NEW ZEALAND'S BIOLOGICAL HERITAGE

Ngā Koiora Tuku Iho

National Science Challenges

2017 Highlights

NEW ZEALAND'S BIOLOGICAL HERITAGE

Ngā Koiora Tuku Iho

National SCIENCE Challenges

c/– Manaaki Whenua - Landcare Research
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From the Chair

The New Zealand's Biological Heritage National Science Challenge, Ngā Koiora Tuku Iho, has made great strides in the three years since its inception, convening research teams drawn from all around New Zealand. Our research collaborations provide science-based solutions to enhance and restore New Zealand's land and freshwater ecosystems. By fostering a collaborative culture and a coherent focus across universities, Crown Research Institutes and research programmes, and in partnership with Māori, we are driving transformational change in the way science and research deliver national-scale impacts.

This annual report captures some of our recent progress. We present early highlights from research projects and demonstrate the collaborative approach across the research organisations involved. It also reflects our links with a range of other organisations around New Zealand that are able to effect transformational change through the science-based solutions we provide.

We are extremely proud of the widespread commitment and enthusiasm that underpin the progress and impacts being achieved. I'd like to thank our Governance Group members for their strategic oversight, Challenge Director Dr Andrea Byrom for her strategic leadership, and all those who have contributed in various ways to the Challenge's progress and successes.

Dr James Buwalda

From the Director

I am delighted to present you with our first report on highlights from New Zealand's Biological Heritage National Science Challenge, Ngā Koiora Tuku Iho. We hope you will gain a greater understanding of what the Challenge is about, get to know our 18 Challenge parties, acquire a more in-depth appreciation of our science and research activities, and see how we are working in partnership with Māori.

Science Challenges are about a new way of working collaboratively in the New Zealand science system. Our Challenge parties have been incredibly supportive of us, and of our aspiration to strive for greater collective impact through protecting biodiversity, improving biosecurity, and building resilience in natural, urban and production ecosystems. Without the excellent research capability and expertise held by all our Challenge parties we simply would not be able to deliver on the Challenge mission. Thank you.

I would also like to thank our Challenge Host, Manaaki Whenua – Landcare Research, which has been very accommodating of our new ways of working and always strives to help the Challenge operate as professionally as possible.

We hope you enjoy our 2017 highlights.

Dr Andrea Byrom

About the Challenge

Why New Zealand's Biological Heritage National Science Challenge was formed

In 2012 the Government launched a television and web campaign[1] asking the public what New Zealand's most important strategic issues were that required science to help solve. Eleven National Science Challenges were formed[2,3], addressing big societal issues: creating healthier lives, managing Earth's land and water resources, tackling climate change and other topics.

One of the most popular Challenges in the public mind was eventually called New Zealand's Biological Heritage – Ngā Koiora Tuku Iho (hereafter called the BioH Challenge). New Zealanders highly value our biological heritage – the natural, production and urban environments in which we live, work and enjoy ourselves. With our economy, lifestyle and sense of identity inseparably linked to our environment, many of us have deep cultural or family connections to land, rivers and lakes.

However, elements of our environment are under increasing pressure. The BioH Challenge aims to transform the way we respond to that pressure and will ensure New Zealanders have the knowledge, tools and technologies to better protect our primary production-based economy, precious native flora and fauna, and unique environments for future generations.

1 https://sciblogs.co.nz/infectious-thoughts/2012/11/11/the-great-nz-science-project-begins/

2 http://www.mbie.govt.nz/info-services/science-innovation/national-science-challenges

3 http://www.mbie.govt.nz/info-services/science-innovation/national-science-challenges/key-documents

Challenge parties

The BioH Challenge has until recently comprised 17 parties which contribute research effort across a wide range of science investments. In 2018, the Cawthron Institute joined the Challenge as the 18th party. In addition to investing in research, our job is to bring together and focus this collective research effort in order to increase the impact it can make for New Zealand.

Mana whenua, iwi and Māori groups, non-governmental organisations, private citizens and numerous stakeholders, such as New Zealand's Ministry for the Environment and regional councils, are also working in the BioH Challenge.

The BioH Challenge is hosted by Manaaki Whenua – Landcare Research.

Manaaki Whenua
Landcare Research

The University of Waikato
Te Whare Wānanga o Waikato

University of Otago
Te Whare Wānanga o Otāgo
New Zealand

agresearch

Plant & Food Research
Rangahau Ahumāra Kai

AUT

Massey University
Te Kunenga ki Pūrehuroa
University of New Zealand

Scion
Forests · Products · Innovation

Te Whare Wānanga o te Ūpoko o te Ika a Māui
Victoria University of Wellington

Cawthron
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Ministry for Primary Industries
Manatū Ahu Matua

ESR
Science for Communities

NIWA
Taihoro Nukurangi

UC
University of Canterbury
Te Whare Wānanga o Waitaha
Christchurch New Zealand

Lincoln University
Te Whare Wānaka o Aoraki
Aotearoa · New Zealand
New Zealand's specialist land-based university

Department of Conservation
Te Papa Atawhai

The University of Auckland
New Zealand
Te Whare Wānanga o Tāmaki Makaurau

GNS Science
Te Pū Ao

How to find out more about New Zealand's Biological Heritage National Science Challenge

Our Mission

Reverse the decline of New Zealand's biological heritage, through a national partnership to deliver a step-change in research innovation, globally leading technologies, and community and sector action.

The mission aligns the aspirations of stakeholders, communities, Māori, industry and scientists.

Our Objective

Protect and manage our native biodiversity, reduce risks to New Zealand's biosecurity system, and enhance ecosystem resilience to global threats and pressures.

Website

http://www.biologicalheritage.nz

You can find many of our founding documents, more detail on our Intermediate Outcomes, the BioH Challenge newsfeed, video clips, information on our research programmes and projects, and other resources[1] on our website.

YouTube

Biological Heritage[2]

Twitter

@BioHeritage_NZ[3]

Facebook

@biologicalheritagenz[4]

Instagram

@bioheritage_nz[5]

Newsletter

http://www.biologicalheritage.nz/news/newsletter

'Crazy & Ambitious' Conference

The inaugural conference for the BioH Challenge was held at Te Papa in Wellington in May 2017. Abstracts from the conference and videos of all the presentations are available at:

http://www.biologicalheritage.nz/resources/crazy-ambitious-2017/crazy-ambitious-2017

1 http://www.biologicalheritage.nz/resources

2 https://www.youtube.com/channel/UCQM0meqcBRW013W3LVg4lGg

3 https://twitter.com/BioHeritage_NZ

4 https://www.facebook.com/biologicalheritagenz

5 https://www.instagram.com/bioheritage_nz

Challenge impacts

Our research projects and science teams are focused on at least one of five impacts to deliver benefits for New Zealand. The impacts fall under three programmes:

- assessing our biological heritage
- reducing risks and threats
- sustaining and restoring ecosystems.

The five impacts:

Impact 1
Protect and restore
secure threatened species and resilient ecosystems

Impact 2
Eliminate threats
weeds, pests, mammal predators and pathogens

Impact 3
Detect and eradicate
minimise impacts from biosecurity incursions

Impact 4
Restore healthy freshwater
wai taonga (treasured water) and mahinga kai (food gathering place)

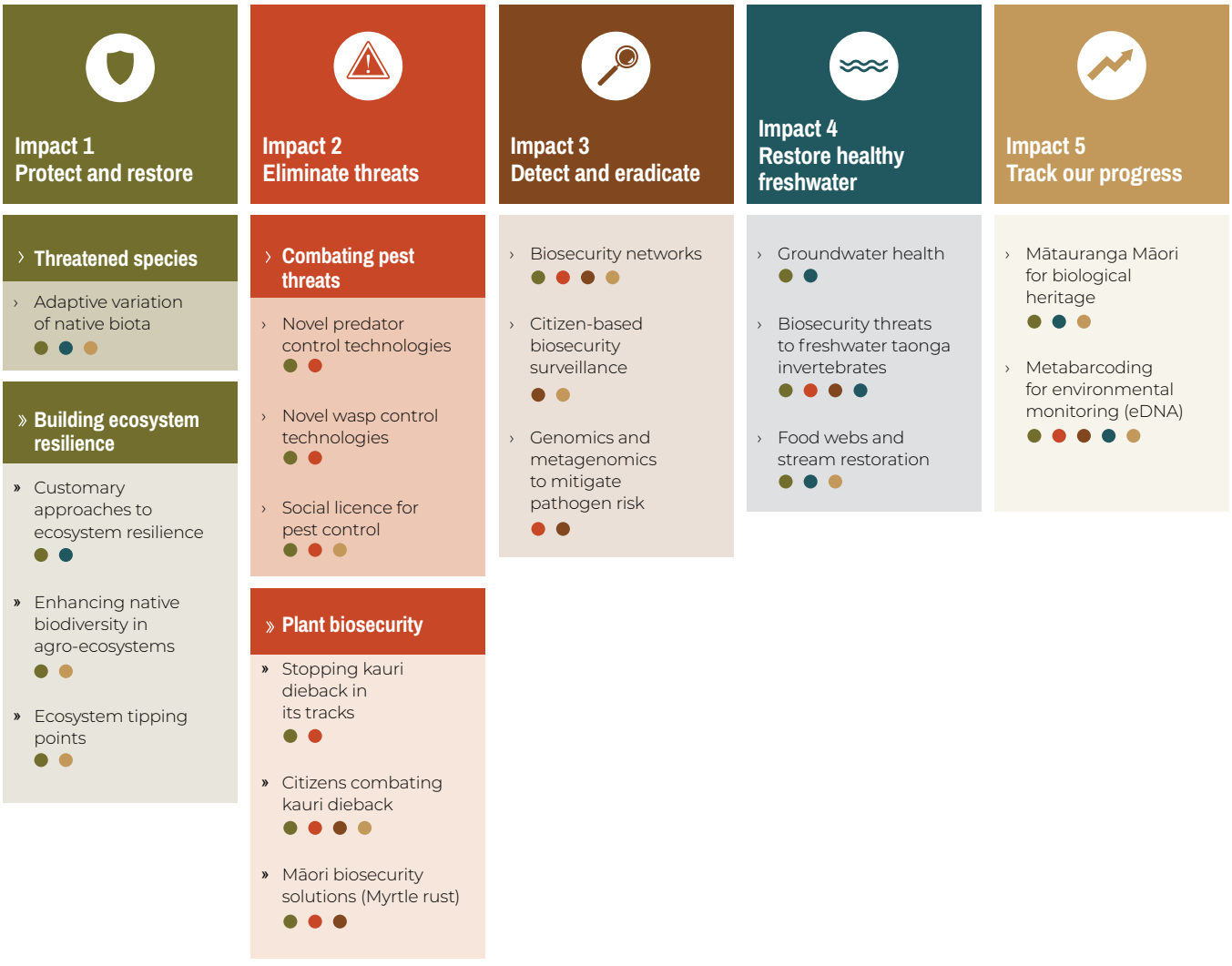
Impact 5
Track our progress
a bioheritage scorecard for New Zealand

Research projects

The BioH Challenge invests in 18 research projects that are listed under each impact below – in addition to other initiatives. Each project is complemented by co-funding from end-users. Co-funding and aligned research help us increase the reach and impact of our investment.

In this document we introduce the research projects under each impact and provide examples of aligned research, followed by a section on Mātauranga Māori (Māori knowledge), engagement, highlights and strategic initiatives.

Many of our research projects target more than one impact. A colour-guide indicates which impacts each project contributes to.

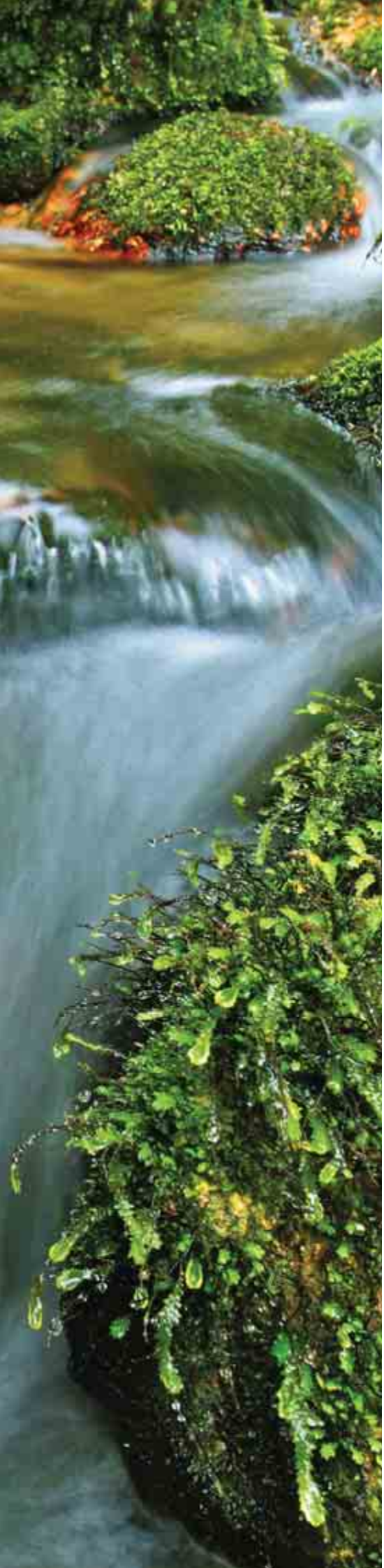


Impact 1: Protect and restore

We're aiming to secure threatened species and resilient ecosystems

Intermediate Outcomes

- The diversity of New Zealand's natural and cultural heritage is restored and maintained.
- Native plants and animals flourish across a network of protected places, including in production landscapes, through enhanced connectivity among remnant native taxa, habitats and ecosystems.
- New Zealand's natural and production ecosystems are resilient to global environmental change.
- Iwi, hapū and whānau are enabled to give effect to kaitiakitanga.



Threatened species

Research project

Adaptive variation of native biota

Associate Professor Tammy Steeves,
University of Canterbury

This project spans both natural and primary production sectors, with a focus on increasing the resilience of both threatened taonga and mahinga kai species to improve conservation, customary and commercial outcomes. The project takes a genomic approach to adaptive resilience, and is developing a framework by which communities in Aotearoa New Zealand can work together to ensure threatened species are more resilient to future environmental change.

Hihi (Notiomystis cincta).
Janice McKenna Department of Conservation Te Papa Atawhai (crown copyright)

Aligned research

Kiwi rescue

John Innes,
Manaaki Whenua

The team in this Ministry of Business, Innovation and Employment (MBIE) programme is studying diverse aspects of kiwi biology and management, which together will lift our knowledge of:

- how many kiwi species there are in Aotearoa
- the total number of kiwi in Aotearoa
- kiwi population trends
- the behaviour and importance of kiwi predators, including stoats, cats, dogs and ferrets
- the trend and status of the Rakiura (Stewart Island) tokoeka (South Island brown kiwi) population
- iwi understanding of, and involvement with, kiwi recovery around the country
- carrot (community change) and stick (forensic DNA) approaches to limiting dogs killing kiwi
- the economics of kiwi recovery programmes and the modelling of kiwi and predator populations.

Kiwi (Apteryx).

The programme is led by Manaaki Whenua. Key partner organisations are the Department of Conservation (DOC), Kiwis for Kiwi, Te Roroa (Waipoua), Makaawhio (West Coast), Canterbury Museum, and Massey University.

Mātauranga Māori

Co-innovation with mana whenua

The approach of the ***Adaptive variation of native biota*** project team is co-development with Te Ngāi Tūāhuriri Rūnanga to use genomics to build resilience in threatened taonga and declining mahinga kai species. Also to ensure that genomic data generated in the project for kōwaro (mudfish) and kēkēwai (crayfish) is responsive to the aspirations of local mana whenua.

Two culturally significant locations have been selected for sampling kōwaro and kēkēwai to generate reference genomes, and a decision has been made to sample kēkēwai using traditional methods (tau kōura). In addition, to maximise transparency, a decision timeline for genome sequencing and resequencing for kōwaro and kēkēwai – including sample handling, sequencing technologies, sequencing facilities, data handling and data storage – has been co-developed with Te Ngāi Tūāhuriri Rūnanga.

Kēkēwai (Paranephrops zealandicus).
Angus McIntosh

Engagement

Unlocking Curious Minds: Ahi pepe | MothNet

Ahi Pepe | MothNet is a citizen science project that aims to engage teachers and connect primary school children and whānau with Mātauranga Māori and science through moths. Ahi Pepe champions learn all about New Zealand native moths and their role in the ecosystem. The goal is to help them view the ecological world as a network of connections. In the process they contribute to the knowledge of moth distributions in New Zealand.

Ahi Pepe is a collaboration between Manaaki Whenua, the University of Otago, Orokonui Ecosanctuary and Te Rūnanga o Ngāi Tahu. The project is supported by the Unlocking Curious Minds contestable fund and co-funded by the BioH Challenge. Challenge funding covers the printing costs of moth guides to enable two copies (one in te reo Māori and one in English) to be sent to every school and public library in New Zealand.

