Pūtaiao

MANAAKI WHENUA SCIENCE SUMMARY / ISSUE 6 / MAY 2021

Science for our biodiversity

All the latest cool research

Pūtaiao

Science for our land and our future

Tēnā koe and welcome to issue 6 of *Pūtaiao* ('Science' in te reo Māori), our quarterly publication showcasing the work of our scientists at Manaaki Whenua.

Creating conservation management strategies to protect our native manu is always a challenge, especially for more mobile species such as tōrea and kākā. If a species is not always in one place, how do you build an understanding of it? And without that knowledge, how can you ensure the environment is right for the species to thrive?

Manaaki Whenua researchers have put those questions at the heart of several programmes designed to forecast predator and bird populations. By using increasingly sophisticated technology, as well as developing stronger partnerships, our researchers are aiming to have more indigenous bird species thriving in their habitats across Aotearoa and beyond.

In this issue of *Pūtaiao*, we highlight two programmes studying bird nesting, food, movements and habitats in and outside forests. Their successful outcomes will help achieve the goal of New Zealand's new Te Mana o te Taiao – the Aotearoa New Zealand Biodiversity Strategy – achieve its 2050 goals of restoring the mana of taonga species.

If you wish to be included on the mailing list for *Pūtaiao*, or to find out more about any of the stories, contact Manaaki Whenua's Communications Manager Dan Park: parkdj@landcareresearch.co.nz

Cover image: Researcher Phil Novis taking snow and ice samples from the Fox Glacier. Photo by Dr John Hunt.

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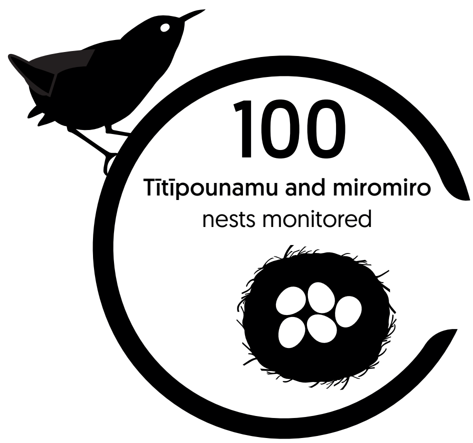
Restoring New Zealand birdscapes

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

More Birds in the Bush: a weather forecast for birds

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

Programme leaders Drs Susan Walker and Adrian Monks emphasise that with more efficient management of forests, benefits for native bird populations can be maximised and unnecessary waste of time and resources avoided.



For instance, their recent research has shown that smaller, more rat-sensitive native bird species have retreated to cooler, high elevation sites due to greater ship rat abundance at warmer, lower sites. However, higher sites may provide less food for birds to raise their young. More effective control of the warmth-loving ship rats at lower altitudes will maximise prospects for forest birds.

Invertebrates, nectar, fruit, and seeds are food for birds as well as omnivorous predators such as possums and ship rats. One ambitious aspect of the More Birds programme aims to determine how food availability varies across an elevational gradient and influences the nesting success of native forest birds both with and without predator management.

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

In a complementary project, Dr Sarah Richardson has led research to map fruit production along the 900 m elevational gradient at Mt Pirongia to understand how different fruit and nectar resources become available at different places. Together, these projects will disentangle how food production and predator management together drive populations of predators and birds along elevational gradients. Results will feed into the development of the large-scale forecasting tool, so that both predator and bird population outcomes and different management options can be evaluated.

