



**MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT**
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National Science Challenges

**Science Board
decisions on second
period funding**

2018

National
SCIENCE
Challenges



Contents

Background	3
Science Board Decisions	3
General Themes from the Mid-way Review Panel Reports	8
Annexes	
Annex One: The NSC Mid-way Review Process	10
Annex Two: Summary of NSC Mid-way review assessments	11
Annex Three: NSC Science Highlights	23

Background

1. In September 2013, Government established the National Science Challenge (NSC) programme to address the most important national-scale issues facing New Zealand through collaborative science. They provide an opportunity to align and focus New Zealand's research on large and complex issues by bringing together the best team of scientists from different institutions and disciplines.
2. Cabinet agreed a ten-year funding envelope for each National Science Challenge, with funding approved in two stages. Between 2014 and 2015, the Science Board agreed to fund the eleven NSCs for their first funding period within the Cabinet-agreed funding envelope. The first funding period saw all NSCs contracted to 30 June 2019.
3. Cabinet agreed that funding for the second five-year period, from 1 July 2019 – 30 June 2024, would be subject to a mid-way review and a further funding decision by the Science Board.
4. On 12 September 2017, the Minister of Research, Science and Innovation issued a Gazette notice to instruct the Science Board to make funding decisions for the second five-year period. The purpose of the mid-way review was to establish whether the NSCs are on track to deliver their objectives and to inform the Science Board's decision about second period funding. MBIE assembled an independent panel of experts for each Challenge to support the review process.
5. The Science Board met on 24 October 2018 to make these decisions, within the Cabinet agreed funding envelope, in line with the assessment criteria outlined in the New Zealand Gazette notice, no. 91 — 12 September 2017.

Science Board Decisions

Science Board decisions were informed by the NSC mid-way review conducted by independent review panels

6. The Science Board decisions were informed by the mid-way review, which provided independent assessment of each NSC's Future Strategy for second period funding and the past performance of each Challenge. Annex One summarises the key stages in the review process. In making their assessments, the review panels adhered to the assessment criteria outlined in the New Zealand Gazette notice, no. 91 — 12 September 2017.
7. Review panels were made up of individuals with knowledge relevant to each Challenge, and whose expertise covered one or more of the following: science strategy and excellence, governance and management, Vision Mātauranga and delivery of impacts and assessment of benefits. Each panel had a Chair and four members.
8. MBIE selected panel members to ensure appropriate diversity. Across the 11 review panels there were 28 international panel members and 27 domestic panel members. Eight panels were chaired by women, and three by men. Across all panels 45% of members were women, 55% were men; 24% identified as Māori.

9. The panels met in July and August 2018. They assessed:
 - the past performance of each Challenge and its progress to date in achieving the Challenge objective, and
 - the Challenge's ability to achieve its objective through its Future Strategy.
10. MBIE's recommendations and analysis, supported by the review panel assessments, were presented to the Science Board at their October meeting. The assessment criteria outlined by the Gazette notice directed the Science Board to focus on assessing the ability of each Challenge's Future Strategy to deliver against its objective, while taking into account performance to date.
11. The NSCs started at different times and have different funding levels; therefore, the review did not directly compare NSCs with each other. Instead, the reviews assessed how each Challenge is progressing in achieving its objective and the extent to which progress to date provides a foundation for a further five years' research.
12. As the panel reports have been developed as an input into a Science Board investment process, they will not be made publicly available. However, draft reports have already been provided to the NSCs, and final reports will be provided to the NSCs along with Science Board decisions and feedback to support their ongoing development. Through the review meetings and the panel reports, panels have provided considerable constructive feedback to enable the NSCs to improve their performance. The NSCs were all open and receptive to panel feedback, and many have already started to respond to suggestions made by the panels.
13. Once they have received formal feedback, NSCs will incorporate suggestions into their plans for research from 1 July 2019, which they will develop over the next seven months.

The Science Board has agreed to continue to fund all eleven National Science Challenges

14. The Science Board has agreed to fund all eleven NSCs at the maximum funding amount set by Cabinet in 2013. In making their decision, the Science Board considered the review panels' assessment of each Challenge against the assessment criteria outlined in the Gazette notice. Table 1 illustrates the funding agreed by Cabinet for each Challenge and the Science Board funding decisions for second period of funding.
15. For many of the NSCs the second period of funding is considerably higher than period one funding. The total funding available in the second period relates to the number and maturity dates of contestable contracts that were mapped to the NSC appropriation when it was established in 2013.

All NSCs are supporting excellent science and delivering impacts that address important national-scale issues for New Zealand

16. The Science Board agreed with the review panels' assessments that all National Science Challenges are delivering collaborative programmes that respond to important national-scale issues for New Zealand, support excellent science focused on delivering impact and have appropriate governance and decision-making processes. Science outcomes are already being realised, examples are included in Table 2 and Annex Three.

Table 2 identifies summaries of the assessment of each Challenge.

Table 1: Science Board decisions for second period funding

Challenge	Cabinet approved funding (up to \$ million)		Science Board agreed funding for 2 nd period (\$ million)	Total funding over 10 years (\$ million)
	1 st period To 30/6/2019	2 nd period 1/7/2019-30/6/2024		
A Better Start <i>To improve the potential of young New Zealanders to have a healthy and successful life</i>	14.2	20.5	20.5	34.7
Ageing Well <i>To harness science to sustain health and wellbeing into the later years of life</i>	14.6	20.3	20.3	34.9
Building Better Homes, Towns, and Cities <i>To improve the quality and supply of housing and create smart and attractive urban environments</i>	23.6	24.3	24.3	47.9
Healthier Lives <i>To reduce the burden of major New Zealand health problems</i>	13.7	17.6	17.6	31.3
High-Value Nutrition <i>To develop high-value foods with validated health benefits to drive economic growth</i>	30.6	53.2	53.2	83.8
New Zealand's Biological Heritage <i>To protect and manage New Zealand's biodiversity, improve our biosecurity and enhance our resilience to harmful organisms</i>	25.8	37.9	37.9	63.7
Our Land and Water <i>To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations</i>	27.6	69.3	69.3	96.9
Resilience to Nature's Challenges <i>To enhance New Zealand's resilience to natural disasters</i>	19.6	39.8	39.8	59.4
Science for Technological Innovation <i>To enhance the capacity of New Zealand to use physical and engineering sciences for economic growth</i>	33.3	72.7	72.7	106
Sustainable Seas <i>To enhance utilisation of our marine resources within environmental and biological constraints</i>	31.3	39.8	39.8	71.1
The Deep South <i>To understand the role of the Antarctic and the Southern Ocean in determining our climate and our future environment</i>	24.0	27.1	27.1	51.1

Table 2: Summary of assessment of each Challenge

National Science Challenges	
Building Better Homes, Towns, and Cities	<p>Building Better Homes, Towns and Cities has achieved a significant amount in a relatively short timeframe and has the potential to deliver impactful science and add real value to, and influence, the national agenda on housing and urban development. It has made a step change by bringing together previously disjointed researchers into a collaborative, multi-disciplinary and multi-institutional research programme that is well connected to stakeholders, communities and end-users.</p> <p>Building Better Homes, Towns and Cities has demonstrated innovation in projects, and delivered high quality science and a number of significant outputs. These include outputs on impacts of land covenants on affordable housing, geospatial tools to support urban planning, and the high profile Te Puea Marae model in Māngere, South Auckland, to respond to the homelessness crisis.</p>
Healthier Lives	<p>Healthier Lives has been a strong performer and made good progress towards reducing the burden of major health problems (cardiovascular disease, diabetes, obesity and some types of cancer). It has developed exemplary methods of community engagement, and has co-created 40% of its research with stakeholders, which means implementation of research is more likely. Healthier Lives is well placed to implement their research strategy in the second period.</p> <p>An example of research already implemented is cardiovascular risk prediction equations to provide the first accurate equations for Māori, Pacific, Indian and Chinese peoples, with the Ministry of Health incorporating these into national guidelines for general practitioners.</p>
New Zealand's Biological Heritage	<p>New Zealand's Biological Heritage has presented a credible and ambitious strategy for research. Partners have aligned \$176 million of their own research projects to help achieve the Challenge objective, illustrating the impressive progress the Challenge has made in coalescing previously disparate biodiversity and biosecurity research activity. The Challenge's significant achievements in the first funding period include a high number of quality science publications and strong strategic leadership of a network of highly engaged scientists.</p> <p>The Challenge's strategy for research continues its research developing innovative tools to eradicate pests and diseases that threaten biodiversity. New 'super-lures' based on ferret odour have been shown to successfully attract stoats, rats and hedgehogs, and are being trialled by regional councils and community and conservation groups in Hawke's Bay and the Hauraki Gulf.</p>
Our Land and Water	<p>Our Land and Water's Future Strategy provides a considered and coordinated framework for research to enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations. The Challenge strategy confirms its strong commitment to co-innovation; in the first period it has made good progress in developing relationships with Māori, key end-users and stakeholders.</p> <p>Science delivery is gaining momentum with good progress made in a relatively short period of time. For example, identification of sources of contaminants in streams is being used to inform stock fencing policy in Taranaki and a review of proposed fencing policies, nationally at farm level, quantification of decreases in nitrogen and phosphorus leaching has demonstrated the potential of precision irrigation technologies to deliver considerable environmental benefits, and Māori in Northland are using maps and open databases generated by the Challenge to explore land-use options and economic potential of their land.</p>
Science for Technological Innovation	<p>Science for Technological Innovation (SfTI) has been consistently high performing and has made significant progress towards achieving its objective to enhance the capacity of New Zealand to use physical and engineering sciences for economic growth. The Challenge is funding scientifically stretchy research (high risk/high reward) with strong links to industry and other end-users, and has conducted real-time, self-reflective research that examines human capacity (people and their skills) and relational capacity (networks between researchers and</p>

