PACIFIC WAVES
Tracking Tonga's eruption

THE EYES HAVE IT
Smart science for scallops

ICE AHEAD?
Changes on the Ross Ice Shelf

COUNTING FISH
Big data from tiny bones

Water & Atmosphere

MAY 2022

"It's not a home anymore"

The science of flood forecasting

Water & Atmosphere

May 2022

Stuart Mackay

Corporal Sean Spivey, NZDF

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Enquiries to:

The Editor
Water & Atmosphere
NIWA
Private Bag 14901
Kilbirnie
Wellington 6241
New Zealand

email:
wa-editor@niwa.co.nz

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NIWA
Taihoro Nukurangi

Cover: Westport resident Dorothy Burrows stands in what was once her living room. She was forced out of the family home in July when Buller River floodwaters swept through the town. (*Stuart Mackay*)

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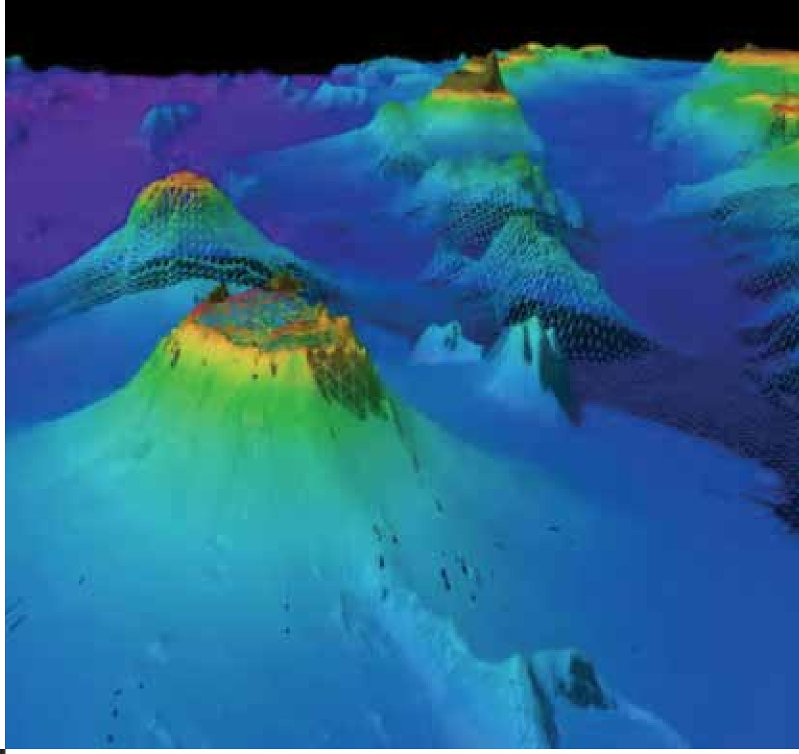
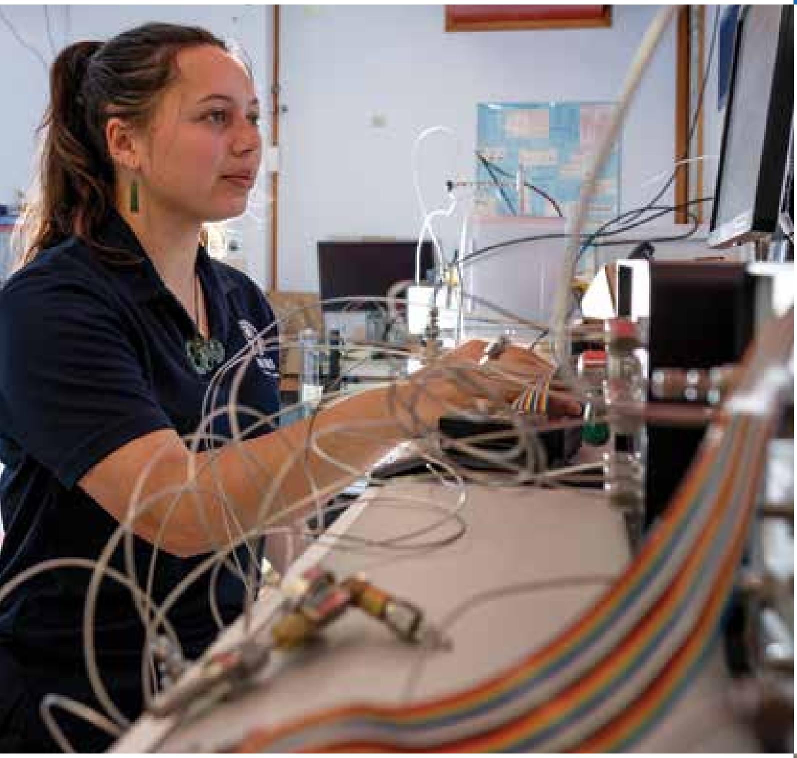




Nava Fedaeff

Forearmed with science

NIWA Chief Executive John Morgan looks at how science supports community flood resilience.

> “Our climate, and our world, are changing fast”
>
> John Morgan

On Monday, 21 March, the rain gauge at Maungatapere, 18 kilometres west of Whangārei, recorded 103mm between 4 am and 5 am.

This is the most rain ever recorded in one hour at a low elevation weather station in Aotearoa New Zealand.

Little surprise that the weather system that delivered this deluge also caused flash flooding and disruptive power cuts across large parts of Auckland and Northland.

Eight months earlier, the floodwaters surging down the Buller River during last July’s West Coast storm were the largest flows ever recorded in a New Zealand river. More than 120 homes were left uninhabitable in Westport.

Our climate, and our world, are changing fast. New Zealand recorded its hottest-ever year in 2021 and climate scientists warn we should prepare for more frequent – and more intense – storm events in the years ahead.

One of the roles of science is to help communities develop the resilience and adaptation skills they need to face the challenges ahead and, as New Zealand’s leading environmental science provider, NIWA researchers are at the forefront of this work.

Our ability to accurately forecast hazards is rapidly evolving through investment in our data science capabilities and our High Performance Computing Facility.

Working with meteorologists and climate scientists, NIWA hydrological modellers are able to translate high-resolution forecast data into advanced catchment flow projections.

Forecasting is never easy, but improved processing power and modelling means not only can science more accurately predict when and where heavy rain will fall, but also where it will go once it hits the ground, and what may happen when it gets there.

The results are a national river flow awareness tool offering detailed forecasts, 48 hours in advance for more than 50,000 catchments across New Zealand.

Civil defence authorities in Westport say this system played a key role in helping to manage July’s inundation.

NIWA scientists are also leading a five-year multi-partner research programme to map flood hazard and risk consistently across the country. This programme will reveal flood risk changes over the next 100 years and help iwi, communities, councils and central government develop the strategies needed to prepare for them.

NIWA science aims to help communities across New Zealand understand the scale of the flood hazards they face and what they can do to prepare.

Because, when your world is changing – to be forewarned is to be forearmed.

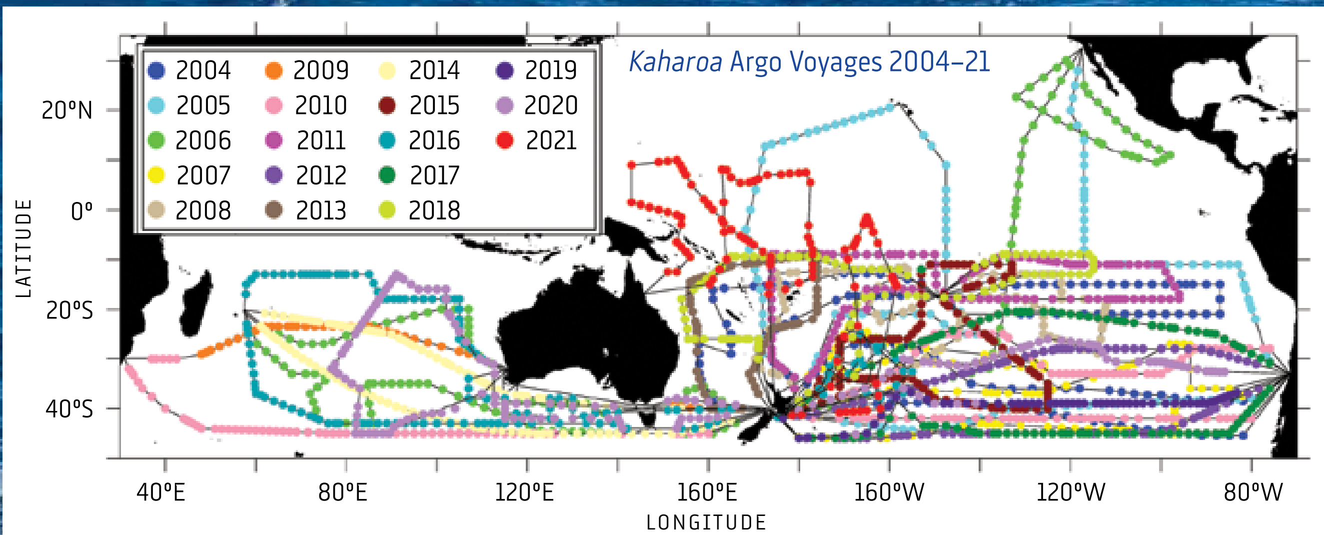
OCEAN DROPS

NIWA's research vessel *Kaharoa* has marked a significant marine milestone – deploying its 2,000th Argo ocean monitoring float during a recent Pacific voyage.

Argo is an international programme collecting data from the world's oceans using a fleet of drifting robotic floats. The floats travel to depths of up to 6000 metres before returning to the surface and relaying temperature, pressure and salinity data to satellites overhead.

This data is vital to help understand ocean changes and their impact on the global climate (*see page 20*).

Kaharoa recently completed a three-month Pacific voyage launching fresh floats north of the Equator. It has deployed far more Argo floats than any other research vessel operating around the globe.



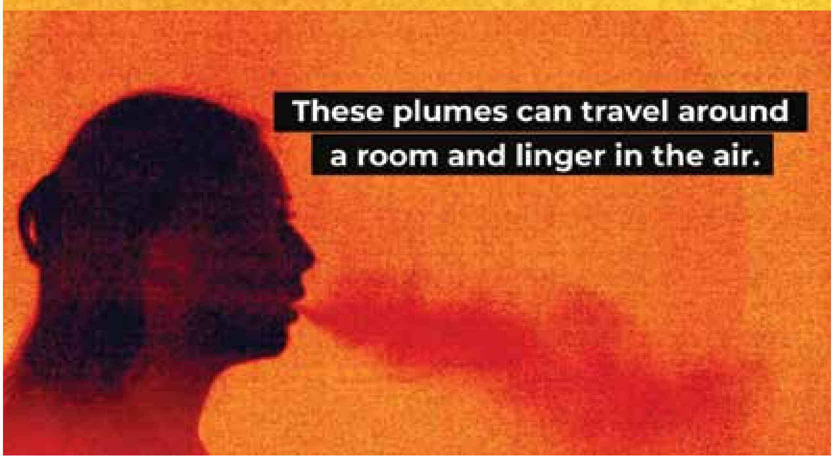
FRESH AIR

Air quality researchers have worked closely with the Ministry of Education to help reduce the risk of COVID-19 spreading through the nation's classrooms.

Led by NIWA's Dr Ian Longley, researchers used CO_2 monitors, smoke simulators and specialist cameras to test a range of scenarios.

The experiments firmly reinforced the role of ventilation in reducing transmission risk, showing that combining ventilation with masks is the most effective way to reduce Covid risk.

The project prompted clear advice to schools that steps such as opening doors and windows, wearing masks and using CO_2 monitors minimises virus spread.



PENGUIN TALES

Wellington penguin researchers will be keeping a close watch out for Flappy, one of a pair of kororā/little blue penguin chicks hatched in a protected nesting box on NIWA's Evans Bay site.

Their birth went viral via Urban Wildlife Trust livestream cameras and thousands tuned in to watch how the young birds fared.

Sadly, Flappy's sibling died, but the plucky little survivor battled on to successfully fledge early in the year, leaving the nest for Wellington Harbour soon after.

Microchipped for research purposes, scientists are hoping he'll be back on site within the next 18 months looking for a familiar breeding site of his own.

Rebekah Parsons-King

NEWS BRIEFS

Natalie Robinson

DELICATE WORK

NIWA researchers have successfully recovered the first intact samples of the fragile ice platelets hidden under the Ross Sea.