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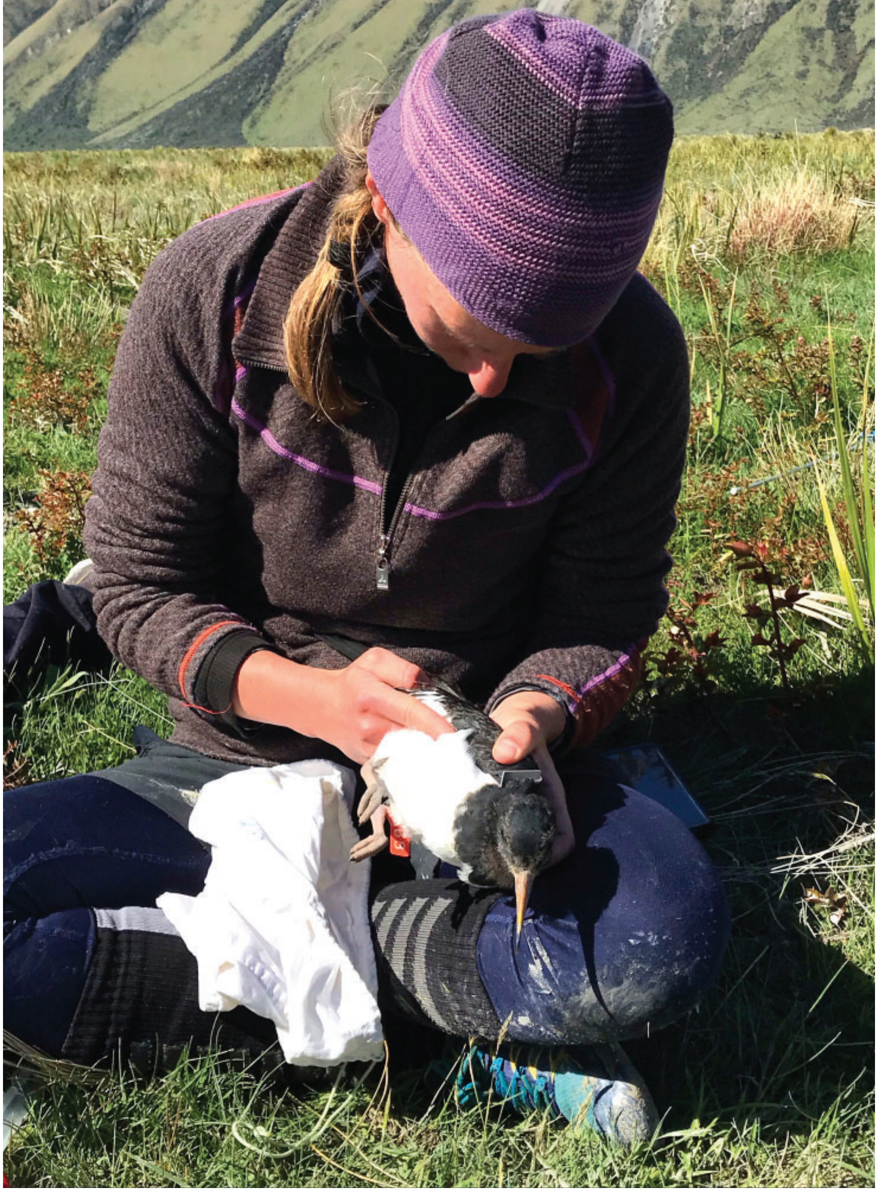
Dr Anne Schlesselmann with a banded tītīpounamu (rifleman).

Where do birds go to? Movements that link landscapes

Designing conservation management strategies to protect native manu is especially challenging for mobile species, which range widely across New Zealand and face multiple threats in different places and at different times. Researchers face additional technical challenges in building knowledge of where individuals travel to and the diverse threats they face across the country. Multiple landowners and managers in distant rohe must form strong partnerships to use that knowledge to ensure that species thrive.

With the ultimate goal of protecting and restoring the mobile manu and birdscapes of Aotearoa, our researchers have recently teamed up with multiple partners in pilot programmes on tōrea (South Island pied oystercatchers), kākā and miromiro (tomtits; see page 5). In all programmes, Strategic Science Investment funding is being used to grow our capability in this research area, while leveraging and engaging the resources and skills of operational and citizen partners and developing new knowledge together.



Measuring body length of a tōrea.

Technology tracking tōrea

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

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

The programme relies on GPS technology to track tagged tōrea that head to winter feeding grounds from the upper Rangitata Valley. Anne Schlesselmann says a research team tagged 32 adult and fledgling tōrea with GPS transmitters in spring 2020. They also monitored the survival of more than 60 nests and fledglings on high country farmland and riverbeds in the upper Rangitata valley.

"We indexed predator densities with cameras to better understand what levels of predator control are necessary for successful tōrea breeding," says Dr Schlesselmann. "Many additional adults and fledglings were banded in the Rangitata valley with small coloured 'flags' to identify them on wintering grounds."

Complementary GPS-tagging and banding by DOC and OSNZ on wintering grounds started last June and is now rolling out across the country's harbours. Early results show high adult and chick survival under predator trapping, as well as some remarkable spatial patterns since birds have taken flight. Already, tracks indicate some key national northward and southward flyways and the sheer extent of the North and South Island habitat network that supports wintering tōrea.

Manaaki Whenua aims to use the data to develop a spatial population model linking wintering and breeding sites of different tōrea subpopulations in different habitats and under different management regimes. DOC's focus is building richer data on flyways and 'nodes' (key sites in time and space) by catching, tagging and banding birds on wintering grounds. OSNZ's national citizen scientist network will boost both through re-sightings of banded birds.

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

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Backpacking kākā and miromiro on the move

Using kākā and miromiro as case studies, Neil Fitzgerald and John Innes hope to improve native bird abundance and connectivity in the different context of fragmented native forests of the North Island. In collaboration with Department of Conservation scientists, 11 kākā were tagged at sites near Hamilton and Morrinsville this spring, with a second tagging exercise scheduled in early June.

