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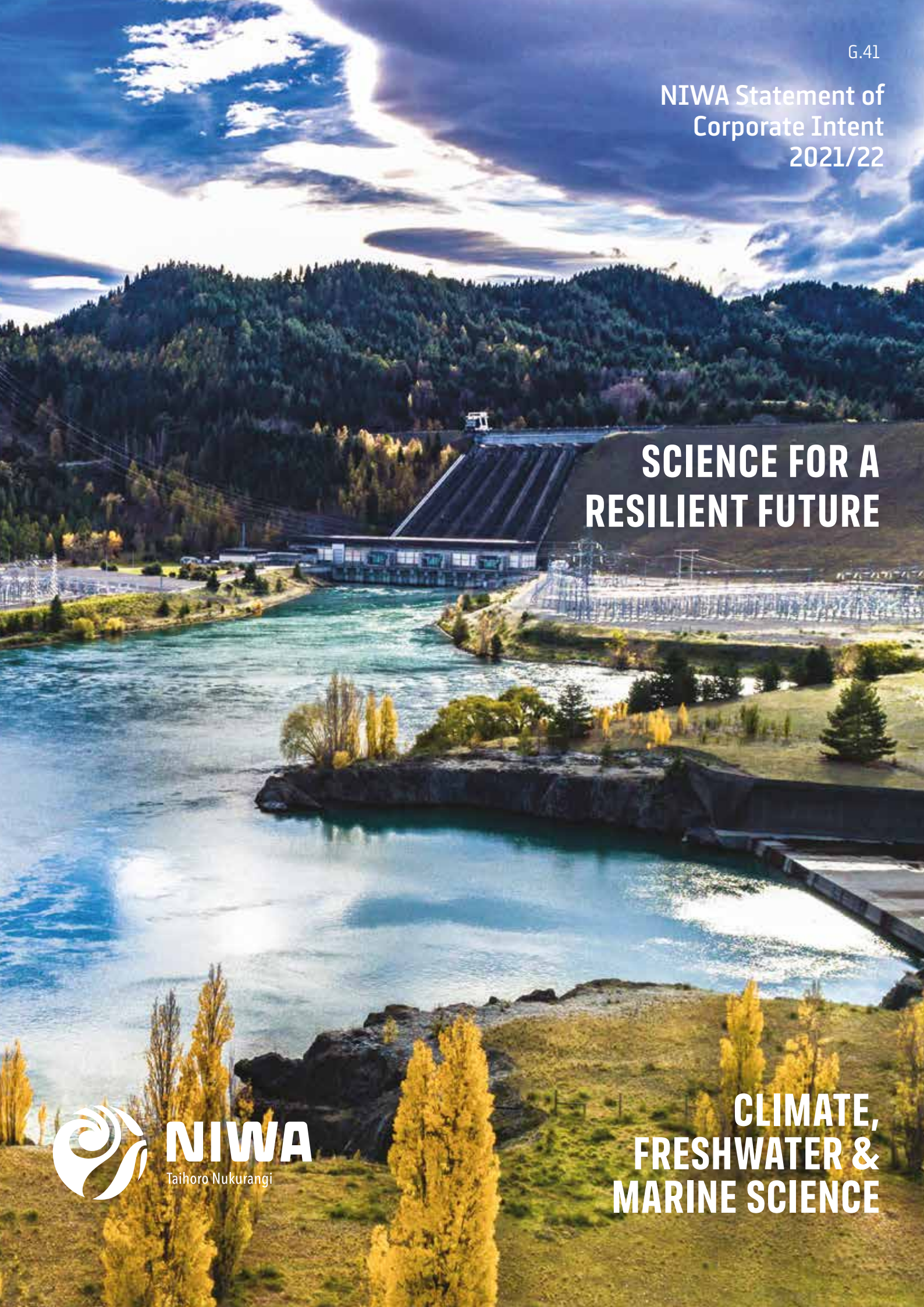
NIWA Statement of Corporate Intent 2021/22



SCIENCE FOR A RESILIENT FUTURE

NIWA
Taihoro Nukurangi

CLIMATE, FRESHWATER & MARINE SCIENCE

WORKING WITH OTHERS

enhancing our collaborations with

- Māori
- national and international science organisations
- customers and stakeholders

to deliver the excellent science New Zealand's needs

58
collaboration projects contracted with other CRIs

23
contracted formal agreements with international science organisations

124
collaboration projects contracted with universities

2
Joint Graduate Schools with universities

849
science projects with more than 100 contracted customers/stakeholders

288
scientific publications jointly authored with other science providers

- Joint CRI COVID-19 Recovery Taskforce to support New Zealand's recovery
- Promoting science as
  - Principal Science Partner of BLAKE
  - Sponsor of the Sir Paul Callaghan Eureka Awards
  - Major sponsor of national Science & Technology Fairs
- Supervision of 116 PhD, MSc or Honours students annually

PARTNERING WITH MĀORI

Te Kūwaha – a dedicated Māori research team, working with others to enable knowledge systems to support kaitiakitanga and provide environmental research excellence that enhances the social, environmental and economic aspirations of whānau, hapū, iwi, Māori communities and Māori business

The National Centre for Māori Environmental Research with 15 Māori scientists and researchers delivering outcomes for Māori, with Māori, by Māori

50
partnerships and collaborations with Māori across Aotearoa

9
Māori staff in senior leadership positions integrated across NIWA's science, operations and cultural functions

34
Maori-led NIWA projects working with whānau, hapū , iwi, Māori entities and Māori communities to realise their research aspirations

4
strategic science (SSIF) programmes to deliver outcomes for Māori in freshwater, coastal, fisheries, aquaculture, climate, natural hazards and economic development

- Opportunities to build Māori capacity through communications and outreach with whānau, hapū, rangatahi, kaitiaki, marae and Māori communities
- Graduate Intern Programme to create pathways to support Māori science graduates into postgraduate opportunities and career pathways
- Māori research capability support via summer internships, MSc and PhD scholarships, taiohi wānanga, supervisory arrangements, and VMCFs.
- Cultural Capability Programme with learning tools and resources to help NIWA staff strengthen their cultural capability (digital apps, noho marae, tikanga/te reo support)

EMBRACING NEW TECHNOLOGIES

Adopting, developing, and applying innovative technologies to ensure we deliver the information, and products and services the nation needs

133
Technology & Innovation staff

8
person Data Science Team being established

$18M
High Performance Computing Facility & Data Centre

2,000+
climate stations providing representative coverage of New Zealand and region (Antarctica, Pacific)

1,900+
hydrological stations for water management

1,000+
freshwater quality monitoring locations

- Two satellite-receiving stations with processing software and databases holding derived products used by science, forecasting and industry (e.g., fishing)
- Real-time sensor arrays deployed for various industries (e.g., irrigation, horticulture) to improve operations within environmental limits
- Investment in enabling technology and services to empower innovation: Industrial carbon-weave 3D printing machine, Autonomous boats and craft for survey, Mechatronics Laboratory, state-of-the-art studio for graphic and model representation
- Environmental databases – Marine, Biological, Geospatial, Image, and Science
- Nationally significant databases and collections for Climate, Water Resources, Marine Invertebrates and Freshwater Fish
- Stable Isotope Analytical Facility
- Commercial drone fleet with ground-penetrating radar, LIDAR, etc.
- High-precision National Weather Forecast Service used by DOC, FENZ and others
- National Flood Forecasting Service providing river flow forecasts for 66,000 catchments nationwide

NIWA
Taihoro Nukurangi

Statement of Corporate Intent 2021/22

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NIWA
Statement of Corporate Intent
2021/22

Contents

Benmore Dam. NIWA measures, models and forecasts weather, river flows and climate variability to help the hydroelectricity sector in regard to supply, demand and transmission. *[Tracey McNamara]*

Chairman and Chief Executive's Overview

We are pleased to present NIWA's 2021/22 Statement of Corporate Intent (SCI), which describes our strategy for meeting the obligations outlined in our Statement of Core Purpose. This SCI builds on the review and refresh of NIWA's organisational and science strategy undertaken last year, and reaffirms NIWA's commitment to delivering quality science for the nation's benefit through collaboration with Māori and others, continuing to invest in our people and assets, and sustaining our financial performance.

While there continues to be economic uncertainty as a consequence of the national and global impacts of COVID-19, we foresee an operating environment with significant opportunities for NIWA over the period of this SCI. These opportunities are based on the nation's focus on climate change and its impacts, the implementation of the freshwater reforms and the growing interest in the value of New Zealand's marine environment. NIWA's considerable investment in advanced technologies and data science will be essential enablers for realising these opportunities, and this SCI outlines how we will continue to invest, build, and apply these leading-edge capabilities in our science.

As a consequence of the support NIWA received from the *COVID-19 Response and Recovery Fund* over the past year, NIWA has been able to retain all its capability and maintain its capital investment programme. It enables us to improve our assets and capabilities, especially the science infrastructure and associated expertise we provide to the wider science sector, such as high performance computing and ocean-going research vessels and equipment.

This financial support also enables NIWA to advance its Future Property Programme (FPP), as outlined in this SCI, that aims to bring the company's properties up to contemporary standards. Connecting, and where appropriate co-locating, with other CRIs and science organisations will be a key consideration when planning these investments to ensure the most efficient use and sharing of resources, services, capability, assets, and people across the science system. NIWA's Board and Executive are committed to continued strong financial performance to ensure we can make these necessary investments.

This SCI outlines NIWA's commitment to maintaining the critical scientific capability, services and support the government needs to ensure evidence-based decision making, and to contribute to the cross-government response required to assist the nation's economic recovery from COVID-19. A particular focus in this SCI is our aspiration to be an exemplar for environmental sustainability and our commitment to a journey of continuous improvement. Our operations and strategic priorities in freshwater, climate and marine science are well-aligned with current government priorities and policies. In this context, during 2021/22 NIWA will:

- Continue to work with the Ministry for Primary Industries, Ministry for the Environment and Department of Conservation as a key contributor to implementation of the *Fit for a Better World Roadmap* and the *Conservation and Environment Science Roadmap*.
- Contribute to development of a collective CRI science strategy in the areas of climate change, freshwater management, energy, biosecurity, biodiversity, and hazard management and emergency response.
- Improve mechanisms for provision and access to its data, and collaborate with the other CRIs on the implementation and development of a National Environmental Data Centre.
- Provide input into evidence-based policy development by central and local government through commissioned reports, membership of expert technical advisory groups and agency secondments.
- Strengthen partnerships with whānau, hapū, iwi and Māori enterprises to sustainably develop their resources and businesses, respecting the obligations to Māori by government through Te Tiriti o Waitangi.
- Continue its focus on building internal knowledge of Te Ao Māori and increasing our capability and capacity in matauranga Māori.
- Recognise potential changes in workforce needs and preferences, and continue to provide a healthy, safe, flexible, and diverse workplace.

- Ensure our staff adapt to new ways of working, especially in relation to travel and maintaining our networks of national and international collaborators, through investing in our IT systems so they can meet the increasing need for digital connectivity.
- Continue to act as a good employer in line with corporate social responsibility practices and the Public Service Commission's principles on remuneration and pay equity.
- Foster diversity within all levels of the organisation with particular reference to gender, age, ethnicity, disability, and sexual orientation.
- Develop a business case for the replacement of its medium-sized research vessel, consistent with stakeholder needs and its vessel fleet strategy.
- Specifically amend its sustainability goals to include a target of achieving carbon neutrality in 2025; and
- Adopt a prudent approach to financial planning in 2021/22 and the out-years.

Barry Harris
Chair

John Morgan
Chief Executive

The National Agricultural Fieldays were held on 16–19 June. In a collaborative effort, four Crown Research Institutes – AgResearch, NIWA, Manaaki Whenua and Scion – demonstrated their focus on helping New Zealand recover from COVID-19 by showcasing science solutions for a changing climate. *[Stuart Mackay]*

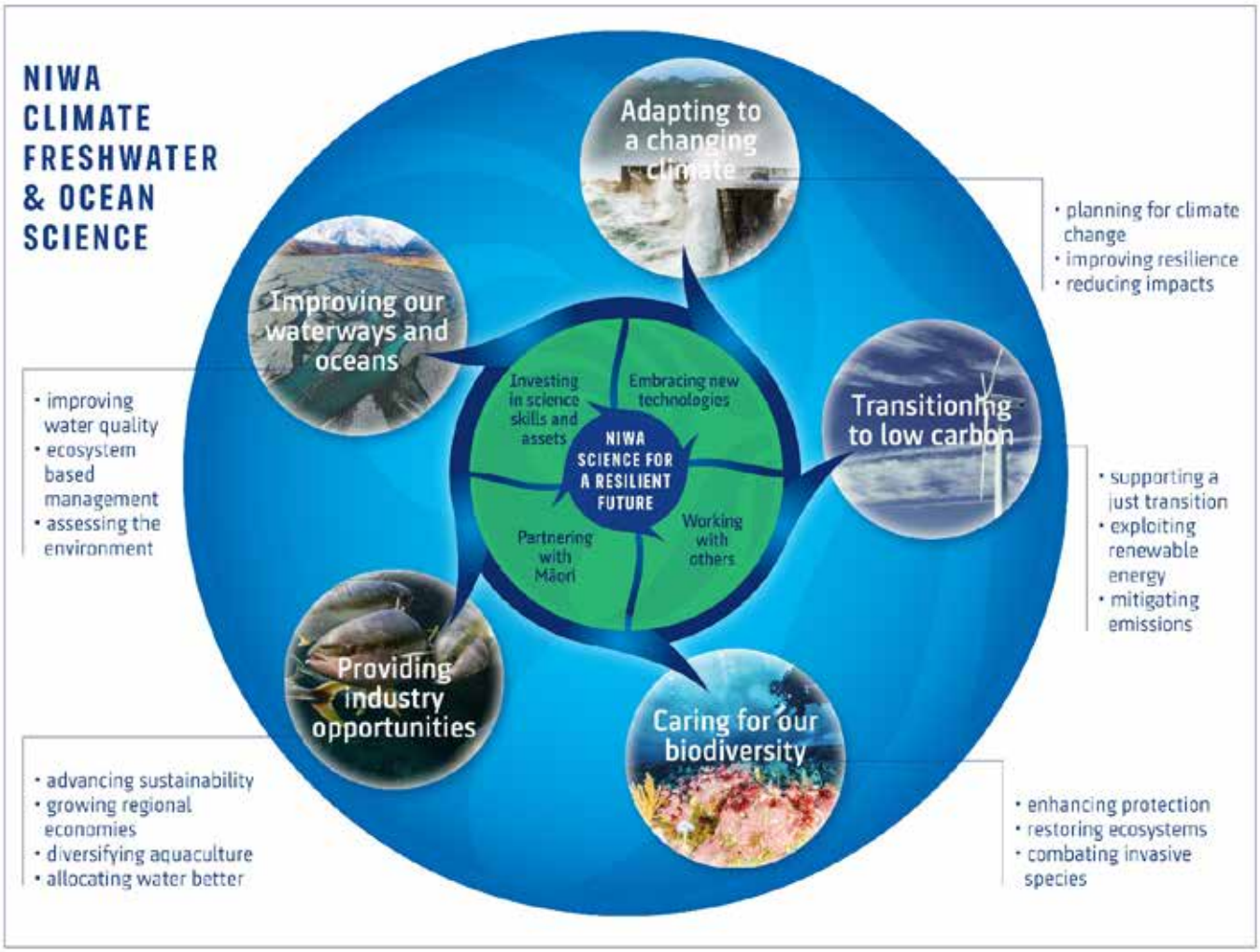
NIWA's core purpose and key outcomes

NIWA's purpose is to enhance the economic value and sustainable management of New Zealand's aquatic resources and environments, to provide understanding of climate and the atmosphere and increase resilience to weather and climate hazards to improve safety and wellbeing of New Zealanders.