Platelet ice is a layer of delicate crystals attached to the bottom of Antarctic sea ice. It forms a unique habitat for algae and bacteria – organisms that underpin the Ross Sea food chain.

Testing a custom-built drill over the summer, marine specialists managed to recover samples without destroying the delicate ice structures.

The breakthrough will enable further investigations into the role this vital layer plays in Antarctic ecosystems.

HOT WATER

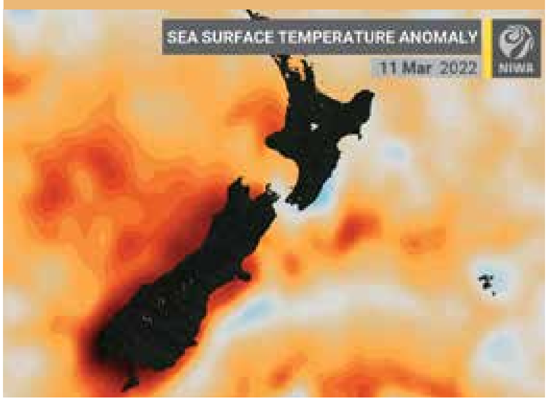
New Zealand sea temperatures this summer were some of the warmest ever.

Marine heatwaves occur when seawater temperatures stay in the warmest 10% of historical observations for at least five days.

Summer's sea surface temperatures were second only to conditions recorded during the summer of 2017–18.

Temperatures reached as high as 5°C above average around coastal Auckland and Waikato in mid-December.

The sizzling summer seas follow confirmation of 2021 as New Zealand's hottest year since NIWA's seven-station temperature series began in 1909.



NeSI

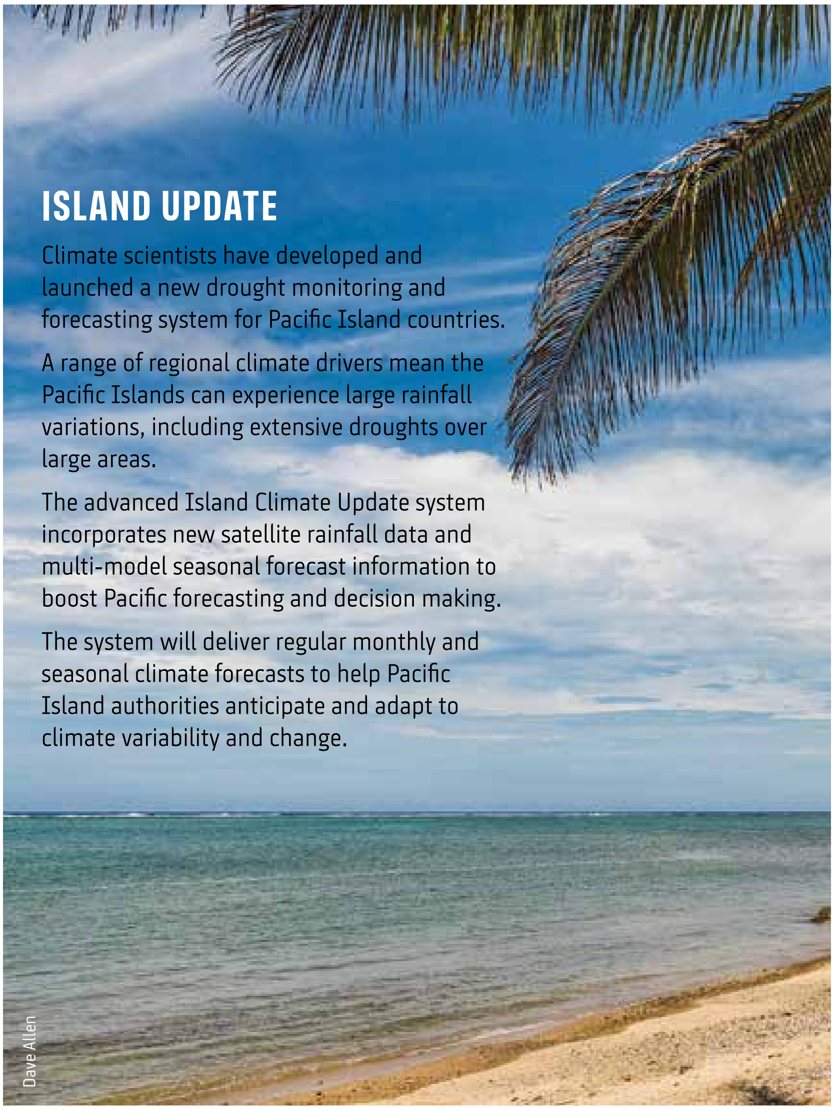
TURBO CHARGED

Maui, the most powerful machine in NIWA's High Performance Computing Facility, is getting a mid-life makeover.

The Cray XC-50 supercomputer was commissioned in 2018 and provides the processing power needed to deliver advanced data science services across NIWA's research platforms.

Planning is already underway for a full upgrade, but rapidly growing demand for additional research support in areas such as artificial intelligence and digital twin technology has prompted the installation of new Graphic Processing Units (GPU).

The addition of the NIVIDA A100 GPUs will boost storage and deliver an up to four-fold increase in performance.



Dave Allen

ISLAND UPDATE

Climate scientists have developed and launched a new drought monitoring and forecasting system for Pacific Island countries.

A range of regional climate drivers mean the Pacific Islands can experience large rainfall variations, including extensive droughts over large areas.

The advanced Island Climate Update system incorporates new satellite rainfall data and multi-model seasonal forecast information to boost Pacific forecasting and decision making.

The system will deliver regular monthly and seasonal climate forecasts to help Pacific Island authorities anticipate and adapt to climate variability and change.

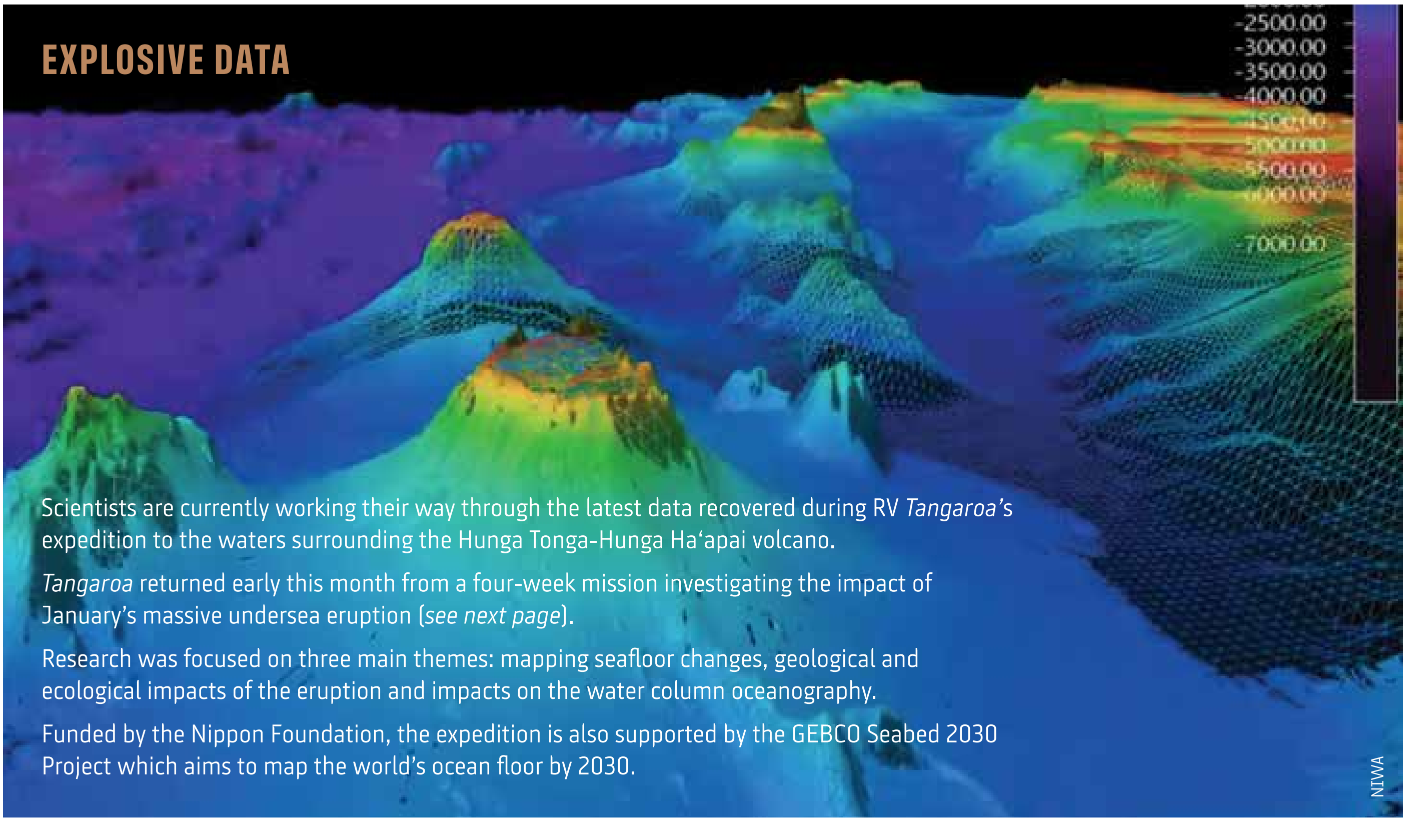
PROVIDING PATHWAYS

Applications open in September for aspiring young Māori researchers to join the next intake for NIWA's Te Kūwaha Graduate Programme.

The graduate programme is part of *Te piko o te māhuri tērā te tipu o te rakau* – NIWA's commitment to building Māori research capability and capacity.

Te Piko is a development initiative that provides pathways and opportunities for young Māori researchers across NIWA's climate, freshwater and oceans platforms (*see pages 26–31*). Each journey is customised to support aspiring researchers in reaching their full potential in the environmental research sector.

EXPLOSIVE DATA



NIWA

Scientists are currently working their way through the latest data recovered during RV *Tangaroa*'s expedition to the waters surrounding the Hunga Tonga-Hunga Ha'apai volcano.

Tangaroa returned early this month from a four-week mission investigating the impact of January's massive undersea eruption (*see next page*).

Research was focused on three main themes: mapping seafloor changes, geological and ecological impacts of the eruption and impacts on the water column oceanography.

Funded by the Nippon Foundation, the expedition is also supported by the GEBCO Seabed 2030 Project which aims to map the world's ocean floor by 2030.

Tracking an eruption

Stacy Mohan looks at how the shockwaves from a remote Tongan island rippled through NIWA's research community.

"Scientifically, the eruption is the biggest thing that has happened during my career"

Dr Emily Lane

Dr Emily Lane was out of phone reception on Saturday 15 January, when Hunga Tonga-Hunga Ha'apai erupted.

The Tongan underwater volcano created huge pressure waves, pumping enough energy into the ocean to unleash a 15-metre tsunami towards Tonga and send damaging waves out across the Pacific.

As ash from the eruption turned Tonga's skies dark, Lane was one of many NIWA researchers who swung into action: from tsunami experts, to meteorologists, atmospheric scientists and marine geologists, it was all hands on deck.

Lane is a Christchurch-based tsunami modeller, who also studies underwater volcanoes. She returned to a flurry of messages, including an urgent request from New Zealand's Tsunami Experts Panel. Lane is a member of the group, which is responsible for advising the National Emergency Management Agency (NEMA) about tsunami hazards.