Kākā are most abundant on pest-free offshore islands such as Te Hauturu-o-Toi / Little Barrier Island and Kapiti Island, and in mainland ecosanctuaries such as the Waipapa Ecological Area at Pureora. Outside of such pest -protected sites, numbers are thought to be in general decline in both the North and South Islands. Kākā visit lowland, central NI places such as around Hamilton annually but never stay to nest there, and their summer ranges were previously unknown.

Neil has mapped the movement of the birds tagged to date: "The information we are getting from this new satellite tag technology will greatly improve our understanding of how this iconic bird uses the landscape beyond their forest strongholds." he says. Most kākā travelled from the Waikato north to Hauraki Gulf islands such as Hauturu, Kawau and Aotea (Great Barrier). Working with DOC has been crucial to getting the information. "We couldn't have done this work without them," says Neil.

Miromiro move on a smaller scale. They were selected as a moderately gap-limited species that may benefit from planted movement corridors. Initially, they are being surveyed in forest fragments between ecosanctuaries at Maungatautari and Pirongia. Later, individual miromiro will be marked and followed.

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www landcareresearch.co.nz/news/backpacking-kaka-in-the-waikato

Te Mana o te Taiao is about making a collective difference

A feature of the projects on the previous pages is the strong theme and spirit of collaboration that run through them.

Manaaki Whenua researchers are working across agencies, and with kaitiaki iwi, community groups and landowners to gather as much species knowledge as possible to create the tools and models that will then feed into regional biodiversity strategies.

This is in line with the new Te Mana o te Taiao - the Aotearoa New Zealand Biodiversity Strategy for the active protection of species that is inclusive of Te Tiriti partner, and the different people, groups and sections involved in biodiversity protection and restoration.

The new Biodiversity Strategy has been described as a chance to reset our priorities and take action together so that nature thrives both for its own sake and as the basis of human well-being.

At the heart of the strategy is the invitation to create connections and build partnerships with different groups, and embrace mātauranga Māori.

Many of our scientists in research programmes are already embracing this call to action, working with community-driven projects and pest-management initiatives, such as the projects highlighted here.

> *“Te Mana o te Taiao envisions Aotearoa as a place where ecosystems are healthy and resilient.”*

These programmes have been designed to ensure we have more birds in the bush and on the plains in the future, and are already demonstrating that the collaborative approach enables better quality and quantity of data collected.

Te Mana o te Taiao envisions Aotearoa as a place where ecosystems are healthy and resilient. DOC consulted widely during the development of Te Mana o te Taiao, including public submissions, a stakeholder reference group that consisted of Forest & Bird, Federated Farmers, Environmental Defence Society, Forest Owners Association, Fish & Game, Fisheries Inshore NZ, a Science Reference Group, and a Te Ao Māori reference group.

The Strategy, which anticipates a future where caring for nature is part of everyone’s values and an integral part of daily life, sets out five core outcomes to ensure nature is thriving by 2050. There are three key themes; getting the system right, empowering action, and protecting and restoring; with specific objectives and goals for 2025, 2030, and 2050.

For us at Manaaki Whenua, protecting our biodiversity means protecting and enhancing whole ecosystems whether through predator control, controlling invasive plant species and pathogens, or understanding environment and climate change. In line with the strategy, collaboration, co-design and partnership will deliver better outcomes and ensure the thriving biodiverse future we all aspire to.

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www *doc.govt.nz/nature/biodiversity/aotearoa-new-zealand-biodiversity-strategy/te-mana-o-te-taiao-summary/*

Jumping the fence: a new inventory of New Zealand's naturalised flora

New Zealand is one of the world's top plant biodiversity hotspots. Because of historical isolation, many of its native plant species are endemic – found nowhere else. However, in the past two centuries an almost equivalent number of plant species in New Zealand have become naturalised – many were brought here deliberately as crops or ornamentals and have jumped the fence to establish wild populations.

Dating from 2006, New Zealand's existing inventory of naturalised plants was due for an overhaul. Working with university colleagues from Lincoln, Canberra, and Syracuse (USA), as well as the Department of Conservation, researchers from Manaaki Whenua recently undertook an updated inventory of the entire naturalised flora of New Zealand, comparing its taxonomic and functional distinctions from the native flora. The work also tested whether valid comparisons of functional traits between native and naturalised plants could be made, focusing on leaf nitrogen content in trees.

The results show how much a flora can change in a very short time. The researchers counted 1798 naturalised plant species in the 2020 dataset, an increase of over 100 species since 2006, including 39 species previously not listed. Of the total, 314 species are now classed as environmental weeds.

