NIWA submission on the Te Ara Paerangi Future Pathway Green Paper

Introduction

The National Institute of Water and Atmospheric Research (NIWA) welcomes the opportunity to provide feedback and input in response the Te Ara Paerangi – Green Paper on science sector reform. As a Crown Research Institute (CRI), NIWA's purpose is to deliver benefit to the nation from its research and services. We support the purpose of the Green Paper to consider changes that will improve the performance of the public research funding system and institutions. This creates an opportunity to better enable organisations like NIWA to provide the research and science that our nation will need if it is to address the significant economic, environmental and social challenges we face over the coming decades.

The CRIs perform a distinct and important role in the New Zealand science system. Their primary function is to undertake mission-led applied research and ensure its uptake and use. Since NIWA was established in 1992, it has become a highly trusted science provider supported by the sectors that it serves. NIWA's independent governance and management has been fundamental to building this trust in both users and communities. This independence has also driven efficiency, enabled increased investment in research assets and infrastructure, and has built and evolved the science expertise New Zealand requires in the NIWA domains. Currently, 50% of the revenues that support NIWA capability is sourced from the users of NIWA's knowledge, expertise, products, and services.

Beneficial outcomes generated by the CRIs for the nation and global science have been considerable. For NIWA this has included:

- Establishment of supercomputing expertise and facilities that support the wider New Zealand research community.
- Development of world-leading high resolution 24/7 forecasting of regional weather and climate and their associated impacts (e.g., services for flood (rivers and coasts) and fire hazard emergency management, irrigation management, regional climate change impacts to inform adaptation).
- River flow networks and measurements that inform the management of hydro-electricity generation and the associated national market.
- Provision of the data, analysis and expertise, along with GNS Science, that enabled New Zealand to claim an extended legal continental shelf under the United Nations Convention on the Law of the Sea. This enabled New Zealand to add 1.7 million square kilometres of seabed to its ocean jurisdiction, an increase of 40%.
- Maintaining the longest running record of atmospheric CO_2 measurements for the Southern Hemisphere (50 years), as well as long term records of stratospheric ozone and other atmospheric gases significantly contributing to the global understanding of climate change and stratospheric ozone depletion.
- Deployment of nearly a third of the profiling floats, via NIWA's research vessel RV *Kaharoa*, for the international Argo Programme, which monitors the climate of the world's ocean in near real-time, enabling ocean warming to be quantified and improves predictions of major climate events such as the El Niño/La Niña Southern Oscillation.
- New tools and approaches to support iwi/hapū co-management and restoration of freshwater taonga species. This includes new predictive models that accommodate customary datasets, taonga species restoration plans and population assessment methods, the delivery of the first taonga species climate change vulnerability

assessment and the deployment of targeted restoration approaches such as artificial habitats, propagation/translocation and restocking.

- Vessel based surveys that have provided a 30 year time-series of relative biomass estimates for New Zealand's inshore and deepwater commercial fish stocks. This information underpins the setting of annual catch levels through the Quota Management System.
- Maintained observational programmes and data sets of key atmospheric, freshwater and marine environmental indicators to inform measures of the state of New Zealand's environment.
- Provision of weather and climate hazard risk information to local and central government agencies, the primary production, finance and insurance sectors, and South West Pacific island countries to inform their planning and actions to mitigate the impacts of storms, flooding, drought, wild fire and sea-level rise.

While there are some excellent aspects of the current system, there is room for improvement. It is our view that an effective science system should be more certain, less time consuming, more accountable, more effective and efficient, sufficiently resourced to deliver on national priorities, and have a greater focus on delivering impact from research for the good of New Zealand. It should reflect New Zealand's distinctive society, support the Te Tiriti relationship, be globally connected and provide for our future science workforce. Together these system improvements would help the nation to achieve its aspirations in an increasingly dynamic world.

There are four key actions that NIWA believes would improve the delivery of national outcomes via the New Zealand science system:

1. Developing a comprehensive national vison, driven by a clearly articulated purpose, for the whole science system to guide any future funding or structural changes. This needs to include the tertiary education sector and other research providers as well as Government research institutions.
2. Reducing competition for research funding to provide greater security for essential research capabilities and services, reduce the excessive transactional and administrative costs associated with funding applications, and create a more collaborative environment.
3. Implementing a simpler ownership, management and access structure for nationally significant science infrastructure and assets, that uses the established capability and expertise of science organisations that are the predominant user of those assets.
4. Sufficiently resourcing mission-led applied research and innovation to enable the public and private sectors and Māori to better realise the benefits and opportunities from existing knowledge and expertise.

