



**ENHANCING THE
BENEFITS OF
NEW ZEALAND'S
NATURAL RESOURCES**

CLIMATE & WEATHER HAZARDS

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

FRESHWATER ENVIRONMENT

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Supporting the sustainable management of our freshwater resources

MARINE ENVIRONMENT

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Understanding, managing and maximising the benefits of our marine estate

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NIWA
ANNUAL REPORT
2016/17

STEPPING UP TO THE CHALLENGE

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CHALLENGE

CHAIRMAN & CHIEF EXECUTIVE'S REPORT 2016/17



Widening concern for the state of our prized freshwater resources, growing recognition of the need to prepare for climate variability and change, a continuing push for sustainable economic growth based on natural resource use, and repeated assaults by nature – hallmarks of a remarkable year in which NIWA's expertise, leadership and technical capabilities were in constant demand.

We had to step up to the challenge in a manner that befits our status as New Zealand's pre-eminent provider of atmospheric, freshwater and marine science.

In our 2016/17 *Statement of Corporate Intent*, we anticipated an intensifying national debate about the current and future state of New Zealand's freshwater resources. That turned out to be the case. The stakeholder conversation was both prolonged and impassioned, fuelled by the release of the Government's Clean Water package of proposed reforms, including the contentious 'swimmable rivers' aspiration.

Clean and abundant freshwater is the lifeblood of our economy, and a defining feature of our national identity, so it is hardly surprising that emotions ran high. However, policymakers and community leaders recognise the need to remove sentiment from the conversation, and inform their decision-making with impartial scientific evidence to ensure outcomes are acceptable for all stakeholders.

That is where NIWA's expertise came into play.

Throughout the year, our hydrologists and water-quality researchers were called upon to assess the complex natural and human influences on freshwater quality and availability, at many scales, and for a variety of purposes. We prepared our own analysis of the Government's Clean Water proposals, and made a key contribution to a seminal report released by Sir Peter Gluckman, the Prime Minister's Chief Science Advisor, titled '*New Zealand's fresh waters: Values, state, trends and human impacts*'. This, coupled with our business-as-usual efforts to measure, predict, protect and mitigate, firmly cemented our position at the forefront of independent freshwater science in New Zealand.



*Marine geologist Dr Phil Barnes addresses journalists at a NIWA press conference after the Kaikōura earthquake.
Dave Allen*

'We rapidly redeployed *Tangaroa* to the waters off Kaikōura and began surveying and mapping the upheaval that had taken place beneath.'

We also expected the drive to prepare New Zealand communities for climate variability and change to reach a turning point during the year. Following the release of NIWA's national climate change projections by the Ministry for the Environment last year, several councils engaged us to prepare outlooks tailored to their regions of responsibility. It is heartening to see that most local authorities now acknowledge the pressing need to incorporate climate change impacts into their economic, infrastructural and environmental planning. NIWA is recognised as New Zealand's authoritative source of guidance in this field.

What we couldn't foresee, however, was the way Nature would repeatedly and dramatically test the resilience of New Zealanders during the year.

In the early minutes of 14 November, central New Zealand lurched violently as the largest earthquake to affect the country in over 80 years struck near Kaikōura. Within a few tumultuous minutes, lives and livelihoods – as well as large tracts of land and seafloor – were radically altered.

This event gave us the opportunity to apply our specialist expertise and sophisticated technology – both to inform the Government, the science community and the public generally in the immediate aftermath of the quake, and to acquire knowledge critical to future hazard-management efforts. We rapidly redeployed our flagship research vessel, *Tangaroa*, to the waters off Kaikōura and began surveying and mapping the upheaval that had taken place beneath. Within a few days, we were able to share valuable insights into changes in the sub-seabed fault structure, the nature and behaviour of the tsunami that followed the quake, and the impacts on marine habitats and resources in the area.

Our agility was similarly tested during subsequent months, when devastating fires swept across Christchurch's Port Hills, wide swathes of New Zealand were buffeted by the remnants of two tropical cyclones, and the country's highly valued oyster industry faced a grave threat from *Bonamia ostreae*. In each case, we quickly diverted expert resources to the task of assessing and analysing the impacts, and informing those involved in managing the response.

Rapid responses to areas of opportunity and need, such as these, characterised the year. This, coupled with significant growth in the scope of core research and applied-science programmes that make up our three research platforms – climate and atmosphere, freshwater, and marine – meant our workload was at an all-time high.

With this additional demand, we had to recruit almost 100 science, technical and support staff during the year, of which about half were new positions. In so doing, we bolstered our ability to deliver outstanding science for the benefit of all New Zealanders – a fact reflected in our very pleasing annual result.

Revenue growth, the resolution of research funding uncertainties in key areas as identified in our 2016/17 *Statement of Corporate Intent*, and tight control over costs contributed to our very pleasing financial performance.

Revenue was \$142.6 million, earnings before interest, tax, depreciation and amortisation (EBITDA) was \$20.8 million, and net profit after tax (NPAT) was \$4.3 million.



Science highlights

Overall, we achieved 44 of the 47 research and applied-science programme Key Performance Indicators we set for the year. Good progress was made with the other three programmes; however, full achievement was delayed by circumstances beyond our control.

Climate & Weather Hazards

Our partnership with Fire and Emergency New Zealand (FENZ) advanced significantly during the year. The NIWA FireWeather Team completed an exacting trial over several months, convincingly proving their ability to provide tailored and accurate weather information and forecasts, on call, to help FENZ manage risk and respond effectively to incidents. This service proved its worth during the Christchurch Port Hills fires in February. We also worked with FENZ to develop a smart, interactive fire-weather web service, giving FENZ resource managers fingertip online access to high-resolution regional weather observations and forecasts, and a range of fire-weather indices.

NIWA's meteorologists were also tasked with assessing the long-range aerial dispersal of myrtle rust, a disease with the potential to devastate several tree species in New Zealand, including the iconic pōhutukawa. Using wind data, the team tracked the likely spread of the disease from eastern Australia, New Caledonia and Raoul Island. Our models can now be used to predict the spread of myrtle rust within New Zealand.

During what was an extraordinarily stormy year, the Forecasting Services Team maintained a high profile in mainstream media and on our social media platforms, helping New Zealanders brace for the impacts and understand the causes of the extreme weather that repeatedly bore down on us. The team has redefined the way weather and climate forecasts and impacts are communicated to the New Zealand public and weather-dependent businesses, making full use of our high-resolution models and cutting-edge graphic and video production facilities.

'We surveyed and mapped 43,000 hectares of the Marlborough Sounds – the largest area of NZ coastline so comprehensively surveyed.'

The NIWA FireWeather Team provided tailored and accurate weather information and forecasts during the Port Hills fires. Christchurch City Council

Freshwater Environment

As noted above, the release of the Government's Clean Water proposals, and the ongoing limit-setting and management requirements placed on local authorities by the National Policy Statement for Freshwater Management, ensured our hydrologists and water-quality experts were kept extremely busy during the year.

New Zealand River Maps is NIWA's new web-based tool that allows users to interrogate and plot estimated values of over 100 river variables – such as width, riverbed sediments, fish distributions and habitats, bird habitats, water quality and allocated water consents – for the entire national river network. The tool is intended for use by planners and environment managers from councils, consultancies and special interest groups, and is designed to aid catchment and regional planning and community consultation.

Underpinning this tool, and much of our other modelling work in hydrology, water quality, freshwater ecology, sediment processes and hazards, is the *NIWA Digital River Network* – a digitised plot of streams and rivers, including lower-order tributaries – covering the entire country. During the year, we updated this vital

resource, adding regional components for Northland, Auckland and Waikato and improving its spatial resolution from 30 metres to 8 metres. This update will have significant benefits for our researchers and customers alike.

Marine Environment

Our inshore research vessel *Ikatere* and our advanced multibeam seabed surveying and mapping technologies were put to work in the Marlborough Sounds to update navigational charts produced in the 1940s. The project, carried out by NIWA and Discovery Marine Ltd on behalf of Land Information New Zealand and the Marlborough District Council, saw 43,000 hectares of seafloor mapped over 280 days, gathering 30 terabytes of data in the process. New navigational charts are just one outcome of the work. The data gathered, coupled with NIWA's unparalleled knowledge of the marine realm, mean that critical connections can now be drawn between the physical environment revealed by the survey, the habitats and behaviours of marine creatures living and passing through the area, and the influence of changing human interactions with the environment. NIWA is uniquely equipped to establish these connections.



We can comfortably meet the demands of continuous supply of juveniles to establish a commercial kingfish aquaculture industry.

Alvin Setiawan



'Over half the world's whale and dolphin species are found in New Zealand waters.'

During the year an unprecedented deployment of undersea acoustic moorings aimed to shed light on the distribution and abundance of whales and dolphins in Cook Strait. Over half the world's whale and dolphin species are found in New Zealand waters, yet little is known about their seasonal distribution and abundance. After six months' deployment, the acoustic mooring results substantially exceeded expectations by recording the sounds of Antarctic blue whales, Antarctic minke whales and several different rarely seen beaked whales. If we know what species are there and when, industry can operate in a manner that accommodates their presence – a win-win outcome. The moorings also dramatically recorded November's magnitude 7.8 Kaikōura earthquake, although the noise was so loud it was outside the sensitivity range of the hydrophones.

In the South Island, our fisheries experts were on the job in late 2016 and early 2017 sampling wild and farmed oyster populations to determine the prevalence and spread of the destructive *Bonamia ostreae* parasite. The information we gathered informed the management strategies put in place by the Ministry for Primary Industries. In addition, NIWA biotechnologists designed a new, highly efficient and cost-effective method for detecting the parasite in raw oyster extracts.

A partnership between our Northland Marine Research Centre and Leigh Fisheries to supply farm-raised yellowtail kingfish to high-end restaurants confirmed strong consumer demand for the product. Whilst the availability of sea space for new finfish aquaculture ventures remains a challenge, we are focusing on collaborating with potential partners to establish a commercial kingfish aquaculture industry for New Zealand.



Ikatere and Rukuwai mapping the Marlborough Sounds seafloor and the habitat in unprecedented detail.
Hamish McCormick

'Despite our strength in freshwater, marine and atmospheric science we also work closely with other science providers to ensure the best possible outcomes.'

National Science Challenges

NIWA is hosting two of New Zealand's 11 National Science Challenges, and we are a key partner in another three. The two challenges we host, *Deep South* and *Sustainable Seas*, made significant progress during the year.

Deep South

Deep South, which is focused on helping New Zealanders adapt, manage and thrive in a changing climate, uses outputs from the New Zealand Earth System Model (NZESM) – a sophisticated computer model – to inform and guide research. This year, we completed initial testing of the NZESM in preparation for its first production runs early in 2018. We also received new data from the *Deep South* region, which will support development of the model and provide insights into relevant climate processes.

Sustainable Seas

Most of the *Sustainable Seas* research is now under way, with 27 active projects (10 of which are led by NIWA). Two projects have already been completed, and their findings are informing other research projects and being taken up externally.

Whilst our science is for the benefit of all New Zealanders, engagement with Māori and stakeholders (particularly central and regional government and some industry sectors) increased

significantly in the past year. During the year there have been seven workshops, more than 60 stakeholder meetings, more than 25 meetings with iwi, and more than 60 presentations to Māori and stakeholders. In addition, more than 40 Māori and stakeholders attended the inaugural annual *Sustainable Seas* conference.

Collaborative and cross-discipline science

Despite NIWA's strength in freshwater, marine and climate science, we have always recognised the importance of working closely with other science providers to assist with addressing challenges of national and international significance, and achieve the best possible outcomes for all New Zealanders. Collaboration remained a cornerstone of many of our achievements during the year.

In that vein, we welcomed investment by the Ministry of Business, Innovation & Employment in New Zealand's new Space Agency, and look forward to playing our part in this exciting field of scientific endeavour. Space has long been integral to our atmospheric and marine science. For decades, we have received weather, sea-surface temperature, ocean colour and other data via satellite dishes at our Wellington and Lauder sites. The new agency will open up opportunities and reinforce our already strong partnerships with the international science community, including the National Oceanic and

Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA).

During the year, we entered a partnership with Spark, Ballance Agri-Nutrients, Farmlands and Landcorp to test low power wide area (LPWA) networks for acquiring, transmitting, managing and applying environmental data from targeted locations to support resource use, enterprise decision making or better understand environmental status.

We also joined forces with GNS Science to add groundwater modelling capability to our high-resolution national river-flow forecasting system. This means we can now trace and predict the above-ground and below-ground pathways that water takes from the moment it lands as rain or snow, to when it flows into the ocean. Incorporating the 'legacy effect' of groundwater into the system greatly improves the accuracy and versatility of our flow forecasts, which are generated for some 66,000 catchments nationwide. We are now working alongside users to develop tools that will convert hydrological forecasts into

tailored, relevant and easily accessible information for a variety of purposes. We can also couple our hydrological model with others to forecast, for example, the transportation of contaminants through linked surface-water/groundwater systems.

We also continue to work collaboratively with the NZ MetService on hazardous weather events.

Collaboration is integral to the long-running Argo ocean buoy project, one of the most ambitious and successful international marine research programmes ever undertaken, and NIWA is one of its most significant contributors. The aim of the programme is to provide a comprehensive picture of the role of the oceans in global climate, weather and climate-prediction systems. NIWA research vessels *Kaharoa* and *Tangaroa* have deployed about one-quarter of the approximately 4,000 Argo floats in the world's oceans, and in March 2017, we hosted a celebration on board *Tangaroa* to mark the outstanding success of this global collaboration.

'We generate river-flow forecasts for some 66,000 catchments nationwide.'

Celebrating the global Argo collaboration on Tangaroa. From left: NIWA chairman Sir Christopher Mace, US Chargé d'Affaires Candy Green, Science Minister Paul Goldsmith, Argo director Howard Freeland, NIWA Chief Executive John Morgan, Hamish McCormick



Meanwhile, NIWA marine researchers worked with colleagues from NOAA, on board NOAA's research vessel *Okeanos Explorer*, to investigate biodiversity among the deep seamounts off the Cook and Tokelau Island groups. The remotely operated vehicles (ROVs) deployed by the team captured some incredible footage from the depths, opening our eyes to the extraordinary life in this rarely-seen part of our planet. These magical images, and our expert commentary on them, were disseminated widely using mainstream and social media, enthraling viewers – scientists and the general public alike – all around the world.