Tatosoma lestevata m.
Birgit E. Rhode

http://www.landcareresearch.co.nz/information-for/citizen-science/shedding-light-on-the-night

https://www.curiousminds.nz/projects/ahi-pepe-mothnet-aotearoa/

@MothNetNZ

@mothNetNZ

Kākā (Nestor meridionalis).
Nicola Toki, DOC

Highlights

Synthesis publication: restoring biological heritage

What will New Zealand's biological heritage look like in 2050? If we are to make meaningful and measurable progress in restoring our biological heritage, a range of fundamental issues need to be addressed. These relate not just to restoration ecology but also to building ecosystem resilience in the wider socio-economic and cultural context within which restoration occurs.

A challenge team, including the current and previous directors (Drs Andrea Byrom and Bruce Clarkson) and two kaihautū (Drs Nick Waipara and Phil Lyver) explored options for reducing threats to New Zealand's biological heritage by 2050 in the journal *Ecological Management and Restoration*

DA Norton, LM Young, AE Byrom, BD Clarkson, PO Lyver, MS McGlone, NW Waipara 2016. How do we restore New Zealand's biological heritage by 2050? *Ecological Management & Restoration* 17: 170–179.

https://doi.org/10.1111/emr.12230

Challenging the status quo

At the Crazy & Ambitious Conference we formed a panel to explore 'Who owns biodiversity genetic data'[1]. Stewardship of such data is important for indigenous people worldwide. A key outcome was to identify a critical need for better co-ownership and co-innovation of research between scientists and indigenous knowledge holders. Associate Professor Tammy Steeves (University of Canterbury), Professor Peter Dearden (Director of Genomics Aotearoa at the University of Otago), Professor Kim Tallbear (University of Alberta) and Dr Aroha Mead (Chair Emeritus IUCN CEESP) were panel members.

1 http://www.biologicalheritage.nz/resources/crazy-ambitious-2017/crazy-ambitious-2017/panel-sessions

Building ecosystem resilience

Research projects

Customary approaches to ecosystem resilience

Dr Phil Lyver,
Manaaki Whenua

This project aims to determine how Māori customary approaches and practices contribute to protecting and restoring ecosystem resilience where humans are an integral part of that ecosystem. Reconnecting Māori communities with their natural environments, rebuilding whānau ora (family health and function), and eventually incorporating customary practices into contemporary environmental legislation are all part of this project.

Manaaki Whenua
Landcare Research

Native vegetation remnants in a NZ agro-ecosystem.
Stacey Bryan

Enhancing native biodiversity in agro-ecosystems

Associate Professor Hannah Buckley,
AUT

What knowledge is required to create and support change in the way native biodiversity is regarded, protected and managed in agricultural landscapes? The project team is addressing this knowledge gap by comprehensively assessing the socio-economic and ecological patterns and processes determining current outcomes for native biodiversity on farmland. They're also predicting future drivers of positive change in New Zealand agro-ecosystems.

AUT

Ecosystem tipping points

Professor Jason Tylianakis,
University of Canterbury

Researchers in this project are developing a framework – that can apply at local, regional and national scales – for detecting ecosystem improvement, reversing ecosystem degradation, and preventing harmful self-reinforcing changes (tipping points or thresholds) in ecosystems. The aim is to reverse degradation across a range of ecosystems and to nudge these systems towards a healthy, self-reinforcing state. A range of case studies span natural and primary production ecosystems in land-based and freshwater domains.

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Inaugural Bruce Clarkson PhD Scholarship

As interim Director of the BioH Challenge, Professor Bruce Clarkson (University of Waikato) shepherded the Challenge through a crucial phase in the formation of Science Challenges. Bruce's vision, passion, and drive for greater collaboration across the science system set the BioH Challenge on a strong path to success. In recognition of Bruce's contribution, the Challenge Governance Group established a PhD Scholarship in his name. Rachel Nepia is the first recipient of the scholarship.

Restoring pollination networks

Ms Rachel Nepia,
University of Waikato

The number of honeybee hives on conservation land has increased markedly over the past 20 years, with a 60% increase in 2017 alone. While honeybees are often thought of as 'the good guys', the list of their negative impacts is extensive: competition with native fauna for pollen, nectar and nesting hollows; inferior pollination of native plants; increased plant hybridisation; physical damage to plants; and exacerbation of exotic weed problems. These potential impacts need to be better understood.

Rachel is investigating how honeybees and native bees visit native plants, how they overlap, and how the availability of resources affects those interactions. Cutting-edge DNA barcoding techniques are being used to analyse interactions among honeybees, native plants and other flower visitors. 3D network modelling then deciphers the properties of these interactions, highlighting where honeybees are important or where native bees are at risk of competitive exclusion. A detailed inventory of flowering and the collection of nectar, pollen and environmental data are part of understanding fluctuations in floral resource production, the impact of those fluctuations on flower visitors, and implications for seasonal apiary management. Rachel's research will clarify a path toward more effective management of apiaries on public conservation lands.

The PhD is co-supervised by Dr David Pattemore (pollination scientist, Plant & Food Research), Catherine Beard (science advisor, ecology, DOC) and Dr Mike Clearwater (University of Waikato), in addition to Prof. Clarkson.

Rachel's blog: https://mypollennation.com/

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

Capturing bee visits to native flowers.
Rachel Nepia

Wiring straw bales in place to create a sustainable inaka habitat.
Dr Lyn Carter, (Kati Huirapa, University of Otago)

Aligned research

People, cities & nature

Professor Bruce Clarkson,
University of Waikato

This MBIE Endeavour programme is undertaking internationally leading research focused on urban nature and the benefits of connecting urban New Zealanders to their biological heritage. The programme seeks to improve the quality of life, health and economic wellbeing in New Zealand's cities and towns through advanced understanding of urban ecology and the creation of flourishing natural environments.

Six teams based at the University of Waikato, Victoria University of Wellington, Otago University and Manaaki Whenua focus on different, but inter-related, subject areas: plantings, lizards, predators, Māori values, green space benefits, and cross-sector alliances.

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

https://www.waikato.ac.nz/news-events/media/2017/restoring-indigenous-nature-in-urban-centres

Community planting at Hamilton's Waiwhakareke Natural Heritage Park.
Catherine Kirby

Kai Tahu kaitiaki, Craig Pauling, harvesting black swan eggs at Te Waihora in August 2017.

Phil Lyver.

Mātauranga Māori

Mātauranga Māori and ecosystem restoration

Research on the restoration of both inanga (whitebait) and black swan egg harvests is being co-developed with Māori knowledge-holders in our two projects on ***Ecosystem tipping points*** and ***Customary approaches to ecosystem resilience***, respectively. The research is being driven by the aspirations of Ngāi Tahu mana whenua to self-authorise the customary management of biodiversity and taonga.

In-kind support from key Ngāi Tahu staff members facilitates the shaping of research priorities by mana whenua and grows relationships with iwi. Co-design of the research provides an important mechanism to restore populations and sustain harvests of mahinga kai, and ultimately facilitates the restoration of interactions between indigenous peoples and their environment, with long-term gains for cultural and biological heritage.

These examples reinforce the view that restoring species or ecosystems often requires a kaupapa Māori approach to ensure appropriate management and assessment of biological heritage, and to sustain intergenerational benefits.

Engagement

Farming and nature conservation can co-exist

Our research project ***Enhancing native biodiversity in agro-ecosystems*** only recently got off the ground (December 2017), but the team made a flying start – creating a newsletter, a Facebook page and Twitter feeds, all organised by early-career researcher and journalism student Stacey Bryan (University of Otago), who has a passion for science communication and a dream to make science more accessible to the public.

The project team works closely with Beef & Lamb NZ as well as the QEII National Trust, NZ Landcare Trust, Ministry for the Environment and regional councils, co-designing ways to include biodiversity conservation in farm management plans. Engagement and co-design for the project is facilitated by knowledge broker Kevin Collins.

Newsletter:
http://www.biologicalheritage.nz/programmes/sustaining-ecosystems/agroecosystems/whats-new/newsletter-december-2017

@FarmNatCons

@FarmNatCons

Cattle in a native vegetation remnant.

David Norton

Highlights

Synthesis publications: A conservation paradox: the role of indigenous peoples in environmental management

Customary approaches and practices of indigenous peoples often reflect a deep knowledge of local biodiversity. The decoupling of indigenous peoples from their environments by conservation policies and the activities of governments and non-government organisations can have negative consequences for indigenous peoples' knowledge processes, and potentially limit future responses to the global biodiversity crisis. This has been described as a 'conservation paradox'.

This paradox was highlighted in two publications: one for a New-Zealand-based journal *(Policy Quarterly)* and one in the prestigious international journal *Science*. The work identifies a need for legislative reforms to expand the way biodiversity is valued in New Zealand. Also to remove barriers to iwi and hapū engaging in biodiversity management in a manner that reflects core tangata whenua rights, interests, values and principles. Conservation law reforms can in future better reflect and support the intent of hapū and iwi to act as kaitiaki (guardians) of New Zealand's biological heritage.

PO'B Lyver, JM Tylianakis 2017. Indigenous peoples: conservation paradox. *Science* 357(6347): 142–143.

https://doi.org/10.1126/science.aao0780

J Ruru, PO'B Lyver, N Scott, J Edmunds 2017. Reversing the decline in NZ's biodiversity: empowering Māori within reformed conservation law. *Policy Quarterly* 13(2): 65-71.

https://igps.victoria.ac.nz/publications/files/e1968bdb873.pdf

Policy brief: Enhancing resilience in production landscapes

The concept of ecosystem 'tipping points' is complex and not easily understood by non-specialists. Scientists have a role in delivering policy-ready information: policy makers can then cultivate New Zealand's capacity to adapt to change by fostering social and ecological resilience.

The ***Ecosystem tipping points*** team distilled complex concepts into a freely available policy brief outlining approaches that can help regional and central government to manage tipping points and drive positive ecosystem change. The team chose to focus on production ecosystems in response to growing interest from industry sector groups, including Māori. The brief includes New Zealand examples and points to knowledge gaps that will be addressed by future research.

J Yletyinen, J Tylianakis, P Brown, R Pech 2017. Planning for tipping points and enhancing resilience in production landscapes. Manaaki Whenua – Landcare Research Policy Brief No. 18 (ISSN: 2357-1713), June 2017.

https://www.landcareresearch.co.nz/__data/assets/pdf_file/0019/142282/Policy-Brief-18-Tipping-Points.pdf

A video presentation of this work, from the Environmental Defence Society conference in 2017, is available at http://www.biologicalheritage.nz/resources/tipping-points

Vineyard in Marlborough.

Strategic initiatives

Climate change impacts on New Zealand's biological heritage

Dr Cate MacInnes-Ng,
University of Auckland

There are few examples of the direct impacts of climate change on biodiversity in New Zealand. Also, the extent to which climate change may exacerbate biosecurity threats to the primary sector is largely unknown.

Yet climate change is likely to intensify existing threats, including invasive species impacts and new invasions, and may further compromise connectivity among small, isolated populations of endemic flora and fauna. Even greater threats to biodiversity may come from an interaction between climate change and pests, as increasing temperatures make a wider range of recipient communities more habitable and as storm events facilitate pest and pathogen movements. These changes will also increase pressure on natural and primary production ecosystems.

The project team established a framework for evaluating climate change impacts on New Zealand's biodiversity, biosecurity, and ecosystem processes. This framework aims to position the BioH Challenge for future research on climate change impacts in our second phase of funding from July 2019.

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Impact 2: Eliminate threats

We're aiming to mitigate the threats posed by weeds, pests, plant pathogens and other drivers of global environmental change.

Intermediate Outcomes

- The resilience of natural and production ecosystems to new and existing pests, weeds and pathogen threats is enhanced.
- System-wide responsiveness to changes in risks from pests, weeds and pathogen threats is improved.
- New technologies and practices for achieving more cost-effective, humane and sustainable control or eradication of existing threats are in use.

Possum (Trichosurus vupecula) scavenges an egg at a kereru (Hemiphaga novaeseelandiae) nest.
Ngā Manu Images

Combating pest threats

Research projects

Novel predator control technologies

Associate Professor James Russell,
University of Auckland

The ability to cost-effectively keep rats, stoats and possums at zero density will be transformational for New Zealand conservation. The ultimate outcome for this project team is to enable scaling up of current efforts to landscape-scale pest freedom. The project aims to accelerate the provision of improved tools, methodologies and strategies for mammal pest control in general, and for local elimination of pests in particular. New technologies will be targeted, next-generation, socially acceptable and cost effective, and will have been proven at pilot scale to effectively eliminate small mammal pests.

Novel wasp control technologies

Professor Phil Lester,
Victoria University of Wellington

Wasps stand out as one of the worst and most stubborn pest problems in New Zealand, with massive impacts on iconic fauna and parts of the production sector such as grape and citrus production. They are also a public health and nuisance pest. New tools for wasp control are one of the top 10 research priority areas for regional government agencies, along with community and industry groups. This project aims to deliver a step-change in the management of wasps, shifting from current small site control towards landscape-scale eradication.

Social licence for pest control

Dr Edy MacDonald,
Department of Conservation

Public acceptance of innovative technologies to control pest species in New Zealand varies widely and new technologies sometimes meet with strong opposition. This project is using pest wasps and rats as complementary case studies. The team is applying social science frameworks to experimentally test the degree – if any – of social acceptance of novel technologies for wide-scale pest control. The research focuses on two groups: the general New Zealand public; and stakeholders and partners including iwi, the commercial bee industry, farmers, and local government.

Watch Edy MacDonald speak about the project: https://youtu.be/Z1vcHbHEdBE

Rat (Rattus rattus) at bird's nest.
Ngā Manu Images

Aligned research

The Vulgar Wasp

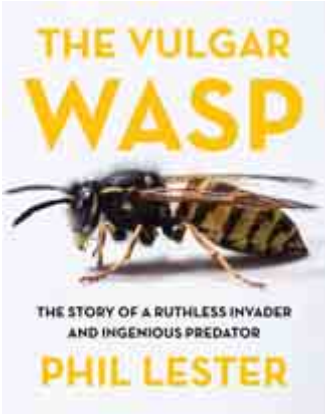
Professor Phil Lester,
Victoria University of Wellington

Wasps are feared and hated by many of us, with good reason – they sting. Wasps also place massive pressure on New Zealand's biodiversity, especially on native birds and insects, including our much-loved honeybees. Phil Lester has spent much of his career studying invasive wasps, ants and other insect pests, and some of his research is aligned to the BioH Challenge. Phil recently drew all his research together in a book[1].

Native to Europe, *Vespula vulgaris*, the common wasp, has been inadvertently transported around the globe. Today in New Zealand the highest known wasp densities are up to 40 nests per hectare. Although we know them as pests, wasps are also amazingly smart, efficient predators. Should we learn to live with them? Should we control their populations, or strive to eradicate every last one from New Zealand?

This book was inspired by the BioH Challenge's work using the common wasp as a case study for new pest management technologies.

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI VICTORIA UNIVERSITY OF WELLINGTON



1 http://vup.victoria.ac.nz/the-vulgar-wasp-the-story-of-a-ruthless-invader-and-ingenious-predator/

Invasive Vespula wasp on an apple.

Mātauranga Māori

The trickster wasp

Dr Ocean Mercier,
Victoria University of Wellington

Aotearoa New Zealand has the opportunity to lead the world in bringing indigenous perspectives to the development of new tools and technologies for pests. Researchers from the ***Novel wasp control technologies*** and ***Social licence for pest control*** teams are working with the Māori Biosecurity Network (Te Tira Whakamātaki) to consider the use of emerging genetic and genomic technologies to control wasps. Also to better understand concerns about, or new ideas from, the communities on whose whenua (land) the technologies will ultimately be deployed.

Team member Dr Ocean Mercier published a paper on the 'trickster wasp' in the *Journal of Indigenous Scholarship*, and the project teams have incorporated mātauranga concepts into a public survey of more than 8,000 respondents that included the views of just over 1,000 Māori on novel pest control technologies. Future results will inform their work exploring Māori beliefs and values towards these technologies.

Mercier, RO. 2017. Bringing the 'trickster wasp' into the discourse on biotechnological controls of 'pest wasps'. *MAI: A New Zealand Journal of Indigenous Scholarship* 6: 74–81.

https://journal.mai.ac.nz/journal/mai-journal-2017-volume-6-issue-1

Engagement

Unlocking Curious minds: LabInaBox (LIAB)

LabInaBox (LIAB)[1] is a mobile science laboratory, built in a 20-foot shipping container. It comes fully equipped with science 'gear' and people – an educator, researchers, and students or professors from around New Zealand. LIAB visits rural schools and communities to support science teaching, spark interest in science, and leave communities with a citizen science project that has continued support from the LIAB team.