	<p>industry) to understand what works best in a New Zealand context.</p> <p>SfTI's approach to co-created research has resulted in increasingly wide-ranging and deep industry relationships. For example, the precision farming technology for aquaculture Spearhead, brought previously disconnected research and industry representatives together for the first time to tackle research questions that are for 'the good of the sector and country' rather than necessarily only being 'good for the company'. The resultant research is strongly aligned with sector strategies, national and international research efforts. This approach is proving popular with private sector businesses who are seeking SfTI out and asking to participate in these 'Mission Lab' processes.</p>
Sustainable Seas	<p>Sustainable Seas has successfully initiated a new dialogue on ecosystem-based management (EBM) and expanded our collective understanding of how EBM applies to the marine environment. Progress to date is viewed very positively, with Challenge achievements including a highly engaged network of researchers, a focus on EBM that has garnered international attention, early research outputs of high quality, a Vision Mātauranga strategy that is embedded across all processes and structures, and a large network of Māori and stakeholders who derive benefit from involvement with the Challenge.</p> <p>The Challenge has produced new scientific understanding and new management tools for decision makers, for example guidance for monitoring for tipping points.</p>
A Better Start	<p>A Better Start aims to take a holistic approach to its three main research themes (Healthy Weight, Successful Learning and Resilient Teens), which are frequently studied in isolation. A fourth research theme, Big Data, enables the Challenge to test associations and interventions in virtual simulations of the real world.</p> <p>A Better Start's researchers focus on early prediction, prevention and early intervention as the way to offer the greatest potential for impact.</p> <p>The Challenge is delivering a number of projects focused on each of the main themes. In the Healthy Weight area there have been a number of achievements including finalising a risk prediction model using 2,205 children from the Growing Up in New Zealand longitudinal study. The prediction model can be used to determine whether a one-year-old infant will have a healthy weight by the time they start school. This enables family, whānau and health professionals to offer advice to prevent obesity and the many later health and other problems strongly associated with not having a healthy weight.</p>
Ageing Well	<p>Ageing Well has made positive steps towards achieving its objective to "harness science to sustain health and wellbeing into the later years of life" and establishing a multi-disciplinary, collaborative research platform, particularly through developing strong relationships across a range of stakeholders and building Vision Mātauranga capability.</p> <p>The Challenge has started to demonstrate impactful "real world" outcomes, for example working with the Health, Quality and Safety Commission, the Challenge has developed nation-wide Frailty Care Guides to improve the quality of life of our most vulnerable elderly to be delivered to all 700 residential aged care facilities in New Zealand.</p>
High-Value Nutrition	<p>High-Value Nutrition has made significant progress in establishing excellent research teams and building an impressive portfolio of research, including identification of 28 potential biomarkers. In the second period, its priority health areas of Metabolic Health, Digestive Health, Immunity Health, and Infant Nutrition continue and remain relevant to New Zealand's Food and Beverage Industry.</p> <p>Through contestable projects it has successfully partnered with industry and raised \$1.16 million in direct co-funding.</p>
Resilience to Nature's Challenges	<p>Enhancing resilience to natural disasters remains a high priority and high profile issue. RNC is addressing this through an improved understanding of New Zealand's riskscape and reducing the nation's vulnerability to natural disaster risks.</p> <p>The Challenge has delivered a strong scientific programme that has been well connected to end-</p>

	<p>users and delivered tangible benefits and impacts. For example, through its ‘Living at the Edge’ programme, RNC contributed to the Clifton Tangoio 2120 (100 year) Coastal Strategy owned by the three unitary bodies of the Hawkes Bay area, along with community and iwi representatives. The strategy is the first of its kind in New Zealand and includes Challenge research into the physical and engineering models of expected coastal change and hazard implications, as well as inputs into the design of how to reduce and adapt to these risks.</p>
<p>The Deep South</p>	<p>The Deep South has performed well in its three years of operation and is undertaking world class field research to improve New Zealand’s climate modelling capability to then enable better medium- to long-term predictions on the potential impacts of climate change and to engage with stakeholders to allow New Zealanders to better respond. Central to this is the development of a New Zealand Earth System Model (NZESM).</p> <p>Field based research in Antarctica and the Southern Ocean is delivering high quality science as part of the Process and Observations programme and has produced notable publications. This programme along with other work is feeding into the Earth System Model.</p>

General Themes from the Mid-way Review Panel Reports

17. While each panel report was specific to the Challenge being reviewed, there were some themes that emerged across the NSCs. The following summarises some initial observations.

All NSCs are delivering collaborative programmes aligned to the Challenge objectives

18. While different NSCs are at different stages of development, it was evident from the reviews that all are delivering collaborative programmes that respond to important national-scale issues for New Zealand, support excellent science focused on delivering impact, and have appropriate governance and decision-making processes.
19. Most NSCs are now delivering strategic programmes of excellent collaborative research, working across disciplines with a broad range of stakeholders and Māori. In some cases, the NSCs have articulated a clear strategy that is influencing the investment decisions of others so that they align their investments to the objective of the Challenge, delivering greater impact than the Challenge is able achieve on its own.

NSCs are supporting excellent science

20. All Challenge leaders are committed to building successful NSCs that support excellent science that will deliver impact for New Zealand. Across all the NSCs, the review panels found evidence of excellent science delivery, noting that the quality and quantity of international publications is increasing. Annex Three provides some science stories that illustrate the progress the NSCs are making.

NSCs are working with stakeholders to deliver impact

21. All NSCs provided evidence of strong stakeholder engagement. In every Challenge, stakeholders were actively involved in the development of the Future Strategy documents that the NSCs provided to MBIE. Stakeholders actively participated in the review process and spoke of the value the NSCs are providing to their work.
22. This strong stakeholder engagement is largely consistent with feedback provided in the MBIE commissioned Colmar Brunton Stakeholder Perceptions 2018 report. This report noted that stakeholders appreciate the Challenge’s strategic perspectives and the clarity of purpose that NSCs have provided to research activities in their sectors. The cross-sector networks developed between researchers and end-users, and the quality of the research expertise, were also valued.

23. Common feedback from the review panels was the suggestion that NSCs refine the frameworks and methodologies used for measuring their delivery of impact against the Challenge objective. MBIE will be working with the NSCs over the next few months to develop outcome frameworks that will clearly identify the pathway to impact for each of the NSCs and inform the development of appropriate Key Performance Indicators that MBIE can use to monitor performance and evaluate impact during the second period.

NSCs are changing the culture of how science is being undertaken in New Zealand

24. The mid-way review process provided the opportunity for scientists who work within the NSCs to share their experiences of being part of a National Science Challenge. They reported that they have been challenged to work quite differently - to be collaborative, to work across disciplines and co-developing science with a broad range of stakeholders and Māori. There is evidence that some members of the science community are enthusiastically embracing this approach. Hosts are also strongly supportive as they recognise the shared value created from wider networks.
25. There is a general consensus from those working within the NSCs that this way of funding science is having a positive impact on the culture of how science is conducted in New Zealand. Many of the internationally based review panel members commented positively on the impact that NSCs are having on the culture of science.