Outcomes

NIWA will fulfil its purpose through the provision of research and transfer of technology and knowledge in partnership with key stakeholders including industry, government, and Māori to:

- increase economic growth through the sustainable management and use of aquatic resources
- grow renewable energy production through developing a greater understanding of renewable aquatic and atmospheric energy resources;
- increase the resilience of New Zealand and South-West Pacific islands to tsunami and weather and climate hazards, including drought, floods and sea-level change;
- enable New Zealand to adapt to the impacts and exploit the opportunities of climate variability and change and mitigate changes in atmospheric composition from greenhouse gases and air pollutants;
- enhance the stewardship of New Zealand's freshwater and marine ecosystems and biodiversity;
- increase understanding of the Antarctic and Southern Ocean climate, cryosphere, oceans and ecosystems and their longer-term impact on New Zealand.



NIWA Science Strategy

NIWA's mission is to support the wellbeing of Aotearoa New Zealand's people and businesses through improved management of the environment, sustainable use of natural resources, and effective responses to global change.

Our strategy aims to deliver the science that enables New Zealand to meet its environmental challenges and thrive in a rapidly changing world. We will innovate, generate new knowledge, and apply our science to facilitate transition to a low carbon economy, adapt to a changing climate, maintain healthy waterways and oceans, and care for our unique biodiversity. To achieve these advancements, we will partner with Māori, embrace new technologies, and support major science infrastructure. We will collaborate with other science organisations and the sectors that apply our science. These national outcomes and overarching approaches are described below.

The global COVID-19 pandemic has changed the needs of New Zealand. The negative impact of COVID-19 on our primary industries has been less than on other sectors, such as tourism. The primary sector will, therefore, be a major contributor to economic recovery, and the government is seeking to increase its sustainability and diversify its product base. These needs are especially important for Māori because of their significant assets in fisheries, forestry, agriculture, and horticulture. Whānau, hapū, iwi and Māori enterprises are actively seeking opportunities to sustainably develop their resources and businesses. We have, therefore, ensured that our planned science activities have included the need to provide the expertise and services required to accelerate New Zealand's economic recovery and aid adjustment to any post-COVID-19 societal challenges.

National Outcomes

The primary focus of government in the near to medium term will be response to the disruption and longer-term domestic and international changes caused by COVID-19. While it aims to accelerate economic recovery, it is also seeking to advance the goals it set before the pandemic. These include regional economic growth, diversifying the economy, transitioning to a low carbon economy, improving water quality, and achieving social equity. NIWA's science will support the realisation of these national outcomes.

NIWA has New Zealand's largest team of freshwater scientists working to enhance the stewardship of our freshwater ecosystems and their biodiversity. *[Crispin Middleton]*

Providing industry opportunities

Advancing sustainability

NIWA's environmental data, data management systems, data analytical and modelling expertise and survey technologies provide opportunities for New Zealand's industries to mitigate environmental risk more effectively and make better business decisions. This applies to land-based farming, land- and sea-based aquaculture and the management of our fisheries, as well as to other sectors, such as energy generation and infrastructure development.

To support sustainable practices and better management and operational decision making within the primary sector, NIWA will:

- Provide new high-resolution environmental modelling, forecasting and validation products to inform limit-setting, reduce environmental impacts and de-risk decision making for land- and sea-based activities.
- Partner with Māori and industry to provide seasonal to decadal climate projections designed to inform sustainable future land- and water-use options and investment decisions.
- Enhance fisheries management by improving fish population assessment methods and developing new tools to monitor fish populations and ecosystems, including new survey technologies and platforms.
- Develop technologies and provide guidance to reduce the impacts of farming, urban development, aquaculture and fishing on freshwater and marine ecosystems and habitats, including reducing bycatch.
- Improve our knowledge of the role of freshwater and marine habitats and climate change on ecosystems, fish distribution and productivity.

Fisheries science at NIWA includes a focus on enhancing stock management by improving assessment methodology and developing new tools to monitor populations and ecosystems. *[Rebekah Parsons-King]*

Growing regional economies

There are significant opportunities to grow regional economies through the development and uptake of tailored products and services. New measurement technologies, data science and improved weather, climate and other environmental simulations provide opportunities to identify potential new products and increase industry efficiencies and market positioning, especially in the primary production, tourism and energy sectors. Application of these advances in partnership with Māori has potential to provide significant benefit to whānau, hāpu, and iwi actively seeking to develop, grow and expand their businesses.

To support regional economic growth NIWA will:

- Develop services based on new data science and models to combine environmental measurements and forecasts with third-party data to increase profitability and risk management by sectors impacted by weather and climate (finance, primary industries, infrastructure, energy, tourism and others).
- Provide scientific data, models, technology and decision-support tools to inform the development and implementation of business plans and environmental policies.
- Develop new weather and climate derivatives to inform production levels, supply chain management and sales forecasting, especially for the energy, retail and primary sectors.
- Add value to the manufacturing sector by co-developing technologies to better predict, and respond to, climate- and weather-related risks in supply chains.

Diversifying aquaculture

To date, the aquaculture sector has not been able to fully respond to the rapid growth in global demand for premium aquaculture products because of complex social licence issues, consumer expectations and accelerated environmental change. It is currently dominated by sea-based farming of relatively low-value species and has suffered over recent years from constrained availability of near-shore areas and climate-related declines in production. Onshore aquaculture, for part or all of the production cycle, represents a significant opportunity to overcome these issues and create new exports, regional economic growth, and business and employment opportunities for Māori and other investors. Onshore aquaculture avoids most current coastal regulatory impediments, can be insulated from climate change impacts, and offers opportunities for circular economy co-products and near-zero waste discharge. It is now a financially viable production option given recent technology advances and the introduction of new high-value species.

To advance and diversify New Zealand's aquaculture sector, and support and complement established farming activities, NIWA will:

- Provide scientific capability, tools, and technologies to improve the environmental sustainability of off-shore and land-based finfish farms.
- Commence commercial-scale trials of yellowtail kingfish grow-out using a recirculating aquaculture system (RAS) to demonstrate the financial viability of onshore aquaculture and opportunities to incorporate circular economic principles.
- Maximise the quality and production of yellowtail kingfish and hāpuku through ongoing development of broodstock.
- Strengthen New Zealand's aquaculture industries by developing tools and techniques to improve the productivity of existing farmed species such as Greenshell mussels and oysters and explore culture of new species such as hāpuku and macroalgae.

NIWA's research has demonstrated that kingfish are particularly well suited for farming in land-based recirculating aquaculture systems (RAS), reaching the marketable size of 3.5kg within 12 months.
[Stuart Mackay]

Allocating water better

In many New Zealand catchments, water allocation is approaching or has exceeded regulatory limits. Water abstraction for irrigation, potable supplies and other uses has increased substantially, as has knowledge of minimum river flow levels needed to sustain aquatic ecosystem health. As a result, competition among water users (including aquatic ecosystems) is steadily increasing, making the inequities of current water allocation systems increasingly apparent. These inequities are caused by first-in, first-served consenting and an inability to reallocate water in response to changes in water availability and demand. Five major changes are needed to rectify these inequities: dynamic and adaptive allocation (possibly through water trading), increased efficiency of water use, rigorously tested procedures for prescribing environmental flows, recognition of all legitimate water uses (including provision for 'cultural' flows), and policies and capability building that enable Māori to exercise their rights and interests in water.

To provide the evidence base to support policy makers and water managers responsible for making these changes, NIWA will:

- Work with hapū and iwi partners to develop methods for assessing cultural flow requirements (using mātauranga Māori) to inform their decision making.
- Work with hapū and iwi partners to develop freshwater accounting systems, characterise water availability for abstractive use (and spatial and temporal variation in water availability), and investigate trade-offs between abstractive use and instream flows needed to protect cultural and ecological values.
- Develop simulation tools to assess the consequences of current water use, planned water allocation, and changes in water demand, availability, and quality as a result of climate change.
- Develop methods for identifying potential locations for new water storage and hydropower systems, and for mitigating adverse effects of these systems.
- Further develop the New Zealand Water Model to provide operational flow forecasting.
- Improve methods for water accountancy, encompassing actual water use, availability, and consents, especially in large, multi-use, multi-industry catchments.
- Develop tools to increase water use efficiency, including irrigation schedules based on soil moisture sensors and weather forecasts.
- Develop predictive models that relate river biota (periphyton, invertebrates, fish, and birds) to flow variation.

Irrigation Insight is a five-year cross-industry project that aims to examine – on working farms – the effectiveness of improved weather forecasting and drainage estimations for on-farm water management. *[Stuart Mackay]*

Transitioning to low carbon

Supporting a just transition

NIWA is well positioned to support New Zealand's transition to a low carbon economy. The Climate Change Response (Zero Carbon) Amendment Act requires this transition to be enduring, equitable and just. Actions to reduce emissions or adapt to climate change may negatively impact some sectors of society more than others. Therefore, the potential negative consequences of change will need to be assessed, evaluated, and reduced. This will require transformative and novel engagement processes, scenario modelling, and assessment of multi-factor and cascading impacts. Transitions are complex and take time.

To support a just transition through transdisciplinary approaches across the science-policy-society spectrum, new collaborations, and novel ways of thinking, NIWA will:

- Collaborate with Māori partners and stakeholders to co-develop transition research programmes, citizen science projects, easy-to-use decision-support tools and implementable plans designed to instigate behavioural change and produce low emission solutions.
- Work with government, industry, teachers, students and whānau to measure and understand sources and pathways of greenhouse gases.
- Work closely with Māori and Pacific Island communities to better understand the risks to their livelihoods and wellbeing associated with the potential consequences of change.
- Communicate the science of climate change, its potential wellbeing impacts, and adaptation and mitigation options in clear, accessible, and engaging ways across multiple media and other channels, and by using novel techniques tailored to the needs of specific groups.

CO_2 emissions from transport account for almost half the greenhouse gas emissions in New Zealand. Early figures suggest an overall reduction in emissions during 2020 of 4.8%, largely driven by a fall in transport emissions, reflecting the impact of COVID-19. *[Stuart Mackay]*

Exploiting our renewable energy sources

The demand for renewable energy generation and storage is projected to rapidly increase over the coming decades as our transport and industrial sectors decarbonise. To meet New Zealand's 2050 zero-carbon goals, we need to double the generation of electricity without using fossil fuels. In this future, most of our energy will come from rivers, wind, sun, and the ocean. Decision makers, whether they are government, generators, lines companies or communities, will need accurate, detailed, and timely information about these renewable energy sources in a form they can use. It will need to support sub-hourly power management through to long-term planning of future technology and capacity, over scales ranging from national to off-grid communities and households.

NIWA Technician Aleki Taumoepeau at Benmore Dam, the largest dam in the Waitaki power scheme. About 80% of our renewable energy is from hydropower, but all power generators and lines companies need accurate, detailed, and timely information.
[Susie Elcock]

To provide the resource information required to increase the generation and use of renewable energy, NIWA will:

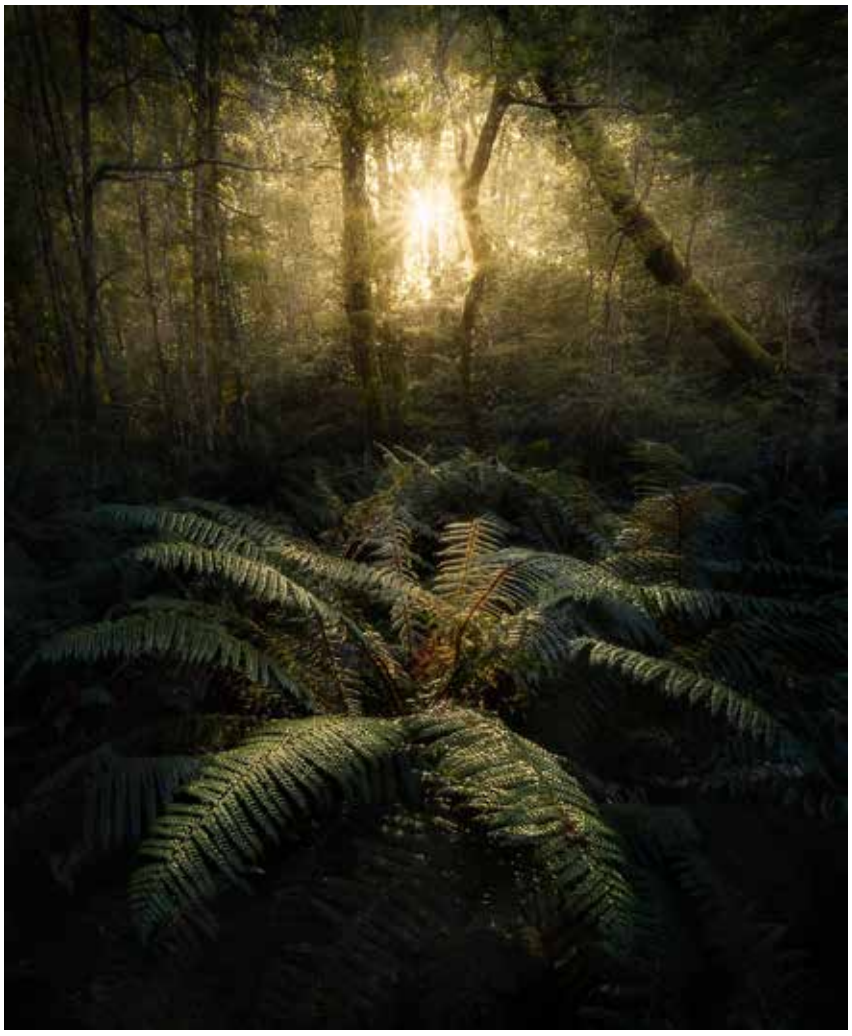
- Work with Māori and Pacific Island communities to design and manage small-scale, multi-source power generation schemes for self-sufficiency, resilience, and economic benefit.
- Deliver custom datasets and tools for electricity generation and optimisation by measuring, modelling, and forecasting weather, river flows, climate variability and ocean conditions to allow predictions of renewable energy supply, demand, and transmission.
- Provide bespoke tools and data to assess present-day and future renewable energy generation and storage options, including pumped hydroelectricity, to support planning and decision making.
- Advise renewable electricity generators on methods to reduce or prevent adverse environmental impacts of operations by applying enhanced understanding of biophysical and ecological processes.
- Quantify New Zealand's marine geological and ocean energy resources.
- Develop innovative methods to extract energy from ocean currents, tide, and waves.