One of our greatest strengths as an organisation is our ability to draw together expertise from across our science platforms to provide clients with a one-stop solution to complex challenges. This ability was to the fore in the development of a new online tool that combines our climate outlooks with our expertise in mussel aquaculture to predict mussel yield in Pelorus Sound, New Zealand's largest mussel aquaculture region. The tool provides

outlooks for up to five months ahead, and is used by the industry to plan farm activities and prepare business projections.

Science and education

Over the past year NIWA continued its commitment to the development of future capability in environmental science by cultivating skills and interest among young New Zealanders.

In August 2016, we were delighted to sign an agreement with the University of Waikato to establish the *NIWA/University of Waikato Joint Institute for Freshwater Management*. The university is New Zealand's main provider of tertiary-level freshwater research education, and NIWA is the country's biggest employer of freshwater science staff, with 230 staff working on freshwater issues. The collaboration significantly enhances New Zealand's research capabilities in this critical domain, and ensures passionate young scientists are given the early guidance they need to make a positive and targeted contribution to future freshwater management efforts.

'The NIWA/University of Waikato Joint Institute for Freshwater Management significantly enhances New Zealand's capabilities.'

Sir Peter Blake Trust Chief Executive Shelley Campbell and NIWA Chief Executive John Morgan formally recognise NIWA as the Trust's Principal Science Partner, on board Steinlager 2, one of Sir Peter Blake's successful racing yachts.

Stuart Mackay





Some of the more than 120 students who entered the NIWA Bay of Plenty Science & Technology Fair.

Tracey Burton

The NIWA/University of Auckland Joint Graduate School in Coastal and Marine Science continued to provide young scientists from New Zealand and around the world with experience in widely varying fields of oceanic research. Like the Joint Institute for Freshwater Management, the Graduate School aims to nurture high-achieving young scientists by giving them access to our world-class scientists and facilities, and by equipping them with the highest levels of scientific discipline to carry forward into their careers.

This year, NIWA staff supervised about 100 PhD and MSc students studying at universities around the country – the highest-ever number of supervisions by NIWA. In addition, we welcomed more than 15 student interns from New Zealand and overseas during the summer months, offering valuable work experience during the long break in their studies.

A major new sponsorship agreement significantly expanded NIWA's long-established and increasingly rewarding partnership with the Sir Peter Blake

Trust. As the Principal Science Partner of the Trust we believe we can achieve more together and make a lasting and positive impact in developing the next generation of New Zealand leaders. This year our sponsorship enabled another four outstanding young New Zealanders to spend time working alongside our science teams as NIWA Blake Ambassadors. The experiences they had were formative, and they continue to perform a vital role inspiring and educating other young people about the nature and importance of our science.

We also actively support the annual Science New Zealand-sponsored Sir Paul Callaghan Eureka Awards, which aim to identify and foster young leaders in science, technology, engineering or mathematics. The Eureka Awards now include a NIWA scholarship, awarded to the student who delivers the most effective presentation aligned with the mission of the *Sustainable Seas* National Science Challenge.

At secondary school level, the nationwide programme of NIWA Science & Technology Fairs continued

to thrive. We are the lead sponsor of six main city fairs and an award sponsor of eight regional fairs, putting us in direct contact with thousands of students, parents and teachers each year. NIWA staff from all levels also act as judges and presenters at these events, and are uniformly inspired by the enthusiasm, sophisticated thinking and creativity the students display.

'Sponsorship of the Science & Technology Fairs puts us in direct contact with thousands of students, parents and teachers each year.'

Health and safety

We are acutely aware that the pursuit of outstanding climate, atmospheric, freshwater and marine science routinely places our people in potentially dangerous situations. From the extremes of Antarctica, the Southern Ocean and the tropical Pacific, to vehicles and laboratories much closer to home, NIWA staff recognise the need for health and safety to be at the forefront of their thinking and actions at all times.

Early in 2017, we conducted a review of our 2013–16 *NIWAsafe* strategy to ensure it remained relevant and addressed the array of risks associated with our fast-changing and highly varied workplaces. The review showed that we had made significant gains in our safety management capability relating to regulatory and customer requirements. While trends in personal harm injuries were variable, there was a steady decrease in work injury claims and a steady increase in near-miss reporting.

Our 2017–20 *NIWAsafe* strategy will place further emphasis on ongoing development of the culture and mindsets that ensure an exemplary health and safety performance.

An undoubted highlight of the year was winning the health and safety category of the Wellington Gold Awards, which celebrate excellence and enterprise among businesses in the greater Wellington region. Our win recognised the comprehensive processes we have implemented to identify and manage actual and potential hazards on board NIWA's vessels, and the way health and safety practices are more broadly integrated into our operations.

Confidently looking ahead

We are confident that the strong demand for our science that characterised 2016/17 will continue, despite inevitable challenges and uncertainties.

New Zealanders are highly passionate and possess a strong sense of fair play when it comes to the use – and misuse – of their treasured natural

environments. NIWA will continue to perform an essential role in ensuring decisions governing the use of our environments and natural resources are informed by the highest-quality science, delivered to policymakers and decision makers in clear, compelling and timely ways.

Of course, Nature doesn't always pay us back in kind! Our communities will always be at the mercy of Nature's occasional fits of fury, which are likely to increase in intensity and frequency as our climate changes. NIWA has already developed substantial high-resolution forecasting capabilities, and the agility needed to be on the job as quickly as possible to assess, learn and inform – so that New Zealanders, and our Pacific Island neighbours, are better prepared for the next assault, wherever and whenever it may be.

The confidence in our ability to resource our future science opportunities and challenges is founded on our approach to responsible financial management. We will continue to maintain the disciplines, processes and checks required to ensure we act with optimal fiscal efficiency and diligence at all times, without denying ourselves the ability to respond quickly and decisively to new opportunities, or newly identified areas of need.

We are confident, too, because we are an organisation of outstanding people. *OneNIWA* – our practice of pulling our capability together as a national team where required – continues to go from strength to strength. This capability has been reinforced by the many new highly skilled staff who joined us this year, and our long track record of effective collaboration across science disciplines, professional domains and international borders.

Finally, we are confident because we are committed to investing wisely in our future. Over and above our usual substantial capital investment in science equipment and infrastructure, plans are underway for the modernisation of our offices in Hamilton, Wellington

and Christchurch, the further development of our Northland Marine Research Centre at Bream Bay, and an \$18 million upgrade of our high-performance computing capability. We provided leadership through the New Zealand e-Science Infrastructure (NeSI) consortium to identify the supercomputing capability that would not only meet NIWA's growing needs, but would also serve the entire New Zealand research community for the foreseeable future. Installation of that capability is now underway.

We thank the Board and the Executive Team for their support and efforts in leading the organisation to a most successful year in meeting the nation's needs for climate, atmospheric, freshwater and marine science.

Our goal is to stay in step with rapid advances in scientific thinking and facilities, digital technology, operational systems and physical infrastructure, to ensure NIWA people are supported in the best possible way in their quest for excellent science with impact.



Sir Christopher Mace, KNZM

Chairman



John Morgan

Chief Executive

FINANCIAL SUMMARY

NIWA Group Financial Summary

For the year ended 30 June 2017

in thousands of New Zealand dollars	2017	2016	2015	2014	2013
Revenue and other gains	142,618	130,309	126,190	123,397	120,559
Research	81,417	68,896	64,075	65,176	62,739
Applied science	61,200	61,412	62,115	58,221	57,820
Other income	1	1	–	–	–
Profit before income tax	5,950	5,492	8,005	7,324	6,581
Profit for the period	4,250	4,011	5,755	5,278	4,640
Capital expenditure	13,053	12,592	15,652	10,852	11,360
Adjusted return on average equity (%)	4.8	4.7	7.0	6.7	6.2
Return on average equity (%)	3.8	3.7	5.5	5.2	4.7

The 'adjusted return on average equity' uses a valuation basis comparable to that used by other Crown Research Institutes. This valuation basis arose from the transition to New Zealand Equivalents to International Financial Reporting Standards in 2006/07 and reverses the effect of the revaluation of certain land and buildings.

Group actual performance versus Statement of Corporate Intent (SCI)

For the year ended 30 June 2017

in thousands of New Zealand dollars	Actual 2017 \$	SCI 2017 \$	Actual 2016 \$
Revenue and other gains	142,618	133,130	130,309
Operating expenses, depreciation, and amortisation	137,539	132,898	125,288
Profit before income tax	5,950	506	5,492
Profit for the period	4,250	362	4,011
Average total assets	151,542	146,170	141,150
Average shareholders' funds	111,454	108,660	107,370
Profitability			
Operating profit margin (%) (EBITDAF/revenue)	14.6	12.0	15.2
Adjusted return on average equity after tax (%) (net surplus/adjusted average equity)	4.8	0.4	4.7
Return on average equity after tax (%) (net surplus/average equity)	3.8	0.3	3.7
Return on assets (%) (EBIT/average total assets)	3.4	0.2	3.5
Profit volatility (%) (non-adjusted ROE)	6.1	10.1	6.4
Forecasting risk (%)	1.1	1.1	2.0
Liquidity and efficiency			
Current ratio	1.7	1.4	1.6
Quick ratio	2.8	2.0	2.2
Financial leverage			
Debt to average equity (%)	–	–	–
Gearing (%)	–	–	–
Proprietorship (%) (average shareholders' funds/total assets)	71	75	73

OVERVIEW OF GROUP FINANCIAL PERFORMANCE

With research funding uncertainties resolved, 2016/17 was an exciting year for NIWA, building revenue and capability and establishing a strong platform for future growth.

Revenue

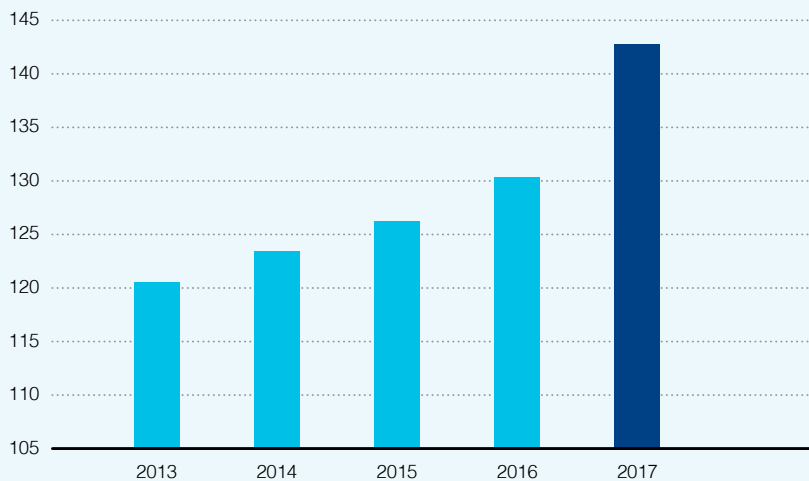
For the 2016/17 year, NIWA published an addendum to its Statement of Corporate Intent (SCI) for the previous year. This addendum recognised that NIWA had faced significant uncertainty associated with its revenue assumptions, in particular in relation to the National Science Challenges, MBIE contestable funding, MBIE Strategic Funding and revenue associated with the RV *Tangaroa*. The SCI addendum made clear that NIWA had been working closely with officials from the Ministry of Business, Innovation and Employment (MBIE) to resolve these areas of uncertainty.

While NIWA was pleased to note the increases in science funding announced in the Government's Budget 2016, it did not expect the Company's funding uncertainties to be resolved for a further several months. With this in mind, NIWA developed a budget for 2016/17 which reflected conservative assumptions of the research revenue available for the year, while not responding with cuts in expenses which would lead to long-term adverse effects on capability.

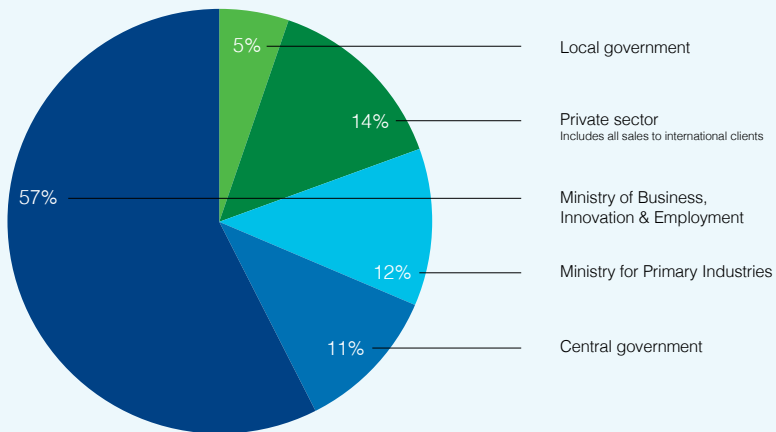
NIWA is pleased to report that the research funding uncertainties identified in its 2016/17 SCI, and noted above, were satisfactorily resolved during the year. NIWA achieved revenue of \$142.6 million in 2016/17, an increase of \$12.3 million compared with the previous year, and \$9.5 million higher than the budget for the year.

As expected, the level of MBIE contestable research funding derived by NIWA during the year continued the trend of previous years, with a further reduction of \$2.8 million, as freshwater contestable research contracts came to a close. However, this was more than offset by an increase of almost \$7.0 million in MBIE Strategic Funding (which replaced the prior Core Funding arrangements). In addition, the National Science Challenges, two of which are hosted by NIWA, picked up further momentum, resulting in a revenue increase of \$7.6 million compared with

Total revenue (includes interest income)
(\$ in millions)



Revenue by source



the previous year – although \$6.0 million of this was accounted for by revenue passed on to collaborators within those Challenges, leaving a year-on-year increase of \$1.6 million to support NIWA's research activities.

The market for commercial research vessel charters softened significantly during the year, driving a \$5.2 million reduction in revenue for NIWA compared with the previous year. Encouragingly, however, this was almost completely offset by a \$5.0 million year-on-year increase in other revenue won on a commercial basis. This gives NIWA

a level of confidence that, over time, recent increases in research revenue will be at least matched by sustainable increases in commercial revenue.

Year-on-year, the share of NIWA's revenue arising from transactions with its key central government clients, MBIE and the Ministry for Primary Industries, rose by 2% to 69%. This was due to increases in MBIE Strategic Funding as well as revenue associated with the National Science Challenges, combined with the impact of lower commercial vessel charter revenue.