The approach taken to co-governance and co-development of research with Māori is world-leading

26. Delivery against the Vision Mātauranga policy is a requirement for all NSCs. Assessment of delivery against this policy was an integral component of the review, with each panel including at least one member who was able to assess Vision Mātauranga. It was evident from the review process that all NSCs are making genuine efforts to work with Māori and to develop partnerships based on shared goals and mutual respect.
27. Different NSCs have different approaches to Vision Mātauranga, and some are more advanced than others in their progress. Those who are leading the way are incorporating co-governance and co-management models where Māori are involved in decision making at all levels across the Challenge activities. NSCs are working with Māori and communities to co-develop research, to incorporate Mātauranga Māori as a legitimate knowledge system and are supporting Kaupapa Māori approaches by Māori researchers.
28. Many of the Māori partners who participated in the mid-way review process were positive about their engagement with the NSCs. While there is still much to be done, they noted the efforts being made to be inclusive, and observed that the long-term funding for NSCs provided sufficient stability on which long-term relationships could be built. The international panel members noted that New Zealand's efforts to work with Māori were significantly advanced compared to international efforts to work with indigenous peoples.

Annexes

Annex One: The NSC Mid-way Review Process

Annex Two: Summary of NSC Mid-Way Review Assessments

Annex Three: NSC Science Highlights

Annex One: NSC Mid-way Review Process

MBIE issued a Terms of Reference in November 2017 outlining the mid-way review process. The process for each Challenge is the same and only the panel meeting dates and panel members vary.

Review process

DATE (2018)	ACTION
May – July	<p>Challenge provides the following information to MBIE:</p> <ul style="list-style-type: none"> > Progress Report for 2017/18 > Overview of progress to date over the period of the Challenge > Financial information on unspent funding > Future Strategy (long-term view, five-year strategy, scenario planning) <p>MBIE assesses the 2017/18 Progress Report and gives feedback to the Challenge.</p>
June – July	<p>MBIE sends documentation and its assessment of the Progress Report for 2017/18 to an independent review panel formed for each Challenge.</p>
July	<p>The chair of each Challenge’s science advisory panel submits a report to MBIE. MBIE forwards the report to review panel members.</p>
July – August	<p>Each review panel meets in Wellington for 2.5 days. Challenge representatives present to the review panel. The chair of each Challenge’s science advisory panel speaks to their report. The review panel will speak to a representative of the Challenge host.</p>
July – September	<p>The review panel prepares a report with its recommendation. MBIE sends the panel’s draft report to the Challenge for feedback. The review panels finalises their reports.</p>

Annex Two: Summary of the NSC Mid-Way Review Assessments

The following section summarises the assessment of each Challenge informed by the mid-way review.



1. The objective of A Better Start NSC is to “*improve the potential of young New Zealanders to have a healthy and successful life*”.
2. A Better Start is hosted by The University of Auckland. Collaboration partners are Auckland University of Technology; University of Waikato; Massey University; Victoria University of Wellington; University of Canterbury; University of Otago; and AgResearch Limited.
3. The Challenge is undertaking research in three key research themes - Healthy Weight, Resilient Teens and Successful Learning, with two enabling research themes, Big Data and Vision Mātauranga that work across the Challenge.
4. A Better Start was launched on 19 February 2016. The Government has allocated up to \$34.7 million for A Better Start over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$14.2 million.
5. The Challenge’s research strategy is new for New Zealand as it takes a holistic approach to the three main themes, which are frequently studied in isolation. All projects aim to improve the potential for young New Zealanders to have healthy and successful lives, in particular tackling those at-risk children early and engaging with their communities. A Better Start has a focus on prediction and prevention research as this offers the greatest potential for impact. Achievements in their first period of funding include the establishment of a network of well-credentialed researchers who are experts in their respective fields and committed to the mission of the Challenge. The leadership team is seen by stakeholders as being fundamental in driving successful partnerships. In 2018, the leadership team have made a considered effort to join up their research efforts to begin creating a more cohesive Challenge narrative.
6. The Challenge is delivering a number of projects focused on learning, obesity and mental health. In the obesity area there have been a number of achievements including finalising a risk prediction model using 2,205 children from the Growing Up in New Zealand longitudinal study. The model has identified the key new-born parameters that collectively best predict obesity in New Zealand children: birth weight, sex, maternal BMI, paternal BMI, number of persons in the household and maternal smoking during pregnancy. The team have also recently found evidence of a 2.2% decline in the obesity rates of 4-year olds between 2010 and 2016. This project is the first of a series of investigations into data from the national B4 School Check (B4SC), the health and developmental check carried out on over 300,000 New Zealand 4-year-olds.
7. A Better Start seeks meaningful engagement with Māori and Pacific communities to increase the cultural competence of its researchers; and New Zealand’s capacity to conduct research that is culturally effective. The Challenge is committed to move its approach to Vision Mātauranga from consultation, through co-design, to Kaupapa Māori approaches. They have invested initial pilot funding to develop a strategy for dedicated Māori and Pasifika research funding of around \$2 million in the second period of funding. The strategy will include Māori and Pasifika co-designed projects delivered by Māori and Pasifika researchers.
8. For the second period of funding, A Better Start will need to ensure it supports a focused research programme. Without appropriate focus, there is the risk that the Challenge will spread its limited resources too thinly in an effort to please a wide range of stakeholders. A review of the governance framework (including science leadership structure/the role of advisory groups) and a review of research priorities are considered to be necessary to help focus A Better Start and build a more integrated narrative. The Challenge also needs to develop a clear strategy that outlines how it will realise a credible pathway to create impacts necessary to achieve their objective.



1. The objective of Ageing Well is “to harness science to sustain health and wellbeing into the later years of life”. The mission is to “push back disability thresholds to enable all New Zealanders to reach their full potential through the life course with particular reference to the later years of life”.
2. The Challenge host is the University of Otago. The Challenge Collaboration Partners include: Auckland University of Technology, The University of Auckland, University of Canterbury, AgResearch Limited, Centre for Research Evaluation and Social Assessment, University of Waikato, Massey University and Victoria University of Wellington.
3. Ageing Well was launched in March 2015. The Government has allocated up to \$34.9 million (excl. GST) for Ageing Well over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$14.6 million (excl. GST).
4. Ageing Well has made positive steps towards achieving its objective and establishing a multi-disciplinary, collaborative research platform, particularly through developing strong relationships across a range of stakeholders and building Vision Mātauranga capability. The Challenge has seen a slow but steady increase in science outputs and has started to demonstrate impactful “real world” outcomes. In conjunction with the Health, Quality and Safety Commission, the Challenge has developed nation-wide Frailty Care Guides to improve the quality of life of our most vulnerable elderly to be delivered to all 700 residential aged care facilities in New Zealand. Other research used the interRAI database to develop the Drug Burden Index for health professionals to help predict the impact of side effects of medications in a way that is easy to interpret. Moving forward, by re-focussing research in the second phase to two focus areas, rather than five compartmentalised research strands, the Challenge has the potential to deliver a more cohesive and integrated research portfolio that will further enhance multi-disciplinary collaboration among researchers and deliver impact for New Zealand.
5. For this Challenge, the most salient issues relate to clarity around the process by which research programmes will be determined and managed across its proposed research portfolio, and insufficient research prioritisation in one of the proposed focus areas, *Health and Wellbeing in Ageing*.
6. The Challenge has demonstrated a particular strength regarding stakeholder engagement and relationship building. This was evident through strong presentations from a range of stakeholders at the mid-way review panel meeting who highly valued engagement with the Challenge and saw real benefit from it. Moving forward, it is timely to further capitalise on these relationships to realise relevant research outputs and ensure positive outcomes on the ground in terms of translation and implementation of research.
7. Ageing Well has demonstrated a clear commitment to address the needs and aspirations of Māori and implement Vision Mātauranga. This is visible through its move towards a co-governance model, appointing a Deputy Director Māori, supporting Māori research and Māori capability building. The Future Strategy appropriately outlines how Ageing Well intends to progress and enhance value derived from its approach to Vision Mātauranga in the first phase. The proposed *Māori and Ageing* research focus area is appropriately focused and guided by a clear set of research priorities.
8. There is a need to bring a similar level of coherence and focus to the *Health and Wellbeing in Ageing* focus area. More clarity and specificity is needed to build a more deliberate, strategic and integrated research portfolio that will deliver excellent and impactful science.