LIAB is a collaboration between the University of Otago, Otago Museum, Victoria University of Wellington, the Bio-Protection Research Centre and Te Papa. The project is supported by the Unlocking Curious Minds contestable fund and co-funded by the BioH Challenge. Challenge funding was used to support a focus on conservation genetics, pest control and eradication, and to initiate conversations about the use of new technologies such as CRISPR and gene drive.

CURIOUS MINDS
HE HIHIRI I TE MAHARA

1 https://labinabox.nz

2 http://www.biologicalheritage.nz/news/news-snippets/social-licence

Social licence to operate

In the BioH Challenge we're very aware that public support for science and research influences our work and how it is taken up by our industry and community partners. This is sometimes called 'social licence to operate' (SLO).

In May 2016 we invited a range of key stakeholders, including industry sectors, government agencies, iwi, environmental and community-based organisations, to establish what SLO involves, where it came from, what risks and opportunities it poses for our stakeholders, and how leaders in the field are addressing it.

The workshop[2] was led by the Challenge's Māori Manager, Melanie Mark-Shadbolt, and was held in Wellington in May 2016.

Presentations from two guest speakers, James Baines (Taylor Baines & Associates) and Dr Katharina Ruckstuhl (University of Otago), can be viewed online:

http://www.biologicalheritage.nz/news/videos/katharina-ruckstuhl

http://www.biologicalheritage.nz/news/videos/james-baines

LabInaBox
Maureen O'Callaghan.

Highlights

I smell you: a super-lure for stoats

Dr Patrick Garvey, Manaaki Whenua and **Associate Professor James Russell,** University of Auckland

Most mammals have a highly developed sense of smell. In the pest control industry trappers exploit this reliance on scent to catch pests. However, food lures degrade quickly and must be replenished frequently to remain attractive so BioH Challenge researchers are seeking to discover new 'super lures' to improve the success of pest control. Stoats are the focal predator of the research.

The team conducted pen and field experiments to explore the potential of ferret odour to increase the capture rates of stoats. Stoats are attracted to predator pheromones, particularly to the scent of ferrets. Adding ferret odour to field monitoring sites increased stoat detections three-fold. The next stage is to isolate the chemicals within ferret odour. By creating an artificial copy of the scent, the longevity of the lure can be extended and sufficient quantities produced for predator control sites around the country.

Ferret odour is already used for predator monitoring in the Cape to City programme, one of the largest operations in New Zealand and a flagship site for the BioH Challenge.

PM Garvey, AS Glen, MN Clout, SV Wyse, M Nichols, RP Pech 2017. Exploiting interspecific olfactory communication to monitor predators. Ecological Applications 27: 389–402.

https://doi.org/10.1002/eap.1483

Stoat (Mustela erminea)

The bioethics of pest management

Is killing animals for conservation acceptable? How can we incorporate a Māori world view into pest management? How will society view new technologies for pest control? How might these attitudes change over the next 20 years? These and many other questions are being debated by a bioethics panel that has been convened by James Russell and Emily Parke (University of Auckland) as part of the ***Novel predator control technologies*** project.

The panel brings together 12 leading academics and industry and community experts to horizon-scan social, cultural and ethical issues around the implementation of high-tech solutions to pest control. Membership is diverse (gender and culture) and includes experience in philosophy, law, psychology, marketing, ecology, genetics, hunting and stewardship. The panel's first meeting was reported in *Science* magazine.[1,2]

A science strategy for Predator-Free 2050 Limited

Predator-Free New Zealand is an ambitious programme[3] launched by the Government in July 2016 to rid New Zealand of our most damaging introduced predators – possums, rats and stoats – by 2050. The aim is to protect threatened native species and benefit regional economies through primary industries and tourism[4].

Under the umbrella of the BioH Challenge, scientists from a range of organisations in New Zealand and Australia, led by Dr Dan Tompkins, developed a science strategy[5] for PF2050 Limited's 2025 interim goal: a 'breakthrough science solution capable of removing one small mammal predator'.

1 http://www.sciencemag.org/news/2017/07/new-zealand-aims-eradicate-invasive-predators-winning-public-support-may-be-big

2 http://www.biologicalheritage.nz/news/research-stories/bioethics-panel

3 http://pf2050.co.nz/

4 http://www.biologicalheritage.nz/news/videos/rob-fenwick

5 http://pf2050.co.nz/research-strategy/

Emily King leads a group with Toutouwai/North Island robin being carried into the release site on Mt Taranaki.
Mark Dwyer, Taranaki Mounga

Strategic initiatives

Flagship sites

To enhance community engagement and raise the profile of science with the public, the BioH Challenge supports several flagship sites. Flagship sites showcase to the public the research done by our Challenge parties. Flagship site partnerships provide a pathway to achieve a fundamental shift in the way we conduct science and research activities in New Zealand. In particular, we believe that transformational environmental change can only be achieved through partnerships with Māori, community, industry and the private sector.

Flagship site: Cape to City

Cape to City[1,2,3] is a large-scale ecological restoration project located in Hawke's Bay. The project is on a mission to transform pest management so that native species can thrive where people live, work and play. Since 2011, Cape to City and sister project Poutiri Ao ō Tāne have been providing significant benefits to Hawke's Bay. Local teachers are learning how to use the landscape as an extended classroom, and ground-breaking predator control systems for a primary production landscape are paving the way for farmers and other landowners to efficiently manage pests. Native species historically lost to the area are being returned, and innovative research is providing a foundation for the future.

Contributing partners: local hapū, DOC, Hawke's Bay Regional Council, Manaaki Whenua, Cape Sanctuary, and the Aotearoa Foundation.

CAPE TO CITY
It's in our nature

1 https://capetocity.co.nz/

2 https://capetocity.co.nz/our-work/research/

3 http://www.biologicalheritage.nz/resources/transforming-biodiversity-conference-2017

Monitoring pest abundance and native biodiversity using camera trap technology in the Cape to City project.

Lauren Buchholz, Cape to City

Flagship site: Taranaki Mounga

Taranaki Mounga[1,2] is a landscape-scale ecological restoration project over an area that includes the 34,000 hectares of national park encompassing Taranaki, Pouākai, Kaitake and the protected Ngā Motu/Sugar Loaf Islands. It aims to help restore ecological links between the mounga and the moana ('mountain and sea'), connecting the park to the coast via river corridors down at least three rivers of importance to Taranaki iwi and communities.

Through building community support and commitment, Taranaki Mounga aims to ensure that the transformational changes it achieves are valued and secured long into the future. The project aims to inspire young people to be the next generation of kaitiaki (guardians) of the mounga and national park.

The mounga's objectives align with the Government's vision of a predator-free New Zealand by 2050.

This research is a collaboration between the Department of Conservation, eight Taranaki iwi, and the NEXT Foundation, supported by sponsors Shell NZ, Jasmine Social Investments, TSB Community Trust and Manaaki Whenua.

1 http://taranakimounga.nz/

2 http://taranakimounga.nz/the-project/flagship-site/

Mount Taranaki.

Pōhutakawa (Metrosideros excelsa), one of a number of taonga species threatened by invasive plant pathogens such as myrtle rust.

» Plant biosecurity

Research projects

Stopping kauri dieback in its tracks

Dr Monica Gerth,
Victoria University

Phytophthora agathidicida is the causative agent of kauri dieback disease. This project aims to combine a biochemical approach with Mātauranga Māori in order to identify chemical signals from native plants that naturally attract or repel *P. agathidicida* zoospores. The team also aims to test the effect of these potentially chemotaxis-disrupting chemicals on the spread of zoospores through soil. The project will clarify how the pathogen uses chemotaxis to spread through the environment, locate kauri trees and initiate infection. It will lead to new approaches for mitigating spread and ultimately protecting iconic kauri.

Citizens combating kauri dieback

Dr Ian Horner,
Plant & Food Research

This project is a collaboration between social and biophysical scientists, community leaders, iwi/hapū and landowners. The aim is to broaden the suite of practical control tools available for kauri dieback, and to provide information to landowners to help them treat their own trees. In the process, citizen scientists collect information and feed it back to the research team. The team aims to foster community awareness about kauri dieback and to provide communities with a sense of hope that they can do something positive to combat the disease.

Māori biosecurity solutions (Myrtle rust)

Drs Nick Waipara and Alby Marsh,
Plant & Food Research

Māori have developed practices and methods such as the use of ritenga (customs, laws, and protocols) and whakapapa (species assemblages within a holistic ecosystem paradigm) to mitigate risks and threats to both endemic biodiversity and primary production systems from pests, weeds and pathogens. However, the 21st century has seen a rapid increase in species introductions to New Zealand, with dramatic consequences for both Māori livelihoods and cultural integrity. This project is focusing on one case study highly relevant to Māori cultural integrity. It will demonstrate the biodiversity benefit from a functional hapū/iwi-specific response, which includes mātauranga approaches, to biosecurity risks and threats. As a consequence, hapū, iwi, and Māori organisations and researchers alike will be challenged to draw on both traditional and contemporary sources of knowledge to achieve transformational, Māori-led outcomes for the benefit of Aotearoa New Zealand.

Aligned research

Healthy trees, healthy future (HTHF)

Dr Nari Williams,
Scion

This collaborative programme[1] aims to address the biosecurity threat of *Phytophthora* pathogens to New Zealand's agricultural, horticultural and forestry industries, and its natural ecosystems. The HTHF programme is now in its fourth year. With partners Manaaki Whenua, Plant & Food Research, Massey University, and kaurilands mana whenua groups, the programme has been digging deep into the cellular and chemical responses of the pathogen and host tree. This will ultimately provide tools to help build natural resistance to new *Phytophthora* in all forest and horticultural sectors, and to combat existing diseases such as kauri dieback and red needle cast.

This year the project team screened radiata pine, kauri and apple trees, giving them confidence that natural plant defence reactions to *Phytophthora* pathogens can be used to identify individual plants with a degree of resistance.

HTHF acknowledges the support of MBIE, the Forest Growers Levy Trust, and the Ministry for Primary Industries' (MPI's) kauri dieback programme in funding this research.

1 https://healthytrees.co.nz/

Mātauranga Māori

Māori indicators of plant health

The ***Citizens combating kauri dieback*** team have sought expertise across West Auckland on cultural health indicators, rongoā (traditional remedies), and the impact that using non-traditional solutions or technologies may have on Māori values. Cultural health indicators and mātauranga approaches are a critical part of the project.

To date, one traditional indicator of tree health (the percentage of moss or lichen on a kauri trunk) has been included in the standard monitoring that all participants regularly carry out on their trees. Two more potential traditional indicators are currently being considered that may show the presence or absence of kauri dieback, and the team will introduce at least one of these in 2018.

Mātauranga Māori expands options for combating kauri dieback

Dr Monica Gerth was faced with a major challenge in designing the ***Stopping kauri dieback in its tracks*** project: the list of possible chemical compounds that attract or repel the swimming zoospores (the reproductive stage of the pathogen) is endless.

To narrow down the possibilities and increase the chances of success, Monica worked with Matua Kevin Prime (Challenge Ambassador and member of our Kāhui Māori). They talked with mana whenua to explore the whakapapa of kauri and consider sibling relationships that may inform plant familial 'immunity', in addition to rongoā (traditional medicinal plants). In this way, Mātauranga Māori informed the choice of the plant extracts being studied.

A project goal is to engage with kaumātua and other experts with mātauranga knowledge of kauri forests. The project addresses the aspirations of Māori as kaitiaki or guardians of the forest, because kauri are taonga to northern Māori and a 'keystone' species, critical for the health and biodiversity of the ecosystem.

One of New Zealand's best-known kauri (Agathis australis) trees, Tane Mahuta (Lord of the Forest).

Engagement

Kauri Rescue

The ***Citizens combating kauri dieback*** project team launched Kauri Rescue in 2017. The team engaged community volunteers, attended community events, established a website, logo and bumper stickers, achieved huge mainstream and social media coverage and started a newsletter. They completed a community survey with 350-plus participants and trained a pilot group. Community feedback was incorporated into treatment protocols and they conducted surveys measuring public perceptions of control measures for kauri dieback to collect baseline data. An instructional manual and videos were created, showing how to apply phosphite treatment to infected kauri.

http://www.kaurirescue.org.nz/

@KauriRescue
@kaurirescue
@kaurirescue

Injecting phosphite into Kauri.
Image: Mels Barton

Highlights

Synthesis publication: stopping kauri dieback – how microbes sense the world

Phytophthora acathidicida is the plant pathogen that attacks kauri, causing kauri dieback disease[1, 2]. Zoospores (the reproductive stage of the pathogen) sniff out kauri roots and swim towards them. The ***Stopping kauri dieback in its tracks*** project team developed novel assays that allow chemical screening and identification of compounds that inhibit different stages of *Phytophthora spp.* life cycles. The development of chemotaxis assays of *Phytophthora* zoospores had not been achieved before, so this research is internationally groundbreaking and a significant step in the development of new tools for the management of kauri dieback.

Phytophthora zoospores can swim up to 0.3 metres per hour, and the team captured amazing video footage of the zoospores of the pathogen – too small to see with the naked eye – swimming around kauri roots and being attracted to substances such as carrot broth. Radio New Zealand's *Our Changing World* programme interviewed project leader Dr Monica Gerth in June 2017 and made footage of the swimming spores widely available[3].

SA Lawrence, CB Armstrong, WM Patrick, ML Gerth 2017. High-throughput chemical screening identifies compounds that inhibit different stages of the *Phytophthora agathidicida* and *Phytophthora cinnamomi* life cycles. Frontiers in Microbiology 8: 10.

https://doi.org/10.3389/fmicb.2017.01340

1 *https://www.nzgeo.com/stories/the-last-of-the-giants/*

2 *https://docs.google.com/presentation/d/1oHWYybSevXt0qiSb5WpRFOhGwynNyZ6YMHMLCVmXfA/present?slide=id.g18337276d7_0_18#slide=id.p*

3 *https://www.radionz.co.nz/national/programmes/ourchangingworld/audio/201846463/kauri-dieback-and-how-microbes-sense-the-world*

Kauri infected with Phytopthora agathidicida (kauri dieback disease).
Plant and Food Research

Strategic initiatives

Perfecting the throw-line and tarpaulin method of seed collection.
Ruth Bone

Seed banking: insurance against extinction of taonga plants

A variety of tools will be needed in the biosecurity toolkits of tomorrow: systems, practices, protocols and new technologies will be required to combat emerging and as-yet-unanticipated biosecurity threats. Seed banking (the collection and storage of plant seeds) offers one possible tool because of its potential to future-proof a species from extinction or to protect plant varieties or strains in perpetuity.

Māori traditionally undertook planting and harvest practices according to the maramataka (lunar calendar). Tikanga (protocols) were in place for the collection and storage of seed, including for taonga species such as pōhutukawa, mānuka and rātā. However, this traditional knowledge has not previously been blended with contemporary international expertise in seed banking.

The ***Māori biosecurity solutions (myrtle rust)*** team, in conjunction with Te Tira Whakamātaki (the Māori Biosecurity Network: see Impact 3), worked with the Royal Botanic Garden and Millennium Seed Bank Partnership at Kew in the UK. They leveraged international expertise in seed banking in response to iwi and hapū concerns about the potential impacts of the plant pathogen myrtle rust on native flora.

Courses on seed-banking and conservation techniques with visiting experts from the Millennium Seed Bank Partnership and Australian Seed Bank Partnership were held at the Auckland Botanical Gardens, and the Otari Native Botanic Garden and Wilton Bush Reserve in Wellington in late 2017. Four ‘drum seed kits’ were built and gifted to rōpū including Ngāti Tamaoho, Ngamanawa Inc. (Ngāti Hangarau) and Te Poho o Huturangi Taioa Hub (Ngāti Porou). The seed kits are easy to build and straightforward to use, enabling communities to collect and store seed according to local collection tikanga.

Impact 3: Detect and eradicate

We're aiming to mitigate impacts from biosecurity incursions, and create a robust biosecurity system for New Zealand.

Intermediate Outcomes

- Primary sector market access and future investment opportunities are enhanced and maintained.
- New biosecurity risks and their likely impacts to natural and production ecosystems are better understood and appropriate interventions are in place.
- Public confidence, support and active engagement in New Zealand's biosecurity system is enhanced.
- The contribution of contemporary science, Mātauranga Māori and local knowledge to biosecurity policy, standards, regulations, investments and operational decision-making is improved across the biosecurity system.

Clutha Gold apricots. Protecting New Zealand's primary industries from invading pests is a major focus of the BioH Challenge.
Plant & Food Research

Research projects

Biosecurity networks

Professor Phil Hulme,
Lincoln University

A major biosecurity challenge is to effectively contain and manage threats following their establishment in New Zealand. Human's play a critical role in the spread of many biosecurity threats. There are considerable economic, environmental and social benefits to containing outbreaks and actively slowing the spread of organisms before they cause widespread damage and intensive management is required. This project brings together different perspectives in network modelling across multiple sectors (freight movement, nursery trade, livestock movement, recreational travel) in order to identify mitigation checkpoints to contain or slow pest spread.

