Pūtaiao

MANAAKI WHENUA SCIENCE SUMMARY / ISSUE 14 / MAY 2023

Beetle mania

Science for our biosecurity and biodiversity

Plus: Manaaki Whenua's cyclone response

Pūtaiao

Science for our land and our future

Tēnā koe and welcome to Issue 14 of *Pūtaiao* ('science' in te reo Māori), our quarterly publication showcasing the work of Manaaki Whenua scientists.

We are the Crown Research Institute for our land, biosecurity and biodiversity, action on climate change, and people's relationship with the environment. We have a clear responsibility to Aotearoa New Zealand: this land, and everything that shares it with us, is our future.

Each issue of *Pūtaiao* describes the benefits and impact of our science in helping to ensure a sustainable, productive future for Aotearoa New Zealand This issue contains stories on the progress we are making in science for our biosecurity and biodiversity, but we begin by showing how our integrated research, across many disciplines, will underpin the local, regional, and national recovery from Cyclone Gabrielle.

Cover image: Research is underway to see if the pico beetle (Leptinotarsa undecimlineata), *a resident of Jamaica in the Caribbean could be the answer to stopping the spread of Solanum torvum, known as the prickly pico shrub, in Vanuatu that is impacting the country's beef industry. See Page 14 for the full story of our work in the Pacific.*

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Integrated research for cyclone recovery

For around 4 days from 12 February 2023, Severe Tropical Cyclone Gabrielle caused significant flooding and damage across northern and eastern regions of the North Island. Gabrielle's effects were felt over a very wide area, including Northland, Auckland, Coromandel, Waikato, Bay of Plenty, Gisborne, and Hawke's Bay.

As the clean-up continues it is becoming clear that much of the landscape in the worst-affected areas has effectively been 'reset' by Gabrielle. It has affected substantial areas of natural and regenerating ecosystems, productive land (including farm, orchard, forestry, and vineyard operations), much vital infrastructure, and many rural and urban settlements.

Manaaki Whenua will have significant immediate and long-term contributions to make to the recovery from the cyclone. One of the most urgent early research responses is to update vital satellite, LiDAR, and optical imagery to discover exactly how landscapes and catchments have changed.

As part of this early response we have made available our expertise in big data analysis and interpretation to support ministries and agencies such as regional and local councils that have an immediate role to play. This work includes assisting GNS Science's response to the cyclone focused on mapping landslides from high-resolution satellite imagery.

We were already involved with a project with Hawke's Bay Regional Council to map landslides following a heavy rainfall event in March 2022. The new regional LiDAR will be used to update our data on landslide susceptibility, landslide-debris mapping, erosion mapping, land characterisation, cultural mapping, and vegetation cover mapping. As initial response gives way to longer-term recovery, Manaaki Whenua will draw on a large body of integrated research knowledge

and data that encompass economic, social, environmental, cultural, and policymaking aspects to ensure relevant, resilience-building research.

We have a current MBIE Endeavour research programme of direct relevance to the devastating soil loss and silt deposition caused by Gabrielle. 'Smarter Targeting of Erosion Control' (STEC), now in its final year, is a pivotal research programme that has significantly improved understanding of spatial and temporal patterns of soil erosion, sediment-related water quality, sediment mitigation, and modelling. The most recent STEC outputs include high-resolution geospatial modelling of shallow landslide susceptibility to better inform targeting of mitigation measures, catchment-based sediment 'fingerprinting' (determining where eroded sediments originated), understanding the sediment contributions of large, slow-moving landslides, and modelling the likely patterns of soil erosion and sediment transport under future climate change (see box).

Led by Manaaki Whenua researchers Chris Phillips and Hugh Smith, STEC includes researchers from NIWA, Massey and Canterbury Universities, and international collaborators from KU Leuven, INRAE, University of Salzburg, and Bern University of Applied Sciences in Switzerland. Our partners include Whanganui iwi (Tamaūpoko Community Led Trust) and Rangitāne o Manawatū. STEC has been supported throughout by Northland, Waikato, Horizons, and Hawke's Bay Regional Councils, Auckland Council, Environment Southland, the Ministry for the Environment, the Ministry for Primary Industries, Our Land & Water National Science Challenge, and Federated Farmers.

Cyclone Gabrielle devastated the Esk Valley leaving layers of silt across land

We offer research expertise in forestry slash management, weed management (weeds may spread onto newly exposed soils), and in wildlife, plant population, and disease modelling as the affected areas recover. Our mapping capabilities will be needed to assess changes in the landscape's carbon stocks through loss of woody vegetation and carbon-rich soil.

In another relevant Endeavour research programme, we are working to understand whether biomass and soil carbon stocks in rural landscapes can be enhanced by the planting or natural regeneration of small clusters of trees, matched with soil and climate conditions.

Our social scientists are also well positioned to help build back better after Gabrielle. We can help to analyse the social and economic impacts of the cyclone, including how change is managed and the inter-related, intergenerational resilience of communities, economies, and biodiversity.

In two Endeavour-funded social research programmes already underway, we are unlocking effective decision-making for land managers, and seeking to identify and demonstrate how kaitiakitanga practices (which might include economic opportunities) achieve biodiversity regeneration, cultural revitalisation, and community well-being.