1. The objective of the Building Better Homes, Towns and Cities NSC (BBHTC) is to *“improve the quality and supply of housing and create smart and attractive urban environments”*. This objective is guided by its mission *“co-created innovative research that helps transform dwellings and places where people live into homes and communities that are hospitable, productive and protective”*.
2. The Challenge is hosted by BRANZ. Collaboration Partners include: Auckland University of Technology, Universities of Lincoln, Massey, Auckland, Canterbury, Otago and Waikato, Victoria University of Wellington, Opus International Consultants, PrefabNZ, Scion, Auckland Council Research Investigation and Monitoring Unit, Centre for Research, Evaluation and Social Assessment and GNS Science.
3. The Challenge was launched in May 2016 and was allocated up to \$47.9 million over 10 years until 30 June 2024. Funding for the first period to 30 June 2019 is \$23.6 million (excl. GST).
4. The Challenge has achieved a significant amount in a relatively short timeframe and is making considerable progress towards delivering on its objective. The housing crisis and the scale and rate of change affecting our built environment is unprecedented. The spatial dimension of this Challenge is unique and has the capacity to integrate the outcomes from other Challenges into environmental, economic, cultural and social solutions for homes, towns, cities and regions. BBHTC has the potential to deliver impactful science and influence the national agenda on housing and urban development.
5. BBHTC has made a step change by bringing together previously disjointed researchers into a collaborative, multi-disciplinary and multi-institutional research programme that is well-connected to stakeholders, communities and end-users. BBHTC has demonstrated innovation in projects, has delivered high quality science and produced a number of significant research outputs. These include outputs on impacts of land covenants on affordable housing, geospatial tools to support urban planning, and the high profile Te Puea Marae model in Māngere, South Auckland, to respond to the homelessness crisis. Uptake of research indicates a good appetite for research produced by BBHTC teams, providing evidence of research relevance and pathways through which the Challenge can influence long-term outcomes.
6. Responding to the relative paucity of researchers able to work in BBHTC research areas, the Challenge has demonstrated a clear commitment to building research capacity and capability among a new generation of Pākehā and Māori researchers; and upskilling of senior researchers to ensure the Challenge has the cohort of researchers required to continue to deliver against its objective.
7. A highlight of Challenge performance is its growing Māori research capability. BBHTC is developing internationally leading, innovative processes in emerging research approaches enabling the integration of Māori science and cultural perspectives with traditional science approaches to the built environment. For example, the Te Pueae Marea model and the Toitū te Kāinga, Toitū te Ora, Toitū te Tangata. This research project aims to realise the aspirations of the Te Matekuare Whānau Trust who are establishing a papakāinga development at Te Whaiti. Experts in design, construction, public health, architecture and sustainability are aiming to enliven Te Matekuare whānau aspirations. This focused on benefits for Māori, and developing mātauranga Māori in relation to affordable housing.
8. BBHTC demonstrated a clear commitment to embed Vision Mātauranga (VM) at all levels. VM is visible across governance and management (evidenced by the co-governance and co-director model), project leadership and composition, engagement and co-creation and research investment.
9. The Future Strategy outlines a sound and clear rationale for the proposed strategic reframe and underlying research priority areas. The strategy is focused, adds cohesion and clearly addresses the needs and aspirations of Māori. Progressing the agenda with carefully built “best teams” provides confidence it will continue to deliver on the objective and outcomes effectively.



1. The objective of Healthier Lives NSC is to “*reduce the burden of major New Zealand health problems*”. The Challenge focuses on cardiovascular disease, cancer, diabetes and obesity.
2. Healthier Lives is hosted by the University of Otago. Collaboration partners are Auckland University of Technology, Victoria University of Wellington, Universities of Auckland, Massey, Waikato, Canterbury and Otago, AgResearch, Institute of Environmental Science and Research and the Malaghan Institute.
3. Healthier Lives was launched on 4 December 2015. The Government has allocated up to \$31.3 million (excl. GST) for Healthier Lives over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$13.7 million (excl. GST). This is the lowest level of funding of the 11 Challenges.
4. Healthier Lives has been a strong performer in the first period of funding and has made good progress towards meeting its objective. The Challenge has prioritised research within a limited funding envelope to develop a range of approaches to reducing the health impact of cardiovascular disease, diabetes, obesity and some types of cancer for individuals and communities and increasing the equity of health outcomes in relation to those conditions.
5. The Challenge has developed exemplary methods of community engagement and has co-created around 40 percent of its research with a range of stakeholders, including Māori and Pasifika communities and end-users, which means that implementation of the research is more likely. Healthier Lives has had two pieces of research implemented already. For example, the Challenge updated cardiovascular risk prediction equations to provide the first accurate equations for Māori, Pacific, Indian and Chinese peoples, and the Ministry of Health has incorporated these equations into national guidelines for general practitioners. Healthier Lives has conducted high-quality research with a strong interdisciplinary component. The Big Data theme has effectively shown how New Zealand’s integrated health and social data can be used to pose and solve policy-relevant questions and the Challenge has contributed to building New Zealand’s research capability in big data. Healthier Lives has leveraged its funds using partnerships with the Ministry of Health, the Health Research Council and non-governmental organisations such as health charities to maximise the amount of research supported. Healthier Lives has evolved governance and management structures that are effective and well-aligned to the Challenge’s equity goals.
6. Healthier Lives is well placed to implement their research strategy in the second period. Non-communicable diseases remain a significant issue affecting New Zealand’s health, wellbeing and economy. The Challenge’s principle of reducing health inequities for Māori and Pasifika communities means that their research will be focused on the areas of greatest opportunity for New Zealand. The Challenge’s Future Strategy introduces a new theme of supporting healthy food and physical activity environments, with a population level focus. It continues existing themes of culturally centred health intervention for Māori and Pasifika (at a community level) and precision medicine (focusing on individual health). The Challenge plans to maintain its focus on increasing health equity, enacting a Treaty partnership and contributing to Vision Mātauranga and co-design. In the second period, Healthier Lives aims to increase its focus on implementation and to evaluate the effectiveness and cost-effectiveness of interventions developed in Challenge research, and these measures should increase uptake.
7. Healthier Lives is a strong performer in relation to Vision Mātauranga. The Challenge has integrated the Vision Mātauranga policy at all levels, including governance (through a co-governance arrangement between the governance group and the Kāhui Māori), leadership, and research. The actions it has taken are congruent with its goals of increasing equity of health outcomes for Māori and it has developed its capability to work effectively with Māori as partners.



1. The objective of High-Value Nutrition NSC (HVN) is to “*develop high-value foods with validated health benefits to drive economic growth*”. The Challenge will enable the transformation of New Zealand’s Food and Beverage industry to become an exporter of high-value foods with scientifically proven health benefits. HVN conducts research into metabolic health, digestive health, immune health, and infant nutrition informed by insights into the needs of consumers in Asia and the Challenge has identified opportunities where investment in food science can have significant economic impact.
2. The Challenge is hosted by The University of Auckland. Collaboration partners are Massey University, University of Otago, AgResearch, and Plant and Food Research.
3. High-Value Nutrition NSC was launched on 1 April 2014. The Government has allocated up to \$83.8 million for High-Value Nutrition over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$30.6 million.
4. HVN was the first National Science Challenge to receive funding. As such, it needed to socialise many of the culture changes such as independent governance, best team approach and inter-institutional collaboration that the NSC policy framework set out. After a bit of a slow start, HVN has made significant progress in establishing excellent research teams and building an impressive portfolio of research, including identification of 28 potential biomarkers. Through contestable projects it has successfully partnered with industry and raised \$1.16 million in direct co-funding. A total of 11 companies are involved in HVN. The Challenge has built a partnership with the NUKU ki te Puku, a cluster of six Māori-owned businesses, which, if successful, could become a model for engagement with Small and Medium Enterprises (SMEs) more broadly.
5. The Challenge’s initial research strategy was developed with the 10-year funding framework of the National Science Challenges in mind. As such, the research strategy for phase two is a continuation of the research being conducted during the first phase of funding. The priority health areas of Metabolic Health, Digestive Health, Immune Health, and Infant Nutrition will continue and remain relevant to the New Zealand Food and Beverage industry. Research will move from pre-clinical models and proof-of-principle studies to clinical studies. The Challenge has assembled a strong team of scientists across the leading research institutions.
6. The focus will remain on China as the targeted export market for high-value products with scientifically-proven health benefits. There are inherent risks in this single-market strategy. The Challenge’s proposed focus on the China Urban Phenotype, which would allow findings to be applied to other global settings with similar characteristics, attempts to mitigate against those risks. The governance group needs to develop a robust risk management framework that anticipates the need to pivot or refocus the research activities at various stages of the research programme, including if the intended clinical trials cannot be successfully conducted in China.
7. HVN was slow in developing and then implementing a credible Vision Mātauranga (VM) strategy. Contrary to other NSCs, HVN chose not to set up a Māori advisory group (Kāhui) but instead to embed Māori advisors in management and governance functions. This approach was only successful following the appointment of a senior Māori scientist to the Senior Leadership Team. HVN needs to ensure that more resources and support are made available to ensure the success of the Vision Mātauranga strategy.
8. HVN needs to take a more targeted approach in its selection of industry partners in phase two. The review panel suggests that HVN develops an industry partner strategy that identifies a pipeline of potential industry partners (including Māori businesses and SMEs) in line with benefit realisation criteria and alignment to strategy.