Lincoln University
Te Whare Wānaka o Aoraki
AOTEAROA • NEW ZEALAND
New Zealand's specialist land-based university

Citizen-based biosecurity surveillance

Dr Steve Pawson,
Scion

Current tools for public participation in surveillance (termed 'general surveillance') have not kept pace with new technologies that have the potential to improve surveillance effectiveness, strengthen the biosecurity system, and ultimately protect our natural and production ecosystems. This project is co-developing a new General Surveillance Network (GSN) in collaboration with central and regional government, Māori, primary sectors and the public. The GSN utilises mobile technologies to facilitate communication and the submitting of observations of weeds, pests and pathogens.

SCION
FORESTS • PRODUCTS • INNOVATION

Genomics and metagenomics to mitigate pathogen risk

Dr Bevan Weir,
Manaaki Whenua

Soil-borne plant pathogens such as *Phytophthora* spp. can have destructive effects on native and exotic plant species. This has been demonstrated widely overseas and more recently in New Zealand by the emergence and spread of the devastating dieback disease of kauri, and the red needle cast of *Pinus radiata*. To future-proof our native and production ecosystems from invasion of new pathogens, rapid assessments of the potential impact of identified and unidentified pathogens are critical. This project uses globally leading genomic technologies to deliver a step-change in risk assessment and the characterisation of novel pathogens, with a focus on detection and assessment of pathogenicity elements (e.g. pathogen effector genes).

Manaaki Whenua
Landcare Research

***Phytophthora agathidicida* oospores.**
Margaret Dick, Scion

Aligned research

Better Border Biosecurity (B3)

B3 is a multi-partner, cooperative science collaboration that researches ways to reduce the entry and establishment of new plant pests and diseases in New Zealand. B3 is fully aligned to the BioH Challenge. The two entities have a shared vision to deliver biosecurity outcomes for New Zealand. The Challenge provides high-level leadership across the broader biosecurity spectrum, linking biosecurity and biodiversity impacts, while B3 provides a single point of access for niche science solutions focused on plant protection and border biosecurity.

B3's Crown Research Institute partners aligned their Strategic Science Investment Fund (SSIF) investment in B3 with the BioH Challenge from its inception in December 2014. Since then B3 has been working closely with the BioH Challenge to cultivate synergies, including:

- integration of the Challenge's Intermediate Outcomes into a refreshed B3 Strategy
- direct alignment of research activity and cross-learning, such as an integrated platform for biosecurity through eDNA sequencing (Plant & Food Research), Māori responses to biosecurity incursions (Plant & Food Research), and the susceptibility of taonga plants to myrtle rust (Scion)
- a joint approach to support important biosecurity initiatives such as the Port of Tauranga Biosecurity Operational Excellence site, and a Scion-led, MBIE-funded 'Biosecurity Toolkit for the Urban Environment' research programme (see opposite page)
- regular interaction between B3, the BioH Challenge and the Bio-Protection Research Centre
- combined meetings with end-users, such as MPI, to align national biosecurity impacts
- joint development of conference symposia.

B3 Science Solutions for BETTER BORDER BIOSECURITY www.b3nz.org

https://www.b3nz.org/

Joint B3/BioH symposium at the Crazy & Ambitious conference:

http://www.biologicalheritage.nz/resources/crazy-ambitious-2017/crazy-ambitious-2017/biosecurity-2025

Biosecurity 2025 and Beyond: video of the panel discussion at the Crazy & Ambitious conference:

https://www.youtube.com/watch?v=KydKqMRNhu4&list=PL-sWnl-Q5z9OA2go8FBOdvbndlkFzP6dg

Dr David Teulon, Director of B3

Protecting New Zealand's primary sector from plant pests: a toolkit for the urban environment

Dr Tara Strand,
Scion

This MBIE-funded programme is aligned with the BioH Challenge and is also part of the B3 (Better Border Biosecurity) collaboration (see opposite page). It is designed to deliver a step-change in the effectiveness of insect eradication programmes in urban environments in order to protect New Zealand's primary industries. Highlights of the programme include:

- progress towards a new approach to active surveillance, with technologies that aim to dramatically shorten the time taken to locate and delimit new pest populations
- development of a new helicopter spot-spraying method applicable to urban or suburban environments
- evaluation of an unmanned aerial vehicle (UAV) platform for targeted spraying
- modelling to identify improved eradication strategies, including non-pesticide methods, to help evaluate the best treatment options for incursion responses
- a rubric, co-developed with MPI, which supports integration of social and technical factors into surveillance
- relationship building to understand social licence for biosecurity (see workshop highlight on page 23) – team members also work with the Māori Biosecurity Network (Te Tira Whakamātaki) to explore cultural acceptability and concerns with emerging biosecurity technologies.

This highly collaborative programme has been given a Gold rating by MBIE.

CONT. »

Organisations involved:

- NZ: Scion, Manaaki Whenua, University of Auckland, University of Canterbury, Lincoln University, AgResearch, PPCNZ Ltd, Will Allen and Associates, Ecoresearch Associates (Shaun Ogilvie), B3
- France: CNRS, INRA
- UK: Forest Research UK
- USA: US Forest Service, Agricultural Research Service, Continuum Dynamics Inc.
- Canada: Simon Fraser University, Canadian Forest Service.

Scion working with programme partner Aeronavics to measure and characterise a UAV wake for targeted spraying application.

Brian Richardson, Scion

Myrtle Rust.
Plant & Food Research, Dr Grant Smith

Mātauranga Māori

Te Tira Whakamātaki (The Māori Biosecurity Network)

Te Tira Whakamātaki (TTW) means 'the watchful (vigilant) ones'. The network was established in 2015 and comprises Māori scientists (plant pathologists, soil chemists, biosecurity officers, sociologists), policy makers, politicians, kaitiaki, iwi leaders and whānau. They are dedicated to ensuring Māori have a voice and are able to participate in New Zealand's biosecurity system, plus provide technical biosecurity support and advocacy to whānau, hapū and iwi.

TTW was initially funded by a Vision Mātauranga grant from MBIE, with co-funding from the BioH Challenge and support from the Bio-Protection Research Centre. The network is increasingly engaged with international collaborators. For example, TTW contributed to an international synthesis paper investigating the role of the social sciences and economics in understanding and informing tree biosecurity policy and planning[1]. In New Zealand, TTW has worked with MPI on the Biosecurity 2025 discussion document and the Primary Sector Science Roadmap.

In two years the team has won two awards: in 2016 they were awarded the inaugural Dave Galloway Innovation Award by the New Zealand Biosecurity Institute, and in 2017 they were presented with the Māori Award at the inaugural New Zealand Biosecurity Awards run by MPI. These awards recognised the efforts of TTW to raise awareness of biosecurity threats and develop strategies to build a healthy future for New Zealand's biological heritage.

Bio-Protection
Bioprotection science for New Zealand

TE TIRA WHAKAMĀTAKI
Māori Biosecurity Network

@TiraWhakamātaki
@TiraWhakamataki

http://www.biologicalheritage.nz/programmes/maori-biosecurity-network

Media: http://www.radionz.co.nz/news/te-manu-korihi/336543/maori-knowledge-honoured-in-biosecurity-award-win

1 M Marzano, W Allen, RG Haight, TP Holmes, E Carina, H Keskitalo, ER Lisa Langer, M Shadbolt, J Urquhart, N Dandy 2017. The role of the social sciences and economics in understanding and informing tree biosecurity policy and planning: a global summary and synthesis. Biological Invasions 19: 3317–3332. https://doi.org/10.1007/s10530-017-1503-4

Seed banking techniques course.
Roberta Hope

Engagement

Recreational user pathways in lakes and rivers: mapping the biosecurity risks

Mrs Isabelle Vollenhoven-De Lange and **Professor Phil Hulme,**
Lincoln University

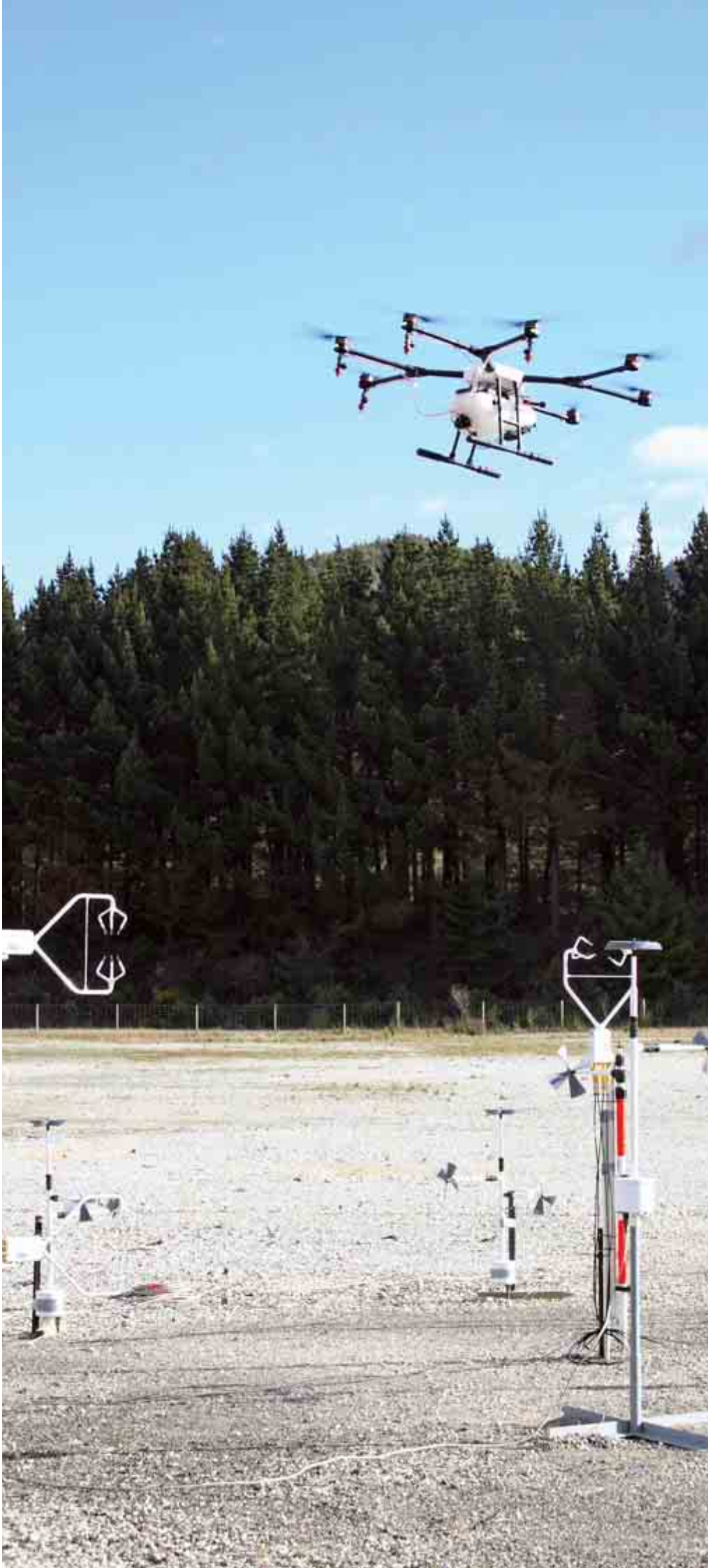
Humans can transport invasive pests long distances as they move around the country. For example, pests such as didymo, or 'rock snot', are transported by recreational users of lakes and rivers on items such as boats, waders and jet-skis.

To raise public awareness of the potential spread of freshwater pests, the ***Biosecurity networks*** team developed an app for users to map their activity. The app is designed to capture data on lake-user movements, thus raising awareness of biosecurity issues and the spread of pests.

The app, as well as a paper version of the questionnaire, was rolled out in both the North and South Islands, with a presentation from Isabelle Vollenhoven-De Lange, the PhD student associated with the project, laying the groundwork for data collection over the busy 2016/17 summer season.

Capturing movement data of lake users and associating this with their attitudes and actions relating to biosecurity will provide an in-depth picture of the risks different users pose to the spread of freshwater pests.

Supporting organisations include: Bay of Plenty Regional Council, Taranaki Regional Council, DOC Taranaki, Hawke's Bay Regional Council, Gisborne District Council, Greater Wellington Regional Council, DOC Taupō, Waikato Regional Council, Northland Regional Council, Horizons Regional Council, ECAN, Fish & Game Nelson/Marlborough, West Coast Regional Council, Otago Regional Council, and Fish & Game Southland.



Unlocking Curious Minds: creepy crawlies meet primary production

Dr Steve Pawson,
Scion and the House of Science

The Bay of Plenty needs good pest management and biosecurity science for its horticulture, farming and forestry industries to thrive. These industries are also the main employers in the region. In a new Unlocking Curious Minds project, Scion and the House of Science have partnered to raise awareness of biosecurity and its underpinning science across the Bay of Plenty region. Together they aim to work with 20 schools throughout the region to promote biosecurity science and its importance to natural and primary production sectors (kiwifruit, avocado, forestry, farming).

Using practical learning resources that include field-based trapping, real-time mobile reporting tools, globally novel cyborg technologies and drone spray packs, the team aims to show students that biosecurity science is exciting and relevant to the protection and prosperity of their local environment and communities. They plan to use the mobile tools developed from the ***Citizen-based biosecurity surveillance*** project as part of the education programme.

CURIOUS MINDS
HE HIHIRI I TE MAHARA

Using sonic anemometers to measure the strength of the wake generated by a UAV configured for aerial spraying.

Rod Brownlie, Scion; UAV owned and flown by HeliResources Ltd

Highlights

Myrtle Rust Reporter: enhancing biosecurity surveillance capability

In response to the new threat posed by the invasive plant pathogen myrtle rust arriving in New Zealand, the ***Citizen-based biosecurity surveillance*** project team released their 'Myrtle Rust Reporter' app in the Apple and Google Play stores in late 2017. The app was co-developed with the Northland Regional Council, Scion, Envirolink, Te Tira Whakamātaki and MPI. It represents a major effort on the part of the BioH Challenge to help MPI with their 4.7 million biosecurity citizens' initiative under Biosecurity 2025, and provides a fun and useful way for citizens to get engaged in important science observations. The app is bilingual (te reo Māori and English).

Myrtle rust is a major threat to many of New Zealand's native species, including pōhutukawa, ramarama, northern and southern rātā, and mānuka, as well as to important plants in the horticulture sector, such as feijoa. The app is integrated with New Zealand's foremost citizen science observation platform NatureWatchNZ.

http://naturewatch.org.nz/projects/myrtle-rust-reporter

Synthesis publication: preventing plant invasions via ornamental horticulture networks

Working with international colleagues, the ***Biosecurity networks*** project team examined how horticultural policy structures could be improved to prevent plant invasions. Ornamental horticulture is a primary pathway for invasive alien plant introductions worldwide.

The team critically appraised published evidence on the effectiveness of four policy instruments that tackle invasions along the horticulture supply chain: pre-border import restrictions, post-border bans, industry codes of conduct, and consumer education. Effective pre-border interventions rely on rigorous risk assessment and high industry compliance, whereas post-border sales bans become progressively less effective as invasive plants become widespread in a region.

Closing the plant invasion pathway associated with ornamental horticulture requires government–industry agreements to fund effective pre- and post-border weed risk assessments that can subsequently be supported by widely adopted and verifiable industry codes of conduct. This will ensure producers and consumers make informed choices, and will help the public to address plant invasions.

Hulme, P. E., G. Brundu, M. Carboni, K. Dehnen-Schmutz, S. Dullinger, R. Early, F. Essl, P. González-Moreno, Q. J. Groom, C. Kueffer, I. Kühn, N. Maurel, A. Novoa, J. Pergl, P. Pyšek, H. Seebens, R. Tanner, J. M. Touza, M. van Kleunen, and L. N. H. Verbrugge. 2017. Integrating invasive species policies across ornamental horticulture supply chains to prevent plant invasions, *Journal of Applied Ecology*, 55: 92-98.

https://doi.org/10.1111/1365-2664.12953

Agapanthus: a gardener's favourite but also a weed.

Strategic initiatives

Network analysis to strengthen New Zealand's biosecurity system: the Māori Vegetable Growers' Collective

The aim of the ***Biosecurity networks*** project team is to compare at least four different networks of human-assisted spread of unwanted organisms in order to learn from these comparisons and shut down future pathways. Each network provides different information about the spread of unwanted organisms and integrating across networks is novel compared to previous approaches.

An exciting development for the team in 2017 was to form a collaborative partnership with Tāhuri Whenua, the Māori Vegetable Growers Collective, with the eventual aim of adding a fifth network to the project. The team will draw on the cultural expertise and existing networks aligned to the Tāhuri Whenua collective to present a clear picture of the Māori relationship to plants and plant distribution.