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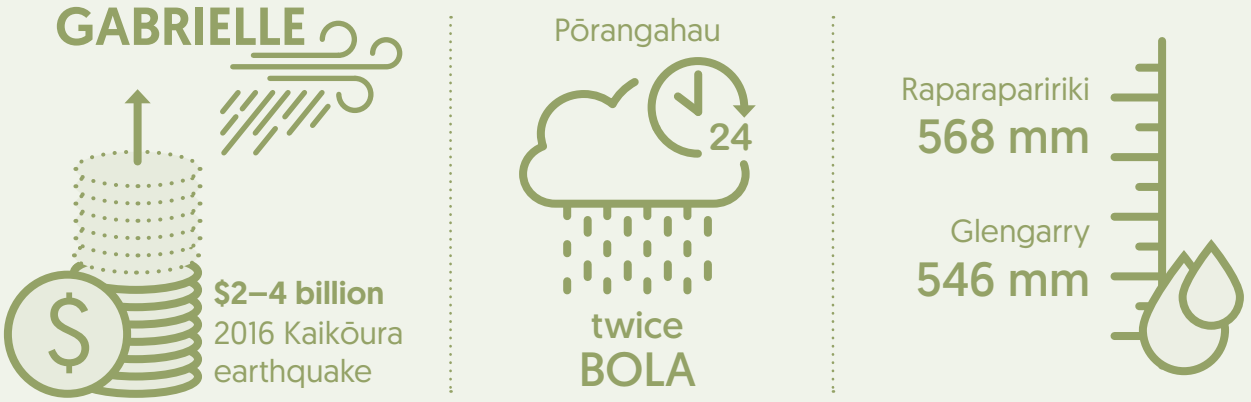
Gabrielle by the numbers

According to the Ministry of Foreign Affairs and Trade, Cyclone Gabrielle was New Zealand's costliest non-earthquake natural disaster to date, with economic losses currently expected to exceed the $2 billion to $4 billion losses of the 2016 Kaikōura earthquake. It was also the deadliest since Cyclone Giselle in 1968.

Weather station data showed that, in places, Gabrielle also brought record rainfall intensities. In the Pōrangahau catchment monitored by Hawke's Bay Regional Council, twice as much rain fell during the most intense 24-hour rainfall period of Gabrielle than during the most intense 24-hour period of Cyclone Bola in 1988. Huge rainfall totals were also recorded elsewhere in the region: Glengarry, near Napier, had 546 mm of rain, 400 mm of which fell in just 12 hours, and 568 mm fell at Raparapaririki in the ranges of Gisborne. NIWA reported that during Gabrielle, Whangārei had its wettest February day on record and Napier its second wettest.



With soils across much of the North Island already saturated from an unusually wet summer, including Cyclone Hale a few weeks earlier, the rapid, unrelenting rainfall of Gabrielle could not be absorbed. The saturated soils triggered shallow landslides in the steep, erodible hill country, displacing millions of tonnes of sediment across a range of land uses – pastoral farming, plantation forestry, native forest, and native scrub. The worst-hit areas were the Hawke's Bay and Gisborne regions.

A tool for solving landscape-scale problems

LUMASS – the Land Use Management Support System developed by Manaaki Whenua – is a data-driven decision-support tool that allows complex land-use planning problems, such as those created by the large-scale landscape modifications of Cyclone Gabrielle, to be mapped and solved.

By integrating data from different science domains, LUMASS enables stakeholders such as regional or local councils to run scenarios to define optimum land-uses at a variety of scales (a landscape, a catchment, a whole region). Desirable outcomes, constraints and trade-offs can be specified, for example the aim of minimising greenhouse gas emissions, or meeting National Policy Statement guidelines for fresh water, or to identify areas suitable for specific agricultural uses.

Current work with LUMASS explores its use for developing climate change adaptation pathways.

River catchment planning for future climate change

To develop effective management plans for river catchments, policymakers and catchment managers need to account for how climate change might affect soil erosion and river sediment loads. However, there has been no published, quantitative assessment of national-scale changes in erosion or suspended sediment loads anticipated under future climate for Aotearoa New Zealand.

To address this gap, Manaaki Whenua's Andrew Neverman and colleagues, in collaboration with AgResearch and NIWA and with funding from the Our Land and Water National Science Challenge's Whitiwhiti ora programme, have produced Aotearoa New Zealand's first national assessment of the potential impact of climate change on erosion and suspended sediment loads.

As part of the project, future erosion and sediment loads were estimated for mid-century (2040) and late century (2090) based on projected changes in climate and hydrology. Changes in suspended sediment loads were modelled under four potential future atmospheric CO2 concentrations, with associated changes in rainfall intensities and amounts.

The results of this modelling, published in the international journal Geomorphology, show that up to 28% of the North Island and 8% of the South Island are estimated to experience a two-fold or greater increase in average annual sediment supplied to the channel network by late century.