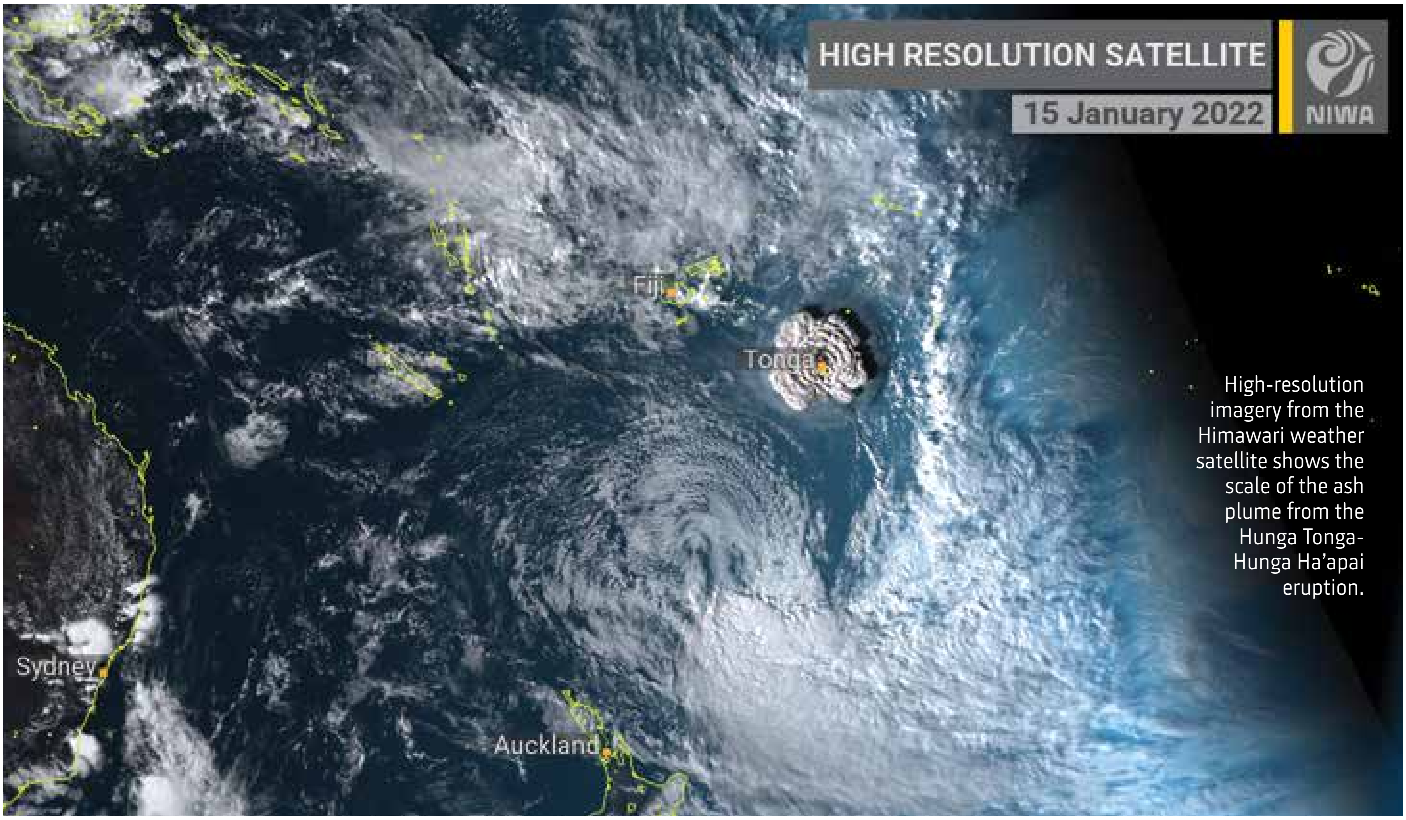
An hour after their first meeting, the group urgently reconvened. One of New Zealand's network of deep ocean tsunami sensors had just detected a large wave travelling away from Tonga.

"We hadn't expected this, because volcanic tsunamis are usually fairly localised – to within a few hundred kilometres of an eruption," says Lane.

The sensors were DART buoys and there are 12 of them in an early warning network set up three years ago by NEMA, NIWA and GNS Science. It extends up into the Pacific, along the Kermadec Trench and past Tonga.

"Having the DART buoys was a complete godsend – we would have been flying blind without them."

Information from the buoys, alongside data from tide gauges in New Zealand and around the world, enabled the panel to estimate the scale of the impending tsunami and alert neighbouring Pacific nations.



High-resolution imagery from the Himawari weather satellite shows the scale of the ash plume from the Hunga Tonga-Hunga Ha'apai eruption.

(*Left*) Kanokupolu automatic weather station, sited 13m above sea level on Tongatapu Island, before and (*right*) after the tsunami – the remains of the tower can be seen in the trees to the right of the concrete pad. (*Tonga Meteorological Services*)

Lane's NIWA colleagues, hazard analyst Dr Shaun Williams and hydrodynamics scientist Dr Cyprien Bosserelle were meanwhile working directly with authorities in Tonga.

The previous day they had registered a smaller eruption and tsunami, foreshadowing Saturday's event. Bosserelle says NIWA's relationship with the Tonga Meteorological Service helped in the issuing of an early tsunami warning that probably saved many lives 24 hours later.

Despite the destructive waves and volcanic ash of January 15, all but one of the weather and sea-level monitoring stations NIWA has helped establish in Tonga remained operational.

Weather and wave data continued transmitting to New Zealand, and instrument technician Evgeny Fardman relayed this crucial information back to Tonga via one of the few live satellite links still operational.

This Tonga Meteorological Services data provided valuable insights into atmospheric pressure, weather and wave activity for researchers and emergency responders across the globe.

Auckland-based NIWA meteorologist Ben Noll says his first inkling of the Hunga Tonga-Hunga Haʻapai eruption came when he heard a strange rumbling sound at about 7pm.

"I then saw the news and went straight to look at the images on Himawari, the Japanese weather satellite NIWA uses – it was the craziest thing I've ever seen on satellite imagery in all my years as a meteorologist. Just jaw-dropping."

Noll posted the images online showing the enormous ash plume erupting into the atmosphere. These went viral, giving millions their first insight into the scale of the event.

In the days that followed, Noll worked with air quality scientist Dr Guy Coulson to estimate how much sulphur dioxide had spewed into the atmosphere. He then used weather data to create acid rain projections, helping Samoa and Kiribati assess the risk to drinking water supplies.

NIWA's Lauder Atmospheric Research Station in Central Otago also tracked the ash plume and the atmospheric pressure wave, which circled the globe up to five times.

"We've kept the LiDAR running and are seeing the ash disperse slowly – a bit like the smoke from the Aussie bushfires in early 2020," NIWA atmospheric scientist Ben Liley says.

Dr Richard Wysoczanski is a marine geologist at NIWA, as well as a volcanologist. He's also a member of New Zealand's Volcanic Advisory Panel. This group has played a key role in analysing the eruption and the lessons for the future.

"The eruption had about 1,500 times the explosivity of Hiroshima – it was on a scale that we didn't think could happen," he says.

Wysoczanski has analysed ash samples to work out the threat from trace metals leaching into the sea and poisoning fish.

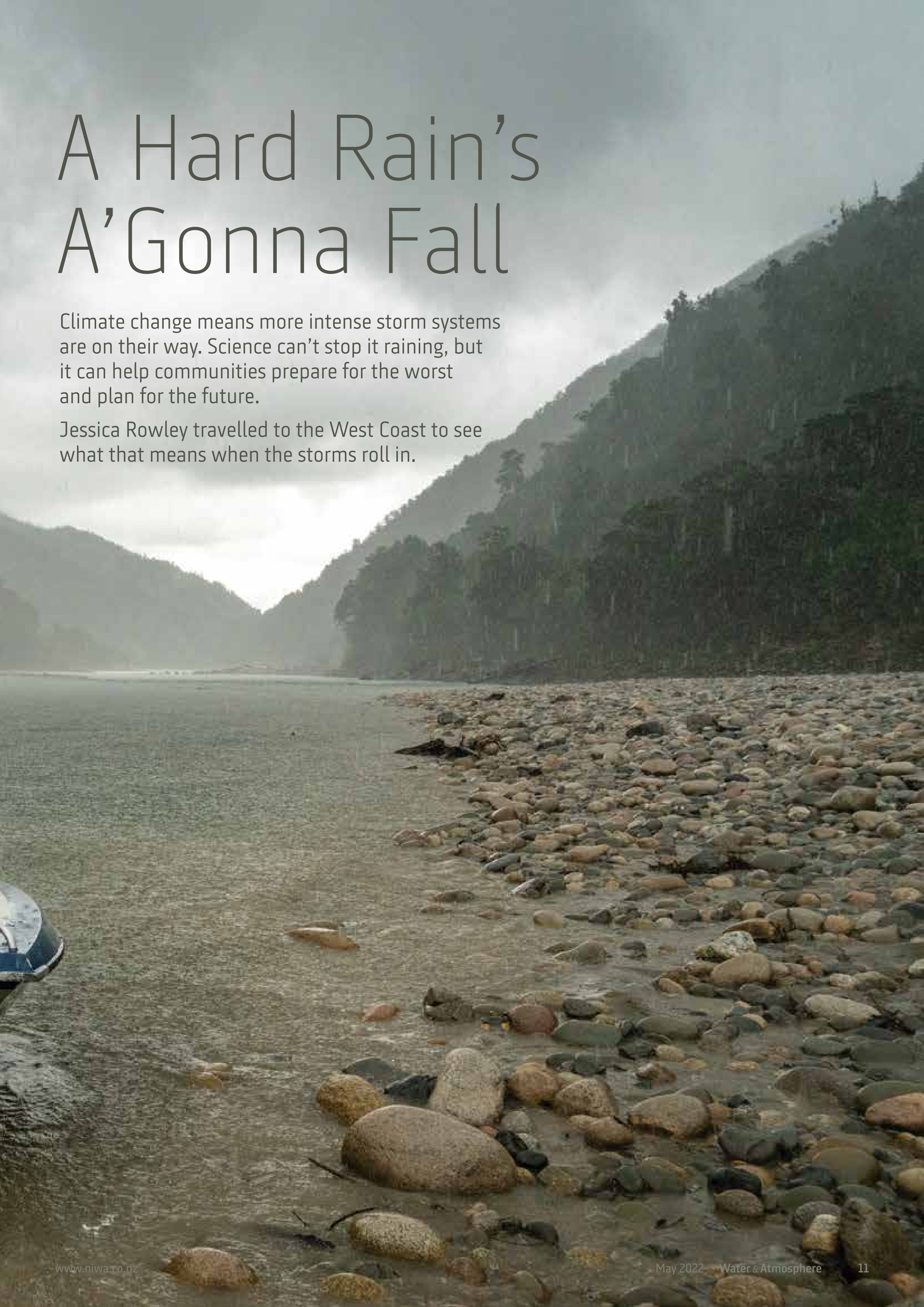
He's also helped plan RV *Tangaroa*'s voyage to the eruption site. The multi-disciplinary expedition used multibeam echosounders to map the seafloor and provides a unique opportunity to investigate the explosion and its impact on the marine environment.

For Lane, Hunga Tonga-Hunga Haʻapai was the "perfect storm", bringing together all the different strands of her research.

"Scientifically, the eruption is the biggest thing that has happened during my career."

She is now one of many scientists at NIWA, and across the globe, who is eagerly awaiting the results of *Tangaroa's* latest research mission.

Stuart Mackay



A Hard Rain's A'Gonna Fall

Climate change means more intense storm systems are on their way. Science can't stop it raining, but it can help communities prepare for the worst and plan for the future.

Jessica Rowley travelled to the West Coast to see what that means when the storms roll in.

Floodwaters almost a metre deep swept through Dorothy Burrows's Westport home in July. (*Stuart MacKay*)

Dorothy Burrows is the epitome of 'Westport born and bred'. In her eighties, she's lived in the West Coast town all her life. Her house has been in the family for over a century.

"When I was knee-high to a grasshopper, I can vaguely remember visiting my grandparents here. They inherited it from my great-grandparents. But it was just a small cottage back then."

Like a decades-long game of Lego, the house has had something added to it by each generation.

"When we moved in, we fitted the aluminium windows, built the deck, and put in a new roof. Everybody has contributed."

But on the evening of 15 July 2021, dark storm clouds rolled in, and Dorothy started to hear an ominous "pitter-patter" on her roof.

Over the next 3 days, 690mm of rain plummeted down on the West Coast. The Buller River swelled, and a flood of almost biblical scale descended on Westport.

More than 2,000 residents were evacuated, and 127 houses left uninhabitable.

Dorothy's home didn't stand a chance. In a matter of hours, a sanctuary that housed generations was ruined.

"When we came back to the house after the waters receded, I opened my kitchen drawer where our cutlery was kept, and water just poured out of it. We've had weddings here, funerals, anniversaries, birthdays, you name it. That's all gone now.

"It's not a home anymore".

