National SCIENCE Challenges

SUSTAINABLE SEAS

Ko ngā moana whakauka

Research Book 2018

Our Vision

> Aotearoa New Zealand has healthy marine ecosystems providing value for every New Zealander

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National Science Challenges
SUSTAINABLE SEAS
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Projects displaying this symbol are supported by the Sustainable Seas Innovation Fund.

Introduction

Our vision is that Aotearoa New Zealand has healthy marine ecosystems providing value for every New Zealander. To support this vision the Sustainable Seas National Science Challenge is developing the knowledge and tools to support ecosystem-based management (EBM) for the marine environment.

EBM is a holistic and inclusive way to manage competing uses and demands on marine resources while also incorporating people's values. It supports the development of a sustainable blue economy that works innovatively with marine resources to add value, improve livelihoods and enhance ecosystem health. We have interdisciplinary teams of researchers, Māori and stakeholders throughout the country who are working on innovative research projects to explore EBM.

The knowledge and tools we are developing will be useful for marine resource managers, Māori, industry and communities. They will help to assess impacts on marine ecosystems and associated resources, activities, values and cultural significance.

This Research Book summarises the progress made by Challenge research projects up to October 2018. The first phase of our research will be completed in June 2019. Check our website for the latest research updates.

I would like to thank everyone who has taken the time to engage with us so far – we look forward to continuing to work with you and others.

DR JULIE HALL
SUSTAINABLE SEAS NATIONAL SCIENCE CHALLENGE DIRECTOR

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Human activities
Humans, along with their multiple uses and values for the marine environment, are part of the ecosystem.
Collaborative decision-making
Collaborative, co-designed and participatory decision-making processes involving all interested parties.
Knowledge-based
Based on science and mātauranga Māori, and informed by community values and priorities.
EBM
Ecosystem-based management for Aotearoa
A holistic and inclusive way to manage marine environments and the competing uses for, demands on, and ways New Zealanders value them.
Sustainability
Marine environments, and their values and uses, are safeguarded for future generations.
Adapts
Flexible, adaptive management, promoting appropriate monitoring, and acknowledging uncertainty.
Tailored
Place and time specific, recognising all ecological complexities and connectedness, and addressing cumulative and multiple stressors.
Co-governance
Governance structures that provide for Treaty of Waitangi partnership, tikanga and mātauranga Māori.

Overview

Data for 1 July 2016 – 30 September 2018

$31.3m
OVER 5 YEARS

222
RESEARCHERS
49 early career researchers*
50 researchers identify as Māori

FROM
36
ORGANISATIONS ACROSS NZ

WORKING ON
40
PROJECTS
13 have Māori researcher(s) on the team

Bringing together New Zealand's best teams to do world-leading research

Engaging with Māori and stakeholders (Government, communities, industry, NGOs)

22 PARTNERS/ ADVISORS
FROM 16 ORGANISATIONS
who are directly involved in research projects

3,700
MEMBERS OF THE PUBLIC SURVEYED
about ecosystem-based management, the marine economy and/or their marine values

100+
MEETINGS WITH IWI, HAPŪ, WHĀNAU OR OTHER MĀORI ORGANISATIONS

250+
WORKSHOPS & PRESENTATIONS

100+
MEETINGS WITH STAKEHOLDERS

*MBIE definition: students, postdocs, researchers with 1 – 4 years experience

Programmes

Our Seas

Developing ways to enhance engagement and participation across all sectors of society, resulting in more efficient and effective decision-making.

Valuable Seas

Developing ways to incorporate economic, social, environmental, spiritual and cultural marine values in decision-making, and identifying innovative ways to add value to the marine economy.

Tangaroa

Developing innovations that enable Māori to participate as partners in marine engagement, provide for the practice of tikanga/Māori custom, and support economic growth.

Vision Mātauranga

Working with Māori to capture the needs and aspirations of all sectors of society, and unlock the potential of Māori knowledge, resources and people.

Managed Seas

Using the knowledge generated by the Challenge to develop innovative and effective tools that support decision-makers and enable EBM.

