiwhiti Ora/Land Use Opportunities programme generated a 'Data Supermarket', an online storehouse of information pertaining to a diverse range of crops and their growth requirements, now and in a climate-changed future.

A nitrogen-loss Risk Index Tool (RIT) was developed by Our Land and Water researchers for the Ministry for the Environment, to assess the spatial risk of nitrogen loss from land through leaching and runoff, using underlying soil, climate and slope characteristics. The RIT helps to address some of the weaknesses in the application of the current models used to estimate nitrogen losses from agricultural land.

Research results from the Monitoring Freshwater Improvement Actions programme indicate that current State of the Environment monthly monitoring practices to detect change in water quality may not detect changes over a 5- or even a 20-year period, depending on the contaminant or cultural health indicator and the nature of the freshwater body. The research continues to develop a tool to inform decisions on monitoring frequency, site choices and provide cost estimates. A presentation to the Regional Councils' SWIMM group (a special interest group for water monitoring and management) highlighted opportunities for this work to be included in a new LAWA initiative to support Regional Councils.

StatsNZ used research from Linking Legacies to Wai that improved estimates of reference conditions, updating its website to refer to the revised reference conditions value.

Environment Canterbury will use Mosaic vs Monoculture researchers' model for farm economics in their Land and Water Regional Plan revision.

Te Whakatōhea Trust has partnered with an MSc student for a project that will further record and spatialise their knowledge using the Peri-Urban Potential spatial tools the Trust Board became familiar with as a partner in that research. This will support the re-integration of mara kai into their papakainga.

Pasture-based and grass-fed branding are often associated with consumer perceptions of improved human health, environmental performance, and animal welfare. However, in a global analysis of nitrogen and phosphorus losses from land relative to the duration of outdoor livestock grazing in confined, grazed and hybrid systems, there was little evidence that grazed dairy systems have lower nutrient losses than confined ones. Moreover, observed nitrogen losses for confined systems were the lowest on a productivity basis. New Zealand's nutrient losses to water can therefore appear high compared to other dairy producers.

The nitrate concentrations expected in the absence of human influence (i.e., reference conditions) have been established for national groundwaters, and can now be used in national water quality reporting.

A 20-year dataset showed that water quality in five large dairy-dominated catchments had improved with 10 years of extension advice and maintained that improvement in the subsequent 10 years. Abrupt decreases in contamination were correlated with extension advice. Water quality improvement was attributed to the isolation of critical source areas and the implementation of mitigation actions bespoke to the catchment. This supports the use of the processes used in current policy to implement freshwater farm plans.

Owing to climate change and more frequent high intensity storms, sediment losses are estimated to increase by up to 233% by the end of the century. Without mitigation, these losses will be greatest in Northland, Gisborne and the Manawatu-Wanganui regions.

Excluding red deer from waterways was found to be effective even 15 years after fencing was erected, indicating that well managed and installed fencing can be a long-term mitigation to improve water quality.

INCENTIVES FOR CHANGE

Incentives for Change research identifies approaches and value chains that motivate people and organisations to make better decisions for te Taiao. The impact will be to reward producers in the agri-food and fibre system for prioritising the vitality of te Taiao.

In collaboration with Healthier Lives NSC, it was demonstrated that NZ can produce enough of the right crops in the right places to deliver a nutritious diet for New Zealanders, profitably and while also meeting ambitions to lower greenhouse gas (GHGs) emissions and nutrient losses to water. The net cost of the required land use change was about $300-500M (<1% of the primary sector's export revenues), but much less than the estimated savings for the health system from an optimised diet ($14B). The work was featured in the media.

Growers in the Pā to Plate project (part of the New Models of Collective Responsibility programme) are supporting others to realise aspirations of returning Māori land to thriving gardens that were there historically. Pā to Plate has onboarded more learner and intermediate growers, with a grower collective now consisting of 5 foundation growers and 8 less mature growers, who together have pursued capability development for preserving kai to feed whanau and marae communities, and to increase sales.

Aotearoa Food Systems connected the Healthy Families group in Invercargill with Māori health expert Dr Ihirangi Heke, who presented his Atua Matua framework for promoting understanding of healthy food. This visit deepened understanding about mātauranga Māori and connecting with Taiao to improve wellbeing outcomes, among representatives from local rūnaka, Māori health and social services providers, education, and whānau.

The Motueka Catchment Collective successfully applied for funding using the 'catchment journey' developed by the Register of Land Management Actions in its proposal.

Research from Credence Attributes On Farm research was used in an assessment of the potential market impacts from meeting (or not) our climate obligation, in work on the economic impacts of He Waka Eke Noa for MPI and MfE.

Analysis of the first global database of topsoil nutrient status indicated higher concentrations and stocks of nutrients in many of our competitors' soils. This may lead to a longer-term legacy of water quality impairment from these soils.

PATHWAYS TO TRANSITION

Pathways to Transition research identifies effective methods to scale land-use change up and out to catchment, regional and national scales. In this theme, land stewards and organisations in the agri-food and fibre system lead the research to extend enhancements to te Taiao through wide-spread land-use change. The anticipated impact is that the agri-food and fibre system will reconfigure to more readily enable resilient, healthy and prosperous land-uses, which will in turn revitalise te Taiao.

The Environmental Defence Society (EDS) released their report Better Linking of Science to Policy on the process used in the development of the National Policy Statement for Freshwater Management (2020). They highlighted the benefit that science-only panels, evidence-based decisions and close connection to officials can have in policy development, but also how parallel considerations of other factors, including implementation practicalities, can moderate the influence of science-based advice.

Within the Wai Kokopu catchment, 52ha of land will be planted this winter using the Tīmata Method. Landowner decisions were assisted by resources produced by Retiring Farmland into Ngahere research. Balanced Forestry can directly attribute orders of 16,000 trees from the resource. Regional councils are also showing an interest in Tīmata to cost-effectively achieve broadscale retirement of steep pastoral land.

The use of drones for environmental compliance was investigated and showed promise for providing greater robustness, speed and safety, particularly for steep farmland. However, issues remain around permissions to capture, store and access footage.

Three Māori Masters scholarships were awarded in 2022-23; two through Pūhoro STEMM Academy and one to a previous Our Land and Water researcher and farm environmental consultant in Ōtautahi who wished to embark on a Masters of Māori and Indigenous Leadership through the University of Canterbury. The connection with Pūhoro STEMM Academy has remained very strong though 2022-23, with the internship celebration in February 2023 showcasing once again the impressive and bicultural capabilities of tauira Māori affiliated with Pūhoro.

Vision Mātauranga Maturity Assessments (using Our Land and Water's Te Ara Hourua framework) have been completed across Our Land and Water, for all programmes with funding over $1M and contracted after January 2022.

A further 12 Rural Professional Fund (RFP) projects were contracted in the third round (October 2022) and 10 in the fourth and final round (April 2023) of this fund. In all, a total of 49 RPF projects have now been funded through this contestable fund, with a combined value of just over $3M. Results of the second round of projects were published in 'New Ground', a magazine-format publication circulated to all rural professionals who are members of NZIPIM, in December 2022.

CSIRO (Australia) has updated its ADOPT modelling program which predicts the time taken to adopt innovation as an result of its enduring science collaboration with Our Land and Water. Augmenting 2021–22 data, the ADOPT model was extended to 12 innovations developed through Our Land and Water-funded research. This showed Our Land and Water's contribution had increased the proportion of potential adopters from 16 to 35% and that the peak of adoption was reduced by 5 years.

Influencing catchment group capability development funding from government

Collective catchment management workshop, March 2021. Photo: Natwick Photography.

Catchment group research has influenced and supported over $32 million of capability funding to grow the skills and knowledge of people with leadership roles in catchment groups. Allocated by the Ministries for the Environment (MfE) and Primary Industries (MPI), this funding will increase the effectiveness of catchment group action to improve freshwater quality, aligning with the Our Land and Water objective and Essential Freshwater policy reforms.

Restoring freshwater quality requires coordinated action in catchments. Catchment groups have proliferated around Aotearoa as communities address local environment health challenges. The New Models of Collective Responsibility research programme worked with community leaders in case study catchments in Southland (Pourakino), Marlborough (Pelorus), Hawkes Bay (Mangaone), and Northland (Waitangi), to accelerate collective actions to benefit water, land and people.

Identifying support needs for catchment groups was a pivotal issue for the research. A key finding was to highlight some disparities between group actions and government expectations. The research produced 30 practical recommendations for government (including financial support for group coordination roles) and catchment groups (including the need to focus on freshwater outcomes).

A policy advisory group was first convened in September 2020 by the research team, led by Jim Sinner (senior scientist, Cawthron Institute), to ensure the research produced realistic, implementable recommendations for supporting catchment collectives. This policy group met six times during the research, bringing together representatives from MfE, MPI, a Māori land trust, NZ Landcare Trust, Beef + Lamb NZ, Dairy NZ, Fish and Game, the Department of Conservation, Hawkes' Bay Regional Council, and Environment Southland.