1. The objective of New Zealand's Biological Heritage (NZBH) is to “*protect and manage our biodiversity, improve our biosecurity and enhance our resilience to harmful organisms*”. The Challenge's research aims to reverse the decline of New Zealand's biological heritage through a national partnership to deliver a step change in research innovation, globally leading technologies and community and sector action.
2. The Challenge is hosted by Manaaki Whenua – Landcare Research. Collaboration partners are all New Zealand universities, all Crown research institutes, the Cawthron Institute, the Ministry for Primary Industries (MPI) and the Department of Conservation (DOC).
3. The Challenge was launched on 29 August 2014. The Government has allocated up to \$63.7 million (excl. GST) for New Zealand's Biological Heritage over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$25.8 million (excl. GST).
4. NZBH's Future Strategy is well aligned with Māori aspirations for New Zealand's environment, the roadmaps for conservation and environmental science and primary sector science and the strategies and plans of a range of stakeholders with biodiversity and biosecurity-related goals. These include MPI, DOC, Predator-Free New Zealand 2050, regional councils, plant industries and community conservation initiatives. The Challenge's future research will inspire New Zealanders to value biological heritage, understand how it is changing and take action to protect it. It will also ensure that New Zealand's biosecurity system is world class, and that natural and production ecosystems are resilient and thriving.
5. The Challenge has consistently delivered substantive and relevant achievements across all seven of the National Science Challenge performance areas. Achievements include strong strategic leadership of a highly engaged network of scientists, research users and community organisations; an impressive number of high quality science publications; fostering collaboration and new research approaches through inclusive, transdisciplinary teams; strong support of, and from, stakeholders. The Challenge has also demonstrated extensive engagement with Māori researchers, iwi and hapū that both embeds Vision Mātauranga in all Challenge research, activity and decisions and provides opportunities for Māori leadership of research; future-thinking and decisive governance; and citizen science contributions to key Challenge research issues.
6. NZBH is developing innovative tools to eradicate pests and diseases that threaten biodiversity. New 'super-lures' based on ferret odour have been shown to successfully attract stoats, rats and hedgehogs, and are being trialled by regional councils and community and conservation groups in Hawke's Bay and the Hauraki Gulf. Significant progress has been made in new technologies to control wasps, using novel science with the potential for major impacts. Complementary research on wasp population dynamics lays the groundwork for field application of the technologies and understanding the response of wasp populations to climate change. NZBH research showed that native plants may provide long-term solutions to kauri dieback by attracting and killing spores of *Phytophthora agathadica*. The Challenge is also empowering several communities to fight kauri dieback on a large scale by providing practical tools and knowledge to delay development of the disease.
7. The Challenge gives effect to Vision Mātauranga (VM) by working respectfully towards common goals in partnership with iwi, hapū and whānau. This includes resourcing VM-specific research, building Māori capability and capacity, and building the capacity of non-Māori researchers and end-users for meaningful engagement with Māori. The Challenge is considered by Māori to have achieved a trusted and authoritative position that has “opened doors for iwi” to engage with the innovation sector and has demonstrated the success that can be gained from dual knowledge systems working together. Approximately 20% of Challenge publications are co-authored with iwi and/or Māori researchers. NZBH's Future Strategy has adopted Māori values for the whole Challenge that have been positively received by Challenge parties.
8. Challenge partners are strongly supportive of NZBH and have aligned \$176 million of research towards the Challenge objective. This illustrates the progress NZBH has made in coalescing previously disparate biodiversity and biosecurity research activity.



1. The objective of Our Land and Water (OLW) is to “*enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations*”.
2. The Challenge is hosted by AgResearch. Collaboration partners include all seven CRIs, Massey, Lincoln, Waikato and Otago universities, Lincoln Agritech and the Cawthron Institute. In August 2018 Victoria and Canterbury universities formally asked to become parties to the Challenge.
3. The Challenge was launched on 26 January 2016. The Government has allocated up to \$96.9 million (excl. GST) for Our Land and Water over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$27.6 million (excl. GST).
4. OLW’s Future Strategy provides a considered and coordinated framework for research to enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations. Maintaining New Zealand’s land and water quality continues to be a high priority for central and local government and land owners and managers who aim to balance economic and environmental benefits. It is also a priority in addressing the wider social and cultural goals of Māori and local communities. Despite various initiatives over many years (e.g., the Land and Water Forum) to optimise land and water management to meet the needs of multiple stakeholders, research gaps and uncertainties remain. OLW is addressing some of these gaps.
5. The Challenge has a clear vision of the impacts its science will deliver in the complex ‘landscape’ of land and water research, kaitiakitanga, stakeholder interests and end-user and community needs. OLW envisages a future primary sector underpinned by a mosaic of land uses that are more resilient, healthy and prosperous than today. The strategy outlines the scope (nine priority science areas) of the Challenge’s proposed research from July 2019 to June 2024, and the impacts expected from that research. It also provides an overview of the processes OLW will use to deliver excellent science, engage stakeholders with land and water interests and to nurture capability.
6. The strategy reaffirms OLW’s strong commitment to co-innovation. This is successfully building a collaborative culture and drawing together research aligned to the objective and has engaged Māori partners, researchers, stakeholders and communities.
7. The role of Māori in land and water management, and meaningful engagement with Māori is a central tenet of OLW’s research. As well as integrating Vision Mātauranga into all research programmes, the Challenge is adopting a Te Ao Māori approach to its science, combining cultural imperatives with commercial aspirations and applying them to opportunities that will create value for all New Zealand. The Kāhui Māori, working closely with the governance group, ensures the Challenge’s research approach will deliver on the aspirations of Māori, including an enduring and inter-generational legacy. In its 2½ years of operation OLW has made good progress in developing relationships with Māori and key end-users and stakeholders. The Challenge has used co-development processes to involve a wide range of stakeholders in designing and implementing research programmes.
8. The three research themes proposed in OLW’s Future Strategy (Characteristics of future productive landscapes, Incentives for change, Capacity for transition) are refinements of current themes and contain a mix of the disciplines needed to deliver outcomes and impacts. Each builds on OLW’s transdisciplinary activities to date that have successfully fostered innovative thinking.
9. Uptake of Challenge science to date demonstrates the value of the research. For example: identification of sources of contaminants in streams is being used to inform stock fencing policy in Taranaki, and a review of proposed fencing policies, nationally. At farm level, quantification of decreases in nitrogen and phosphorus leaching has demonstrated the potential of precision irrigation technologies to deliver considerable environmental benefits. Māori in Northland are using maps and open databases generated by the Challenge to explore land-use options and economic potential of their land.