Expenditure

Operating expenses (including depreciation and amortisation) increased by \$12.3 million compared with the previous year, matching the increase in revenue. Half of this increase is due to higher amounts of National Science Challenge revenue passed on to collaborators, as noted above. The balance of the increase in expenses is accounted for by higher direct costs associated with the revenue increases, higher personnel costs as NIWA began to build the capability needed to support sustained higher levels of science activity, and higher overhead costs, mainly related to continuing investments in Information Technology.

Total costs were up by \$4.6 million compared with the budget for the year. Of this increase, \$2.0 million resulted from above budget spending with subcontractors on science collaboration. The balance of the variance to budget related to higher personnel and other project costs, in both cases associated with the higher than budget revenue performance.

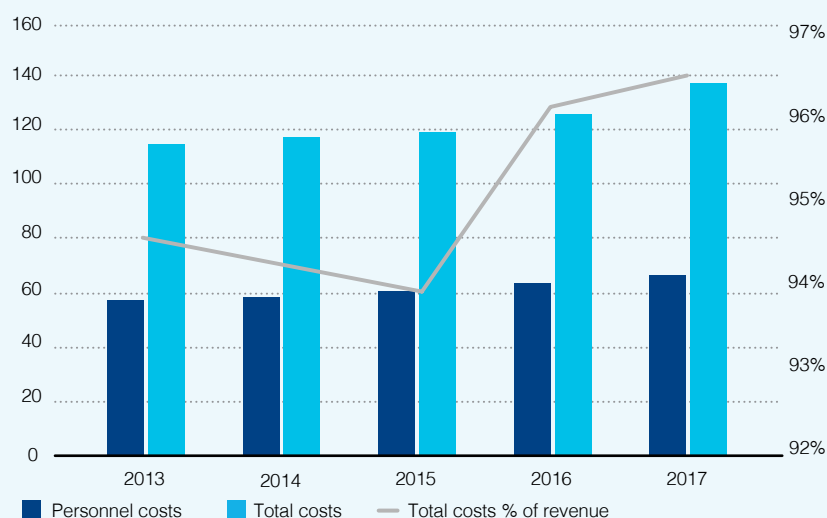
Profitability

The satisfactory resolution of previous uncertainties around research funding, noted in the revenue section above, resulted in profit before tax of \$5.95 million and after tax of \$4.25 million. This represented a material improvement on the budget projection of approximately \$0.5 million before tax and \$0.4 million after tax. Compared with the previous year, NIWA achieved modest increases in profitability, by \$0.5 million and \$0.2 million respectively.

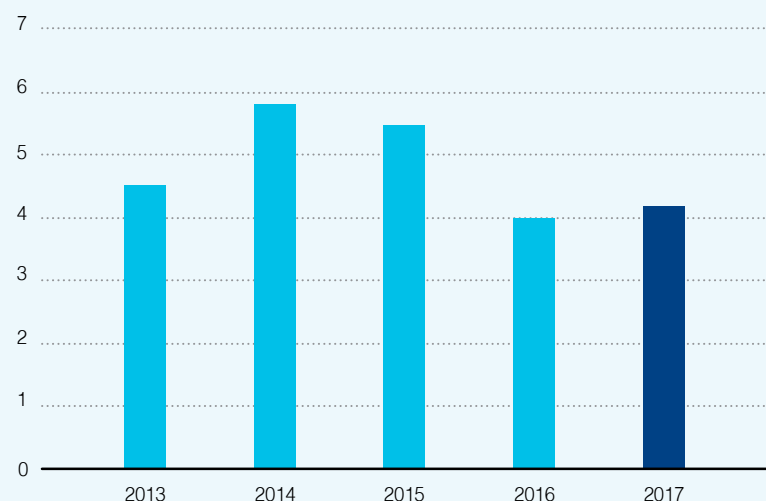
NIWA also closely monitors its Earnings before Interest, Tax, Depreciation and Amortisation (EBITDA), because this measure assists in understanding NIWA's capacity to fund future investments and carry debt. It is encouraging that performance against this measure increased by \$1.0 million compared with the previous year, to \$20.8 million. This bodes well for NIWA's ability to finance its previously-signalled planned investments in upgrading major facilities over the coming several years.

NIWA's fundamental financial performance metric is adjusted return on equity (ROI), which enables comparison between CRIs on an equivalent basis. NIWA delivered an adjusted ROE of 4.8% this year, up from 4.7% last year and 4.4% better than the budget objective.

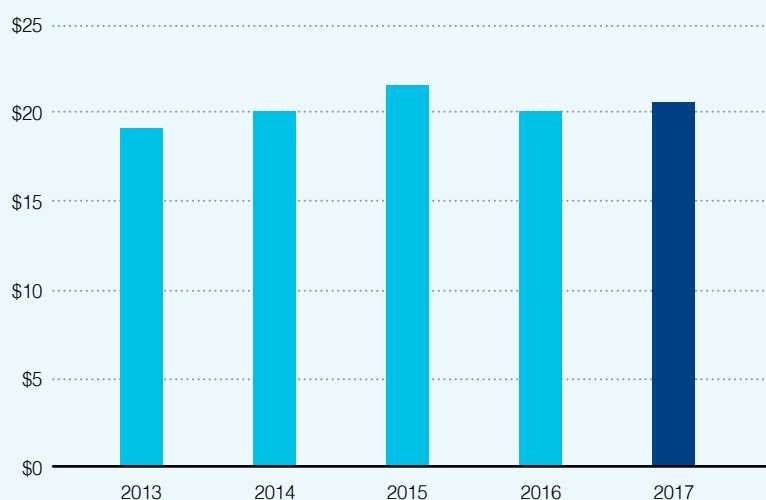
Expenditure
(\$ in millions)



Net profit after tax
(\$ in millions)



Earnings before Interest, Tax, Depreciation and Amortisation
(\$ in millions)



CAPITAL MANAGEMENT AND CASH

Cash flows

The following table summarises NIWA's cash flows this year and last year:

(\$ in millions)	2017	2016	Change
Net cash flows from operating activities	24.956	23.061	1.895
Net cash flows from investing activities	(37.853)	(12.192)	(25.661)
Net cash flows from financing activities	0.0	0.0	0.0
Net increase/(decrease) in cash	(12.897)	10.869	(23.766)

The above presentation is consistent with New Zealand Equivalents to International Financial Reporting Standards and therefore treats cash flows relating to short-term deposits with maturities greater than three months as investing activities. In order to provide more useful and relevant information concerning NIWA's cash flows, the table below restates the summary of cash flows, treating all short-term investments as equivalent to cash:

(\$ in millions)	2017	2016	Change
Net cash flows from operating activities	24.956	23.061	1.895
Net cash flows from investing activities	(12.853)	(12.192)	(0.661)
Net cash flows from financing activities	0.0	0.0	0.0
Net increase/(decrease) in cash including other term deposits	12.103	10.869	1.234

Net cash flows from operating activities

Net cash inflows from operating activities increased by \$1.9 million to \$25 million in 2017. This year-on-year change was more than explained by further funding received from MBIE associated with the National Science Challenges in advance of those Challenges fully completing the associated work projects. Such funding is recognised as a liability on the balance sheet ('revenue in advance').

Net cash flows from investing activities

Net cash outflows from investing activities (excluding the impact of cash flows associated with term deposits with maturities in excess of three months) increased by \$0.6 million to \$12.9 million. This year-on-year variance is within the normal variability of NIWA's spending on infrastructure and equipment.

Net cash flows from financing activities

Net cash outflows from financing activities remained at zero due to NIWA paying no dividend during the year. This was signalled in the previous year's *Statement of Corporate Intent*, and reflects upcoming essential and material investments designed to ensure that NIWA's science facilities remain fit for purpose for the coming decades.

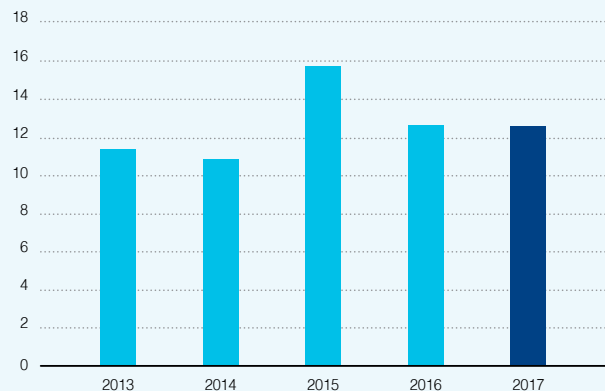
Capital spending

The following table summarises NIWA's capital expenditure this year and last year:

(\$ in millions)	2017	2016	Change
Land, buildings & improvements	1.175	0.740	0.435
Equipment	6.423	7.740	(1.317)
ICT equipment	1.904	1.183	0.721
Vessel equipment	0.255	2.059	(1.804)
Other	3.296	0.870	2.426
Total capital spending	13.053	12.592	0.461

Total capital expenditure was \$13.1 million during the year, up from \$12.6 million during the prior year.

Capital expenditure (\$ in millions)



Capital structure and liquidity

Shareholders' equity at 30 June 2017 was \$113.6 million (2016: \$109.3 million), which was \$4.8 million higher than the level forecast in the SCI budget. Total assets at year end were \$156.0 million (2016: \$147.1 million). As at 30 June 2017, the Company's net debt balance was zero, equal to that at the prior year end.

NIWA's liquidity is mainly provided by operating cash flows. In addition, NIWA has access to financing facilities of \$10.5 million provided by its bank, although this facility was not required to be called upon during the year.

Dividends

As foreshadowed in NIWA's *Statement of Corporate Intent*, the Directors of NIWA have decided not to declare a dividend in respect of the 2017 year. This is in light of a series of significant capital investments which will be required to maintain and build capability and financial sustainability for the future. These investments include renewing NIWA's high performance computing capability, renovating or replacing the physical infrastructure and facilities at three main sites, and continued development at the Northland Marine Research Centre at Bream Bay.

NIWA's most significant investments (over \$200k) during the year included:



\$759,000 New Greymouth facility

A new office, workshop and laboratory facility has been constructed in Greymouth. This strengthens NIWA's ability to more quickly and effectively service customers on the South Island's West Coast.



\$285,000 Oceanographic instrumentation

A range of oceanographic equipment was purchased, including acoustic current profilers, ocean current meters and water property loggers. These investments are important for NIWA's core research around measuring ocean parameters.



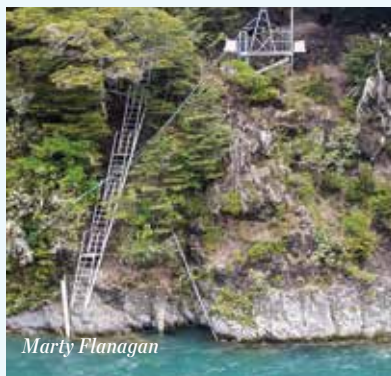
\$242,000 Geoswath

Designed for use on vessels in shallow water, the geoswath can collect bathymetric soundings in a swath perpendicular to the vessel (as well as from the side). It has already been used on a hydrographic survey of the Marlborough Sounds and for a marine survey in Lyttleton.



\$348,000 Real-time monitoring buoy

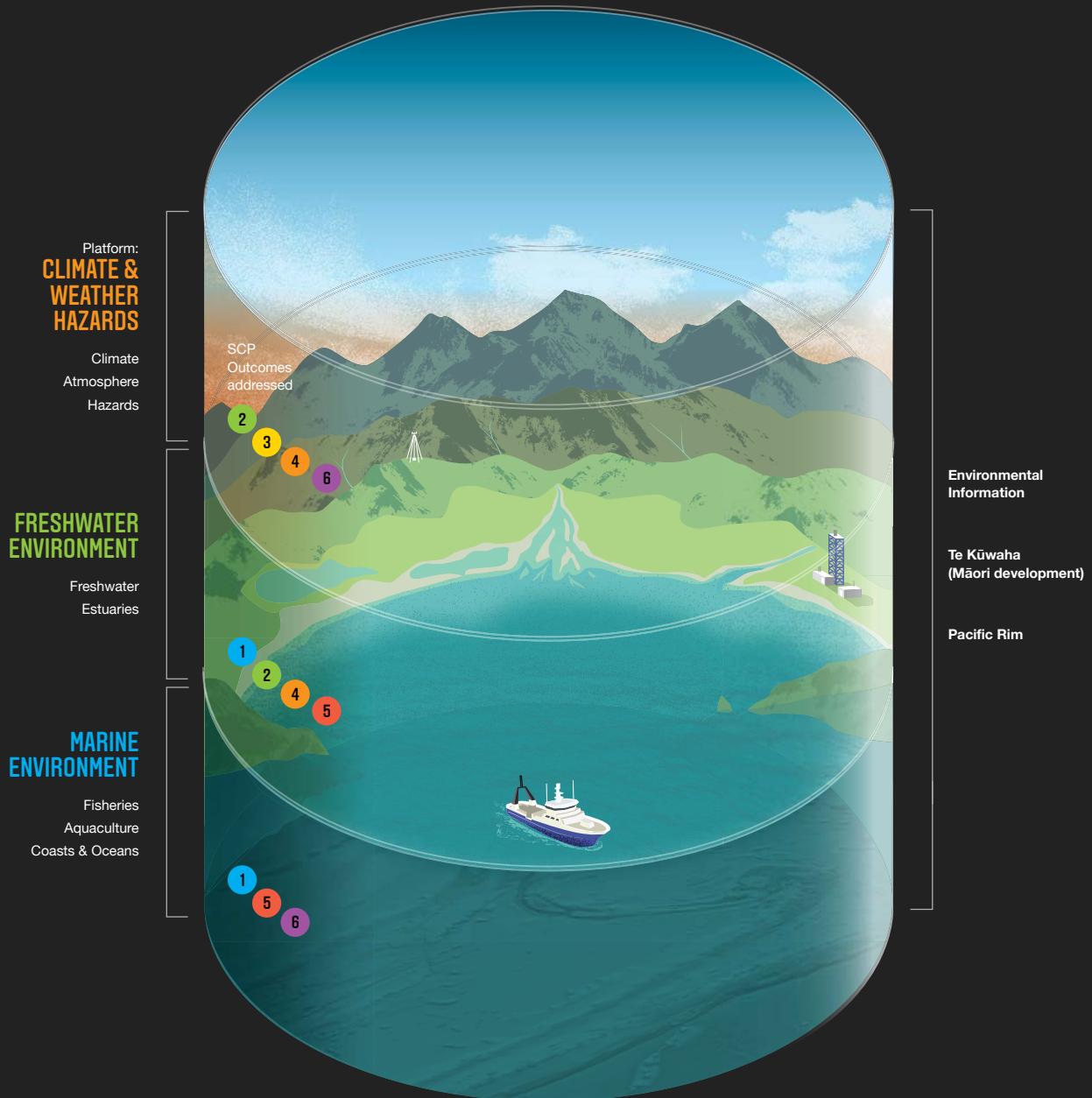
A joint initiative between NIWA and Greater Wellington Regional Council, the buoy is one example of how NIWA is working with local government to monitor the environment and provide quality, evidence-based data. It is the most sophisticated monitoring buoy in New Zealand and can deliver real-time data of currents, waves, salinity, temperature, oxygen, chlorophyll, ocean acidification and wind.



