

NEW ZEALAND'S
BIOLOGICAL
HERITAGE

Ngā Koiora
Tuku Iho

National
SCIENCE
Challenges

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

STRATEGY

2019–2024

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Long-term view

The opportunity

New Zealanders value highly our biological heritage: the natural, urban, and production environments in which we live, work and play. These landscapes underpin our sense of national identity and most of us have deep cultural, spiritual or family connections to mountains, forests, farms, lakes and rivers. Our economic, environmental and cultural prosperity are inextricably linked to, and strongly depend on, our biological heritage.

However, our biological heritage is under threat from invasive organisms and from new pressures emerging in a rapidly changing global environment. Stewardship of biological heritage is in our hands, but we need to inspire New Zealanders to take action to protect and manage our biodiversity, improve our biosecurity, and enhance our resilience to harmful organisms.

Science and research have a major role to play in reversing the decline of our biological heritage. In our 2019-2024 strategy we sharpen the focus on how New Zealand's research and innovation system can connect and accelerate progress to deliver enduring impact and benefit for New Zealand.

Our vision

To reverse the decline of biological heritage, blend traditional knowledge with modern research, reconnect people with nature, create thriving ecosystems, and leave a legacy for future generations.

A 2050 view: what success will look like for New Zealand's Biological Heritage



Our legacy

Known **priority threats** to New Zealand's biological heritage (e.g. wasps, plant and animal pathogens, small mammal predators, and invasive weeds) can be removed or mitigated, **emerging threats** can be better predicted, and our ecosystems are **resilient** to future changes.

Our science & innovation system will have greater capability and capacity to make **strategic, long-term, impact oriented** progress on sustaining and restoring New Zealand's biological heritage; is more inclusive, diverse and collaborative; is enhanced by organisational and individual collaboration; respectful of expertise from a diversity of knowledge holders; and proud of the legacy it leaves to future New Zealanders.

Our five-year strategy

Overview

Stewardship of New Zealand's unique biological heritage in the face of multiple threats from global change is every New Zealander's responsibility. Science and research are needed to discover, develop and deploy new knowledge in innovative ways. However, biological heritage is complex: threats, environmental states and community aspirations are dynamic and often interact with human decisions and actions that have direct and profound effects on our environment. As a consequence, there is no single solution or intervention capable of 'reversing the decline' of our biological heritage. Addressing this complexity through national leadership to solve complex problems is at the heart of the Biological Heritage National Science Challenge.

Our emphasis for 2019 to 2024 is to actively lead better and faster pathways from science discovery through to delivering **impacts** at regional or national scales. By 'impact' we mean a set of final, long-term effects or benefits in a value chain. A rich array of talents are needed to better understand and manage our biological heritage and deliver impact, but many science and research efforts in New Zealand have increasingly become fragmented. For example, our Challenge Parties identified c. \$179M of research over 3 years representing >700 research projects or programmes aligned with the Mission of our Challenge. However, this diverse effort has lacked overall cohesion and focus, in part because it has never been harnessed in a strategic framework to deliver measurable benefit for New Zealand.

Leadership, cohesion and strategic focus are urgently needed, as are mechanisms to foster greater collaboration amongst individuals and institutions, and integrate across disciplines and sectors. Over the past four years our Challenge has begun to apply the leadership, focus and cohesion to this diverse effort, but more is needed. In our strategy we take a national 'innovation system' approach to ensure that greatest progress possible is made towards achieving strategic, long-term goals. This will require coordination of a variety of diverse individuals and institutions, each of whom contribute different roles and skills to different stages along a value chain from discovery science to national benefits. This is a 'collective impact' approach: **the commitment to a common agenda of a group of important actors from different sectors for solving specific strategic problems that will deliver enduring national benefit.**

New Zealand's Innovation System

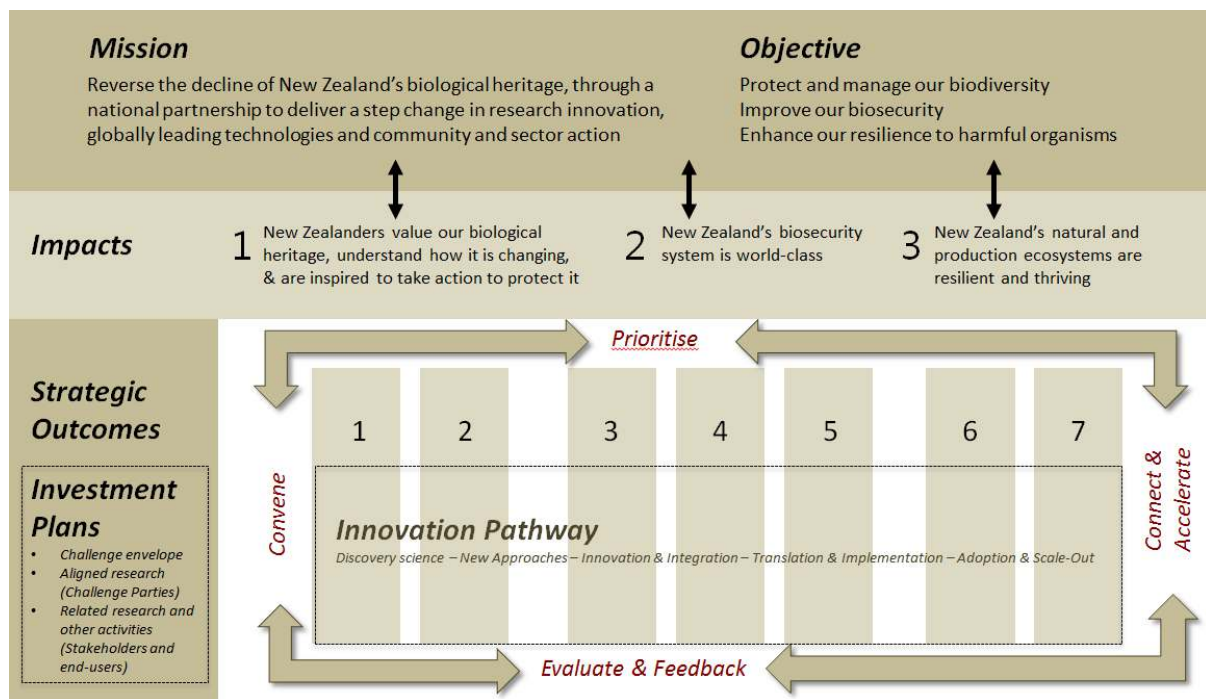
Our strategy explicitly draws on a much larger portfolio of knowledge, science, research, innovation and technology development – being conducted across our 18 Challenge Parties, in communities, and in government agencies – than the Challenge alone can invest in. Since 2014, we have worked hard to build trust: with research organisations; with iwi, hapū and whānau; with agencies; and with individual researchers and knowledge holders. These individuals and institutions have expressed confidence in our inclusive way of working: they have given us a mandate to provide leadership and direction for a wider portfolio aimed at delivering transformational change both for biological heritage and for the New Zealand innovation system.

During extensive consultation, there was widespread agreement that our Strategy should focus on modelling this new 'innovation system' in order to deliver otherwise unachievable impact and benefit for New Zealand's biological heritage. Moreover, there is strong support for the Challenge to **prioritise** research effort; to **convene** interested parties to facilitate the required integration; to **connect** and **accelerate** this diverse effort; and to **review** and evaluate progress towards our goals. Our efforts in Tranche 1 identified 'exemplar' areas for investment (projects) which undoubtedly raised the profile and visibility of priority issues. We were also successful at developing processes to break down

barriers and create the best teams to address large, complex problems. However, a collection of individually-excellent projects will not in themselves deliver the transformational change for New Zealand's biological heritage that we are striving for. Our renewed focus on the innovation system should enable many organisations to optimise their own priorities and investments so that collectively we generate the greatest impact for New Zealand. How the Challenge will deliver that transformational change is outlined below.

An integrated set of end-user needs was used to focus down to **three Impacts and seven Strategic Outcomes (SOs)** (the process by which these were identified from end-user priorities is documented in the section entitled 'Our process for developing this strategy', p.14). SOs are intended to influence the nature, scale, and direction of aligned research activity across the science sector (e.g. SSIF funding, university research, contestable funding pools, operational research), as well as to 'invite' many other contributors to complement and enhance research investment to deliver specific outcomes for New Zealand (Figure 1).

Figure 1. Conceptual framework for how the Challenge will operate. We will prioritise, convene, connect and accelerate work being conducted across our 18 Challenge Parties, in communities, and in agencies, through Strategic Outcomes. Review and evaluation of progress towards delivery of impact is built into this operating framework.



Strategic Outcomes are also the right unit of effort for applying an **intervention logic** approach: an innovation pathway (Figure 2). The innovation pathway encompasses all stages of effort from generation of new ideas or tools through to achievement of impacts:

1. We need targeted **discovery science** to characterise and value our biological heritage, understand the things that threaten it, and provide new insights into how future changes will affect it.
2. Based on these discoveries, we need to apply **new approaches** to intervene to protect our biological heritage and deal with threats.

3. New approaches need to be integrated across knowledge systems and environmental domains. We need **innovators** to put these parts together in new and tangible ways.
4. New knowledge and technologies will only help if the people who use and conserve our biological heritage find them useful. We need **coaches, translators and communicators** to create practical value from the knowledge and technologies we generate.
5. We need the right partnerships among researchers, technologists and innovators, Māori, government agencies, industry, and the public to co-design solutions and to **maximise adoption and scale out** of new approaches.

Figure 2. Our representation of the innovation system. The innovation pathway encompasses all stages of effort from generation of new ideas to achievement of impacts, and allows for a diversity of contributions from a range of individuals and institutions.



This framework is scaleable (e.g. as new priorities emerge or new funding becomes available), and will enable the Challenge to: (1) **prioritise** according to end-user needs, (2) **connect and accelerate** diverse and fragmented effort across the innovation system to ensure that it is coordinated and strategically-focused; and (3) **review and evaluate** success. The framework explicitly includes a wide range of end users and knowledge holders in co-design. Science and research have a vital role, but success is highly dependent on a diverse range of skills, institutions, and knowledge holders at every stage along the innovation pathway if we are to achieve transformational change.

What the Challenge will contribute

Each Strategic Outcome is likely to have different strengths, weaknesses, barriers and opportunities that reflect current knowledge and environmental states. Challenge investment will be targeted to critical knowledge gaps, road blocks and leverage points along the innovation pathway for each Strategic Outcome. Explicit identification of key resources and capabilities needed to accelerate progress towards achieving impact will be a critical part of the design process for each SO. This will provide all potential contributors with greater clarity about where along the pathway their efforts can best be targeted to complement Challenge investments, and will ensure that Challenge focus is maintained on the intended impact and benefit for New Zealand.

Impacts and Strategic Outcomes: scope

Impacts can be considered **aspirational goals that will leave a lasting legacy** for New Zealand's biological heritage over a 20-30 year time frame. SOs are intended to be an order of magnitude larger in scale than our current research programmes, deliverable in a 10-15 year time frame. Impacts and SOs are deliberately not defined by discipline: consistent stakeholder feedback conducted by Colmar

Brunton (e.g. in our 2017 and 2018 surveys) requested that we shift focus away from research programmes and towards a clear narrative as to how the Challenge will deliver impact.

Impacts and SOs were developed and designed through months of consultation with a wide range of end users, stakeholders, and Challenge Parties (documented in the section entitled 'Our process for developing this strategy', p.14). SOs are designed to:

1. Be cross-cutting (i.e. deliver to more than one Impact);
2. Stimulate integrative or transformative research, innovation and translation that cannot be achieved easily through other investment mechanisms in the New Zealand innovation system;
3. Draw on a wider landscape of research already underway across the New Zealand innovation system and, as a result, ensure progress towards delivery of impacts is accelerated.