Exploring the impacts of climate change on Māori

In October 2021, Ngā Pae o te Māramatanga and Manaaki Whenua released a report offering new guidance for te ao Māori on climate change adaptation and mitigation. *He Huringa Āhuarangi, he Huringa Ao*: *A Changing Climate, a Changing World* was produced by a multidisciplinary Māori research team working across many research institutions and led by Manaaki Whenua's Dr Shaun Awatere.

Using a novel kaupapa Māori risk assessment approach to climate change, the report synthesised the latest climate change research through a Māori lens, and identified the potential impacts, implications, mitigation and adaptation strategies for whānau, hapū, iwi, and Māori business.

He Huringa Āhuarangi, he Huringa Ao predicts that Māori well-being across all four key domains – environment, Māori enterprise, healthy people, and Māori culture – will be moderately affected by 2050. By 2100 the risks to ecosystems are likely to show severe impact, compromising many aspects of Māori well-being.

Further developments in incorporating a Māori world view into issues of climate change are discussed on the back page of this issue of *Pūtaiao*.

The taonga of Rangitāhua

"Tō tātou hā i te tuatahi ko te moana, hā tuarua nō tātou te whenua – Our first breath is from the ocean, our second from the land" – Ngāti Kuri whakataukī.

Halfway between Aotearoa New Zealand and Tonga lie Rangitāhua (the Kermadec Islands), a volcanic group of islands rich in biodiversity and taonga to Ngāti Kuri. They have been scientifically identified as one of only four pristine marine ecosystems on Earth.

Manaaki Whenua senior researcher Peter Bellingham recently travelled to Rangitāhua aboard the Navy vessel HMNZS Canterbury. The January voyage took place mid-way through a 5-year MBIE Endeavour programme called 'Te Mana o Rangitāhua', which Ngāti Kuri co-leads with Auckland Museum, with support from Manaaki Whenua, Massey University, NIWA, the University of Auckland, Auckland University of Technology and the University of Waikato.

The programme aims to identify tohu (signs) of ecosystem change and to develop methods to ensure the long-term well-being and resilience of ecosystems of Rangitāhua. Through Treaty settlement, Ngāti Kuri have co-governance of the islands and are re-engaging with them through the connections of their tūpuna.

The group spent 5 days on the largest island of Rangitāhua, with Peter's role being to assist in understanding the ecology of the forests and other ecosystems of the island and contribute to dialogue about future management plans. Representatives from the Department of Conversation, MetService and GNS Science were also present to undertake their own work and infrastructure projects.

Peter says it was a privilege to be part of the Ngāti Kuri conversations and discoveries about their connections to the island plants, birds, and other animals. "Rangitāhua has never been connected to a larger landmass, and it has a unique subtropical ecosystem. In its isolation, it has evolved a unique biodiversity, above and below the waterline."

Peter highlights the island's precariousness: it is an active volcano, it is subject to powerful earthquakes and cyclones, and it is vulnerable to introduced species such as goats, cats, and Norway rats. "These mammal pests are now all eradicated, but the ecosystems were devastated and radically altered, and are only now recovering. For example, rats and cats decimated seabird populations by 2000, but black-winged petrels have since recolonised and are now abundant," he says.

Reflecting on the voyage, Peter says "In my career, I've been lucky to see many different island ecosystems, but the cultural perspective on this trip gave me entirely new insights.

"The main benefit for me of the trip was to be part of seeing and learning about the moutere from Ngāti Kuri's viewpoint and to see their manifestation of mana motuhake (sovereignty and self-determination) on Rangitāhua. A next step for me will be supporting Ngāti Kuri to give some of these plants names to reflect the plants' important part of their history there."

Strategic lead of the Ngāti Kuri Trust Board, Sheridan Waitai says there are

many who could learn from Peter by the way he works with iwi, hapū, and whānau. “Peter has strengthened the wider relationship with Manaaki Whenua, and for us it was an honour to take him and hold him as part of our family. Rangitāhua needs many hands and minds to help transform the environment into to a thriving space, and we look forward to working with the multitudes to do this.”

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Clockwise from far left:

This palm is a close relative of the nikau, but unique to Rangitāhua.

A tropical seashore member of the pea family that has a scientific name (Canavalia rosea) *but currently lacks a name in te reo Māori.*

A navy helicopter with sling departing Rangitāhua.

A black-winged petrel on the forest floor.

Peter Bellingham beside a pou whenua (boundary marker) that Ngāti Kuri kaumātua installed on Rangitāhua in 2001.

Rangitāhua Island from the sea.

Do native birds have enough to eat in mountain forests?

A good pair of binoculars and lots of patience lie at the heart of new research putting the focus on forest food sources and food abundance as part of a wider effort to boost Aotearoa New Zealand's native bird populations.

Dr Anne Schlesselmann and her Manaaki Whenua colleagues recently published the results of the first study to look for an elevational gradient in reproductive success for New Zealand birds in the *New Zealand Journal of Ecology*. The research, which is part of the MBIE Endeavour research programme 'More Birds in the Bush', looks at understanding the relationship between elevation and food supply for forest birds, and subsequent nest survival.