Mitigating greenhouse gas emissions

The greenhouse gas emission reductions required for New Zealand to meet its commitments under the Paris Agreement are now law, under the Climate Change Response (Zero Carbon) Amendment Act. New Zealand has an unusual emissions profile, and our path to reducing emissions is likely to be different from that of most other developed countries. We have a high proportion of agricultural greenhouse gas emissions, and the carbon that is absorbed as our forests grow offsets about 30% of our total greenhouse gas emissions. Quantifying carbon cycling in our forests and other terrestrial and aquatic ecosystems is therefore critical, but it is not well understood. The carbon mitigation potential of urban land management, forest restoration, afforestation, and pasture soils must be measured to enable land management decisions that reduce, not exacerbate, greenhouse gas emissions. This is especially important because the agriculture sector recently agreed to design and implement an emissions reduction scheme at farm scale. This would be a world-first, but it will require innovative technological and scientific solutions, detailed multi-sensor observations and modelling, and deep collaboration across the agriculture industry, Māori, and government for it to succeed.

To help quantify and verify greenhouse gas mitigation initiatives, NIWA will:

- Maintain and globally disseminate high precision, long-running measurement series of key atmospheric parameters, such as greenhouse gases, vital to understanding the drivers of climate change.
- Develop and validate methods for measuring greenhouse gas emissions and determining their sources, from global to farm scale, to identify opportunities for emissions reduction and to inform policy.
- Make surface-based atmospheric column measurements to monitor trends in climate-active compounds and to validate satellite-based greenhouse gas measurements, including from the MethaneSat mission, to support domestic and international monitoring of atmospheric change.
- Partner with Māori, government, business, and national and international research institutions to investigate scientifically-based approaches to reduce greenhouse gas emissions.
- Identify and map marine ecosystems that act as carbon sinks, including the origins, pathways and processes that affect carbon sequestration at the seabed (Blue Carbon).
- Assess the effectiveness of proposed and implemented policy or management measures for reducing greenhouse gas emissions or sequestering carbon, and quantify their co-benefits, such as improving air and water quality or restoring degraded environments on land and offshore.



NIWA's CarbonWatch NZ programme confirmed that mature, indigenous forests in Fiordland have the potential to absorb more carbon than previously thought. *[Shannan Crow]*

Adapting to a changing climate

Planning for climate change

Appropriately responding to present-day and future impacts of a changing climate is one of the greatest challenges of our time. Relationships between temperature changes, wind patterns, sea-level rise, salinisation, ocean acidity, rainfall and snowfall, glacier and polar ice-sheet mass balance and their effects on our rivers, groundwater and coasts are complex and dynamic. The potential impacts of these changes on our biodiversity, taonga species, productive and natural systems, water and food security, air and water quality, human and animal health and built environments are just emerging. How these impacts will affect our cultural heritage, economy, social structures, governance, Pacific neighbours, and international relations and trade are still poorly understood. NIWA's ongoing research on changes in climate and its impacts will, therefore, be fundamental to New Zealand's ability to strengthen its adaptive capacity and long-term resilience to global change and disclose climate-related risks.

Severe drought in 2019 resulted in Auckland water storage dams dropping to near record low levels. High-resolution forecasts and climate projections help planners better prepare for there being more events like these in future. *[Stuart Mackay]*

To provide the guidance and expertise required by New Zealand decision makers to respond and adapt to the impacts of climate change, NIWA will:

- Develop improved high-resolution projections of climate, freshwater and ocean state, including extremes, on timescales from months to a century. This will be achieved using a state-of-the-art modelling chain (covering the observations and Earth system, regional climate, and hydrological modelling) and data analytics on NIWA's High Performance Computing Facility.
- Determine the role of tropical cyclones, the Southern Ocean and Antarctica in the global climate system by characterising the magnitude and variability of climate-related parameters and processes in the ocean and atmosphere.
- Better understand the impacts of climate change on the frequency and intensity of droughts and heavy rainfall, marine heatwaves, sea-level rise, groundwater levels, river flows and flooding, through enhanced process understanding and big data analytics, in collaboration with local and international experts.
- Apportion the relative contribution of anthropogenic climate change to historic and recent extreme events, such as floods, marine heatwaves, and droughts.
- Enhance understanding of the impacts of climate change on freshwater and marine ecosystems, biodiversity and associated social and cultural values.

- Produce government guidance and tools for better decision support for dynamic adaptive pathway planning for climate change.
- Work alongside Māori and our Pacific partners, government, and stakeholders to better characterise their climate change perceptions, exposures, impacts and risks.
- Develop frameworks for engaging with affected parties and enabling adaptation, including assessment of financial and wellbeing implications.
- Produce tailored information and guidance for whanau, hapū and iwi and Māori business on the management of natural hazards and climate change risks to support their resilience planning and decision making.

Reducing adverse effects of climate change

Climate change and associated sea-level rise and ocean and freshwater acidification adversely affect New Zealand's aquatic ecosystems. These environmental changes can have synergistic impacts, such as the effects of sea-level rise and increased storm surge on coastal wetlands, increasing sea temperatures and acidity on shellfish or increased drought and lower river flows on fish migration. These complex cascades make predicting, preventing, and ameliorating adverse impacts challenging. Meeting these challenges requires improved understanding of environmental-change cascades and incorporating that understanding into predictive models and tools that enable the development of measures to counteract or reverse any adverse effects.

To reduce the adverse impacts of climate-related changes to our aquatic ecosystems, NIWA will:

- Improve hydrological models to predict the impacts of climate change on the dynamics of surface and groundwater storage and flows and combine this with the impacts of land-use change, such as afforestation.
- Develop and validate models to predict river and lake water temperature responses to global warming and develop guidelines for the use of riparian planting and environmental flows to counteract increasing water temperatures.
- Improve understanding of the cascade of changes linking climate drivers to erosion and runoff, river sediment loads, sediment accretion in estuaries, and the effects of sea-level rise on this cascade.
- Predict the effects of sea-level rise on coastal lowlands and associated freshwater and marine ecosystems, land usage and infrastructure, and the compounding effects of sea-level rise, river flooding and land subsidence.
- Research and predict the separate and interactive effects of human activities, such as land use and extractive industries, and climate change on aquatic ecosystems, and means to mitigate these impacts.
- Examine the ecosystem effects of acidification on marine primary production, food quality, key habitat availability and biotic communities, including in Antarctica.
- Investigate sensitivity and resilience to predicted levels of ocean acidification of different life stages of economically important fish and shellfish species to inform population forecast models.
- Predict changes in the establishment, spread and impact of aquatic non-indigenous species under changes in climatic conditions that alter their habitat, potential ranges, population growth and behaviour.

Improving resilience to natural hazards

Natural hazard risks around the world are increasing, primarily due to population and asset growth and the increasing frequency and severity of climate- and weather-related hazardous events. The National Disaster Resilience Strategy dictates proactive management of adverse risks and the building of resilience in New Zealand to natural physical hazards. This requires increased preparedness in New Zealand and the Pacific Islands to weather, climate, and coastal hazards, along with air pollution, drought, severe tropical storms, storm surge/waves, erosion, tsunamis arising from earthquakes and underwater landslides, floods, and sea-level rise. The ability to forecast these hazardous events and risk is rapidly evolving through access to high performance computing, big data, and machine learning techniques. These forecasts are essential for society to be able to prepare for and mitigate the impacts of future hazard events.

To provide, in real time, decision-relevant data on natural hazards via bespoke forecasts and data services, NIWA will:

- Deliver and maintain its 24/7 operational multi-hazard forecasting system.
- Advance the next generation of high-resolution forecasting models, to produce accurate forecasts of localised flash flooding, river flows, coastal and flood plain inundation, droughts, wildfire risk, storms, tsunamis, and air quality.
- Refine our knowledge of the underlying processes associated with hazards to improve the tools and guidance required by agencies, businesses, Māori, and individuals to mitigate weather and climate hazard impacts.
- Enhance the RiskScape model to enable its use and application by national and Pacific Island users to estimate, plan for and manage future natural-hazard-related risks.
- Work closely with international scientific organisations, especially the United Kingdom Met Office through the global Unified Model Partnership, to significantly contribute towards and harness leading-edge advancements in weather, climate, and hazard modelling.

Residential properties sustained severe damage after the town of Edgecumbe was inundated by flood waters in April 2017. 24/7 forecasting systems are essential for predicting such hazards and helping society prepare for and mitigate these events.
[Dave Allen]

Improving the health of our waterways and oceans

Reversing decline in water quality

Water quality degradation is one the highest-priority environmental issues for New Zealanders. Recent NIWA research indicates that contaminant levels are elevated, and ecosystem health indicators are reduced in many rivers, lakes, estuaries, and coastal areas. This research has also linked water quality degradation to land-use intensification, and water quality improvement to mitigation measures such as riparian planting and effluent diversion. The National Policy Statement for Freshwater Management (2020) has set out multiple water quality and aquatic ecosystem health objectives. Achieving those objectives will require a mix of mitigation measures and preventative steps, such as land-use change and water-sensitive urban design. However, these approaches are costly, so stakeholders need assurance that they will be effective.

Clear, sparkling water in Southland's Eglington River. NIWA is developing operational forecasting systems to inform the public about recreational water quality before exposure. *[Rebekah Parsons-King]*

To provide the effective preventative and mitigation measures required to improve New Zealand's water quality, NIWA will:

- Develop a range of modelling tools to predict contaminant generation on land in rural and urban settings, its transport to freshwater, estuarine and marine ecosystems, and its ecological and cultural impacts in those ecosystems.
- Develop tracer technologies to identify contaminant sources, including geochemical, isotopic and radionuclide tracers and mixing models.
- Quantify the occurrence, distribution and ecosystem impacts of microplastics in freshwater, estuarine and marine environments.
- Design, implement and test contaminant mitigation systems, such as riparian buffers and detention bunds, constructed wetlands, lake sediment capping and aeration, bioreactors and bioremediation, stormwater treatment systems, restored shellfish and seagrass beds and other soft-engineering structures.
- Design, implement and test cost-effective wastewater treatment systems, including pond and wetland systems for marae, papakāinga and primary production systems.
- Develop operational forecasting systems to inform the public about recreational water quality before exposure.

Ecosystem-based approaches to resource use

Ecosystem-Based Management (EBM) is a strategy for the management of natural resources that recognises the full array of interactions within an ecosystem, including human. It promotes both sustainable use and conservation in an equitable way. New Zealand's marine and freshwater ecosystems are subject to a wide variety of competing uses, such as fishing, recreation, transport, tourism, land use, aquaculture, and cultural uses, only some of which are well monitored and managed. EBM differs from current management strategies by considering all activities that affect the environment, rather than managing individual species or sectors.

To provide the environmental science evidence required to implement ecosystem-based approaches to the management of our aquatic resources, NIWA will:

- Enhance understanding of the environmental and biological drivers and fate of primary production in freshwater, estuarine, coastal, and oceanic areas over multiple time and space scales.
- Develop and validate coupled models that link catchment land use to contaminant (e.g., sediment, nutrients, metals) loss, transport, and input to aquatic ecosystems.
- Improve physical, ecological, and spatial modelling tools to better understand key system processes and interconnections, including the role of benthic habitats and functioning of pelagic systems, to inform management and protection of New Zealand's marine estate and Antarctica.
- Advance biological and ecological knowledge of target and bycatch species to enable an ecosystem approach to fisheries management.
- Develop ecosystem-health-based tools to support kaitiakitanga and decision makers that can deal with cumulative effects and uncertainty and focus on translating impacts on ecosystem components to impacts on human values (cultural, social, and economic).
- Develop new mātauranga-embedded cultural assessment approaches that contribute to EBM, in a manner consistent with tikanga-ā-hapū/iwi, to assist Māori in their natural resource decision making and co-management.
- Develop methods to predict both degradation and the potential for recovery of aquatic ecosystems, especially with communities actively engaged in rehabilitation initiatives.

Measuring the state of our environment

Regular measurements of the state of our atmosphere, waterways and oceans inform the sustainable management of natural resources and climate adaptation planning. They are also essential for assessing the physical and ecological health of our aquatic environments and the effectiveness of policy interventions in achieving the health outcomes desired. In many cases regulatory decisions are difficult to make because no baseline environmental data exist. A recent review by the Parliamentary Commissioner for the Environment highlighted shortfalls in the consistency of current measurement and analysis methods for state of the environment reporting. It also identified the need for greater inclusion of mātauranga Māori, strategic information that is needed by Māori (i.e., Crown commitments to protect certain taonga under the Treaty), and aquatic biodiversity measures.