It is intended that each SO will connect and coordinate several million dollars worth of aligned research effort in addition to contributions from end-users. In other words, SOs are **large, cohesive, interconnected portfolios of collective effort** rather than smaller, standalone research projects. Within each SO, we expect that Challenge investment may be targeted to an optimal mix of project sizes to connect and coordinate aligned research and optimise delivery of the SO as a whole.

Impacts and Strategic Outcomes: co-design

To ensure an integrated and collective approach to achieving impacts is developed, our processes and criteria (elaborated in the sections on science quality (p.25) and pathway to impact (p.28)) ensure that all SOs will be co-designed by Māori, communities, industry and end user agencies **at the beginning**, and **reviewed on an ongoing basis**. The Challenge Science Leadership Group and Governance Group will plan, oversee and drive the scoping stages of SOs, and identify the networks and contacts needed to assemble the right team at all stages of each innovation pathway. Aligned research and critical national capability from Challenge Parties and other organisations will inform co-development of each SO, but this will not guarantee Challenge funding to participants. Each SO will also be expected to leverage other domestic and international expertise (see 'The process by which Strategic Outcomes will be scoped and refined', p.28). Innovative models for co-leadership, mentoring, and novel career pathways for researchers and natural resource managers/kaitiaki will be expected within and among SOs to future-proof New Zealand's capacity and capability to reverse the decline of New Zealand's biological heritage.

Challenge investment

Challenge investment will focus on **leverage points** and **building interconnections** among individuals, organisations, and knowledge holders along the innovation pathway for each SO. The relative balance of our investment will be tailored according to the specific needs of each SO.

The following organisations have agreed in writing to **contribute investment or expertise** in addition to aligned research from our 18 Challenge Parties (targeted to particular SOs depending on each organisation's strategic interests and alignment): the Ngā Pae o te Māramatanga CoRE (social research and Mātauranga Māori), the Te Pūnaha Matatini CoRE (complex systems analysis, measurement of impact), the Bio-Protection Research Centre (plant biosecurity), Genomics Aotearoa (genetic and genomic tools for pest control and biodiversity resilience), the Better Border Biosecurity (B3) consortium (biosecurity risks, pathway management, surveillance, diagnostics and eradication), and four other National Science Challenges (Our Land & Water [land-water interface], Deep South [climate change models], Sustainable Seas [ecosystem resilience], and Science for Technological Innovation [novel biosecurity and pest control tools & technologies]).

Predator-Free 2050 Limited and the Department of Conservation will coordinate with the Challenge to focus research effort aimed at the **predator-free 2025 goal** of delivering a breakthrough solution to eliminate one small mammal predator from the mainland of New Zealand.

SOs will also be expected to actively pursue **leverage investment opportunities** in research, technology and innovation (e.g., from industry or philanthropic sources). Any leverage opportunities should benefit Challenge Parties by focusing effort on the most impactful goals whilst potentially creating new revenue streams for them (balanced against the need for extra investment to be targeted appropriately to deliver impact).

At the suggestion of our International Science Advisory Panel, we will set aside 20% of the Challenge envelope for **strategic contingencies**. This will not be a separate 'fund' as such: it is intended instead to signal flexibility and responsiveness to emerging opportunities that are strategically aligned with end user priorities in one or more SOs. The contingency will be fully committed by 2022 in order to create maximum impact from Challenge investments by 2024.

Investment priorities: Impacts and Strategic Outcomes

Impacts and SOs are detailed below. Under each SO, a set of **indicative** Intermediate Outcomes (IOs) are provided. Our intent is that IOs will be refined and narrowed as each SO is scoped, co-developed and a complete innovation pathway finalised; IOs may also be added or removed depending on emerging priorities. **Indicative** research areas at each stage of the innovation pathway are provided for each SO. Research areas will be scoped in detail and refined by groups charged with developing each SO. We have suggested potential areas where the Challenge may invest based on known end user priorities (in **red text**), but it is highly likely that these will change as critical needs are identified during the scoping of each SO.

It is expected that each SO will require a different emphasis in terms of Challenge investment, and have different needs depending on maturity and degree of aligned research effort. Detail on the processes by which SOs will be developed, and criteria to be addressed before SOs can proceed, are in the sections entitled 'Assessment criteria for Strategic Outcomes', p.25 and 'The process by which Strategic Outcomes will be scoped and refined', p.28. Briefly however, our intent is that the Challenge Science Leadership Group and Governance Group will take an active role in facilitated co-design and in directing and shaping each SO.

Potential synergies are indicated by cross-referencing linkages among SOs.

Impact 1: New Zealanders value our biological heritage, understand how it is changing, and are inspired to take action to protect it

Our measure of success: *By 2024, a majority of New Zealanders value our biological heritage, & are enabled to actively contribute to positive change*

Strategic Outcome 1: We report progress using a biological heritage scorecard for Aotearoa (Linkages to SOs 2, 6, 7)

2024 Intermediate Outcomes:

- *Common metrics to measure progress to reverse the decline of biological heritage will be developed and agreed;*

- *Quantitative and qualitative measurement and assessment tools will be integrated across land and water domains and characterised at a range of scales;*
- *All interested parties will be adapting their interventions by harnessing greater value from biological heritage data using a Biosphere Data Commons;*
- *We will be tracking and evaluating progress to make our interventions smarter over time.*

Indicative research:

Discovery science: Discovery of new biota and new linkages across all taxonomic kingdoms – including Mātauranga and citizen science – and development of novel tools and methods (e.g. molecular methods, digital technologies, reference genomes) to characterise the identity and function of indigenous and introduced biodiversity and ecosystems.

New approaches: New advanced engineering, digital, and molecular technologies developed, automated and applied to common metrics of biological heritage to quantify ecosystem state and change. Research to integrate citizen and community data to build this picture, aligned with international best practice in monitoring and evaluation.

Innovation and integration: Integration of common metrics and tools across land and water domains at relevant scales and in real time.

Translation and implementation: Biodiversity and biosecurity data – collected by citizens and agencies – are shared in a trusted Commons framework. New ways of visualising and communicating data and new analytical tools (e.g. virtual and augmented reality) are developed to provide evidence-informed narrative to shape public opinion.

Adoption and scaling out: Management of biological heritage underpinned by common metrics on a biological heritage scorecard for Aotearoa. A diversity of value systems inform evidence-based policy.

Strategic Outcome 2: We empower New Zealanders to demand and enact environmental stewardship and kaitiakitanga (Linkages to SOs 1, 3, 4, 5, 6, 7)

2024 Intermediate Outcomes:

- *The market and non-market values of New Zealand's biological heritage will have been quantified to inform intergenerational policy and governance decisions across social, cultural and institutional frameworks;*
- *Social partnerships with motivated and enabled citizens, knowledge holders and decision-makers are established to maximise adoption and scale out of new tools, technologies and solutions;*
- *People will be enabled to make decisions and take action to benefit our biological heritage;*
- *The weight of public opinion ensures that Government recognizes the value of our biological heritage and is adjusting policy and resource decisions to ensure that the decline is reversed.*

Indicative research:

Discovery science: Social, psychological, marketing and behavioural theory applied in new ways to inspire people to take action to protect biological heritage. Local and regional values and community interests characterised and results used to inform social-ecological models in SO6.

New approaches: Research to demonstrate the value of social and primary industry partnerships to manage biosecurity threats and restore indigenous species and ecosystems (e.g. in case study regions). Better understanding of organisational and societal barriers that prevent communities restoring biological heritage.

Innovation and integration: Research to quantify market and non-market values of New Zealand's biodiversity and costs avoided or mitigated through biosecurity interventions (linked to Impact 2). Research to align social, cultural and institutional frameworks and inform intergenerational policy and governance decisions (with SO6).

Translation and implementation: Communication, education and outreach are better designed to build strong public confidence. Research and capability building to support the active engagement of people in protection of New Zealand's biological heritage.

Adoption and scaling out: Case studies demonstrating how invested communities and industry can work with agencies to make environmental decisions. Understand the processes whereby communities see their values reflected in policy, standards, regulations, investments and operational decision-making, and translate generic learnings to new regions.

Impact 2: New Zealand's biosecurity* system is world class

Our measure of success: *By 2024, New Zealand's biosecurity system is fit for purpose*

*In New Zealand, under the 1993 Biosecurity Act the definition of 'biosecurity' means pre-, at-, and post-border (i.e. both new incursions and established invaders).

Strategic Outcome 3: We anticipate both emerging & latent biosecurity risks, and avoid new or recurring invasions (Linkages to SOs 4, 5, 6)

2024 Intermediate Outcomes:

- *Better tools and processes are used to anticipate, detect and evaluate emerging (including offshore) biosecurity risks and their likely impacts;*
- *Exemplar biosecurity risks, & their likely impacts in urban, production & natural ecosystems, will be identified and appropriate interventions developed for them;*
- *We are learning from previous biosecurity breaches in order to increase public confidence in the biosecurity system;*
- *Primary sector market access and future investment opportunities will be enhanced and maintained as a result of confidence in our biosecurity system.*

Indicative research:

Discovery science: New models of risk assessment that take into account new incursion pathways, within-species variability or rapid evolution, and novel interactions amongst species or other drivers (land use or climate change) are developed. Research to better understand how natural and anthropogenic risk factors are associated with emergence of biotic threats (link to SO7).

New approaches: Network theory is applied to better predict when and where management interventions should be deployed to mitigate future biosecurity risks. Environmental sensors are deployed and networks implemented to monitor key parameters and these data are linked to remotely sensed data to enhance model predictions and improve pest/disease management.

Innovation and integration: *New risk assessment models in combination with knowledge of management interventions is used to better understand and predict future changes in the risk profile of biosecurity threats. Reflection and feedback are utilised to strengthen the biosecurity system.*

Translation and implementation: New risk assessment and management interventions developed and refined to inform biosecurity strategy and guide deployment of interventions across multiple biosecurity risks.

Adoption and scaling out: Risk pathways for high-impact pests, weeds and pathogens are quantified. Tools to optimise interventions developed and new 'fit for purpose' policy designed to prevent incursions through greater public deployment and targeted management.

Strategic Outcome 4: We have state-of-the-art biosecurity surveillance systems (Linkages to SOs 1, 2, 3, 5)

2024 Intermediate Outcomes:

- *Biosecurity surveillance data, information, & expertise from citizens, industry and agencies will be available, accessible, relevant & used in more effective & timely ways across the biosecurity system;*
- *Information technology and statistical or modelling techniques will provide informed guidance to government and industry to assist in decision-making through uncertainty, and advice on where to direct limited funds to optimise biosecurity surveillance.*

Indicative research:

Discovery science: Co-design surveillance theory, proof-of-freedom, and new approaches with improved models of biosecurity risk assessment (with SO3 discovery science). New surveillance, diagnostics, and early detection technologies have been invented.

New approaches: Research to develop and deploy cost-effective multiple surveillance tools and technologies across different stages of the invasion curve. Includes research to detect and mitigate new biosecurity incursions as well as monitoring longer-established weeds, pests or pathogens. New technology to monitor key drivers that trigger outbreaks.

Innovation and integration: Integration of biosecurity data collected by citizens using new digital tools and technologies with data collected by industry and agencies. Research to understand how biosecurity surveillance and interventions are shaped by social, cultural and economic drivers. New and existing research and operational data sets (including agency data) are brought together to learn/strengthen the biosecurity system.