Dynamic Seas

Using biophysical science to investigate how ecosystems work, are connected and how they respond to change; and providing an evidence-base for effective EBM.

Our Seas

PROGRAMME LEADER
DR CAROLYN LUNDQUIST,
NIWA/UNIVERSITY OF AUCKLAND

> We encourage all New Zealanders to help manage our oceans sustainably by participating wherever possible in marine decision-making.


© Chris Williams

SUMMARY

Our research aims to identify new ways for people to get involved in making decisions about the management and future of Aotearoa New Zealand's marine estate. Ocean management processes need to be collaborative, with input from Māori, non-industry stakeholders and the public. Effective management should incorporate indigenous knowledge and support Treaty of Waitangi partnerships.

This programme explores participatory processes and frameworks that involve people in decision-making. We are building on increasing interest from New Zealanders in maintaining healthy estuaries, coasts and oceans. By including a diversity of Māori and stakeholders in decision-making, there is an increasing likelihood of gaining a 'social licence to operate' because people perceive that their values are being considered and accounted for.

We are developing new frameworks that provide the opportunity for all sectors of society to participate in ecosystem-based management (EBM). This will help develop solutions for ocean management that benefit communities, the economy, and support people who make their living from the marine environment.

WE ARE:

- Providing participatory frameworks that support Māori and stakeholder involvement in shaping Aotearoa New Zealand's marine management.
- Providing best practice guidance for engaging with Māori and stakeholders with an interest in marine resource management.
- Enabling industry to understand how best to approach social licence to operate.
- Helping Māori and stakeholders engage with, and develop trust in, marine science.

At the beach. © Paula Blackett, NIWA

ONGOING

Testing participatory processes for marine management

PROJECT LEADERS	DURATION	BUDGET
Dr Paula Blackett, NIWA & Prof Richard Le Heron*	Apr 2016 – Jun 2019	$1,310,000

We are identifying the best ways to involve interested parties in decision-making about the governance and management of marine environments.

In Aotearoa New Zealand and internationally, there is a move towards using collective or 'participatory' decision-making in marine resource management.

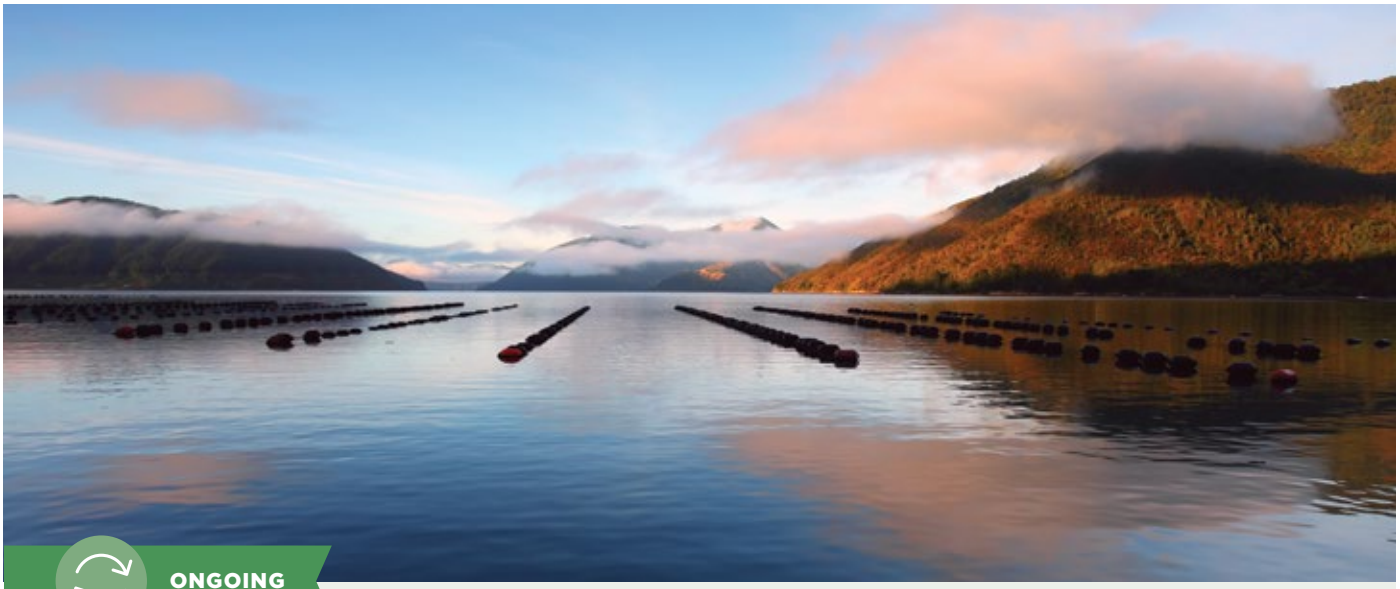
Our research found that people participate in decisions about the marine environment in different ways depending on the opportunities available. For example, community groups and initiatives (e.g. coast care) tend to form when a problem is local and can be solved with local actions and resources. Activist groups tend to appear when a group cannot affect change on their own and need to involve others to make change happen. Others participate through complex collaborative processes established and led by a central or local government agency.