1. The objective of Resilience to Nature's Challenges NSC (RNC) is to “*enhance New Zealand's resilience to natural disasters*”.
2. The Challenge is hosted by GNS Science. Collaboration partners are NIWA, Scion, The University of Auckland, Massey University, Victoria University of Wellington, University of Canterbury, Lincoln University, University of Otago, BRANZ and Opus International Consultants.
3. The Challenge was launched on 30 June 2015. The Government has allocated up to \$59.4 million for Resilience to Nature's Challenges over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$19.6 million.
4. The Natural Hazards Research Platform (NHRP) contract ends on 31 October 2019 following ten years of funding (total \$68.1 million GST excl.). The increase in the appropriation for RNC in Phase 2 reflects the mapping of NHRP money into the Challenge. Therefore, whilst RNC funding essentially doubles between Phase 1 and 2 there is no net increase to hazards sector funding.
5. Enhancing resilience to natural disasters remains a high priority and high profile issue for New Zealand and the Challenge is addressing this through an improved understanding of New Zealand's riskscape and reducing the nation's vulnerability to natural disaster risks. The Challenge has delivered a strong scientific programme during Phase 1 that has been well connected to end-users and delivered tangible benefits and impacts. For example, through its 'Living at the Edge" programme, RNC contributed to the Clifton Tangoio 2120 (100 year) Coastal Strategy owned by the three unitary bodies of the Hawkes Bay area, along with community and iwi representatives. The strategy is the first of its kind in New Zealand and includes Challenge research into the physical and engineering models of expected coastal change and hazard implications, as well as inputs into the design of how to reduce and adapt to these risks.
6. The Challenge has demonstrated research adaptability and responsiveness evidenced through its research contribution, following the 2016 Kaikoura earthquake. The Infrastructure toolbox led the coordination of infrastructure impact assessments for the earthquake and worked with several partners to develop and embed infrastructure resilience tools into practice. Through its collaborative efforts, the Challenge has brought a sound co-creation ethos to the hazards sector that has positioned RNC well heading into Phase 2 where it aims to broaden and deepen Phase 1 research learnings.
7. The Challenge has navigated a complex sector involving many research organisations and end-users at a range of levels and has astutely incorporated the strongest elements of both the Natural Hazards Research Platform and RNC Phase 1 efforts. This has been a considerable undertaking by the Challenge to ensure that those not involved in RNC in Phase 1 were provided opportunity to contribute to the strategic settings of RNC for Phase 2. The integration of these programmes will improve the ability of the Challenge to strengthen underpinning hazards research and exert a greater influence on relevant sectors to deliver against its objective (to enhance New Zealand's resilience).
8. In drafting its Future Strategy, the Challenge's review of relevant strategies across the government sector and in particular its alignment to the draft National Disaster Resilience Strategy (NDRS) is positive and demonstrates evidence that RNC has engaged end-users to ensure it delivers research that will enhance New Zealand's resilience to natural disasters. The overarching framework of the Multi-hazard Risk Model and Resilience in Practice Model and their underpinning themes are appropriate by providing an integrated approach to translational science. This will support end-user knowledge and uptake, respond to the RNC objective and align with nationally significant strategy settings.
9. While there is strong Vision Mātauranga (VM) activity in pockets of the Challenge, it appears to be relatively isolated, in part because of the shortage of relevant Māori researcher capability. In Phase 2 RNC is encouraged to give more thought to how VM will be more widely embedded and integrated across the entire Challenge.



1. The objective of Science for Technological Innovation NSC (SfTI) is to *“enhance the capacity of New Zealand to use physical and engineering sciences for economic growth”*.
2. The Challenge is hosted by Callaghan Innovation. Collaboration partners are all New Zealand universities, GNS Science, Scion, AgResearch, Lincoln Agritech.
3. The Challenge was launched on 16 September 2015. The Government has allocated up to \$106.03 million for Science for Technological Innovation over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$33.32 million.
4. SfTI is a consistently high performing Challenge. SfTI has made significant progress against its objective. The Challenge is funding scientifically stretchy research (high risk/high reward) with strong links to industry and other end-users. In doing so SfTI has conducted real-time, self-reflective research through its Building New Zealand’s Innovation Capacity programme that examines human capacity (people and their skills) and relational capacity (networks between researchers and industry) to understand what works best in a New Zealand context.
5. SfTI has supported twenty-six human capacity development activities. Initiatives included a Māori Data Futures Workshop aimed at developing skills and opportunities for Māori in relation to data science (with 67 iwi representatives, data specialists and Māori youth); Relational Leadership workshops; ‘Impact Pitching’ competition to develop skills in pitching ideas to funders; and media management.
6. SfTI’s approach to co-created research has resulted in increasingly wide-ranging and deep industry relationships. The precision farming technology for aquaculture Spearhead, brought previously disconnected research and industry representatives together for the first time to tackle research questions that are for ‘the good of the sector and country’ rather than necessarily only being ‘good for the company’. The resultant research is strongly aligned with sector strategies, national and international research efforts. This approach is proving popular with private sector businesses who are seeking SfTI out and asking to participate in these ‘Mission Lab’ processes. In the field of material science SfTI has researched biopolymer applications in new 3D / 4D additive manufacturing printing for new engineering components and furniture, bringing together process modelling, materials science, design and engineering researchers to co-develop solutions for printing bio-composite materials.
7. SfTI has been innovative in forming its best research teams; the Challenge invites researchers to ‘submit ideas’ around which teams coalesce. SfTI’s governance and management processes support stretch science, allowing research teams one ‘pivot’ as research unfolds. Collectively, SfTI’s approach has demonstrated considerable additionality and has the potential to result in a culture change by altering the way in which scientific research is framed, developed and delivered across the wider science sector. Through its strong adoption of Vision Mātauranga principles SfTI also has the potential to establish an internationally unique approach to incorporating and providing for indigenous knowledge and interests.
8. SfTI’s will extend its learning-by-doing approach into Phase 2. SfTI has identified future strategic research areas that will require an integrated and multidisciplinary approach to be fully realised. The Challenge’s connection to industry, Māori and other end users will help to ensure that its research programmes will remain targeted and deliver scientifically stretchy outcomes and associated economic gains. To support this, SfTI will be encouraged to strengthen its research pathways to commercialisation and ensure it aligns its efforts to other key partners (such as Callaghan Innovation) to clearly articulate the value and role SfTI plays within the science system.
9. SfTI has developed relationship building engagements with Māori which offer the potential to establish an internationally unique approach to incorporating indigenous knowledge. Specific initiatives from include requirements for a minimum 20% of funding going toward supporting projects with strong Vision Mātauranga alignment, an additional front loaded Vision Mātauranga project ballot; and an effective and active Kāhui with the direct involvement of the Director and Vision Mātauranga Theme Leader. Such initiatives will evolve in Phase 2, together with the strengthening of relationships with the Federation of Māori Authorities (FoMA) and the Ātea Te Taumata (a distinguished council of Māori Leaders).



1. The objective of Sustainable Seas NSC is to “*enhance utilisation of our marine resources within environmental and biological constraints*”.
2. The Challenge is hosted by the National Institute for Water and Atmospheric Research (NIWA). Collaboration partners are The University of Auckland, University of Waikato, Victoria University of Wellington, University of Canterbury, University of Otago, Institute of Geological and Nuclear Sciences (GNS), and Cawthron Institute.
3. The Challenge is undertaking research required to support implementation of ecosystem-based management (EBM) as a mechanism for managing Aotearoa New Zealand’s marine environment. This holistic approach is about managing all marine resources sustainably so that marine ecosystems are healthy and the blue economy is strong. Sustainable Seas NSC will provide the tools, knowledge and approaches for decision makers to move to an EBM approach.
4. Sustainable Seas was launched on 4 September 2014. The Government has allocated up to \$71.1 million (excl. GST) for Sustainable Seas over ten years to 30 June 2024. Funding for the first five-year period to 30 June 2019 is \$31.3 million (excl. GST).
5. The Challenge initiated a new dialogue on ecosystem-based management (EBM) and expanded our collective understanding of how EBM applies to the marine environment. The success can be seen in Minister Nash’s recent announcement of the need for an EBM approach to fisheries by 2020. Sustainable Seas’ focus continues to be in line with government priorities and societal values. The Challenge has produced new scientific understanding and new management tools for decision makers. For example, guidance for monitoring for tipping points. Sustainable Seas’ has put a significant effort into building strong and sustained relationships with Māori and stakeholders and created a highly engaged and active network that spans several iwi and hapū, industry, regional and central government and community groups.
6. Sustainable Seas’ five-year strategy builds on the Challenge’s significant achievements in Phase 1. These include a highly engaged network of scientists across 36 organisations, a focus on ecosystem-based management that has garnered international attention, early science outputs of high quality, a Vision Mātauranga strategy that is embedded across all processes and structures and a large network of Māori and stakeholders who derive benefit from involvement with the Challenge. For Phase 2, the Challenge will focus its science around four themes-based sets of questions – “Understanding degradation and recovery in socio-ecological systems”; “Creating value from a blue economy”; “Addressing risk and uncertainty”; and “Enhancing EBM practices.” The questions are designed to continue the Challenge’s trajectory on fostering interdisciplinary research, encouraging cross-Challenge collaboration and facilitating transdisciplinary research.
7. Sustainable Seas’ has embedded Vision Mātauranga in all their research projects. Additionally, the Challenge created a separate research programme, the Tangaroa programme, which places Māori at the centre and promotes and supports Māori-led or partnered projects. The projects directly benefit the iwi, hapū, or commercial groups involved. The Challenge makes significant resources (financial and staff support) available to ensure the success of these projects. Overall, Sustainable Seas’ approach to implementing the Vision Mātauranga strategy and engaging with Māori is exemplary.
8. The Challenge should develop appropriate mechanisms to enable full exploitation of generated data (for scholarly as well as commercial purposes), develop a roadmap to impact through a Theory of Change approach, and to provide more resources to the management of the Challenge. Based on previous feedback, Sustainable Seas is already in the process of addressing the second and third points. Due to its world leading status in EBM, the Challenge should engage more widely internationally and more fully integrate with global efforts. New Zealand could be a world leader in research on, and application of, EBM.