Policy group member Alice Bradley, principal advisor for investment at MfE, reports that a key research impact was to influence and support

investment decisions made by government in November 2021.

"Government was trying to understand what catchment groups might be able to achieve, and how best to support them," said Ms Bradley. "Objective evidence was urgently needed to support any government investment in catchment groups, and the Our Land and Water research programme – even though it was quite early in its research – provided foundational insight and demonstrated there was evidence coming."

Government decisions needed to be made before the research was complete, so MfE commissioned the research team to conduct a catchment group survey and produce a report (Catchment and Community Environment Groups in Aotearoa New Zealand: Goals, Activities and Needs, January 2022) drawing on the Our Land and Water-funded research.

Ms Bradley says the policy group discussions also provided valuable insights, connected MfE to a wide cross-section of stakeholders, and built trust in the research. Ms Bradley also met with the research team additionally, at least monthly.

Information from the research and policy group insights were channelled into a November 2021 Cabinet Paper (BRF 915) on the Jobs for Nature programme, resulting in approval for substantial government investment in catchment groups under the Essential Freshwater Fund from the six sustainable land-use Ministers (representing portfolios for environment, primary industries, conservation, economic development, climate change, local government, biosecurity, forestry, and land information).

MfE developed a detailed programme of work for this investment, with the Our Land and Water-funded research shaping three programmes:

- Wai Connection, offering tailored support, resources and expertise to help catchment groups solve issues, and promote collaboration ($18m via Mountains to Sea Conservation Trust);
- Resource manager support to build capability and gain qualifications to meet regional needs of councils, catchment groups and farmers ($1.34m via NZARM); and
- Aotearoa Catchment Extension (ACE) to improve catchment group leader and co-ordinator capability ($2.96m via NZ Landcare Trust).

Our Land and Water is now supporting the NZARM and ACE projects with the development of learning resources based on findings from a range of research.

MPI also directed a $10m Essential Freshwater Fund into catchment group capability-building programmes.

MPI had funded catchment groups for four years within its extension services programme, with projects due to finish by June 2023. This research gave strength to arguments for additional funding to support catchment groups, says Janet Gregory, MPI extension specialist and a policy advisory group member. "The work that Jim and team were doing reinforced and supported the thinking behind our funding to support catchment groups and added credibility to support MPI extending our funding programme," says Ms Gregory.

The unique contribution of Our Land and Water as funder was its requirement for a wide range of stakeholders to be engaged in the research. This supported the creation of the policy advisory group nurtured throughout the research, a collaboration Ms Bradley says MfE found valuable and wouldn't have seen otherwise.

Contact: Jim Sinner, Cawthron Institute

Scientific Quality

Our Land and Water is performing well according to standard metrics used to assess science quality.

29 journal articles were published since our previous annual report.

72% of published articles were in the top 25% of journals in their field.

156 other science outputs were delivered, including 53 presentations by Our Land and Water researchers at conferences.

Our Land and Water researchers were invited to give 7 keynote presentations at domestic conferences and international conferences.

We invested in 27 new research programmes and projects, and 22 Rural Professionals Fund special projects.

Best Research Teams

Choosing the best research teams is the first step to ensuring research excellence. Our Land and Water research teams bring people together from a range of disciplines, from across universities, all of the CRIs, businesses, industry bodies, Māori, government and non-government organisations, private citizens and regional councils.

Stakeholders are collaborators and co-innovators in all our research design and implementation, either in advisory or research roles. Including stakeholders in research teams helps to break scientists out of their routine ways of thinking and working, promotes cross-fertilisation of perspectives with respect to both problem definition and study design. Stakeholders can also provide strategic insights for achieving higher impact to the research and help identify capability gaps.

A collaborative relationship with Ministry for Primary Industries, Ministry for the Environment and Department of Conservation has been fruitful with one example being Our Land and Water's involvement in the Risk Index Tool that was committed to following the 2022–23 review finding that Overseer could not spatially analyse the risk of nitrogen loss from land to water. It was recognised in these meetings that Our Land and Water produced datasets that would prove essential for the tool's development.

Programmes receiving Our Land and Water investment have consistently maintained a higher level of collaboration than aligned or non-aligned programmes. This reflects the wide diversity of research being undertaken, our use of co-innovation and co-design which includes stakeholders in research teams and our strategy to invite participation in Our Land and Water research from a broad range of providers.

38% of journal publications were co-authored with stakeholders and 48% had international co-authors over 2022–23, ensuring Our Land and Water science is relevant and applicable.

86% of publications in the top 25% of journals involved authors from different institutes or organisations in New Zealand.

Quarterly meetings are held with Ministry for Primary Industries, the Ministry for the Environment and DOC to discuss research capability needs, particularly about the anticipated development of policy affecting land and water management.

100% of new research programmes, working groups and think pieces were co-designed with stakeholders in 2022–23.

57% of the Our Land and Water Governance Group members are Māori, maintaining the commitment that at least 50% of members must have depth of experience in te ao Māori at any given time. Leadership by Māori within the Our Land and Water Directorate remains the same as 2021–22 at 35% (of total FTE).

Of the 6 large research programmes ($750K-$1M) that commenced in 2022–23, 4 were mātauranga Māori-led, with built-in impact with and for the communities engaged in the programmes.

In 2022–23, we had 136 Mātauranga Māori experts contributing directly to Our Land and Water research across 34 separate research programmes. 70% of these programmes had more than 1 Māori researcher on the team.

4 dedicated leads are required in large research programmes, accountable for: science excellence, te ao Māori, implementation of the research, and project management. We expect 0.25FTE to be dedicated to each role.

28% of researchers in programme teams (excluding stakeholder members) are early career scientists, post-docs and students.

Funding Distribution

Our Land and Water collaborated with more organisations in 2022–23 than in previous years. Funding is being distributed widely, beyond large research institutions.

All new research programmes in 2022–23 were co-designed and co-developed with stakeholders, and over half (52%) of these new programmes were initiated by (and are now being led by) consultants and agencies in the agri-food and -fibre system.

Just over 40% of funding is invested in Māori-led or co-led programmes. A further 40% of programmes include a significant component of kaupapa Māori research, while the remaining 20% could be classed as mainly "biophysical science".

Following a workshop held in late 2021 with the international Science and Stakeholder Advisory Panel, several research topics were identified to address some of the external factors potentially influencing the Our Land and Water mission. This included factors such as global environmental events affecting domestic markets, land-use opportunities presented by plant-based food systems and how environmental criteria in international trade agreements may affect the future of land-use in Aotearoa. A $5M contestable funding round was run in early 2022, seeking research proposals addressing four topic areas:

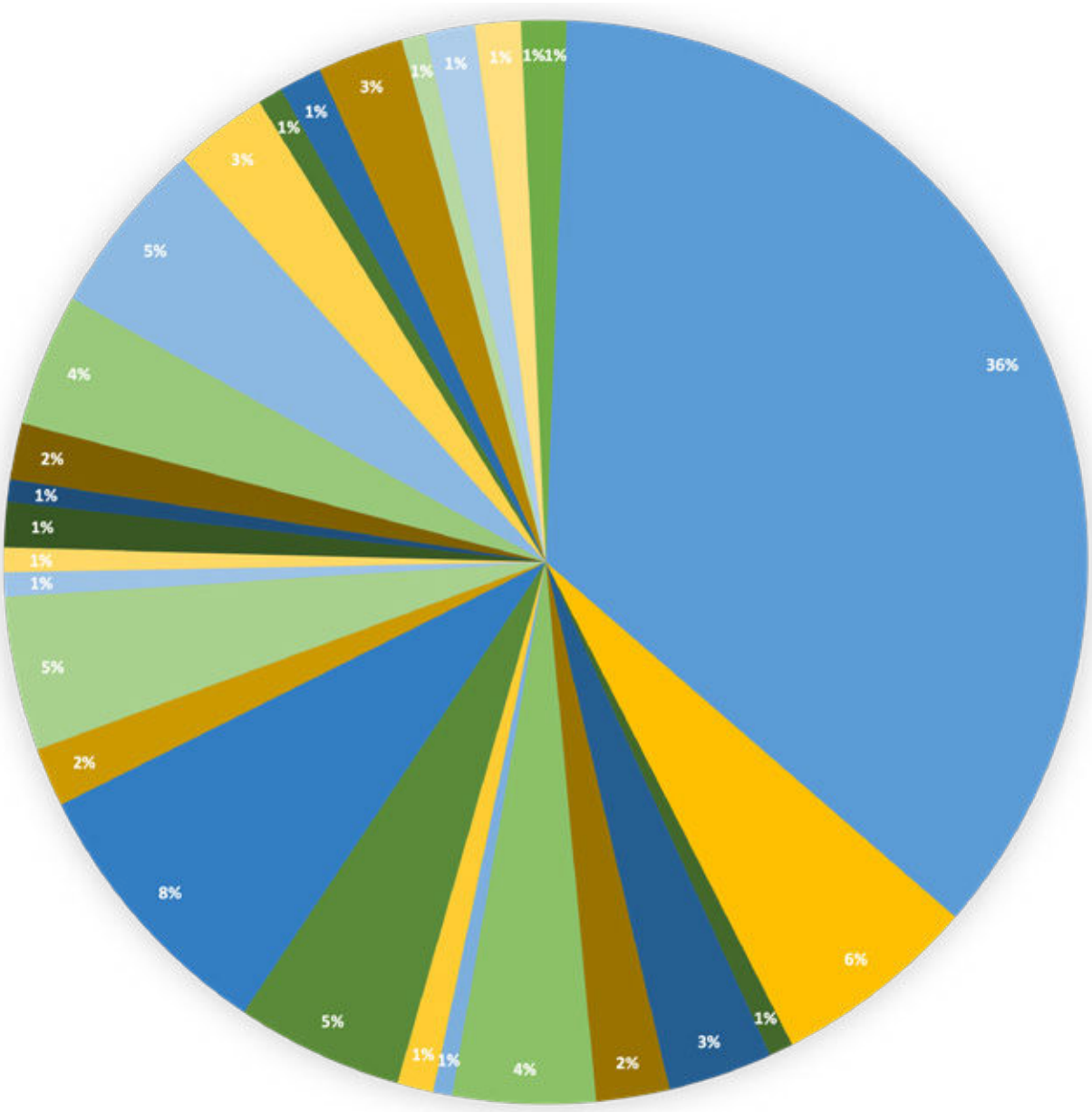
- the effects of global disruptions on trends in land-use decisions;
- the pace and long-term consequences of land-use change;
- understanding the social license to farm; and
- the development of a stable, publicly accessible digital platform for land and water monitoring data and tools.