Naturalised flora near Hanmer Springs.

The new inventory shows that naturalised plants in general are more taxonomically diverse, more likely to be herbaceous, and less woody than native species. Naturalised trees are also, in general, more productive than native species, as shown by higher leaf nitrogen. More effective nutrient uptake may further promote invasions of naturalised tree species at the expense of native trees.

With proof-of-concept established, further comparison of functional traits, for example resistance to fire or grazing, will enable land managers and conservationists to assess how naturalised species affect ecosystem processes differently and to support better management of invasive plant species.

"Some invasive plants in New Zealand receive most of our attention, and for good reason, but it's useful to look at the whole picture to better understand plant invasion and potential impact. We need to think about which species might be flying under the radar now but could become problems in the future," says lead researcher Dr Angela Brandt.

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HTTPS *doi.org/10.1007/s10530-020-02393-4*

A range of work in wetland biodiversity

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

Using eDNA to monitor wetland biodiversity

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

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

Microbial DNA sequenced from soil cores taken **4 metres** below the surface

Study co-author Dr Bev Clarkson says that there are many potential applications of the new eDNA approach. “We need to study more wetlands to refine this tool and see whether these patterns hold across different wetland types, but these preliminary results show that the technique works. Ultimately, eDNA may provide a useful tool for

monitoring real-time wetland condition and identifying when critical thresholds are being approached. In the same way, eDNA may also serve as a tool for helping monitor the success of projects focused on the restoration of wetland ecosystems."

Applying the 'leaf economics spectrum' to wetlands

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

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

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What is eDNA?

DNA extracted from samples of soils, air, water, and other substrates (known as environmental DNA, or eDNA for short) is fast becoming a vital tool for studying a wide range of species, such as microbes, insects, fish, and other vertebrates, across many different ecosystems. The technique amplifies and then sequences all the DNA found in a sample, enabling species identifications to be made.

HTTPS
doi.org/10.1038/s41467-020-18354-3
doi.org/10.1371/journal.pone.0243363

Waiwhakareke Natural Heritage Park in Hamilton

Turning the next page on predator control in New Zealand

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

In response, numerous ecological restoration projects have been set up across New Zealand and its offshore islands. However, we don't yet know how the story will end. Each project has reported local predator control successes, but their collective contribution to the overall biodiversity narrative has remained unclear.

Manaaki Whenua researchers Rachelle Binny, John Innes, Andrea Byrom (NZ Biological Heritage National Science Challenge), Neil Fitzgerald, Robbie Price, and Roger Pech recently joined forces with researchers at DOC, University of Canterbury, and Te Pūnaha Matatini, to undertake a national meta-analysis of mainland restoration projects and their biodiversity outcomes. Over the past 17 years, Manaaki Whenua has run annual ecosanctuaries workshops to facilitate contact between practitioners and to act as a conduit for science into the national sanctuary network. The relationships established through these meetings laid the foundations for a data-sharing collaboration among 27 ecosanctuaries, including projects led by community trusts, regional councils and DOC, who contributed close to 80 biodiversity datasets surveying hundreds of species for this national analysis.

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

For each response measure an 'effect size' was calculated to measure the biodiversity benefit of pest control and these sizes were then combined to give an overall measure of biodiversity benefit across multiple projects. Changes in benefits for birds, invertebrates and vegetation were tracked for each year that there had been intensive multi-species pest control, over 20 years of restoration.

The results, published recently in *Ecological Monographs*, found that there were strong benefits

Male wētā amongst decaying plant matter at Elsthorpe Bush in Hawke's Bay.

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

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

"Thanks to this data-sharing collaboration among ecosanctuaries, we now have extensive new evidence that invasive pest control is an effective approach to ecological restoration," says Dr Binny. "Knowing the long-term biodiversity benefits we get from eradication compared with suppression will be critical for designing an effective national strategy for restoration on Aotearoa's mainland."

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When hunters become the hunted

Manaaki Whenua's research capabilities are in demand worldwide, even in the Southern Atlantic Ocean where mice are decimating seabirds on remote Gough Island.

Manaaki Whenua's rodent ecologist Araceli Samaniego travels to the island in May to join the season's Gough Restoration 2021 programme, an ambitious attempt to achieve mouse-free status on a much larger island than previously achieved worldwide.

Around eight million seabirds raise their chicks on Gough Island annually. Many of them are burrow-nesting, including several species of petrel and the near-endemic and endangered MacGillivray's prion.

Rodents are seriously affecting populations of all the burrow-nesters, and with near or total breeding failure almost every year for the past 4 years, the MacGillivray prion will face extinction if mouse predation is not checked.

Dr Samaniego brings her experience working on eradicating invasive rodent populations from islands around the globe. The team hopes to have totally eradicated mice on Gough Island by the end of the programme in late August.