This submission focuses initially on those elements of the science system that NIWA believes are performing well, and then highlights those elements we believe should have greater emphasis in the proposed system review. The remaining focus of the submission addresses aspects raised within each of the six review areas outlined in the Green Paper.

What is working well within the current science system

There are a number of elements and characteristics of public institutions and the research funding system that NIWA considers to be working well. We believe that these should be preserved when considering any changes. These include:

- New Zealand science organisations have invested in and established world class research infrastructure. Since their establishment in 1992, CRIs have all invested in state-of-the-art science equipment and in many cases developed globally recognised research facilities. This infrastructure is managed by experts and operated efficiently and cost effectively (see section below).

- In general, the CRIs have met the requirement of the CRI Act to be financially sustainable over the past 30 years through sound management of resources (people, operations etc) and business risk, the generation of high quality science and the application and transfer of their science to the sectors they support. This is despite the growing competitive nature of the New Zealand science funding system, and at times encouragement from shareholding Ministers to pay dividends (collectively over $100M) and carry debt.

- Operational systems that drive efficiency, performance and project delivery are well established in CRIs. This has ensured that research funds have been used effectively, and that the knowledge and IP generated by the CRIs provides national benefit through meeting end-user needs. It has also ensured that infrastructure is operated cost effectively.

> An international 2009 benchmarking exercise was undertaken by research vessel operators to assess the costs of managing and operating research vessels. This exercise found that compared with the five other countries involved in the assessment, NIWA had the lowest average cost base (relative to the length of ships operated) and costs were 20-30% less than the next lowest vessel operator.

- There are high levels of collaboration across the New Zealand science system. CRIs have strong relationships with each other, the universities and other science organisations through joint research programmes and graduate schools, and have established formal relationship agreements with key stakeholders (local and central government, industry, research organisations), both nationally and internationally.

- The CRIs have established long and enduring relationships with iwi and have been instrumental in helping to build Māori capability and capacity (science, technical, business support, management). They have also established programmes for building employment pathways for Māori researchers, building Māori cultural competency within their organisations and incorporating Mātauranga Māori into their research programmes (see below).

- Research organisations, especially the CRIs, have focussed on mission-led research application and have been adaptive to changing societal/sector needs and research context. Examples include the uptake of digital technologies and data science, the growing amount of research undertaken with and for Māori, the growth in citizen science, and the move to co-development of research with partners and communities.

- The science system and research organisations have and continue to grow the benefits that are derived from their knowledge, skills, products and services. Over 50% of the research and services provided by CRIs is now supported through direct funding from the sectors that they serve (central government agencies and entities, local government and industry and other private sector organisations). The significant contribution made to New Zealand's response to COVID-19 attests to the quality of the capabilities that the nation's research organisations have established and maintained. The CRIs have established a stable and strategic approach to the provision of their capability and services, and maintained their status as independent objective providers of expertise.

Critical aspects of the science system needing greater emphasis

The focus of the Te Ara Paerangi – Green Paper is on six key aspects of the New Zealand science system. There are several key elements of the system, however, that are poorly considered that we believe should be included in the science system review. These include:

- The primary focus of the Green paper is the design of the 'public' research system, and it defines the six key functions of the system planned for review. But before defining the functions to be reviewed, the overall strategy and key strategic directions/vision for the science system should be identified (i.e., strategy before structure, form before function). This essential exercise should also include all the elements that make up the public research system. The Green Paper should therefore not only focus on CRIs, but the tertiary education sector and other research providers (e.g., IROs, government agencies and entities), along with government funders of research (e.g., MBIE, Tertiary Education Commission, MPI, DOC etc).

- Give greater consideration of the importance of innovation, and how this is achieved through applied research and experimental development. This element is fundamental to successful science uptake and use. Any changes to the science system should grow innovation, as well as ensure that funding systems support the integration of knowledge from its creation through to its use. The applied science and national distribution of facilities and activities (e.g., environmental measurement networks and field stations) of CRIs is fundamental to generating national benefit from research investments and is equally important to the research system as knowledge creation and academic achievement.