Translation and implementation: Targeted and cost-effective surveillance, diagnostics, and early detection technologies have been deployed to deliver integrated responses to combat priority threats, across all NZ landscapes including inaccessible areas.

Adoption and scaling out: Information technology and statistical or modelling techniques provide informed guidance to regional and national government, industry and citizens to assist in decision-making despite uncertainty, and advice on where to direct limited funds to optimise threat surveillance.

Strategic Outcome 5: We deploy novel tools, technologies & strategies for control or eradication of biotic threats (Linkages to SOs 2, 3, 4, 6, 7)

2024 Intermediate Outcomes:

- *Autonomous systems and the use of sensor technology will have improved efficiency of control or eradication of biotic threats;*
- *Tools and strategies to enable the control or eradication of exemplar biosecurity threats identified in SO3 will have been developed;*
- *Scale-able tools and strategies to enable the control or eradication of at least one predator and at least one priority plant pathogen from mainland New Zealand will have been developed.*

Indicative research:

Discovery science: New tools (e.g. gene editing, novel toxins, artificial intelligence), methods or approaches to control biological threats (weeds, pests and pathogens) are invented.

New approaches: Research on autonomous systems and the use of sensor technology to improve the efficiency of control or eradication of biotic threats. Research on deploying existing tools differently. New skills brought to bear on priority problems (e.g. small mammal predators; phytophthora).

Innovation and integration: Research to integrate biological knowledge of threats with current and new intervention tools and strategies to make step-change progress on control or eradication of selected biotic threats. Develop improved technologies that can be applied in production landscapes.

Translation and implementation: Barriers and opportunities to deploy future technologies currently not feasible because of technical or social drivers will have been quantified (with SO2) and strategies to overcome them identified.

Adoption and scaling out: New technologies and strategies for achieving cost-effective, humane and sustainable control or eradication of biotic threats are deployed at large spatial scales, including by citizens and communities. (Link to SO6 resilience e.g. knowing how ecosystems respond when predators are removed)

Impact 3: New Zealand's natural and production ecosystems are resilient and thriving

Our measure of success: By 2024, we understand social and ecological linkages in natural and production ecosystems, and will be designing technical, policy and governance frameworks to ensure our ecosystems are resilient to current & future threats

Strategic Outcome 6: We quantify social-ecological linkages for use in managing, protecting and restoring land and water ecosystems (Linkages to SOs 1, 2, 3, 5, 7)

2024 Intermediate Outcomes:

- *Native biodiversity and ecological function will improve across natural, urban and production landscapes, through enhanced connectivity and function among taxa, habitats and ecosystems;*
- *We understand and can measure a range of dynamic and complex responses to management interventions, and will be able to predict potential trajectories, in social-ecological systems;*
- *People will be re-connecting to their local environments, and we will be quantifying linkages between human and environmental health;*
- *Interdependencies among land and water domains will be recognised in order to support integrated ecosystem management.*

Indicative research:

Discovery science: Research to quantify hierarchical social, cultural and biological interdependencies from genes to ecosystems across spatial scales. New genomic technologies applied to threatened and endangered species management. Metrics to identify both target biota (linked to SO1) and unwanted organisms to anticipate perverse ecosystem outcomes in response to management interventions and determine how biological heritage is changing.

New approaches: Determine how social, cultural and biological interdependencies (including commercial and cultural uses) could be used to design interventions at relevant spatial scale(s). Biology and ecology of threatened and endangered species to build connectivity across natural and production landscapes.

Innovation and integration: Interdependencies among land and water domains (including but not limited to primary production ecosystems) are considered as a whole system. We understand how decisions made by individuals, communities and institutions shape ecosystem change. Research to quantify how ecosystem linkages are altered when invasive predators are removed.

Translation and implementation: Tools to measure ecosystem responses to management interventions (e.g. translocations of native biota; restoration planting; or wide-scale predator control) and prevent tipping points in case-study natural, urban and primary production ecosystems to validate predictions about how social-ecological systems will respond.

Adoption and scaling out: Research to ensure that social-ecological connections are understood and used by communities to drive positive ecosystem trajectories nationally, regionally and locally (e.g. stream restoration).

Strategic Outcome 7: We enable people are to build biological heritage resilience with the right policy and governance instruments (Linkages to SOs 1, 2, 5, 6)

2024 Intermediate Outcomes:

- *Relevant new knowledge and evidence will be informing law, policy, governance, investments & operational decision-making;*
- *Intergenerational biological heritage legal, policy and governance frameworks will have been developed across social, cultural and institutional boundaries;*
- *System-wide resilience to climate change, land use change, and biotic threats will have improved across natural and production ecosystems;*
- *People understand and act on the knowledge that biological heritage is a vital element of New Zealand's economic, cultural and social wellbeing and national identity.*

Indicative research:

Discovery science: Research that integrates multiple threats and environmental changes (climate, invasive species, land use change) and how communities will respond to these (i.e. a 'systems' approach). Research to develop a rubric or heuristic for 'resilience' that is applicable in New Zealand.

New approaches: Policy, legislation, governance and decision-making relevant to biological heritage are better informed by more complete evidence, and are open to other knowledge systems and world views.

Innovation and integration: *New data and information drawn from Impacts 1-3 (e.g. the biological heritage scorecard; human values) are assembled in new ways to guide institutional decision-making for future generations.*

Translation and implementation: Frameworks for enduring decision-making that are adaptive, and responsive to multiple streams of emerging evidence.

Adoption and scaling out: New Zealand is showing international leadership in adaptive governance and decision-making for biological heritage.

How our strategy builds on activities from the first funding period

The Transition from Tranche 1 to Tranche 2. Development of our strategy builds on a legacy of excellent science, mainstreaming Mātauranga Māori, and identification of aligned research. We also developed novel processes to prioritise, to incentivise collaboration, to build the best teams, and forge new stakeholder interconnections. These processes created the foundations that we are now building on to accelerate towards the Challenge Mission. As part of Progress Reporting (May 2018), the Challenge submitted an 'Overview of Progress' document for Tranche 1. In that document, we detailed our successes to date and signalled areas for further development. We recap key successes that we have built on to shape our Strategy below.

Breakthrough science. 'World first' breakthroughs include: (1) genome sequencing of the *Vespula* wasp; (2) native plant extracts (identified using Mātauranga Māori) attracting and killing the pathogen that causes kauri dieback; (3) a lure for invasive predators and (4) highlighting the 'conservation paradox' for involvement of indigenous peoples in conservation. Breakthroughs of global relevance include: (A) quantification of societal values towards pest control in one of the largest public surveys ever conducted; (B) elucidation of Māori worldviews to guide conservation; (C) technologies for biosecurity surveillance; (D) DNA metabarcoding for environmental monitoring and (E) major conceptual progress in understanding resilience and predicting tipping points. We also ensured that some 'exemplar' projects were Māori-led, as well as interweaving Mātauranga Māori, citizen science, community engagement and social methods throughout our research.

Whilst our investment strategy for Tranche 2 is clearly different from Tranche 1, priority research areas will be maintained. The 'innovation pathway' framework is designed to deepen collaborations for existing research teams in addition to providing stronger pathways to impact.

Transformational approaches. A strength of the Challenge to date has been to integrate across research disciplines and knowledge systems to generate new inter- and transdisciplinary approaches and ways of working. We now need to scale what we have learned to ensure that new breakthroughs are translated into tangible tools for on-the-ground action, adopted into policy, and rapidly deployed at landscape scales.

Aligned research. A cornerstone of our Future Strategy is to connect, integrate and coordinate the large amount of aligned research being done by our Challenge Parties. Building trust and strong relationships has been a unique success factor in encouraging alignment by them. Our Challenge parties have requested that we continue to deepen these relationships to deliver greater impact through focused and scaled-up effort. We will build directly on these successes from Tranche 1, but are now at a stage where we can more clearly direct and reshape Challenge investment to explicitly target gaps and priorities to deliver impacts than was possible in Tranche 1. Detail on how this will be achieved is in the section entitled 'The process by which Strategic Outcomes will be scoped and refined', p.28.

End user co-design. At the inception and early stages of the Challenge (2015 and 2016) we undertook extensive consultation on end user needs, resulting in an [agreed list of Intermediate Outcomes](#) across industry, NGOs, Māori, and agencies. To ensure continuity, we integrated many of those original Intermediate Outcomes with new end user priorities emerging coincident to the development of our new strategy. End users are very satisfied with our research directions and priority setting (2018 Colmar Brunton survey), but have requested deeper involvement in the Challenge as we move into Tranche 2. Our innovation pathway (Figure 2) is explicitly designed to ensure that end users and a wide range of knowledge holders work in partnership with scientists, and that they are driving the research agenda.

Vision Mātauranga. Implementing the Vision Mātauranga policy and mainstreaming Mātauranga Māori into science has been a strength of the Biological Heritage Challenge, and a strategic priority for our Governance Group. Our Kāhui Māori played an active role in shaping our future directions, and in ensuring that Te Ao Māori is embedded in our vision, values, and ways of working. We will build on this success to ensure partnership and equity throughout the Challenge, and clearly demonstrate the enhanced value created through integration of Mātauranga Māori and Te Ao Māori.

Integrating across sectors, including the previously-disconnected biodiversity and biosecurity domains. Prior to inception of the Challenge in 2014, biosecurity and biodiversity research in New Zealand were barely connected or coordinated. End users from industry sectors, NGOs, and regional and national government agencies worked together with our Kāhui Māori to identify Intermediate Outcomes that transcended these differences. Challenge investment was then targeted towards exemplar problems that delivered across several Intermediate Outcomes. We aim to build on this success by focusing cohesive effort towards key priorities to deliver transformational change.

Building capability and capacity: We afforded new opportunities for PhD students, postdocs/early-career researchers, and summer students in Tranche 1, providing emerging researchers with opportunities to be mentored across institutional boundaries including by staff in end user agencies. We intend to build on this success through: (1) opening up new opportunities for leadership and co-sharing of roles; (2) Challenge investment aimed at targeting early-career researchers and a diverse

range of career pathways; and (3) Challenge investment aimed at ensuring Mātauranga Māori is adequately resourced in order build capability and capacity in emerging Māori researchers as well as satisfy strong demand from non- Māori researchers to work in partnership with Māori.

Forging international linkages: We took a strategic approach to build enduring, high-impact international partnerships deemed likely to leverage international expertise and build international networks for New Zealand researchers. This approach is already yielding new collaborations and opportunities, and we will build on this success in Tranche 2.

Our process for developing this strategy

We applied an intensive collaborative, co-design approach throughout the development of our strategy, working closely with our 18 Challenge Parties and a wide range of stakeholders and end-users with interests aligned to the Challenge objective and Mission. Consultation processes with Challenge Parties, end users and stakeholders, our Kāhui Māori, and International Science Advisory Panel began in the latter half of 2017; this recent intensive consultation built on our ongoing efforts to broker relationships across a wide range of sectors since the inception of the Challenge in 2014.

Stakeholder and end-user co-design

Senior executives: To ascertain big-picture strategic issues that, if solved, would deliver significant benefit to New Zealand, from late 2017 to March 2018 our Governance Board hosted informal events for senior representatives (e.g. CEs) across a range of sectors, local and regional government agencies, and NGOs. Issues of concern to these sectors or organisations emerged from this process and were incorporated as a set of high-level priorities. We used these priorities to scope draft Impacts and Strategic Outcomes, and to road-test them with end-users via their own strategic prioritisation processes (see 'Co-development of research priorities with end users', next page).