Each of these ways of participating are set against a complex backdrop of institutions, relationships, contested multi-uses, and existing positions, rights and aspirations.

The range of ways in which participation occurs and the different scales at which it happens means that there is no single recipe to follow to ensure success. However, we have identified several factors which are important:

- Encouraging co-learning/social learning within the participation process.
- Providing room for co-design and co-facilitation in any process.
- Building capacity for co-leadership throughout.
- Involving a diverse range of people.
- Recognising that participatory processes are mandated bases for action that must be constantly refreshed.
- Negotiating a vision that is transformational, then focusing on how to implement it.

*University of Auckland



Marlborough Sounds mussel farm. © Aquaculture New Zealand

ONGOING

Frameworks for achieving and maintaining social licence

PROJECT LEADER	DURATION	BUDGET
Jim Sinner, Cawthron Institute	Apr 2016 – Jun 2019	$380,000

We are investigating the use of the term 'social licence' in Aotearoa New Zealand and what factors influence social licence.

Social licence refers to public acceptance of commercial activity. It is not a legal permit, but an indication of community approval and trust. Without social licence to operate, a business can incur delays and costs, and find further development blocked.

From interviews of marine-based businesses, Māori representatives and stakeholders, we have found that the nature of social licence depends on a business's size and ownership. The level of social licence held by a business can change as it expands its markets or as new people join the local community who don't have an existing relationship with the business.

Larger companies often engage with interest groups and organisations rather than individuals or local communities. Māori generally prefer to use social licence concepts based on Māori values and tikanga.

We have also studied how and by whom the term 'social licence' is being used in New Zealand. The term implies that communities have power to grant or withhold approval of commercial operations, but public usage of the term has been dominated by industry and central government voices. They frequently state or imply that industry already has social licence and just needs to maintain or improve it, often without reference to community groups and iwi. Changes in wording by business groups could send a more empowering message to iwi and community groups about seeking their acceptance and trust.

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ONGOING

Navigating marine social-ecological systems

PROJECT LEADER	DURATION	BUDGET
Dr Karen Fisher, University of Auckland	Apr 2016 – Jun 2019	$920,000

Our aim is to identify and/or improve our understanding of institutional, social and cultural factors that need to be incorporated into ecosystem-based management (EBM) for it to be successfully used to manage Aotearoa New Zealand's marine resources.

Our research is using social science to examine key issues in the marine environment. We are engaging with Māori, industry representatives, resource managers, decision-makers, environmental organisations and communities.

We are considering how knowledge about cumulative effects – environmental effects resulting from multiple activities over time – can improve decision-making for the marine environment. In 2016, we hosted a workshop with 40 scientists and senior policymakers from across New Zealand. It supported cross-institutional and cross-cultural dialogue to address issues raised by cumulative effects.

We are using sci-art and creative works to engage New Zealanders about EBM and the risks to the marine environment from human activities. We held sci-art workshops with 1600 students at 16 schools in Nelson and Marlborough. The resulting combined artwork created by the students, *The Unseen* (page 65), was exhibited at Albion Square, Nelson. We have also produced short films and other creative outputs to engage with the public.