1. The objective of The Deep South NSC is to “*understand the role of the Antarctic and Southern Ocean in determining our climate and future environment*”. The Challenge is undertaking research to address its mission to enable New Zealanders to adapt, manage risk, and thrive in a changing climate. It has five programmes of work delivering into this mission: Process and Observations; Earth System Modelling and Observations; Impacts and Implications; Engagement; Vision Mātauranga.
2. The Challenge is hosted by the National Institute for Water and Atmospheric Research (NIWA). Collaboration parties are Victoria University of Wellington, University of Otago, GNS, Maanaki Whenua Landcare Research, New Zealand Antarctic Research Institute and Antarctica New Zealand.
3. The Challenge was launched on 5 August 2015. The Government has allocated up to \$51.1 million for The Deep South to 30 June 2024. Funding for the first period to 30 June 2019 is \$24 million.
4. The Deep South has performed well in its three years of operation with research across its five programmes and is delivering against its objectives. The Challenge is undertaking world class field research to improve New Zealand’s climate modelling capability to then enable better medium- to long-term predictions on the potential impacts of climate change. The Deep South is then identifying and working with stakeholders to understand the scope and scale of these potential impacts to feed into and inform policy and decision-making. This work is due to continue in Tranche 2 as the earth system modelling is further refined and integrated with other New Zealand modelling activities to provide a better forecasting of climate change impacts to key user groups, including Māori communities.
5. The field based research in Antarctic and the Southern Ocean is delivering high quality science as part of the Process and Observations programme and has produced notable publications. This programme along with other work is feeding into the Earth System Modelling (ESM) and Predictions Programme and the development of a New Zealand Earth System Model (NZESM). This work has proceeded well and the availability of the new High Performance Computer within NIWA has been helpful. The creation of a NZESM can be a key legacy of The Deep South and will be one measure of its additionality. The NZESM is an extension of the UK Met Office ESM (a world leading climate model) and has leveraged NIWA’s relationship with the UK. In July 2018 the UK announced delays to the final releases of its ESM. This will have an impact on the speed at which a full NZESM can be tested and deployed. The model is also a driver of much downstream activity. Noting that the UKESM has now been released to the Challenge, The Deep South team and governance group are aware of the ongoing need to examine modelling options and related programme impacts for the Challenge.
6. The Deep South have developed an engagement model termed ‘Dialogues’ that has provided a mechanism for informing research paths and aligning and tailoring research activity to specific end user fields of interest from particular potential climate impact areas. Initially slow to start, the Challenge has expanded its engagement activities. However, there is a danger of The Deep South becoming thinly spread and raising expectations of delivery across a very broad landscape. The Challenge needs to identify key user areas to focus on that can be lead demonstrators of The Deep South’s work.
7. The Deep South is working well across the New Zealand research community and has established strong international collaborations. This can be seen in both the bibliometric evidence and in the formation of best research teams.
8. Vision Mātauranga is integrated into Challenge activity through a Vision Mātauranga specific programme. There are good levels of Māori involvement both in project design and participation and a Māori scholarship programme is making good progress.

Annex Three: NSC Science Highlights

The following stories provide a sample of science achievements from the National Science Challenges.



Building Resilient Teens

More than half of New Zealand's young people never access professional help when they experience mental health issues. The Challenge is tackling this issue by creating practical, evidence-based e-health solutions to make a measurable difference for our tamariki. Young people often find it hard to ask for help and services are not always youth friendly or easily accessed. Digital tools make evidence-based therapy available to any young person with a smartphone or computer. The HABITs (Health Advances through Behavioural Intervention Technologies) programme is developing an integrated web- and mobile-based data platform with a gamified smartphone app to teach resilience and emotional regulation. The app draws on well-established cognitive behavioural therapy and has been developed with Māori and Pasifika young people and their communities. The Challenge has successfully co-designed and tested an early version of the app with a large number of young people from a range of schools in Auckland and Waikato, as well as family and whānau.

The digital platform incorporates an online version of YouthCHAT, the tool used by mental health professionals to assess lifestyle risks and emotional well-being. The research team includes young Māori and Pasifika kaimahi (staff) who have taken a lead in the co-design process. The research was recently presented at the 2018 Congress of the Royal Australian and New Zealand College of Psychiatrists in Auckland by the young people involved, their science teachers and kaimahi alongside the researchers. The research was selected as one of the country's best public sector digital technologies at the D5 Showcase at Parliament in February, 2018. The D5 Showcase was held in conjunction with the D5 Summit, a global forum made up of leading digital governments: Estonia, Israel, South Korea, the United Kingdom and New Zealand. The ultimate goal of the research is to create and make accessible a suite of effective, evidence-based e-mental health tools to young people to make a real impact at a national level.



Electrical brain implants faster stroke recovery show huge promise for faster stroke recovery

Strokes are debilitating. If they are not fatal, there are often months and years of painstaking rehab ahead of stroke victims, but what if recovery could be speeded up? Ageing Well looked at whether an innovative, state-of-the-art electrical stimulator implanted in the brain will accelerate stroke recovery.

Strokes are caused by an interruption of normal blood flow within the brain, and results in death of brain cells in that area. Despite rehabilitation efforts, 85 per cent of stroke patients never regain full use of the arm and hand. To maximise recovery, the brain cells closest to the damaged area need to take over the lost function. However, after a stroke, this is difficult to achieve due to the over activity of the electrical circuits that tend to 'turn off' or inhibit these surviving areas. One of these circuits originates in the side of the brain on the opposite side of where the stroke occurred. Challenge researchers aimed to target this circuit and turn down its activity using an electrical stimulator planted onto the brain opposite the stroke.

Ageing Well's research project has resulted in a proof-of-concept and sufficient data to allow to the team to apply for a larger follow-up HRC study.



Te Manaaki o Te Marae

In the winter of 2016, Te Paea Memorial Marae initiated a marae-based kaupapa Māori response, opening their doors to vulnerable whānau seeking emergency housing. In the legacy of Te Paea Herangi, the marae answered the call of homeless whānau in Tāmaki and in doing so, disrupted the Auckland housing narrative by making visible and naming the 'crisis'. More than this, Te Paea Memorial Marae demonstrated that a marae can be an integral part of urban housing solutions.

The Building Better Homes, Towns and Cities Challenge has provided the opportunity to examine the effectiveness of marae within the housing continuum. The research looks at how can marae be strengthened to manaaki tāngata and assist in addressing whānau aspirations and needs for long-term, affordable, and healthy housing. While the focus of this research project is the role of marae in providing emergency housing, this is only one dimension of te manaaki o te marae. The broader research context concerns marae-led housing interventions premised on the ability of marae to extend their cultural reach into communities. The transformational potential of marae for Māori is heightened as the Auckland housing crisis continues to escalate, and the number of Māori living in the region is expected to grow. Marae have always been the epicentres of our whānau, hapū, iwi, and communities. This research will strengthen marae (mana whenua, taura here, and mataawaka) to engage in the housing crisis for urban Māori in culturally-consistent and sustainable ways. It also aims to enable (local) government agencies and NGOs to better engage with and support marae-led Māori housing solutions.



Cardiovascular disease risk prediction for unique New Zealand populations

In 2018, the Ministry of Health used research co-funded by Healthier Lives, the Health Research Council and the Heart Foundation to provide New Zealand doctors with better tools to more accurately predict someone's risk of cardiovascular disease (CVD). Potentially more patients who are at higher risk will be picked up early and treated more effectively. The Healthier Lives research is based on New Zealand data, and provides information tailored to the risks of different ethnic groups within New Zealand. The work was published in the prestigious journal, *The Lancet*, and a Ministry of Health expert group on CVD risk assessment and management has endorsed the revised CVD Risk Assessment equations that came from the research.

Early detection and better treatment is one of the keys to reducing the health burden of diseases such as CVD. New Zealand has led the world in developing cardiovascular risk assessment approaches and introduced population based screening for risk factors for CVD in the early 2000s. But doctors were using risk predictions and treatments based on other countries' data, which did not reflect our ethnicities – known to have different rates/risk for CVD. By using NZ big data to predict and make these assessments, doctors will be able to better treat all our populations.

The research used PREDICT software and data from more than 400,000 people, (including 55,000 Māori, 55,000 Pacific and 35,000 people of Indian descent). These data were linked to national mortality and hospital discharge data from the Ministry of Health) to produce the equations, which give a detailed picture of individuals' health, and build an overall picture of different ethnic groups' risk factors. Patient privacy is protected because all the individual data is anonymised.