Under the guidance of Dr Nick Roskruge (Massey University), a series of interviews and case studies is being undertaken in order to understand the geographical reach of Māori horticultural networks. This is achieved primarily through hui with Māori horticulturists. The collective appointed Rodrigo Estrada, a recent graduate in Pacific horticulture, to work with a committee and kaumātua rōpū to facilitate information gathering. The team compiled relevant mātauranga associated with some of the most important Māori crops, focusing on taewa (Māori potatoes) and kūmara.

Regional workshops and discussions identified several challenges faced by Māori in the commercial production and distribution of their crops. The geographical localisation of key Māori growers enables the project to better understand horticultural flows, regionally and nationally. Mātauranga associated with the crops and the challenges identified will be important factors that define future approaches to the management of biosecurity threats of relevance to Māori horticulture.

www.tahuriwhenua.org.nz

Tāhuri Whenua
National Māori Vegetable Growers Collective

Impact 4: Restore healthy freshwater

We're aiming to restore wai taonga and mahinga kai.

Intermediate Outcomes

- Streams, rivers, wetlands and estuaries including wai tapu and wai taonga are maintained in a healthy functioning state.
- Measures of ecosystem resilience are monitored, trajectories understood and tipping points anticipated and mitigated.
- A full range of threatened and taonga species are restored to a functioning, non-threatened level which can support various uses.
- The wellbeing of current and future generations is enhanced through the use of contemporary science, mātauranga Māori, and local knowledge to inform management decisions.

Hinapouri Tarn.
Dr Andrea Byrom

Research projects

Groundwater health

Dr Graham Fenwick, NIWA and
Dr Louise Weaver, ESR

This project characterises the biodiversity of a little-known fauna: groundwater invertebrates. The project team is also investigating land-use effects on these invertebrates by sampling across three regions, seven catchments, and differing land-use intensities. The resulting identifications and genetic information from the organisms are being used to evaluate measures of biodiversity as indicators of ecosystem health. They will also deliver a foundation database for next-generation sequencing approaches to measuring and monitoring this neglected biodiversity and ecosystem.

Both NIWA and ESR contribute additional resources to this project via SSIF, with ESR's experience in microbial organisms in groundwater adding an extra dimension by using eDNA (environmental metabarcoding) to confirm the findings from morphological approaches.

Biosecurity threats to freshwater taonga invertebrates

Dr Ian Duggan,
University of Waikato

This project is focused on safeguarding freshwater taonga species (kākahi [freshwater mussels] and kōura [crayfish]) from pest fish and invasive macrophytes through a combination of traditional science scholarship and Mātauranga Māori. The project team aims to integrate contemporary science with hapū and iwi responses and empower Māori communities to implement Māori values, a Māori world view, and technical knowledge.

Food webs and stream restoration

Dr Catherine Febria and
Dr Helen Warburton,
University of Canterbury

'Resistance' and 'resilience' are terms used to describe the capacity of an ecosystem to withstand and recover from a disruption. Community resistance and resilience are often desired impacts for ecosystem health and are commonly associated with healthy communities being able to withstand disturbances.

However, degraded ecosystems can also be resistant and resilient to disruptions, making them 'restoration-resistant'. In New Zealand, many ecosystems are degraded, having exceeded critical tipping points that leave them locked in a resistant state.

This project team is using freshwater ecosystems as a model to develop and test a resistance–resilience–restoration framework that will be applied to stream restoration.

Decanting a stygofauna catch
Brian Smith, NIWA

Aligned research

Can geo-engineering rehabilitate shallow lakes?

Dr Ben Woodward and
Dr Deborah Hofstra,
NIWA

Many shallow lakes are highly eutrophic and have 'flipped' from a clear-water state with submerged plants to being turbid and dominated by phytoplankton. This degraded state is perpetuated by phosphorus recycling from lake sediments. This project uses lab and field experiments to validate selected geo-engineering products as tools for rehabilitating Waikato shallow lakes. The team discovered that allophane is an effective flocculant.

The project is funded by NIWA SSIF, Waikato River Authority, Dairy NZ and Waikato Regional Council, with in-kind support from the University of Waikato and support from local landowners.

NIWA Taihoro Nukurangi

https://www.niwa.co.nz/freshwater-and-estuaries/freshwater-and-estuaries-update/freshwater-update-74-august-2017/shallow-lake-rehabilitation

Development of a groundwater health Index

Dr Brent Gilpin and
Dr Louise Weaver,
ESR

Increasing demand for freshwater and land-use intensification has led to an increased risk of contamination entering groundwater supplies. Contaminants have an unknown effect on the groundwater communities present in the aquifer, yet these communities are the underground food web that protects our drinking-water supply.

There is little known about the complex processes that take place below ground to remove contaminants, and no knowledge of cumulative and chronic effects of contaminant addition into groundwater.

This SSIF-funded research is aligned with the ***Groundwater health*** project. The team identifies organisms across the domains of bacteria, archaea, fungi, protozoa and macroinvertebrates present in groundwater, focusing on the shallow alluvial aquifers in Canterbury and Southland. The aim is to produce a simple-to-use, tiered assessment of the groundwater quality related to the presence or absence of the keystone species.

ESR Science for Communities

In situ sample deployed in wells.
Louise Weaver, ESR

Water quality monitoring on lake Milicich.
Aleki Taumoepeau

Mātauranga Māori

Working in partnership to restore Kākahi (freshwater mussels)

The ***Biosecurity threats to freshwater taonga invertebrates*** team is working with the Te Arawa Lakes Trust (TALT) in the Waikato to co-design their project. The iwi consider kākahi to be an extremely important resource, and they feature highly in TALT's fisheries management plans and taonga species action plans. However, given the scarcity of kākahi, like the kākāpō, this has become more conceptual than real in recent times. There is huge concern about the decline of kākahi and the impact this decline has had on the engagement of their people with this freshwater taonga.

Co-design of the project between the hapū around the lakes and the project team investigating the ecology of kākahi will help restore these cultural connections. Collection of kākahi is done together with Te Arawa students (and sometimes their whānau) from schools around Lake Rotorua. The project team also make presentations at each of the schools, discussing kākahi and the research being undertaken.

Kākahi (freshwater mussel).
Stephen Moore

Engagement

Regional councils co-design research on freshwater ecosystem health

Management of freshwater is important for regional councils because the health of organisms in groundwater is a topic of intense public interest. ***Groundwater health*** team members work with a number of regional councils including Environment Canterbury, Hawke's Bay Regional Council, and Environment Southland. With regional council staff, the team identifies candidate bores and suitable land-use types for sampling aquifers.

Year 10 Māori students collect data at a restored wetland on a dairy farm as part of the He Puna Pūtaiao programme.
Catherine Febria

www.carex.org.nz

@UC.CAREX

http://www.canterbury.ac.nz/science/outreach/he-puna-putaiao/

Kia ora te wai – enhancing connections through freshwater restoration and outreach with tamariki (children) and rangatahi (youth) in the Waihora catchment

For more than four years, researchers and farmer partners from the ***Food webs and stream restoration*** team have opened their gates to the wider community – including industry, councils, central government, schools and iwi – to communicate the science and lessons learned from freshwater restoration trials. One of the most meaningful connections has been with the younger generation of leaders – tamariki and rangatahi – and efforts to connect them with real-world examples of collaborations in restoration taking place across their rohe (region). The team engages with them at multiple ages and pathways, from primary school to postgraduate.

As part of the Canterbury Waterway Rehabilitation Experiment (CAREX), the team, along with their student, recently carried out a tamariki day with Te Taumutu Rūnanga. Whānau sampled and explored a 15-year-old wetland restoration site in the Waihora catchment to learn first-hand about wetland and freshwater biodiversity. Annually, for the past five years, they have also engaged and participated in science mentorship as part of the University of Canterbury's He Puna Pūtaiao programme. This connects Year 10 Māori students from schools across Christchurch to engage in and conduct their own science projects about the health of Te Waihora Lake Ellesmere.

Cultural context and values are also delivered as part of a freshwater field skills course in the Waterways Centre for Freshwater Management. The team partners with the regional council's cultural land management advisor to connect concepts of freshwater restoration and mahinga kai restoration in the Waihora catchment to council biomonitoring and restoration assessments.

Highlights

Freshwater traits: an integrating concept

Attributes of biological communities are commonly known as *traits*. In November 2017 the ***Food webs and stream restoration*** team kicked off a national workshop on freshwater traits for New Zealand. They gathered a wide range of knowledge holders and data users for freshwater species, ecosystems and management contexts across the country. Attendees had expertise in fish, invertebrates, algae and macrophytes, and discussed how traits are currently being used, the broad range of existing and potential applications, and commonalities that would help form the basis of a national database for freshwater fauna (primary producers, macroinvertebrates and fish). The one-day workshop was facilitated by BioH Challenge knowledge broker Kevin Collins.

The workshop achieved consensus on basic traits common across all trophic levels. This laid a foundation for a shared database, useful to a wide range of stakeholders and applications. The workshop emphasised working together to enhance existing knowledge bases, and the potential for biological attribute data to inform research and management needs and questions.

The freshwater traits workshop and database that will emerge are a strong integrator across the BioH Challenge, facilitating greater collaboration across a range of organisations and freshwater domains.

Freshwater traits workshop.
Kevin Collins

Lake Minchin in the heart of Arthur's Pass National Park is a relatively pristine lake but is nevertheless susceptable to climate change. Here, a long summer drought Jan–March 2013 exposed many of the macrophyte beds in the lake.
Angus McIntosh

Impact 5: Track our progress

We're aiming to contribute to a bioheritage scorecard for Aotearoa New Zealand through national monitoring and reporting frameworks.

Intermediate Outcomes

- Comprehensive biological heritage data and information, including taxonomy and distribution, are available at relevant scales and in real time to enable effects to be considered in management decisions across all environmental domains.
- Baseline information on pressures, state and trends in New Zealand's biological heritage is known, and data and information are accessible to all New Zealanders.
- New Zealanders value, and are inspired and enabled to actively enhance and sustainably manage, our shared natural and cultural heritage.
- The contribution of science to informed biodiversity policy, standards, regulations, investments and operational decision-making is improved.
- Multiple ecological, social, cultural and economic values associated with biodiversity and ecosystem services are well understood by society.

Research projects

Mātauranga Māori for biological heritage

Dr James Ataria and
Ms Melanie Mark-Shadbolt,
Bio-Protection Research Centre,
Lincoln University

This project aims to co-develop a methodology between Mātauranga Māori holders and potential users that allows the application of this knowledge to restore and futureproof the transfer of Mātauranga Māori and reverse the decline of New Zealand's biological heritage. Stewardship and restoration of the biological heritage of Aotearoa New Zealand is inseparable from this body of knowledge.

Lincoln University
Te Whare Wānaka o Aoraki
AOTEAROA · NEW ZEALAND
New Zealand's specialist land-based university

Metabarcoding for environmental monitoring (eDNA)

Dr Gavin Lear,
University of Auckland

New Zealand needs state-of-the-art molecular tools to detect incursions, and to assess the state of biodiversity and ecosystem function in order to implement effective mitigation strategies and assess conservation performance. The integration of nationally consistent eDNA (environmental DNA or environmental metabarcoding) methodologies with existing monitoring programmes aims to deliver a step-change in biodiversity assessment.

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Aligned research

Tier 1 monitoring programme:

Department of Conservation (DOC)

DOC's National (Tier 1) monitoring programme consists of a network of approximately 1,400 permanent sites on an 8 x 8 km grid across public conservation land. The programme is designed to provide national-scale estimates of status and trend in biodiversity condition. DOC has been working with and supporting the BioH Challenge by:

- providing a fundamental source of biodiversity data for researchers
- along with regional councils, working with researchers at Manaaki Whenua and the University of Auckland to test and refine field methodologies for plot-based biodiversity assessments using eDNA
- sharing skills and knowledge to support the development of a national eDNA informatics platform.

Department of Conservation
Te Papa Atawhai

Pest-proof fence protecting native biota within Maungatautari Ecological Island Reserve, Waikato, from the threat of invasive mammalian predators.
Rachelle Binny

How do pest control regimes impact native biodiversity?

Dr Rachelle Binny,
Manaaki Whenua

Despite decades of small mammal pest control aimed at conserving New Zealand's unique native biota, there is still uncertainty around its impacts for biodiversity at a national scale. Dr Rachelle Binny is comparing the responses of native plants, animals and ecological communities to the major pest control regimes.

Different regimes include fenced sanctuaries, unfenced mainland islands, pest-free offshore islands, and large-scale possum control. Ecological communities in each regime may have different responses depending on which pests are removed and which pests remain in the ecosystem. For example, a fenced sanctuary where all species of mammal pests are removed may have a different response compared to an ecological community where just possums are the primary control target.

Rachelle is analysing long-term monitoring data aggregated from DOC mainland islands and fenced and unfenced sanctuaries to gain insights into the dynamics of pests and native species, and into key processes driving biodiversity recovery. This work is funded by Manaaki Whenua, and is aligned with the BioH Challenge and Te Pūnaha Matatini Centre of Research Excellence.

Manaaki Whenua
Landcare Research

Te Pūnaha Matatini

Mātauranga Māori

Mātauranga Māori for biological heritage: Whakamanahia ngā mātauranga o nehe hai oranga tangata, oranga taiao

Indigenous ecological knowledge (IEK) has evolved over thousands of years of community associations with their respective local environments. Ecology and culture are inseparable – one is defined by the other. Collectively this corpus of knowledge is intimately and spiritually entwined with indigenous communities through frameworks of familial relationships. Such knowledge has an important role to play in creating contemporary solutions that address many global threats such as climate change and invasive species.

However, the role of IEK in the conservation of biodiversity has yet to be fully explored and utilised. Fragmentation of Māori culture resulting from colonial processes has impacted the intergenerational transmission and succession of Mātauranga Māori. This is important because stewardship and restoration of the biological heritage of Aotearoa are inseparable from this body of knowledge. This is a problem faced by indigenous peoples all over the world.

Holders of Mātauranga Māori and kaitiaki (guardians) are aware of and concerned about the vulnerability of their knowledge. Accordingly, kaitiaki are committed to ensuring it is adequately protected and transmitted to future generations to avoid the risk of demographic concentration of knowledge among the elderly. This process requires restorative development and implementation of an approach that acknowledges Mātauranga Māori, its origins and potential in local, regional and national contexts.

Monitoring tree growth.

Department of Conservation (Te Papa Atawhai), National Biodiversity Monitoring and Reporting programme

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Restoration of Mātauranga Māori processes will require the creation of an environment where Māori cultural processes predominate and the wellbeing of the knowledge holders and the knowledge can be assured: Nā te Māori, mai te Māori mā te Māori – From Māori, by Māori, for Māori.

The ***Mātauranga Māori for biological heritage*** project team is co-developing a methodology for Mātauranga Māori holders and potential contemporary and future users that facilitates the application of knowledge to restore and futureproof Mātauranga Māori processes and frameworks. The team has formed a rōpū of respected and knowledgeable kaumātua, who will examine issues relating to the management of indigenous knowledge, and offer advice on the development of best practices and wellbeing indicators.

In January 2018 the team travelled to Northland and interviewed a number of kaumātua, before holding a wānanga in Motatau with this project's knowledge holder rōpū. Despite rain, flooding and mudslides, the researchers and knowledge holders spent two days in the ngahere (forest) disconnected from the trappings of modern life (power and mobile service) but connected to the taiao (nature). The kōrero (discussions) that naturally flowed when surrounded by nature included: how we explain the inter-relationship Māori have with trees and trees have with other species; who can hold knowledge; depth of knowledge; and the best times to transmit knowledge. The team also began to develop indicators for identifying knowledge holders and for assessing the health of the environment.

Engagement

Unlocking Curious Minds: signs of our time – fusing technology and science to connect people to place

This project aims to develop a mātauranga tool that will take a cross-domain perspective on the health of the environment from whenua to moana (land to sea). The aim of the pilot is to develop a te ao Māori framework with Te Wharekura o Maniapoto (Te Kuiti) and Te Wharekura o Rakaumanga (Huntly) which will measure the state of the mauri (the essence of all living things) in the habitats. The ultimate goal is to transfer the framework into a mobile application to support students to engage in kaitiakitanga, with the long-term expectation of promoting the tool throughout the region.

The project is a collaboration between Manaaki Whenua and Te Wharekura o Maniapoto, Te Wharekura O Rakaumanga, Manaaki Te Awanui, Ngāi Te Rangi – Otawhiwhi Marae, Te Wānanga o Aotearoa and Boffa Miskell. The project is supported by the Unlocking Curious Minds contestable fund and co-funded by the BioH Challenge. Challenge co-funding will be used to support three initial wānanga, which will develop the framework and then support planning for a regional showcase of the mobile app with the tauira (students) who designed it.