Another focus of our research, is to understand how trust among researchers can enhance the quality of knowledge needed for EBM. We are using focus groups and interviews to consider how trust is developed and maintained between Challenge researchers and experts who have diverse interests and experiences. We are also exploring the Challenge's capacity to build trust with Māori and stakeholders.

Maketū spit from the North. © Julian Fitter, Maketū Ongatoro Wetland Society

COMPLETED

Participatory processes for marine ecosystem restoration

PROJECT LEADER	DURATION	BUDGET
Dr Patrick Barrett, University of Waikato	Oct 2016 – Sep 2018	$293,000

We have examined how the Kaituna River re-diversion strategy was developed, to identify success factors in stakeholder and iwi engagement that could be applied in other marine resource contexts.

A long process of engagement between the Bay of Plenty Regional Council and the community has resulted in the partial re-diversion of the Kaituna River into the Maketū estuary. The aim was to restore estuarine habitats by reducing sedimentation, re-establishing wetland and salt marsh environments, and replenishing shellfish and other fish stocks.

Our research examined interactions between the council and the community that led to this outcome. We interviewed key individuals and groups involved in planning and designing the project to identify principles and practices for effective community engagement. We spoke with iwi and hapū, landowners, developers, environmental NGOs, councils and recreational users.

We also examined a large archive on the history of flood and drainage works affecting the estuary.

We found that while marine science was important in developing the restoration strategy, the planning process was ultimately a social and political activity. A social science perspective allowed us to uncover these dynamics, showing how politics, ideas and engagement strategies all contributed to the outcome. The reason the strategy was successful was that it provided the opportunity for multiple perspectives to be heard, and fostered mutual learning among participants and the development of a common vision.

The case provides noteworthy examples of local traditional knowledge being incorporated into technical designs, improving the likelihood of effective outcomes. These insights suggest scientists and engineers engaged in planning processes will be more effective acting as informed facilitators than subject experts.

We need a ki uta ki tai (mountains-to-sea) strategy to manage cumulative effects on marine systems. © Dave Allen, NIWA

ONGOING

Enabling inter-agency collaboration on cumulative effects

PROJECT LEADER	DURATION	BUDGET
Dr Kate Davies, NIWA	Jul 2017 – Jun 2019	$300,000

We are producing guiding principles to help decision-makers manage the cumulative effects of human activities and natural events on the marine environment.

Managing the cumulative effects that arise from human activities and natural events is one of the most urgent and complex problems facing marine resource use decision-makers today.