> **"We've had weddings here – funerals, anniversaries, birthdays, you name it. That's all gone now"**
>
> Dorothy Burrows

Previous pages: NIWA hydrological staff use jet boats to access flow monitoring sites along the Buller River. These feed vital data through to emergency planners downstream in Westport. (*Stuart Mackay*)

Like death and taxes, floods are an inevitable part of life in New Zealand. They're our most frequent natural hazard.

The power of water can be devastating – just half a metre of water will pick up and carry the largest of vehicles. When moving at 40km/h, 15 centimetres of water has the pressure equivalent of wind blowing at 1,270km/h.

Insurance Council figures show floods cost New Zealand a record $248 million last year.

With around two-thirds of the population living in flood-prone areas, the health, homes, and livelihoods of hundreds of thousands of New Zealanders are at risk. There are also major implications for infrastructure and the economy.

The people of Westport know this all too well. The same day that Dorothy started to hear rain start to fall, Westport's then Civil Defence Controller Bob Dickson had been looking at forecasts from NIWA showing a monumental amount of water was on its way.

The following day he recommended a civil emergency be declared. Next came the agonising decision for mandatory evacuation.

Dickson ordered people out of their homes, pushing them to seek higher ground, stay with friends or family, even sleep in their cars if they had to.

It was the right thing to do.

The next morning, NIWA environmental monitoring technician Mike O'Driscoll raced up the bulging Buller River in his jetboat.

Using a radar gun, he measured its water flow. A reading flashed on O'Driscoll's screen, and he knew immediately things were bad: 7,640 cubic metres per second – the largest river flow measurement ever recorded in New Zealand.

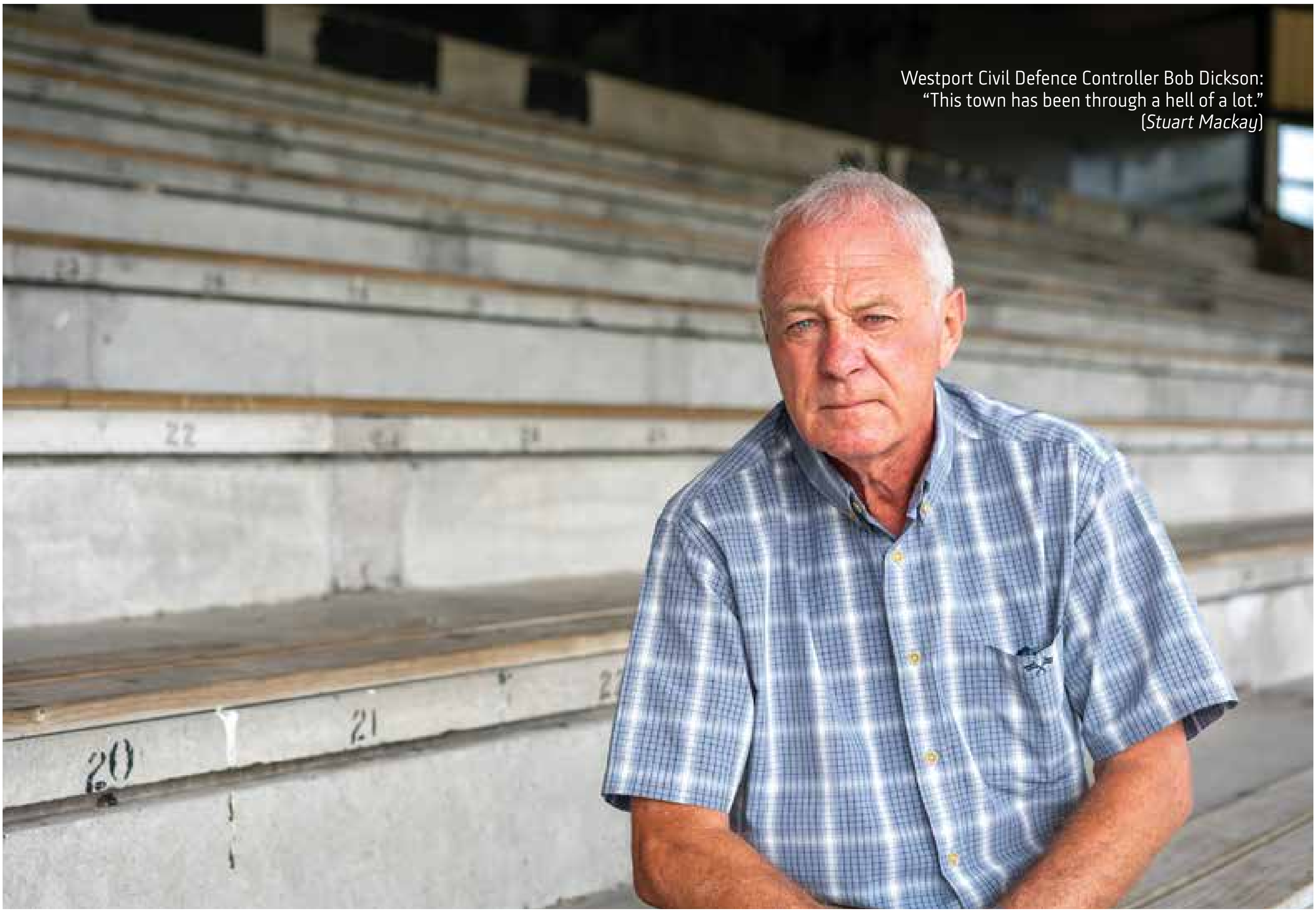
That water was plunging down the gorge towards Westport, coinciding head-on with the high tide.

Dickson's decision saved lives. But how did he come to it and how do you calculate flood risk?

The process for forecasting a flood hasn't always been exact.

"Down by the Buller Bridge, there's an old swing that we used to use. It's got a couple of markers on it, so

NIWA Environmental technician Mike O'Driscoll checks flows in the lower Buller Gorge. Combining high-resolution rain forecasts with catchment and flow data can give emergency managers up to 48 hours warning of trouble ahead. (*Stuart Mackay*)



Westport Civil Defence Controller Bob Dickson: "This town has been through a hell of a lot." (*Stuart Mackay*)

“We were able to provide information from real-time data about how, when and where the flood was about to happen”

Dr Céline Cattoën-Gilbert

Dr Céline Cattoën-Gilbert is working to develop an early flood warning system for Westport. (*Stuart Mackay*)

when water got to a certain height, we knew we were in trouble. It’s unscientific, but it helps,” says Bob.

To really help communities during these momentous events, however, we need to throw in the best that science can offer.

Flood risk is a hyper-localised measurement. Even nextdoor neighbours can have different flood risk ratings. Predicting the precise extent, location and potential damage of floodwater takes data, a lot of data. Elevation of the land, soil type, building materials, vegetation, and proximity of people to water sources are just some of the factors that need to be considered.

In July, this information, amongst a barrage of other data points, advice, warnings, and worries, was being channelled to Dickson and the anxious, sleep-deprived team at the West Coast Regional Council.

NIWA’s national flood awareness system played a key part in helping to decipher that deluge of data.

Dr Céline Cattoën-Gilbert is a hydrological forecasting scientist with NIWA. From her office in Christchurch Cattoën-Gilbert and her colleagues were helping Dickson and the regional council make calls on how to deal with the events that were unfolding.

Cattoën-Gilbert is fine-tuning a national river flow tool that combines high-resolution rainfall forecasts with detailed catchment data. The tool models flows for close to 50,000 rivers across New Zealand.

“Luckily, we had been working with the West Coast on river forecasting just a couple of months before last year’s flood. When the weather came in, we were able to provide information from real-time data about how, when and where the flood was likely to happen, giving us a high-resolution forecast up to 48 hours in advance.

“Usually, river gauges only give the town 1.5 hours notice to evacuate. We were able to help with decision making and get people out much earlier,” she says.

For Dickson and his team, it was invaluable.

“The advice we were receiving around the modelling and predictions matched, almost to the letter, what was happening on the ground. It was great science to have in our back pocket.

“It gave us peace of mind about the decision we made to keep ahead of this event and to get

“Having a national-scale lens means that we can start making fair and equitable decisions”

Dr Emily Lane

evacuations underway. We have quite an elderly population and people with their own unique medical problems; there is an old people's home that we were ready to evacuate, which would have caused significant difficulties. Luckily, the modelling showed that we didn't have to.

“This town has been through a hell of a lot. That science supporting our decision making is so critical, and working with our colleagues at NIWA and the Regional Council proved to be an absolute bonus. It's first class,” says Dickson.

This flood forecasting work feeds into a much larger five-year, NIWA-led, multi-partner research programme to map flood hazard and risk consistently across the whole country.

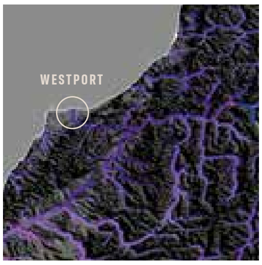
Called Mā te Haumaru ō te Wai, the programme will investigate the vulnerability of communities, buildings, and infrastructure networks, along with the long-term sustainability of flood schemes and defences.

Dr Emily Lane is a hydrodynamic scientist at NIWA who specialises in natural disasters and leads the programme. She says the project will, for the first time, provide a national look at flooding hazards, risks and solutions.

“There are areas in New Zealand that have a fairly clear idea of flooding outcomes, but this isn't the case everywhere. We have an incomplete and inconsistent picture; some places are getting left behind. Having a national-scale lens means that we can start making fair and equitable decisions,” she says.

The project is providing a forum for researchers, iwi, stakeholders, and government to investigate flood inundation hazard and risk, and to co-develop strategies for communities to use to become more flood resilient.

An important step is translating hazard into risk. Heavy rain in a flood prone area is a hazard, so at what point does this become a risk to people and places? Where is the water going to go and how



Catchment modelling shows extreme water flows heading for Westport.

Hydrodynamic specialist Dr Emily Lane (second left) leads a multi-partner research programme to map flood hazard across the country. (*Lana Young*)

> “We’re already seeing impacts I thought my children were going to see”
>
> Dr Emily Lane

bad will it get? How will different types of land, e.g., farms versus forests, impact water depths, and what could the potential damage costs be?

Lane says this kind of information is crucial for emergency responses such as those seen in Westport last year. It helps communities know who to evacuate and when. It also helps with the coordination of sending the right defences and resources to the right places. Who might need sandbags to protect their home? Where should temporary shelters be set up? How will supplies get to the people most in need?

In the longer term, it can help planners when creating new developments or changing land use. For example, if you build a new road, how might it impact where water flows during a flood?

The second part of the project is about understanding how people react to flood hazards, particularly over the long term, to assist in developing adaptation strategies.

The team at NIWA is working closely with communities to understand how they react to flood hazards.

Dr Paula Blackett, NIWA’s Principal Scientist of Environmental Social Science, heads this work.

“A lot of our emergency response practices are about the immediate aftermath and saving lives, trying to get back to the original state as quickly as you can.

“However, we don’t fully understand how floods affect people’s lives over space and time. People can be out of their houses for months, their insurance premiums are higher, they have repair costs. They can be so traumatised by an event that they don’t come back,” she says.

Lane says flood risk is all about what’s important and valuable to people, and individual responses to flooding vary widely.

“We want to understand how communities deal with it, so we are working with them to figure out what’s right for them, empowering people to make their own decisions.”

Lane says Vision Mātauranga is a major part of the project’s framework.

“Māori have spiritual connections with their land and interact with it in different ways to Pākehā. Altering nature by putting in things like stopbanks and seawalls might not fit with their worldview and

Westport, July 2021. The Buller River has forced some locals out of their homes three times in the past nine months. (*NZ Defence Force*)

> “Climate change is here. It’s real. And Mother Nature always wins”
>
> Bob Dickson

what’s important to them. Including the Māori worldview is an important part of finding solutions.”

There’s also a giant elephant in the room: climate change.

Temperatures are rising, leading to a warmer atmosphere and more evaporation. The result, says Lane, is more intense storms ahead.

Before the 1970s, New Zealand was hit with just one or two big floods a year. Now, it’s about four to seven, according to the Insurance Council.

Human changes to the environment, such as deforestation and building on wetlands, often increase the intensity and frequency of flooding too.

Lane says understanding climate change is fundamental to both the modelling and mitigation.

“We now know a bit more about how climate change is playing out, so we must go back to our old data and models to adapt them. We have built flood defences to a certain level in the past. But now with climate change, the biggest flood we expected has been completely outdone.”