\$209,000 Hydrometric monitoring network upgrade

The hydrometric network is a key data network for water resources and energy purposes. The upgrade involved installing state-of-the-art technology to greatly improve data recording and transmission by satellite and cellphone networks.

NIWA IN A NUTSHELL



Statement of Core Purpose Outcomes

- 1** Increase economic growth through the sustainable management and use of aquatic resources.
- 2** Grow renewable energy production through developing a greater understanding of renewable aquatic and atmospheric energy resources.
- 3** Increase resilience of New Zealand and South-West Pacific islands to tsunami and weather and climate hazards, including drought, floods and sea-level change.
- 4** 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.
- 5** Enhance the stewardship of New Zealand's freshwater and marine ecosystems and biodiversity.
- 6** Increase understanding of the Antarctic and Southern Ocean climate, cryosphere, oceans and ecosystems and their longer-term impact on New Zealand.

NIWA's three science platforms align with the SSIF Platforms we are contracted by MBIE to deliver and the Statement of Core Purpose Outcomes.

Enhancing the benefits of New Zealand's natural resources

Core purpose

- ▶ **Enhance the economic value and sustainable management of New Zealand's freshwater and marine resources and environments**
- ▶ **Improve our understanding of the atmosphere and New Zealand's climate**
- ▶ **Increase resilience to weather and climate hazards to improve the safety and wellbeing of New Zealanders**

Science strategies



Climate and Atmosphere

- ▶ Improve our understanding of the changing climate to enable adaptation to its impacts
- ▶ Contribute to global understanding of atmospheric composition and dynamics
- ▶ Improve forecasting to reduce the impact of weather – and climate-related hazards
- ▶ Produce environmental forecasts tailored to weather-dependent sectors and customers

Freshwater

- ▶ Improve our understanding of New Zealand's freshwater quantity and quality
- ▶ Maximise sustainable use of New Zealand's water resources for economic benefit
- ▶ Support the implementation of the Government's freshwater reforms

Marine

- ▶ Improve our understanding of New Zealand's marine environment to inform decisions about its management
- ▶ Maximise sustainable use of New Zealand's marine resources for economic benefit
- ▶ Develop new finfish aquaculture species to grow the industry in New Zealand

Data services

- ▶ Collect, quality assure and curate nationally significant environmental data
- ▶ Efficiently deliver environmental data and information to stakeholders at an appropriate price
- ▶ Develop value-added, data-based products and services

Enabling strategies

Customer focus

Keep promises, communicate well, deliver on time, within budget and to specification

Science excellence

Globally recognised and respected; objective and most trusted by stakeholders

Facilities and assets

Modern facilities, infrastructure and state-of-the-art science equipment and methods

Māori engagement

Respected value-adding collaborator and commercial partner of Māori enterprises

Communication

Most respected and trusted brand, with innovative messaging tailored to audiences

People and leadership

Best scientists, technicians and support staff – the 'employer of choice'

Safety

Zero harm to our people and those who work with us

Productivity

Most cost-effective and efficient with resources, time and service delivery

Agility

Adaptable, responsive, opportunistic and embrace change

IT

Contemporary IT infrastructure and tools to deliver efficient and value-added services

All photos by Dave Allen

CLIMATE & WEATHER HAZARDS

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

- ▶ Improving our understanding of the changing climate to enable adaptation to its impacts
- ▶ Contributing to global understanding of atmospheric composition and dynamics
- ▶ Improving forecasting to reduce the impact of weather and climate-related hazards
- ▶ Producing environmental forecasts tailored to weather-dependent sectors and customers.

NIWA employs New Zealand's largest team dedicated to research and applied-science services in weather and climate and associated hazards.

NIWA's experts utilise world-class data gathering, management and processing facilities, as well as leading-edge communications technology, to translate their science into precise, meaningful and timely weather and climate information, benefiting a wide range of end users in many sectors. NIWA's goal is to enhance knowledge and apply science in ways that inform operational and risk-management decisions made by businesspeople, policymakers and hazard and environmental managers in New Zealand and the South-West Pacific. A key focus is to identify the drivers and consequences of climate change, so that communities can prepare and adapt.

NIWA also participates in extensive global collaborations, which enrich New Zealand's science and provide opportunities for adding greater benefit.

Camping on the ice at Antarctica while undertaking climate change research.

Natalie Robinson

NIWA's climate, atmosphere and weather science includes:

- ▶ Observing, analysing and modelling the atmosphere and climate of the New Zealand region
- ▶ Determining the role of oceans in influencing New Zealand's climate
- ▶ Predicting the effects of climate change and variability on New Zealand and the South-West Pacific
- ▶ Determining the impacts of air pollutants on human health, and evaluating mitigation options
- ▶ Predicting and evaluating risks, impacts and potential losses from weather-related hazards
- ▶ Developing and delivering operational weather and weather-impact forecast models.

Key assets

- ▶ The National Climate Database, which holds decades' worth of quality-assured climate information from approximately 7500 monitoring stations around New Zealand, the South-West Pacific and Antarctica. Some records date back to the 1850s
- ▶ A national monitoring network, comprising 200 NIWA stations and supplemented by many more operated by local and central government agencies and other parties, which take regular climate readings day and night and transmit them direct to the National Climate Database
- ▶ A High Performance Computing Facility, or 'supercomputer', which runs sophisticated weather, climate and environmental forecasting models using data from the National Climate Database and other sources. The models produce precise, highly localised forecasts which are deployed to a wide range of end users to support operational and risk-management decisions
- ▶ A fully equipped digital media studio, enabling the communication of weather, climate and other science information in innovative, compelling and timely ways.

Resources

- ▶ Approximately 225 staff working nationwide and collaboratively with other providers and end users across the South-West Pacific and further afield.

Investment

- ▶ \$39 million annually for research and applied-science services
- ▶ An additional \$70 million over the next five years to enhance the quality and reach of our weather and climate research.



HIGHLIGHTS CLIMATE & WEATHER HAZARDS

NASA's flying laboratory makes a low pass over Lauder to calibrate instruments.

Lisa Davidson



scientists on board as they each took a series of atmospheric measurements simultaneously.

During that leg, which began in American Samoa, the plane made 12 descents to 152m before climbing back to 10,670m to sample air at a range of altitudes. In the clear weather conditions the plane was easily visible from the ground.

NASA and NIWA scientists were able to compare measurements – an invaluable exercise, as the Lauder instruments are all ground-based and use remote sensing to infer the total atmospheric column and profiles of various gases, while the NASA plane had the advantage of taking measurements in situ. Lauder scientists described this rare opportunity as “like gold”.

The measurements have been fed into the global network TCCON – Total Carbon Column Observing Network – a ground-based network of precise measurements of greenhouse gases throughout the atmosphere. The NASA mission will be repeated annually for four years.

Collaborating in global atmospheric research

NASA completed a ‘fly by’ visit of NIWA’s atmospheric research centre at Lauder, Central Otago, late last year.

The DC-8 flying laboratory was on a world-first mission to measure airborne particles and more than 200 gases which have strong effects on the climate. Instruments on board the California-based plane

measured pollutants over the oceans, in a bid to determine how they react to and eventually disappear from the atmosphere. The mission was particularly interested in methane, ozone and black carbon.

The flight path of one leg saw the plane, with 42 scientists and crew on board, passing over Lauder, where NIWA scientists communicated with

Land carbon uptake by native South Island forests

New research by NIWA has identified a major carbon uptake in New Zealand that is most likely to be occurring in native forests in the South Island.

The research was published in February and concludes that New Zealand’s forests and other land areas may be absorbing up to 60 per cent more carbon dioxide than previously thought. Carbon dioxide is a primary greenhouse gas and responsible for most of the human-induced warming in the atmosphere.

New Zealand’s forest carbon uptake played a key role in meeting commitments under the Kyoto Climate treaty, and this research has significant ramifications for the future management of national emissions.

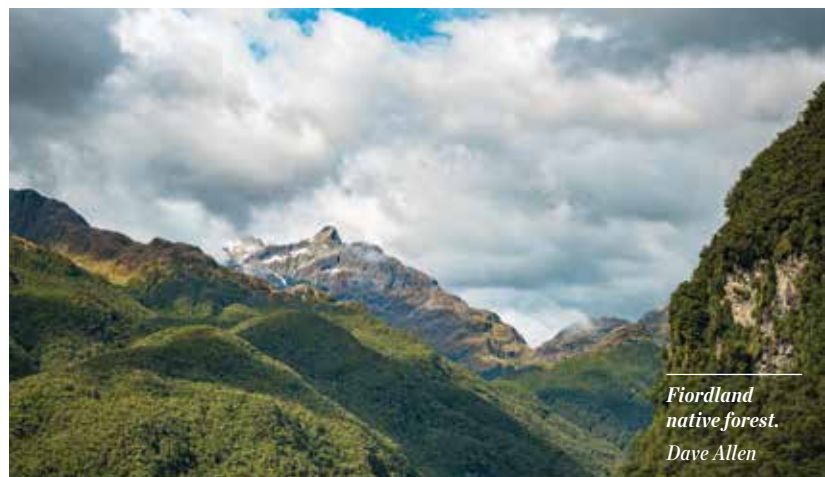
Scientists used an inverse modelling approach to estimate the amount of carbon uptake. This measured the carbon dioxide in the atmosphere at a network of sites, and then used high-resolution weather models to determine what parts of the country the air had passed over before reaching the site.

Once combined with simulations from a land model and ocean carbon data, calculations were made to determine the best combinations of sources and sinks to match the data.

The results indicate that there is a large carbon sink somewhere in the South Island, and the areas that appear responsible are dominated by indigenous forests.

However, the data did not rule out the role of hill country and farm pasture in contributing to the carbon uptake.

These results challenged conventional thinking that strong carbon uptake is usually associated with peak growth of recently planted forests, and slows as forests mature. It is not yet known whether this is unique to New Zealand or part of a wider global process.



*Fiordland native forest.
Dave Allen*



Collaboration drives Pacific tropical cyclone guidance

Each year, NIWA's Weather and Climate Applications and Forecasting Services Teams collaborate with MetService, the Australian Bureau of Meteorology, Meteo France and Pacific Island National Meteorological Services to prepare an outlook for the upcoming tropical cyclone season in the South Pacific region, including New Zealand.

The outlook indicates the expected number, severity and location of storms across the region during the November to April peak season. This information is critical for the formulation of local hazard management and recovery plans.

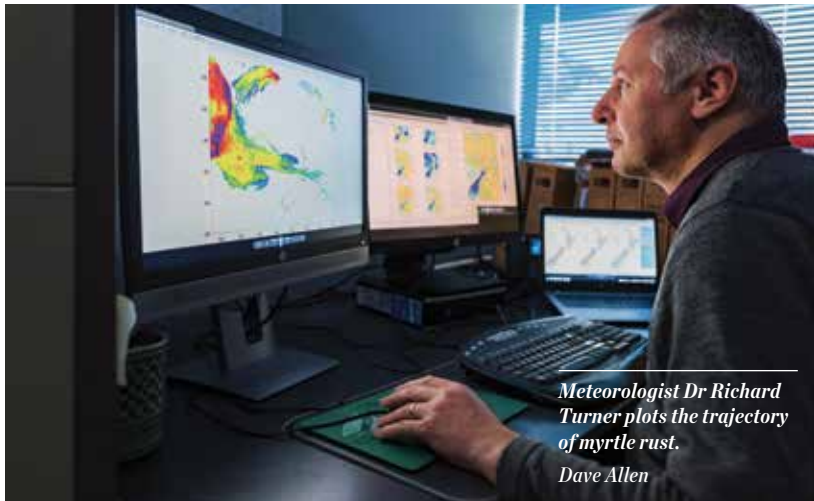
The consortium draws on a range of data sources and analyses to evaluate current conditions, including the state of the El Niño-Southern Oscillation (ENSO). Each ENSO phase – El Niño, La Niña or neutral – influences tropical cyclone formation across the region in its own way. When ENSO conditions are changing rapidly, the outlook is updated mid-season.

Scientists also look for analogue years – similarities between past and current pre-season conditions – for guidance on how the season ahead might unfold.

Data and analysis is then aggregated to produce a statistical outlook for cyclone numbers and severity in different parts of the region.

NIWA delivers the outlook to a range of organisations involved in hazard management in the Pacific, including the New Zealand Ministry of Foreign Affairs and Trade, Red Cross, the United Nations Development Programme, the World Meteorological Organization and The Secretariat of the Pacific Regional Environment Programme. In addition, NIWA produces a video summary of the outlook and helps Pacific Island National Meteorological Services to disseminate the guidance using social media and other appropriate channels.

*Satellite image
of Cyclone Donna.
NASA/JSC*



*Meteorologist Dr Richard Turner plots the trajectory of myrtle rust.
Dave Allen*

Myrtle rust

The expertise of NIWA meteorologists was in demand when the fungus myrtle rust was discovered in a Kerikeri plant nursery in early May, and a week later in Taranaki.

Myrtle rust is a serious fungal disease that attacks members of the Myrtaceae plant family, which includes pōhutukawa, mānuka, kānuku and rātā. It became established in Australia about five years ago, and was detected

on Raoul Island in the Kermadecs earlier this year. Myrtle rust spreads by producing microscopic spores that are easily dispersed by wind.

When the fungus was discovered here, the Ministry for Primary Industries approached NIWA to establish when weather conditions were most likely to have brought the spores from Australia and Raoul Island, and on to New Zealand, and to identify areas most at risk.

Using highly sophisticated numerical weather modelling, NIWA scientists were able to calculate the likely dates of aerial dispersion of the spores from July 2016 onwards.

Modelling long-range dispersal required some adaptation to existing models to account for the huge distances involved. Aerial dispersion was modelled using a particle trajectory approach and calculated movement from a large number of trajectory sources with positions updated every 10 minutes. Modelling also took into account the effects of ultraviolet radiation and washout.