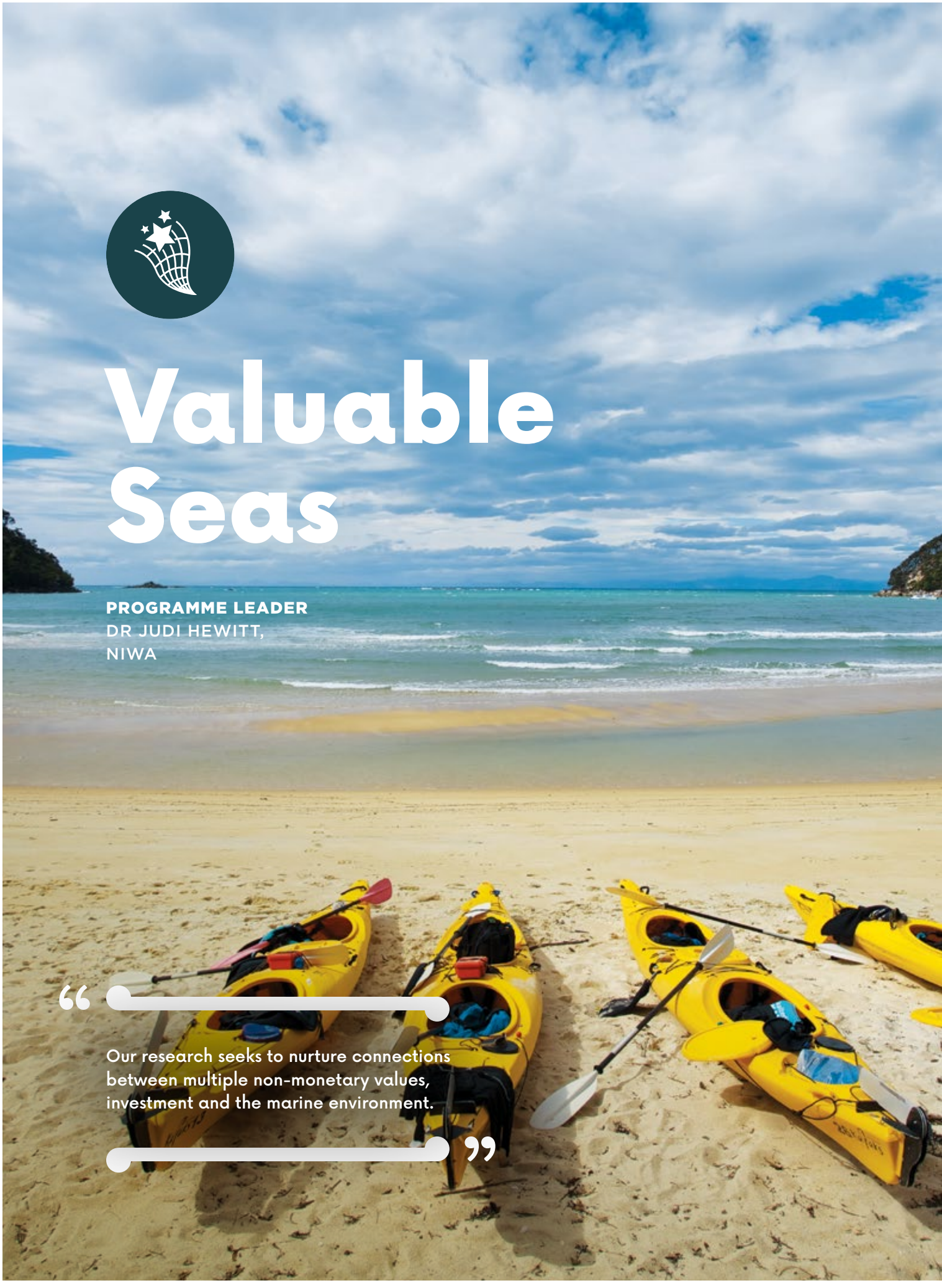
Cumulative effects management in Aotearoa New Zealand is fragmented and inconsistent. This is largely due to disjointed legislative regimes and institutions. There is a need to account for interactions at different scales; data scarcity and uncertainty; and conflicting societal and economic expectations, values, and rights that are poorly integrated into decision-making. A consistent, ki uta ki tai (mountains-to-sea) strategy is needed because human and natural stressors cross political, jurisdictional, cultural and geographic boundaries.

Until now, there has been little impetus for changing behaviours and management of marine ecosystems. Through this research, many of the agencies and institutions interested in cumulative effects management are working together to address this challenge.

We are showing where values, knowledge, and practices can be aligned to create more systematic approaches to managing cumulative effects and developing a framework that will help agencies and institutions do this. Our research recommendations will let managers make more informed decisions within existing legislative and institutional constraints.

PROJECT PARTNERS

The research team represents a range of organisations including: Aquaculture NZ, Bay of Plenty Regional Council, Department of Conservation, Environmental Protection Authority, HH & R Mikaere Ltd, Marlborough District Council, Ministry for the Environment, Ministry for Primary Industries, Ministry of Foreign Affairs and Trade, NIWA, Te Ohu Kaimoana, Tūtaiao, University of Auckland, and Victoria University.



Valuable Seas

PROGRAMME LEADER
DR JUDI HEWITT,
NIWA

> Our research seeks to nurture connections between multiple non-monetary values, investment and the marine environment.

Kayaks at Bark Bay, Abel Tasman National Park. © Mark Meredith, mychillybin

SUMMARY

Aotearoa New Zealand's marine environment has abundant natural resources that could benefit the country's economy. It also has significant social, cultural and spiritual value for generations of New Zealanders.