With native forest bird species in Aotearoa New Zealand under threat from introduced mammal predators such as possums, rats, and stoats, the ranges of many native forest bird species have contracted to cooler, higher-elevation tracts of forest that support fewer introduced mammals. However, while the birds are escaping predators, higher, cooler elevations have less food available, potentially leading to lower survival or breeding success.

Being able to determine the factors that limit populations in this way is therefore fundamental for effective conservation management of Aotearoa New Zealand's threatened bird species. If places with optimal conditions can be identified, these can be targeted for predator control and lead to faster recovery of dwindling bird populations.

In spring and summer 2020/21, working at six sites at each of three different elevations on the sides of Pirongia Mountain, the researchers sampled invertebrate prey while simultaneously monitoring the fate of 55 tītitipounamu/rifleman (*Acanthisitta chloris*) nests and 33 miromiro/tomtit (*Petroica macrocephala*) nests, and the number of fledglings produced by each. Invertebrates were sampled on the ground and on the wing, and their biomass calculated. Camera traps and tracking tunnels were used to monitor predator numbers.

Mammal predators are routinely suppressed on Pirongia Mountain. Rats and possums do not only eat birds, but also the same food as native birds. Hence, only when rats and possums are at low numbers is it possible to investigate whether there are environments that are intrinsically more productive for birds, such as low-elevation forests.

The results from the 18 sites somewhat supported the theory that there would be less invertebrate food available for the birds at higher elevations and that their reproductive success would be lower as a result. In general, though, nest survival and number of fledglings produced by tītitipounamu and miromiro were not

A miromiro/tomitit nest.

Recording a tītitipounamu/rifleman nest using GPS. The nest that the bird has made cosy by using feathers is on the underside of a dead log.

strongly related to elevation or food availability. Understanding differences in survival will be the next step to better understand food limitations.

"Studying food availability for birds is harder than studying predation and has been rarely done in New Zealand," says co-researcher John Innes. "Yet we know from overseas research that birds make more nesting attempts when food is abundant."

Anne Schlesselmann says careful work such as this is the key to understanding likely habitat quality and bird population vulnerability to achieve thriving bird populations across the land.

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Typical tall tawa forest on Pirongia Mountain with a researcher at left observing a nest that shows the scale of the forest.

Historical newspaper articles unfold the story of the near-extinction of kākāpō

Kākāpō, the world's only flightless parrot, once ranged throughout the forests of Aotearoa New Zealand. However, early European observers noted the bird population declining rapidly within their own lifetimes and speculated this was due to packs of feral European dogs and other mammal predators.

A new study led by Manaaki Whenua researcher Dr Jo Carpenter, designed to better understand the dynamic processes of extinction, has shed new light on the processes leading to the near-terminal decline of kākāpō. Dr Carpenter and her co-authors, Dr Janet Wilmshurst (Manaaki Whenua) and Professor George Perry (University of Auckland), used a unique combination of fossils and historical records to examine how kākāpō distributions changed through time.

"Historical newspaper articles from the nineteenth and twentieth centuries are a treasure trove of information on where kākāpō were distributed," says Dr Carpenter. "We also gathered information from kākāpō museum specimens, by recording when and where they were collected."

These data were used to predict the kākāpō's likely local extinction dates, which were between 1936 and 1959 in the North Island and between 1990 and 2006 in the South Island – a time lag of around 31–70 years. The researchers explain this time lag as resulting from different prehistoric hunting and predation pressures, and the extents of habitat transformation on the North and South Islands.

In the historical era packs of feral dogs appeared to be a less important driver of kākāpō decline. "Our analysis of more than 100 geo-referenced newspaper and scientific reports shows the distribution of kākāpō and feral dog packs did not overlap strongly anywhere, suggesting they did not frequently interact," says Jo. "Kākāpō also persisted in the South Island for up to 70 years after the last noted observation there of feral dogs in 1913."

Conversely, the explorers were right about the European-introduced stoats, possums, cats, and Norway and ship rats, which have been a much more important contributor to kākāpō decline since European arrival. "These animals would certainly have been the *coup de grâce* for this species if the birds hadn't been rescued from the wild," says Dr Wilmshurst.

In 1995 the kākāpō population had fallen as low as 51 known individuals. In 2023, thanks to years of intensive conservation efforts by the Department of Conservation Kākāpō Recovery Group and Ngāi Tahu (kaitiaki of kākāpō), the numbers of this critically endangered species have rebounded, with approximately 250 birds now confined to offshore, predator-free islands.

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An 1888 lithograph of a kākāpō in A History of the Birds of New Zealand.

Core blimey: how an old Hoover revealed the secrets of a wetland

The Pakowhai wetland on Tim Brownlie's Frasertown farm.

East Coast farmer Tim Brownlie and QEII regional representative for Gisborne Malcolm Rutherford have become fascinated by the world of palaeoecology.

Malcolm was aware peat deposits, which form under wetlands, can preserve pollen grains, and these tiny microfossils can offer insights into the past vegetation of an area, before the land was cleared, drained and farmed.

He approached researcher Janet Wilmshurst from Manaaki Whenua's Long Term Ecology Laboratory about a wetland area on Tim's farm. The lab specialises in reconstructing past ecosystems and former species interactions using microfossil and molecular analyses.