Targeted stakeholder representatives via Colmar Brunton Survey: We worked with MBIE to seek input from stakeholders who were familiar with the Challenge and who we hoped would provide robust feedback. Feedback indicated that these individuals had strong confidence in our governance and leadership, and they requested deeper involvement and engagement during Tranche 2, including greater integration of Mātauranga knowledge holders into our investment processes. Our re-focusing of the Challenge around Impacts and SOs, and our intent to target investment at specific leverage points along the innovation pathway, are a direct response to this feedback. Our processes for scoping SOs will address their request for the Challenge to prioritise and focus effort.

Technical and operational: Early in our consultation process, stakeholders reported 'consultation fatigue': since 2015, numerous documents articulating research priorities relevant to biological heritage have been generated by industry bodies, iwi, and local, regional and national government agencies. As just two examples, the pastoral sector released a forage strategy in late 2017 that identified biosecurity research priorities (which we incorporated into our strategy); and our strategy explicitly addresses seven of the 8 research priorities identified in the 2017 Conservation & Environment science roadmap. Development of many of these documents usually included extensive bottom-up consultation processes.

To avoid repeating grass-roots consultation or duplication of efforts, we harvested common themes and emergent research needs (e.g. social partnerships and licence to operate; market and non-market valuation of biological heritage; data integration and big data; novel technologies for pest control; ecosystem linkages and tipping points) across all major strategy documents. These were then cross-referenced with key issues emerging from our consultation with senior executives (previous section)

by testing with end-user organisations, and used to further refine our Impacts and Strategic Outcomes.

Co-development of research priorities with end users: In recent months (since mid-2017) several end-user organisations have refreshed their own strategic research priorities and needs, and these processes coincided with development of the Challenge's Future Strategy. Our Challenge Science Leadership Group and Knowledge Brokers worked closely with these organisations to understand their science priorities. They include:

- Members of the Challenge Science Leadership Group have worked with New Zealand's **Ministry for Primary Industries** to draft priority science needs emerging out of Biosecurity 2025. MPI made extensive use of our 'harvested' biosecurity priorities (see previous paragraph) to inform their own prioritisation processes, and we worked with them to refine these priorities and consult with a range of end users via MPI's networks. At time of writing, ongoing consultation will be completed to coincide with development of Strategic Outcomes from November 2018. Our SOs are strongly reflective of priority research needs identified through the Biosecurity 2025 process.
- Challenge Knowledge Broker Bill Dyck and Programme Leader Maureen O'Callaghan worked with the **New Zealand Plant Producers Institute** and **plant industry sector** biosecurity managers respectively, to obtain a consolidated view of biosecurity science priorities from plant-based industry sectors, and we used these priorities to inform the development of our Impacts and SOs. This industry-led initiative provided an opportunity for joined-up thinking across industry bodies, enabled greater industry influence on the Challenge and Biosecurity 2025 prioritisation process, and enhances alignment between the Challenge and B3, a research consortium with a plant biosecurity focus.
- **Regional Councils and Unitary Authorities** are currently undertaking a refresh of their biosecurity and biodiversity priorities (their 2014 statement informed the Challenge's original research and business plans). In 2018, a bioscience working group (a sub-group of the Regional Council Bio-Managers' group) had significant input to informing our priorities and in co-designing better processes for deeper engagement with Councils. In particular, Councils provided the Challenge with a 'co-design' model that will eventually ensure commitment of key staff from their organisations at critical points along the innovation pathways during development of SOs from November 2018. This will ensure strong alignment with their priority science and research needs.
- Our Impacts and Strategic Outcomes were also informed by the 2017 **Conservation & Environment Science Roadmap**, and Challenge Director Andrea Byrom is a member of the implementation group for the Roadmap, ensuring seamless integration of seven of the eight priorities from the Roadmap with the Challenge's Strategic Outcomes. This is an ongoing process, but fortuitously aligns with the next stage of our development of Strategic Outcomes from November 2018. It will closely involve a number of end user organisations across New Zealand's Natural Resources Sector, and will also be conducted in collaboration with four other National Science Challenges to ensure any co-investment is targeted appropriately.
- We responded to the **Ministry for the Environment's** science needs outlined in their recently-released science strategy and worked with them (via a coordinated process of consensus views from the Ministry) to refine our Impacts, SOs and proposed co-design processes in response to their feedback. Key personnel have been identified by them for further input at implementation stage of our strategy from November 2018.
- With c. **30 stakeholders** from regional councils, NGOs, private companies, government agencies, and community pest control groups, Challenge Knowledge Broker Kevin Collins worked with two Challenge Parties to [review gaps in current knowledge](#) associated with near-to-market tools for

mammal predator control and identify [research priorities](#) to address these needs. These priorities were used to inform the development of our Impacts and SOs.

- We worked with **Predator-Free 2050** Limited to map the research landscape for PF2050 investment, and used the map to inform development of our Impacts and SOs.
- We worked with the **Department of Conservation** to: (a) coordinate and align research needs in an emerging 'Biodiversity Prospectus' that is being developed in response to new government investment in conservation in the 2018 budget round; (b) design the next steps for working more closely with DOC science staff from November 2018; and (c) reflect emergent biodiversity priorities as well as DOC's priorities for the Predator-Free New Zealand initiative in our strategy.

These extensive connections and networks will be leveraged during implementation of our strategy to further refine priorities and inform the intervention logic process for each Strategic Outcome.

Co-design with the science community

Consultation with scientists and researchers was conducted via our 18 Challenge Parties.

- Our Science Leadership Team and Knowledge Brokers worked extensively with existing Challenge research teams to strengthen existing and build new networks, often via targeted workshops. This engages new stakeholders as well as identifies new collaborators on an ongoing basis.
- We consulted with representative 'thought leaders' from each organisation (ranging from 5-15 individuals) during April and May 2018. All 18 Challenge Parties were consulted. We sought input on draft Impacts and Strategic Outcomes (developed by end-users; see previous section) and on proposed draft processes for development of Impacts and SOs. A particular focus of these conversations was on aligned research, which is a key part of our Future Strategy. This process resulted in significantly greater engagement with, and understanding of, this Challenge and our intent to deliver impact for New Zealand. Importantly, the focus of these conversations was not on research funding *per se* but instead focused on alignment, collaboration and coordination across the innovation system to achieve transformational goals. This was an extremely valuable process at this stage of the Challenge because there is still relatively low awareness and understanding amongst New Zealand researchers about the role of the Science Challenges or potential opportunities associated with them. We will leverage these networks of thought leaders during the co-design phase of Strategic Outcomes beginning from November 2018.

Co-design with Māori

- Numerous hui were conducted via our current research activities and via Te Tira Whakamātaki (the Māori Biosecurity Network) to seek emergent biodiversity and biosecurity priorities from whānau, hapū and iwi across New Zealand. These priorities were used to inform the development of our Impacts and Strategic Outcomes. Key individuals have also been identified to contribute to the design teams for the implementation phase from November 2018.
- Māori Manager Melanie Mark-Shadbolt presented to, sought input and received feedback from Pou Taiao Iwi Leaders Group members. Pou Taiao is a group of environmental leaders and technicians representing 74 iwi who make up the Iwi Leaders Forum (ICF). Their priorities relevant to biological heritage (in biodiversity conservation, freshwater restoration, and climate change resilience) are reflected across all three Impact areas in our strategy. Other specific needs such as (1) greater access to relevant environmental information in order to inform decision-making, and (2) support for capability and capacity building, have also been incorporated into our strategy.
- We sought feedback from key Māori academics and researchers from across the country.

- Our Kāhui Māori, Governance Group, and Science Leadership Group worked together to refine draft Impact and Strategic Outcomes statements that the Challenge used for consultation.

Input from our International Science Advisory Panel

Our ISAP provided high-level guidance both on content (i.e. suitability of Impacts/SOs) and process (i.e. the innovation pathway). They were strongly supportive of the 'innovation pathway' approach to orienting greater effort towards a set of shared goals. In particular they provided feedback on (1) our processes and criteria for scoping SOs, (2) how we will ensure that contestability is built into the development of SOs to ensure inclusion of new skill sets and emerging ideas into each SO as they develop (see the section entitled 'Ensuring dynamic introduction of new capability', p. 23). They also (3) recommended that the Challenge hold a proportion of the overall budget as a flexible contingency that can be targeted to new opportunities aligned with emerging strategic priorities. We have incorporated all their suggestions into our strategy.

A strategic, integrated and multidisciplinary portfolio

Strategic: In developing the strategy, both end users and Challenge Parties agreed that we should prioritise 'issues' or strategic areas (Strategic Outcomes) that require a collective impact approach, and that cannot easily be achieved by individual research providers or through other funding mechanisms. Our signalled intention to invest in critical parts of the 'innovation pathway' is a direct response to this feedback. SOs were widely supported by end users and stakeholders, and the intention for design teams to further refine and prioritise the Intermediate Outcomes builds flexibility and agility into the overall portfolio.

Integrated: The innovation pathway enables, and is designed to influence, others to align and integrate effort – whether that be through research activities, technology development, in-kind contributions from communities and agencies, and involvement of Māori at all stages. We have also secured agreements in principle to co-invest in areas of mutual interest from three other National Science Challenges and three Centres of Research Excellence. These entities share similar philosophies in collaboration and interdisciplinary research.

Multi(inter/trans)disciplinary: There was strong enthusiasm and desire from both Challenge Parties and end users to contribute to larger portfolios of integrated effort aimed at delivering impact, which necessitates integration across disciplines. We have ensured significant opportunities for high-impact inter- and trans-disciplinary research across environmental domains within our framework: the innovation pathway approach requires explicit and deliberate design of a portfolio of research across a spectrum that includes discovery science, technology, integration, translation and adoption.

Meeting the Challenge objective and outcomes

The **Challenge objective** (protect our biodiversity, improve our biosecurity, and enhance our resilience to harmful organisms) is reflected across all Impacts and SOs, although the Impacts and SOs are designed to be integrated and therefore deliver on the objective across all three Impact areas. We also paid careful attention to ensure that the five **Themes** in the Gazette Notice were integrated into our proposed portfolio of work (Figure 3). The Themes are explicitly addressed in our framework even though the Challenge structure is not designed around the Themes *per se*. Key concepts (e.g. characterisation, resilience, restoration, interdependencies, social licence, measurement and assessment) in the Impacts, SOs, and Intermediate Outcomes link to the Themes in the Gazette Notice. Our new Strategic Outcomes and Intermediate Outcomes reflect the original **Outcome**

Statements in the Gazette notice, but have been updated to reflect recent end user needs and emergent priorities.

Figure 3. Schematic representation of linkages between the original Themes in the Gazette Notice and our Impacts and Strategic Outcomes.



Challenge funding is relatively modest compared to both aligned research efforts and other contributions needed to achieve impacts. In order to deliver a **step change**, the intervention logic structure and process (i.e., the 'innovation pathway') is deliberately designed to deliver practical outcomes over the lifespan of the Challenge. We intend to drive the transformation needed to achieve the Mission through incentivising diverse communities and institutions to connect, prioritise, and accelerate towards common goals and to measure and evaluate success.

How we address the Themes in the Gazette Notice

We directly address all five Themes in the Gazette Notice (Figure 3), albeit with a change in structure that reflects a different innovation landscape in New Zealand relative to initial scoping of the NSCs in 2013 (see section above). Our renewed focus on Impacts was developed through co-design with end users and with Māori, and more strongly reflects their needs than our original research programmes. We did this in response to specific feedback from stakeholders in the 2018 Colmar Brunton survey that we re-focus around benefit to New Zealand, and in turn this prompted our shift from subject-based programmes to outcome-focused SOs. Although superficially our structure appears similar to Tranche 1, with three Impact areas replacing the three research programmes, this change reflects a fundamental shift in organising principles to clearly focus on meaningful impact, inviting deepened and sustained engagement amongst the research community, Māori, stakeholders and end users.