The way Aotearoa New Zealand governs and manages its marine environment needs to acknowledge and accommodate Māori and community concerns, views and values, as well as resource use. To do this, we must stocktake our natural capital, define values – social, environmental, cultural, spiritual and economic – and indicators of the marine economy.

We are developing processes to measure the values New Zealanders have for the marine environment. Our research seeks to nurture connections between multiple non-monetary values, investment and the marine environment.

We want to understand the economic measures that encourage innovation and add value to the marine economy, whilst also maintaining or improving other values. Our aim is to provide ways to balance kaitiakitanga with economic benefit. We believe that identifying these values, and the marine habitats and ecosystem processes that underpin them, will improve Aotearoa New Zealand's ability to prioritise management actions, make informed decisions, and define trade-offs.

WE ARE:

- Developing a framework to incorporate monetary and non-monetary values in decision-making.
- Identifying the values New Zealanders hold for the marine environment.
- Determining whether ecosystem services can be used to predict how impacts on ecosystem health and function affect human values.
- Developing ways in which blue marine economies can be measured and enhanced.

Mussel farm, baches and forestry in Marlborough Sounds. © Jim Sinner, Cawthron Institute

ONGOING

Development of valuation frameworks and principles

PROJECT LEADER	DURATION	BUDGET
Jim Sinner, Cawthron Institute	Apr 2016 – Jun 2019	$300,000

We are identifying frameworks and principles for recognising the multiple values of the marine environment to support ecosystem-based management.

Values are central to environmental decision-making, but there is no consensus about how they should be used.

Environmental valuation involves describing why places and environments are important. In our research, we engaged with 'values-holders' about their experiences with planning processes in the Marlborough Sounds. We found that formal marine environment valuation and decision-making processes can alienate participants, demanding huge investments of time and personal sacrifices. While assessment of values is intended to improve decision-making, formal processes can generate antagonism that undermine people's confidence in democratic institutions. All valuation processes are imperfect, so our research covers use of both formal and informal methods to enable people to present their values.

We have identified several tentative principles about how to acknowledge diverse values and values-holders and help to maintain confidence in democratic institutions. We have explored valuation frameworks that represent three broad approaches to assessing values for decision-making: cost-benefit analysis, ecosystem services and multi-criteria analysis.

Māori resource management professionals have expressed that ecosystem-based management should sit within the Treaty of Waitangi framework. Among other things, mana whenua want to explore how they can share decision-making. Further engagement is needed to identify frameworks and principles that would give Māori confidence in the decisions being made.

These and other frameworks and principles will be further tested in a Sustainable Seas case study in Tasman and Golden Bays to generate recommendations for future practice.

Fishing on rocks. © Darryl Ward, New Zealand Story

ONGOING

Mauri Moana, Mauri Tangata, Mauri Ora

PROJECT LEADER	DURATION	BUDGET
Dr Shaun Awatere, Landcare Research	Apr 2016 – Jun 2019	$675,000

We are exploring ways to assess the values New Zealanders hold for the marine environment.

Economic benefits are often the primary consideration in marine environmental planning, policy, and decision-making in Aotearoa New Zealand. Our research is exploring the need to recognise ecosystem services and non-monetary benefits of the oceans when planning. We need to acknowledge the importance of ecological, social, spiritual, metaphysical and moral values.

We have identified three key social values emerging from people's association with the sea in Aotearoa New Zealand: (1) Physical benefits and recreational activities, such as surfing, swimming and fishing, (2) Spiritual benefits, such as peace and tranquility, (3) Communal benefits, such as social cohesiveness through shared activities or whānau gatherings at the beach.

Māori are partners in the management of marine environment and are increasingly interested in co-management and co-governance. We have found that, while resource management agreements increasingly recognise the legitimacy of Māori values as part of decision-making processes, there are difficulties in applying this to policy and regulatory systems.

We are advocating a shared governance framework – Te Waka Taurua – to promote Māori values at all stages of the resource management process, from the formation of governance institutions through to application of policy and interventions by government agencies and iwi/hapū. Te Waka Taurua is metaphorical framework where indigenous values and broader social values can be considered in a balanced way, either individually or together. A Waka Taurua is a temporary double canoe, formed by lashing two waka together to achieve a common purpose.