The round was very successful and 20 new research programmes and think pieces commenced in 2022–23, between July and October 2022, with investments ranging from $110K to $986K.

As well as research in the three themes, in 2022–23 Our Land and Water funded more strategic initiatives to extend and broaden the impact of the Challenge. This has included $550K invested in extending the impact of completed research (12 projects), $300K to support an analysis of how embedding te ao Māori in the Challenge has influenced researchers and research impact, and $860K in catchment-scale scenarios of land-use change for water quality improvement.

We estimate that there was $60,000,000 of aligned research funding in 2022–23.

Research funding is distributed widely



Fertiliser Association practice guidelines based on Our Land and Water science

The Fertiliser Association of New Zealand published a revised and updated Code of Practice for fertiliser management in March 2023, drawing on science produced by Our Land and Water.

The Code of Practice is a key resource tool for the management of fertiliser on arable and pastoral farms, horticulture and viticulture blocks, and market gardens, to avoid or minimise the loss of nutrients to the environment. Improving nutrient management is an important mitigation activity that can support improvements in freshwater quality, a critical aspect of Our Land and Water's core objective.

The Code provides guidance for farmers, growers and farm advisors to use when developing nutrient budgets, nutrient management plans, farm plans and freshwater farm plans. It is also relevant for regional council planning and technical staff.

The revised Code (replacing the previous version published in 2013) had extensive input from agricultural and scientific experts, including Our Land and Water's chief scientist Professor Richard McDowell, who has led our research into Phosphorus Best Practice. Research from four Our Land and Water-funded journal articles, cited in the Code's references, was used in four sections of

the Code that provide guidance on practices to address risk:

1. Risk: Phosphorus exceeding plant or pasture requirements
2. Risk: Unacceptable environmental impacts from direct application
3. Risk: Fertiliser nutrient loss from susceptible production areas
4. Risk: Fertiliser nutrient loss by not matching timing with crop growth stage, weather conditions and soil temperature

In those sections, Our Land and Water science provided the definition of soil test target ranges, areas of accumulation, avoiding soils with low ASC (P retention) and critical source areas.

Phosphorus Best Practice research investigated whether practice and policy for fertiliser and farm dairy effluent (FDE) application were sufficient to minimise phosphorus loss. The research also explored the factors affecting phosphorus loss after the application of fertilisers.

One key finding of this research was that when fertiliser is managed badly, it's responsible for 30 to 80% of the phosphorus that drains away from a farm. When it's managed well, that can decrease to less than 10%. This research also provided a scientific basis for New Zealand and Australian farmers to follow the fertiliser industry-developed '4R guidelines': apply fertiliser in the Right place, at the Right time, at the Right rate, and in the Right form.

Key collaborators in the Our Land and Water research were AgResearch, Lincoln University, the South Island Dairy Development Centre and Ballance Agri-Nutrients who supplied time and resources including study sites and fertilisers.

Our Land and Water's chief scientist is a frequently published expert on phosphorus in freshwater, with his own wide network of established phosphorus researchers working in an agricultural context and a strong connection into the fertiliser industry. This meant that Our Land and Water was very well positioned to identify new and effective ways to reduce the impact of fertiliser-derived phosphorus in our waterways, to communicate these to the industry, and to provide an overview of the new Code of Practice.

Contact: Professor Richard McDowell,

Our Land and Water

Commitment to Te Ao Māori

Last year Our Land and Water focussed on building trusted relationships with Māori researchers, practitioners and entities who could contribute to the delivery of our mission.

In the last year we have increased the number of mātauranga Māori experts contributing directly to Our Land and Water research to 136 (an increase of 109%). This figure does not include extended teams within Māori case study partners, which would likely increase this figure by 3–4 times. 25% of these people are working across multiple Our Land and Water research programmes.

The increase of capacity and capability across Our Land and Water programmes, coupled with an increase of researchers working across multiple programmes supports the ability of the programmes to more effectively integrate mātauranga Māori.

In 2022–23 seven Māori-led research programmes were established. Four of the seven are large research initiatives that demonstrate strong integration of mātauranga Māori including:

- Kaitiaki Intelligence Platforms
- Whakatupu: Supporting Landuse Decision Making for Māori Landowners
- Ngā Tohu o Tai-o-Rongo
- Implementing Te Mana o Te Wai (phase 2)

Kaitiaki Intelligence Platforms

Kaitiaki Intelligence Platforms looks to establish Māori agribusiness entities and collectives as national first movers in high resolution environmental monitoring in ways that support dynamic value chain transparency. It considers the technologies Māori authorities and enterprises should prioritise from an investment perspective to ascertain the impact of land management practices on the mauri and mana of human and non-human communities at farm and rohe scales including:

- A supply-chain intelligence platform – that can communicate and authenticate indigenous production values and leading environment performance to markets and consumers, ensuring preferential market access and attracting premiums for product.
- A financial market intelligence platform – that can communicate and verify indigenous production values and environment performance to the sustainable finance sector, while providing climate & nature related risk assurance to lending banks and the broader green finance sector.
- An assurance & verification platform – that can automate environmental performance reporting to regulators.
- A kaitiaki monitoring platform – that can provide iwi with accurate environmental monitoring information, built on tauutuutu ethics, to inform iwi management plans and policies and assist iwi in prioritizing their time and investment priorities.

Our Land and Water currently supports 4 post-graduate students with Masters scholarships, for thesis research both directly and indirectly related to Our Land and Water research programmes. Three of these scholarships are for Māori students. A high level of sponsorship is maintained for the Pūhoro STEMM Academy, who support Māori students in STEMM subjects at secondary and tertiary levels. Our Land and Water has committed to continue sponsoring the Academy through to June 2024.

Whakatupu

Whakatupu was initially established to look at how Māori could benefit from the $8M funding investment into the Whitiwhiti Ora research programme. It will deliver a web-based interface to better support Māori in land-use decision making. The interface is aimed at small to medium scale landowners to help them better understand the land-use decision making process. It prioritises potential land uses based on owner aspirations and provides land-use information in the context of their whenua. This helps to support Māori landowners to be more empowered when entering the next phase of detailed feasibility assessments.

Our Land and Water's Māori research partners

Māori stakeholder groups that were involved in Our Land and Water research in 2022–23 span the length of Aotearoa and include:

Northland hapū, marae and whānau growing collectives
Te Arawa Primary Sector Group
Te Arawa Lakes Trust
Te Pumautanga o Te Arawa Trust
Tātau Tātau o Te Wairoa
Ngāi Tahu Farms
AuOra (Wakatū Incorporation)
Ātihau Whanganui Incorporation
Ngāti Tawhirikura
Te Kotahitanga o Te Atiawa
Opepe Farm Trust
Te Rūnanga o Ngāti Whakahemo
Southland Te Ao Mārama Inc (Ngai Tahu ki Murihiku)
Te Uri o Te Ngahere Trust
Akapatiki A Block Incorporation
Pūrākaunui Incorporation
Te Rūnanga o Whaingaroa
Kura Kai
Te Rūnanga o Te Whānau-ā-Apanui
Mana Tāhuna Charitable Trust
Nikau Farms
Te Ao Marama Inc (Ngāi Tahu ki Murihiku RM agency)
Waerenga Trust
Ngāti Kuia Trust
Te Rūnanga o Te Rarawa

In the last financial year 28 Māori entities and collectives were engaged in Our Land and Water research (an increase of 25% from last year). Of the above list, 12 are new to Our Land and Water research in the last year. These entities have come through a combination of new programmes, case studies through existing programmes, and a few through the Rural Professional Fund and final Contestable Fund rounds.