Through partnerships with government departments, hapū/iwi, councils, and other organisations that run monitoring programmes, NIWA will:

- Develop, improve, and apply methods for environmental monitoring, including field measurements, satellite techniques, telemetered sensors, remotely operated vehicles, real-time in-situ analysers, and geospatial survey instruments, meeting or surpassing relevant national and international standards.
- Design monitoring networks and approaches for different environmental domains and parameters (including air quality, greenhouse gases, and freshwater, estuarine and coastal water quantity, quality, and biodiversity).
- Maintain NIWA-run observation programmes and datasets for key environmental indicators (including air pollutants, river water quality, freshwater fish and plants, hydroclimatic measurements, sea-level rise, bathymetry, glaciers, ocean temperature and pH, and fisheries surveys and catch sampling) at sites around New Zealand, ensuring best practice data management and accessibility.
- Further develop and test ecosystem health indicators, including new methods and integration of ecological, societal, and cultural indicators.
- Provide predictions of environmental parameters for unmonitored locations, including rivers, lakes, aquifers, estuaries, coastal zones, the alpine region, and oceans.
- Continue curation of internationally significant collections and samples, including sediment cores, atmospheric gases, and marine invertebrates.
- Improve data analysis and visualisation of environmental data.

Caring for our unique biodiversity

Enhancing biodiversity protection

With about 410,000km of freshwater systems and a marine estate more than 21 times the area of our land, understanding New Zealand's unique biodiversity, how it is threatened and how best to protect it, is a major challenge for scientists and resource managers alike. Our biodiversity supports a wide range of native birds, plants, fish, and other animals that are highly significant to Māori. For Māori, the health of our ecosystems, taonga species and the wellbeing of whānau, hapū and iwi are interconnected. Sophisticated biodiversity modelling approaches are needed to fill information gaps, and increased understanding of connectivity, resilience and recovery of marine and freshwater communities will be crucial for effective biodiversity protection measures.

To increase knowledge of our biodiversity and establish the spatial management tools needed to effectively mitigate threats to our ecosystems and the species they support, NIWA will:

- Co-develop research priorities, methods, tools, and products with whānau, hapū and iwi that inform new approaches for the sustainable use, protection, restoration, and co-management of the environment and associated taonga species.
- Predict, map, and prioritise key ecological habitats and locations for the conservation of biodiversity and ecosystem integrity.
- Collect, identify, and curate organisms from New Zealand's aquatic ecosystems, from the tropics to the Antarctic.
- Analyse field data to define key habitat associations and improve individual species and community distribution models, trophodynamic models and ecosystem models, and identify problematic information gaps.
- Develop innovative modelling approaches and spatial management tools that address knowledge gaps in biodiversity information.
- Improve understanding and quantification of population and ecosystem connectivity to increase our ability to predict ecosystem resilience and recovery.
- Develop new innovative approaches to ecosystem protection, monitoring and management, including Antarctic aquatic environments.
- Enhance understanding of the adverse effects of resource use, habitat and climate change and invasive species on biodiversity and taonga species, including protected species.

Partnering with local iwi for the protection, restoration and co-management of taonga species – glass eels (tuna) in this instance. *[Rebekah Parsons-King]*

Restoring degraded aquatic ecosystems

Through a combination of land-based sedimentation and nutrient effects, compounded by physical and biological disturbance by anthropogenic activities, the freshwater, estuarine, and marine environments in many areas of New Zealand have been degraded. Key

habitats have been lost. Degraded habitats result in compromised ecosystem services (e.g., nursery grounds, biodiversity, carbon sequestration, cultural and recreational use) and adverse impacts on valuable fisheries and aquaculture. The restoration of taonga species, degraded cultural values, and freshwater and marine socio-ecological systems are key elements of Te Tiriti o Waitangi settlements. Māori are seeking the knowledge and tools required to restore degraded ecosystems and associated taonga under a changing climate to provide for their intergenerational cultural, social, environmental, and economic needs.

To develop effective tools and approaches to restore and rehabilitate degraded aquatic ecosystems, NIWA will:

- Co-develop approaches that draw together mātauranga Māori and other knowledge systems to provide the strategic information, tools and approaches required by Māori to restore aquatic ecosystems and their associated cultural values, uses and practices.
- Identify and predict the responses of aquatic ecosystems to environmental stressors, including multiple interacting stressors such as land use, climate change and habitat loss.
- Design and test methods and structures that reduce migration barriers for native freshwater species.
- Define success for restoration activities in terms of social and cultural values and ecosystem services.
- Develop indicators of aquatic ecosystem condition, including criteria for determining Key Ecological Areas and the link to the services they provide.
- Further develop tools to reduce the environmental impact of extractive industries such as fishing and mining.

Protecting aquatic environments from invasive species

Protection of our marine and freshwater environments from harmful organisms has been challenged by the growth and diversification of New Zealand's trade and tourism, changes in the pathways for the entry and spread of risk organisms, and pressures from established pests and diseases. Our changing climate is adding to this dynamism by providing opportunities for the emergence and establishment of new pests and diseases, and by driving changes in the distribution and impacts of existing pests. Incursions into our aquatic systems impact a broad range of stakeholders, necessitating a partnership approach to management, surveillance, eradication, and control. Māori have unique interests in the biosecurity of waterways through their role as kaitiaki, as treaty partners and through investments in fishing and aquaculture.

NIWA freshwater scientists trialling new technologies combining Artificial Intelligence (AI) software with autonomous boats to detect invasive weeds in Waikato waterways. *[Mary De Winton]*

To strengthen international and domestic biosecurity partnerships, respond to climate change, and recognise the centrality of mātauranga Māori in New Zealand's biosecurity system, in line with the government's Biosecurity 2025 strategy, NIWA will:

- Partner with whānau, hapū and iwi to support the use of mātauranga Māori and tikanga in the assessment and prioritisation of biosecurity risks, and in the design and implementation of tools for surveillance, response, and pest management.
- Improve the sensitivity of surveillance of aquatic pests and diseases through development and application of new technologies and survey designs.
- Improve our understanding of the dynamics of aquatic diseases in relation to climate change and their potential impacts on production systems and aquatic ecosystems.
- Develop models to predict the future establishment, spread and impact of aquatic pests, as influenced by climate and land-use change, and changes in vectors and exclusion and control actions.
- Develop more effective technologies and strategies for eradication or control of established aquatic pests.
- Improve the availability and usefulness of biosecurity data and data products for decision making. This may include virtual information exchanges to keep stakeholders updated on biosecurity risks and provide them with guidance on preventing and controlling aquatic pest establishment and spread.
- Work with and share research with our international partners, including Australia, Canada, the US and the Pacific, to understand emerging threats and develop consistent best-practice approaches to pathway management.

Embracing new technologies

NIWA adopts, develops, and applies innovative new technologies in our science and operations to ensure we can deliver the information and products and services the nation needs.

Globally, science is making revolutionary advances on the back of innovative new technologies. Radical improvements have been made and continue to occur in environmental sensing, molecular biology techniques, satellite-based communications and earth observations, High-Performance computing, data analytics/AI, modelling, and presentation technologies like augmented reality. These provide insight into our environment and predictions of change that were unimaginable not so long ago. Application of these new technologies will be essential to solve the increasingly complex issues associated with natural resource use and environmental change. This will be especially important for growing our climate-dependent sectors, especially primary production, energy, and tourism, reducing carbon emissions, and managing aquatic resources.

NIWA has always been a developer and early adopter of new technologies. These have included high performance computing, precision environmental forecasting, real-time sensor arrays, remote sensing, big data analytics, and advanced isotope measurement. We have developed and maintain state-of-the-art environmental monitoring networks to measure atmospheric constituents, weather, river flow and water quality, ocean acidity and sea level; satellite receiving stations; a high-performance computing facility and data centre; and large environmental databases and aquatic organism collections. These not only support NIWA, but also a wide range of stakeholders.

In recent years, we have increased our focus on technological innovation and capability in NIWA, with the appointment of additional senior staff and better integration of our IT team with our data and science operations. We have also established an accelerator seed fund and a programme to develop the digital capability of our staff.

To achieve our vision of a fully integrated, digitally connected, science pipeline from data collection through to delivery of our information, products, and services, NIWA will:

- Continue to advance our Information Technology to ensure our capabilities, processes and systems remain secure, enable remote working, and meet our operational and science needs.
- Further develop our remote sensing capability, both far-field and near-field, to increase the resolution and spatial extent of field observations.
- Continuously enhance our environmental monitoring networks by integrating new high-density and remote sensing measurements alongside third-party data to support next-generation environmental modelling and forecasting systems.
- Expand and further develop new data science capabilities to complement existing deterministic models across all areas of science.
- Develop a more cloud-centric architecture for a new data facility to streamline and enhance big data management and processing and the delivery of data products to stakeholders.
- Continue roll-out of a digital capability development programme.
- Lock in, and further enhance, the gains made during COVID-19 in remote ways of working.

NIWA marine geologists collaborated with Swedish colleagues from the University of Gothenburg to bring this 6.5m autonomous underwater vehicle (AUV) to New Zealand for deployment off *Tangaroa* for detailed bathymetric mapping of the Kaikoura Canyon seafloor. *[Lana Young]*

Investing in science assets

NIWA will invest about $15 million annually to grow or refresh our technology, equipment and assets of national significance to ensure they meet New Zealand's future science needs.

NIWA owns and operates core national infrastructure on behalf of the wider New Zealand science system. This includes three key assets: the deepwater research vessel *Tangaroa*, the National Environmental Monitoring Networks, and the High Performance Computing Facility. NIWA also maintains nationally significant databases and collections, including the National Climate Database, the New Zealand Freshwater Fish Database, the NIWA Marine Invertebrate Collection, and the Water Resources Archive. NIWA has two additional key assets of international significance, the Northland Marine Research Centre and the Lauder Atmospheric Research Station.

In addition to RV *Tangaroa*, NIWA operates a smaller ocean-going vessel, RV *Kaharoa*, a fleet of inshore coastal vessels, including *Ikatere* and *Rangitahi III*, and about thirty other small certified boats. NIWA maintains specific

state-of-the-art specialist facilities that include a Stable Isotope Analytical Facility, satellite receiving stations at Lauder, Maupuia and Greta Point, and equipment at Arrival Heights Atmospheric Research Laboratory in Antarctica. In addition to the four main sites in Auckland, Hamilton, Wellington and Christchurch, NIWA also has ten field offices across the country supporting our science.

To provide the science assets needed by NIWA and the wider science system, NIWA will:

- Provide voyage time on RV *Tangaroa* to science providers, including voyages to Antarctica, and for fisheries stock assessments and the deployment of New Zealand's tsunami dart buoy network.
- Partner with the Ministry of Business, Innovation and Employment to undertake a review of New Zealand's longer-term research vessel needs and on-going support for RV *Tangaroa*.
- Design and cost a new replacement vessel for the aging RV *Kaharoa* and prepare a business case as appropriate.
- Continue to support the operation of the High Performance Computing Facility and provide expertise to the collaborative National e-Science Infrastructure initiative and contribute to development of a strategy to meet New Zealand's long-term high performance computing needs.
- Scope a 'mid-life' upgrade of our current High Performance Computing Facility to ensure it meets New Zealand's science needs for the next 5 years.
- Maintain our measurement networks, including development of new environmental monitoring and sampling technologies, to meet end-user needs and support enhanced environmental modelling and forecasting systems.
- Complete the upgrade of the mass spectrometers in the Stable Isotope Analytical Facility.
- Design and construct a commercial-scale recirculating aquaculture system (RAS) for part or all of the production cycle of high-value finfish species.

NIWA's deepwater research vessel *Tangaroa* recently completed its 14th scientific voyage to Antarctic waters. As New Zealand's only ice-strengthened and dynamic position system-equipped research vessel, *Tangaroa* is a critical national asset.
[Stuart MacKay]

Partnering with Māori

“Ki te pūwaha te tai nei, hoea tahi tātou”
“When there is a break in the waves, we paddle together”

NIWA’s aim is to have enduring partnerships with Māori to support kaitiakitanga and provide environmental research that enhances the social, cultural, environmental, and economic outcomes for whānau, hapū, iwi and Māori businesses.

Māori play an increasingly critical role in the co-governance and co-management of New Zealand’s natural resources. Māori are proactively developing their own resources (human and natural) to improve economic prosperity, social wellbeing and environmental outcomes for whānau, hapū and iwi.

Both local and central government are recognising the important contribution of mātauranga Māori, and the kaupapa-Māori research approach of co-innovation informed by tikanga Māori, mātauranga Māori and science working together. As such, the government’s Vision Mātauranga science policy requires greater engagement, collaboration, and partnerships with different levels of Māori society. This places significant pressure on Māori research capacity and requirements for Māori engagement, and remains a significant challenge to the realisation of practical and sustainable solutions for Māori and New Zealand generally.

NIWA has a successful track record in working with Māori across climate, freshwater and ocean environments. Te Kūwaha, a unique team of NIWA researchers, helps combine scientific expertise with mātauranga Māori in accordance with tikanga Māori. They work at the interface of knowledge systems to generate fit-for-purpose methodologies, tools and products required by Māori as kaitiaki, resource owners, managers, and decision makers.

The Mā te haumaru ō te wai flood resilience programme was formally launched in April with a two-day noho marae hosted by Wairewa Runanga of Ngāi Tahu. The five-year programme aims to build flood resilience under a changing climate for communities across New Zealand. *[Lana Young]*

To strengthen our partnerships with Māori, NIWA will build capacity in the Te Kūwaha team and grow their influence across the organisation. For our Māori partners this will ensure that: water quantity and quality provide for the cultural, environmental, social and economic needs of Māori; the capacity and capability of whānau, hapū, iwi and Māori businesses are strengthened to enable them to respond and adapt to climate change risks and impacts; and the health and wellbeing of taonga species, aquatic (freshwater and marine) environments, mahinga kai and Māori livelihoods are safeguarded.