This project is an extension of the Unlocking Curious Minds project Tūhonohono from 2017, connecting people to place.

CURIOUS MINDS
HE HIHIRI I TE MAHARA

https://www.curiousminds.nz/stories/how-can-we-keep-tabs-on-our-tuna/

Oligosoma notosaurus, the southern skink gravid female, Whenua Hou, Codfish Island, NZ
James Reardon

Highlights

Synthesis publications on DNA metabarcoding: a window on the hidden world of New Zealand's terrestrial biodiversity

Forensic science has revealed the potential to explore the diversity of life within any sample – not just from DNA in live cells, but from the skin, hair and bodily fluids of organisms inhabiting or moving through an environment.

This ability to extract and sequence DNA directly from environmental samples (environmental DNA, or eDNA) is transforming our understanding and measurement of biological diversity. It is no longer necessary to sight an organism or an individual to confirm its presence at a sampling location. 'Metabarcoding' of DNA thus provides a window into the world of microbial and microscopic diversity that would otherwise be largely hidden from view.

Current approaches for analysing biodiversity based on eDNA vary widely among laboratories, particularly among scientists focusing on different taxa. Comparing data collected by different researchers can be subject to biases, many of which remain poorly quantified. These biases are an impediment to scaling up the application of DNA metabarcoding and addressing national-scale questions.

Two fundamental issues must be overcome in order to harness the potential of eDNA. First, standardised procedures for identifying life from environmental DNA must be developed. Second, to achieve a nationally integrated picture of biodiversity that incorporates eDNA data, streamlined sharing of such data is critical.

To capitalise fully on this powerful new technology, the ***Metabarcoding for environmental monitoring (eDNA)*** team assessed the current strengths and weaknesses of DNA metabarcoding and developed a conceptual framework for validating eDNA data and integrating it with

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conventional methods. They also explored potential applications for national biodiversity assessment and for primary sectors. A nationally standardised framework for sharing, integration, validation, re-use and interpretation of the vast array of taxonomic data obtained from eDNA is a first for New Zealand.

Holdaway, R. J., J. R. Wood, I. A. Dickie, K. H. Orwin, P. J. Bellingham, S. J. Richardson, P. O. Lyver, P. Timoti, and T. R. Buckley. 2017. Using DNA metabarcoding to assess New Zealand's terrestrial biodiversity, New Zealand Journal of Ecology, 41: 251-62.

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Lear, G. I. , J. Dickie, S. Banks, H.L. Boyer, T.R. Buckley, R. Buckley, A. Cruickshank, K.M. Dopheide, S. Handley, J. Hermans, C.K. Kamke, R. Lee, S.E. MacDiarmid, D.A. Morales, R. Orlovich, J. Smissen, Wood, and R. Holdaway. 2017. Methods for the extraction, storage, amplification and sequencing of DNA from environmental samples, New Zealand Journal of Ecology, 42(1):10-.

https://doi.org/10.20417/nzjecol.42.9

A virtual hub for sharing eDNA data

The ***Metabarcoding for environmental monitoring (eDNA)*** team has facilitated researchers from more than 20 research organisations and consortia, and stakeholders, to develop a 'virtual data hub' to share molecular genomic data across organisations, enable data visualisation, and detect biosecurity threats. International connections with the European Bioinformatics Institute, the eResearch 2020 consortium, the Biomes of Australian Soil Environments (BASE) project in Australia, and eResearch 2020 have provided significant in-kind support.

Aboveground diversity of mushrooms reflects just a fraction of the microbial diversity beneath the soil.

Dr Andrea Byrom

Lockwood Range, Kahurangi National Park.
Andrea Byrom

Strategic initiatives

International partnership: Biomes of Australian Soil Environments (BASE)

A key strategic aim for the BioH Challenge is to provide opportunities for New Zealand scientists to collaborate internationally. The team in the ***Metabarcoding for environmental monitoring (eDNA)*** project is collaborating with BASE[1], which aims to develop an eDNA atlas of biodiversity for Australian soils, informatics infrastructure, and standardised methods of analysis for such data. The collaboration allows the New Zealand team to exchange staff and hold workshops to considerably extend their scale and reach and share expertise with Australian colleagues.

A biosphere data commons for Aotearoa

Most data in today's world are controlled by large private and public organisations, which in practice regard data as their own private property. They share such data only within narrowly defined parameters, where the value of such data is only for the private user. Yet data sharing is key to identifying large-scale trends and to answering big questions. Data modellers need access to multiple big data sets to tackle 'wild problems'.

However, data sharing is a complex issue. Data access requires the removal of legal and financial barriers, it needs technical solutions relating to storage, and it requires an understanding of the issues around data sovereignty, including the need for Māori governance of data that are uniquely Māori. While data sharing and reuse at scale can create significant value for all parties, this only works if participants can create and maintain a high-trust relationship.

Existing models for enabling data sharing, integration and reuse fail because they do not address how to maintain a high-trust relationship. The dominant approach tends to be to build technically focused point solutions that are highly specific to a particular context. Moreover, data users tend to address only their own needs, frequently overlooking the interests of the data contributor. At best there is lip service to consent and minimal personal control for the contributor, or at worst coercive harvesting of data. Because these attempts fail to develop trusted relationships from the beginning, they become costly and hard to scale. The alternative is to establish a data commons.

A commons-based approach builds trust and scalability by adhering to a set of principles and impacts that embed an inclusive and open approach to data for every participant. In addition, by setting up a protocol-based approach, the data commons is scalable and lower-cost.

The New Zealand Data Futures Partnership, the NEXT Foundation, the BioH Challenge and Inflection co-funded development of a blueprint for an alternative model to enable data sharing in New Zealand. The New Zealand Data Commons Blueprint is published[2] under an open Creative Commons licence. The next step is to test a number of 'biosphere' case studies related to New Zealand's biological heritage in the pest, biosecurity, biodiversity and freshwater domains.

1 https://data.bioplatforms.com/organization/about/bpa-base

2 http://datacommons.org.nz/

Information bites

Challenge at a glance

Research funding in Tranche 1

$25.8M

2014-2019

Number of Challenge parties: **18**

Funded projects: **18**

Vision Mātauranga projects: **4**

Research aligned from our Challenge parties in just 1 year:

$55M

Investing in future biological heritage capability

PhD students: **19**

Masters students: **7**

Undergraduate students/summer scholars: **8**

Postdoctoral fellows and early-career researchers: **9**

Getting our work out there

In 2017 the BioH Challenge:

Received at least **118** media mentions in newspaper and online articles, and 25 radio/TV commentaries, including 15 international outlets

Provided written articles for **14** popular magazines

Gave more than **84** conference presentations

Built co-innovation partnerships with **37** iwi and hapū

What they say about us

"*It was great meeting you and the others yesterday. We are excited about the prospects this work stream could contribute to Māori across ngā motu, and we hope that we can work together on this in the future. I understand you have a massive job in front of you but hope that you take the time to pop in for a cup of tea/coffee/water etc. if you are passing through."*

— member of a Māori community

"*What a fantastic wee tool! I have shared it on our Māori & Polynesian Textile Plants FB page."*

— feedback on Challenge-funded project ***Citizen Science for Biosecurity Surveillance***

"*I loved the total inclusion of tangata whenua throughout the conference and the amount of Mātauranga Māori being adopted within many of the presenters' kōrero."*

— feedback from the Crazy & Ambitious conference

"*Breadth and diversity of topics presented at a single conference. Provided a great opportunity to inform us all of the diverse activity to understand and protect NZ's biological heritage. Great impact for this conference theme."*

— feedback from the Crazy & Ambitious conference

"*Just wanted to say that you did a great job and the conference was amazing. Some really great challenging and interesting sessions, and lots of opportunity for discussions and connecting with people in between sessions. I really liked the space given to discussing some of the hard things, like 'ownership' of genetic data, and getting a chance to hear lots of different ideas around how to make this work … hope you are celebrating!"*

— feedback from the Crazy & Ambitious conference

"*The scientists leading [the Challenge] are well published (are good scientists) as well as good leaders. They have shown an ability to grasp the stakeholder perspective and take the information from their … peers and translate that into perspectives that stakeholders can understand and appreciate. They have shown a talent for innovation and so can be relied on to spot and progress a good idea when it comes up."*

— Colmar Brunton survey

"*I wasn't sure if this was going to be a good use of my time but I found the conference very inspiring. I met some really interesting people who I hope to collaborate with in the future. I thought the strong mātauranga presence was excellent. We can all improve our engagement with Māori and Bioheritage is providing a good model for how to do that."*

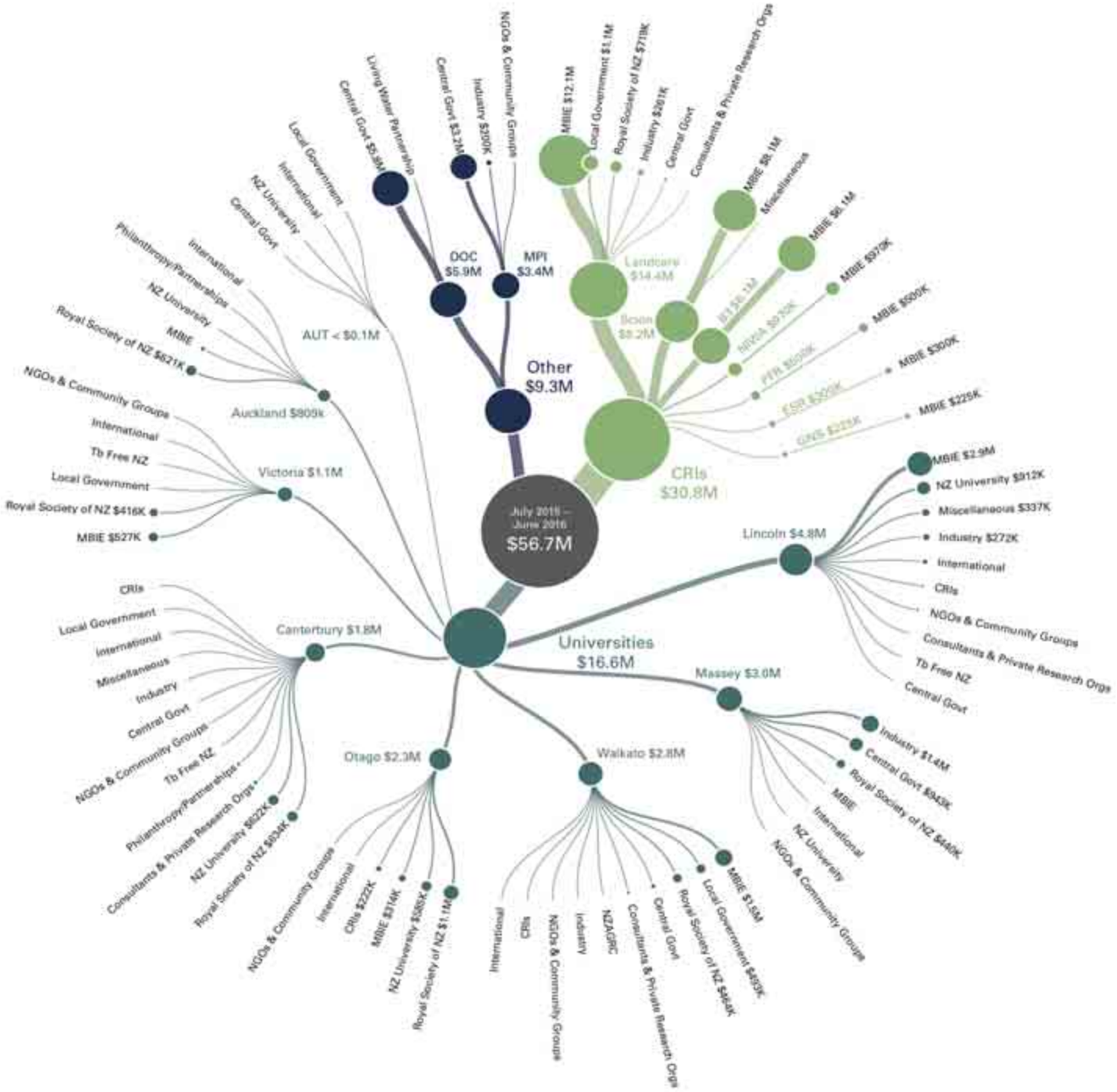
— feedback from the Crazy & Ambitious conference

"*I have dealt with the science leadership on several occasions and have always been impressed with their science capacity."*

— Colmar Brunton survey

Aligned research

Over two years, Challenge parties have aligned more than $111 million of research funding with the BioH Challenge from a range of sources. We work with Challenge parties to connect previously fragmented and un-coordinated research to build scale, and to focus efforts to achieve our impacts.



Crazy & Ambitious Conference

May 2017

Held over three days, the BioH Challenge's inaugural Crazy & Ambitious conference was a resounding success. We welcomed an inspiring line-up of nationally and internationally recognised speakers and attendees. Fifty percent of attendees were from stakeholder organisations. Attendees still mention the conference, highlighting diversity and different perspectives as memorable features.

Video presentations can be accessed at:

http://www.biologicalheritage.nz/resources/crazy-ambitious-2017/crazy-ambitious-2017

https://twitter.com/BioHeritage_NZ/timelines/864285485736239104

#CrazyAmbitious

Panel discussions at the Crazy & Ambitious conference

Panel discussions at the Crazy & Ambitious conference were designed to increase audience engagement. Topics included:

- Biosecurity 2025 and beyond
- Predator Free 2050: from crazy to collaboration
- Who owns biodiversity genetic data?
- Opportunities and challenges for biodiversity on private and farming land
- The future of pest control tools

You can find the panel discussions online at:

https://www.youtube.com/playlist?list=PL-sWnl-Q5z9OA2go8FBOdvbndlkFzP6dg

http://www.biologicalheritage.nz/resources/crazy-ambitious-2017/crazy-ambitious-2017/panel-sessions

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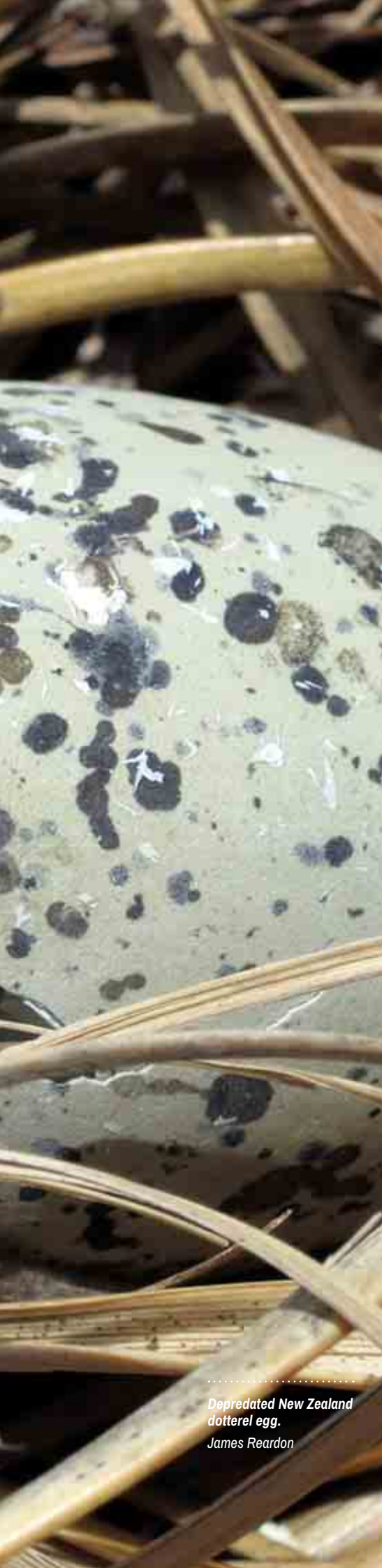


Depredated New Zealand dotterel egg.
James Reardon

In depth

Think piece 7

Applied research to progress and support close-to-market pest control tools and their strategic application

Mr Bruce Warburton,
Manaaki Whenua,
Dr James Ross & Ms Lyne McFarlane,
Lincoln University

When the National Science Challenges were established, some research teams had contestable contracts 'mapped' into the Challenges, with little certainty that the research would continue. Investment signals were for Challenges to re-invest such funding in higher-risk research. In the BioH Challenge, this resulted in a loss of funding in a critical area: pest control technologies.

End-users expressed concern about the lack of support for improvements to currently available tools, which they depend on for the foreseeable future. To address this concern, we asked the research teams and stakeholders to review recently developed and close-to-market-tools, and identify key areas of research required to support their incremental improvement.

The review was led by Mr Bruce Warburton at Manaaki Whenua, and Dr James Ross and Ms Lyne McFarlane from Lincoln University. The authors identified gaps in current knowledge and clarified priority areas of research. The review focused on the three main predator species (possums, ship rats and stoats) encompassed by the Predator Free 2050 initiative. The authors identified 15 priority areas needing further research. The final priority list is now being vetted and ranked by stakeholders.