Pūhoro STEMM Academy

Our Land and Water continues its strong commitment to the Pūhoro STEMM Academy's transformational kaupapa for Māori pupils in STEMM (Science, Technology, Engineering, Mathematics and Mātauranga), from Year 11 through university.

This kaupapa continues to demonstrate academic excellence and provides a critical pipeline of Māori research talent into land, water, and agribusiness science.

Pūhoro has grown from approximately 1,500 students in 2021–22 to over 2,000 students this year.

73 students participated in the summer internship programme supported by Our Land and Water, almost double the number in previous years, hosted by city/regional councils and research institutes on topics ranging from freshwater macro-invertebrate indexing to vineyard disease control and land management register tools.

We have continued to support Masters scholarships through Pūhoro, with both of the 2022 Masters scholarship recipients joining summer internship placements from December 2022 to February 2023.

Image courtesy of Pūhoro STEMM Academy

30-hectare wetland is being restored to support the health of the Waihī estuary

Waihī Estuary at Pukehina. Photo: Bay of Plenty Regional Council Toi Moana

Whānau of Ngāti Whakahemo at Pukehina marae, undertaking a kaupapa Māori project to understand the needs of the Waihī estuary, leveraged $125,000 of Our Land and Water funding into $7 million.

In partnership with Bay of Plenty Regional Council and mana whenua groups, those funds have been used to undertake a significant multiyear restoration programme, including the purchase of 30 hectares at the edge of the estuary to restore wetland ecosystems. This is anticipated to protect and improve the mauri of the estuary, a key objective for Our Land and Water, and provides an exemplar for hapū around the motu.

This project was funded by Our Land and Water to extend the Healthy Estuaries research programme, a partnership with the Sustainable Seas National Science Challenge.

The overarching programme responds to an unintended gap created through the separation of land- and sea-based issues in the National Science Challenge structure. It aims to assess cumulative impacts of land use and freshwater contaminants on estuarine environments and to identify the contaminant thresholds required to restore their ecological function. The programme includes three case study estuaries.

Tāwharautia te Wahapū o Waihī was developed to explore a different approach in one of those case studies. Led by Professor Kura Paul-Burke (University of Waikato), whānau of Ngāti Whakahemo sought to understand the history of the estuary and its experiences over time through kōrero tuku iho (oral histories and traditions), and through developing closer relationships with the estuary via monitoring and observation. This enabled Ngāti Whakahemo to help the estuary

have its own voice, and a means to determine what it needs to be well again.

The Waihī estuary is severely degraded with permanent health warnings for collection of shellfish and declining populations of shellfish, seagrass meadows, bird species, and fish species. Nana (seagrass), one of the most important health indicators of the estuary, has reduced from 80 hectares in 1943 to less than one hectare today.

With a relatively small total catchment area (approximately 35,000 hectares) the ability to affect change through collective action is high. However, there are serious challenges to overcome. At the outset of the project, the four main tributaries emptying into the estuary were straightened canals., with no buffers or contaminant filtration mechanisms.

Our Land and Water funding provided Ngāti Whakahemo and Pukehina Marae with resources to build their internal capacity to support the voice of the estuary. The project also initiated collaborative fieldwork by Ngāti Whakahemo with NIWA and the University of Waikato, resulting in rapid habitat assessment maps and temperature loggers to better understand the impact of climate change on the estuary and mahinga kai.

A key finding of the research was the importance of mātauranga Māori and marine science working together to provide evidence-based information on the current state of the nana (seagrass), tuangi (cockles) and tōrea (oyster catcher birds) in the estuary.

With increased capacity to understand the estuary, Ngāti Whakahemo gained confidence to directly engage others on opportunities to support restoration action. This led to the collectivisation of Ngāti Whakahemo with four other iwi partners who also border the estuary (Ngāti Whakaue ki Maketū, Ngāti Pikiao, Ngāti Mākino, and Tapuika), marking the first time that all five iwi have banded together to advance the cause of the estuary.

The iwi collective, with support from Bay of Plenty Regional Council, were successful in securing funding from Ministry for the Environment's Freshwater Improvement Fund for a four-year restoration programme, Te Wahapū o Waihī.

Together, the iwi collective and Bay of Plenty Regional Council have purchased 30 hectares of land adjacent to the estuary to re-establish a wetland/saltmarsh, providing much-needed filtration between the estuary and the catchment canals. The research team is considering an invitation to work with The Nature Conservancy and Terra Carbon to establish carbon monitoring once it is constructed.

Te Wahapū o Waihī will also work with local farmers and provide support to assist with Farm Environment Plans. Local community groups, regional and central agencies have also indicated interest in engaging with the kaupapa.

Our Land and Water's commitment to te ao Māori has motivated it to think differently about how it connects to, resources, and supports kaupapa Māori research, making it a unique funding partner. Whānau, hapū, and marae-based research is quick to gain momentum and demonstrate excellence when strong Māori leadership with science sector experience is in place. The research team were confident the kaupapa would draw restorative investment from communities, government and industry, which proved correct.

Contact: Professor Kura Paul-Burke,
University of Waikato

Stakeholder Engagement

For the final two years of Our Land and Water, engagement with land stewards, rural professionals, Māori land trusts and incorporations, and primary sector bodies is particularly critical.

In March 2022 a Rural Engagement Advisor was employed to extend the reach of Our Land and Water research into the agrifood and fibre sector. Mark Woods has been connecting with rural contacts to assess farmers' needs and understanding of freshwater management, their levers and challenges. Insights have come from activities such as farmer interviews, strengthening connections into farmer-facing organisations, attending industry events, catchment forums, environmental awards, field days and A&P shows).

Research programmes are connecting with stakeholders across all key audiences. In 2022-23, over 25 regional authorities, regional development agencies and cross-council Special Interest Groups engaged with Our Land and Water-funded researchers. 10 government ministries or agencies were involved in research activities. Research projects engaged with 14 primary sector bodies, 8 NGOs, 21 catchment groups, 20 agribusinesses (including 8 Māori agribusinesses), and 3 programmes engaged with banks and financial organisations. Over 46 Māori community, whanau, hapu and iwi groups were engaged with by research teams.

Enhancing Assurance Schemes research partnered with Synlait, which provided $10k in-kind support, and involved MPI and others who will promote the project further. 30 interviews were conducted with Synlait and Māori respondents. The team presented preliminary findings to SAM Group (key actors in assurance led by MBIE) and the board for International Independent Organisations for Certification (trade body of international certification and assurance bodies).

Whakatupu: Empowering Māori Landowners in Land-use Decisions research engaged 18 participants from across the motu, representing whenua Māori decision-making at a range of maturity states, for user-experience testing of existing tools to understand needs for information about making decisions for alternative land-use opportunities. The research team also presented to senior management in MPI Agribusiness.

Tāwharautia te Wahapū o Waihī (Voice of the Estuary) research was developed in collaboration with Ngāti Whakahemo and iwi members at Pukehina Marae.

Cross-NSC research collaborations include Land Use Opportunities: Whitiwhiti Ora (Deep South NSC), Land Use for Nutritious Diets (Healthier Lives NSC), Healthy Estuaries (Sustainable Seas NSC and MfE) and an initiative to capture the te Tiriti journey of all 11 NSCs.

Kuaha Matihiko: Digital Gateway research engaged with a range of end-users to co-design an online platform enabling access to land and water datasets. Partners include Mana Tahuna Charitable Trust, Te Pumautanga o Te Arawa, and Te Whanau-a-Apanui iwi, who provide feedback on design and accessibility.

The Kaitiaki Intelligence Platforms research team has formed a collaboration plan with Ngāi Tahu and Te Atiawa following workshops to develop environmental 'digital twins'. The team consulted with 40 experts in the green finance, regulatory, and market assurance sectors to identify their environmental reporting data needs and determine the readiness of their systems for new technological approaches. 20 experts in environmental sensing and modelling were also consulted on their technologies.