Meeting the needs of our end users: focus, balance, and related research

See above ('Stakeholder and end user co-design') for a summary of how the Challenge has responded to the **needs of end users** and stakeholders, and for how we are comprehensively addressing relevant **strategies and plans** (e.g. Biosecurity 2025; the Conservation and Environment Roadmap; Predator-Free 2050 Limited; industry bodies).

Focus in our research portfolio is achieved through explicitly designing larger portfolios of research (the SOs) to focus on impacts that are at once priorities for end-users and essential for reversing the decline in biological heritage. Further focus will be assured during design and implementation of SOs, through refinement of Intermediate Outcomes.

Balance of the research portfolio has shifted from the current approach we used to establish a set of research projects. We consider balance to be the complete set of knowledge, skills and adoption needed to ultimately achieve impact, and this necessitates inclusion of a greater set of skills or organisations than most *status quo* programmes of research.

Related research: From a Challenge perspective, understanding the relative contributions (not just from research organisations but also from kaitiaki, communities, agencies and NGOs) already in train along an innovation pathway will enable us to optimally deploy our own resources, and harness related efforts, to ensure an impact-oriented approach. SO teams will be expected to scan emergent national and international efforts to identify synergies and new tools or approaches, pool resources, and work to common goals where there is mutual benefit.

Building on NZ and international research, capabilities and user communities

New Zealand research and capabilities: Elsewhere we have indicated that our strategy builds extensively on aligned research efforts from our Challenge Parties, which include all New Zealand CRIs and Universities as well as the Cawthron Institute, DOC and MPI. As a consequence we are in a strong position to show leadership across the NZ innovation system. Our aim is to prioritise and focus these efforts using an intervention logic process for each SO.

Our Challenge Parties have already indicated a willingness to move beyond a simple spreadsheet documenting alignment of research programmes. Instead they are willing to join impact-oriented SO areas and jointly seek contestable funding from other sources to target knowledge gaps and strengthen specific components of SOs. Further, our framework provides a mechanism for other knowledge holders and relevant expertise across a diverse range of individuals and institutions to contribute complementary effort and skills along the innovation pathway for each SO.

International connections: In Tranche 1, we took a strategic approach to building international connections, with investment aimed at identifying, developing & fostering priority international linkages to:

- Assist in delivery of the Challenge objective;
- Enhance science quality and excellence;
- Leverage international capability and resources in priority areas for New Zealand that are of mutual interest to international collaborators;
- Contribute to global research efforts;
- Build New Zealand and Challenge profile internationally.

We will continue to take this strategic approach in Tranche 2. SO leaders will be expected to identify international opportunities where investment could enable demonstrable growth in scale and impact in areas of strategic importance to New Zealand, preferably spanning multiple SOs and Impacts, and to make a case for investment to the Governance Group and Science Leadership Group. We expect that international opportunities will be resourced within each SO, however the Challenge will retain oversight of the overall portfolio of strategic international opportunities.

User communities: In the section on 'Stakeholder and end user co-design' we outlined how user communities have co-developed Impacts and SOs and signalled how they will be embedded in future. Our innovation pathways are designed to engage and involve user communities from the outset in order to make best use of their (often complementary) skill sets and expertise at all stages along the pathway.

Accessing funding and support from a range of sources: In the section on 'Balance of Investment' we identified a number of organisations (including CoREs and other Science Challenges) prepared to contribute investment or expertise in addition to our Challenge Parties. End user agencies (e.g. DOC, MPI, Regional Councils) have also indicated a willingness in principle to contribute staff time (and operational research support where appropriate) to co-design SOs from their inception, and (on an ongoing basis) work in partnership to achieve these outcomes – particularly (but not limited to) the translation and adoption parts of the innovation pathway. Further, our Future Strategy will connect, convene and focus currently-fragmented and disjointed research effort to contribute more directly to deliver impacts. We worked to build trust with our Challenge Parties to drive cohesion and focus, and whilst these efforts will take time to mature, we have secured their collective commitment.

How we will give effect to the Vision Mātauranga policy

Overview

Māori have strong connections to the biological heritage of Aotearoa, with valuable intergenerational views and belief systems that can underpin decision-making, governance and stewardship. We have embraced Te Ao Māori throughout the Challenge, because these values strengthen our commitment to leaving a legacy in the New Zealand science and innovation system. We also embrace the mission statement of the Vision Mātauranga policy: *'To unlock the innovation potential of Māori knowledge, resources and people to assist New Zealanders to create a better future'*. Our work to date has placed us in a strong position to step up to a new level of commitment and respectful partnership at all levels of the Challenge, and to demonstrate leadership in the wider New Zealand innovation system.

Our success so far: We have given effect to the VM policy through:

- Partnerships with iwi, hapū and whānau;
- Building relationships and fostering co-innovation;
- Being innovative and working respectfully towards common goals;
- Building transdisciplinary research projects that blend Mātauranga and scientific method;
- Building Māori capability and capacity;
- Resourcing of VM-specific research;
- Building capacity in non-Māori researchers and end users to build trust and confidence in their own ability to engage.

The next steps: We will give effect to the Vision Mātauranga Policy and build on our success through:

- **Confirming our commitment to partnership**, and giving effect to Te Ao Māori perspectives, at all levels of the Challenge;
- Seeking opportunities for the right mix of skills – including Māori – through succession planning for **governance roles** in Tranche 2;
- Creating opportunities for **emerging Māori leaders** and exploring co-leadership models;
- Further building capacity amongst **non-Māori researchers and end users** to enable them to work confidently in partnership with tangata whenua;
- Investment in, and promotion of, **Kaupapa Māori** and **Māori-led research**;


- Ensuring that Māori researchers and/or iwi, hapū and whānau are **embedded** in Challenge investments, with our investments demonstrating **at least 3 on the Vision Mātauranga scale** (defined as projects where Mātauranga Māori is collected and incorporated, Māori are involved in the design and implementation of the research, and where the work is contributing to iwi, hapū and whānau aspirations and outcomes; more information on the VM scale is on our website);
- Ensuring that teams developing SOs actively seek opportunities for **meaningful co-design** of Strategic Outcomes by Māori;
- Taking a **proactive role** in our partnerships with Māori researchers and communities and investing Challenge resources in building relationships early to ensure trust and respect are an integral part of the way we work;
- Ensuring **knowledge exchange with indigenous researchers and communities worldwide**, with opportunities to contribute to key relevant international processes (e.g. IPBES);
- **Partnering** with other entities seeking to build Māori capability and capacity across the New Zealand science system (e.g. the Ngā Pae o te Māramatanga and Te Pūnaha Matatini research CoREs) through (1) supporting existing Māori researchers to build better CVs through leadership opportunities and publications; (2) providing emerging Māori researchers with mentoring and professional development opportunities (e.g. through scholarships); and (3) providing opportunities for students through summer scholarships for undergraduates, and resourcing for postgraduate study;
- **Enriching** our research and innovation investments by blending Mātauranga Māori with contemporary research methods;
- **Equitable and fair resourcing** of Māori capability and knowledge within each SO;
- **Leading by example** and showing how increased diversity and inclusivity in science can generate better outcomes for Aotearoa.

Our values

We worked with our Kāhui Māori to identify the values that have become a part of our Challenge culture (Figure 4). We have made a purposeful commitment to embracing and embedding these values in every facet of the Challenge.

Figure 4. Our values and how we apply them.

| Our Values | How We Apply Our Values |
|--|--|
| <i>Mahi whaipanga</i> | We care about making a difference for Aotearoa |
| <i>Ngākaunui / Uekaha / Ngakau Whakapuke</i> | We are passionate and enthusiastic about our work |
| <i>Whanaungatanga</i> | We work as a family We have fun together |
| <i>Manaakitanga</i> | We build trust and create a place that others want to be a part of We build mana in others around us to enhance the mana of the whole |
| <i>Mana Motuhake / Tino Rangatiratanga</i> | We recognise and empower sovereignty and autonomy |
| <i>Whakapapa</i> | We recognise interconnections We have an intergenerational vision |
| <i>Kaitiakitanga</i> | We enable stewardship of our biological and cultural heritage |
| <i>Mātauranga</i> | We recognise the value of blending traditional and modern knowledge |
| <i>Tohungatanga / Ngā tiketitanga o te pai</i> | We apply excellence to everything we do |
| <i>Mahi rangapū</i> | We work respectfully in partnership |



Ensuring quality and excellence in research, science & technology

How we will build on the skills of New Zealand and international researchers

Making best use of the skills and expertise of New Zealand researchers

We recognise that a step change is required in science and research in Aotearoa if we are to deliver greater impact at scale. This strategy explicitly identifies, and will foster, excellence in a number of dimensions including in science and across a range of research activities. We take a broad view of 'excellence' that encompasses current metrics of publishing quality and rate of work, but given the integrative and aspirational nature of the Challenge, we also need to recognise excellence at all stages along the innovation pathway. Put another way, major contributions or breakthroughs in research, science, innovation and adoption are all critical to achieving impact, but require a broader understanding of excellence to demonstrate the value of a collective approach.

Our Impacts and Strategic Outcomes framework breaks down outdated views of a dichotomy between 'discovery' and 'applied' research. To that end, a wide variety of skills, expertise and capability will be required from New Zealand researchers, and our collaborative model requires that the contributions of individual researchers are recognised in novel ways (e.g. [Lebel & McLean 2018](#)). Consultations with our Challenge Parties confirmed that such skills and capabilities exist, but they are currently constrained to a few career pathways (e.g. academia). Our framework will ensure that diverse skills are harnessed in new and unique roles – working closely with end users, communities, and knowledge holders, to translate new knowledge into policy and practical outcomes, and to build narratives shaping the future of Aotearoa.

Leveraging international expertise

Each SO will aim to leverage international expertise to ensure internationally leading approaches are deployed where possible or developed when necessary. We outlined our strategic approach to building international linkages in the section entitled 'International connections', p.20.

Ensuring dynamic introduction of new capability

Although the initial stages of scoping and designing SOs will be done via negotiation, SO teams will be expected to bring in new skill sets, capability or ideas for the duration of the SO. This will not be pursued as an open competitive funding round for science projects, but rather through targeted contestable processes that ensure new capability or collaborations are included. Our intent is to ensure ongoing opportunities to include new ideas, people and approaches within SOs through several mechanisms including:

- **Contestability of capability.** SO teams will be expected to advertise for key roles including project managers, communicators, translators and knowledge brokers, postdoctoral fellows and/or research associates, ensuring contestability in building new impact-oriented capacity and capability in the innovation system.
- 'Seed and scope' **discretionary funds**, where a small investment may be required to overcome a critical knowledge gap or barrier and innovative approaches are required to overcome these.
- Incoming or outgoing **fellowships** (or secondments) to stimulate new thinking, approaches or collaborations during short visits between organisations.
- **Flexibility to pursue emerging strategic opportunities.** SO teams will be expected to allocate a proportion of their overall budget to new opportunities for involvement with new research teams

or stakeholders that had not previously been involved, but whose involvement would significantly accelerate towards delivery of an Intermediate Outcome(s).

Our experience in Tranche 1 was that running an open contestable process involved significant costs and did not deliver the desired outcome (that outcome being larger, focused, interdisciplinary efforts across the innovation system). We believe that the targeted contestable processes outlined above are more likely to deliver such an outcome.