These predictions helped focus surveillance efforts, and NIWA is also providing information on the dispersal of spores from infected sites within New Zealand. The rust has subsequently been found in Waikato and Bay of Plenty.

Work is also under way to expand long-range and short-range dispersal for rust, spider mite and gypsy moth, and NIWA climate scientists are creating a 10-year climatology that will determine the best conditions for the spores to be produced and dispersed.



FRESHWATER ENVIRONMENT

Supporting the sustainable management of our freshwater resources

- ▶ Improving our understanding of New Zealand's freshwater quantity and quality
- ▶ Maximising sustainable use of New Zealand's water resources for economic benefit
- ▶ Supporting the implementation of the Government's freshwater reforms.

NIWA's freshwater and estuarine team conduct research and deliver applied-science services focused on the water cycle, the consequences of water use and allocation, water quality, the impacts of catchment land use, pollutant mitigation, invading weeds and pest fish and the restoration of ecosystem health.

They use the data and knowledge they acquire to design models and tools that help a wide range of New Zealanders better manage their interactions with freshwater supplies, maintain or improve water quality, and protect downstream estuarine systems. NIWA staff work alongside central, regional and local government, other science providers, iwi groups, industry sectors and commercial operators to achieve this goal.

NIWA's freshwater and estuarine science includes:

- ▶ Predicting the dynamics of water availability and the ecosystem limits to allocation
- ▶ Understanding the interactions between surface water and groundwater, including the pathways for transfer of contaminants
- ▶ Identifying threats from introduced aquatic plants and animals and developing tools to mitigate their impact
- ▶ Developing techniques to enhance ecosystem health in response to contaminants and habitat modification
- ▶ Developing improved operational tools to forecast floods.

Key assets

- ▶ A nationwide network of hydrological and soil-moisture stations
- ▶ The Snow and Ice Monitoring Network, which measures the quantity of freshwater stored in alpine areas as snow and ice
- ▶ The National River Water Quality Network, which provides reliable scientific information on physical, chemical, and biological characteristics of 77 sites on 35 rivers throughout the country
- ▶ A wide range of purpose-built tools and models, such as NZ Rivers, TopNet (a national stream-flow model), CLUES (Catchment Land Use for Environmental Sustainability) and C-CALM (Catchment Contaminants Load Model), which support planning, ecosystem management, environmental assessment and consent applications
- ▶ Specialist laboratories and analytical equipment.

Resources

- ▶ Approximately 350 staff working nationwide and collaboratively with other providers and a wide range of freshwater users.

Investment

- ▶ Approximately \$34 million annually for research and applied-science services
- ▶ An additional \$60 million over the next five years on research and the transfer of knowledge to government and industry.

HIGHLIGHTS FRESHWATER ENVIRONMENT



Informing the freshwater issue

The quality of New Zealand's freshwater has been a politically-charged subject in the last year, and NIWA science has been crucial in informing the debate.

From providing a comprehensive view of the state, trends and human influences on our freshwaters for publication by the Office of the Prime Minister's Chief Science Advisor to briefing Members of Parliament in the *Speaker's Science Forum*, NIWA has been at the national forefront of freshwater science.

When the Government proposed amendments to the National Policy Statement for Freshwater Management ('the Clean Water proposals') in February, there was considerable confusion and public debate about the swimmable rivers component related to *E. coli*. NIWA prepared a technical background paper which informed those submitting on the proposals.

We also reviewed and provided significant data and interpretive science to the *State of the Environment Freshwater Domain Report* published by Statistics NZ and the Ministry for the Environment, which was published in April.

Other freshwater quality achievements include the launch of the New Zealand River Maps tool (<https://shiny.niwa.co.nz/nzrivermaps>) to allow better predictions and inform more sustainable water allocation decisions. This is part of our work improving understanding of the effects of human activity on rivers and groundwater systems.

Water contamination has also been a hot topic, and in the last 12 months, NIWA scientists have been successfully trialling the ColiMinder, a revolutionary piece of equipment which may make it possible to provide near real-time analysis of microbial contamination of water to deliver timely public health risk warnings.

Huka Falls.

Dave Allen

Sharing environmental data

NIWA collects and holds more environmental data than any other New Zealand science agency. Over the past year, 60 terabytes of new freshwater, marine, climate and atmospheric data was collected and managed through a range of data and quality management systems.

An important part of NIWA's work involves capturing relevant metadata (data about data) that can be easily understood by future users. The Station Information Management System, for instance, contains metadata for about 10,000 deployments of on-land sensors across New Zealand, Antarctica and the Pacific going back over 100 years.

NIWA's data management capabilities are widely recognised and used. A new water data management system is being built for Singapore, for instance, and an ocean data repository for New Zealand has been built and will be made available through the web.



*Eric Stevens services a Tier 2 weather station in the Takahe Valley.
Dave Allen*

NIWA has also recently been working with the Government's National Science Challenges – developing a system for New Zealand scientists to manage and catalogue metadata.

Many of NIWA's core databases are publicly accessible over the web, and are well-used. The NIWA climate database, for example, which produced

452 million rows of data last year, has 39,000 registered users.

NIWA is supporting and promoting the use of open standards for data exchange and is working with international leaders in the field. Much of NIWA's public data is available through open standards and can be easily integrated by users into their systems.

Flood forecasting

The vulnerability of New Zealand's urban areas and productive land to river flooding was highlighted repeatedly during late 2016 and early 2017. Edgumbe, Christchurch and large tracts of farmland in Northland, Bay of Plenty, Canterbury and Otago all succumbed during what was an exceptionally stormy period.

Heavy rain events with the potential to cause rivers to overflow are likely to increase in frequency and intensity as our climate changes – with a corresponding increase in potential impacts on lives and livelihoods.

NIWA has combined its advanced data-gathering, high-resolution weather forecasting and hydrological modelling capabilities into an operational system

that predicts river flows for 66,000 catchments nationwide, up to 48 hours ahead. As model resolution and capacity increase over the next few years, it is expected that forecasts for more than one million catchments and sub-catchments will be operationally available.

The model, called the New Zealand National Hydrological Model, draws on NIWA's high-resolution weather forecasts and factors in the many catchment-specific pathways that precipitation can take to reach a river channel.

NIWA is now working closely with regional councils and other users to develop tools that will convert hydrological forecasts into tailored, relevant and easily accessible information for different river users and hazard managers. NIWA remains committed to the goal of developing a state-of-the-art national river flood early-warning service utilising these well-developed capabilities.



The Rangitaiki River in flood.

Dave Allen

An environmental Internet of Things

NIWA is keeping a close eye on (and developing technology for) the Internet of Things (IoT). IoT involves connecting sensors to the physical environment, then connecting those devices to the internet for monitoring, control and decision purposes.

A partnership has been established with Spark in a primary sector IoT project which has seen weather stations and soil-sensing equipment installed at three North Island farms and a Marlborough vineyard.

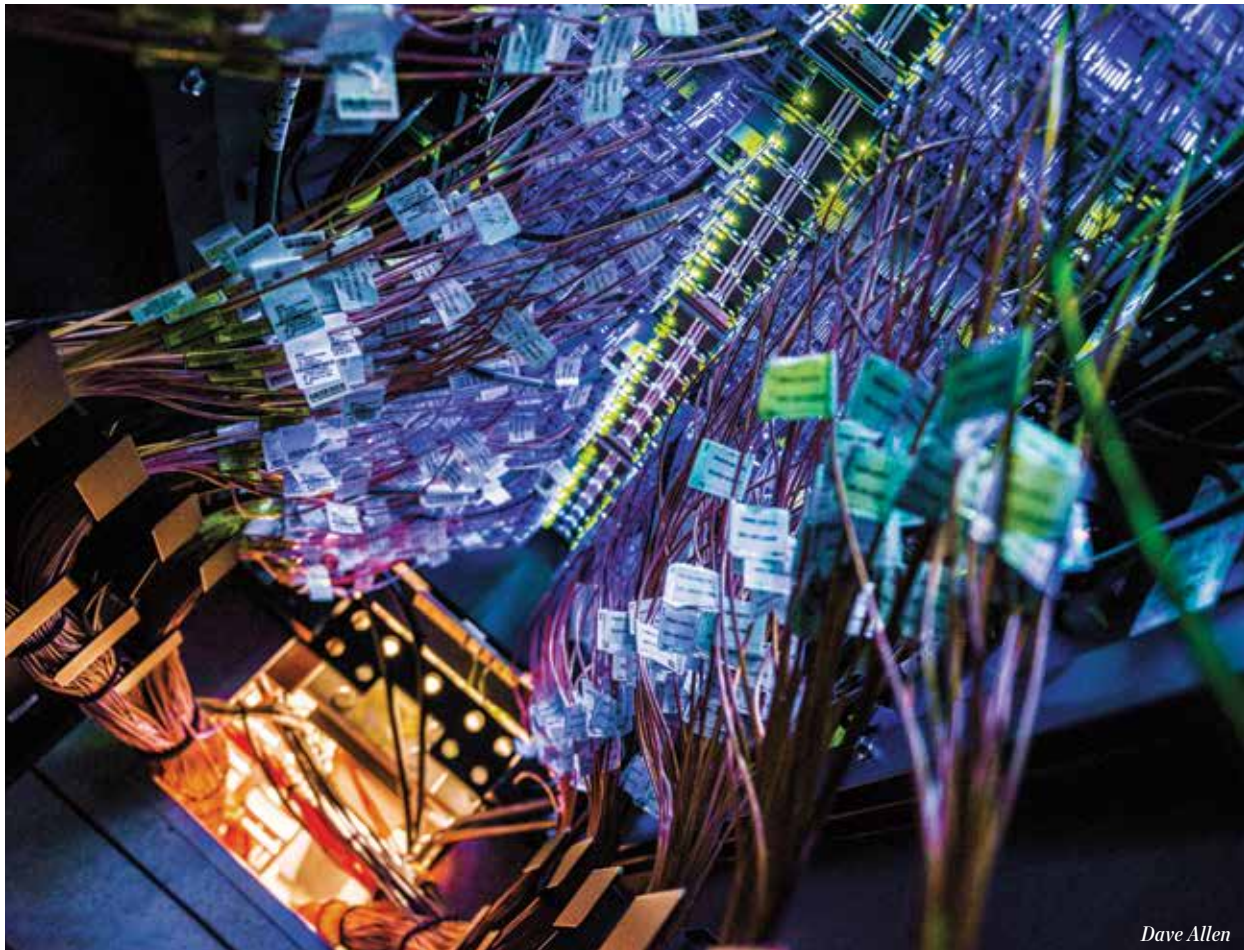
The installations have helped NIWA evaluate Spark's IoT network coverage and connectivity, test our new IoT hardware and evaluate the performance of sensors. An agreement has also been reached with NIWA's strategic partners Ballance Agri-Nutrients and Farmlands to work on new low-cost sensors. These will help in the development of new decision tools relating to pasture growth, silo management and on-farm safety for the benefit of New Zealand's agricultural sector.

Over and above the IoT, NIWA develops and sells the Neon range of IP data loggers. These sophisticated pieces of equipment monitor things such as water levels and gas pressure over mobile phone and satellite networks. They are also used in control applications for the management of water within irrigation schemes.

Demand for Neon products has increased this year, and new product releases have included the Neon remote logger suite, and Neon server and data management system extensions.

New laser water level sensors/bore loggers and flow measuring instruments have also been introduced. One of the new water sensors, for instance, is now being used for continuous, unattended, non-contact groundwater-level monitoring in the Tasman District.

NIWA's sensors were also put to work after the 2017 Christchurch floods, and a new prototype is even being used to measure grain levels in farm silos.



Dave Allen



Diver Rohan Wells, during a survey of Lake Denny, one of the Ashburton (Ō Tū Wharekai) lakes.
Tracey Burton

Pest-free ports and waterways

NIWA is a leader in biological surveillance in New Zealand, checking for unwanted pests in our ports and waterways.

An important part of the work is a contract with the Ministry for Primary Industries (MPI) to deliver biosecurity monitoring in 11 ports and harbours. Twice a year, surveys (involving diving, trapping and visual observation) are undertaken to find high-risk marine pests that have not yet established a foothold in New Zealand, and establish whether any known pests have increased their range.

This work is helping the Government and regional councils make decisions about intervention at an early stage, to limit or prevent damage to New Zealand's priceless natural resources and, for example, the valuable aquaculture industry.

NIWA freshwater experts have undertaken surveillance for new pest plant incursions contracted by regional councils, MPI, the Department of Conservation and Land Information New Zealand in water bodies from Northland to Southland. These surveys have led to detection of new incursions and successful eradication programmes of, for example, oxygen weeds and hornwort in several Northland lakes.

Sampling for algae during these surveys detected the nuisance species lake snow (*Lindavia intermedia*) in several South Island lakes. It is likely an introduced species, and is mostly an issue in Lake Wakatipu (where it forms matted slicks) and Lake Wanaka (where it has blocked drinking water intakes). Lake Coleridge and Lake Hāwea have also been affected.

As with port work, surveillance of New Zealand's freshwaters helps local authorities put together preventative plans to contain any potential spread and, in some cases, remove the threat of major invasive pests.

MARINE ENVIRONMENT

Understanding, managing and maximising the benefits of our marine estate

- ▶ Improving our understanding of New Zealand's marine environment to inform decisions about its management
- ▶ Maximising sustainable use of New Zealand's marine resources for economic benefit
- ▶ Developing new finfish aquaculture species to grow the industry in New Zealand.

NIWA is New Zealand's largest marine science organisation. NIWA's coasts and ocean team undertake research and consultancy services that support sound management of New Zealand's complex and dynamic marine environments – for the benefit of all.

NIWA's goal is to enhance economic and social benefits from marine resources, while maintaining the biodiversity and integrity of our coastal and marine ecosystems. To achieve this, research focuses on discovering how our marine environments work, including their biological and physical composition and the interacting geological, evolutionary, ecological and human processes that shape them.

NIWA develops approaches to the management of oceanic and coastal habitats that consider whole ecosystems, ensuring vulnerable components can be protected and economic and social benefits are realised. Work is undertaken to assess the risks to marine ecosystems and commercial activity from human activities, pests and diseases, and develop mitigation strategies where necessary.