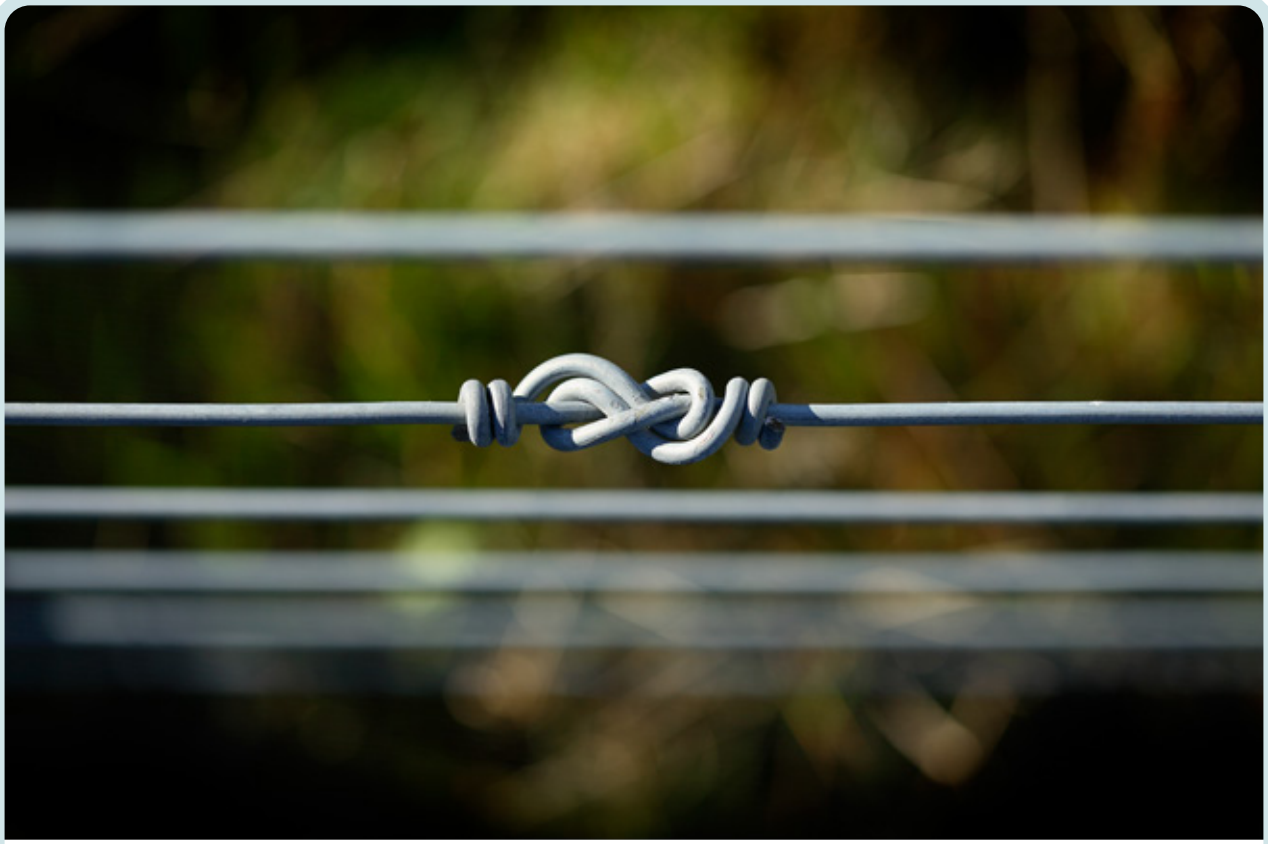
Linking Legacies to Wai researchers collaborated with DairyNZ on its final survey of around 100 dairy farms, completing a 20-year study to understand the effects of extension advice on water quality trends. It found that abrupt decreases in contamination correlated with extension advice.

Both of Our Land and Water's calls for research proposals issued in 2022–23 required stakeholder involvement. Proposals for the Contestable Funding Round were required to be scoped with stakeholders to accelerate research impact. Proposals for the RPF required the project team to include a rural professional and farmer to ensure the research resulted in practical outcomes and advice.

Our Land and Water contribution to external initiatives

In 2022–2023, Our Land and Water research and staff contributed to the following stakeholder-led initiatives and documents:

- Food Waste: A global and local problem (Office of the PM's Chief Science Advisor, July 2022)
- Mana Kai Framework (Aotearoa Circle, November 2022)
- A joint submission (with High Value Nutrition and Healthier Lives NSCs) on the Food and Beverage Industry Draft Transformation Plan (MPI, March 2023)
- Fertiliser Association Code of Practice (March 2023)
- Ministry for the Environment's Our Freshwater report (April 2023)
- Agri-Sector Climate Change Scenarios (Aotearoa Circle, April 2023)
- Ministry for the Environment's Long-term Insights Briefing 2023



Rural Professionals Fund

The Rural Professionals Fund enables farmers/entrepreneurs and rural professionals to team up with researchers to test innovative ideas. Participants in funded projects are required to use their networks to grow awareness and implementation of their findings among the wider rural profession and farming community.

In the third round of the Rural Professionals Fund (RPF) 12 projects of up to $75,000 each were funded. This fund encourages farmers, rural professionals and researchers to work together to test innovative ideas to improve farming systems and their environment.

The fourth (and final) round was also run in 2022–23, with 10 projects funded, so the research could be completed by December 2023.

In all, a total of 49 RPF projects have now been funded through this contestable fund, with a combined value of just over $3M.

Our Land and Water commissioned plain language articles about the 12 completed RPF projects for the magazine New Ground, distributed in print to NZIPIM members and shared via e-news as a PDF. The articles were released under Creative Commons license to media and industry bodies, who republished 8 articles, increasing the reach of the projects' results.

45 media articles were published about the projects in 2022–23. Articles were republished 12 times across a range of mainstream and industry media outlets.

Public Outreach

Public communication and outreach are central to Our Land and Water, with effective outreach regarded as a key to success for the National Science Challenges. Our Land and Water aims to connect science with land stewards, making our knowledge, research outputs and resources accessible to all. This includes making user-friendly content available via channels aimed at different community and stakeholder groups, and members of research teams engaging in-person with audiences.

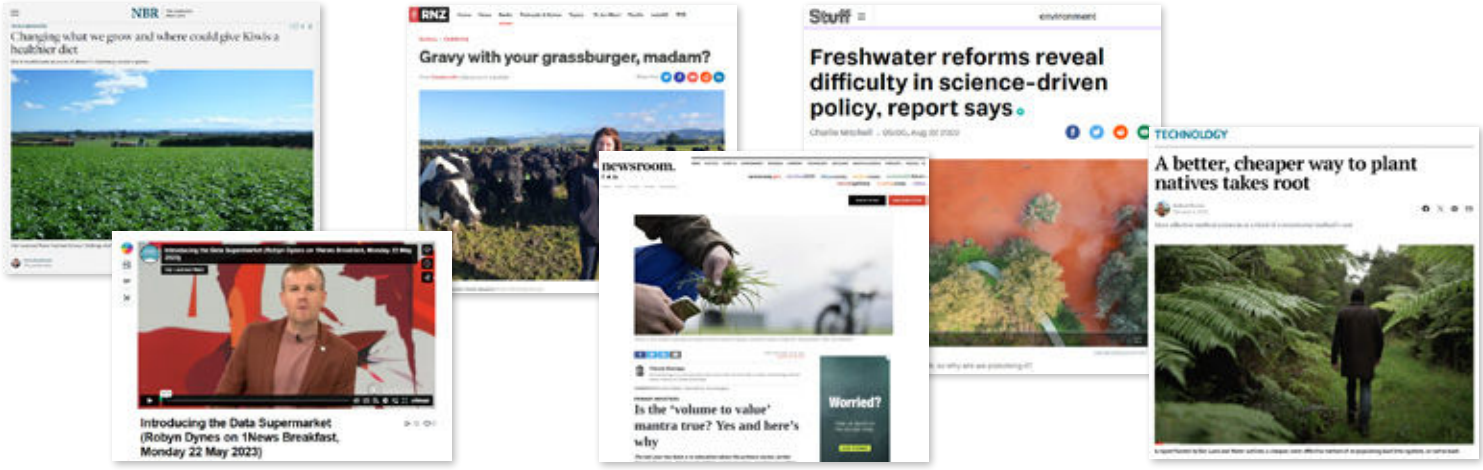
Over 2022–23, Our Land and Water recorded more than 50 public outreach or participation activities. Activities included workshops and wānanga, conference and forum presentations, interactive presence at events, and public surveys.

Revitalising Te Taiao research is particularly active in public engagement. Two national Fieldays at Mystery Creek exhibiting alongside Agrisea provided the ideal opportunity to connect with farmers, agri-suppliers, MPs, technology developers and government, as did the Wanaka A&P Show with 44,000 attendees. The Loyal to Soil Tour was a significant outreach event across five locations nationwide, attracting over 600 attendees from all sectors and creating a network of farmers, rural professionals, and scientists that are following the research. There were presentations to Eat New Zealand Kaitaki Collective, Wānaka Rural Professionals Group, and 100+ guests at the BOP Balance Awards Supreme winners field day. Multiple articles, video interviews and newsletters were published.

The Retiring Farmland into Ngahere project engaged regularly with the public, with several events with catchment groups, presentations at the APEN conference and to the NEXT Foundation fellows and affiliates. The project was featured on the television show Rural Delivery and a podcast by The Whole Story. Research team member John Burke regularly provided tours across his property, including a field day with catchment groups and a Māori delegation. The research leads appeared in numerous media articles in Farmers Weekly and the Bay of Plenty papers.