Curious about the small wetland, Janet was keen to get a few samples, known as 'cores', to find out what the pre-human vegetation cover was like in the area, as there are few pollen records from this part of the Gisborne region. Janet suggested Malcolm collect a few samples of peat from the wetland to get the research started. In the November 2022 issue of QEII's National Trust magazine, *Open Space*, Malcolm details how they went about getting their 'sample'. "Tim and I found ourselves hammering an old vacuum cleaner tube into the ground on the edge of a newly fenced and covenanted wetland," he writes.

Janet received a nicely 'vacuum-sealed' core she could analyse under the microscope for pollen. "Pollen analysis provided us with a list of at least 43 pollen and fern spore types," she says. "This included podocarp trees such as rimu, miro and tōtara, as well as numerous broadleaf trees and shrubs that made up the canopy, including maire, pōkākā, māhoe, akeake, rewarewa, kohekohe, and nīkau."

She also recorded the presence of tree ferns, climbers, perching plants, parasitic plants, and ground ferns. "It's a huge increase from the 11 known native species from the wetland today."

Janet says one of the most exciting finds was pollen of te pua o te rēinga (*Dactylanthus taylorii*), or the wood rose, a semi-parasitic plant that grows as a root-like stem attached to the root of a host tree. "Its distinctive pollen is rarely found in the pollen record, but I have recorded it before in pre-human sediments from Lake Tūtira."
This plant is now nationally threatened, and forest clearance and introduced mammals have reduced it to a tiny fraction of its former range.

Janet's analysis showed that the 'sample' Malcolm sent her was typical of sediments that accumulate in lakes. Furthermore, the absence of any wetland pollen in these sediments suggested the site was formerly a shallow lake surrounded by tall forest rather than a wetland. Because there were no signs of charcoal in the samples, the sediments probably started accumulating in the small basin in the pre-human era between 3,000 and 1,000 years ago.

Janet compared the pollen spores from Tim's Frasertown farm with records from other regions in Gisborne and the Hawke's Bay. "Pollen records show us what the vegetation was like across New Zealand long before people arrived," she says. "Understanding what plant species survived and flourished in an area in the past is a good reference point for informing current land-management decisions."

Tim has fenced off the basin to protect it from his stock and named it the Pakowhai Wetland. The area is now registered as a QEII National Trust Covenant. "Who knows what might show up if a vacuum cleaner tube were to be pressed into the peat to take a core sample in another 1,000 years," says Malcolm.

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Rats and flax: traps reveal surprising facts

A study into birds as pollinators of plants in Aotearoa New Zealand has led to interesting questions – are rats eating precious nectar and what impact does this have on our birds?

Manaaki Whenua senior researcher Dr Manpreet Dhami and NSF postdoctoral Fellow Dr Marion Donald, both from our Biocontrol and Molecular Ecology team were working to understand more about bird pollination of nectar in flowers, as well as the fascinating workings of microorganisms in nectar, when they made a surprise discovery.

For this study, recently published in the New Zealand Journal of Ecology, the team used seven camera traps to monitor vertebrate visitation to mountain flax (*whaririki Phormium cookianum*) in a small, restored wetland area that borders a residential neighborhood in Lincoln. The camera traps were programmed to be motion activated and either take bursts of photos or short videos.

"Over the nine-day study, we photographed and video recorded a ship rat climbing across mountain flax flowers and feeding on mountain flax nectar on six different nights – which was a surprising finding," says Manpreet.

In New Zealand, the ship rat (*Rattus rattus*) is considered at fault for the rapid declines of many bird populations.

"While seed masts have been associated in rat population booms, we think that alternative food resources, like floral nectar, may play a role in rat-bird interactions," says Manpreet. "This footage also indicates possible pollination services by rats, which opens other research questions."

These findings suggest that attention should be paid to nectar as a limited resource that may support

Researchers found rats were drinking the nectar of mountain flax (whaririki, Phormium cookianum*) flowers.*

Photos from across multiple nights and camera traps, show a ship rat climbing across and appearing to feed from a mountain flax flower and reaching across to another open flower. During the feeding and when it reaches the other flower, the rat appears to contact the stamens and pistil, which extend above the petals and sepals.

> *It stands to reason that as seed resources dwindle, rats may increasingly consume nectar, which could lead to resource competition with nectivorous birds*

rat populations, as well as attract rats for pollination services. “This increased resource competition with birds could have important consequences,” says Marion.

Nocturnal consumption by rats may deplete the limited nectar resource on which the nectar-feeding birds rely.

These scientists write “studies tracking the amount of floral nectar removed during the night compared to the amount removed during the day would help determine whether rat consumption reduces nectar availability for diurnal birds.”

Interestingly during this study the rats did not damage the flax flowers while drinking the nectar, Marion says.

“As rats have a near global distribution we think their role as resource competitors and pollinators may be widespread, so we’re excited to explore this further.”

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Dr Marion Donald using a waratah to install the camera posts next to the flax.