Gough Island Restoration 2021 is an international biodiversity restoration effort. Araceli joins colleagues from the UK's Royal Society for the Protection of Birds, Mexico's Grupo de Ecologia y Conservacion de Islas and the Royal Zoological Society of Scotland, as well as staff from the Department of the Environment, Forestry and Fisheries in South Africa.

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Prion chick with injury caused by mouse attack.

Snow business: black carbon, red algae, and future glacier survival

In early 2020, large parts of eastern Australia burned. Bushfires turned the land black, the skies orange, and the sun red. In New Zealand, 2,000 km away, ash from the fires also coated our glaciers and snow-capped mountains, turning them a shade of caramel.

With New Zealand's glaciers already in steep decline owing to climate change, the coating of bushfire ash attracted concern from scientists, members of the public, and even from former prime minister Helen Clark, worried that the dark dust would absorb the sun's heat and accelerate icemelt.

Manaaki Whenua's Dr Phil Novis, an algae expert whose interest in ice stems from the microbial communities naturally present there, is now working with Drs John Hunt and Ben Jolly, also of Manaaki Whenua, Drs Lynda Petherick and Ruzica Dadic from Victoria University, and Dr Heather Purdie from the University of Canterbury to investigate the interactions between snow algae and the bushfire aerosols, and their impacts on melting.

Fundamentally, the project is about albedo: a measure of the amount of solar radiation that is reflected back from the Earth's surface. The albedo of pure snow is high, with a large proportion of the incoming radiation reflected back, keeping things cool. However, explains Dr Novis, it takes surprisingly little to lower the albedo of snow.

"One substance that reduces the albedo of snow very efficiently is black carbon, which is formed by incomplete combustion of biomass, as happened with the Australian bushfires. A huge quantity of material including black carbon was carried across the Tasman – we estimated that around 80 tonnes of black carbon, other organic matter and dust fell on the Fox Glacier alone. Earlier research has shown that black carbon present in fresh snow at concentrations undiscernible by the human eye could substantially reduce its albedo. Given how discoloured glaciers became during the bushfires, we expect a large – but currently unquantified – impact."

Researcher Phil Novis taking snow and ice samples from the Franz Josef Glacier in Westland Tai Poutini National Park.

Adding to the problem are microbial communities including snow algae, which visibly add colour to snow (typically red, pink, or orange) when they bloom. These communities also reduce the albedo of snow and cause positive feedback loops: they need liquid water in the snow to grow, and their growth promotes liquid water by increasing albedo and melting, and so the cycle continues.

According to Dr Novis, we don't yet know how these types of particles interact. "Bushfire ash is a fertiliser, but adding it to an ecosystem can raise the pH, something to which snow algae are known to be sensitive. Do aerosols in snow from the bushfires promote algal growth, or hinder it? The answer could have large implications for the effect of these events on our glacial systems.

To help answer these questions, field plots will receive randomly assigned standardised application of bushfire material to snow, with the effect on albedo measured using radiometers above the plot and on a nearby temporary weather station. Other changes to snow physics and chemistry will also be determined. The main site for the field experiments will be the snow accumulation zone at the head of the Tasman Glacier.

"Possible impacts of the Australian bushfires on New Zealand glaciers, and the primary producers that colonise them, are even more concerning, given recent findings that these glaciers may be a global diversity hotspot for cryophilic invertebrates (https://doi.org/10.1038/s41598-021-83256-3). These species ultimately rely on snow and ice algae at the bottom of their food chain."

"My hope with these interdisciplinary projects is always that they are greater than the sum of their parts – by working with people of different backgrounds and skills we can address questions that might otherwise go unanswered – and maybe even think of questions that no one has thought to ask! In this case, it's the interaction between snow microbiology, physics and chemistry in the context of climate change and the predicted increase in frequency of bushfires in Australia affecting glacial systems here."

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John Hunt

Fukushima: the whole picture from atmosphere to ocean

A Manaaki Whenua expert in land-water interactions has been involved in the most comprehensive review to date of the impact from Japan's Fukushima nuclear disaster on the terrestrial environment.

Published as Japan was marking the 10th anniversary of the event, the review sheds greater lighter on the fate of radioactive fallout, particularly Cesium-137 and Cesium-134, in terrestrial environments, including forest, agricultural and urban areas, movement into the soil, and transport through rivers to the ocean.

Geomorphologist Dr Hugh Smith was invited to join the study by programme lead Prof Yuichi Onda shortly after the deadly March 2011 disaster, in which the Fukushima No, 1 plant was crippled after being hit by a tsunami caused by a 9.0 magnitude earthquake. It was the world's second worst nuclear accident after Chernobyl.