Media coverage of Our Land and Water increased 82% this year with 206 mentions of Our Land and Water (or Our Land and Water research) in mainstream, industry, and rural media. Of these articles, 33 were published under a paid content partnership agreement (29 in Farmer's Weekly, and 4 in Shepherdess).

Audience numbers across all Our Land and Water-owned social media channels continued to increase with LinkedIn now well-established as Our Land and Water's most engaging social media platform. LinkedIn followers increased 94%, e-newsletter subscribers 21%, and Facebook followers 22%. Our Land and Water launched an Instagram channel in June 2022 to reach new audiences and over the year reached a following of 491.

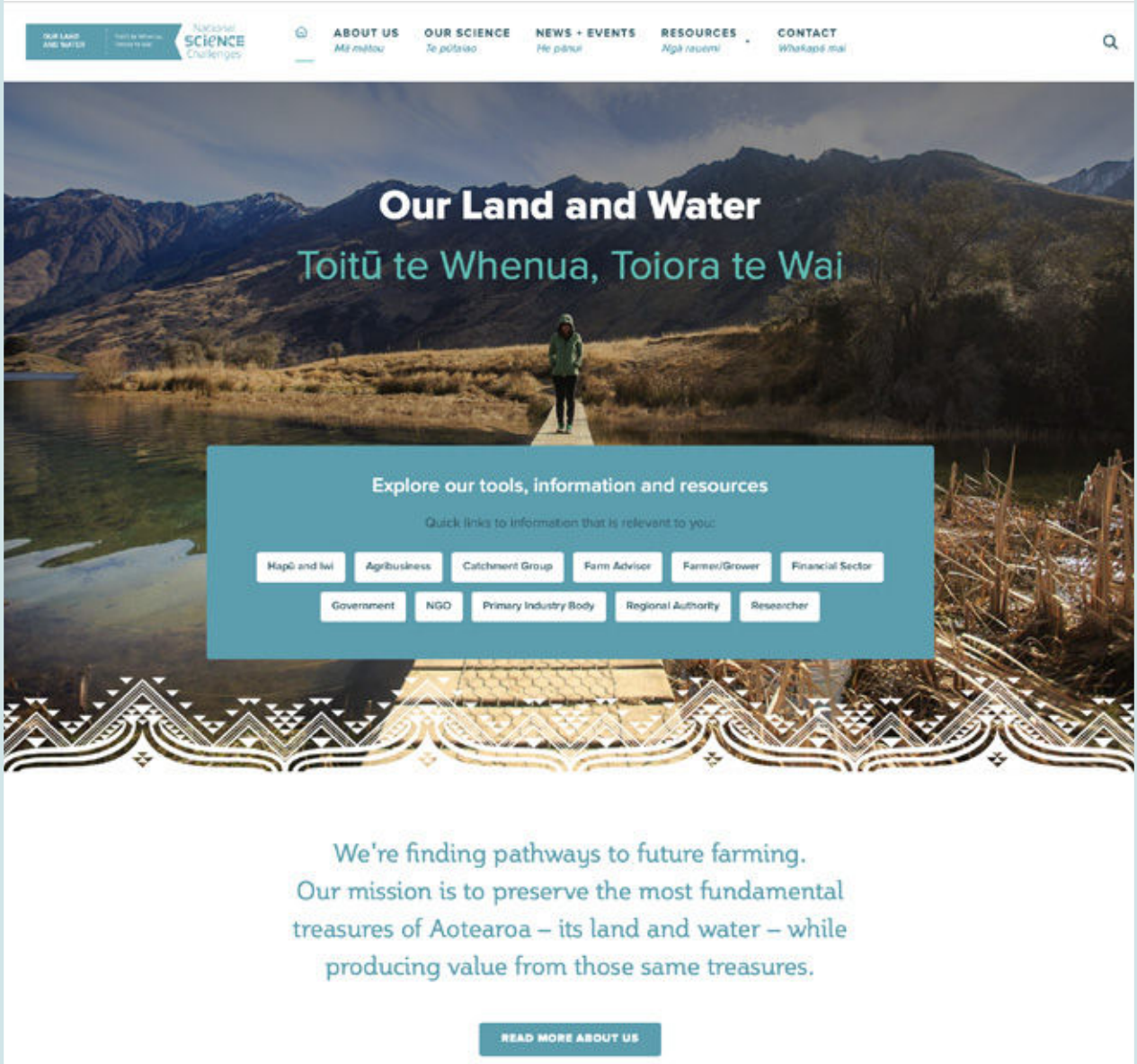


Website refresh

The launch of the Our Land and Water website refresh in December 2022 was a significant event, adding a resource search filter to improve searchability and enable more direct access to information relevant to the user's role and interest. Over 500 research outputs were tagged by topic and audience.

The Our Land and Water website continued to reach an increasing audience, with page views increasing 13%, user numbers increasing 3%, number of sessions increasing 6%, and number of pages viewed per session up 7%.

Our Land and Water continued to summarise research findings and outputs as news stories on our website. We published 65 news articles on the website over the year, up 12% from 58 last year. 29 of these summarised research outputs in plain language, including 12 RPF project summaries.



Partnership

- Our Land and Water remains an exhibition partner for the Te Taiao exhibition that opened at Te Papa in May 2019, which has been seen by 2,361,414 manuhiri since opening. The exhibition received 689,355 visitors over 2022–23 and was again the most-visited space in Te Papa for the year.
- Our Land and Water again partnered with Eat New Zealand to sponsor the Kaitaki Collective, a talented group of 100 young New Zealand influencers aged 16–35, from Northland to Rakiura. They each represent a different aspect of our food system and are committed to championing change. Collectively the Kaitaki Collective has a social media reach and audience of over 250,000 followers: our next generation of eaters.
- Our Land and Water entered a content partnership with Farmer's Weekly in November 2022. 29 articles published under terms of the partnership were viewed online 8569 times, and at least 8 were published in the print editions (circulation 77,216). One story from early February 2023, 'A better, cheaper way to plant native trees takes root' about Retiring Farmland into Ngahere's Tīmata Method, proved extremely popular with almost 3000 views online since published.
- Our Land and Water also has a content partnership with Shepherdess magazine, a contemporary women's rural lifestyle title sold in over 500 retail outlets nationwide. Each issue has an estimated readership of 15,500+, and their following on Instagram, Facebook and email subscribers total 26,300. The 2022– 23 issues featured insights from research related to regenerative agriculture (spring 2022), revitalising te Taiao in Wanaka (summer 2022–23), value chains (autumn 2023) and peri-urban spaces (winter 2023).

TOITŪ TE WHENUA, TOIORA TE WAI

OUR LAND AND WATER

Soil Studies

WRITER: AS TOLD TO ANNA BRANKIN (KĀI TAHU, KĀTI MĀMOE)
PHOTOGRAPHER: MICHELLE PORTER

Caring for the land and the environment starts with caring for the soil. That's the ethos behind Rere ki Uta Rere ki Tai – a collaborative project on ten farms combining farmer know-how, scientific research and mātauranga with a view to honouring the mana and mauri of soil. One farmer participating in the project, Jenny Smith, joins project manager Dr Ashna Khan and Kairangahau Māori Erina Wehi-Barton in conversation to share what they've learned from the soil with *Shepherdess*.

Jenny: We knew nothing about soil before. My husband, Miah, and I were sharemilkers down in New Plymouth, and when we bought our farm and shifted up to Ātiamuri we did what we'd always been told – smash the grass with fertiliser and it'll grow. After two or three years we hit a brick wall. It was really disheartening and frustrating. We felt like we were doing all the right things, everything we'd been taught for years and years, and it wasn't until Miah went along to a workshop with ecologist Dr Christine Jones that we realised there might be another way.

Ashna: Rere ki Uta Rere ki Tai began with a trial on Jenny and Miah's land, and it has now been scaled-up to ten farms. We are looking at how we can undertake different land management practices that lead to better outcomes. We advocate for less nitrogen use and instead rely on what we call the "underground army" to do the work for us – the living bugs within the soil. It is fundamental for us to focus on the mana and mauri of the soil, respecting and honouring it as a living being, and giving it time to heal and flourish.

Erina (Ngāti Rereahu, Ngāti Maniapoto, Ngāti Rārua): The whakapapa of our people comes from oneone. These are our pūrākau that are told to us as tamariki. Within the project of Rere ki Uta Rere ki Tai, we use a cultural perspective soil-health framework – this is achieved by assessing, observing and moderating the mana and mauri of soil and how we give effect to sustaining the well-being of the oneone. Ko au ko te taiao, ko te taiao ko au – I am the environment and the environment is me.

Jenny: Every farmer is looking after their land as best as they know how, but the problem is that we don't know what we don't know. Before we started learning about soil, we always farmed what was on top and we never thought about farming what was underneath. It's just a lack of education. The issue is getting the information out in a way that allows people to learn from it without feeling judged for doing what we were always told was best practice.