“We’re already seeing impacts that I thought my children were going to see. Our instincts for what floods might be like may no longer be accurate because it’s not a static climate anymore, it’s changing, it’s getting worse.”

Bob Dickson echoes her comments.

“People must adapt. We’re in a very changing situation, a fluid situation. Climate change is here. It’s real. And Mother Nature always wins.”

So, what’s next for Dorothy Burrows and her beloved town of Westport? Sadly, for Dorothy, she’s lost her family home.

“I’m not coming back here. It would be too unsettling at my age. I don’t think I could sleep at night if we got a heavy rain forecast again. I just want to get on with the rest of my life, not that I’ve got a lot of years ahead.”

It’s too late for Dorothy Burrows but Lane hopes Mā te Haumaru ō te Wai will help communities like Westport make the right decisions as the climate changes.

After all, flooding may be here to stay, but we don’t have to let it drown us. W&A

NZDF

Corporal Sean Spivey, NZDF

Chasing deepsea shadows

Mia Blyth catches up with a marine biologist hunting for ocean ghosts.

Rare find: a newly hatched deepwater ghost shark. (*Brit Finucci*)

What small creature lives hundreds of metres below the waves, has big dopey eyes and a tiny little mouth that you can only just get your pinky finger into?

Surprisingly, it is a type of shark. *Oxynotus bruniensis*, to be precise, more commonly known as the prickly dogfish.

A prickly dogfish was the first deepwater shark that fisheries scientist Dr Brit Finucci saw. It is now one of the self-confessed shark hugger's all-time favourites.

Mention the word shark and most people picture a large, menacing coastal marauder. But nearly 80% of New Zealand's sharks spend their lives deep below the surface and are hardly ever seen.

Surviving at depths of more than a kilometre below the waves, with some even generating their own bioluminescence, they are part of a weird and wonderful family.

NIWA's resident shark specialist is on a mission to throw new light on these quirky deepwater residents, and the role they play in our marine ecosystems.

Growing up landlocked in Canada, Finucci didn't see the ocean until she was 14 years old. It was another five years before she saw her first shark in the wild.

Finucci says she was struck by how little was known about the fundamental biology and ecology of these intriguing fish, along with their vulnerability.

"We are lacking so much ecological data for this group of animals, but we also know through fisheries and trade information that many species are now in serious trouble."

As she gained more understanding of marine biology and conservation, she became increasingly determined to turn this situation around.

Two degrees, and three countries later, Finucci found herself working alongside NIWA fisheries scientists, including acclaimed shark expert Dr Malcolm Francis, as she completed her PhD in *"Deepsea Chondrichthyan Biology, Ecology, and Fisheries"* at Victoria University of Wellington.

New Zealand has about 10% of the global diversity of chondrichthyans – the subclass of cartilaginous fish that contains not only sharks, but also rays and chimaeras. Finucci works across all three groups.

"For a small nation, we do have a good representation of the global diversity and about 20% of our species are found nowhere else in the world."

Chimaeras, relatively small, mysterious fish with names such as ratfish, spookfish and ghost sharks –

Ghost sharks are Chimaera – closely related to other sharks and rays. Some are found up to 2.5km below the surface. (*Brit Finucci*)

> "We are lacking in so much ecological data for this group of animals"
>
> Dr Brit Finucci

hold a particular fascination for Finucci.

"Take the ghost sharks, for example, we have no idea at what age they mature, in fact we don't even know how long they live."

So, when Finucci – in an incredibly rare find – discovered a newly hatched deepwater ghost shark during a recent Chatham Rise survey, everyone seemed excited.

Media outlets across the globe jumped on the unique find. The BBC, CNN and Reuters were among channels queuing up for interviews, and "Ghost shark" made the top 10 search list on Google UK.

Much of her work has a strong focus on shark conservation and management, and, for Finucci, the baby ghost shark media storm was a perfect opportunity to raise the profile of deepwater sharks.

"Having sound knowledge and understanding of their biology and ecology, such as age-at-maturity and population structure, is important for fisheries management."

Finucci's journey as a researcher has not always been plain sailing. She lost seven kilos on her first survey voyage on the Chatham Rise. But she loves the work and remains determined to characterise New Zealand's full range of unique deepwater chondrichthyans.

While deepwater sharks are her favourite, Finucci has now taken on projects researching many New Zealand sharks, including a project ageing New Zealand white sharks.

"We are working with a sample collection spanning over 30 years. To my knowledge, this collection includes what may be the only known sample of a pregnant white shark. Once we have completed this work, we are hoping to explore new ageing techniques, such as DNA methylation, which are currently being developed overseas."

Finucci's passion project, however, is to initiate a long-term deepwater shark tagging programme in New Zealand waters.

"This will tell us more about how these animals are using their deepwater habitat, and how they move around New Zealand waters, and tagging programmes can also be used to assess the impact of fishing activities, for example by measuring post-release survival."

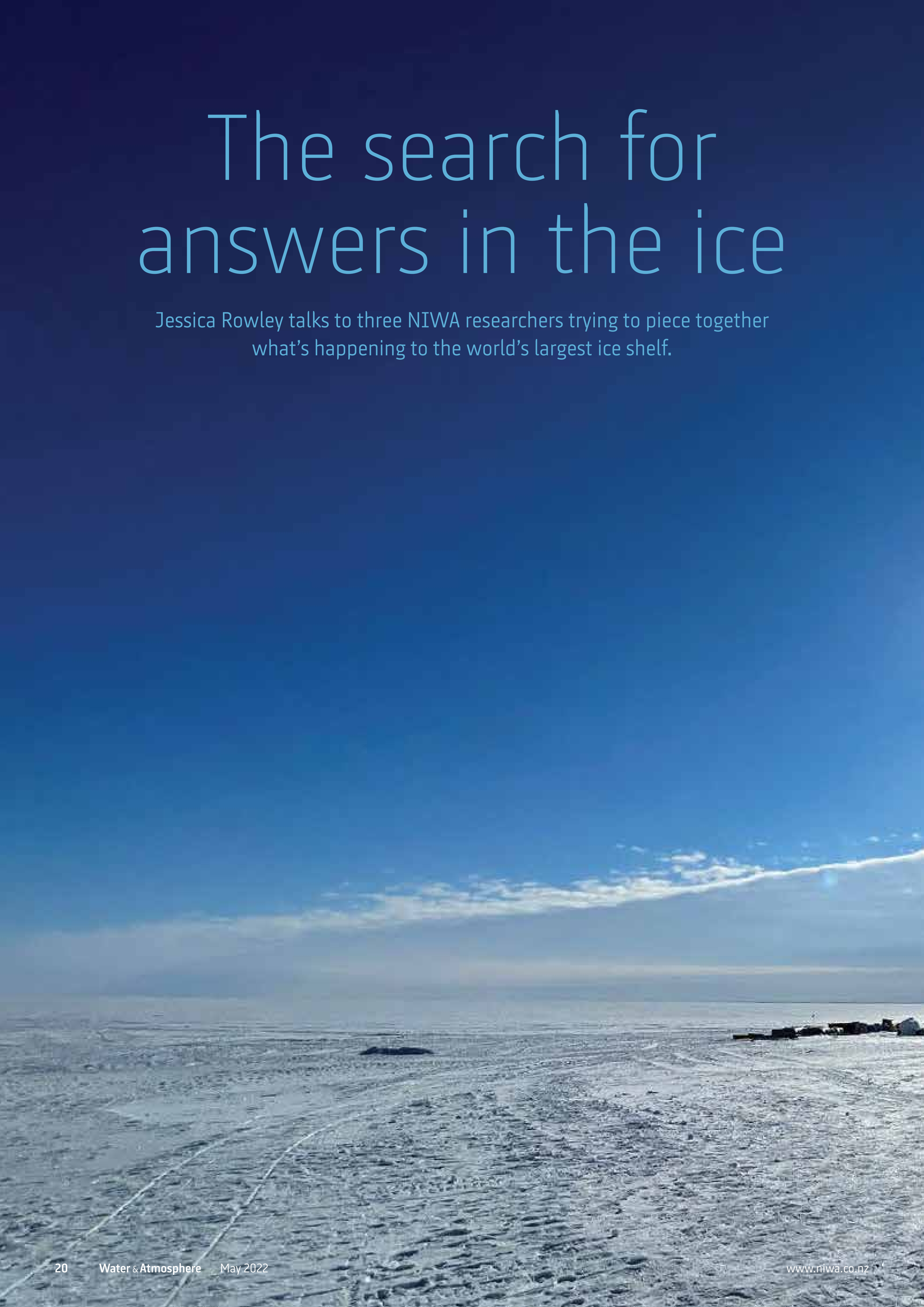
It is no easy feat working with creatures that often live more than a kilometre below the surface.

However, the determined shark fanatic, viral media star, and five-time national Muay Thai champion brings her own unique skill set to the challenge.

Fisheries scientist Dr Brit Finucci has a determined streak. The self-confessed "shark hugger" is also a national Muay Thai (Thai boxing) champion. (*Lana Young*)

The search for answers in the ice

Jessica Rowley talks to three NIWA researchers trying to piece together what's happening to the world's largest ice shelf.



Coldest, driest, windiest, iciest, highest, most southerly – Antarctica is a continent of extremes.

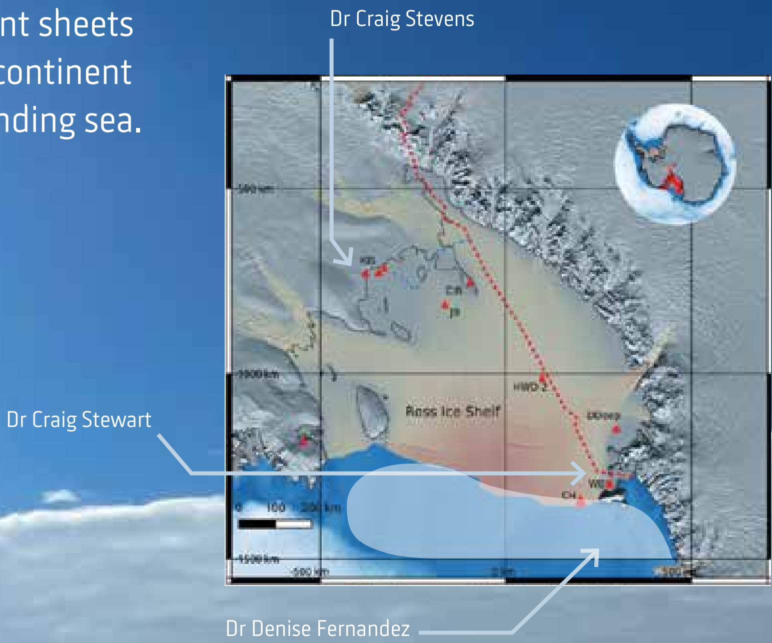
It's bigger than Europe and has ice covering 98% of its land, at a hefty average thickness of nearly 2km. Holding 90% of the world's ice and 80% of its fresh water, Antarctica has a profound effect on the planet's oceans and climate.

Antarctica is also remarkable for its massive ice shelves, giant sheets that flow out from the continent and float on the surrounding sea.

The Ross Ice Shelf – the world's largest – lies above the Ross Sea, almost due south of New Zealand.

It's little surprise, then, to find three NIWA scientists, each working on Antarctic Science Platform research projects focused on trying to piece together the changes in the Ross Sea and the ice shelf above.

Study areas for these three NIWA scientists researching the Ross Ice Shelf



> "Changes have big implications for sea-level rise and ocean circulations around the world"
>
> Dr Denise Fernandez

FAST FACTS

If all Antarctica's ice melted, global sea levels would rise by

58m

A March heatwave pushed East Antarctica's temperatures

40°C

higher than normal

Dr Denise Fernandez's research takes place where the Ross Sea meets the outer edges of the ice shelf, where Antarctica connects to the Southern Ocean and the rest of our planet beyond. She studies the interactions between the ocean, ice and atmosphere.

"We want to understand the mechanics of the Ross Sea and how it might change under different climate scenarios," she explains.

Because ice shelves float, there is a continuous circulation of water underneath that comes in and out of the open ocean. You might presume that this is all cold, but some columns of water are comparatively warm and can cause ice shelves to melt from below. There is also salt present in the environment, which can have impacts on the ice. It's these processes that Fernandez and her international colleagues are trying to figure out.