To build collaboration with whanau, hapū and iwi and Māori businesses NIWA will:

- Underpin our relationships with Te Tiriti o Waitangi principles of partnership, participation and protection.
- Ensure whanaungatanga (fostering relationships), kotahitanga (partnership), manaakitanga (reciprocity and generosity), and kanohi kitea (becoming a familiar face) are fundamental to how we do what we do.
- Empower Māori interests and mātauranga Māori by bringing knowledge systems together to inform their unique responsibilities as kaitiaki and managers of environmental resources.
- Co-develop research priorities, work together to undertake them, and use Māori knowledge and methodologies where appropriate.
- Build science capability and capacity for the benefit of whānau, hapū, iwi and Māori businesses.

NIWA will build on two successful 'pilot' initiatives established in 2020/21. Firstly, NIWA will embed and expand it's Māori Graduate Internship Programme which seeks to create better and more visible pathways to support the transition of Māori science graduates into postgraduate (MSc and PhD) opportunities and career pathways. Based and mentored within the Te Kūwaha team, all graduates contribute to several active Te Kūwaha/NIWA projects, providing practical experience, building relationships/networks, and engaging in the realities of delivering Māori environmental research at the interface between science and Te Ao Māori as a platform from which to consider a long-term career in science.

Secondly, following the launch of 'Taihoro Nukurangi – NIWA's cultural intelligence App' in November 2020 and its swift response and uptake by staff, NIWA will continue to improve the efficacy of the app as part of its suite of learning tools and resources for strengthening the cultural capability of NIWA staff. The App builds on and complements a number of existing activities (i.e., noho Marae, tailored Maori language learning, culturally significant events (e.g., Matariki/Te Wiki o te Reo)). Alongside our Pou Ārahi (i.e., the NIWA cultural and engagement advisors located across our main sites across New Zealand), the App is seen as a platform for launching new cultural learning initiatives for staff development into the future.

Supporting New Zealand's efforts in the wider world

NIWA's aim is to leverage our science to contribute both to supporting our foreign policy objectives and creating enduring partnerships across Te Moana-nui-a-kiwa to support the security and prosperity of our Pacific neighbours.

NIWA contributes significantly to supporting New Zealand's efforts in the wider world. Through our three science platforms (climate, freshwater and marine) we provide scientific and evidence-based information and advice to support our international obligations on climate change, Antarctica, fisheries and biodiversity; to understand, mitigate and adapt to major environmental global challenges, including climate and ocean change; and to more effectively manage marine and freshwater resources.

NIWA is particularly engaged in the Pacific region, where we have long and enduring relationships with our Pacific partners through collaborating across a wide range of activities that supports local needs and builds local capacity. We are committed to playing a fundamental role in contributing to, and advancing, New Zealand's Pacific reset and as a strategic partner in building long-term resilience in partner countries.

NIWA's Pacific Rim Centre coordinates our engagement with the relevant agencies in New Zealand and the Pacific region, builds and maintains our long-term relationships, works to understand needs and to leverage and develop the relevant skills across our science platforms to support and build local capacity to meet these needs.

NIWA partnerships in the Pacific region help build resilience and sustainable development. *[Dave Allen]*

We will meet our goal of leveraging our science and relationships to support New Zealand's international objectives through:

- Continuing to underpin our work in the Pacific region based on the values of whanaungatanga (fostering relationships), kotahitanga (partnership), manaakitanga (reciprocity and generosity), and kanohi kitea (becoming a familiar face).
- A long-term commitment to building and maintaining our relationships across Te Moana-nui-a-kiwa through providing a constant supportive presence to our partners in the region.
- Working collaboratively with our Pacific colleagues to address Pacific resilience priorities, including disaster risk reduction and climate change adaptation, water security and sanitation, fisheries, and other marine resource management.
- Supporting the continued development of the capability and capacity of our partners in the Pacific region and through opportunities for New Zealand-based Pasifika.
- Deploying new ways of working, applying our science, technology and innovation to support and sustain development activities in the region.

Working with others

NIWA's aim is to enhance our collaborations with Māori, other national and international science organisations and stakeholders to deliver excellent science that meets New Zealand's needs.

Multi-disciplinary science that covers the environmental, economic, and social domains is fundamental to solving national and global environmental challenges. Advances in measurement technologies, data science and computing are providing new research opportunities for system-based solutions and the development of new innovative science-driven tools and services. The application of these advances requires strategic partnerships and collaborations that bring together expertise, technologies and communities of interest.

NIWA has a reputation for science excellence and has established strong partnerships and collaborations with leading international research and technology organisations, local universities, and the other Crown Research Institutes. Our delivery of relevant science has led to strong collaborations with Māori and the key sectors our science supports.

We will use these relationships to:

- Ensure our science meets the needs of Māori, communities, and the sectors we serve.
- Deliver knowledge, products and services derived from our research.
- Provide access to critical national science infrastructure we own and support.
- Develop the science capability the nation will need in a rapidly changing world.
- Contribute to and leverage the expertise, knowledge and technologies developed by others.

We will meet our goal by strengthening stakeholder partnerships and collaborations, including with:

- Central and local government agencies as they develop policies associated with transitioning to a low carbon economy, adapting to climate change, improving water quality, managing aquatic natural resources and ecosystems, and growing regional economies.
- Māori researchers, tribal authorities and businesses.
- Key business sectors to better understand their issues and opportunities and work together on solutions.
- Crown Research Institutes in the areas we lead or contribute to, including the development of a joint CRI science strategy.
- Universities to expand our research skills and help build capability.
- International weather and climate science organisations to improve the accuracy of weather forecasts and climate projections.
- BLAKE (The Sir Peter Blake Trust) to promote an awareness among future leaders of the environment and the opportunities that science provides.
- International science organisations involved in joint global marine and climate research initiatives.
- National e-Science Infrastructure parties to provide high performance computing.

Communicating for impact, uptake and understanding

NIWA's aim is to ensure that the knowledge our science develops is communicated to our stakeholders and society to inform policy and planning and better business and societal decision making.

Excellent science is fundamental to the sustainable management of our natural resources and a society that prospers in a rapidly changing world. But science is often complex, so we must engage with our audience using a style and manner they can understand, readily access, and easily use.

NIWA audiences are many and varied, but all need to better understand the disruptive and complex world we live in – from central and local government agencies making management and policy decisions, to climate-sensitive businesses that need accurate forecasts, and the general public seeking to better understand the impacts of our changing world. Society has changed – people expect information and data to be immediately available. Technology has altered the way messages are delivered and received. Skilful communication reinforces our reputation as the provider of independent, impartial, innovative and authoritative science.

NIWA has invested significantly in its communications team and their resources to ensure we can meet this demanding scenario. This investment has ensured a high profile, with 110 media releases in the last year and a very active social media presence. This has resulted in an annual mainstream media audience of well over 100 million and a social media reach of more than 13 million. We also engage with thousands of school and university students each year as the major sponsor of science and technology fairs nationwide, through the Sir Paul Callaghan Eureka Awards, as the Principal Science Partner of BLAKE, and by supporting Sea Life Kelly Tarlton's Aquarium.

We have a fully equipped studio and staff capable of producing sophisticated and tailored data visualisation to communicate our science. Output includes graphics and animations of weather modelling and observations for the presentation of tailored forecasts for clients and their websites, conveying long-term climate change projections, visualising changes in air quality, forecasts of river flows, or presenting bathymetric data. Seasonal Climate Outlooks and Pacific Island Climate Updates are filmed in the studio, as are many of our live feeds for social media. We make our studio available to other research organisations and stakeholders seeking to communicate their messages in new and engaging ways.

NIWA's high-resolution weather, tide and current forecasting capabilities were a drawcard at the Spark Innovation Hub on the Auckland waterfront. *[Stuart Mackay]*

NIWA has an extensive, dynamic, and informative website that also functions as a library for hundreds of media releases and videos designed to tell our science stories in a simple, engaging style.

To meet its communications goal, NIWA will:

- Present the organisation as a primary authority and source of information in climate, freshwater and marine science.
- Lead public engagement and understanding of the critical issues in these areas of science.
- Continue development of our communication and engagement with Māori to support greater uptake and use of the latest science and guidance for Māori authorities tasked with planning and development in their communities.
- Enhance knowledge transfer and stakeholder uptake through the continual development of dynamic, highly visual imagery and innovative technologies and tailored stakeholder communications and engagements.
- Remain agile, proactive and responsive in the rapidly evolving media environment.
- Stay committed to enhancing the understanding of the role and benefits of science and, in particular, fostering an interest in science among students of all ages.
- Communicate NIWA's environmental sustainability programme of work.

Our people

NIWA aims to provide a healthy, safe and productive work environment.

NIWA and its people have coped well with the ongoing changes and challenges which the COVID-19 pandemic has brought to all organisations. They needed to quickly 'shift gear' in response to rapid changes, learning to work in different ways, including working from home and upskilling in new technologies for communication and connection. The health, safety, and wellbeing of our people was a particular focus over this time.

NIWA's reliance on the international labour market to source specialised skillsets has been tested by the closing of New Zealand's border, but we have found ways to meet these challenges. A consequence of constraints on international recruitment has been an increasingly competitive New Zealand labour market for in-demand science and information technology skills, which is likely to continue in the short to medium term. However, our reputation continues to attract high calibre candidates for our positions, and we continue to seek to provide a competitive package of remuneration and benefits relative to the New Zealand general market.

In today's environment of uncertainty and rapid change, NIWA's recruitment and workforce planning processes need to remain agile and seek people who are highly adaptable and have the capabilities to meet science, technology, and support needs with contemporary knowledge.

NIWA is fortunate to have a highly motivated and high performing workforce, for whom it is important to feel adequately involved and informed about policies and decisions that affect their work. We note the heightened awareness and expectations of staff regarding NIWA's environmental sustainability programme of work, and momentum in this area will accelerate in the coming year, with opportunities for increased staff involvement.

NIWA will continue to provide a highly flexible, diversity-aware, and family-friendly workplace, elements which are increasingly expected and valued by today's workforce. Enhancing diversity and inclusion has been an important cultural development focus for NIWA in recent years. NIWA has increased the Te Kūwaha team of Māori environmental researchers and associated staff, who will continue to assist in developing our bicultural organisational capability. Our focus continues on wellbeing, including mental health awareness, resilience to change, and preventing and responding to unacceptable behaviour at work.

NIWA's three-year Senior Leadership Development Programme commenced in 2021, with a focus on skills and mindset development, exposure to contemporary thinking and research on effective leadership, and opportunities to apply these learnings to current challenges at NIWA.

Marine biology technician Caroline Chin calibrating plankton recording instruments during *Tangaroa*'s recent scientific expedition to the Ross Sea.
[Stuart Mackay]

Health and safety is paramount at NIWA, and we promote excellence through improving safety leadership, personal decision making, and health, safety and wellbeing practices. Our health and safety systems and tools are being refined, with an emphasis on simple, user-friendly, automated processes. In the coming year a focus will be on regular communication of key safety messages to all staff.

To continue to maintain a positive, safe, and progressive environment for our workforce, NIWA will support:

- Working with the other Crown Research Institutes to develop a more diverse science workforce.
- Continuing to achieve organisational performance targets for collaboration, knowledge transfer, operational efficiency, and on-time delivery.
- Leadership development and succession to ensure we proactively grow current and future leaders.
- Staff to participate in professional meetings, seminars, workshops and conferences to upskill, network, develop collaborative opportunities, and transfer knowledge or technology to stakeholders.
- Providing career development opportunities for NIWA staff and promoting collaborative endeavours through Joint Graduate Schools, Centres for Excellence, and joint appointments with New Zealand universities.
- Encouraging staff secondment arrangements between NIWA, government agencies and other stakeholder organisations.
- Building science capacity and capability through inclusion and co-supervision of more than 80 postgraduates within our science programmes and postdoctoral positions and by sponsoring science experts as visitors.
- Additional resources to ensure early career science staff and other staff at a point of challenge in their career have good quality individual development plans, including provision of mentoring when appropriate.
- Continuing to refine systems and processes to enable data-driven decisions, to enhance health and safety performance.
- Building clarity and consistency in health and safety training for our critical risk areas.
- Consolidating our approach to project management including strengthening project scoping and work breakdown structures, environmental reporting, and a continued focus on health and wellbeing in projects.
- Regular and effective communications to all staff on topical health and safety issues.

Environmental Responsibility

NIWA's aim is to conduct our activities with the lightest possible environmental footprint.

Environmental responsibility is one of the four pillars of our Organisational Sustainability Framework. We commit to Organisational Sustainability through:

- Investing in our people, technology, and infrastructure.
- Providing advice and services to end users and stakeholders.
- Partnering with iwi, local communities, and the wider society.
- Ensuring environmentally sustainable operations as practicable.

NIWA is committed to environmental sustainability, with much of our research focused on working with others to deliver solutions that impact, influence, or contribute to the sustainable management of natural resources.