Challenge support for the design and ongoing management of an SO is outlined in the section entitled 'How the Challenge will support delivery of Strategic Outcomes', p.26.

Science quality

Contribution to science quality

Within and among SOs, the Challenge is expecting to invest across the innovation pathway from discovery science to translation, adoption and scale out. This should provide an overall balance between high risk/high return research and less risky (but still critical) research, innovation and translation (also see the sections on focus and balance, p.19).

Balance across science disciplines

We have identified at a high level indicative areas of research that will be needed (see detailed research needs under Impacts and SOs). The balance of disciplinary skills needed is extremely broad and includes (but is not limited to) biologists, zoologists, ecologists, modellers, social researchers, psychologists, physiologists, pathologists, epidemiologists, biocontrol, science communicators, translators, policy and law specialists, genomics experts, citizen scientists, economists, engineers, and chemists. The Challenge Science Leadership Group will ensure that a diverse range of disciplines are approached during the scoping phase of each SO.

Novel indicators of science excellence

Our approach necessitates a wider evaluation of science excellence because it works along the entire innovation pathway. As a consequence, we will build on traditional methods of assessing science excellence (e.g. citation scores, Scopus metrics, impact factors), but will widen and develop our own measures of performance and success by evaluating the collective contributions of research and aligned efforts to making new progress and breakthroughs. This does not mean that we will disregard 'traditional' definitions of excellence, but it does recognise that there are high expectations for Science Challenges and that we need to deliver 'excellence' across all seven Performance Areas for a Science Challenge. Additional indicators of excellence will include:

- Connectivity and collaboration: amongst researchers, and between the research community and stakeholders, using network analyses and other measures of collaboration success.
- The impact of inter- and transdisciplinary research being conducted at the intersectional boundaries between disciplines, sectors, and environmental domains, using metrics emerging from the global literature on this topic (e.g. [Leahey et al. 2016](#)).
- Transdisciplinary metrics with an explicit focus on blending Mātauranga Māori with scientific methods and other knowledge bases, emerging from indigenous research worldwide.
- Capability and capacity building (e.g. for early-career researchers and Māori) ([Lebel & McLean 2018](#)).
- Other measures of excellence that demonstrate major breakthroughs along the innovation pathway from discovery science to adoption and scale out.

Re-defining scientific excellence is a hot topic internationally (e.g. [Goring et al. 2014](#); [Nature editorial 2018](#); [Lebel & McLean 2018](#)). However, alternative metrics of excellence are not always easy to characterise. We will contribute to a growing body of researchers demonstrating international leadership in developing the above alternative metrics, and will further scope ideas for alternative metrics of excellence with international collaborators. All Challenge investments will still undergo independent peer-review by our International Science Advisory Panel and/or others with relevant expertise, and (as now) assessors will be provided with clear criteria for evaluation of proposed work.

Helping end users take up research

Our 'innovation system' approach is explicitly designed not just to ensure end user 'uptake', but to remove perceived barriers and constraints across organisational boundaries, with end users and knowledge holders shaping and co-designing the research agenda to drive a paradigm shift towards impact-oriented science and research. Under our framework, all types of skills and roles – including those of end users – will be required if the Challenge is to deliver on its Mission. Our commitment to resourcing (for example) broker and translator roles is one example of what will be needed; equally, end users have indicated a strong willingness to commit time and expertise.

Assessment criteria for Strategic Outcomes

If the Challenge is to set a course for achieving the greatest long-term impact for biological heritage, we need to deliver excellence across the seven common performance areas for all NSCs. We intend to ensure excellence in research breakthroughs, end user co-design, Mātauranga Māori, capability building, succession planning, and international connections. To achieve this, the following criteria will be used to assess whether SOs are investment-ready.

- Each SO must clearly demonstrate how it contributes to the Impacts and to achievement of the **Challenge Mission**;
- Each SO will need to have **scale and critical mass** (i.e. will likely represent several million dollars of effort across each innovation pathway), and/or be scaleable in future as new opportunities and new connections come to light.
- Each SO will be expected to **develop a narrative** about the overall portfolio of effort, and to include storytellers and/or translators in the team.
- Critical knowledge gaps, potential risks, and barriers to delivery must be clearly identified and **plans to target Challenge investment** to overcome these clearly articulated.
- Each SO must demonstrate a **balance of skill sets, research disciplines and career pathways** including (but not limited to) project management, conceptual science leadership, interdisciplinary researchers, agencies and communities, and how each will be resourced.
- Clear **lines of accountability** will need to be indicated in terms of delivery of KPIs.
- SO teams must demonstrate the **processes they intend to use to cease investment** if the investment is not delivering the KPIs.
- Challenge funding and resourcing should be allocated with an **overall focus on successfully delivering Intermediate Outcomes** by 2024.
- **Co-leadership** of SOs, including consideration of **succession planning** for **postdocs, early-career** researchers and/or **Māori** leaders, will be strongly encouraged.
- Each SO will be expected to identify **international connections and collaborations** according to the Challenge's strategic guidelines (see the section entitled 'International connections', p.20), and to resource these from within the SO (where appropriate SOs can pool resource if mutually-beneficial international connections are identified).

- SO teams will be expected to identify and outline plans to pursue opportunities to **leverage investment from the private sector**.

How the Challenge will support delivery of Strategic Outcomes

The Challenge will:

- Provide a supportive infrastructure (e.g. streamlined contracting processes, etc) for all SOs; however it will be expected that SO teams will have identified other sources of potential administrative support (e.g. from Challenge Parties, end user organisations, and others).
- Commit to investing in some critical skill sets and roles within the management and/or support structure in order to support SOs (e.g. communications, project management, knowledge brokering). It may also be appropriate, for example, to share project management resourcing across more than one SO.
- Work with organisations across the innovation system to support flexible and dynamic contracting agreements, to overcome potential sticking points, and to offer alternative contracting models that are aimed at a high degree of flexibility and autonomy.
- Ensure that rapid decisions are made by the Governance Group and Science Leadership Group such that a minimum of 3-4 SOs have been designed, scoped and are ready for contracting by mid 2019.
- The ISAP will provide peer review where required and help to identify relevant international connections, as they have in Tranche 1.
- The Challenge Governance Group are committed to using their networks and influence to help leverage private sector investment.

How we will deliver impact

We aim to deliver impact for biological heritage in three areas:

1. New Zealanders value our biological heritage, understand how it is changing, and are inspired to take action to protect it.

Success measure: *By 2024, a majority of New Zealanders value our biological heritage, & are enabled to actively contribute to positive change*

2. New Zealand's biosecurity system is world class.

Success measure: *By 2024, New Zealand's biosecurity system is fit for purpose*

3. New Zealand's natural and production ecosystems are resilient and thriving.

Success measure: *By 2024, we understand social and ecological linkages in natural, urban and production ecosystems, and will be designing policy and governance frameworks to ensure our ecosystems are resilient to current & future threats*

Of necessity, these Impacts are sufficiently high-level and signal our long-term vision for Aotearoa. However, our strategy explicitly establishes a framework to enable rapid focus, cohesion, and prioritisation of effort below the level of an Impact: through seven Strategic Outcomes that are designed to be cross-cutting, inter-disciplinary, and – most importantly – enable end-user and Māori-led prioritisation.

Once priority areas of focus have been established, SO teams will develop a **results framework** and use intervention logic to measure progress at every step along the innovation pathway. Success of the Science Challenges is measured across 7 common performance areas:

1. Delivery of the Challenge objective

2. Science Quality
3. Best Teams
4. Stakeholder Engagement
5. Mātauranga Māori
6. Governance & Management
7. Public Participation

In our strategy, Performance Area 1 (delivery of the Challenge objective) enables us to set up a results framework along the intervention logic pathway from discovery science to adoption and scale out, and the 7 Performance Areas effectively provide mechanisms by which performance can be measured. This approach will provide clear line of sight from discovery science to impact.

Our framework will be most effective if resourcing is provided to facilitate co-design by a broad range of skill sets and roles including end users, Mātauranga knowledge holders, and translators during the scoping phase of the Strategic Outcomes. These individuals will be directly involved at the beginning to shape and focus effort towards their desired goals, and our proposed criteria (see section entitled 'Assessment criteria for Strategic Outcomes', p.25) will ensure that they remain involved as active partners throughout.

Our intention to target Challenge investment towards barriers or road blocks along the innovation pathway – where new knowledge, innovation or translation are most needed – will further ensure rapid adoption and scale out to deliver impact.

We have identified a number of skill sets and roles that will be needed to drive transformational change along the innovation pathway, including:

- **Discovery Science:** Conceptual and theoretical ('blue skies') researchers;
- **New approaches:** Interdisciplinary researchers;
- **Innovation:** Project managers, coordinators, transdisciplinary researchers;
- **Translation:** Knowledge brokers, storytellers, facilitators, technical expertise in end user agencies;
- **Implementation:** End user operational expertise from agencies, industry and NGOs, citizen scientists, and kaitiaki;
- **Mātauranga Māori** can be interwoven at any point along the innovation pathway.

Recognising and resourcing the diversity of skill sets needed, and treating them as equal partners, is strongly aligned with our values and will build the collective effort needed to deliver transformational change.

The process by which Strategic Outcomes will be scoped and refined

Scoping, design and refinement of SOs will begin from November 2018, and their development will occur in two stages (Figure 5). Whilst the SOs have been broadly defined in our strategy, Intermediate Outcomes are indicative only. Clarifying and finalising Intermediate Outcomes will be a critical first step in focusing the research to deliver 2024 measures of success. The Science Leadership Group and Governance Group will provide strong oversight, direction and guidance during initial scoping of SOs.

Stage 1: Late 2018 and early 2019

At Stage 1 (design and scoping stage), a core group (5-6 individuals) will be convened by the Challenge and will receive seed funding to begin time-limited, initial scoping of each SO. The Challenge will provide Terms of Reference (ToR) to the core group – including defining the personal qualities and leadership skills that will be required – outlining the scope, responsibilities and processes for developing the SO. The core group will be chaired and facilitated by one of the group members.

End users and knowledge holders (including Māori) will form part of the core group: the Challenge Governance Group and Science Leadership Group will work with users and knowledge holders to identify critical skill sets needed at this early stage. These individuals may comprise end users, potential Māori co-leaders, facilitators, and experts in knowledge translation. Science and research skills will be drawn from thought leaders within (but not limited to) our Challenge Parties (identified through recent consultation processes).

The co-design process will be focused on constructing a complete innovation pathway toward achieving Intermediate Outcomes that will be agreed by the group (see above for skills and roles required). Each core SO scoping group should have no expectations that their skills will be required as part of the ongoing leadership team, and acknowledgement of these expectations will be built into the 'seed and scope' contract and ToR.

Scoping SOs at Stage 1 will involve several steps as part of an intervention logic process, although steps could occur concurrently:

Step 1: prioritise. Clarify end user and community priorities and solidify Intermediate Outcomes, and identify key activities or pieces of work needed at each stage along the innovation pathway(s) to achieve the Intermediate Outcome(s). In Step 1, the team will also be expected to identify potential knowledge gaps and to co-develop priorities across researchers, end-users and communities.

Step 2: convene. Identify meaningfully aligned research activity. The core SO team will be required to reach out to research leaders (identified via our previous identification of aligned research) to

determine potential connections and opportunities to add value to existing research effort, and opportunities for re-shaping research directions through aligned research. Initially, both research activities and end user priorities will draw on the Challenge's previous efforts, but will be focused here on populating the innovation pathway for a specific Intermediate Outcome.