"We're developing models to analyse the heat, salt and energetics of this water. How warm and cold is it? Is more warm water coming in? How will this affect melting? Changes have big implications for sea-level rise and ocean circulations around the world."

Fernandez and her team use Argo floats, robotic instruments that collect data by drifting with the ocean currents. The floats move through the water column collecting information at different depths. Every 10 days they return to the surface and transmit their data to passing satellites. The floats can stay in the ocean for several years.

After analysing the Argo float information, they found that the coldest parts of the Ross Sea are near the surface, but there is an inflow of warm water below 2,000m. There is also a spike in salinity in this deeper region.

"The evidence from the Argo floats helps us to build simulations for various potential future climates, so we can see the implications of changing currents, temperatures and salinity on this delicate system," she says.

They were also able to look at seasonal changes by comparing data from different years, as well as analysing the water's oxygen profile, which can point to life and biological ecosystems. Global trends show that the oceans are losing oxygen, but we don't yet have full data for much of Antarctica.

"It's like a puzzle we're slowly building. We have the big picture, but we need to put the smaller pieces together."

Argo floats drift on Ross Sea currents, travelling through the water column and regularly surfacing amongst the ice floes to transmit data to satellites overhead. (*https://argo.ucsd.edu*)

Previous pages: Base camp for the Kamb ice drill team. Fellow NIWA researchers work on the outer edges of the Ross Ice Shelf, more than 500km away. (*Craig Stevens*)

Dr Craig Stewart's team spent hours transporting ApRES instruments by skidoo and sled to their monitoring sites on the outer edge of the Ross Ice Shelf. (*Craig Stewart*)

Dr Craig Stewart, along with his colleagues from the University of Canterbury and the British Antarctic Survey, work on the edges of the Ross Ice Shelf itself. They are looking at what happens when the shelves lose mass.

Ice shelves do an important job: they apply backwards pressure on the glaciers that feed them, acting as "brakes". But when they disintegrate, more and more glacial ice slides into the ocean.

"We care about this because the loss of land-based ice is now the largest single contribution to sea-level rise. While some ice shelves are melting rapidly, others such as the Ross Ice Shelf are close to equilibrium. Understanding these differences is key to predicting how the ice sheet will evolve in the future." says Stewart.

Ice shelves are also more sensitive to melting in some regions than others. Computer simulations have shown that removing just 1m of ice from the base of the shelf near Ross Island can affect flow rates across the shelf, showing just how connected and sensitive the system is.

To investigate melt rates in this sensitive region of the world's largest ice shelf, the team are using 12 specially designed radar units. These ApRES instruments are like aircraft landing radar, sending a pulse of radiation down through the ice which bounces back off the bottom of the shelf. You can gauge the thickness of the ice by the reflection time.

Buried on the shelf, the ApRES instruments will transmit data about the ice's thickness every hour for over a year, giving the team a real-time map of melting from all 12 sites.

By looking at this information, along with satellite data, Stewart has already observed that rapid melting is occurring near the ice front and open water areas.

Nestled into the ice, 12 ApRES units are now transmitting hourly data on ice shelf thickness back to New Zealand via satellite. (*Craig Stewart*)

"This is where wind blows the sea ice away from the permanent ice shelf, which allows sun to get in and heat it in the summer. This has a more local and immediate impact than the heat coming from the warm deep-ocean currents that Denise is studying.

"The process of ice shelf melting is very important for the mass balance of Antarctica. Thankfully, the Ross Ice Shelf is melting much slower than other locations, so by understanding the processes behind it, we can improve forecasts of the future of the ice sheet."

The final team, including NIWA marine physicist Professor Craig Stevens, were based near the Kamb Ice Stream, more than 500km south east across the ice, where the shelf joins the mainland. Stevens is part of a multi-disciplinary research partnership involving scientists from GNS Science and Victoria, Otago and Auckland universities.

Like a Sherlock Holmes novel, this group were following an intriguing set of clues that led to some landmark discoveries.

Back in New Zealand, Steven's colleague, Huw Horgan, Associate Professor of the Antarctic Research Centre at Victoria University of Wellington, was studying satellite imagery showing a location where the ice shelf starts to flow out from the continent, when something caught his eye.

"He could see a groove in the ice," says Stevens. "We suspected it might be an under-ice estuary."

Researchers have long suspected that there's a network of hidden freshwater lakes and rivers flowing underneath the Antarctic ice sheets. But these hidden rivers have yet to be directly surveyed.

Two years later, Stevens and the team are gathered on the Antarctic continent looking for that "groove". But finding it was harder than they thought.

"It looked dramatic from the satellite imagery, but when you get there and you're looking around you're thinking: 'Where's the groove?' But then we find this tiny, gentle slope and guessed we'd got the right spot."

Using a hot water hose, they melted through half a kilometre of ice underneath the small depression, and with laser-like precision, drilled straight into the meltwater river below.

Here, they observed things that had never been seen before.

"There was a huge element of discovery for us. The first surprise was that the meltwater tube wasn't nice and smooth as we expected – it had a strange structure and was quite narrow, with loads of undulations. It looked like a loaf of bread, with a bulge at the top and narrow slope at the bottom. The water within comprised four or five different layers flowing in different directions.

"This changes our current understanding and models of these environments. We're going to have our work cut out understanding what this means for melting processes."

On top of this, when they put their camera down to study the water below, it was swarmed by arthropods.

"In a normal experiment, seeing one of these things would have you leaping up and down for joy. We were inundated. Having all those animals swimming around our camera means there's clearly an important ecosystem process happening there, which we will do more research on by analysing water samples to test for things like nutrients."

The excitement didn't end there.

The team had deployed to the area just a few days before the dramatic eruption of the Tonga volcano, Hunga Tonga-Hunga Ha'apai. While studying the estuary, their instruments detected a significant pressure change as the tsunami made its way through the cavity.

"Seeing the effect of the Tongan volcano, which erupted thousands of kilometres away, was quite remarkable," says Stevens.

"It is also a reminder about just how connected our whole planet is. The climate is changing, and some key focal points are yet to be understood by science."

"But what is clear is that great changes are afoot – all the more if we don't work together to change our greenhouse gas emissions." W&A

Researchers position a hot water drill system, developed by Victoria University of Wellington, to melt through half a kilometre of ice. (*Craig Stevens*)

> "There was a huge element of discovery for us"

Professor Craig Stevens

Te piko o te māhuri, tērā te tipu o te rākau

The way in which the young sapling is nurtured, determines how the tree will grow.

This whakataukī speaks to the nurturing of a tipu or new shoot to allow it to grow into its full potential.

NIWA's Te Piko o te māhuri programme was developed to grow, support and mentor the next generation of Māori researchers.

Since its inception in 2019, five researchers have embarked on the Te Piko journey.

They have worked across NIWA's climate, freshwater and marine platforms to develop their capabilities and passion for research.

> "It was really cool to see so many interested smiling faces staring up at you"
>
> Ngāpera Keegan

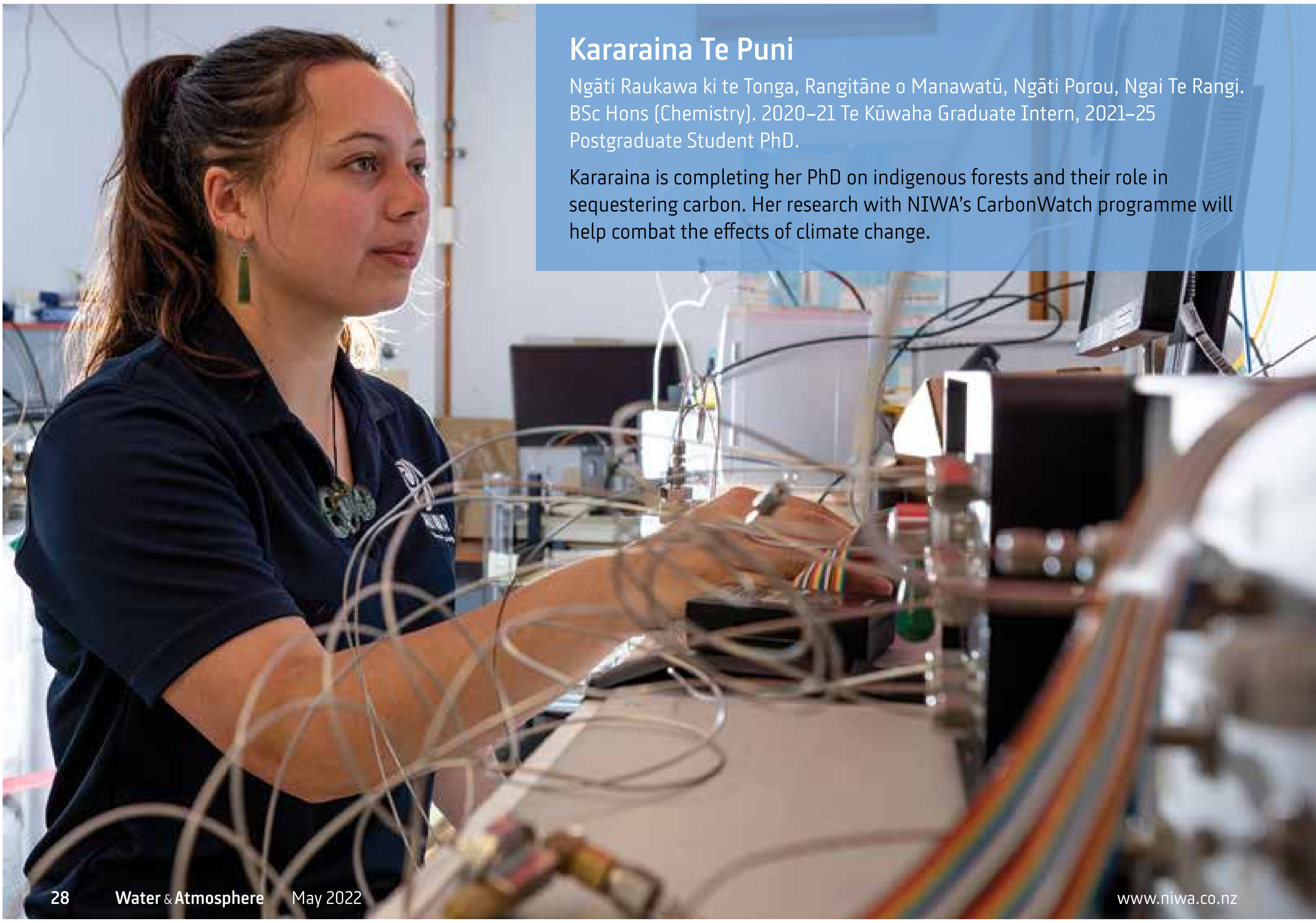
Rebekah Parsons-King

Ngāpera Keegan

Waikato-Maniapoto, Ngāti Apakura.

BSc (Environmental Science) 2019–20 Te Kūwaha Graduate Intern, 2021 NIWA Research Assistant, 2022–23 Postgraduate student MSc.

Edgecumbe school children quiz Ngāpera as she explains the life cycle of tuna during a science outreach visit. Ngāpera had worked overnight with NIWA researchers and community members sampling glass eels at the nearby Rangitāiki River mouth.



Kararaina Te Puni

Ngāti Raukawa ki te Tonga, Rangitāne o Manawatū, Ngāti Porou, Ngai Te Rangi. BSc Hons (Chemistry). 2020–21 Te Kūwaha Graduate Intern, 2021–25 Postgraduate Student PhD.

Kararaina is completing her PhD on indigenous forests and their role in sequestering carbon. Her research with NIWA's CarbonWatch programme will help combat the effects of climate change.