- The need to grow applied research. This is considered essential if New Zealand is to successfully address the major challenges it will face over the coming decades, such as climate change, social equity and well-being, building a strong economy, and strengthening the Crown – Māori partnership. Climate change is already impacting New Zealand. There is an increasing need to focus on solutions to the problems arising from climate change impacts, and the actions needed to achieve these solutions, within both the public and private sectors. This is a key role of CRIs, especially with respect to commercialisation of products, input into government policy, generation of new management tools and the provision of data and services.

- The exponential growth in digital technologies, in all its guises, is not only changing how research is undertaken but also enabling new research directions and opportunities in all science disciplines. This includes digital connectivity, data science

(AI, machine learning etc) and big data, sensor technology and remote sensing, high performance computing, new visualisation techniques, and instrument miniaturisation. It will be essential that changes to the science system enable these advances to be realised if New Zealand's science capabilities are to remain world-class and deliver the outcomes our country seeks from its research investments.

- The importance of organisational culture, independence and the related societal trust in our science organisations. COVID-19 has demonstrated the importance of these elements for science. Any changes to institutions within the science system need to consider organisational culture, independence and trust, which are especially important in mission-led research and its application, and with partnering with Māori.

> The creation of the CRIs in 1992 led to a paradigm shift in culture, and a loss of capacity and performance over many years. This transition was a major disruption to the Government's science capability. Given the immediate challenges the nation is facing, any significant structural change to CRIs needs to consider impacts on institutional culture and potential loss of science skills and capacity.

- The characteristics and expectations of the science system need to be balanced and clearly defined. The roles of institutions and associated cultures, levels of collaboration, operational efficiency and productivity, breadth of stakeholder engagement, and competition for ideas, funds and skills are all important but need to be balanced against each other in a fit-for-purpose science system. For example, the strong incentives for collaboration have resulted in investments that are spread too thinly with too many partners, which results in failure to deliver productive research or meaningful outcomes.

- The New Zealand science system is small relative to many other countries around the world. Close connections, formal relationships and collaboration with the international science community and organisations provides access to knowledge, skills, intellectual property, technologies and resources not held in New Zealand. Strengthening and growing international connectivity within the New Zealand science system will be essential if it is to address the countries future challenges.

Response to specific areas of consideration raised in the Green Paper

The following section provides feedback on specific elements raised within the Green Paper.

- *Section 1: Research Priorities*
    - NIWA strongly supports the development of transparent processes for identifying research priorities for the nation. The last efforts to prioritise New Zealand's research investment occurred in the late 1990s through the STEP and SPRR processes. Both exercises involved the establishment of an expert national panel and robust processes for establishing priorities. We suggest that an independent Research, Development & Innovation Council, consisting of Māori, industry, government and research community representatives, be established to identify and prioritise key national areas of research need to guide future government science investment.

- The growing reliance of research institutions on highly contested competitive research funds compromises employment security and the development of long-term strategies and infrastructure investments to meet national priorities. This issue could be addressed by increasing levels of base funding for research organisations.

- The science system needs to ensure that it addresses the research priorities of Māori, consistent with the recognition and protection of Tino Rangatiratanga and equity. A national process for setting priorities for Māori should be led by Māori.

- *Section 2: Te Tiriti, Mātauranga Māori, and Māori Aspirations*

  - A fit-for-purpose research system requires we move from simply engaging with iwi to embedding Te Tiriti o Waitangi principles of partnership, participation and protection across all aspects of the research system. This will require sufficient stable funding for research organisations to support enduring iwi/hapu relationships and Māori capability and capacity across all research areas.

  - Mātauranga Māori needs to be better recognised, protected, respected, valued and resourced within institutions and policy/funding agencies. Kaitiakitanga and leadership of Mātauranga Māori, however, must remain with Māori and iwi and hapu.

  - Frameworks and improved systems for assessing Kaupapa Māori research applications needs to be co-developed with, and preferably by, Māori. Application assessments for many research funds lack or have poor systems for evaluating Kaupapa Māori approaches, Māori capability and Vision Mātauranga outcomes.

  - Te Ao Māori cultural competency and expertise must be valued, appreciated, and resourced within all institutions throughout the research system. This must be enabled through funding and institutional settings.

- *Section 3: Funding*

  - New Zealand's level of research investment continues to lag that of the OECD. The Government goal of reaching a national investment level of 2% of GDP will be essential if New Zealand is to have an effective science system, capable of helping the nation to meet its future economic, social and environmental aspirations.