Ashna: All of the data and evidence we are collecting tells a story, and that story will help us advocate for a transition away from conventional farming methods. This project is managed by AgriSea, a small seaweed-based biostimulant company with strong values. We don't focus on mistakes that have been made in the past. What we want to do is provide farmers a safe space to try out new approaches and we are hoping that it gains momentum.

Erina: What I love about Rere ki Uta Rere ki Tai is the fact that we've developed a knowledge buffet for our farmers where they can use what they need from mātauranga Māori and Western science. I think that's great and it's groundbreaking. For too long, people have always said that science has a greater weight than mātauranga Māori, but we are the living

Events

Our Land and Water exhibitions at field days remain a key method to grow public awareness. We attended 7 A&P Shows or field days, with a combined audience total of 425,000.

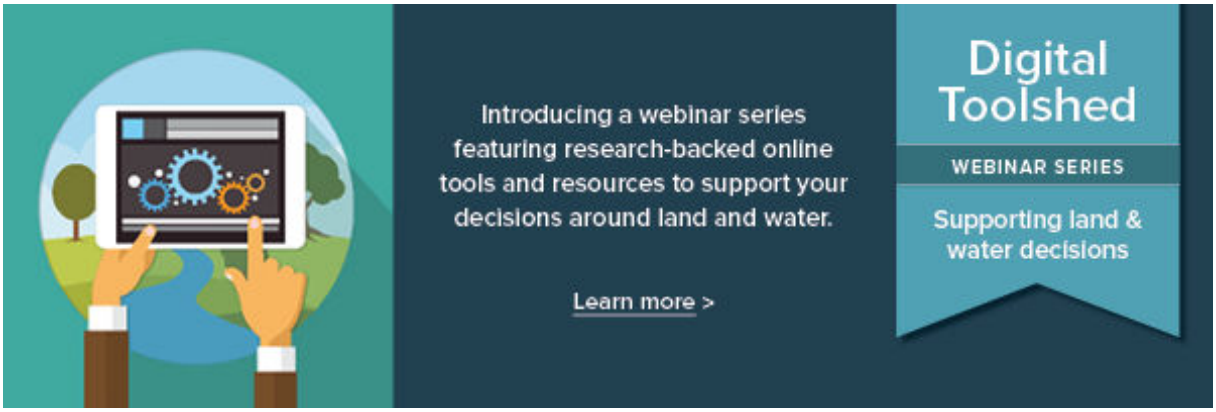
Our Rural Engagement Advisor and other team members and researchers have attended 6 industry forums and events, including the NZIPIM Conference and the National Catchment Group Forum, and close to 20 farm field days and workshops, catchment group meetings and environmental awards.

For example, at the South Island Dairy Event (SIDE) in Invercargill Our Land and Water had a prominent site, good interactions and uptake of collateral, and made effective connections with other organisations.

A trial roadshow series was developed in June 2023 to take Our Land and Water science into rural communities nationwide to provide face-to-face opportunities for learning, engagement and discussion about research with farmers and rural professionals. It is expected to be an effective engagement tool to promote farm-ready and usable research.

The Value Project

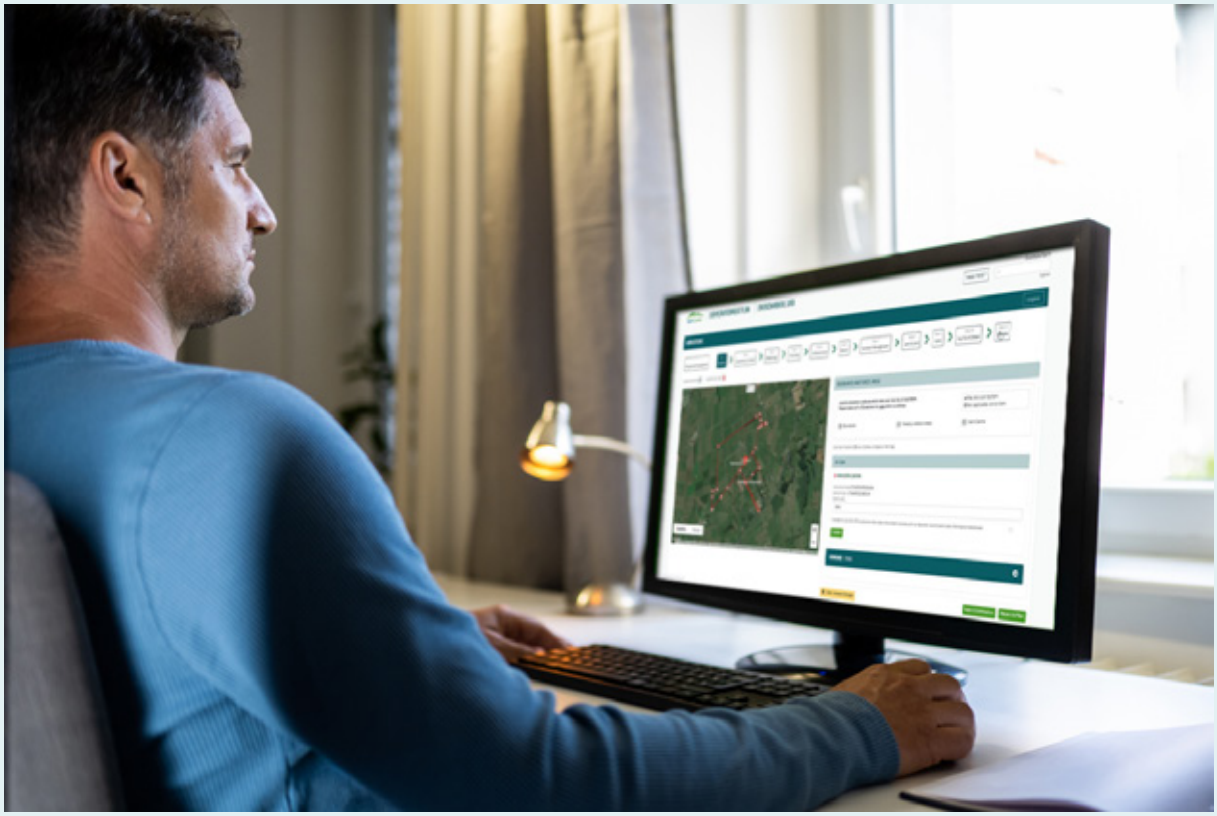
The Value Project (thevalueproject.nz) was an impact initiative launched in May 2022 to expand awareness and understanding of the nine attributes of successful supply chains identified by Rewarding Sustainable Practices research. The campaign finished in April 2023 following 3 webinars held in partnership with NZTE for which there were 556 registrations (attendance of 237). Attendees included people from Brothers Beer, Fonterra, Wakatū, Yealands Wine Group, BLNZ, ANZCO Foods, NZ Pork, Silver Fern Farms, Kono NZ, Hort NZ, Ngāti Porou Holding Company and Tikitere Farm.



Digital Toolshed

Our Land and Water launched a new webinar series, Digital Toolshed, providing end-users with a practical demonstration of tools developed by Our Land and Water-funded projects. The series launched in May 2023, demonstrating the Data Supermarket (from the Whitiwhiti Ora (Land Use Opportunities) research programme), which had 354 registrations and 147 attendees. The second in this series demonstrated the LandscapeDNA tool (built as part of Physiographic Environments of NZ research), with 357 registrations, 174 attendees. The series will run through to June 2024 to feature as many tools as possible.

Farm action prioritisation tool being used by agribusiness



Milk company Open Country Dairy is connecting the Farm Action Prioritisation Tool (FarmAPT) with over 1000 dairy farmer suppliers, supporting them to identify and prioritise mitigation actions for water quality improvement for inclusion in farm environment plans (FEPs).

FarmAPT is an online geospatial tool developed by DairyNZ, led by senior scientist Dr Katrina Macintosh, and co-funded by the Our Land and Water Rural Professionals Fund in 2020. The project team identified an opportunity to link farmers to the most relevant mitigation options for their farm, underpinned by science, to support the development of effective and targeted FEPs. This will boost farmers' confidence in their FEPs, therefore accelerating change.

The uptake of prioritised mitigation actions on farmland to help improve water quality is critical to the Our Land and Water objective. The actions in the tool are informed by three Our Land and Water-funded journal papers and have been aligned to support the required 'good farming practices' actions under the Dairy Tomorrow strategy.

The FarmAPT tool helps its users identify the best water quality mitigation actions for their farm, at the least cost. It achieves this by weighting the effectiveness and cost-effectiveness of a range of evidence-backed actions for reducing nitrogen, phosphorus, sediment, and *E. coli.* FarmAPT prioritises mitigation actions based on each farm's geophysical characteristics, using the dairy typology framework that incorporates climate, slope, soil/drainage, and wetness, developed by Our Land and Water's Sources & Flows and DairyNZ's Healthy Waterways research programmes. These typologies are important for determining which mitigations will be most effective in reducing contaminants.

FarmAPT also displays the location of the nearest downstream regional council water quality monitoring data, so users can understand their catchment pressures and hence the need for collective action to address freshwater issues.