Manaaki Whenua Landcare Research

Lincoln University Te Whare Wānaka o Aoraki AOTEAROA · NEW ZEALAND
New Zealand's specialist land-based university

Think piece 3

Summer Internship for Indigenous Genomics (SING) – Aotearoa

Associate Professor Māui Hudson,
University of Waikato

SING – Aotearoa is a residential programme that provides participants with knowledge and experience in genomic research. The programme is open to Māori wanting to better understand the opportunities and challenges associated with genomic research, including technical, cultural and ethical issues.

This initiative started in 2016 through a Vision Mātauranga Capability Fund project led by the University of Waikato. The BioH Challenge, and the Science for Technological Innovation Challenge provided co-funding to establish the programme which has now run for three consecutive years and has developed an on-going exchange with a similar programme for Indigenous students in the USA.

Three cohorts of university students and community members now have new skills in curating biological samples, DNA sequencing, computer analysis, biostatistics, and understanding cultural and ethical scenarios. SING – Aotearoa alumni are taking up scholarship opportunities and working collaboratively with genomic researchers on Vision Matauranga-related projects across the country.

Funding for an additional seven years has been secured through the newly established Genomics Aotearoa platform. New partnerships with entities including Plant & Food Research and the Maurice Wilkins Centre of Research Excellence will give alumni exposure to other genomics-related conferences and events.

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

The Faces of the Biological Heritage Challenge

Governance Board

Responsible for oversight of the strategic development, risk management and delivery of the BioH Challenge.

Dr James Buwalda
Independent Chair

James has consulted on strategy and innovation matters for government, tertiary education and industry bodies. He has also had extensive experience in New Zealand government, including 11 years in chief executive roles.

Professor Emily Parker
Victoria University of Wellington & Manaaki Whenua

Emily received her PhD in biological chemistry at the University of Cambridge in 1996, and joined the Ferrier Research Institute in June 2017 to lead the Chemical Biology Research Group. Her research focuses on the chemistry and biochemistry of enzyme-catalysed reactions, with the aim of aiding the development of new treatments for diseases and using natural biosynthetic machinery for the efficient generation of valuable products.

Mr Barry O'Neil
Director, Keronlea Limited

Barry is a biosecurity specialist consultant. His previous roles have included being the CEO of Kiwifruit Vine Health, and before that leading MAF Biosecurity NZ. Barry's experience includes policy and international standard setting, trade negotiations, and operational biosecurity and food safety risk-management activities. He is currently on the boards of Horticulture NZ, Scion, and the Bio-Protection Research Centre.

Mr Devon McLean
Director, Project Janszoon

Devon had a 30-year career in the New Zealand forest industry, including 10 years on the Operating Committee of Carter Holt Harvey, 10 years as a member of the NZ Forest Industries Council, with five as Chairman, Director of the National Association of Forest Industries of Australia, and Director of the NZ Forest Research Institute (now Scion) for seven years.

Dr Dan Walker
Chief Scientist, ACIAR, Australia

Daniel is Chief Scientist at the Australian Centre for International Agricultural Research (ACIAR). His role is to oversee ACIAR's research portfolio – science quality and impact assessment. Prior to this Daniel was Research Director for Agriculture and Global Change in CSIRO Agriculture. He was previously Chief of Division for CSIRO Ecosystems Science.

Ms Maria Pera
Te Rūnanga o Ngāi Tahu

Maria hails from Bluff on Te Wai Pounamu, where she is a representative of the Awarua Rūnanga. Maria is on the executive committee of the Federation of Māori authorities and has served as a ministerial appointed member to several boards, including the Parole Board, District Health Boards, and local prison committees. Currently Maria Chairs the Treaty Tribes Coalition, and Kāitahu Tai Whenu Ltd. She is also a member of Te Aparangi (TRONT) committee and a director on the Ngāi Tahu Seafood Board.

Mr Rob Phillips
Chief Executive, Environment Southland

Rob is Chief Executive for Environment Southland.

Science Leadership Group

Responsible for strategic planning and delivery of research with high value, impact and relevance, and for building alignment of research activity towards the BioH Challenge impacts.

Dr Andrea Byrom
Director

Andrea has a background in invasive species management, with a focus on mammal pests. Prior to taking up her role as Director in 2015, Andrea managed Manaaki Whenua's invasive species research portfolio.

Associate Professor Thomas Buckley
Science Lead

Thomas's research focuses on the application of genomics to understanding and conserving terrestrial invertebrates. He is Research Leader for invertebrate systematics at Manaaki Whenua, and is a director of the New Zealand Arthropod Collection. He also holds a part-time appointment at the University of Auckland.

Dr Maureen O'Callaghan
Science Lead

Maureen is a Principal Scientist at AgResearch and an adjunct Associate Professor at Lincoln University. In her current role Maureen leads a large multi-institute trans-disciplinary research programme, which aims to develop prototype biopesticides for control of New Zealand's most significant and intractable pests and diseases in the pastoral, horticultural and arable sectors.

Dr Duane Peltzer
Science Lead

Duane brings experience in ecosystem ecology and dynamics. He has experience organising and contributing to diverse, multi-institutional working groups ranging from transdisciplinary research for intractable weed management issues, to linking paleo- and neo-ecology for ecosystem processes. Duane leads a large multi-institute interdisciplinary research programme on wilding conifers at Manaaki Whenua.

Ms Melanie Mark-Shadbolt
Māori Manager

Melanie (Ngāti Kahungunu, Ngāti Porou, Ngāti Raukawa, Te Arawa, Te Āti Awa) is the Māori Research & Development Manager with the Bio-Protection Research Centre, Lincoln University, and leads Te Tira Whakamātaki, the Māori Biosecurity Network. Her areas of research include the human dimensions of environmental health, specifically how indigenous people participate in the management and protection of their culturally significant spaces and species.

Dr Nick Waipara
Kaihautū

Nick (Rongowhakaata, Ngāti Ruapani ki Turanga) works at Plant and Food Research, specialising in plant pathology, mycology and biological control. Nick's role as kaihautū is to facilitate, link and promote research prioritised by Māori. This includes recognition of Mātauranga Māori to improve the holistic health of ecosystems and their taonga species, as well as manage biosecurity threats.

Kāhui Māori

Provides advice and support to the BioH Challenge on Vision Mātauranga, the Treaty of Waitangi and WAI 262 principles, as well as wider cultural matters.

Ms Glenice Paine (chair)

Chair of Te Tira Whakamātaki, Deputy Commissioner with the Environment Court

Glenice is of Te Āti Awa and Ngāi Tahu descent. She has extensive experience in resource management and has held roles on or with the Ministry for the Environment, Environmental Protection Authority, Conservation Boards and iwi, and was on the peer review panel for MPI's recently released Biosecurity 2025 Direction Statement. She brings a huge kete of experience as well as a steady hand to the Kāhui Māori. Glenice also brings South Island representation.

Mr Kevin Prime

Commissioner with the Environment Court, Steering Group Chairperson – Reconnecting Northland

Kevin Prime is of Ngāti Hine, Ngāti Whātua, Tainui and Welsh descent. Kevin was named Conservationist of the Decade in the 1990s and has long been a role model in the community, in roles with various companies, trusts and community organisations relating to philanthropy, health, conservation, justice, Māori development, education, environment, forestry, farming and sport. He has also served on ministerial advisory groups pertaining to health, forestry, conservation, Māori affairs, the environment, Crown Research Institutes, lands and sports.

Mr Jan Hania

NEXT Foundation

Jan is of Ngāti Tūwharetoa and Ngāti Raukawa-ki-te-Tonga descent. Jan has trained and worked in electronics and environmental systems engineering and is very interested in the social aspects of environmental restoration. Jan spent seven years with the Department of Conservation leading teams at district, regional and national level, building partnerships and developing large-scale collaborative impact projects focused on people, biodiversity and water. Now working for the NEXT Foundation as Environmental Director, Jan leads the Taranaki Mounga Project and assists with the development and evaluation of a number of NEXT's environmental endeavors.

Mr Thomas (Tame) Malcolm

Puna Consultants Ltd, Te Arawa and Ngāti Ruanui

Thomas has worked for Waikato Regional Council, Canterbury and Marlborough Animal Health Boards, the Department of Conservation, and the Wallaby Project (Environment Bay of Plenty/DOC). Along with his grounding in te reo Māori and tikanga, he also brings 10-plus years' experience in biosecurity and biodiversity management.

Ms Erina Watene-Rawiri

NIWA

Erina is of Waikato-Tainui, Ngāti Maniapoto and Ngāi Te Rangi descent. She is a freshwater scientist and works at the interface between iwi, policy and science. She is a strong advocate for undertaking research that is co-developed with Māori, based on their aspirations and values, which result in tangible outcomes that build the capacity of Māori. She has worked for several iwi and trusts and is a member of numerous freshwater and fisheries societies in New Zealand and Australia.

Dr Gail Tipa

Tipa & Associates, and Trustee of Te Rūnanga o Ngāi Tahu

Gail consulted on the Ngāi Tahu claim and other iwi resource management projects, and since 1996 has increasingly focused on work that enhances Māori aspirations. This includes representation of her rūnunga and iwi on committees and boards. She continues to hold responsibilities for resource management on behalf of Te Rūnanga o Moeraki. At the time of writing Gail has resigned from Te Kāhui Māori to focus on her work with Ngāi Tahu.

International Science Advisory Panel

Leading international experts who provide high-quality, independent scientific advice and support to the BioH Challenge

Professor Stephen Goldson

Principal Scientist, AgResearch; Professorial Fellow, BioProtection Research Centre; Advisor to the Office of the Prime Minister's Chief Science Advisor; FRSNZ FNZIAHS

Professor Goldson has spent much of his career as an applied scientist working on long-term biological control projects in AgResearch and MPI. Stephen also works as strategist to the Chief Science Advisor to the Prime Minister, concentrating mainly on Crown Research Institute and environmental issues. In 2014 Stephen was made an Officer of the New Zealand Order of Merit (ONZM) for his services to science in the New Year's Honours List.

Associate Professor Phillip Cassey

University of Adelaide, Australia

As a trans-disciplinary scientist, Assoc. Prof. Cassey brings critical analytical techniques to the study of invasion ecology, wildlife trade, and biosecurity risk management. His research group focuses on analytical, conceptual and applied techniques for conducting high-impact research. His research has led to significant advances in the discipline of global change biology, and the prioritisation of evidence-based biosecurity decision-making.

Professor Richard Duncan

Institute for Applied Ecology, University of Canberra, Australia

Professor Duncan's specialties are in ecology, weed biology and conservation, with a focus on biological invasions and extinctions. His recent work examines the ways in which invasive species arrive, establish, spread and impact natural ecosystems. Richard was formerly a member of the Bio-Protection Research Centre at Lincoln University.

Professor Rob Ewers

Imperial College, London, UK

Professor Ewers works on spatial patterns of forest ecosystems, and the biodiversity contained within those forests. His research involves investigating and trying to predict patterns of forest cover from local through to global scales, sampling taxa within selected landscapes located in both temperate and tropical parts of the world, and manipulative experiments in both the field and lab. Most of his work uses invertebrates as a model system, with a focus on beetles.

Associate Professor Joshua Viers

University of California, Merced, USA

Professor Viers is a watershed scientist with expertise in resource management and environmental decision-making. He is a former Executive Associate Director of the Center for Watershed Sciences at UC Davis, and he joined the faculty at UC Merced in August 2013 as an associate professor in the School of Engineering. He is also UC Merced's Director of the Center for Information Technology Research in the Interest of Society (CITRIS), which promotes collaborative research on California's pressing environmental, social and health care problems. His research interests investigate the geospatial aspects of watershed science.

Professor Andrew Young

CSIRO, Australia

Professor Young is a plant ecological geneticist, and is the Director of the CSIRO-hosted National Research Collections Australia. The 15 million specimens held in these collections, and their associated genomes and contextual data, represent a vast amount of underpinning biological knowledge about Australia's unique biodiversity.

Knowledge brokers

The knowledge brokers work with Challenge project Leaders on stakeholder engagement and implementation of research findings in the real world.

Mr Bill Dyck

Bill Dyck Ltd

Bill is a science and technology broker. Bill's main role is to bring end-users and scientists together, both to ensure science gets used, but also to ensure that end-users communicate their needs in advance to scientists.

Mr Kevin Collins

Collins Consulting

Kevin has an MSc in environmental science and policy from Johns Hopkins University in the United States and more than 30 years of practical experience in policy development and implementation, media and communications, public relations, project facilitation and advocacy, and writing and editing. Kevin has a strong interest in 'interdisciplinary translation' – improving communication and understanding between different political, administrative, technical, scientific and community groups.

Mr Thomas (Tame) Malcolm

Puna Consultants Ltd
Te Arawa and Ngāti Ruanui

Thomas has worked for Waikato Regional Council, Canterbury and Marlborough Animal Health Boards, the Department of Conservation, and the Wallaby Project (Environment Bay of Plenty/DOC). Along with his grounding in te reo Māori and tikanga, he also brings 10-plus years' experience in biosecurity and biodiversity management.

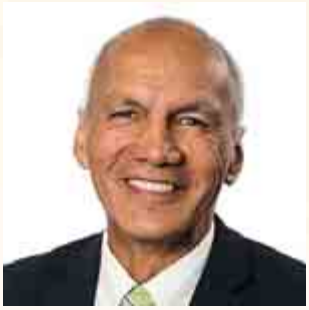
Challenge ambassadors

Our Challenge ambassadors have been involved in the BioH Challenge since its formative stages and now work to help us promote the BioH Challenge way of working throughout the science system.

Professor Bruce Clarkson

Deputy Vice-Chancellor Research, University of Waikato

Professor Bruce Clarkson was the interim Director for the Challenge. In 2005, together with independent consultant Dr Wren Green, he conducted a review of progress on the New Zealand Biodiversity Strategy for the chief executives of the sponsoring government agencies. In 2006 Bruce was awarded the Loder Cup, New Zealand's premier conservation award, and in 2016 he received the RSNZ Charles Fleming Award for environmental achievement. Bruce is a board member of the Australasian chapter of the International Society for Ecological Restoration and a member of the Governance Group for the Building Better Homes, Towns and Cities National Science Challenge.



Mr Kevin Prime

Commissioner with the Environment Court, Steering Group Chairperson – Reconnecting Northland

Kevin Prime is of Ngāti Hine, Ngāti Whātua, Tainui and Welsh descent. Kevin was named Conservationist of the Decade in the 1990s and has long been a role model in the community, in roles with various companies, trusts and community organisations relating to philanthropy, health, conservation, justice, Māori development, education, environment, forestry, farming and sport. He has also served on ministerial advisory groups pertaining to health, forestry, conservation, Māori affairs, the environment, Crown Research Institutes, lands and sports.

Project Leaders

Dr James Ataria

James is a deputy director of Ngā Pae o te Māramatanga and a senior lecturer at the Bio-Protection Research Centre at Lincoln University. James is a Māori business development manager and researcher at the Cawthron Institute, Nelson, and he is also a trustee of the Tuaropaki Trust. His research interests are in the development and application of ecotoxicological tools for the assessment of the biological effects and impacts of legacy and new emerging contaminants on culturally significant species and sites (especially freshwater) in New Zealand.

Associate Professor Hannah Buckley

Hannah is an associate professor in ecology at Auckland University of Technology. She researches spatial and temporal patterns and processes in biological communities.

Dr Ian Duggan

Ian is an invasion biologist from the University of Waikato. His primary research interests are the exploration of vectors responsible for the transportation of non-indigenous aquatic species, as well as their effects and management.

Dr Catherine Febria

Catherine is a freshwater restoration ecologist working at the interface of science, practice, management and policy. She integrates scales (local to global, genes to ecosystems) with knowledge bases / ways of knowing in order to develop and test freshwater restoration solutions.

Dr Graham Fenwick

Graham, a principal scientist with NIWA in Christchurch, has worked on aquatic invertebrate biodiversity for over 30 years from Antarctica to sub-Arctic Canada. He has a background in marine sediment biodiversity and crustacean taxonomy. He brings his specialist knowledge of groundwater crustaceans to the BioH Challenge.

Dr Monica Gerth

Monica is a biochemist and microbiologist. She obtained her PhD in biomolecular chemistry at Emory University (USA), and in 2007 moved to New Zealand as a FRST postdoctoral research fellow (Massey University, NZ). Since 2012 she has led a diverse research group that is tackling a range of problems in human health, agriculture and the environment. Monica is based at Victoria University of Wellington.

Dr Ian Horner

Ian is a plant pathologist working for Plant & Food Research since 1984, studying the biology and control of soil-borne diseases of horticultural and forest crops and trees. His research is focused on finding practical, economically and environmentally sustainable solutions to disease problems.