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Weed busting and capacity building across the Pacific

"We succeed only by working together in sustainable partnership" is the philosophy that underpins Manaaki Whenua's approach to long-term solutions to issues faced by our Pacific neighbours, such as climate change, biosecurity threats, food and nutrition security, and biodiversity loss.

Our international work is an extension of our work in Aotearoa New Zealand and develops capability within governments, research institutes, and civil society.

The Manaaki Whenua Weed Biocontrol Group, for instance, has extended its expertise overseas, working with biosecurity teams across the Pacific as part of the collaborative Managing Invasive Species for Climate Change Adaptation in the Pacific (MISCCAP) resilience-building programme, funded by the Ministry of Foreign Affairs and Trade (MFAT).

The Secretariat of the Pacific Regional Environmental Programme (SPREP) and the New Zealand Department of Conservation are also contracted parties in the MISCCAP project.

Some – but not all – of our collaborative projects are outlined here. Each of these has involved intense periods of activity, including building relationships, undertaking surveys, providing training, and determining work plans and priorities.

Loisi Taufa from Tonga looks through specimens, including many from the Pacific Islands, held in the New Zealand Arthropod Collection (NZAC) during a NENS workshop held in Auckland recently.

Natural enemies, natural solutions

Eight countries in the Pacific will introduce natural enemies in order to reduce the impacts of key weeds in the island nations under the umbrella of Manaaki Whenua's 'Natural Enemies – Natural Solutions' (NENS) programme.

The Cook Islands were the site of the first major release of biocontrol agents, specifically for the African tulip tree (*Spathodea campanulata*). Introduced to many Pacific islands as an ornamental plant, the trees pose a huge threat to island biodiversity across the region. Native to tropical Africa, this fast-growing, evergreen tree infests rainforests, out-competes native vegetation, and affects agricultural production.

Biocontrol agents include African tulip tree flea beetles (*Paradibolia coerulea*) and gall mites (*Colomerus spathodeae*), which are both specialist natural enemies of the African tulip tree. The beetles feed on the leaves and the mites form leaf galls, known as erinea, which stunt new growth. Working together, these two natural enemies will reduce this invasive tree's competitive ability. This work is being undertaken with assistance from the National Environment Service, the Ministry of Agriculture, and members of the Te Ipukarea Society and the Natural Heritage Trust.

The mites have also been supplied to Tonga and Vanuatu. The mites were establishing well in Vanuatu prior to Cyclones Judy and Kevin, which

stripped the leaves from many trees, including the African tulips. However, Biosecurity Vanuatu kept a colony of mites safely under cover and they will be used for further field releases, if necessary.

African tulip tree was also determined to be the top priority for Fiji, where the NENS team of Lynley Hayes, Quentin Paynter, and Temo Talie ran a weed prioritisation workshop with representatives from a range of government and regional institutions, including Fiji's Biosecurity Authority, the Department of the Environment, The Pacific Community, the University of the South Pacific, and Fiji National University.

They also conducted fieldwork and natural enemy surveys, collected samples for molecular work, and visited academic institutions. Staff at the Ministry of Agriculture at Koronivia Research Station, in Suva, will support the work needed to import, mass rear, and release the African tulip tree mite and beetle.

While delivering the African tulip mites to Vanuatu, Manaaki Whenua researchers also visited the Vanuatu Agricultural Research and Technical Centre to view trials underway to optimise conventional control of wild peanut (*Senna tora*). This work will help farmers while natural enemies are being sought for this key pasture weed. The team provided training on how to analyse photos using software, which will be needed to assess the trials and other future project activities.

The NENS team has also begun research and risk assessments into the shrub *Solanum torvum* (known by many names, including pico and prickly solanum), which is having a major impact on the beef industry in Vanuatu. Native to the Antilles, this prickly shrub can form dense, impenetrable thickets.

*Team members from Biosecurity Vanuatu releasing parthenium beetles (*Zygogramma bicolorata*) just a few days after Tropical Cyclone Kevin.*

Our recently completed molecular study has shown that populations of *S. torvum* in the Pacific are genetically very similar and originate from the Antilles, confirming the Caribbean to be the best place to look for natural enemies. Testing of a pico beetle (*Leptinotarsa undecimlineata*) obtained from Jamaica has ended, and since the beetle is both damaging and highly host specific, an import risk assessment is now being prepared for Vanuatu.

MFAT is also supporting the work to develop natural enemies for pasture weeds in Vanuatu in another project, 'Improving Productivity of the Beef Industry in Vanuatu'. This project is assisting with the release of natural enemies already available for pasture weeds. In recent months the nail grass psyllid (*Heteropsylla spinulosa*) and parthenium beetle (*Zygogramma bicolorata*) have been introduced to Vanuatu with the assistance of collaborators in Australia.

Capacity building

Lynley Hayes and Temo Talie ran a highly successful week-long training course in Auckland in January, a key output for the MISCCAP programme this year to upskill 16 collaborators from Fiji, Samoa, Tonga and Vanuatu in all aspects of the NENS programme for weeds. The workshop also touched on related topics, such as dealing with the media, presentation skills, health and safety, and raising awareness of the Pacific material held in our Nationally Significant Collections.