Tangaroa in Wellington Harbour.
Dave Allen



NIWA's marine science includes:

- ▶ Assessing the geological and biological resources of the seafloor
- ▶ Understanding ocean currents and productivity
- ▶ Determining the effects of stressors on marine ecosystem resilience and recovery, taking an ecosystem-based approach
- ▶ Identifying threats from introduced seaweeds and animals, and developing tools to mitigate their impact
- ▶ Assessing fish stocks and developing ecosystem-based approaches to fisheries management
- ▶ Determining the impacts of fisheries and aquaculture on marine ecosystems
- ▶ Developing techniques for the aquaculture of established and new finfish and shellfish species.

Key assets

- ▶ A world-class fleet of ocean-going and inshore research vessels, including RV *Tangaroa*, ice-strengthened and equipped with a DP2 dynamic positioning system, which serves as the ideal platform for a wide range of marine research and commercial activities
- ▶ A range of state-of-the-art vessel-mounted sampling and imaging equipment, including swath-mapping echosounders, a sub-bottom profiler, and multichannel, very high-frequency seismic reflection equipment
- ▶ A full range of seafloor and water column sampling and monitoring equipment
- ▶ Remotely operated submarine vehicles fitted with sampling and high-definition photographic equipment

- ▶ A High-Performance Computing Facility, or 'supercomputer', which runs sophisticated environmental forecasting models using data from a wide range of sources
- ▶ The Northland Marine Research Centre at Bream Bay near Whangarei, where leading research into the breeding and management of farm-based finfish and shellfish aims to support industry targets for growth and environmental performance.

Resources

- ▶ Approximately 255 staff working nationwide and collaboratively with other providers and a wide range of marine stakeholders.

Investment

- ▶ Approximately \$55 million annually for research and applied-science services
- ▶ An additional \$120 million over the next five years to advance marine research.



HIGHLIGHTS
MARINE ENVIRONMENT

Ikaterere and Rukuwai mapping the Marlborough Sounds seafloor and the habitat in unprecedented detail.

Hamish McCormick

Revealing the seabed in the Sounds

NIWA has been mapping the undersea landscapes and habitants of Queen Charlotte Sound/Tōtaranui and the Tory Channel/Kura te Au in a nationally significant project for Land Information New Zealand (LINZ) and the Marlborough District Council (MDC).

The project is a comprehensive seabed survey which will be used by LINZ to update its nautical charts, helping

support the needs of the shipping and cruise industry as the number and size of vessels visiting the region is increasing.

The detailed appraisal of the 43,000 hectares of coastal marine area will help MDC, industry and the community better understand, sustainably manage and protect resources and important coastal marine ecosystems. NIWA, together with Discovery Marine

Limited, used multibeam echosounder technology from two of NIWA's coastal research vessels, *Ikaterere* and *Rukuwai*, to map the shape and depth of the seafloor and define the habitat in great detail.

NIWA has been heavily involved in the mapping of more than 1,500,000km² of New Zealand's seafloor using multibeam echosounder equipment. The multibeam data is also used to assess the type of substrate or sediments (for example, hard gravel or soft mud) and what else is on and above the seafloor, such as cables, kelp beds and biological aggregations (schooling fish), and geological fault lines. The team also collected bottom photographs and sediment samples to inform and illustrate the multibeam data.

Throughout the survey there were 229 sightings of marine mammals and 923 images – mainly of bottlenose dolphins, dusky dolphins, common dolphins, Hector's dolphins and New Zealand fur seals.

Exploring the Kermadecs

In October-November, NIWA led a *Tangaroa* exploratory research voyage to survey the biodiversity of the Kermadec Islands and offshore waters of the Kermadec Ridge.

The voyage was made possible under the Ministry of Business, Innovation & Employment's funding for *Tangaroa*, and seven agencies collaborated in the multidisciplinary research survey.

Three key objectives centred on coastal biodiversity using specialist divers, marine mammal observations and biopsy sampling of humpback whales, and deepsea sampling in offshore waters.

It was the first time small boat and deepsea sampling had been combined on a *Tangaroa* voyage, which broadened the scope of the voyage and enabled a large amount of research to be carried out in the area for the first time.

The broad range of sampling included surface plankton, line fishing, vertical distribution of plankton, midwater and bottom trawls, deep-towed camera, epibenthic sled, beam trawl, fish trapping, and CTD operations.

The survey took place along transects off Raoul Island, Macaulay Island, L'Esperance Rock, and the Star of Bengal Bank. It covered areas never sampled before, and will considerably

improve knowledge of biodiversity around the islands down to more than 3000m.

Samples collected included more than 230 fish and 250 invertebrate taxa. Many were new records for the Exclusive Economic Zone, including a number of new species. The survey developed strong collaboration between the teams onboard, which will further increase as the data sets and samples are processed and analysed by the various agencies.

Tangaroa also transported a rare Hawksbill sea turtle that had been nursed back to health by Kelly Tarlton's Sea Life Aquarium. The turtle's successful release at Raoul Island marked the first NIWA live streaming event on Facebook.



Humpback whales, Kermadecs.

Hamish McCormick

Alternative water supply for Wellington

NIWA expertise has been used to help Wellington Water Ltd and Greater Wellington Regional Council find an alternative drinking water supply under Wellington Harbour that could be used in the event of a large earthquake or other emergency.

A barge and drilling rig were deployed off the Te Motu Kairangi/Miramar Peninsula in June to drill into the Waiwhetū Aquifer.

NIWA mapped the upper part of the Waiwhetū Aquifer from where it intersects the borehole off Matiu/Somes Island across the harbour to the peninsula. Gravels, which contain the fresh water, were identified 20–30m below the seafloor buried under a layer of marine mud. Scientists used shallow geophysical techniques involving sound sources and hydrophones, towed behind survey vessels, to track the aquifer in the subsurface.

These techniques enabled NIWA to pinpoint optimal locations for the drilling rig as well as areas to avoid, such as greywacke basement rocks and seafloor depressions.

The drilling team has successfully located fresh water and is now in the process of testing its salinity and flow rates from the aquifer before being able to confirm its suitability as a backup supply for the city. NIWA also provided technical expertise in the testing and monitoring stage to assist in determining if the aquifer is suitable as a drinking water source.

In addition, analysis of core samples from the seabed will provide a wealth of new information about the geological history of Wellington Harbour over the past 70,000 years.



A barge pulls a freshwater drilling rig into position off the Miramar Peninsula.

Wellington Water Ltd



High-tech on the high seas

NIWA's flagship research vessel *Tangaroa* is used extensively to implement New Zealand's research requirements, but every year a variety of requests are received for *Tangaroa* to work throughout New Zealand's Exclusive Economic Zone, the Indian and Pacific Oceans.

While any organisation can seek to 'hire' *Tangaroa*, when not used by NIWA it is mostly chartered by research partners, national and international science organisations, other Crown Research Institutes and government departments.

Over the past year, the Australian Bureau of Meteorology (BOM), the Ministry for Primary Industries, the University of Auckland, Te Papa, the University of Malta and GNS Science among others used *Tangaroa* as their marine research platform.

The Maltese worked with NIWA researchers to investigate offshore groundwater systems – bodies of freshwater occurring in sediments on the ocean floor. GNS Science led a multi-institutional voyage to an area

off the New Zealand coast where the Pacific and Australian plates collide.

Tangaroa was also chartered by Australia's BOM to service two tsunami buoys off the coast of Fiordland – replacing two surface buoys and their bottom pressure sensors.

Tangaroa's crew have extensive maritime experience, but what sets them apart is the care and attention they take of the vessel and those who sail on it, and their enthusiasm and experience in designing, deploying and servicing research equipment.

When an organisation hires *Tangaroa*, they get more than a floating platform. They benefit from NIWA's can-do attitude, combined with rigorous and award-winning attention to health, safety and environmental procedures, technological excellence and decades of on-board expertise in fitting, rigging and deployment.

Tangaroa leaving Wellington Harbour.

Dave Allen

Premium consumer demand for farmed kingfish

A partnership between NIWA and Leigh Fisheries for the supply of farm-raised yellowtail kingfish from NIWA's Northland Marine Research Centre (NMRC) to high-end restaurants has revealed strong demand for the product from chefs and customers.

Such positive market feedback follows confirmation last year that the science behind the successful breeding and production of kingfish, perfected at NMRC, can comfortably meet the demands of continuous commercial supply. NMRC researchers have also confirmed that kingfish perform very well in a range of 'on-growing environments' – such as sea cages, which are anticipated to form part of the commercial production mix.

As a result, NIWA made strong progress during the year towards securing a long-term commercial partner for the supply and sale of kingfish.



Meanwhile work continues on establishing the processes and testing the on-growing environment performance of hāpuku, another farmed finfish species with outstanding premium market potential.

Kingfish being prepared by chef Ben Barton at Scarecrow, Auckland.

Petra Pearce

Antarctic toothfish spawning area found

The first winter fisheries survey in the Ross Sea last year resulted in an exciting discovery for NIWA scientists.

Aboard the commercial fishing vessel *Janas*, scientists from NIWA and the Italian Institute of Marine Science used plankton nets to collect eggs of Antarctic toothfish – the first time in the world that had been done.

Those eggs unfortunately died, but a back-up plan which involved artificially fertilising eggs from fish caught by the *Janas* team was enacted.

The team also caught fertilised eggs and adults in spawning condition, providing a known start time to observe developmental rate.

The discovery of developing toothfish embryos documented the timing of spawning, confirmed areas where spawning was suspected to occur, and provided new information about the depth at which the drifting eggs reside in the water column.

The research was part of a collaborative survey to study the reproduction of the Antarctic toothfish, their distribution and their role in the Ross Sea ecosystem. It was funded by the Ministry for Primary Industries, the Commission for the Conservation of Antarctic Marine Living Resources and Talley's Ltd.

It is expected the new information can be integrated with models of ocean currents to predict where the eggs

and larvae will be transported as they develop and grow to become part of the juvenile population.

Antarctic toothfish spawn under sea ice that extends more than 1000km from the continent during winter, protecting them for most of the year from Weddell seals and killer whales.

The winter voyage also collected oceanographic information and plankton, released toothfish with satellite tags attached, recorded sightings of whales and dolphins, and showed that these challenging types of voyages at this time of year are possible.



Toothfish eggs.
Darren Stevens



Looking after the Kaikōura lobsters

In the aftermath of November's magnitude 7.8 Kaikōura earthquake, urgent work was needed to determine the impact on the rock lobster fishery – one of the region's most valuable fisheries.

A temporary emergency closure of the fishery was put in place a week after the earthquake by the Ministry for Primary Industries (MPI), further disrupting livelihoods and potentially putting a thriving industry at risk.

Significant uplift of the seabed had occurred along about 100km of the coast, and determining the effect on the lobsters required specialist knowledge and skills.

In a joint approach, the Rock Lobster Industry Council, MPI, NIWA and local fishermen cooperated in the field to carry out a stock assessment that would quickly be able to come up with some answers. This required a measured, but rapid, response, and NIWA researchers were quickly on the scene taking part in a catch sampling programme by measuring and tagging lobsters.

The researchers also took blood samples from the lobsters to test blood protein levels – known as blood refractive index sampling. This testing method indicates how well the lobsters have been feeding, and their likely nutritional status and condition.

After 10 days' work, the researchers determined there had been no significant change to the fishery, and it reopened the week before Christmas.

NIWA is continuing to work with MPI to monitor the status of both the rock lobster and paua fisheries in the Kaikōura region.

Marine ecology researcher Mark Fenwick on the Kaikōura coast after November's earthquake.

Ken McLeod



Scampi in the spotlight

Last year, NIWA researchers on Kaharoa carried out a stock assessment survey of scampi on the Chatham Rise.

Scampi are small lobsters, highly valued in culinary circles for their taste, which live in many parts in New Zealand's Exclusive Economic Zone, including the sub-Antarctic Islands.

New Zealand's annual scampi catch is relatively small, but it is important that the stock is well-managed. NIWA's annual scampi surveys contribute to an 'index of abundance' – how many scampi there are and how the population changes over time.

NIWA has been surveying scampi in New Zealand waters since the late 1990s. It is a challenging task because

these lobsters spend much of their time in burrows – coming out more during the day to feed on worms and fish.

For this reason, NIWA's scampi surveys mostly involve still cameras with laser sensors. The cameras hang from a trawl wire about four metres above the seabed, and the resulting images reveal the number of burrows – although specialised expertise is needed to identify burrows – and the size of the scampi.

These photographic surveys are supplemented by a small number of trawl surveys, from which the sample catch is counted and measured.

Scampi on the seafloor.

NIWA

Scallops scarce

Collaborative surveys undertaken by NIWA, the Ministry for Primary Industries (MPI) and the fishing industry resulted in the closure of scallop beds at the top of the South Island last year due to sustainability concerns. Stocks are currently low, but NIWA's expertise is helping give the bivalve a fighting chance at recovery.

Last year, NIWA undertook surveys for the fishing industry in Northland's Bream and Rangaunu Bays, and for MPI in the Marlborough Sounds and Tasman and Golden Bays to ascertain scallop populations.

Scallops exhibit cryptic behaviour, burying themselves in a fine layer of sand to hide from predators.

For this reason, dredge surveys are the most efficient way to estimate scallop abundance, distribution, and size composition.

NIWA surveys show evidence of recovery in Northland (particularly Bream Bay) and that the decline observed in Marlborough Sounds since 2009 has discontinued. Although there are only a limited number of beds with high densities of large (harvestable-size)



scallops left in Marlborough, there is evidence of an increase in numbers of juvenile scallops, which, if they survive, will increase the numbers of harvestable-sized scallops.

Results from Tasman and Golden Bays were not as promising. This follows major stock declines in the 2000s – likely the result of anthropogenic and environmental effects, including fishing and habitat change.

Scallop stock assessment is important in helping manage the sustainability of fisheries for what is, at times, a susceptible species, and these results put MPI in a good position to make informed management decisions.