  - The New Zealand research funding system has become increasingly competitive and in real terms the value of the non-contestable funding that supports the core national capability and services of the CRIs has reduced (for most CRIs this is now less than 30% of their total revenue). To increase the application and use of the knowledge and expertise held by the CRIs this trend must be reversed. Reducing contestability within the science system will also facilitate meaningful collaboration and connectivity, both with research organisations and stakeholders.

- The high levels of contestability for research funds, and low success rates, is adding cost, reducing productivity and generating significant inefficiencies in the science system. While we agree that a "contest of ideas" is an essential element of science and helps drive science excellence, we believe the current level of competitiveness for research funds, and the associated grantsmanship by providers, is failing to maximise national benefit from the investment. There is also an urgent need to evaluate the effectiveness of large competitive funds, such as the Endeavour Fund, to ensure they are delivering the benefits as intended.

- The National Science Challenges and some of the more recent Platforms are extremely expensive to administer and manage, and have added complexity to an already crowded science system. While they have established high levels of collaboration, this has been at the expense of focused effort, productivity and outcomes. Such programmes frequently include large numbers of researchers with low levels of funding working on unlinked projects which too often miss the opportunity for significant collective impact. Some fund large numbers of PhD students but only low numbers of experienced researchers.

- The introduction of the full cost funding model for research was intended to overcome failures of the 'bulk funding model'. It has enabled research providers to prioritise and increase science infrastructure investment, build capability in areas of need, and to develop and deliver research strategies in response to national need. Any changes to the funding model need to ensure that these elements are not lost.

- The introduction of a 'marginal cost funding model' will potentially be difficult to establish and costly. Most research providers are dependent on revenues from applied science services to maintain their current capabilities, expertise and scale (for CRIs this is over 50% of their revenues). There is also a risk that marginal cost funding will disincentivise the applied science components of the science system to pursue end-user relationships, thereby reducing provider awareness of the needs of end-users.

- The quantum of science funding allocated specifically for Māori driven research (e.g., VMCF) has been woefully low and needs to be increased if New Zealand is to increase Māori research capability and capacity and deliver beneficial outcomes for Māori across the diversity of research areas required. In addition the funding gap must be addressed that exists between short-term projects (e.g., VMCF) and longer-term research programmes, such as Endeavour, to help progress Māori entities along the implementation and capability building pathway at a faster pace and at a broader scale.

- *Section 4: Institutions*

  The focus of the Green Paper in this section is primarily on a review of the CRI model. Key elements that need to be considered are:

  - While the company model for CRIs is not considered essential, its removal is unlikely to bring about improvements to the performance of CRIs unless there are significant changes to other parts of the science system (e.g., science funding and levels of support for core national capability). An underestimated

benefit of the company model is its influence on financial sustainability, driving efficiency and productivity, maintaining core national capabilities, meeting end-user needs and delivery performance.

- Any changes to the CRIs needs to ensure that elements currently working well are retained. This includes, but is not limited to:
  - Important to the provision of science services to Government through the delivery of commissioned work on time and to budget (difficult to achieve in an 'academic freedom' environment).
  - Processes for the efficient allocation and use of resources and infrastructure.
  - High levels of training, mentoring and support for staff.
  - Investment in state-of-the art science equipment.
  - Extensive end-user networks and relationships and stakeholder collaborations, along with enduring relationships with iwi, that go beyond relationships between specific individuals.
  - Established brands/reputations as trusted, independent providers of research, knowledge and expertise.
  - Provision of unique national research capability and associated services (e.g., 24/7 forecasting of natural hazards and response – earthquakes, tsunami, floods, fire; biosecurity services and response; health/forensic services etc).
  - Stewards of nationally significant data bases and collections (e.g., soils, fruit and crop germplasms, climate, indigenous land, freshwater and marine organisms) and science infrastructure (e.g., research vessels, super-computers, ice core facility, GeoNet).
  - Dedicated business units with specialist skills, expertise and networks such as Te Kūwaha, NIWA's National Centre of Māori Environmental Research and associated programmes.
  - Fit-for-purpose leadership roles (science, operational, cultural) that bridges the gap between science and Te Ao Māori, policy and business.

- Any restructuring of CRIs should consider relationships with other government science organisations to maximise opportunities that could arise from any institutional changes, while recognising the critical importance of independence for science providers.