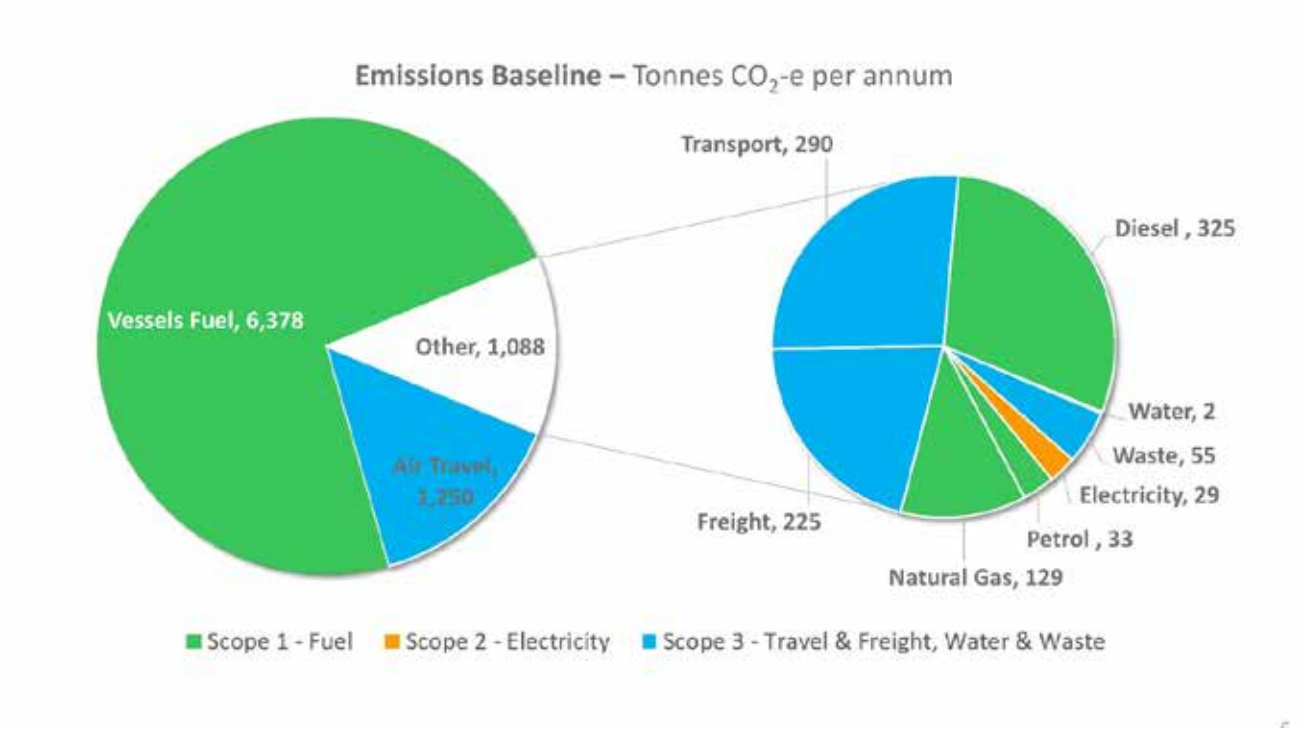
In making that contribution NIWA itself seeks to operate with the lowest possible environmental footprint. NIWA aspires to be an exemplar in environmental sustainability and is committed to a journey of continuous improvement. Our initial focus is to achieve carbon neutrality by 2025, with the aim of minimising our energy, waste and water footprint and offsetting our remaining emissions.

NIWA's carbon baseline

Sustainability initiatives have been successfully operationalised over past years to reduce emissions at both national and site levels. These include reducing energy consumption by 50% in the High Performance Computing Facility, as well as significant investment in virtual machine technology, file sharing platforms and conferencing systems which allow all NIWA staff to work collaboratively without traveling to other NIWA sites. We consume various resources and produce a variety of waste materials, and actively follow reduction, recycling, and diversion processes at our sites. Vessel fuel consumption, and therefore emissions, have long been reduced by a reduction in vessel speed, while maintaining safe operations and meeting survey requirements, along with fitting new, efficient engines.

Continuing the journey to minimise our footprint, during 2020 an analysis of NIWA's annual carbon, water and waste footprint was undertaken to establish baseline emission estimates from our best assessment over a full calendar year, 2019. The initial outcome of that analysis with respect to carbon footprint reflects CO_2 from activities within NIWA, and currently excludes downstream or indirect activities such as distribution, transport, or purchased goods and services emissions.

NIWA's baseline estimated CO_2 emissions equate to 8716 CO_2-e tonne p.a. Energy sources are primarily electricity, natural gas, petroleum, diesel, and vessels' marine fuel. Excluding vessel fuel (73% of CO_2 emissions) used to deliver science and research solutions, CO_2 emissions equate to 2338 CO_2-e tonne p.a. NIWA's remaining largest energy usage is related to its facilities operations and field-based science and research.



NIWA's approach

NIWA is committed to reducing its carbon footprint and will achieve this by:

- Measuring, reducing, and reporting our footprint, with independent verification of our baseline footprint from buildings, vehicles, vessels, travel, water, and waste.
- Ensuring our Green Star 5 Future Property Programme integrates energy saving design and operational efficiency as a core principle.
- Continuing to purchase electricity from hydroelectric or renewable energy providers, and reducing electricity and water usage, as well as improving infrastructure maintenance and contractor screening practices, installing energy efficient lighting and leak detection in regional facilities.

- Implementing vehicle fleet replacement, while maintaining a fit-for-purpose fleet, using the lowest emitting in class and hybrid and electric vehicles.
- Ensuring future vessels are designed with a view to low emission propulsion technologies, and continuing reduced emission practices by reducing vessel speed while maintaining safe operations and meeting survey requirements.
- Maintaining the 'Why Fly' practice of continuing to reduce air travel and upgrading digital communication technologies.
- Continuing the regional sustainability groups to promote regional activity, as well as leveraging internal expertise to work on, for example, improved energy and waste management and maximising benefit from carbon credits.
- Continuing to invest in science that supports transitioning to low carbon, advancing projects that contribute to supporting a just transition, exploiting our renewable resources, and mitigating greenhouse gas emissions.
- Offsetting our carbon emissions through participation in an New Zealand based carbon credit scheme that has other environmental and social benefits.

Organisational sustainability framework

NIWA incorporates organisational responsibility into its business on an ongoing basis, consistent with the principles and actions set out in its Sustainability Framework below. The Framework sets out NIWA's intent and aspirations for minimising impact on the environment and contributing positively to social, economic, cultural and environmental sustainability. The Framework embraces both the United Nations Sustainable Development Goals and the New Zealand Treasury Living Standards Framework.

The Sustainability Framework is operationalised through a companion set of operating policies and principles which are used as a guide to our decision making, including sustainability themes, actions, and SMART objectives that will help NIWA achieve its key business goals.

NIWA is committed to contributing positively to the social, environmental, cultural, and economic wellbeing of New Zealand.

Future property programme

NIWA aims to invest in its properties to ensure they are contemporary and will meet the future needs of our workforce and science.

NIWA owns or leases facilities in 17 locations around New Zealand, those locations being chosen for proximity to the environments it studies and to its customers. Most of these facilities have either already been upgraded to contemporary standards or are the subject of projects already under way. The Future Property Programme addresses the needs of the Company's three most significant research centres, in Hamilton, Wellington and Christchurch.

In planning this programme, NIWA has carefully considered and responded to changes in the way in which science is undertaken. These 'new ways of working' are more flexible, collaborative and creative, while responding to the rapidly changing needs and expectations of a modern workforce. Responses to these changes include a move away from traditional individual offices to open workspace environments, with laboratories consisting of adaptable, multi-use spaces, rather than being dedicated to single functions.

The need for change at the three sites is compelling. Thorough investigations by NIWA and by external experts demonstrated that:

- Buildings are at the end of their useful life, are functionally obsolete and cannot support NIWA's science into the future.
- The sites and buildings, and their associated process flows, are dysfunctional and inflexible, compromising science delivery, safety, and the ability to respond flexibly to changing future requirements.
- The sites are unappealing, dated and of low quality; they do not appropriately reflect NIWA's values (including sustainability and an ongoing partnership with Māori), nor do they convey an appropriate image to NIWA's stakeholders.

In short, without significant investment in modernising NIWA's properties, continuity of business operations cannot be assured beyond the short term. The sites would also fail to support the evolving needs of contemporary science.

Three overarching investment objectives have been identified for the programme. These are to:

- Protect NIWA's ability to deliver its science for the foreseeable future.
- Promote efficient and effective science operations, ensure the safety of staff and visitors, and ensure that NIWA can respond flexibly to changing future needs.
- Properly reflect NIWA's values, including sustainability and an ongoing partnership with Māori, and convey an appropriate profile to all stakeholders.

An Investment Logic Map has been developed for the programme, which links problems with the current state with the benefits intended from the programme. A series of measures and targets has also been developed, against which the programme's delivery can be assessed.

After thoroughly reviewing available options to deliver the programme's investment objectives, NIWA intends to undertake the following developments:

- Redevelop NIWA's existing site at Greta Point in Wellington, with all-new laboratory and office facilities, and renovated storage buildings.
- Construct an all-new research facility in Hamilton, replacing the existing facility on the University of Waikato campus. NIWA will remain on the university campus, and we have agreed a suitable new site.

- Construct an all-new research facility in Christchurch as a co-location/co-investment initiative jointly undertaken with Scion.

The combined cost of the three developments is estimated at $170 million. As discussed elsewhere in this SCI, this investment will be funded from NIWA's own resources and debt, with no Crown funding being required.

NIWA Chairman Barry Harris and CEO John Morgan with Te Ariki Tamaroa Whatumoana Paki and Tainui CEO Donna Flavel at the ground-breaking ceremony for the new Hamilton building. *[Peter Drury]*

This programme will be an important contributor to NIWA's strategy for achieving its environmental sustainability goals and supporting the Government's initiative to achieve a carbon neutral public sector by 2025. NIWA intends its major new facilities to achieve equivalence to Green Star 5 ('National Excellence') standard as well as NABERSNZ energy rating certification at the 5–$5^{1/2}$ Star level. It is anticipated that the new facilities will offer energy efficiency performance about 50% better than current-code-compliant reference buildings, with much more significant improvements in comparison with the performance of NIWA's existing facilities.

The environmental footprint of NIWA's buildings will be reduced through this programme by the following key initiatives:

- Use of high-efficiency all-electric plant.
- Extensive insulation driving excellent thermal performance.
- Building management systems able to support continuous building tuning, diagnostics and fault identification.
- Demand-driven lighting and ventilation.
- Reduced consumption of potable water.
- Reduced volumes of wastewater discharge.
- Lower volumes of waste to landfill due to proper sorting facilities on site.

The programme's Single Stage Business Case received the support of shareholding Ministers and the approval of the NIWA Board in November 2019. Before construction contracts are awarded, however, approval by shareholding Ministers of an Implementation Business Case (ImBC) for each project will be required.

The Developed and Detailed Design phases have been completed for the Wellington and Hamilton sites. Ministers have approved the ImBC for the Hamilton facility, and construction is expected to begin in June 2021.

NIWA expects to submit the ImBC for Wellington later in 2021 for Ministers' consideration. In respect of Christchurch, an agreement for NIWA to purchase land for a new facility has been reached with the current owner and the designs are currently under way. It should be noted that at every decision point throughout the programme the overarching strategy is tested and reconfirmed, including ensuring that it best supports collaboration, connectedness and co-location/co-investment among Crown Research Institutes as well as across the wider science sector.

It is hoped that construction of all three facilities will be completed by the end of 2025.

A financial approach that enables delivery

As a Crown Research Institute, one of NIWA's fundamental operating principles, set out in its Statement of Core Purpose, is that it must run in a financially sustainable manner. This means that, in addition to securing enough revenue to fund day-to-day expenses, it must generate sufficient cash flow to ensure that it can continually invest in maintaining and upgrading the assets that NIWA requires to support its science mission for the long term.

This focus on maintaining and upgrading key science assets is especially critical for NIWA because its areas of science expertise require state-of-the-art scientific equipment as well as several large assets, such as its High Performance Computing Facility, its marine research vessels, and its office and laboratory buildings. Ensuring that NIWA is in a position to deliver on this requirement requires careful planning. These plans must be continually reviewed in the light of changing circumstances and modified as required to ensure that the organisation's financial sustainability is protected for the long term and NIWA can continue to deliver on its science mission on behalf of the nation.

NIWA maintains a Long-Term Financial Plan with a ten-year horizon. The revenue and cost assumptions in this plan reflect a prudent view of NIWA's financial outlook, consistent with those reflected in this Statement of Corporate Intent for the coming five years. The plan identifies NIWA's anticipated investment needs over the next ten years and the operating and financing cash flows necessary to fund them.

Underpinning NIWA's approach to financial planning is the way it manages its operations to deliver financial performance in the short term and financial sustainability in the long term. This involves a close focus on delivering the margins necessary to ensure the delivery of sufficient operating cash flows to support its long-term investment plan. NIWA achieves this through a rigorous approach to project management, with all its science activities, whether research or applied science, being managed through its project management and accounting system. This enables all NIWA's research and applied science work to be closely managed to ensure its completion within budget, and thereby the delivery of the margin objectives.

The Finance, Procurement and Legal function supports and enhances NIWA's organisational health and financial sustainability by delivering the following four outcomes:

- Effective processes which 'just happen'.
- Insight to guide decision making.
- A source of trusted professional advice.
- Properties fit for world-class science.

The Finance, Procurement and Legal function has the following key objectives:

- Financial accounting and external reporting will be delivered on time, free from material error and as efficiently as possible.
- Financial and administrative operations will be effective, efficient and well controlled, while allowing seamless interaction with our customers, suppliers and staff.

- Management reporting and financial analysis will be insightful, intuitive and well positioned to support agile decision making at all levels of the organisation.
- Risk management activities will help all areas of the business prosper by ensuring that risks are managed to an acceptable level while facilitating an agile and responsive operating environment.
- Property upgrades will be consistent with an overarching property strategy that ensures that all NIWA's properties are of a contemporary standard and closely align with its future needs.
- Internal audit activities will identify opportunities to improve systems and processes while providing assurance to the Executive and Board that risks are being appropriately managed.

An important current initiative supporting the function's key objectives is the selection, configuration and implementation of a new finance and project management system. Three overarching investment objectives have been identified for the programme. These are to implement a solution that:

- enables NIWA to operate efficiently and effectively into the future;
- enables scalability and adaptation to changing user needs; and
- provides excellent usability and supports new ways of working.

The programme is now well under way and it is anticipated that delivery of the new system will occur during the first half of 2021/22.

Financials

The financial assumptions reflected within this SCI reflect NIWA's ongoing recovery following the impacts of COVID-19. Agile and careful risk management over the past eighteen months has placed NIWA in a position where attention can now return to long-term strategic planning and seeking out opportunities with a focus on continued growth. This SCI provides for the capital investment programmes required to deliver the facility upgrades discussed elsewhere in this document, together with continuing investment in the scientific and other equipment and infrastructure required to ensure NIWA retains its place at the forefront of environmental science.

In developing our financial projections, we have assumed only marginal changes to NIWA's current operating environment. In particular, we have taken a prudent approach to assumptions around increases in government research funding as well as commercial charter voyages for RV *Tangaroa*.