Scorpion fish on a rocky outcrop. © Leigh Tait, NIWA

ONGOING

Measuring ecosystem services and assessing impacts

PROJECT LEADER	DURATION	BUDGET
Dr Drew Lohrer, NIWA	Apr 2016 – Jun 2019	$1,020,000

We are finding new ways to measure and map the ecosystem services provided by marine ecosystems.

Marine species and habitats provide many ecosystem services that are of value to people and communities, such as food, coastal protection, improved water quality and nutrient cycling. We are developing ways to measure two ecosystem services:

1. The provision of refuge habitat that supports young finfish and shellfish.
2. The removal of pollutants, specifically nutrients, from our coastal waters.

We have predicted and mapped variation in the amount of refuge habitat in the Hauraki Gulf (14,000 km^2) and in the Marlborough Sounds (30,000 km^2). The work in the Hauraki Gulf has been validated with survey data from 57 sites.

Excessive nutrients are a problem for coastal ecosystems, and it is important to identify areas that can process or remove nutrients efficiently. Denitrification is one such process that removes nitrogen, but it is difficult and expensive to measure. We have found environmental measures that correlate well with denitrification, and these can be used to predict areas where high levels of nutrient removal occur. We have developed maps of the nutrient removal service for two bays near Auckland: Whitford and Wairoa.

Our results will be useful for regional government agencies seeking to identify marine 'hotspots' of ecosystem service delivery that require protection. We are also working closely with other Challenge researchers to clarify the links between New Zealanders' social and cultural values for marine areas and the ecosystem services they provide.

Seaweed harvesting. © Waikaitu Ltd

ONGOING

Creating value from a blue economy

PROJECT LEADER	DURATION	BUDGET
Dr Nick Lewis, University of Auckland	Apr 2016 – Jun 2019	$1,135,000

We are studying initiatives to create economic value from sustainable marine activities based on healthy ecosystems. We will use the findings to map and model a blue economy.

In recent years, advocates for sustainable oceans have focused attention on building a sustainable 'blue economy', where innovative practices that promote and sustain diverse industries are based on healthy marine ecosystems.

We are studying Aotearoa New Zealand-based initiatives to create economic value from sustainable marine practices and activities. We have considered five broad and overlapping marine sub-economies (iwi, techno-science, commodity, community, and small business), and are investigating connections between them. Our research is:

- Defining what a blue economy means for Aotearoa New Zealand and working with economic enterprises and agencies to ensure that its opportunities are recognised and realised.
- Ensuring that blue economy considerations are incorporated into models of ecosystem-based management.
- Identifying sites and possibilities for transitions to a blue economy.
- Identifying and supporting regional development initiatives to foster regional blue economies and develop their potential.
- Highlighting specific enterprise-level production and investment practices that are helping to bring about a blue economy.

We have found several activities that are helping Aotearoa New Zealand transition to a blue economy including: investor commitments to sustainable futures (Seafood New Zealand's 'Our Promise' campaign), consumer-oriented and community education programmes; the emergence of Māori enterprises with long term and kaitiakitanga approaches to blue economy; blue economy champions (individuals and organisations) who support participatory processes; and a host of practices from precision seafood harvesting to harvesting of seaweed.

Green-lipped mussels. © Dave Allen, NIWA

ONGOING

Ocean acidification mitigation strategies for the mussel industry

PROJECT LEADER	DURATION	BUDGET
Prof Cliff Law, NIWA/University of Otago	Feb 2017 – Jan 2019	$300,000

We are testing techniques to raise the pH of coastal waters around mussel farms to improve shellfish growth.

Coastal waters are becoming more acidic due to increasing atmospheric carbon dioxide and local processes such as microbial respiration. This is a threat to Aotearoa New Zealand's shellfish aquaculture industry, because mussels are less healthy and don't grow as well at lower pH.

We are testing two techniques to see how effective they are at alleviating acidification around mussel farms. The first involves using waste mussel shells, which could raise pH and dissolved carbonate as they break down.