"At the time there was no information available about the movement of radiocesium fallout from the land to rivers and the ocean," says Dr Smith. The first six continuous monitoring stations to measure this were set up in June 2011 with a further 24 stations installed by October 2012 within the Abukuma River catchment, as well as other rivers draining the coastal catchments of the Hamadori district.

"The stations were located in heavily contaminated areas and designed to monitor radiocesium attached to sediment that was washed into rivers from a range of sources, including steep forested slopes and flat paddy fields.

"We didn't know how much radiocesium was going from the land into the rivers, and where it was going from here."

While most radioactive material released into the atmosphere was blown out to sea, a change in the prevailing winds resulted in fallout across land. The government initiated an immediate evacuation of nearly

Contaminated soil in storage following decontamination (removal of topsoil).

160,000 people within 1600km^2 around the nuclear plant. As of March 2020, following extensive land remediation efforts including removing the top layer of topsoil across much of the agricultural land in the area, this has been reduced to 330km^2.

Because of the steep and mountainous terrain, with rivers flowing short distances to the ocean, the contributions to riverine radiocesium transport made by forested and human-affected areas could be evaluated. “Ten years on, our level of understanding has progressed enormously, including how this event differed from Chernobyl, which has until now always been the reference point,” says Dr Smith.

He adds that the fact we are dealing with relatively long-lived isotopes means this isn’t the end of the story, and remediation efforts will still be needed for decades. “Nuclear power will remain a significant source of power in the future, particularly with growing populations and energy demands,” says Dr Smith. “These data will form the basis for policy and planning in case of future events.”

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HTTPS *doi.org/10.1038/s41597-020-00774-x*

Forest monitoring site - Dr Hugh Smith, front and Prof Yuichi Onda, programme lead, behind.

Changes in the rural hazardscape

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

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

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

Manaaki Whenua's Dr Nick Cradock-Henry, who has been involved in all the above research and has also recently contributed to an OECD case study on building agricultural resilience in New Zealand, says that this work is challenging, but worth it. "Reassuringly, the OECD has recognised that New Zealand's disaster risk management processes are in good shape, especially with their emphasis on building personal mental resilience, but that more work is needed in the anticipatory phases of the disaster risk management cycle. Through co-created knowledge, policy makers, practitioners, and researchers can enhance resilience, via learning and pre-event preparedness, identifying their vulnerabilities to natural hazards early."

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HTTPS *doi.org/10.1016/j.envsci.2020.02.020*

Farmland after the floods of 2015, Foxton, New Zealand.

He matawara o mua – Taking account of shifting ecological baselines

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

Two generations of Tūhoe, Te Whenua Te Kurapa and Puke Timoti, discuss their impressions of abundance and productivity witnessed in the forests of Te Urewera over their lifetimes.

Ecological indicators based on western science systems are often used in monitoring and reporting to understand environmental change, but the short timeframes in which data are collected can hinder understandings. Increasingly, conservation and restoration organisations are looking to Indigenous peoples to detect and track long-term environmental changes through their direct interactions with natural resources (e.g. customary harvest) or general observations during time on land or sea. However, this type of work often uses language concepts and ordinal scores (e.g. few, some, a lot), so these systems can also be vulnerable to how individuals perceive, experience, and remember past natural resource states.

A recent study by Manaaki Whenua and Tūhoe Tuawhenua Trust set out to determine the relationships between ordinal scores and quantitative estimates (e.g. flock size) used by members of the Tuawhenua community of Ruatāhuna to gauge different forest indicators. The researchers also investigated whether community members of different ages gauged these indicators differently. The researchers showed that while the observed relationships remained consistent across all age classes, there was a significant intergenerational shift in how community members understood the abundance and size of a selected group of species.

The findings suggest the mitigation of shifting ecological baselines will be critical to how kaitiaki perceive change in their environments and determine the scale and level of action and investment required to recover those populations. This will be particularly important for younger kaitiaki who have not witnessed the historical abundance, productivity, and function of past ecosystems. In this regard, kaumātua offer valuable accounts of past and current ecological thresholds. The protection of customary harvest practices and/or the establishment of community-based environmental monitoring initiatives offer opportunities to maintain contact with species and their environments and track changes.

Iwi- and hapū-led conservation and restoration initiatives stand to benefit from the accounts of kaumātua through strong intergenerational knowledge transfer and community-focused monitoring. It also gives tangata whenua an important stake in future environmental interpretation and decision-making processes, while ensuring a continued interaction with their mātauranga.

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Reducing the mismatches between conservation research and practice

Conservation research and practice have traditionally been viewed as taking a linear pathway, where scientific evidence informs people's action on the ground. However, in practice, knowledge generation may not lead directly to knowledge use. Mismatches exist between research and practice that may limit our ability to achieve our conservation goals.