The three-year financial plan reflects an expectation of continued growth in both research funding and revenue from the delivery of applied science services, with operating costs continuing to be tightly controlled. The budgeted Group revenue for 2021/22 is $171.3M, with total costs of $161.7M, delivering an operating surplus before tax (EBIT) of $9.5M and an adjusted return on equity of 5.0%. NIWA expects to continue to deliver strong operating cash flows, with a budgeted EBITDAF of $31.0M in 2021/22.

Revenue

In 2021/22 NIWA Group revenue is budgeted at $171.3M, up by $2.1M compared with the forecast for the 2020/21 year and by $11.5M compared with the level contemplated by last year's SCI. The increase on the prior year forecast is mainly driven by commercial and National Science Challenge (NSC) revenue, offset by the conclusion of the COVID-19 Recovery and Response Funding, which has been received for the past two financial years.

Commercial revenue increases to reflect a partial recovery to normal levels, following the initial impact of COVID-19. NSC revenue increases as work is well under way in the second phase. Most of the NSC revenue

increase relates to work undertaken by collaborators on the two challenges NIWA hosts, and so is largely offset by an increase in subcontractor expense.

Research funding has not increased in line with inflation in recent years, which is putting pressure on NIWA's ability to conduct fundamental research aligned with the goals of the nation. This is partially mitigated by projected increases in applied science revenue throughout the period as we continue to collaborate with other science organisations and the sectors that apply our science products and services. Nonetheless, continued real terms erosion in Strategic Science Investment Fund (SSIF) funding will inevitably lead to erosion in NIWA's capability over time, if not addressed.

Operating expenditure

In 2021/22, operating expenses are budgeted at $161.7M, up from $157.7M forecast in 2020/21. The increase in costs is mainly attributable to higher NSC-related subcontractor costs (as discussed earlier) and staff costs.

Beyond 2021/22, operating cost efficiency gains are expected to be maintained, and we have assumed that inflation will continue at a low level. In the final year of the SCI period, we have provided for an increase in operating expenses associated with the ramp-up of production capacity for the 600-tonne Recirculating Aquaculture System (RAS) at NIWA's Northland Marine Research Centre.

Balance sheet management

NIWA's science is capital intensive and requires an ongoing investment in scientific equipment if we are to deliver excellent science, secure revenue and be financially sustainable. In order to protect the Company's ability to deliver the science that the nation needs for the long term, NIWA plans to continue to make provision for these essential investments.

Alongside the underlying requirement to continue to renew its science equipment and infrastructure, NIWA plans to make significant strategic investments in renewing many of its properties and facilities. The forecast set out in this SCI contemplates a requirement to spend in the region of $170M on renovating or replacing the physical infrastructure and buildings at most of NIWA's sites, including its regional centres. The bulk of this relates to NIWA's Future Property Programme, the Single Stage Business Case for which received Ministerial support in late 2019. NIWA expects to fund this investment requirement from a combination of its existing resources, operating cash flows, and debt facilities.

Additionally, during the 2021/22 year, we intend to complete the replacement of our field office at Tekapo with a new facility in Twizel, which is better suited to our growing requirements in that area. As previously signalled, NIWA has completed a review of the operations of the ageing RV *Kaharoa* and determined that the purchase of a replacement is the best option to meet the continuing needs of the business. An investment of up to $25M is provided for during the SCI period to fund this.

NIWA, in partnership with Northland Regional Council (NRC), will design, construct, and operate a 600-tonne prototype recirculating aquaculture system (RAS) unit at the Northland Marine Research Centre. This project is expected to require an investment of $12–14M, with $6M funded by NRC and the balance by NIWA.

Cash flow

NIWA expects its operating cash flow to remain steady, with an EBITDAF margin of about 20% throughout the SCI period, and EBITDAF of $33.4M rising to $36.6M in 2023/24. Beyond the period reflected in this SCI, NIWA expects to require debt financing of about $97M to support its strategic capital investment needs, with this financing being repaid over the following six to seven years. This financing requirement continues to represent an estimate at this point, and will evolve as the certainty of both the costs of NIWA's strategic capital spending needs, and of profitability in the SCI out-years and beyond, increases over time.

Dividend

Based on the strategic capital investment needs identified above, no dividends are planned during the period of this SCI; however, the NIWA Board will continue to review this on an annual basis.

Return on equity

NIWA's budgeted adjusted return on equity in 2021/22 is 5.0%, down from a forecast 7.8% in the prior year. This metric is expected to recover to 6.6% by the end of the SCI period.

Risks

There is some forecasting uncertainty associated with NIWA's revenue expectations. The revenue assumptions built into the SCI forecast reflect an expectation that applied science revenue will increase to meet the growing demands for science services within NIWA's key areas of expertise. The assumptions also reflect an expectation that NIWA will continue to be successful in growing its share of contestable revenue contracts. If these expectations are not realised to the extent forecast, then profitability will be adversely impacted in the short term, while in the longer term NIWA would need to adjust its cost structure to restore its financial sustainability.

We note that a key challenge facing NIWA in the coming several years is the assumption reflected in this SCI that the SSIF that underpins the Company's research capability will remain at current levels for the SCI period. This continues a lengthy period during which the real value of this funding has eroded. NIWA's financial planning assumes that a gradual reduction in science capacity will be required to maintain NIWA's financial sustainability.

Uncertainty also exists around revenues from commercial charters of NIWA's vessel RV *Tangaroa*. While the SCI reflects a relatively conservative realistic assessment of available commercial charter days, the maintenance and operation of this important science capability for the nation does remain reliant on NIWA winning such commercial contracts. If the market for this charter work significantly deteriorates, then NIWA's profitability will be adversely impacted. We further note that the financials reflected in this SCI assume an increase in funding for research conducted at sea on RV *Tangaroa*, beginning in 2022/23. If this were not to occur, then the long-term viability of the financial model for the nation's only significant deepwater research vessel would be in question.

Overall, we consider NIWA's financial planning to be realistic, and are of the view that there is broadly equal downside risk and upside opportunity. We are confident that NIWA's plans remain robust in the near term to potential negative volatility, and we will actively monitor and respond to any emerging risks.

NIWA Group
Ratios and statistics

Statement of Corporate Intent ($M)	Forecast 20/21	SCI 21/22	SCI 22/23	SCI 23/24
Revenue	169.14	171.25	178.04	184.47
Revenue growth	6.5%	1.3%	4.0%	3.6%
Operating results				
Operating expenses & depreciation	157.74	161.73	165.41	170.09
EBITDAF	33.44	31.03	34.21	36.58
EBIT & dividend received	11.39	9.53	12.63	14.39
Profit before income tax	12.31	9.30	11.84	12.64
Profit after tax	8.89	6.03	8.01	9.05
EBITDAF per FTE	0.049	0.045	0.050	0.053
Average total assets	196.69	205.10	216.06	248.29
Average equity (Shareholders' funds)	136.51	143.60	150.62	159.15
Adjusted average total assets*	169.46	177.86	188.83	221.05
Adjusted average equity*	113.65	120.74	127.76	136.29
Capital expenditure (incl. Capital committed)	24.94	47.46	60.22	73.82
Capital expenditure % to revenue	14.7%	27.7%	33.8%	40.0%
Liquidity				
Current ratio	135.7%	116.8%	59.3%	63.9%
Quick ratio (aka Acid test)	2.91	2.04	0.83	0.86
Profitability				
Adjusted return on equity*	7.8%	5.0%	6.3%	6.6%
Return on equity	6.5%	4.2%	5.3%	5.7%
Return on assets	5.8%	4.6%	5.8%	5.8%
EBITDAF margin (aka Operating profit margin)	19.8%	18.1%	19.2%	19.8%
Operational risk				
Profit volatility	15.1%	12.8%	7.1%	4.2%
Forecasting risk (non-adjusted ROE)	1.5%	2.1%		
Coverage				
Interest cover	28.0	15.8	13.5	8.22
Growth/Investment				
Capital renewal	118.6%	251.2%	319.3%	381.4%
Funds available for distribution ($M)	0.0	0.0	0.0	0.0
Financial strength				
Gearing	0.0%	0.0%	5.3%	26.1%
Equity ratio (aka Proprietorship)	69.4%	70.0%	69.7%	64.1%
Cash and short-term deposits	47.25	29.05	0.50	0.50
Financial debt	0.00	0.00	8.58	57.68

*Statement of Corporate Intent indicators.

Performance targets 2021/22

NIWA will measure its performance against the outcomes and operating principles in its Statement of Core Purpose using the following set of indicators.

Financial indicators

Measure	Calculation	Reporting frequency	Forecast 2020/21	Target 2021/22
Operating margin	Earnings Before Interest, Tax, Depreciation, Amortisation and Fair-value (EBITDAF)/Revenue	Annually	19.8%	**18.1%**
Profit per FTE	EBITDAF/FTEs	Annually	$49,000	**$45,000**
Quick ratio	Current assets less inventory less prepayments/Current liabilities less revenue received in advance	Quarterly	2.91	**2.04**
Interest coverage	EBITDAF/Interest paid	Quarterly	28.0	**15.8**
Profit volatility	Standard deviation of EBITDAF for the past five years/Average EBITDAF for the past five years	Annually	15.1%	**12.8%**
Forecasting risk	Five-year average of return on equity less forecast return on equity	Annually	1.5%	**2.1%**
Adjusted return on equity	NPAT excluding fair value movements (net of tax)/Average of share capital plus retained earnings	Quarterly	7.8%	**5.0%**
Revenue growth	% change in revenue	Annually	6.5%	**1.3%**
Capital renewal	Capital expenditure/Depreciation expense plus amortisation expense	Quarterly	118.6%	**251.2%**

Organisational performance indicators – 2021/22 at a glance

Measure	Calculation	Reporting frequency	Target 2020/21	Forecast 2020/21	Target 2021/22
End-user collaboration*	Revenue per FTE from commercial sources	Quarterly	$80,000	$88,000	**$99,000**
Research collaboration*	Publications with collaborators	Quarterly	85%	93%	**85%**
Technology & knowledge uptake*	Commercial reports per scientist FTE	Quarterly	1.0	1.3	**1.0**
Science quality*	Impact of scientific publications	Annually	2.5	2.5	**2.5**
Operational efficiency*	Revenue per FTE	Quarterly	$225,000	$247,000	**$247,000**
Operational delivery	% projects delivered on time	Annually	>90%	>90%	**>90%**
Strategic progress	% annual KPIs achieved	Annually	>90%	>90%	**>90%**

*Ministry of Business, Innovation & Employment generic indicators.

Science and support key performance indicators 2021/22

1. Enhanced regional climate change projections are being developed for New Zealand, the Southwest Pacific region and the Southern Ocean to inform mitigation policy and adaptation options.
2. Climate and hydrology seasonal forecasts and near real-time climate indices and data series have been produced and made available to stakeholders for operational decision making.
3. National greenhouse gas measurements and modelling have been used in the Integrated Global Greenhouse Gas Information System to support New Zealand inventory development, mitigation and verification activities required for transitioning to a low carbon economy.
4. Tailored information and guidance on the management of natural hazards and climate change risks has been produced to support resilience planning and decision making by government, communities, whānau/hapū/iwi and businesses.
5. Coastal and river flood-plain climate change hazard and risk exposure is further quantified for use in risk assessments and financial disclosures.
6. Innovative technologies for fisheries data collection and newly developed data analysis tools have been implemented.
7. Spatial complexity in fish stocks and fisheries is better understood and has been incorporated into fish stock assessments.
8. Completed scientific surveys and assessment of the current status of selected fish stocks, and assessment of the environmental impacts of selected fisheries on bycatch species and habitats, has informed Fisheries New Zealand management.
9. The engagement of Māori communities in taonga species and customary fisheries research has enhanced their capabilities and informed local and regional decision making.
10. A nationally consistent method for estimating streamflow depletion has been devised, tested and published to inform water use planning and consenting processes.
11. Models have been developed to describe fine sediment transformation in estuaries, and its effects on light transmission and particle settling, to inform guidance on seagrass conservation and restoration.
12. A catchment model has been developed and calibrated to predict the hydrological effects of large-scale tree planting in steep catchments, to inform land management and the forestry/carbon credit sectors.
13. Guidance on analysing and reporting trends in ecology and water quality indicators has been developed and distributed to increase national consistency in environmental reporting.
14. Design of a commercial-scale, land-based recirculating aquaculture system for production of high-value fish at the Northland Marine Research Centre has been completed and construction is underway.
15. The impact of environmental variability and change on annual aquaculture production levels of algae, shellfish and/or fish has been determined and informs industry pathways to adaptation or mitigation.
16. Marine biodiversity data from New Zealand and Antarctica have been curated and access provided to 5000–7000 new specimen registrations.
17. Marine biogeochemical and physical forecasting models have been developed for New Zealand's Exclusive Economic Zone and a focused shelf-sea region.
18. Changes in key coastal species distributions and flow-on effects on ecosystem functions and kaimoana have been quantified in high-use areas in consultation with Māori and end users.
19. Data from NIWA's climate and hydrological networks have been collected to high quality standards, archived, audited, and made available to stakeholders.
20. NIWA's digital geospatial reference datasets (including river, coastal and marine classifications) have been maintained, updated, and made available through NIWA's website.
21. RV *Tangaroa* has completed and met the science objectives of voyages for fisheries stock assessments and the deployment of New Zealand’s tsunami DART buoy network.
22. The business case for a replacement vessel for RV *Kaharoa* has been completed and approved by the NIWA Board and shareholding Ministers.
23. The High Performance Computing Facility has met the computational demand from the New Zealand science community and the National e-Science Infrastructure for at least 98% of the time.