- Any perceived benefits of restructuring the CRIs needs to be weighed against the likely costs of the restructure process itself. For example, the 1992 restructuring of DSIR into CRIs cost over $100M at the time. A restructure will disrupt staff and culture, and cause loss of capability and productivity for the years that follow.

- *Section 5: Research workforce*

  - While enabling mobility of the research workforce is both desirable and beneficial, this should not be created at the expense of the stable permanent employment opportunities in the research system that are desired by researchers. Although mobility of the CRI research workforce is increasing through a range of mechanisms (e.g., secondments, joint appointments), there is little reciprocity from other stakeholders. There is a need to explore

mechanisms for increasing the mobility of the workforce across the wider research system, including with key end-users.

- Improved understanding of the wider research system, including end-users, by the research workforce is considered beneficial. Targeted funding to enable exchange opportunities improves the technical skills and expertise, as well as the personal development, of individuals and the research workforce as a whole. For example, NIWA supports secondments or sabbaticals to national or international institutions, and secures funding for in-house consulting/advisory roles within partner organisations such as central and local government. These arrangements are extremely valuable both for delivering impact from science with partners and end-users, and for career development of the individuals involved.

- While CRIs work collaboratively with universities to generate the graduates they need (e.g., NIWA supervises over 100 PhD students each year), the New Zealand tertiary education system still fails to produce graduates in all the research fields required by CRIs. This necessitates employment of the required expertise from overseas. Mechanisms for prioritising the skills and training within the tertiary sector, along with a balanced immigration policy, will be required if New Zealand is to build and acquire the science skills it needs.

- To be high performing and fit for purpose, our future research workforce requires a significant increase in all types of diversity. Targeted capability development schemes, for instance NIWA's Te Piko o Te Māhuri (growing Māori research capacity) strategy, is effective at attracting and retaining Māori capacity in the research system, but are resource intensive. The EDI fund is a start, although we believe it is insufficient to grow the diversity needed within the research workforce.

- Co-location of research institutions or researchers can support collaboration, but is <u>not</u> essential. There are already significant levels of collaboration within the New Zealand science system. Contestable funding processes require collaboration but too often fail to create the 'best teams'. Increased allocation of base funding for government research institutions, reducing institutional reliance on contestable funding, would be more likely to encourage meaningful and productive collaboration between institutions.

- *Section 6: Infrastructure*

  - The Green Paper highlights a perception that there are major impediments to science infrastructure investment across the science system. In our view this depends on scale, and through the full cost funding model, science providers have managed to build world class facilities and embrace new technologies. While CRIs have the ability to manage their finances in such a way as to accommodate the capital costs of the large science infrastructure they require, the current research funding system does not generally support the full operational costs over the life of large science assets. Key elements that need to be considered include:

- A consistent approach to supporting the operations and broader access to key national science infrastructure.
- Whether multiple ownership and "club models" are appropriate for national scale infrastructure; this approach adds excessive complexity, incurs high management costs, and restricts access by research organisations that are non-club members.
- Reliance on highly contestable relatively short-term research grants to support key national science infrastructure puts the financial viability of the infrastructure at risk.

- The full cost funding model (or similar) should be retained to support specific organisational science infrastructure. This ensures that procurement, management and use of the infrastructure is supported by the appropriate expertise, and that areas of science receive the equipment they require (i.e., levels of capital expenditure vary according to science discipline and priorities, which is best managed by the individual research organisations). Research providers generally have the specialist technical expertise and robust processes for investing in and managing their infrastructure requirements.

- There are successful models for enabling access to specialised science infrastructure within the science system. The RV *Tangaroa* for example, while owned and operated by NIWA, is made available to all research providers through a merit-based access system supported by MBIE funding.

NIWA has successfully managed its finances to ensure that it generates the funds required to invest in the large capital items it owns and operates on behalf of the Crown (i.e., super computers, research vessels which are made available to all research providers through MBIE funding), along with the science equipment and infrastructure it requires to undertake its research and deliver services. Over the next 10 years NIWA will invest over $330M from its own balance sheet on research infrastructure. In the next 4 years NIWA will build a new coastal research vessel ($33M) and an experimental commercial scale recirculation aquaculture system ($9M) and replace its supercomputers ($18M). Also, NIWA has an ongoing investment of over $12M each year in science equipment and infrastructure.