The uniquely New Zealand equations have been integrated into the Ministry of Health's [New Zealand Guidelines for CVD Risk Assessment and Management for Primary Care](#). The Ministry is supporting a national programme to roll out the equations to general practices (GPs) around New Zealand.



Finding the elite mussel type

Research funded through High-Value Nutrition has helped identify ways in which Greenshell™ mussels can improve the health and wellness of consumers, and industry partners have begun to adopt the research as a step to gaining higher profit margins for mussels. Sanford Limited is now co-funding a clinical trial with High-Value Nutrition that will generate scientific evidence about the health benefits of Greenshell™ mussels and assist the industry to identify and develop the best Greenshell™ mussel-based functional food products that will appeal to the emerging market of health-conscious consumers.

The Cawthron Institute has identified what would be the ideal composition of an “elite” type of Greenshell™ mussel with potential benefits for health and wellness. Allied to this, the wider team including researchers from Massey University has validated a research model that combines two chronic diseases to test the efficacy of Greenshell™ mussels on influencing the chronic effects of inflammation, this model being a world first. The Cawthron researchers have also perfected a highly-efficient new test using novel technology to detect high-value bioactives during processing, which has led to commercial investment in the technology by industry partner Sanford. The development of these new technologies may also have wider benefits in the aquaculture industry in the future.

The composition of an ‘elite’ Greenshell™ mussel taking into account variability in growing conditions has been published in a peer-reviewed journal and affirms the research premise that Greenshell mussels™ have potential health benefits that can be validated to support future commercial opportunities, especially in Asia. This comprehensive capture of data over a 12 month period has signaled the viability to select for premium mussels to support a high-value marketing concept.



Stopping kauri dieback in its tracks

New Zealand’s Biological Heritage research has shown that extracts from some native plants may be able to attract and kill spores of *Phytophthora agathadicida* – the pathogen causing kauri dieback. Little is currently known about how the disease spreads. Better understanding of the interactions between *P. agathadicida* and kauri is essential to develop control strategies.

Challenge research identified chemical signals from kauri and other native plants that attract or repel the mobile spores (zoospores) of *P. agathadicida* that initiate infection. Māori knowledge (mātauranga) of native plants significantly advanced initial screening of plant extracts. How the chemicals identified affect movement of spores through soils is now being investigated.

A second project is engaging the public in refining a tool to treat kauri dieback. Participants are treating infected trees with phosphite, collecting data for analysis, and testing alternative practices, in particular Mātauranga Māori solutions. This research will help broaden the suite of practical tools available to control kauri dieback. Both projects contribute to the Challenge goal of future-proofing New Zealand’s biosecurity system from threats.



Maximising and sharing export returns from agri-foods

Credence attributes valued by consumers of New Zealand's export agri-foods have the potential to increase returns to producers. Our Land and Water surveyed consumers of four products in two markets to identify the environmental, social and cultural attributes consumers were willing to pay for. The four products, chosen in collaboration with stakeholders for their potential to create value that could be shared with producers, were: kiwifruit and yoghurt in Shanghai, and beef and wine in California.

Results showed that different market segments display value attributes differently, resulting in a wide range of 'willingness-to-pay'. Such data underpin design or modification of value chains to identify and reward producers for sustainable on-farm practices.

Research results are being used by Beef+Lamb NZ to develop its 'Red Meat Story' for international markets, and to underpin its environment strategy to ensure industry claims are met.

The research was led by Lincoln University in collaboration with researchers in six agencies, and with 13 stakeholder organisations, four central government agencies, Ngai Tahu and two Māori businesses.



Transportation network resilience

In collaboration with our Urban laboratory, Auckland Transport and the NZ Transport Agency, a new road criticality rating framework was developed and tested on central Auckland. This produced better connectivity assessment algorithms, and tested a broadening the scale of criticality to better distinguish secondary (less critical) transport links. The road network was also tested for evacuation capabilities, a key question for volcanic hazard managers. The research led to improved characterisation and identification of critical routes to enable better business case development resilience investment. The demonstration led to a broader application of the Challenge approach to the greater Auckland transport system.

With the Governance and Risk programs, and the Ministry of Transport Resilience Group the Challenge examined data use and communication channels following the Kaikoura earthquake. Workshops and interviews to complete the research involved over 60 representatives from 35 government, industry and community organisations. The Challenge used the resulting data to improve the design and adoption of a new post-event data structure across New Zealand's transport system. A Transport System monitoring tool was also developed, which will feature in an invited presentation at the "Understanding Risk Forum" in Mexico City in 2018.



Magnetic silver clusters – a disruptive technology in bio-imaging

The World Health Organisation believes the number of new cancer cases will increase by 70% in the next 20 years: it is clear improved diagnosis is needed, is in high demand, and will increase. Currently the market for MRI contrast agents is driven by gadolinium. However, this is plagued by toxic effects, low sensitivity, short imaging time, and large injection volumes. The aim of this Seed project is to develop new, highly efficient magnetic resonance imaging MRI contrast agents for early disease detection. To achieve this aim the project has worked to generate silver nanoclusters: a non-toxic, <10nm size nanomaterial with magnetic and fluorescent properties. The team sought to provide first time characterisation of magnetic properties and develop capacity in the area of material synthesis, bio-imaging and drug delivery, with the aim of potentially resulting in a positive impact on New Zealand's future economy.



Protecting mussels from ocean acidification

Coastal waters are becoming more acidic due to increasing carbon dioxide from the atmosphere as well as local processes such as microbial respiration. This is a potential threat to New Zealand's shellfish aquaculture industry, as mussels do not grow as well at a lower pH. Sustainable Seas has carried out preliminary tests to determine the potential application of two techniques to alleviate local acidification around mussel farms. The first involves returning waste mussel shell to the water around the farm, which may raise pH and dissolved carbonate as it dissolves. The second is strategic aeration of farm waters during the night, when carbon dioxide is higher and pH naturally lower.

The results from the trials will be compared and then used in hydrodynamic models to predict their effects on pH in mussel farms at in the top of the South Island and the Firth of Thames. The impact of these methods on the survival and condition of mussel spat and juveniles will also be assessed.

The aquaculture industry is very interested in the research with preliminary research detailed in an invited presentation at the New Zealand Aquaculture Conference in 2017. In addition Sanford and Waikato Regional Council have also supported this research financially. The aquaculture industry has indicated that they will be interested in recommendations the Challenge will make about how to mitigate acidification in coastal ecosystems.



Representation of Solar Variability, including Photolysis in the NZESM

Natural climate variability is partly driven by solar variability. The sun has an 11-year cycle and other variations in its output on both shorter and longer timescales. The New Zealand Earth System Model (NZESM) has a partial implementation of solar variability which affects solar heating rates in the model, but its effect on photolysis, the break-up of molecules when hit by sunlight is presently excluded. Solar variability is included in the photolysis schemes of many other Earth System Models, which would make the NZESM an outlier in multi-model comparisons.

The Deep South researchers have implemented a formulation of solar variability in the NZESM that separates the variable part of the solar output into the product of a function of wavelength and a time-varying

term. Both were derived from a widely used solar forcing dataset. This product decomposition nearly completely captures the full variability of the dataset. This modification was then implemented into the two photolysis schemes in the model (one for the far ultraviolet part of the spectrum, affecting the mesosphere, and one for the near-ultraviolet and visible part of the spectrum, effective everywhere). At the short-wavelength end of the spectrum considered in the model (at a wavelength of ~110 nanometres), solar variability amounts to more than 10% of the mean solar output, decreasing at larger wavelengths.

Various important photolysis reactions occur in the far-ultraviolet part of the spectrum. One such reaction is the photolysis of molecular oxygen (O₂); the resulting two free oxygen atoms (O) can then combine with other oxygen molecules to form ozone (O₃). This process dominates the production of ozone in the stratosphere and mesosphere. Significant impacts of this solar variability modification occur in the mesosphere where such far-UV light is absorbed. For example, the photolysis rate of oxygen changes in proportion with solar irradiance, leading to deviations of up to 10% from the mean. However, dynamical and chemical impacts of solar variability are detectable in the stratosphere because changes in mesospheric ozone affect the penetration of light to lower levels throughout the ultraviolet spectral range where ozone is an absorber.

The changes are presently subject to peer review at the Met Office, with a view towards incorporating them into upcoming releases of the Unified Model. This is the first scientific contribution by the Deep South NSC to the formulation of the NZESM; as such it has gained some significant attention by our partners at the Met Office and at the University of Cambridge, UK.