Scallop survey in the Marlborough Sounds.
James Williams

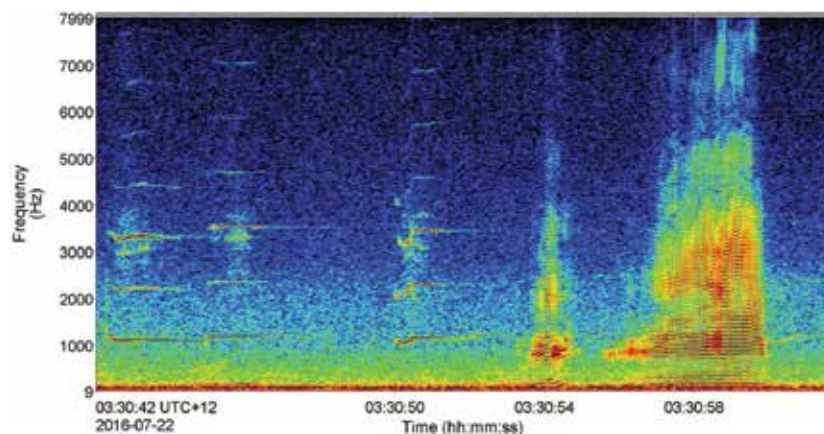
Listening for whales and dolphins

The sounds of whales and dolphins rarely seen in New Zealand waters have been recorded by NIWA scientists in a pioneering underwater sound project led by marine ecologist Dr Kim Goetz.

Seven acoustic moorings deployed in Cook Strait were retrieved in December, and preliminary results revealed the sounds of common whale species, as well as Antarctic blue whales, Antarctic minke whales and what are likely to be the first recordings of Gray's and strap-toothed beaked whales in New Zealand waters.

More than half the world's whale and dolphin species are found in New Zealand waters, and the research is an attempt to find out more about their presence, distribution, and migration paths.

It seems that Cook Strait may be segregating different whale populations – with Antarctic blues primarily heard on the east side and pygmy blues primarily on the west.



Dr Goetz, whose work was supported by OMV Group, Chevron and the Marlborough District Council, was also interested in finding out what anthropogenic sounds, like vessel noise, could be in heard in the waters of Cook Strait.

The moorings also recorded November's magnitude 7.8 earthquake centred off Kaikōura, although the noise was so loud, it was outside the sensitivity

range of the instruments. The acoustic moorings have been redeployed for a second six months, and extra staff have been employed to help process the massive amount of data produced.

A spectrogram showing the call of the humpback whale.
NIWA



Bonamia biosecurity

The discovery of the lethal parasite *Bonamia ostreae* at two Stewart Island oyster farms in late May saw NIWA lending crucial expertise in a crisis situation.

Bonamia ostreae was first discovered in New Zealand in 2015 in the Marlborough Sounds, but this was the first time it had been found in another area of the country. It is difficult to contain and eradicate and has greatly reduced oyster stocks in the Northern Hemisphere.

NIWA fisheries scientist Keith Michael fronted several public meetings to explain the risk posed by the parasite, and worked closely with the Ministry for Primary Industries (MPI) to inform the biosecurity response and carry out surveillance programmes to monitor any further spread.

The main concern was the possibility of the parasite reaching the nationally important wild oyster population in Foveaux Strait. NIWA's expertise in dealing with the related parasite

Bonamia exitiosa, which has caused substantial mortality in the Foveaux Strait oyster population, was invaluable.

The two *Bonamia* species are similar in size and structure. The most reliable way of telling them apart is to use molecular methods targeting species-specific DNA. NIWA biotechnologists have designed a new method for detecting *Bonamia* in oysters from raw extracts, which is cost-effective and can screen large numbers of samples quickly. NIWA is also making use of advances in molecular technology to develop a better understanding of shellfish diseases.

NIWA will continue to assist MPI, continuing surveys to monitor the presence of *B. ostreae*, and to determine the success of the MPI response in Big Glory Bay.

Oyster fishing vessel in Foveaux Strait.

Tony Smith

Remote deepsea discovery

Never-before explored parts of the deepsea around the Cook Islands and Tokelau Islands were revealed to the world earlier this year through collaboration between NIWA and the US National Oceanographic and Atmospheric Administration (NOAA).

NIWA scientists onshore, working with their US counterparts on NOAA's research vessel *Okeanos Explorer*, surveyed seamounts and ridges of the Tokelau Islands and Cook Islands via a remote operated vehicle (ROV). The vessel was exploring US territories in the central and southwest Pacific Ocean and transiting through the Tokelau and Cook Island regions. After consulting with Tokelau and Cook Islands contacts, NIWA successfully applied for multibeam survey work and ROV dives to improve knowledge of the deep seafloor and biodiversity in the region.

The vessel operation differs from that of most vessels, with only a few scientists onboard, and much of the science planning and dive observations done by telepresence with real-time video feeds from the ROV, and live interaction from science teams around the world.

This included deepsea experts across several NIWA campuses, who



advised on the survey track, species identifications, and sample collection. The Cook Islands dive featured impressive footage of deepsea fauna, including 'forests' of bamboo corals up to three metres high with associated invertebrates – crabs, sea stars, sea lilies, barnacles and rare sponges that were significant for NIWA scientists studying the taxonomy and distribution of such species.

NIWA and NOAA communication teams also collaborated, with a live interaction between the onboard expedition

coordinator and science leader and New Zealand media, hosted at NIWA in Wellington. This generated substantial online, broadcast and print coverage, as well strong engagement on NIWA's social media channels.

Scientists Dr Malcom Clark and Di Tracey go deepsea exploring via a video link to the Okeanos Explorer operating near the Cook Islands.

Hamish McCormick

OUR PEOPLE



Our people deliver world-class science and answer some of the most important scientific questions facing New Zealand and the planet. We operate with agility to deliver relevant, customer-focused science of the highest quality, and develop national and international collaborations which place NIWA at the forefront of scientific advancements.

Recruiting and retaining NIWA's talent

Over the course of the year, 39 new permanent positions were approved. Most of these were science positions to meet the increased demand for answers in our key science areas. Our total staff stood at 672 at 30 June, compared with the total of 634 at the same time last year.

NIWA continues to use best practice recruitment processes, and our managers receive detailed training in recruitment. This year we also offered a shortened recruitment workshop for selection panel members or managers who needed refresher training. All new staff receive a comprehensive induction, which covers both generic and job-specific information, and the quality and relevance of the inductions are evaluated via a post-entry interview.

Some of NIWA's Christchurch freshwater team (from left): Doug Booker, James Griffiths, Mandy Home, Phil Jellyman, Murray Hicks, Amy Whitehead, MS Srinivasan.



At the 2017 Wellington Gold Awards NIWA received an Immigration Gold, in association with Immigration New Zealand, citation for outstanding global skills recruitment and retention. Each year NIWA completes a gender analysis of workforce demographics and human resource processes. The results for the 2016/17 year indicated that NIWA's selection, promotion, remuneration and recognition processes are fair and non-discriminatory. One of the key observations was an increase in the percentage of women joining NIWA. Over the course of the year, 51% of new science staff were women.

NIWA's staff retention rate continues to remain high – over 93% – and annual workforce planning strategies operate to ensure that NIWA is well resourced to meet the needs of our current customers, while also able to respond with agility to market changes.

Leadership and culture

The theme of the annual NIWA Leaders' Forum this year was 'Being more effective – having more impact'. NIWA staff with leadership responsibilities came together at the Forum to review the year, discuss operational strategy, network with fellow leaders and external stakeholders and focus on how we can maximise the impact of our science through innovation, technology and outstanding communication.

NIWA is an equal opportunities employer, and all NIWA policies and practices are based on the principles of fairness, equity and non-discrimination. We value diversity and inclusion, and we proactively engage with employees and their representatives about improvements in workplace programmes and practices.

NIWA is committed to an inclusive work culture, where diversity is valued. Our flexible working practices help staff accommodate both work and non-work commitments, and 14% of our staff work part time.

NIWA recognises its responsibility to be a good employer under Section 118 of the Crown Entities Act 2004, and we operate human resource policies which are consistent with the fair and proper treatment of employees in all aspects of their employment.

Continuing our focus on staff development

We continue to actively plan for and resource staff development through the Performance and Development Review process, including Individual Development Plans, and the annual Workforce Planning process. Our identified Future Leaders are a focus for accelerated development. We provide a suite of in-house leadership and management development programmes, including Crucial Conversations, Recruitment & Selection, Developing Others, Challenge of Change – Resilience, and Project Management workshops, plus a range of other regional training courses.



We are active in ensuring staff have access to a range of technical training opportunities, and we make a significant investment in national and international conference participation and other professional development opportunities for staff. We update succession plans for all levels of the organisation annually, and during the year we spent \$518,000 on training and development-related activities. Our staff are also encouraged to consider their broader personal development, with the provision of three personal development leave days per year for most staff.

Workplace diversity and inclusion continued to be a focus, with the development of a new unconscious bias resource for staff and the pilot of an Inclusiveness in Action workshop which will be rolled out for all staff in the coming year.

Rewarding the contribution of our people

NIWA's core strength is its people, and we have a remuneration framework which includes regular market benchmarking to ensure that staff are appropriately rewarded.

During October 2016, we initiated a comprehensive market relativity review for science positions, and that resulted in over 180 science staff receiving significant remuneration increases, bringing NIWA's medians in line with the general market. The combined investment of these market relativity increases for science and the standard salary reviews was close to \$1 million for the year, demonstrating our ongoing commitment to retaining NIWA's exceptional talent.

This year we were pleased to confirm the promotion of 14 science staff as a consequence of our level review process. This is a rigorous, peer-reviewed process in which staff are required to demonstrate a significant increase in their science skills, knowledge and contribution to NIWA science.

NIWA has continued to refine the new Individual Employment Agreement (IEA) for non-union members. The new IEA continues to be well received and recognised as a flexible and contemporary employment agreement which reflects changing requirements.

The significant talent and dedication of NIWA staff was displayed at the fifth annual NIWA Excellence Awards ceremony.

Our remuneration framework includes regular benchmarking to ensure staff are appropriately rewarded.



The Awards ceremony celebrated the achievements of 20 individual winners and runners up. In 2017 we introduced a Team Excellence Award to recognise excellence in teamwork and collaboration, customer focus and project delivery in either science or support areas.

NIWA is renowned for excellent photography – in part a reflection of the extraordinary environments in which we often operate, but also in recognition of the importance of imagery in communicating our science to our customers and stakeholders and engaging the wider public with science and our work. Each year we hold regional photography competitions which feed into a national competition with five award categories.

Engaging with the next generation of science staff

NIWA is committed to actively engaging with the next generation of science staff and promoting science career opportunities.

NIWA has naming right sponsorship of six main city Science & Technology Fairs, and provides specific targeted awards for eight additional regional Science & Technology Fairs. The outcome is significantly enhanced engagement with science, and NIWA in particular, of students and their parents, teachers and the general public by enhanced media outreach, particularly via social media.

As Principal Science Partner of the Sir Peter Blake Trust, NIWA works with the Trust to deliver high-quality leadership programmes and adventures to engage and educate young New Zealanders in science, together developing the next generation of leaders who can help enable the sustainable management and development of New Zealand's natural resources. This expansion of our already strong relationship with the Trust also aims to increase awareness and appreciation of science in all New Zealanders by sharing inspiring and engaging content.

39 new permanent positions to help meet the increased demand for our science.

Some of NIWA's Hamilton freshwater team (from left): Andrew Swales, Fleur Matheson, Neale Hudson, Cindy Baker, Mary de Winton, Rupert Craggs, Brian Smith.

Chairman Sir Christopher Mace delivers the opening address of the 2016 NIWA Leaders' Forum.

Dave Allen



We continue our support of the very successful Blake Ambassador programme which provides opportunities for up to six young New Zealanders to work on projects in Antarctica, the Southern Ocean and New Zealand to advance understanding and address some of the big environmental questions and challenges facing society.

NIWA works with the other Crown Research Institutes, through Science New Zealand, in the annual Sir Paul Callaghan Eureka Awards, which aim to identify and foster young leaders of our community and provide them with the opportunity to present their ideas on how science and technology can benefit New Zealand. In addition, NIWA sponsors a Gold Scholarship through the Eureka Awards which is awarded to the student who presents the most innovative and creative science, technology and/or engineering solution which addresses issues at the core of the *Sustainable Seas* National Science Challenge.

We continue to actively support the Auckland STEM Alliance steering group. The Auckland STEM Alliance aims to encourage young people into science careers and facilitate collaboration between the education sector and STEM businesses to assist this. The STEM Alliance works with COMET Auckland to oversee 'SouthSci', the South Auckland pilot of the Participatory Science Platform aimed at involving South Auckland students, their families and communities in science activities.

NIWA also continues to provide significant support for tertiary students, supervising close to 100 Masters and PhD students around the country in 2016/17.



*The NIWA Fielddays team.
Stuart Mackay*

Members of the NIWA Vessels team collecting the ACC Workplace Safety Award at the Wellington Gold Awards.

Brady Dyer



Our Joint Graduate Schools are an important collaborative channel for encouraging and enabling young people in their science careers, as are our Centres of Research Excellence, and we continue to offer summer internships, PhD scholarships and postdoctoral fellowships.

Health and safety

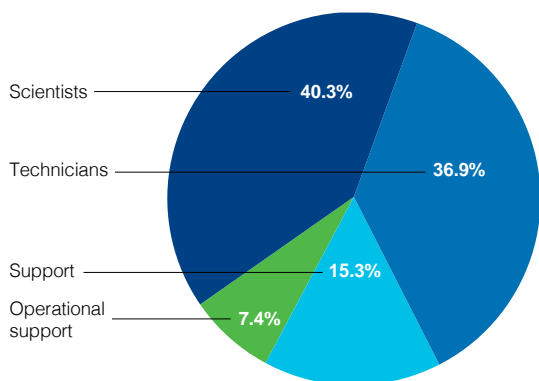
NIWA has successfully incorporated the Health and Safety at Work Act 2015 requirements into organisational policies and procedures. Our existing focus on managing six critical risk areas across our science operations allowed a smooth progression into the new regulatory environment. NIWA's ongoing emphasis on health and safety excellence was externally recognised with NIWA Vessels being announced as the winner of the ACC Workplace Safety Award at the prestigious Wellington Gold Awards. NIWA Science was also awarded tertiary level accreditation in the new ACC Safety Audit Standards.

During the year, a review of our NIWAsafe strategy was completed to assess its success and identify opportunities to enhance future effectiveness. It was pleasing to note that safety performance over the past five years indicates significant gains in our safety management capability, a slow but steady downward trend in work injury claims, and a consistent increase in near miss reporting. The review identified some minor changes that will further improve our health and safety practices, and these will be implemented in the coming year.