At the International Congress for Conservation Biology in 2019, a workshop – including Manaaki Whenua's Dr Natalie Forsdick – identified five key mismatches between conservation research and practice. Differences in the spatial scale of research and the local conservation context can cause spatial mismatch. Research topics may not be aligned with the needs of practitioners, resulting in priority mismatch.

Temporal mismatch occurs when research timelines are disconnected from funding, decision-making, and policy timelines. Research evidence may be inaccessible to practitioners, and conservation outcomes may not be available to researchers – a communication mismatch.

Underpinning all of these is institutional mismatch, where differences in the ways in which institutions operate may limit the opportunities for researchers and practitioners to interact. While the investigators perceive that there has been progress to reduce these mismatches over the past five years, there is still more work to be done.

The researchers have now identified ten strategies to improve the alignment of research and practice, enhancing conservation outcomes (see diagram).

While mismatches remain, we must challenge ourselves, our collaborators, and our institutions to strengthen the alignment between conservation research and practice. Through relationship-building, knowledge-sharing, and collaborative practice, we can achieve our goals of improving conservation outcomes.

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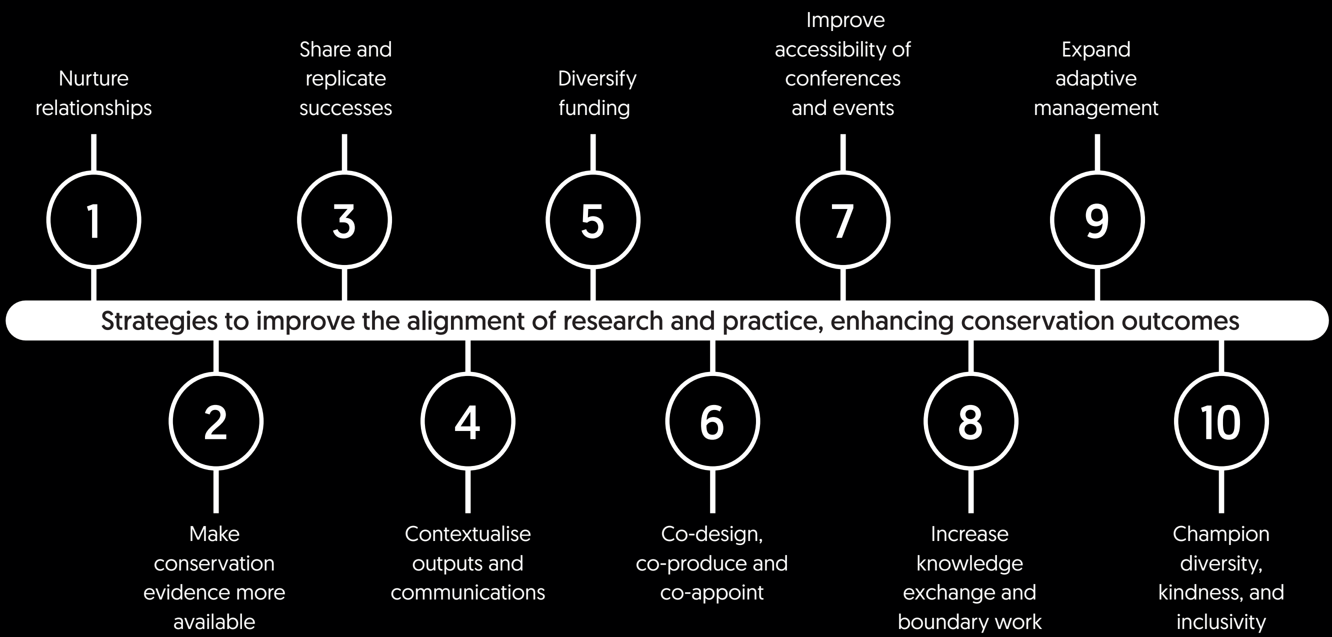


Celebrating our achievements

Sandra Lavorel is among a trio of international researchers awarded the BBVA Frontiers of Knowledge Award in Ecology and Conservation. Sandra, and fellow ecologists Mark Westoby (Macquarie University in Sydney, Australia) and Sandra Díaz (National University of Córdoba, Argentina), were recognised for expanding the concept of biodiversity through their pioneering work to discover, describe, and coordinate the measurement of the functional characteristics of plants. The catalogue of these functional traits has now become a vast database, added to and used by researchers around the world, for modelling the impact of global change on ecosystems and identifying mitigation measures.