Jessie Scarrott

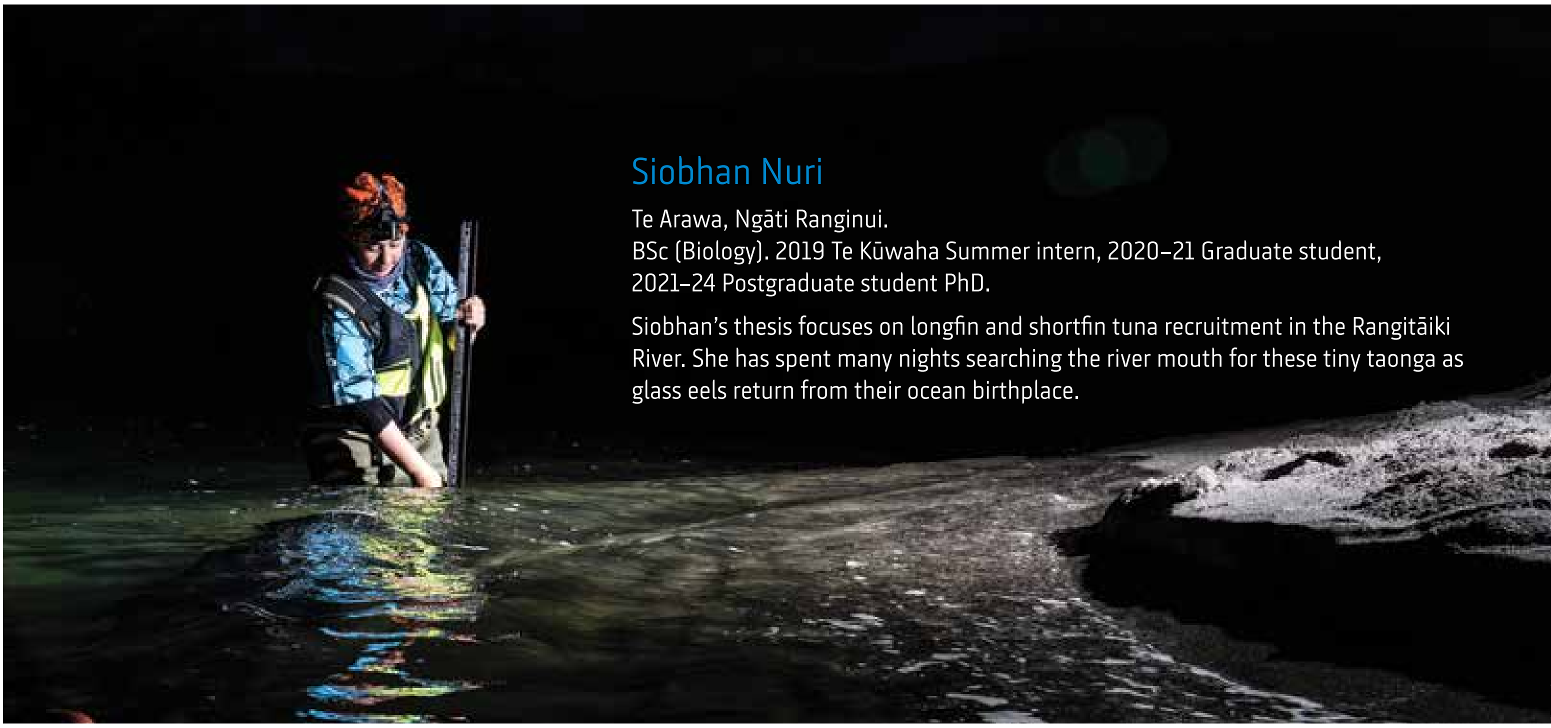
Ngāti Hako, Ngāti Tara Tokonui rātou ko Ngāti Māhanga.
BSc (Ecology and Zoology). 2021–22 Te Kūwaha Graduate Intern, 2022 Completing a postgraduate diploma in marine science.

Jessie recently joined NIWA's biosecurity surveillance team surveying upper North Island ports for invasive marine pests. In this composite image, she analyses survey samples back in the lab.

Transforming their motel room into a mini field lab, Tekiteora (*right*) works with Siobhan Nuri to identify juvenile tuna netted earlier that evening from the Rangitāiki River.

Tekiteora Rolleston-Gabel

Tūhoe, Ngāti Kahu, Ngāi Te Rangi, Ngāti Awa.
BA (Te Reo Māori), BSc (Biology). 2018 Te Kūwaha Summer Intern, 2019–20 Te Kūwaha Graduate Intern, 2021–22 Postgraduate student MSc.



Siobhan Nuri

Te Arawa, Ngāti Ranginui.
BSc (Biology). 2019 Te Kūwaha Summer intern, 2020–21 Graduate student, 2021–24 Postgraduate student PhD.

Siobhan's thesis focuses on longfin and shortfin tuna recruitment in the Rangitāiki River. She has spent many nights searching the river mouth for these tiny taonga as glass eels return from their ocean birthplace.

Ngāpera Keegan (*pictured*) and Tekiteora Rolleston-Gabel helped with the development and testing of the *'Lake-side Monitoring Tools for Communities Field Guide'* in 2021.

The guide supports lake monitoring where communities can select indicators based on local goals and priorities.

Melanie Mayall-Nahi (*left*) and Kararaina Te Puni get a taste of life on the high seas, joining scientists and marine electronics technicians aboard RV *Tangaroa* on fisheries survey duties off the east coast of the North Island.

> "There are so many things to do and people we want to learn from"
>
> Melanie Mayall-Nahi

Melanie Mayall-Nahi

Ngāti Whātua, Te Rarawa.
MSc (Environmental Management), BSc Hons (Geography).
2020–21 Te Kūwaha Graduate Intern, 2021 Recruited as NIWA Environmental Social Scientist.

Melanie identifies a juvenile tuna (elver) during the Wairua River catchment survey in Northland.

Going easy on the scallops

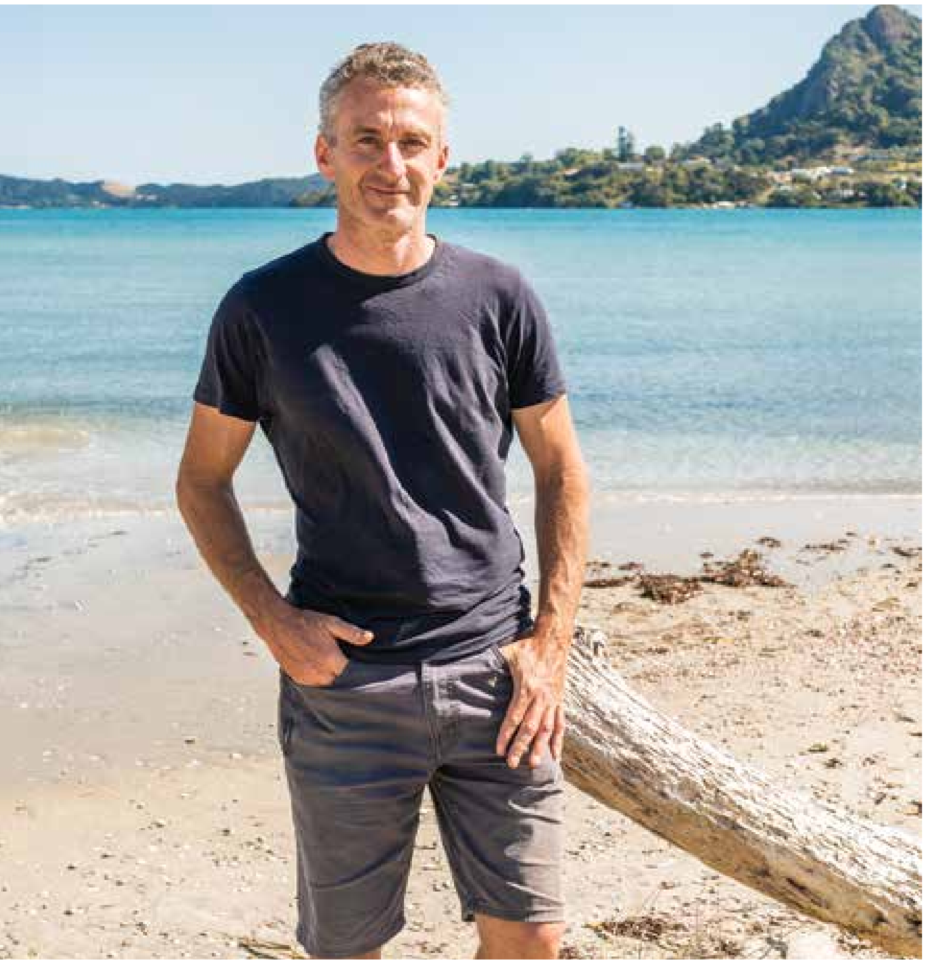
From scallop beds to trawl nets, a little bit of data science can make a big difference. Melissa Bray explains.

Scallops are a national treasure. They are a taonga species, a key component of the marine ecosystem and highly valued as kaimoana by customary, recreational and commercial fishers.

But major declines in scallop abundance are being recorded across New Zealand.

This is largely thought to be due to a combination of factors, including overfishing, recruitment limitation and habitat degradation.

The current use of dredges to harvest and survey scallop populations isn't helping either, with the heavy underwater equipment impacting on both the shellfish and their habitat.



NIWA fisheries scientist Dr James Williams worked with colleagues using the ROV, above, to gather underwater video images of scallops lying on the seabed. (*Lana Young*)

Previous pages: Glittering like an underwater necklace, tiny eyes help a resting scallop sense movement or predators. Each eye is about the size of a poppy seed. (*James Williams*)

NIWA fisheries scientist Dr James Williams has been working with University of Canterbury experts Professor Richard Green (computer vision) and Associate Professor Michael Hayes (mechatronics) to develop innovative, non-invasive alternatives for surveying scallops and harvesting.

And thanks to a combination of some smart computer algorithms, and thousands upon thousands of little blue scallop eyes, an answer may now be on the horizon.

Independent scientific surveys are essential to the management of a sustainable scallop fishery, says Williams.

The surveys estimate population abundance, distribution and size. Together with information on scallop biology and ecology and the nature and effects of fishing, estimates are generated to determine the number or biomass (combined weight) that can be harvested sustainably.

"Surveys are really the bread and butter of monitoring how our fisheries are doing."

Using dredges for surveys, however, not only comes at an environmental cost, but is also inefficient because the dredge catches only a proportion of the scallops in its path.

"The idea was to come up with a better, more effective way than dredging. One that doesn't negatively affect undersize scallops, other organisms and their supporting habitats."

With the help of NIWA's Marine Science Advisor Dr Barb Hayden, Williams started working with the Computer Vision team at the University of Canterbury. Several thousand images of scallops were captured using underwater cameras mounted on the university's underwater drone (ROV). The images were then used by data scientists in designing algorithms to detect the scallops.

"To be honest I was pretty dubious about whether it could be used for scallops," acknowledges Williams.

"Our species, *Pecten novaezelandiae*, is very cryptic. It recesses itself into the seabed, essentially covering itself in a fine layer of sand or silt to hide.

"I thought, oh it's going to be really difficult to see using cameras."

“We can achieve a high detection rate using image-based machine learning”

Dr James Williams

This is where those beautiful scallop eyes come squarely into frame. Scallops are bivalve molluscs with two fan-shaped shells connected by a hinge. When the two shells open for the scallop to feed, there are up to 200 eyes staring out from a multitude of sensory tentacles found along the margins.

Scallops use these eyes to detect motion and changes in light intensity that may indicate a predator approaching. Unlike many other bivalves, scallops can also move using jet propulsion by clapping their shells together.

“They can actually lift themselves off the seabed and swim up to a few metres,” says Williams. All of this is extremely relevant when it comes to bringing artificial intelligence (AI) into play.

“It’s those distinctive features, the tentacles and the eyes, which stick out when the scallop is at rest that you can see in the camera imagery,” says Williams. “The work to date suggests that we can achieve a high rate of detection using this image-based machine learning.”

University of Canterbury Computer Science PhD student, Tim Rensen, explains: “The artificial intelligence is what’s called a convolutional neural network (CNN) which basically slides a bunch of stencils over the camera image. It’s a scallop-shaped stencil and when it goes over a scallop, it fits, the pattern fits and that’s a match for a scallop.”

A key step in the development process involves using divers to compare what the computer is finding with what is actually on the seafloor.

Richie Hughes is one of NIWA’s scientific divers involved in this validation step.