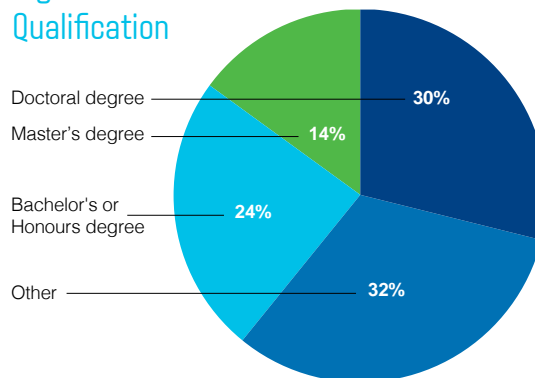
NIWA BY THE NUMBERS

All figures are for NIWA Group as at June 30 2017

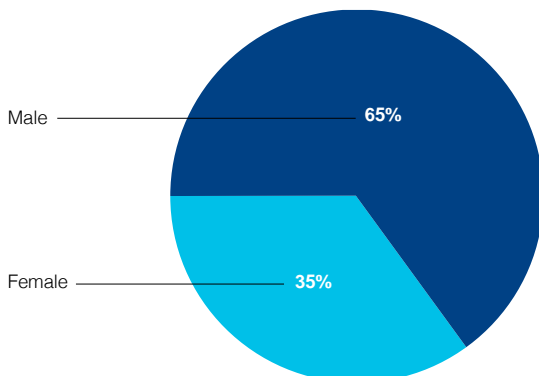
Roles



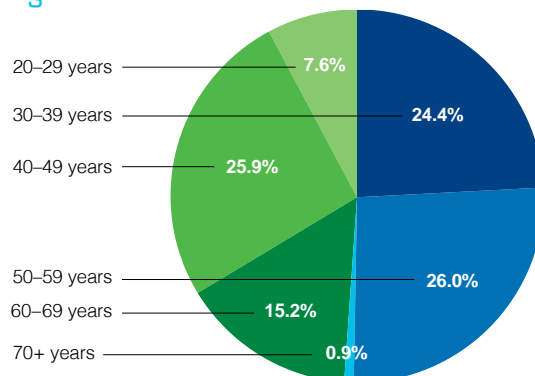
Highest Qualification



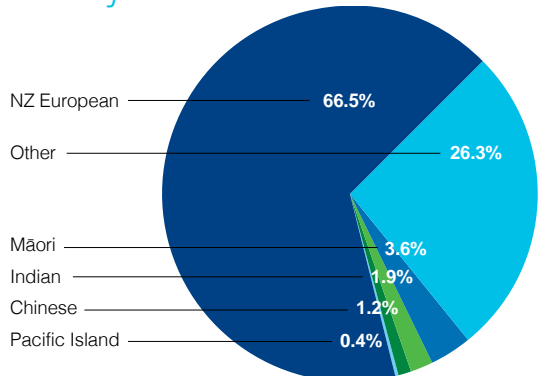
Gender



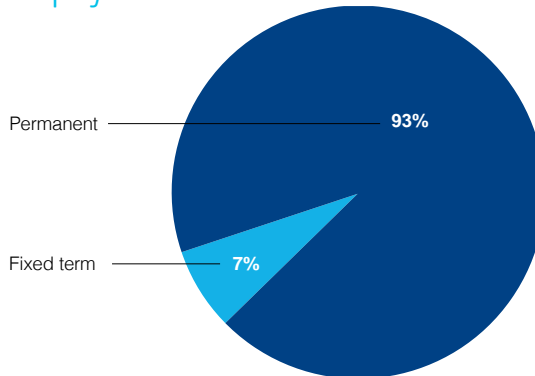
Age



Ethnicity



Employment Status



Headcount

672

Recruitment

39 approved new permanent positions

32 approved replacement positions

26 approved fixed term positions

Staff turnover

NIWA Group – 5.97%

Personal development leave

(NIWA Science)

3 days of Personal Development Leave is provided annually for staff, except those on management employment agreements

PSA membership

341

Disabilities

1% of staff have a form of disability

Remuneration reviews

(in addition to standard annual review)

Extraordinary market relativity increases (T1 and S1-3)	187
Operations relativity review	28
Support relativity reviews	37
Level promotions	14
Salary appeals	19
Performance rating appeals	3
Total	288



*Tony Bromley and Zoë Buxton
conduct measurements of
weather conditions and how they
affect power lines.*

Dave Allen

COMMUNICATING OUR SCIENCE

NIWA's science is fundamental to decisions on how New Zealand's natural resources are managed, but our scientists also contribute substantially to the advancement of national and international understanding.

The successful communication of our science facilitates its transfer and uptake, reinforces NIWA's position as the authority, and demonstrates the impartiality and value of our research.

We devote substantial resources to communicating our science, continually making use of new communication channels and new technologies to make our stories even more compelling, and upskill our scientists so their research is transferred and used by our customers. Every story has a unique communication strategy designed to ensure the science is used and the audience is maximised.

Our science communication encompasses everything from a vital phone call from one of our weather team to firefighters battling a blaze, to articles in specialist publications for niche groups such as kiwifruit growers or lifestyle block owners.

In between are conference speeches, media releases, radio and television interviews, live website chats, presentations to Members of Parliament, school visits, client reports, journal papers, imaginative visual displays at large events such as Fieldays, book launches, tours, reports, advice for officials, events, media briefings and social media postings in an ever-changing communication landscape.

We are the principal science partner of the Sir Peter Blake Trust, the lead sponsor of six regional science and technology fairs for school students and secondary sponsors of a further eight, and award sponsors of the Sir Paul Callaghan Eureka Awards. These high profile initiatives all successfully promote the value of science to a wide audience.

This year Lauder also hosted the Antarctica New Zealand Winter School for media, an opportunity for journalists to spend extended time with scientists to increase their understanding.

NIWA's photography and videography team has expanded as demand for our iconic images and video has increased. Video is now included in some client reports – for example, it particularly enhanced communication of climate change scenarios for the Wellington region. Our Auckland-based weather forecasting team has led the way in communicating via a number of innovative methods. They use GIFs, animated graphics and high resolution maps in their presentations, filmed in our Auckland studio, and they reach their audience through a multitude of mainstream and social media channels.

1333

Total science outputs

345

Commissioned client reports

115

Other reports

497

Presentations

350

Published/submitted articles and books or book chapters



*Koha, a rare Hawksbill turtle, was farewelled from Auckland before being transported aboard Tangaroa for release in the Kermadecs. The farewell was screened live by Television New Zealand.
Hamish McCormick*



This strategy was most successful in the past year for communicating information about extreme weather events. Remember the Tasman Tempest? That was our description and it resonated with media and the public, making us the leading forecasters for that event.

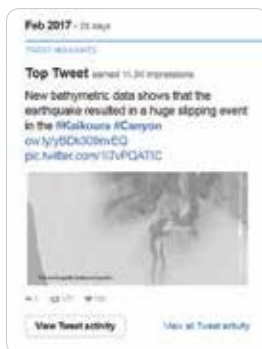
We also brought the world of undersea exploration to NIWA's Wellington site, collaborating with the US research vessel *Okeanos Explorer* exploring parts of the deep sea around the Cook Islands for the first time – in a live video interaction between the scientists on the vessel and NIWA experts in Wellington site, with the media in Wellington engaging directly with both in real time.

Our social media following is climbing steadily and is closely integrated with our mainstream media outputs which continue to attract high engagement.

Our first Facebook live screening was undoubtedly a world-first for location, as scientists relocated a rare Hawksbill turtle to the Kermadecs.

The most notable and important science communication for NIWA in the past year was our response to the Kaikōura earthquake in November. We were closely involved in the emergency response and the work of our marine geologists since then continues to attract widespread media attention.

During the year NIWA featured in the media more than 4,300 times, attracting a total audience of just over 80 million – 10 million up on the previous year. Our Facebook, Twitter, Google+, LinkedIn and Instagram channels reached and engaged with 6,670,000 people.



Media

- Total audience: 80,049,786
- Media releases: 122
- Total equivalent advertising space rate: \$12,250,000
- Number of items in mainstream media: 4347

OUR VALUES

Safety

Working safely is paramount at all times.

- ▶ Zero harm is our safety target for our people and those working with us
- ▶ We take personal responsibility for the safety of ourselves and others
- ▶ We are always safety conscious, thinking “What am I about to do? What could go wrong? How can I do it safely?”
- ▶ We maintain high standards of safety in all working environments
- ▶ We report all hazards, incidents and near misses, acting on and learning from them
- ▶ We continually improve our safety systems and processes.

Excellence

We strive for excellence in everything we do.

- ▶ We apply the highest standards of rigour to our work
- ▶ We are creative and innovative in our thinking and apply leading-edge practice
- ▶ We are highly professional in the way we operate
- ▶ We are proud of our reputation for high-quality science
- ▶ We are efficient, effective and resourceful, seeking to eliminate waste and maximise opportunities.

Customer focus

We provide our customers with an outstanding service and experience.

- ▶ We recognise that NIWA wouldn't exist without its customers
- ▶ We all work together to ensure a positive customer experience
- ▶ We value and respect our customers, and act to ensure excellent and enduring relationships with them
- ▶ We communicate with our customers openly and proactively
- ▶ We deliver on our commitments to customers – in full, on time and within specifications
- ▶ We seek customer feedback to help us improve.

*Dr Murray Hicks uses a Real-Time-Kinematic GPS for rapid, precise surveying of river channel topography, Waimakariri River.
Dave Allen*

NIWA's core values are part of our ongoing efforts to maintain a positive and strong culture, and be clear about what we need to promote, and stand for, in order to continue to be a successful organisation.

Agility

We are agile, resourceful and responsive to opportunities and challenges.

- ▶ We actively create, identify and develop new opportunities
- ▶ We react quickly and flexibly to changing priorities
- ▶ We are positive, solution-focused and future-oriented in our outlook
- ▶ We recognise change as continuous, and treat it as an opportunity
- ▶ We are committed to continuous learning and improvement.

People and teamwork

We are 'OneNIWA' and work collaboratively for the greater benefit of NIWA and our customers.

- ▶ We help and support our colleagues, treating each other with courtesy and respect
- ▶ We value diversity and respect other cultures
- ▶ We value the opinions, knowledge and contributions of others, and celebrate success
- ▶ We willingly share our expertise
- ▶ We all take responsibility for getting things done
- ▶ We listen openly and communicate honestly and constructively
- ▶ NIWA's interests and reputation take precedence over advancing our own individual interests and reputation.

Integrity

We are honest, trustworthy and reliable in our work and our relationships with others.

- ▶ We uphold the highest ethical standards
- ▶ We deliver
- ▶ We take ownership and are accountable for our actions
- ▶ We provide accurate, evidence-based information and advice
- ▶ We maintain objectivity at all times, avoiding advocacy and bias
- ▶ We are viewed as trusted professionals in our areas of expertise
- ▶ We avoid or declare all conflicts of interest.

NIWA is committed to contributing positively to the social, economic and environmental wellbeing of New Zealand, as outlined in our Organisational Responsibility Charter below.

Social

NIWA is committed to work practices, operations and science outcomes that support our staff and the wider community.

We are committed to:

- ▶ Ensuring that people are safe in our workplaces and subject to zero harm
- ▶ Engaging positively with the communities in which we operate and live
- ▶ Respecting cultural values and diversity in New Zealand and in the countries where we work
- ▶ Fostering positive interactions with, and outcomes for, Māori.

Economic

NIWA is committed to operating with fiscal discipline to ensure that we retain our long-term viability and meet our core purpose science responsibilities to generate sustainable economic benefit to New Zealand.

We are committed to:

- ▶ Fair trading and observing high standards of behaviour, integrity and ethics
- ▶ Maintaining positive relationships with our customers, partners and collaborators
- ▶ Taking a broad approach to decision making and business development with the aim of benefiting all of New Zealand.

Environmental

NIWA is committed to operating in an environmentally responsible way when carrying out our activities, and ensuring that we meet our core purpose science responsibilities to contribute to better environmental outcomes for New Zealand.

We are committed to:

- ▶ Minimising the environmental effects of performing our business
- ▶ Integrating environmental perspectives into our wider business planning
- ▶ Complying with all regulatory requirements, standards and best practice guidelines.



Satellite image
of New Zealand.
NASA/JSC

Operating to our Charter Principles

We must ensure that the commitments we give are owned by all our people and demonstrated by their actions.

Social

We will support the Organisational Responsibility Charter by:

- ▶ Being a good employer, particularly in relation to:
 - ▶ providing equitable access to employment opportunities,
 - ▶ leadership, accountability and culture,
 - ▶ recruitment, selection and induction,
 - ▶ employee development, promotion and exit,
 - ▶ flexibility and work design,
 - ▶ remuneration, recognition and conditions,
 - ▶ harassment and bullying prevention.
- ▶ Treating our employees and all others with whom we interact with dignity and respect, including fostering long-term relationships built on trust and mutual benefits
- ▶ Ensuring staff have opportunities to participate in work-place improvement programmes
- ▶ Making available best practice systems and training to achieve a fit and healthy workforce
- ▶ Empowering our employees to identify and resolve safety concerns so that potential hazards are eliminated and safe processes and work methods are under continual improvement
- ▶ Maintaining open communication with local communities and ensuring our activities and staff respect their traditions and cultures
- ▶ Supporting our employees to participate in voluntary activities that benefit the wider community
- ▶ Working closely with individual employees to help them reach their goals and provide NIWA with talent for the future
- ▶ Striving for 'no surprises' in our internal and external relationships.

Economic

We will support the Organisational Responsibility Charter by:

- ▶ Being fair and honest in all our business dealings
- ▶ Maintaining objectivity in our service provision and avoiding actions that could damage NIWA's reputation for impartiality
- ▶ Taking a 'NZ Inc.' approach to business decisions and using any market advantage responsibly
- ▶ Delivering on our project commitments – on time, to budget and with the expected quality
- ▶ Employing our assets responsibly both to benefit the company and the wider community
- ▶ Abiding by the laws of the lands in which we operate
- ▶ Resolving differences without the need for litigation.

Environmental

We will support the Organisational Responsibility Charter by:

- ▶ Ensuring that all our activities and assets comply with resource consents, relevant environmental standards, biosecurity and biodiversity regulations, and permitting requirements
- ▶ Maintaining full compliance with animal ethics procedures and ensuring that all sampling and work with live animals complies with the Animal Welfare Act 1999
- ▶ Minimising material waste and resource use, and making maximum practical use of recycling and electronic media
- ▶ Minimising energy consumption and greenhouse gas emissions, within the constraints of business sustainability
- ▶ Supporting our employees to take positive actions to reduce the effects of their activities on the environment at work and beyond.



Tangaroa.
Dave Allen