Open Country Dairy has created a comprehensive digital FEP interface that incorporates FarmAPT via an API wholly funded by DairyNZ. This 'wizard' is used by Open Country's FEP facilitators, and directly by farmers.

The wizard consists of an 11-step process that results in a complete FEP. Step 2, 'Catchment Context', pulls water quality monitoring data from FarmAPT. A full list of prioritised risk mitigation actions is pulled from FarmAPT into Step 3, 'Waterways'. Relevant actions are also pulled from the API into a section entitled 'Other actions you may wish to consider' in each of Steps 5, 6 and 8 ('Infrastructure', 'Blocks' and 'Land & Soil').

Open Country environment and sustainability manager Dr Caleb Higham says the wizard was two years in development and aims to "make FEPs as painless for farmers as we can". The company hopes to add risk mitigation actions for greenhouses gases in the future. The wizard has been used to complete FEPs for 371 dairy farmers, and a further 630 FEPs are in progress.

The Open Country wizard was developed by Qconz, which has also integrated FarmAPT into its own FreshWater Farm Plan digital tool. This paid service ($200pa) is being used by around 100 farmers and growers in the sheep, beef and horticulture sectors. Qconz anticipates significant growth, expecting to reach over 1000 users by mid-2024, says Justin Moss, GM of information technology at Qconz.

The FarmAPT API is also integrated into Fonterra's Tiaki FEP Tool, an employee-facing geospatial tool used by 45 Sustainable Dairying Advisors to develop FEPs for their dairy farmers. The catchment context section of these FEPs is automatically populated with the water quality monitoring data provided via FarmAPT. This partial use of FarmAPT supports the development of FEPs that respond to the catchment context.

DairyNZ is planning to publicly launch FarmAPT as an open-access, farmer-facing tool on its website once the interface is fully functional. Ongoing development of the tool functionality will align water quality mitigation actions with actions to reduce GHGs, to support farmers to act on water and climate requirements and make decisions based on a better understanding of co-benefits.

Zespri has also requested that elements of FarmAPT be integrated into its freshwater-FEP software solution in development by Qconz, where it has the potential to reach 3000 growers. This tool will be in a pilot phase across 100 Waikato orchards in 2023–24.

Our Land and Water's focussed Rural Professionals Fund was created to connect farm advisors, farmers and scientists in collaborative practical research. This unique funding approach enabled the development of the practical FarmAPT tool, which expands access to research previously funded by Our Land and Water.

Contact: Dr Katrina Macintosh,
DairyNZ

Governance

2022–23 has been a period of stability for Our Land and Water National Science Challenge's Governance Group, Science and Stakeholder Advisory Panel (SSAP) and the Directorate. All groups remain fully engaged with the Challenge and focussed on optimising the impact of Our Land and Water-funded research. Where necessary, some roles have been modified to better support this final stage of the Challenge.

As identified in the 2021 review, the Governance Group members, SSAP members and the Challenge host continue to be strongly engaged with, and contribute to, Our Land and Water's vision and purpose.

Governance Group

Our Land and Water continues to have a single Governance Group, chaired by Hone McGregor and drawing on members with diverse stakeholder perspectives, from regional council staff to farm managers and primary industry directors. The Chair creates an environment and culture that fosters constructive debate and mutual learning experiences. It is a requirement that at least 50% of the membership are required to have a deep understanding of te ao Māori perspectives, and currently 4 of the 7 governors fulfil this requirement (57%).

There was a single change to the membership in 2022–23, initiated by the resignation of a long-serving governor, Jim Peters, at the end of 2022. Cheyenne Wilson, a young Māori farmer and primary industry youth leader, was invited to join the Governance Group at that time. The new appointment was endorsed by the AgResearch Governance Board, the Challenge Parties Group and MBIE.

With less emphasis on assessing new research priorities, and more on planning for the end of the Challenge, the focus is on ensuring all opportunities for creating impact from Our Land and Water research are realised by actively guiding the Directorate towards planning and outreach actions that will optimise impact of research, both before and after June 2024. They are also attempting to ensure that the lessons that have been learnt about the effective management of mission-led research are passed on, as the structure of the research sector in Aotearoa is redesigned during the Te Ara Paerangi process.

Science & Stakeholder Advisory Panel

The Science & Stakeholder Advisory Panel (SSAP) supported investment of $7.6M in the final research programmes to get underway since June 2022. This has been through the efforts of individual members of the SSAP, and there was no need for a formal meeting in the 2022–23 year. Now that the research funds have been almost fully committed and no major new research proposals are anticipated, the SSAP are re-evaluating their role.

Challenge Parties Group

The 16-member Challenge Parties Group (CPG) met twice in 2022–23, in October and in December 2022. These meetings occurred shortly after the quarterly Governance Group meetings had been held, as had been the usual pattern throughout the Challenge lifetime. The meetings had all been virtual since 2019.

The CPG ceased to meet quarterly after December 2022. Instead Our Land and Water will communicate and interact with the 16 CPG members individually as needed. Researchers from the CPG membership are well, but not exclusively, represented in the active and proposed research programmes of Our Land and Water.

Councils have early evidence to help communities accept that naturalised E. coli still indicate potential health risk from faecal pathogens

Regional authorities are regularly questioned by community members and industry representatives about *E. coli* as an indicator of faecal contamination, where the *E. coli* is considered 'naturalised' in the aquatic environment rather than due to recent faecal contamination.

There are two types of naturalised *Escherichia*, both detected as *E. coli* by standard methods of water quality monitoring:

1. *E. coli* from aged faecal pollution; and

2. environmental *Escherichia* that do not belong to the *E. coli* species.

New molecular evidence has demonstrated that water containing naturalised *E. coli* from aged faecal sources can also contain faecal pathogens. Therefore *E. coli* monitoring remains an important sentinel of faecal contamination. This evidence will help regional water managers support community members to accept the potential health risk from aged sources of faecal contamination.

This finding is a significant contribution to the evidence base that ensures New Zealand's water quality standards for swimmability are protective of human health. Where faecal contamination is identified as the source of *E. coli*, mitigation actions can be targeted to improve water quality. These outcomes align with the Our Land and Water objective to enhance the value and quality of our water.

The evidence comes from a research partnership between the Faecal Source Tracking project – led by Dr Adrian Cookson (AgResearch senior scientist) and funded by Our Land and Water – and ESR, using water samples collected as part

of the Quantitative Microbial Risk Assessment (QMRA) funded by Ministry for the Environment (MfE). Research was conducted in three stages, each building on earlier work. Meg Devane, senior scientist at ESR, has been a member of all research teams and the connected MfE research.

The initial Our Land and Water-funded Faecal Source Tracking research applied DNA sequencing to water samples collected in Waikato and Tararua. This identified 23 strains of naturalised *Escherichia* that represent a distinct evolutionary population. The strains were not associated with risk to human health.

The research team was later granted 'impact extension' funding to work with ESR to examine 42 water samples from chronically polluted water bodies, collected by MfE's QMRA pilot study. This stage of research highlighted the potential health risk from aged faecal contamination. Water samples containing *E. coli* from aged faecal sources are often dominated by *E. coli* subtypes B1 and B2, whereas fresh sources contain multiple subtypes (A–G). This research detected pathogens in samples that contained predominantly B1 and B2 sub-types. In addition, environmental *Escherchia* that do not belong to the *E. coli* species were identified infrequently in the 42 water samples.

Routine monitoring methods do not differentiate the two types of naturalised *Escherichia*. This stage of research also identified traits that may be used to rapidly distinguish environmental *Escherichia* from *E. coli* associated with faecal contamination. This aspect of the research received funding to continue to 2022 through the 2019 Endeavour Fund ('Novel discriminatory tests for *E. coli* to improve water quality assessments').

Evidence from the 42-sample study was presented in September 2021 to the regional council special interest group for Surface Water Integrated Management (SWIM), made up of freshwater scientists and regional council experts from around New Zealand, and in November 2022 to water managers via the NZ Freshwater Sciences Society.

SWIM executive member Dr Elaine Moriarty, science collaboration lead at ECan, said: "The advances in determining the health risk attached to a variety of *E. coli* types in water is fundamental to how regional councils manage our waterways. This knowledge allows us to work with our communities and share the health risk from all faecal sources. This research is a cornerstone of our knowledge and vital that it is continued."

In 2022, Our Land and Water provided funding for further research into *Escherichia* delineation and pathogen detection with researchers at ESR. An additional 300 water samples collected for Stage III of the MfE QMRA are now being analysed using high-resolution molecular methods. Samples are from a broader spectrum of water bodies, including sites where contamination is absent or intermittent.

This work will extend understanding of the association of *E. coli* from aged faecal sources with pathogens. It will provide additional evidence to evaluate the initial finding that low concentrations of environmental *Escherichia* identified in chronically polluted water bodies are not confounding routine water quality monitoring. Guidance will be provided to all regional water managers, who will disseminate advice to community members and industry representatives.

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