Manaaki Whenua's biological collections are not only the repository of knowledge of New Zealand's flora and fauna, but they also contain specimens collected from the wider Pacific, making them an internationally significant research resource. Making these databases, such as the New Zealand Arthropod Collection (NZAC) - Ko te Aitanga Pepeke o Aotearoa

available to Pacific Communities is a priority for Manaaki Whenua.

Creating sustainable seed and plant material systems

Manaaki Whenua is collaborating in six Pacific countries on seed and plant material systems. This work is crucial to ensure sustainable food production in the face of natural disasters and climate change, and to improve the health of Pacific people by broadening their crop diversity.

Sera Dau from CePaCT - The Centre For Pacific Crops and Trees in Fiji worked alongside molecular technician Ana Podolyan in Manaaki Whenua's GEM lab to screen for plant virus using taro culture samples.

The Pacific Seeds for Life (PS4L) initiative began in 2020 with the aim of building a resilient and diverse portfolio of high-quality plant genetic resources for farmers and growers that would be available at all times.

In Vanuatu we've been working with the 'Seeds for Life' team, visiting project activities with local teams in Efate, Espiritu Santo, and Malekula to confirm plans and activities for the next 12 months.

Farmers in remote locations are training in seed saving, new plant varieties, organic production, subsistence agriculture, and agribusiness opportunities. The MFAT-funded programme is also funding seed storage facilities at the provincial level to ensure plant materials can be readily conserved and then shared in times of recovery after adverse weather events.

The Centre for Pacific Crops and Trees in Suva, Fiji, is a one of these genebanks, and it holds the largest collection of taro varieties in the world. Manaaki Whenua facilitates the efficient

Top: Lynley Hayes and Temo Talie run a prioritisation workshop in Fiji with the team from the Ministry of Agriculture.

Bottom: Quentin Paynter with members of the VARTC team in Vanuatu analysing photos.

screening of viruses in these different taro varieties and helps to keep the collection disease-free.

Healthy taro seedlings are distributed to farmers around the Pacific region, contributing significantly to food security in the area.

Soil management

In Tonga we are working with local soil scientists on soil-testing services that will help the recovery of the agricultural sector following the January 2022 volcanic eruption and tsunami.

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Using artificial intelligence to monitor wildlife

Camera traps (motion-triggered cameras) are used for monitoring a range of wildlife species in Aotearoa New Zealand, including native and invasive animals. These cameras provide essential information on animal abundance, distribution, and behaviour, but they have one major drawback: they can produce thousands of images, many of which are empty, and which are time-consuming and costly to process.

With funding from Predator Free 2050 and MBIE's Kiwi Rescue programme, Manaaki Whenua researchers Brent Martin and Al Glen have developed a free online tool, CamTrapNZ, which allows users to manage their images quickly and easily. The tool uses artificial intelligence (AI) to identify images of 15 taxa commonly detected by camera traps in Aotearoa New Zealand: kiwi, other birds, cats, deer, dogs, ferrets, goats, stoats/weasels, possums, rodents, hedgehogs, rabbits/hares, wallabies, pigs, and livestock. The model could be trained to recognise more taxa in the future.

The accuracy of species identification depends on the species, and also whether the image is colour (daytime) or black and white (night), says Al. "For example, the AI will detect wallabies around 98 percent of the time, but has much lower accuracy for mice. This is mainly because mice are so small that they often appear as little more than a dot in the images. Accuracy is generally higher with colour images than with black and white ones."

Some species are grouped together because the images captured by camera traps don't always show distinguishing features. For example, stoats and weasels can easily be distinguished if the tail is visible (e.g. images a and b below), but sometimes the images don't show the tail (e.g. image c). Rats and mice are particularly difficult to separate.

Results can be viewed in a web browser or in a spreadsheet, which shows the species identified in each image, as well as a confidence score. This allows the user to sort images according to the level of confidence. For example, users might choose to manually check any images with a confidence rating below a certain level. In addition, the online tool allows users to produce maps, graphs, and other reports of their results. The software is hosted on TrapNZ (www.trap.nz), a free online platform widely used for recording pest control, monitoring, and biodiversity outcome data in Aotearoa New Zealand.

Further improvements to CamTrapNZ are planned, subject to funding availability. For example, Brent and Al hope to improve the accuracy of species identification by training the AI with larger numbers of sample images. "We also hope to add more species, and to add the capability for the system to improve over time by constantly retraining from the images users upload. We are also building a version of the software that runs on the user's own computer, without the need to upload images to a server. This will be useful for users with very large numbers of images," says Brent.

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A) *A clear image of a stoat, identifiable by the long tail with a black, bushy tip.* B) *A clear image of a weasel, identifiable by the short, stubby tail.* C) *An image that is not clear enough to determine confidently whether the animal is a stoat or a weasel.*

Survey of Rural Decision Makers No. 6

The Survey of Rural Decision Makers (SRDM) is the leading source of information about Aotearoa New Zealand's primary sector. Conducted by Manaaki Whenua every 2 years, thousands of farmers, foresters, growers, and lifestyle block owners from Cape Reinga / Te Rereanga Wairua to Halfmoon Bay complete the survey. The SRDM is one of the largest and longest-running rural surveys in the world.