Professor Phil Hulme

Phil is currently the leader of the Biosecurity Theme in the Bio-Protection Research Centre. He holds the inaugural Chair in Plant Biosecurity at Lincoln University, a unique position jointly supported by Lincoln University and the New Zealand Ministry of Agriculture and Forestry. His primary research focus is predicting the risks arising from plant invasions.

Dr Gavin Lear

Gavin's research explores complex interactions among microbial communities and the varied environments they inhabit. He investigates how microbial communities adapt to human influences such as pollution events and agricultural management, as well as to natural variability in environmental conditions, at the University of Auckland.

Professor Phil Lester

Phil Lester is a professor at Victoria University. His research focus is on the community ecology of invasive social insect species. Phil has a leadership role in the Novel Pest Control Technologies programme, which uses wasps as a model system.

Dr Phil Lyver

Phil is a programme leader in the Ecosystems and Global Change team at Manaaki Whenua. He works on scientific and indigenous knowledge approaches to monitoring and interpreting ecosystem state and trends. He is also interested in the legal frameworks used by indigenous peoples to achieve governance and management over their lands and natural resources.

Dr Edy MacDonald

Edy is the Manager of the Social Science team at DOC. Edy has a strong background in psychology, with an emphasis on learning and behaviour, and extensive experience working with a variety of stakeholders, including government agencies, the general public, NGOs and scientists. In addition to her BioH Challenge project, she is researching how to activate urban New Zealanders for greater conservation gains, increasing compliance to mitigate the spread of kauri dieback disease.

Dr Steve Pawson

Steve is Research Leader Entomology at Scion. He has a background in forest entomology, biodiversity, biosecurity (both border and export phytosanitary treatments), surveillance, and contributions by citizen scientists to biosecurity.

Associate Professor James Russell

James is a conservation biologist at the University if Auckland. He specialises in invasive species research and management on islands, with a focus on vertebrate eradication, and advises Predator Free New Zealand.

Associate Professor Tammy Steeves

Tammy co-leads the Conservation, Systematics and Evolution Research Team (ConSERT) at Te Whare Wānanga o Waitaha. In partnership with mana whenua, ConSERT uses genomic and non-genomic data to develop conservation management strategies for some of Aotearoa New Zealand's rarest taonga species.

Professor Jason Tylianakis

Jason is a professor in ecology at the University of Canterbury, a part-time chair in ecology and biodiversity at Imperial College London, and a principal investigator in the Bioprotection Research Centre. His research examines how communities of interacting species respond to environmental changes.

Dr Nick Waipara

Nick (Rongowhakaata, Ngāti Ruapani ki Turanga) has a research background, specialising in plant pathology, mycology and biological control. Nick's role as kaihautū is to facilitate, link and promote research prioritised by Māori. This includes recognition of Mātauranga Māori to improve the holistic health of ecosystems and their taonga species, as well as manage biosecurity threats.

Dr Helen Warburton

Helen is a freshwater ecology lecturer and researcher working at the University of Canterbury. Her research focuses on testing and developing ecology theory, which is relevant to both applied and fundamental ecology.

Dr Louise Weaver

Louise is an environmental microbiologist with a keen interest in the role microbes play in the world undertaking key metabolic functions in every environment. Her background is in pathogenic microbes from work and studies in the UK in the water and wastewater environments. Once Louise arrived in New Zealand to work for ESR in the groundwater team, she started becoming fascinated with the roles microbes play in the groundwater environment.

Dr Bevan Weir

Bevan's research interest is the systematics and phylogenetics of fungi and bacteria, particularly those with a symbiotic or pathogenic relation to a host. He is curator of the national culture collection (ICMP) and leads the fungal and bacterial systematics research at Manaaki Whenua.

Support Team

Our support team keep the BioH Challenge wheels turning behind the scenes, including day-to-day operations, contracts management, reporting and evaluation, data management and budgeting.

Mr Aaron McGlinchy
Challenge Operations Manager

Aaron studied Forestry at Canterbury University, followed by a Post Graduate Diploma in Wildlife Management at Otago University. He has held multiple positions within Manaaki Whenua, both in the field and in the Research Office. Today Aaron is in a split role, with half his time as Research Data Manager for Manaaki Whenua and the other half as Challenge Operations Manager.

Mrs Andrea Airey
Research Activities Manager

Andrea started working for Manaaki Whenua in 1994 as a research technician for the Pest Control Technology Team. Over the years she has had held several positions in both research and administration. In her role as Research Activities Manager she works to promote and implement efficient and effective reporting and evaluation of all research activities taking place in the BioH Challenge.

Dr Liz McCallum
Challenge Research Coordinator

After working in London for over seven years in planning and consultancy roles, Liz moved to New Zealand to study for a PhD in human physiology. She has worked in various research support roles since, joining the BioH Challenge in 2017.

Ms Kerry Barton
Communications Advisor

Kerry assists with the BioH communication strategy, profiling research through the website and social media. Prior to joining the team Kerry worked for Manaaki Whenua as a research technician, studying penguins in Antarctica and assisting with their websites.

Mrs Carla Ashby
Challenge Personal Assistant

Carla joined the BioH Challenge in January 2016 after several years as a marketing manager in the commercial real estate industry. Her role includes assisting the Science Leadership Group, Governance Group and Kāhui Māori.

Mrs Lauren Gillanders
Challenge Personal Assistant

Lauren joined the BioH Challenge in January 2017 as parental leave cover for Carla Ashby.

Early career researchers and postdoctoral fellows

Impact 1

Ecosystem tipping points

Dr Johanna Yletyinen is based at the University of Canterbury conducting a systems analysis on the social and ecological drivers of tipping points to identify key leverage points that can effect positive changes in the state and trajectory of New Zealand's ecosystems.

Enhancing native biodiversity in agro-ecosystems

Dr Jennifer Pannell is a research fellow at Auckland University of Technology. She recently completed her PhD at the Bio Protection Research Centre, which focused on predicting invasive plant spread in New Zealand. Her expertise is in spatial modelling and GIS.

Impact 2

Novel predator control technologies

Dr Patrick Garvey is based at Manaaki Whenua working on a project to develop highly effective lures for wildlife management. His previous research explored invasive predator interactions and investigated how olfaction underpins these interactions.

Novel wasp control technologies

Dr Bob Brown is a researcher at Manaaki Whenua, where the majority of his research is centred on investigating the potential for using classical biological control to manage invasive wasp populations.

Stopping kauri dieback in its tracks

Dr Scott Lawrence is a postdoctoral fellow working on the kauri dieback project. He says, 'While my background is in marine microbiology, I'm excited to be part of this project, and hope I can play a role in ensuring the survival of these important trees.'

Impact 3

Citizen-based biosecurity surveillance project

Ms Rebecca Turner is a post-doctoral fellow at Scion, collaborating with researchers at the University of Canterbury. She is developing a pest risk alert model to help direct users of new mobile tools for general biosecurity surveillance.

Impact 4

Food webs and stream restoration

Dr Elizabeth Graham is a freshwater ecologist at NIWA Hamilton. Her research focuses on community, food web and population dynamics across natural and anthropogenic environmental gradients, and applications to ecological restoration. Her current work includes invertebrate dispersal and recolonisation, assembly processes, and community resilience and stability.

Dr Kristy Hogsden is a freshwater ecologist at the University of Canterbury. She is interested in using food webs to help better understand how environmental stressors affect freshwater and in developing more effective restoration strategies. Kristy connects communities and stakeholders with science by communicating research findings through a variety of media and outreach events.

Impact 5

Metabarcoding for environmental monitoring (eDNA)

Dr Andrew Dopheide is a postdoctoral researcher at Manaaki Whenua, where he works on the analysis of biodiversity in terrestrial ecosystems using DNA sequencing, bioinformatics, and data visualisation techniques. He completed his PhD in 2016, during which he used DNA metabarcoding techniques to analyse the biodiversity of bacteria, fungi, micro-eukaryotes and invertebrates on Hauturu (Little Barrier Island).

Students

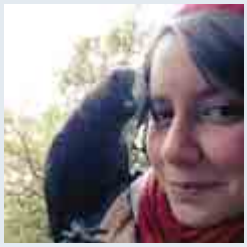
Impact 1

Bruce Clarkson PhD Scholar

Ms Rachel Nepia completed her BSc and MSc at the University of Waikato, specialising in forest ecology. After completing an 18-month mission in Orlando, Florida, she returned to the University of Waikato to take up a position as a research assistant in the Environmental Research Institute (ERI). After a year and half of experience at the ERI, Rachel decided to undertake a PhD. She is focused on the impacts of honeybees on indigenous forest ecosystems and hopes to fill some knowledge gaps in the management of conservation lands.

Adaptive variation of native biota

Ms Aisling Rayne holds an honours degree in conservation genomics from Canterbury. Her PhD involves investigating adaptive variation in kēkēwai/freshwater crayfish.



Ms Denise Martini came all the way from Italy almost two years ago for her PhD. She is using cutting-edge genomic methods to learn all she possibly can about the New Zealand kākā. With this knowledge she will predict a better future for this species.

Customary approaches to ecosystem resilience

Ms Corinne Lucas-D'Souza was born in France and lived there until she finished university, completing a degree in foreign languages. She then worked as an account manager in the print industry in the UK before moving to New Zealand and returning to university to study psychology. She gained a MSc in Applied Psychology in 2015 and started her PhD in July 2016. Corinne has a passion for te reo Māori, which she is currently learning. Her PhD is focusing on intergroup relations in a Treaty context.

Mr Mark Herse is originally from Chicago. He earned his BSc from Montana State University, and MSc from Kansas State University, where he studied the influences of agricultural conversion and rangeland management on threatened grassland birds. His research focuses on understanding how customary harvest practices by Māori influence the population dynamics of a culturally significant waterfowl, the black swan.

Ecosystem tipping points

Mr Quinn Asena completed a masters degree in Environmental Science at the University of York. Currently he is undertaking a PhD at the University of Auckland on critical transitions in ecosystems using palaeoecological methods, spatial analysis and modelling, with an aim to inform restoration and protection of current ecosystems.

Ms Rose Gregersen is a PhD student at the University of Auckland. Her project focuses on understanding lake ecosystem response to agricultural catchment use. She aims to combine contemporary ecology with palaeolimnology, bridging the gap between long-term, qualitative records and short-term quantitative ecology.

Students

Impact 2

Novel predator control technologies

Mr Zachary Carter is a PhD candidate in the School of Biological Sciences at the University of Auckland. He is developing predictive models to assist with invasive pest eradication prioritisation throughout New Zealand.

Novel wasp control technologies

Ms Gemma Mclaughlin is researching genetic methods to control or even eradicate invasive wasp species in New Zealand. This includes using RNA interference as a type of species-specific poison, and CRISPR gene editing techniques, possibly as a form of gene drive.

Ms Julia Schmack is an international PhD student from Germany investigating *Vespula* wasp invasion on New Zealand's offshore islands, based at the University of Auckland. She graduated in ecology and evolution (MSc) in Frankfurt (Main) and worked in international projects fostering urban biodiversity and organic farming.

Impact 3

Biosecurity networks

Mrs Isabelle Vollenhoven-DeLange is examining the risks of pest spread by users of waterways in New Zealand, based at Lincoln University. She has a BSc and MSc in Civil Engineering from Delft University of Technology. She has strong skills in GIS and MATLAB, and is familiar with using gravity models.

Ms Sabrina Greening is modelling the evolution and transmission of pathogens in livestock movement networks at Massey University. She has an MSc) in Veterinary Epidemiology from the Royal Veterinary College, University of London, and a first-class BSc in Animal Science from the University of Nottingham.

Ms Rogini Runghen is examining the role of visitors in the spread of weeds and plants pathogens in the natural areas of New Zealand at the University of Canterbury. She has a Master in Ecology (specialisation in modelling of ecological systems) from the University of Toulouse, and a BSc (Hons) in biology (specialisation in environmental protection) from the University of Mauritius.

Impact 4

Food webs and stream restoration

Ms Isabelle Barrett is a PhD student at the University of Canterbury investigating degraded, restoration-resistant freshwater communities in New Zealand. She is using a trait-based approach to determine what is preventing biological recovery and how this can be overcome.

Biosecurity threats to freshwater taonga invertebrates

Mr Tom Moore is a PhD candidate investigating the interactions between non-indigenous fish, aquatic plants and terrestrial predators with our native freshwater mussel, *Echyridella menziesii*. This project is based at the University of Waikato.

Impact 5

Metabarcoding for environmental monitoring (eDNA)

Ms Natascha Lewe is a PhD candidate at Victoria University of Wellington. Natascha uses her background in biology and chemistry to study plant–microbial communication.

Mr Ralph Wainer is a PhD candidate at the University of Canterbury. He completed an MSc in Biology from the University of Nottingham (UK) and an MRes in genetics from Durham University (UK). His research centres on the below-ground microbial interaction networks surrounding invasive plants in New Zealand.

Ms Chloe Mathieu is a PhD candidate at Auckland University of Technology. Her research topic focuses on the spatiotemporal variation of microscopic communities.

Ms Syrie Hermans is a PhD candidate at the University of Auckland. Her research focuses on the impact human land use has on soil bacteria and how they can be used to indicate soil health. She is also investigating the effects of DNA extraction methods on the detection of micro- and macro-organisms in the environment to improve biodiversity monitoring methods.

Co-Innovators

Our project teams co-innovate with a wide range of knowledge holders, many of whom sit outside traditional science organisations. We profile some of them here.

Mr Nigel Scott

Customary approaches to ecosystem resilience project

Nigel has over 20 years experience working with Ngāi Tahu Whānui and other iwi in the South Island, and has also worked with key commercial and recreational fishing stakeholders for more than 20 years, most notably through his role as customary fisheries advisor to the Guardians of Fiordland Fisheries and Marine Environment Inc. and Te Korowai o Te Tai o Marokura (the Kaikōura Marine Guardians). Over this time he has led the development and implementation of the Ngāi Tahu Customary Fisheries Management Framework, and has managed the Ngāi Tahu Customary Fisheries Protection Areas Project, spread throughout the Ngāi Tahu Whānui Takiwā, with the 18 Ngāi Tahu papatipu rūnanga and their tangata tiaki/kaitiaki.

Nigel has worked with fisheries scientists to develop a partnership Te Tiaki Mahinga Kai, a research and monitoring programme aimed at supporting kaitiakitanga led by tangata tiaki/kaitiaki, appointed under South Island customary fishing regulations.

Ms Waitangi Wood

Citizens combating kauri dieback project (Kauri Rescue)

Waitangi is of Ngāti Awa, Ngāti Kahu and Ngāpuhi Nui Tonu descent. She hails from Ngatirua hapū in Te Tai Tokerau. Inspired by Māori difference and tenacity, Waitangi has worked across sectors including iwi/hapū environmental and biosecurity management and strategic development, and Māori public health.

Waitangi is currently a board member of Te Tira Whakamātaki and a tangata whenua rōpū representative on the governance of the Kauri Dieback Response Programme. Her other work in the environmental sector includes: supporting Mātauranga Māori and tikanga (traditional process and practice) as a biosecurity solution and edifying Māori cohesion and connection supporting mana whenua to influence policy, strategy and systems that have an impact on taonga tuku iho (transfer of intergenerational knowledge).

Mr James Mansell

Data Commons initiative

James Mansell is a philosopher, data scientist and social entrepreneur. He introduced advanced analytics and an outcomes-centred operating model into the social sector: first in child protection, then at the Ministry of Social Development, then with the Minister of Finance across the whole of government. James is an Edmund Hilary Fellow, is on the board of Te Pūnaha Matatini, and is currently working on free-flowing data via the notion of a data commons.

Kea, Murchison Mountains, Fiordland.
James Reardon

About the Challenge Host

Manaaki Whenua Landcare Research

Our Challenge host, Manaaki Whenua – Landcare Research plays a number of important roles, including providing legal, accounting, human resources, IT, editing, communications and graphics support.

Manaaki Whenua undertakes research that focuses on preserving New Zealand Aotearoa's rich biodiversity, improving biosecurity, and looking after the land and environment. Tō tātou whenua, mō āpōpō (Our land, our future) is the essence of why Manaaki Whenua exists.

Manaaki Whenua aligns more than $15 million a year of research activity with the BioH Challenge via the Strategic Science Investment Fund (SSIF), government-funded contestable research programmes, and commercial (non-government) sources.

Manaaki Whenua's SSIF funding supports numerous Challenge projects including *Metabarcoding for environmental monitoring (eDNA), Customary approaches to ecosystem resilience, Adaptive variation of native biota, Social licence for pest control, Novel predator control technologies, Novel wasp control technologies, Genomics and metagenomics to mitigate pathogen risk,* and *Ecosystem tipping points.*

Manaaki Whenua
Landcare Research

New Zealand's Biological Heritage
National Science Challenge

www.biologicalheritage.nz