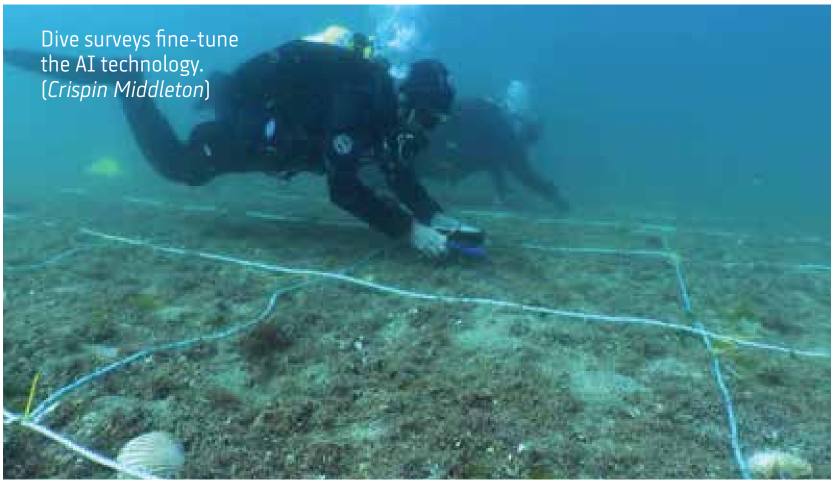
“We carefully search and collect all scallops present in the area of the seabed transect that the ROV has filmed and bring them to the surface to be counted and measured,” says Hughes.

“I had to go through every image and annotate individual scallops by drawing a square around every scallop and categorising whether it was live or a shell.

“When we could clearly see the live scallops in the images on screen and the data science guys were like, ‘this is working well, we’re getting a good detection rate’, for me that was the turning point where I thought, ‘maybe there’s something in this’.”

Regularly opening their shells, scallops leave a distinctive imprint on the seabed. (*James Williams*)

AI technology identifies individual shellfish by sliding computer-generated stencils over video images.



Dive surveys fine-tune the AI technology. (*Crispin Middleton*)

Williams says it has opened his eyes to the potential of imagery and AI to gather so much more data.

"To be able to capture high quality underwater images and automate the process of detecting and measuring the features of interest by training the computer is amazing."

The work has only just begun. With recent funding approval of $1 million from MBIE's Endeavour Fund, this 'Smart Idea' research project will continue over the next three years.

The first stage is the refinement of the image and AI-based method of accurately surveying scallops. The focus here is on collecting more imagery of scallops in different environments. Detectability can vary depending on habitat and water clarity and this will need to be programmed into the machine learning system to help finalise detection and measurement of the shellfish.

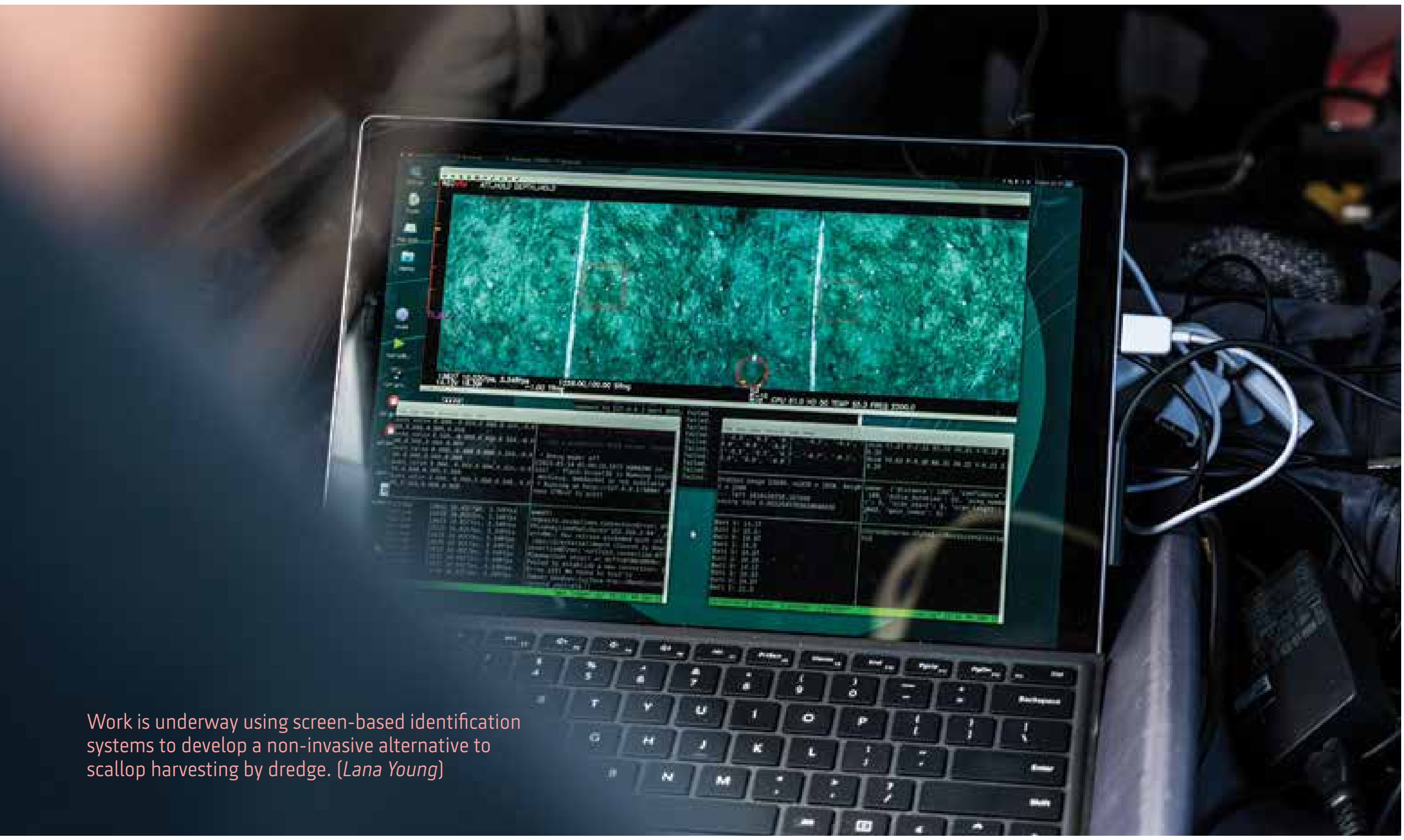
The second stage is to develop a proof-of-concept, non-invasive harvester that differentiates scallops from other objects on the seabed, assesses whether they are of legal size and picks them up with minimal contact with the surrounding seafloor.

Williams is excited about what the research team has achieved already and where the project is heading. He's equally enthusiastic about the implications of this data science collaboration for future marine research.

"To be able to overlay images and stitch them together so you build up a photo mosaic image of the entire seabed is going to rapidly advance our understanding of benthic habitats and marine ecosystems."

He points out that the use of AI is rapidly spreading across NIWA's research platforms and says the potential benefits are enormous

"It is changing the way we do our science." W&A



Work is underway using screen-based identification systems to develop a non-invasive alternative to scallop harvesting by dredge. (*Lana Young*)

Fishing with data

"Data science can potentially help change the way the fishing industry operates"

Dr Alan Tan

Data scientists are multi-disciplinary, mixing computer science, maths and domain knowledge with the latest technology. They are also masters of finding patterns.

To work effectively, the data scientist first needs to understand what the researcher wants to achieve and from that, develop machine learning algorithms to create computerised solutions.

Dr Alan Tan is one of NIWA's eight-strong team of data scientists.

"When I came to NIWA I could see that there was big potential for data science here," he says.

Tan is currently working with marine ecologist Dr Emma Jones to help her find patterns in fish. Jones is leading an MBIE-funded, underwater fish identification project which aims to generate a system to give commercial fishing operators real-time control over what they're catching.

The data science part of the project involves designing the machine learning tools, used in combination with underwater cameras on the trawl net, that can identify what species of fish are being caught and to count and size them.

Having this information on screen, and on deck, allows the fishing operator to reduce their bycatch by knowing what fish to let into the trawl net.

The project is also working to develop a trawl net with a release mechanism that could be triggered by computer vision to free under-sized or unwanted catch.

The backbone of this work is the use of video imagery that can then be interpreted and understood by a computer via coding and subsequent algorithms.

Tan is also working closely with the University of Washington. The university has expertise in machine learning for deepsea fishing, developing models for the detection and classification of fish species.

"It's a good opportunity to establish this international collaboration," says Tan.

Tan provides the link between Jones's research goals and the data science. This helps ensure the underwater imagery being collected on the fishing boat is used in the best way by the machine learning team.

"We decide what kind of data we need and make sure we have that."

The data is then electronically mapped to 'teach' the computer to detect species. A prototype is developed which can be tested in a real-life setting.

"This project is a good example of how data science can potentially help change the way the fishing industry operates," says Tan.

"It allows much more control over what is caught well before it is brought to the surface."

What's in a fish's ear?

The tiny ear bone of a fish holds a wealth of information. Gather enough and you get a snapshot of what's happening beneath the waves. Stuart Mackay explains.

A microscope reveals the tiny growth rings on a 16-year-old snapper's ear bone (otolith). (*Stuart Mackay*)

It's just after 4am and the Sanford fish-processing shed on Auckland's Viaduct Basin is a riot of activity.

Hundreds of snapper, fresh off the boat, are coming down the line. Skilled filleters make short work of the cuts for restaurant tables or supermarket chillers. Whole fish are readied for export.

Two NIWA researchers, Rikki Taylor and Dr Darren Parsons, are also hard at work on the line, sampling for science.

Fisheries New Zealand (FNZ) is the government agency that manages the sustainability of our fisheries. It does this by determining the dynamics of individual fish populations and deciding how many fish recreational anglers and commercial operators can catch.

This requires data – lots and lots of data, about a range of factors including age, sex and the growth rates of target species. Fisheries scientists use this data to produce detailed models of the health of regional populations and it is these models that guide the FNZ decisions underpinning sustainable fisheries.

NIWA has been providing independent fisheries science to FNZ since the 1980s. Much of the data driving this work is gathered at sea during targeted research surveys carried out by NIWA's research vessels, *Tangaroa* and *Kaharoa*.

But the thousands of fish prepared for market every day in processing sheds across the country also provide much additional data.

Down on the Viaduct processing line, Taylor and Parsons are carefully working their way through a randomly selected sample of the catch, measuring each fish and then meticulously removing their tiny ear bones for detailed investigation.

"The boats that are coming in are part of our sampling lens," says marine ecologist Parsons.

"They are going out there fishing and they see what is happening first hand. We are in partnership, piggy backing along to get a good view of what is happening in the water right now."

Later, back in one of NIWA's Auckland laboratories, fisheries modelling technician Helena Armiger puts

Otolith data, combined with other information sources, helps build a detailed picture of fish population structure and health. This enables stocks to be managed sustainably. (*Nava Fedaeff*)

“The boats that are coming in are part of our sampling lens”

Dr Darren Parsons

Fisheries researchers Rikki Taylor and Dr Darren Parsons carefully gather otolith samples during the early morning shift at Sanford’s Auckland fish-processing shed. (*Stuart Mackay*)

those ear bones under the spotlight.

Like trees, fish produce annual growth rings. These rings are most pronounced in their ear bone – or to give them their scientific name, the otolith. Using her microscope, Armiger can carefully count the individual rings and work out a range of factors, including the exact age of each fish.

It takes about 10 minutes to age one otolith. Examine a large enough sample from each catch and you start to build a picture of the age structure and the health of the target fishery.

In the last year alone, in processing sheds from Leigh to Bluff, NIWA researchers extracted over 17,000 ear bones, from key species like snapper, tarakihi, trevally and blue cod.

“We don’t let an otolith go until two readers agree on an age, so we can give the best possible information to FNZ,” says Armiger.

If you know how many fish you are catching and how the age structure of your fish population changes over time, you can track the sustainability of your fishery. Lots of young fish, for example, is a sign of strong recruitment and a growing population.

Combine the information gathered from the otoliths, with other data sources such as biomass estimates from standardised research surveys or catch rates from commercial operations, and fisheries modellers can build a detailed picture of the health of specific fish populations.

“Obtaining information on the age structure of the commercial fishery is crucial to successful stock assessments,” says Marc Griffiths, Principal Science Advisor with FNZ.

“If a stock is doing well and it is above its target, we can increase the catch. If the stock is down below the target, we can cut back and rebuild the stock.”

Rikki Taylor doesn’t mind the early starts.

“We measure one fish here today, that will be one line of data. But this builds into a huge data set for Fisheries New Zealand.”

She also knows the difference that data will make.

“When you or I go out fishing on the weekend, I know there are going to be fish.”

Principal technician Helena Armiger aging a snapper otolith. (*Stuart Mackay*)

Back cover photo:

A relatively benign Buller River heads for the Tasman Sea near Westport. The Buller surged bank to bank in July with peak flows in the gorge behind reaching up to 13m above normal levels. (*Stuart Mackay*)