24. NIWA's Māori Graduate Internship Programme has created opportunity for three Māori science graduates to advance into postgraduate and career pathways.
25. Knowledge transfer and stakeholder uptake has been enhanced through the publication of at least 100 media releases and science videos.
26. NIWA has sponsored at least 12 Science Fairs nationally to increase community appreciation of the role and benefits of science, especially for students of all ages.
27. In respect of the Future Property Programme, construction is tracking according to plan in the Hamilton project, designs have been completed for the Christchurch facility, and Implementation Business Cases for both the Wellington and Christchurch projects have been submitted to shareholding Ministers.
28. The new NIWA Senior Leadership Development Programme, with its first cohort of twelve participants, has been trialled and refined.
29. A minimum of five targeted opportunities have been created to increase and further develop Māori research capacity to strengthen internal NIWA capability.
30. Inclusion and co-supervision of at least 80 university postgraduates within our science programmes.
31. NIWA's 'Seasonal Safety Messages' campaign has been revitalised, with quarterly updates provided to all staff.
32. A new finance and project management system for NIWA has been successfully implemented.
33. Staff engagement with the Executive Team has been increased through regional roadshows, newsletters, open forum discussions, and informal catch ups with new starters.
34. Project management has been strengthened with the implementation of a new Finance and Project Management system.
35. RV *Kaharoa* replacement vessel design has accommodated low emission vessel propulsion technologies.
36. Independent verification of our carbon emissions baseline has been obtained.
37. Plans are in place and implemented to minimise our carbon emissions through continued reduction in energy and water use and waste footprint.
38. Our domestic flight emissions have been reduced by 10% relative to our 2019 baseline.

Appendices

Statement of Core Purpose

NIWA's purpose is to enhance the economic value and sustainable management of New Zealand's aquatic resources and environments, to provide understanding of climate and the atmosphere and increase resilience to weather and climate hazards to improve safety and wellbeing of New Zealanders.

Outcomes

NIWA will fulfil its purpose through the provision of research and transfer of technology and knowledge in partnership with key stakeholders including industry, government and Māori to:

- increase economic growth through the sustainable management and use of aquatic resources
- grow renewable energy production through developing a greater understanding of renewable aquatic and atmospheric energy resources
- increase the resilience of New Zealand and South-West Pacific islands to tsunami and weather and climate hazards, including drought, floods and sea-level change
- enable New Zealand to adapt to the impacts and exploit the opportunities of climate variability and change and mitigate changes in atmospheric composition from greenhouse gases and air pollutants
- enhance the stewardship of New Zealand's freshwater and marine ecosystems and biodiversity
- increase understanding of the Antarctic and Southern Ocean climate, cryosphere, oceans and ecosystems and their longer-term impact on New Zealand.

Scope of operation

To achieve these outcomes, NIWA is the lead CRI in the following areas:

- aquatic resources and environments (with a focus on surface freshwaters and coastal environments)
- oceans
- freshwater and marine fisheries
- aquaculture
- climate and atmosphere
- climate and weather hazards
- aquatic and atmospheric-based energy resources
- aquatic biodiversity (including biosystematics) and biosecurity.

NIWA will work with other research providers and end users to contribute to the development of the following areas:

- biosecurity, freshwater and hazards management
- climate change adaptation and mitigation
- ocean floor exploration
- seafood sector
- urban environments
- Antarctica.

Operating Principles

NIWA will:

- operate in accordance with a Statement of Corporate Intent and business plan that describes how NIWA will deliver against this Statement of Core Purpose, and describes what the shareholders will receive for their investment
- meet its obligations as a Crown Company and remain financially viable, delivering an appropriate rate of return on equity

- develop strong, long-term partnerships with key stakeholders, including industry, government and Māori and work with them to set research priorities that are well linked to the needs and potential of its end users
- maintain a balance of research that provides for both the near-term requirements of its sectors and demonstrates vision for their longer-term benefit
- transfer technology and knowledge from domestic and international sources to key New Zealand stakeholders, including industry, government, and Māori
- develop collaborative relationships with other CRIs, universities and other research institutions (within New Zealand and internationally) to form the best teams to deliver its core purpose
- provide advice on matters of its expertise to the Crown
- represent New Zealand's interests on behalf of the Crown through contribution to science diplomacy and international scientific issues and/or bodies as required
- seek advice from scientific and user advisory panels to help ensure the quality and relevance of its research
- establish policies, practices and culture that optimise talent recruitment and retention
- enable the innovation potential of Māori knowledge, resources, and people
- maintain its databases, collections and infrastructure and manage the scientific and research data it generates in a sustainable manner, providing appropriate access and maximising the reusability of data sets
- seek shareholder consent for significant activity beyond its scope of operation.

Other matters required by the CRI Act 1992

Information to be reported to Shareholders

NIWA will provide information that meets the requirements of the:

- Crown Research Institutes Act 1992 (the Act);
- Companies Act 1993;
- Financial Reporting Act 1993;
- Crown Entities Act 2004; and
- External Reporting Board (XRB) with regards to Generally Accepted Accounting Practice (GAAP).

The following information is made available to enable our shareholders to make an informed assessment of NIWA's performance:

- A Statement of Corporate Intent (SCI) which sets out NIWA's strategy for delivering against its core purpose and the company's financial and non-financial performance targets. The draft SCI is due not later than 1 month before the start of the financial year (31 May).
- An Annual Report containing sufficient information to allow an informed assessment to be made against the performance targets in the SCI. This report includes comments on our core business and how we communicate our science, financial statements (including audit report), and a report from the Directors to the shareholders. The Annual Report is to be provided within three months of the financial year ended 30 June. A public Annual General Meeting is to be held no later than six months after balance date and not later than 15 months after the previous AGM.
- A Half-Yearly Report containing unaudited financial statements (including comparatives of the same period in the previous year) and major highlights during the period. The Half-Yearly Report is due within two months of the first half of each financial year ended 31 December.
- A Quarterly Report containing information such as unaudited financial statements (including current quarter and year-to-date budgets and a forecast for the financial year ended 30 June). The Quarterly Report also includes financial performance measures and progress towards meeting non-financial performance targets. The Quarterly Report is currently requested within one month of each financial quarter ended 30 September, 31 December, 31 March, and 30 June.
- Any other information relating to the affairs of the company, as reasonably required by shareholders, under section 20 of the Act and section 45B of the Public Finance Act 1989.

Policy and Procedure Statements

NIWA Group consists of:

- National Institute of Water and Atmospheric Research Ltd
- NIWA Vessel Management Ltd
- NIWA Environmental Research Institute
- NIWA Natural Solutions Ltd
- NIWA Australia Pty Ltd
- EcoConnect Ltd
- Unidata Pty Ltd

All companies have 100% ownership and voting interests, except Unidata Pty Ltd which has 80% ownership and voting interest. NIWA Group will adhere to the following procedures, as required to be discussed under section 16 of the Crown Research Institutes Act.

Accounting Policies

NIWA adopts generally accepted accounting practice in New Zealand as prescribed by the External Reporting Board. The accounting policies for the measurement and reporting of financial performance, movements in equity, financial position, and cash flows are detailed in NIWA's Annual Reports available at www.niwa.co.nz.

Dividend Policy

Profit retention and dividend distribution will be determined from year to year by the Board. The policy's objective is to ensure that an appropriate level of funds is maintained in the company to sustain financial viability, whilst providing an adequate return to the shareholders.

In considering this objective, the Board each year determines the level of surplus funds by reference to NIWA's:

- medium- and long-term capital investment requirements (including equity investments);
- ability to maintain and expand operational capability;
- ability to repay debt (if any);
- funding requirements for subsidiaries;
- capacity to fund RV *Tangaroa*;
- working capital requirements;
- legislative requirements, e.g., ensuring section 4 of the Companies Act 1993 (Solvency test) has been satisfied.

Any dividend would be paid within two months of the financial year-end.

Shareholder Consent for Significant Transactions

The Board will obtain prior written consent for any transaction or series of transactions involving full or partial acquisition, disposal, or modification of property (buildings, land, and capital equipment) and other assets with a value equivalent to or greater than $10M or 20% of the company's total assets (prior to the transaction), whichever is the lesser.

The Board will obtain the prior written consent of Shareholding Ministers for any transaction or series of transactions with a value equivalent to or greater than $5.0M or 30.0% of the company's total assets (prior to the transaction):

- the acquisition, disposal, or modification in a joint venture, partnership, or other similar association;
- the acquisition or disposal in full or in part of shares or interests in external companies, subsidiaries, and business units;
- transactions that affect the company's ownership of a subsidiary or a subsidiary's ownership of another equity;
- other transactions that fall outside the scope of the definition of the company's core business or may have a material effect on the company's science capabilities.

The Board will advise the Shareholding Ministers in writing (in the Quarterly Report) before entering into any transaction below this threshold related to property or to a specific commercialisation venture which involves change in intellectual property ownership or control.

Ratio of Shareholders' Funds to Total Assets

The target ratio of 'shareholders' funds to total assets' is as follows:

	2021 Forecast	2022 Plan	2023 Plan	2024 Plan
%	69.4	70.0	69.7	64.1

Shareholders' funds are defined as the sum of the 'share capital' and 'equity reserves' (otherwise called 'total equity').

Total assets are defined as the sum of the net book value of 'current' and 'non-current assets'. This is 'as disclosed' in the company's balance sheet as per the Annual Report, prepared in accordance with the accounting policies adopted by the Board.

Shareholders' funds and total assets are averaged over two years.

Commercial Value of the Shareholders' Investment

Section 16(3) of the Act requires the NIWA Group to furnish an estimate of the current commercial value of the Crown's investment.

The NIWA Board is satisfied that the net asset position (or shareholders' funds) as at 30 June 2020 is a fair and reasonable indication of the commercial value of the Group. The net asset position as shown in accordance with the company's accounting policies for 30 June 2020 was $131.711M.

Activities where Shareholder Compensation would be required

The Board would look to seek compensation from the shareholders in the following circumstances:

- Where the shareholders instruct NIWA to undertake activities or assume obligations that would result in a reduction of the company's profit or net realisable value.
- Where the Board may consider undertaking strategic investments for the wider benefit of the New Zealand public, involving financial outlays beyond those incorporated within the company's Statement of Corporate Intent or financing capabilities.

No request for compensation is currently being sought from the shareholders. At this time no such investment has been identified, nor have any financial projections for such investment been included in NIWA's 2020/21 Statement of Corporate Intent. In the longer-term NIWA will be reviewing deepsea marine capability and future high performance computing capability and how investment in these national science infrastructure assets may be supported.

Other Matters Specifically Requested by the Shareholder

There are no other matters that have been specifically requested by the shareholders.

The following information can be found on NIWA's website:

- Personnel policy that complies with the principles of a good employer
- Equal Employment Opportunities programme
- Corporate Social Responsibility policy

Barry Harris, Chairman

Nick Main, Director

Directory

Board of Directors

- Barry Harris (Chairman)
- Nick Main (Deputy Chairman)
- Dr Helen Anderson (Term ends 30 June 2021)
- Dr Tracey Batten
- Professor Gillian Lewis (Term ends 30 June 2021)
- Mary-Anne Macleod

Executive Team

- John Morgan (Chief Executive Officer)
- Dr Rob Murdoch (Deputy Chief Executive, General Manager Science)
- Dr Helen Neil (General Manager Operations)
- Marino Tahi (General Manager Māori & Pacific Partnerships)
- Dr Mary-Anne Dehar (General Manager People & Capability)
- Warrick Johnston (General Manager Technology & Innovation)
- Dr Alex Thompson (General Manager Research Strategy)
- Patrick Baker (Chief Financial Officer)
- Geoff Baird (General Manager Communications & Marketing)

Solicitors

Bell Gully
Atkins Holm Majurey Ltd

Auditors

Price Waterhouse Coopers on behalf of the Auditor-General

Bankers

ANZ National Bank of NZ Ltd

Insurance Broker

Marsh Ltd

Registered Office

41 Market Place
Auckland Central 1010
New Zealand

Private Bag 99 940
Newmarket
Auckland 1149
New Zealand

Website

http://www.niwa.co.nz
https://www.facebook.com/nzniwa
https://twitter.com/niwa_nz

CLIMATE SCIENCE

New Zealand's pre-eminent provider of atmospheric and climate science

230

SCIENCE STAFF

New Zealand's largest team of climate scientists

$42M

ANNUAL INVESTMENT

In weather and climate research

7,500

CLIMATE STATIONS

The National Climate Database with information from 7,500 climate stations covering New Zealand, South-West Pacific and Antarctica

$18M

SUPERCOMPUTER

Enabling precise, highly localised forecasts

- Climate change and variability
- High-precision weather forecasting
- Weather-related hazard forecasting
- Adaptation and mitigation

NIWA's atmospheric research station in Lauder is one of five global charter sites in the international Network for the Detection of Atmospheric Composition Change (NDACC). *[Dave Allen]*

FRESHWATER SCIENCE

Supporting the sustainable management of our freshwater resources

240

SCIENCE STAFF

New Zealand's largest team of freshwater scientists

66,000

NATIONAL FLOOD FORECASTING SERVICE

Providing river flow forecasts for 66,000 catchments nationwide

$40M

ANNUAL INVESTMENT

Increasing knowledge of water quantity and quality

500

HYDROLOGICAL MONITORING STATIONS

A nationwide network of water and soil moisture monitoring stations

- Freshwater quality and quantity
- Biodiversity and biosecurity
- Sustainable use
- Flood forecasting

NIWA was a major contributor to the Science and Technical Advisory Group established to provide scientific expertise on the freshwater reform package announced by government last year. *[Petra Pearce]*

MARINE SCIENCE

Understanding, managing and maximising the benefits of our marine estate

260

SCIENCE STAFF

New Zealand's largest team of ocean scientists

NORTHLAND MARINE RESEARCH CENTRE

New Zealand's leading science facility for finfish aquaculture

$67M

ANNUAL INVESTMENT

In coast and ocean, fisheries and aquaculture science

STATE-OF-THE-ART RESEARCH VESSELS

Supporting the New Zealand science community

- New Zealand's marine estate
- Sustainable use of marine resources
- Biodiversity and biosecurity
- High-value finfish aquaculture

Development of a commercial-scale recirculating aquaculture system (RAS) is underway at NIWA's Northland Marine Research Centre. It is a sustainable, land-based venture that aims to prove the technical and economic feasibility of farming kingfish in tanks at commercial scale. *[Crispin Middleton]*

Science working for New Zealand

The Crown Research Institutes (CRIs) proudly work, individually and collectively, to create a more prosperous, sustainable and innovative New Zealand

agresearch
āta mātai, mātai whetū

ESR
Science for Communities

GNS SCIENCE
TE PŪ AO

Manaaki Whenua
Landcare Research

NIWA
Taihoro Nukurangi

Plant & Food™ Research
Rangahau Ahumāra Kai

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NIWA
Taihoro Nukurangi
Climate, Freshwater & Marine Science