The sixth SRDM will run from June until August 2023 and will include questions related to:

- ownership and structure
- land use and land-use change
- future planning
- management practices – winter grazing, weed control, and forestry management
- farm finances
- values
- well-being
- the regulatory environment
- sources of advice.

The SRDM is designed to build a better picture of decision-making at the farm level. Economic, social, and environmental data are integrated to provide research and advice to benefit policy makers, industry, and the rural sector alike.

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HTTP landcareresearch.co.nz/srdm

Celebrating our achievements

A recent paper co-authored by **Maksym Polyakov** and colleagues from the University of Western Australia, 'Do protected areas increase household income? Evidence from a meta-analysis', won that university's Department of Agriculture and Resource Economics People's Choice Award for Best Publication. The paper appeared in the journal *World Development.*

The Survey of Rural Decision Makers (SRDM) scooped the 2022 Quality of Research Communication Award at the 2023 Australasia Agricultural and Resource Economics Society conference for the suite of outputs from the survey. **Pike Stahlmann-Brown**, who runs the survey, accepted the award on behalf of the wider team who create the survey outputs: **Nicolette Faville**, **Karen Scott**, **Pam Booth** and **Leah Kearns**.

Kaihautū Māori Research Impact Leader **Phil Lyver** (Ngāti Toa Rangatira ki Wairau) has been elected a Fellow of the Royal Society Te Apārangi. Phil's extensive and world-leading research leverages science and mātauranga Māori to advance knowledge at the interface of kaitiakitanga, ecology, and conservation. Phil says it has been a privilege over the years to work with tohunga, pūkenga, kaumātua, and kaitiaki from different iwi, who have been so generous with their knowledge and allowing him to learn from their expertise. The new Fellows were formally inducted at an event in Wellington on 27 April 2023.

Maksym Polyakov.

Pike Stahlmann-Brown.

Phil Lyver.

Māori frameworks needed to recloak the whenua

Noho tahanga a Papatūānuku kia whakakororwai i ai ia Papatūānuku [The earth mother] lays bare; we must recloak her
– Keita Ngata (Ngāti Porou)

In the wake of the devastation caused by Cyclone Gabrielle and the increasing impact of climate change, there is a call to ensure a Māori world view is incorporated into risk assessment frameworks and decision-making processes.

Led by Manaaki Whenua Kaihautū Māori Research Impact Leader Dr Shaun Awatere, the impact of extreme weather events and climate change on Māori communities is being investigated by a team of researchers focused on a te ao Māori (Māori world view) perspective.

Dr Awatere says during this period of recovery there is a need to ensure Māori are part of the process when it comes to making decisions on replanting, rebuilding, and economic choices concerning their communities.

"There is a need to rebalance the system and ensure Māori are at the decision-making table. For example, they will have views on what should be replanted and where, as well as the importance of certain culturally significant sites that have been lost or damaged. They know and understand their whenua [land]."

Cyclone Gabrielle highlighted the vulnerability of Māori communities on the East Coast of the North Island, as many marae and urupā (cemeteries) are located in coastal, low-lying areas that are prone to flooding and sea-level rise.

"It is mana whenua who understand their whenua and must be consulted and involved in the rebuild in order to ensure the whenua is recloaked for future generations," says Dr Awatere.

The whakataukī (proverb) above, which was gifted to researchers, highlights that the earth mother lays bare, as she has been stripped and disrespected, in part caused by unsustainable forestry practices, leaving her vulnerable to landslides and erosion.

Dr Awatere has developed a kaupapa Māori disaster risk reduction framework, which gives mana (value) back to the environment and demonstrates that we are obligated to treat the environment with respect.

"The Māori view is more holistic, relational, and cyclical, emphasising the need for balance. The cosmic forces of mana and mauri provide a powerful yet relatively simple way of understanding risk and vulnerability," he says.

A reduction in risk is achieved through mātauranga (Māori knowledge), whakapapa (connectivity), kaupapa (key issues), community, and tikanga (principles and practices), which provide the knowledge, connections, ethics, scale, and behaviours for reduction.

"Likewise, the framework highlights that resilience can be enhanced through strengthening community, care, capital goods, culture, and control, empowering communities to take the lead on reinforcing their capacity to withstand hazards."

Dr Awatere and his colleagues have also developed the framework He Waka Taurua, which conceptualises a decision-making framework through a te ao Māori lens, with the symbolic waka intended to serve as a Māori cultural memory retention device.

He Waka Taurua explicitly identifies a te ao Māori world view and associated values as a distinct and complete knowledge system, separate from a Western science world view. This is represented by the two hulls, waka Māori and waka Tauiwi, and the hoe (paddles), which represent the tools, actions, and approaches relevant to each world view.

These world views are kept separate from each other, while the papanoho (deck) between the canoes represents a shared or 'negotiated space', where engagement and innovation can occur.

As the recovery and rebuild phase following Cyclone Gabrielle continues, it is hoped these frameworks can be used to empower Māori and create sustainable whenua and local economies.

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