Step 3: connect and accelerate. Identify other critical skills, roles, international connections and institutions needed at each stage along the pathway. As part of Step 3, the team will be required to explore opportunities for embedding key end users and knowledge holders more fully, i.e. where their expertise could best be deployed to accelerate and make progress towards adoption of practical solutions to deliver the Intermediate Outcome(s).

Step 4: evaluate. Preliminary critical steps that will form the basis of Key Performance Indicators (KPIs) will be identified by the core teams. Key pieces of research where Challenge investment will be targeted will be identified, and two or three international peer reviewers identified. Potential barriers to delivery will be identified and plans to overcome these clearly articulated. Critical steps will be suitably high-level in order to achieve economies of scale, to maintain a culture of flexibility, and to reduce reporting burdens.

The core team will submit the SO design from Stage 1 (including indicative budget) to the Challenge's Science Leadership Group, who will evaluate the design and make a written recommendation to the Governance Group as to whether the SO should proceed to Stage 2. Assessment criteria will be based on the likelihood that an SO will deliver the Intermediate Outcome(s), or whether it will require further refinement and identification of the right skills and roles before proceeding (details below).

Stage 2: Early to mid 2019

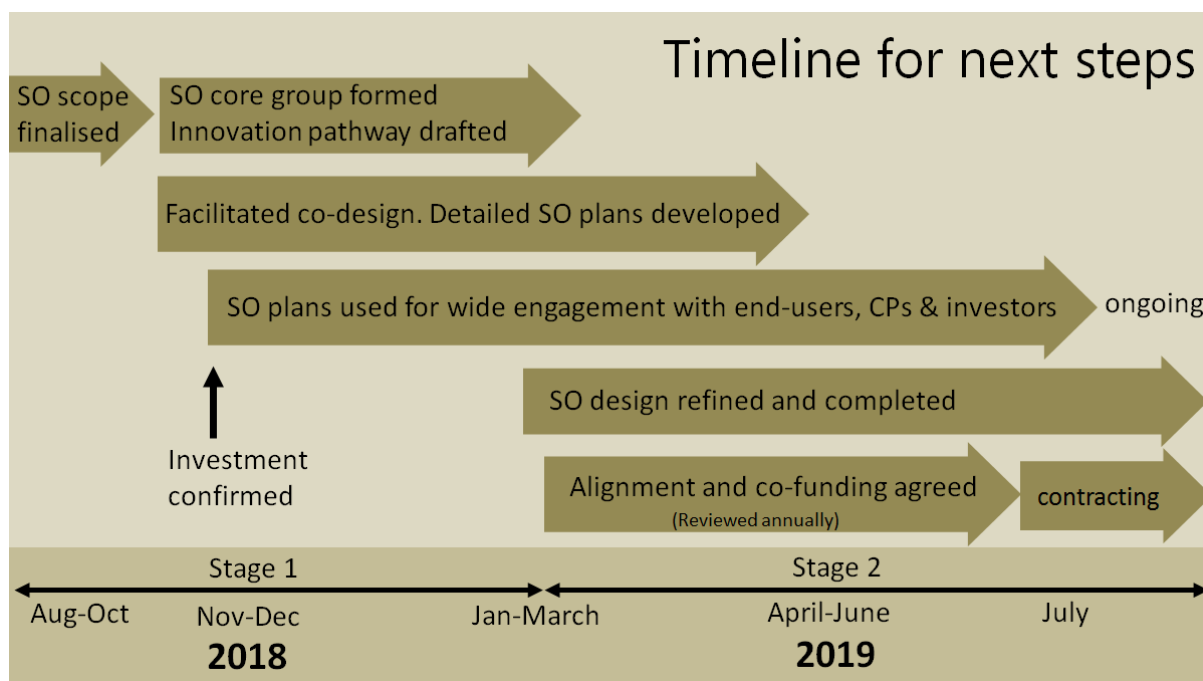
At Stage 2, SO teams will be convened by the Challenge, again with strong direction and ToR from the Governance Group and Science Leadership Group. SO teams may comprise members from Stage 1, but this is not guaranteed. SO teams will be contracted to:

- Finalise appropriate and relevant aligned research investment through the Challenge Parties, and identify the capability and resources needed to connect the relevant effort into an overall portfolio of work.
- Confirm commitment of meaningfully aligned effort from institutions and organisations outside of the Challenge Parties, and identify resource and/or capabilities, skills and roles needed to ensure that such connections are fit-for-purpose and will endure throughout the timeframe of each SO. Draft advertisements for skills and roles required.
- Specify how and where Challenge investment should be targeted across the innovation pathway, what will be delivered, and by when (including design of fast-fail / innovation or seed funds where needed).
- Identify linkages with Māori communities, researchers and organisations, and draft cultural safety agreements where needed.
- Identify strategic international linkages, and draft agreements to work with international collaborators.
- Obtain peer review of relevant parts of the SO, including from the International Science Advisory Panel.
- Finalise KPIs across the innovation pathway.
- Scope opportunities for leveraging investment from the private sector, and ensure that SO teams have the right mix of skills to build the required relationships.
- Submit SO for approval to the Science Leadership Group and Governance Group.

Mid-late 2019

- Contracting begins for investment-ready Strategic Outcomes. Investment readiness will be assessed according to clear criteria (see 'Assessment criteria for Strategic Outcomes', p. 25). We expect that 3-4 SOs will be investment-ready by mid 2019, and another 3-4 by the end of 2019. In Tranche 1 we gained considerable insight into constructing large teams of interdisciplinary researchers, community participants, and end users; this experience will be applied to streamline our investment processes.

Figure 5. Indicative timeline for Stages 1 and 2 of Strategic Outcome development. Stages are approximately consecutive, but the speed and timing of development is likely to differ amongst SOs as a result of differences in their scope, complexity and maturity of current effort.



Benefits and additionality to New Zealand

Additionality: To date, we have been successful in convening new teams that cross organisational and disciplinary boundaries, with emerging evidence that this effort will generate better outcomes for Aotearoa. For example, many Māori communities report satisfaction that they can access science and research expertise more readily, and early-career researchers have been afforded opportunities for leadership that they would not otherwise have been offered. We have also aimed to enhance the mana of our Challenge Parties, and to communicate their stories and successes as part of the whole. We will strive to build on these successes to drive greater impact and paint a compelling collective vision for New Zealand’s biological heritage.

Future leaders: A cornerstone of our strategy is to mentor and build capability in future leaders, whatever their skills, roles and backgrounds. Emerging leaders will be exposed to new opportunities via the Challenge that not be afforded them through their own institutions. Building on exemplars in Tranche 1, our strategy empowers and stimulates leadership skills from within agencies and communities.

Interdisciplinary research: In Tranche 1, social and economic research, and Mātauranga Māori were integrated with biophysical research in order to create additionality and new ways of working. We will

deepen these interdisciplinary activities in Tranche 2. As SOs are scoped, specific disciplinary needs will be identified. The Challenge will target investment to inter- and trans-disciplinary research at intersectional boundaries between disciplines, sectors and organisations in order to drive new interconnections and integration.

Inspirational narrative: As a credible and trusted voice for New Zealand's biological heritage, the Challenge is in a unique and privileged position. Through a combination of science and outreach we are ready to inspire New Zealanders and tell the stories that need to be told about the state of New Zealand's biological heritage, the impact of our research, and the benefits for human wellbeing as people become connected with their environments, delivering previously unrecognised social benefits and building community resilience.

Thought leadership: We bring teams and citizens together and overcome institutional barriers to move difficult conversations forward, striving for thought leadership on difficult topics, such as discussions about novel technologies.

How we will engage with the public, and how we will measure our success: We aim to engage all New Zealanders and inspire them to take action to protect our biological heritage. Bringing science teams, citizens, knowledge holders and communities together enables us to overcome institutional barriers. Our outreach activities will be targeted at public engagement through mainstream and social media, and through capability building specifically aimed at rangatahi (youth) to inspire them to connect with science and research. We will also continue with our '[Flagship Site](#)' approach to raise the profile of science and research in areas where diverse communities are implementing on-ground restoration to protect biological heritage. Further, our current communications expertise in the Challenge has specialist knowledge in monitoring and evaluating the success of engagement activities. We will connect our social and policy research (particularly in SOs 2, 6 and 7) with this expertise and with the proposed translators and communicators in each SO to drive public engagement and learn from our efforts using measurable KPIs established within and across SOs.

Our legacy: New Zealand is a small country, but has the opportunity to demonstrate international leadership in solving strategic national problems through more cohesive and integrated research and innovation that enables discovery science, new approaches, innovation, translation and rapid uptake of new tools. What is lacking is the overall strategic leadership and coordination required: National Science Challenges have the opportunity to do this because they connect and coordinate across all research organisations as well as a wide range of agencies. Our aim is to demonstrate successful alternative ways in which science and innovation can be harnessed and integrated across a diverse set of actors and institutions, creating a science and innovation system that has a more strategic, long-term view and is focused on solving priority issues for New Zealand.

Decision-making and accountability

Our decision-making and accountability arrangements will be sound, enduring, and fit-for-purpose.

Governance

No major changes are proposed to the Challenge governance structure. Membership was recently expanded to broaden and deepen Māori knowledge and perspectives by appointing an additional Māori leader (the current chair of the Kāhui Māori) to the Governance Group.

We intend to retain a skills-based Governance Group, with accountability to the Manaaki Whenua (Challenge Host) Board. Our Governance Group and Kāhui Māori have drafted a statement of mutual commitment to the shared success of the Challenge, and have established a working group to determine what diverse skills and roles – including Māori – may be required to ensure fit-for-purpose governance in future.

The Governance Group and the Manaaki Whenua Board have also agreed on a statement of shared commitment between the Host and the Challenge. This is particularly important as Manaaki Whenua seeks to use SSIF and other funding mechanisms to identify how best to contribute along the innovation pathway for each of the Challenge's Strategic Outcomes.

Management and Support

Our Science Leadership Group will be re-structured around Impacts and Strategic Outcomes. All of the current Science Leadership Group are committed to a transition period in the 2018/19 financial year.

A range of complementary skill sets will be required to lead each Strategic Outcome. For example, good science leadership will need to be complemented by strategic oversight, project management, Mātauranga Māori and Māori leadership, end users, communicators, and knowledge broker equivalents. Given this need, leadership of Strategic Outcomes will comprise small teams of 5-6 people, with one individual identified and selected to become a member of the Science Leadership Group. At least one end user agency has offered staff time to contribute to a leadership role at management level. The Challenge is committed to exploring such novel models of leadership.

Key individuals at management will be appropriately resourced (e.g. a minimum of 0.5 FTE) with role descriptions reflecting the impact-oriented focus of the roles.

The Challenge will continue to resource dedicated support roles including project management, communications, facilitation and coordination, contracts operations and management, and executive assistance. There may be opportunities to blend support roles with the new management structure.

Financial structures and contracting arrangements

No major changes to the financial arrangement of the Challenge are proposed. We are aiming to streamline contracting processes in Challenge envelope funding, with greater flexibility and a significantly reduced focus on compliance reporting in Tranche 2. Strategic Outcome leaders will primarily be responsible for delivering Intermediate Outcomes by 2024 with SOs and Impacts in mind.

Accountability

The Governance Group will remain responsible for strategic oversight and direction of the Challenge, including approval of priority investment that will deliver greatest impact. The equivalent of the

current Science Leadership Group will be responsible for implementing the strategy by applying any agreed criteria for investment (see 'Assessment criteria for Strategic Outcomes', p. 25).