Sandra Lavorel

Bev Clarkson was recently recognised for a lifetime of work dedicated to restoration ecology at The Kudos Science Excellence Awards. Bev, and her husband Bruce, a botanist at the University of Waikato, were jointly awarded the Kudos Lifetime Achievement Award for leadership in the study of New Zealand's terrestrial ecology. Bev is an honorary lecturer at the University of Waikato and a senior scientist at Manaaki Whenua. She is well known for her best practice handbook on wetland restoration.

Bev Clarkson with Bruce Clarkson at The Kudos Awards

Phil Lyver (Ngāti Toarangatira ki Wairau) was awarded the 2020 NZ Ecological Society Te Tohu Taiao award for ecological excellence. Over the past 25 years he has had the privilege of working with tangata whenua and Indigenous communities around the world engaging traditional knowledge systems (mātauranga) with science-based approaches to determine state and change in populations and ecosystems, and the cascading effect of those changes on cultures. Phil was a member of the Multidisciplinary Expert Panel advising the establishment and first thematic assessments of IPBES, and co-Chair for the aligned Indigenous and Local Knowledge Task Force.

Phil Lyver

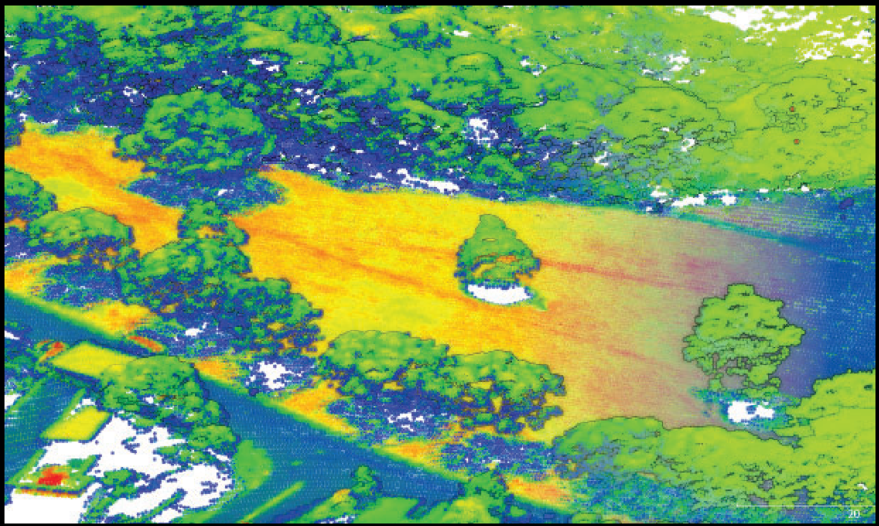
John Innes was recently the recipient of a special award dedicated to his long years working in kōkākō recovery in the North Island. At a celebration of progress at the Pureora ecosanctuary to mark the 2000th kōkākō breeding pair, largely thanks to the work of community groups, iwi and scientists working together since the late 1970s to learn about the birds and to attempt large-scale rat control on the mainland, John was presented with a carved fencepost by Adrian Rurawhe, MP for Te Tai Hauāuru.

John Innes

What is the future of biodiversity monitoring?

Fiona Carswell – Chief Scientist

Biodiversity monitoring is required to set conservation priorities and assess effectiveness of conservation management.



LIDAR mapping of individual trees in central Wellington.

Back in 2013, Essential Biodiversity Variables (EBVs) were proposed as a set of generalised measures of biodiversity, and suitable as a way to track progress towards targets defined by the Convention on Biodiversity, e.g. the Aichi Targets for 2020 (https://geobon.org/ebvs/what-are-ebvs/). EBVs can also provide the foundation for developing biodiversity forecasts under different policy and management scenarios. Widely advocated internationally (e.g. through the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services, IPBES), EBVs fit into broad classes of genetic composition, species populations, species traits, community composition, ecosystem structure, and ecosystem function.

Given our success in mapping entire stands of forest through LiDAR imagery, we have been asking whether the future of biodiversity monitoring could be through remote sensing. We've found that some species populations' data can be obtained by this method, along with the trait of phenology (where changes can be picked up visually). However, ecosystem structure is the EBV that shows most promise for remote approaches, through live cover fractions and ecosystem distribution/vertical profiles. Once individual trees can be identified to species level, carbon estimates can also be derived, assuming that wood density has already been established *in situ.*

The future looks bright as we continue to develop this technique for monitoring ecosystem structure. The work is being helped by a major collaboration between Manaaki Whenua, Scion, two Singaporean research institutes, the University of Canterbury and Victoria University of Wellington. The programme, one arm of which is being led by Manaaki Whenua's Dr Jan Schindler, is using data-science methods to extract tree species information from multi-resolution remote-sensing data to model tree species and their interactions with the environment. The programme even aims to quantify the socio-economic effects of trees.