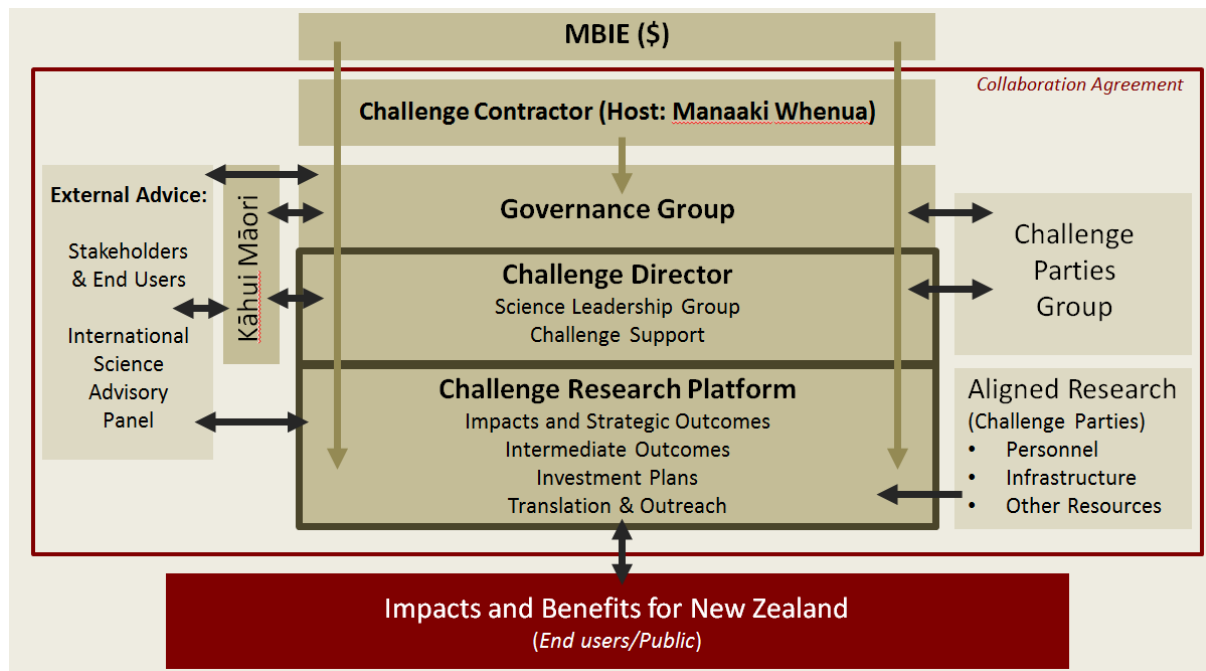
Vision Mātauranga

Our plans to give effect to the Vision Mātauranga policy are covered in a previous section (p.20). In line with our intent to embed Te Ao Māori throughout the Challenge, and in line with our values (p.22), the Challenge intends to invest in VM research, capability and capacity building in Māori researchers, and in mentoring and co-leadership roles.

Proposed Challenge structure

Our proposed structure is similar to Tranche 1, but has been updated to reflect impact-oriented investment and an active role for the Kāhui Māori in working closely with the Governance Group (Figure 6).

Figure 6. New Zealand's Biological Heritage National Science Challenge Governance, Management and Support structure, and research platform.



Five-year indicative budget

Below we provide indicative budget allocations across Impacts and SOs. Allocations will be further defined once prioritisation occurs through the investment logic process at Stage 1 of SO development for each SO.

The Challenge will seek maximum opportunities for integration between SOs. The Governance Group and Science Leadership Group may therefore strategically redistribute investment between SOs in order to achieve maximum impact and benefit from the Challenge portfolio as a whole.

At this stage our intention is to scope 3-4 SOs during the 2018/19 financial year using remaining funds from Tranche 1. This will maximise the opportunity for contracting to begin in July 2019. As the scoping process rolls out, we will be able to provide more specificity on between-year investments within each SO.

| | | | |
|---|--|--|--|
| TOTAL BUDGET (2019-2024): \$37.9m | | | |
| Research investment – 87% of total budget \$33.0m | Impact 1 (\$7.8m) SO1 – \$3.9m SO2 – \$4.4m | Impact 2 (\$9.8m) SO3 – \$3.1m SO4 – \$3.4m SO5 – \$3.3m | Impact 3 (\$8.8m) SO6 – \$4.4m SO7 – \$3.9m |
| Contingency (\$6.6m) – 20% of science budget, to be allocated across 7 SOs as/where/when needed | | | |
| Communications & Engagement – 8% of total budget: \$3.0m | | | |
| Governance & Management – 5% of total budget: \$1.9m | | | |

SOs will also be expected to signal indicative allocations to specific areas including:

- Giving effect to Vision Mātauranga;
- Innovation;
- Capacity and capability building;
- Seed funding for new/risky ideas;
- Co-funding for post-docs or secondments;
- Fostering and leveraging international collaborations;
- Contingency/unallocated funding to capitalise on new opportunities.

The Challenge does not intend to be prescriptive at this stage as each SO will have different needs and priorities.

Scenario planning

Climate change adaptation

Climate change is likely to be a significant driver of long-term changes in biological heritage through direct effects on species, or indirectly through interactions with other drivers such as biological invasions and altered land use. Within the scope of our strategy, we plan to work with the Deep South NSC to link new predictions of future climate change or extreme events with future biosecurity risks and resilience of native species and ecosystems. However, a fuller understanding of climate change impacts on natural capital, and biological heritage adaptation across systems (biological, economic and social), and research aimed at future-proofing New Zealand's natural, urban and primary production ecosystems against climate change impacts more generally (e.g. expansion of warm season weeds like C4 grasses), would require significantly larger and consolidated investment to resolve.

Marine biosecurity

The scope of the Biological Heritage NSC focuses on freshwater and terrestrial domains, and does not currently cover marine biodiversity or biosecurity. Likewise, whilst invasive organisms are considered a potential stressor in the 'Ecosystem-Based Management' focus in the Sustainable Seas Challenge, by and large, urgent issues in marine biosecurity remain a gap between Science Challenges and in the science system. Effective marine biosecurity is important to protect New Zealand's environmental, cultural and economic values from the impacts of invasive species, but has struggled to receive the support it requires given the extent and complexity of our marine domain. It is widely acknowledged, particularly through the development and implementation of MPI's Biosecurity 2025 process, that this area is underfunded. The extent and value of New Zealand's marine resource and marine biodiversity make this a significant concern. Of priority is a 'whole system' approach to addressing the spread and impact of invasive organisms in the marine domain, and to develop better marine biosecurity prevention and management tools, surveillance technologies and solutions to existing biosecurity problems that are threatening biodiversity values. Given the scale of effort needed to make substantive progress on reducing or mitigating the impacts of invasive marine organisms, this gap would require significantly greater investment aimed at leveraging expertise across a range of organisations. New investment in this area would provide opportunities for creative cross-domain multidisciplinary solutions from the Challenge. With its focus on strengthening end-to-end biosecurity, the BioH NSC is well placed to coordinate such an effort and work with the Science for Technological Innovation NSC, the Cawthron Institute, NIWA, and others to apply new technologies, new science, and new engineering solutions in the marine environment. Significant new investment has the potential for a step change for marine biosecurity.

Glossary and Acronyms

Glossary of terms

| | |
|--------------------------|--|
| Aligned Research | Research being done by the Challenge's 18 Parties that is aligned to the Mission but not contracted or directed by the Challenge. http://www.biologicalheritage.nz/programmes/aligned-research |
| Biotic Threats | Weeds, animal pests, pathogens and viruses. |
| Challenge | The New Zealand's Biological Heritage National Science Challenge. |
| Challenge Parties | Eighteen organisations with research capability, expertise and infrastructure who have signed the Collaboration Agreement. http://www.biologicalheritage.nz/about/parties |
| Cross-cutting | Spanning more than one Strategic Outcome or Impact |
| Co-design | Involvement of end users and knowledge holders in shaping and designing research objectives to deliver impact |
| End user | Individuals or organisations who adopt and use new knowledge and tools; beneficiaries of the research. |
| Environmental domains | Major ecosystem types e.g. terrestrial, freshwater etc. |
| Flagship Site | The Challenge supports Flagship Sites to enhance the profile of science and to deepen community engagement. http://www.biologicalheritage.nz/programmes/engagement/flagship-sites |
| Governance Group | Challenge governance board. http://www.biologicalheritage.nz/about/structure/governance-group |
| Hapū | Māori sub-tribe |
| Impact | The final, long-term effect in a causal results chain (MBIE definition). |
| Innovation Pathway | Operating model that the Challenge will use in Tranche 2 to ensure delivery of long-term impacts and benefits for New Zealand. |
| Intergenerational | Spanning multiple human generations |
| Intervention Logic | Process used during planning and implementation of a programme to depict logical causal relationships between resources, activities, outputs, outcomes, and impact (sometimes called 'Theory of Change'). |
| Iwi | Māori tribe. |
| Kāhui Māori | Group that provides strategic advice and support to the Challenge Governance Group and Science Leadership Group on Vision Mātauranga, the Treaty of Waitangi, tikanga (protocol) and other strategic matters. http://www.biologicalheritage.nz/about/structure/kahui-maori |
| Knowledge Broker | The Challenge employs three Knowledge Brokers to help with translation and on-ground implementation of our research. http://www.biologicalheritage.nz/about/structure/knowledge-brokers |
| Knowledge holders | Individuals or institutions who can contribute knowledge and expertise to the Challenge. Often (but not always) used to refer to Mātauranga Māori. |
| Mātauranga Māori | Māori knowledge. |
| Resilience | The ability to recover from a major disturbance or disruption. |
| Science Leadership Group | Challenge management team. http://www.biologicalheritage.nz/about/structure/science-leadership-group |
| Stakeholder | The diverse group of individuals and institutions involved in the Challenge. |
| Te Tira Whakamātaki | The Māori Biosecurity Network. |
| Thought Leaders | Individuals (researchers, communicators and research office staff) identified as key contacts for each of our 18 Challenge Parties. |
| Tipping point | Rapid ecosystem degradation to an alternative state. |
| Transdisciplinary | Integration across science and research disciplines to create a new holistic approach. |
| Vision Mātauranga | A policy framework developed by the New Zealand government to guide research to unlock the potential of Mātauranga, resources and people. |
| Whānau | Extended family or family group. Also used in our Challenge to refer to the feeling of being part of a 'family'. |
| Acronyms | |
| B3 | Better Border Biosecurity |
| CEs | Chief Executives |
| CoRE | Centre of Research Excellence |
| DOC | Department of Conservation |
| ISAP | International Science Advisory Panel |
| KPI | Key Performance Indicator |

| | |
|--------|--|
| MBIE | Ministry of Business, Innovation & Employment |
| MfE | Ministry for the Environment |
| MPI | Ministry for Primary Industries |
| NSC | National Science Challenge |
| NGOs | Non-Government Organisations |
| NZ | New Zealand |
| PF2050 | Predator Free 2050 Limited |
| SO | Strategic Outcome |
| SSIF | Strategic Science Investment Fund (core funding for Crown Research Institutes) |
| VM | Vision Mātauranga |

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Our Challenge Parties (the Challenge Host is Manaaki Whenua)



Appendices (attached to email with submission)

1. 2017 Highlights Report, which was submitted as part of the Progress Reporting in May 2018.
2. A concise, non-specialist visual representation of this strategy, which has been designed for use as an engagement tool with stakeholders in future. All information in that document is contained in this primary strategy document (i.e. there is no stand-alone or extra material).

NEW ZEALAND'S
BIOLOGICAL
HERITAGE

Ngā Kōiora
Tuku Iho

National
SCIENCE
Challenges