The second is strategic aeration of farm waters at night, when oxygen and pH are naturally lower.

In May 2018, in collaboration with the New Zealand seafood company Sanford, we measured the impact of these techniques at one of their mussel farms. The results are being used in hydrodynamic models, to estimate the benefits for mussel farms at the top of the South Island. We will also test the impact of these techniques on the survival and condition of mussel spat and juveniles.

In addition to assisting the shellfish aquaculture industry, this research may contribute to mitigation of acidification in natural coastal ecosystems.

Maui A platform in Taranaki Bight. © Shell New Zealand

COMPLETED

Re-use of offshore infrastructure and platforms: assessing value to communities, industry and the environment

PROJECT LEADER	DURATION	BUDGET
Dr Alison Lane, ERM New Zealand Limited/Elemental Group	Oct 2016 – Mar 2018	$247,000

We have investigated the regulatory, social, economic and environmental considerations relating to decommissioning offshore oil and gas infrastructure in Taranaki, New Zealand.

Five offshore oil and gas installations in Taranaki are approaching the end of their life and are expected to be decommissioned between 2020 and 2046.

Our research explored the impact of three decommissioning options – complete removal, partial removal, or not removing offshore structures. We reviewed:

- International frameworks for re-use and decommissioning.
- Ocean floor ecological studies and marine mammal sightings.
- Cost-benefit analysis of decommissioning options.
- Community attitudes and awareness.

In some regions in the world, there is evidence of environmental benefits if decommissioned infrastructure is left in place. We found no evidence that these benefits would apply to the Taranaki marine ecosystem. However, our research did not include fish surveys, due to safety issues from working close to offshore structures.

The New Zealand Government is developing a national framework for decommissioning and this will require consultation and engagement with New Zealanders and stakeholder groups. Our studies revealed a limited awareness of the implications of different decommissioning options. We held hui with local iwi who indicated a clear desire to be equal parties in these discussions.

We recommend that the oil and gas industry engage with iwi representatives and the wider community to ensure that their voices, values and opinions are incorporated into decommissioning plans.

Tasman and Golden Bays on the 29 September 2014 with large sediment plumes from a storm event. © Cawthron Institute-generated image from Landsat-8 data (provided by the United States Geological Survey)

ONGOING

Forecasting contamination risk for shellfish harvest and beach use

PROJECT LEADER	DURATION	BUDGET
Ben Knight, Cawthron Institute	Feb 2017 – Jun 2019	$450,000

We have developed a near real-time forecasting tool for Tasman and Golden Bays to help predict when aquaculture sites and beaches are safe to access.

Seawater in Tasman and Golden Bays is periodically contaminated with bacteria, causing temporary closure of commercial shellfish harvest and public beaches. The aquaculture industry and regional councils want more accurate and timely forecasting to better predict and manage risk. We are creating the first near real-time forecasting tool for the region, which will improve the prediction of contamination risk.

The coasts are at the 'end of the pipe' for discharge from local rivers and streams, so seawater quality is sometimes compromised by bacteria from land-based activities. This can affect the revenue of shellfish growing areas and close local beaches to public use.

Although improved land management practices may ultimately reduce contamination risk, our research aims to improve forecasting so that beaches are not closed when bacterial levels are within safe limits and harvesting of shellfish is not unnecessarily delayed.

Our team of national experts, from the Cawthron Institute, NIWA and MetOcean Solutions Limited, have built connected models from the land to the region's main rivers to the sea. We have combined river flow estimates with river bacterial measurements to predict contaminant discharges on the coast. The model is a daily forecast – like a weather map – of river plumes entering the sea and contaminant measurements that accurately estimate contaminant risk.

Kina. © Matt Miller, Cawthron Institute

ONGOING

Huataukīna tō iwi e: Developing marine bioactives from kina

PROJECT LEADER	DURATION	BUDGET
Dr Matt Miller, Cawthron Institute and Ruihana Paenga*	Jul 2017 – Jun 2019	$300,000

We are working collaboratively with hapū in Tairāwhiti to develop bioactives from kina. Bioactives can treat diabetes, heart disease and other serious conditions.

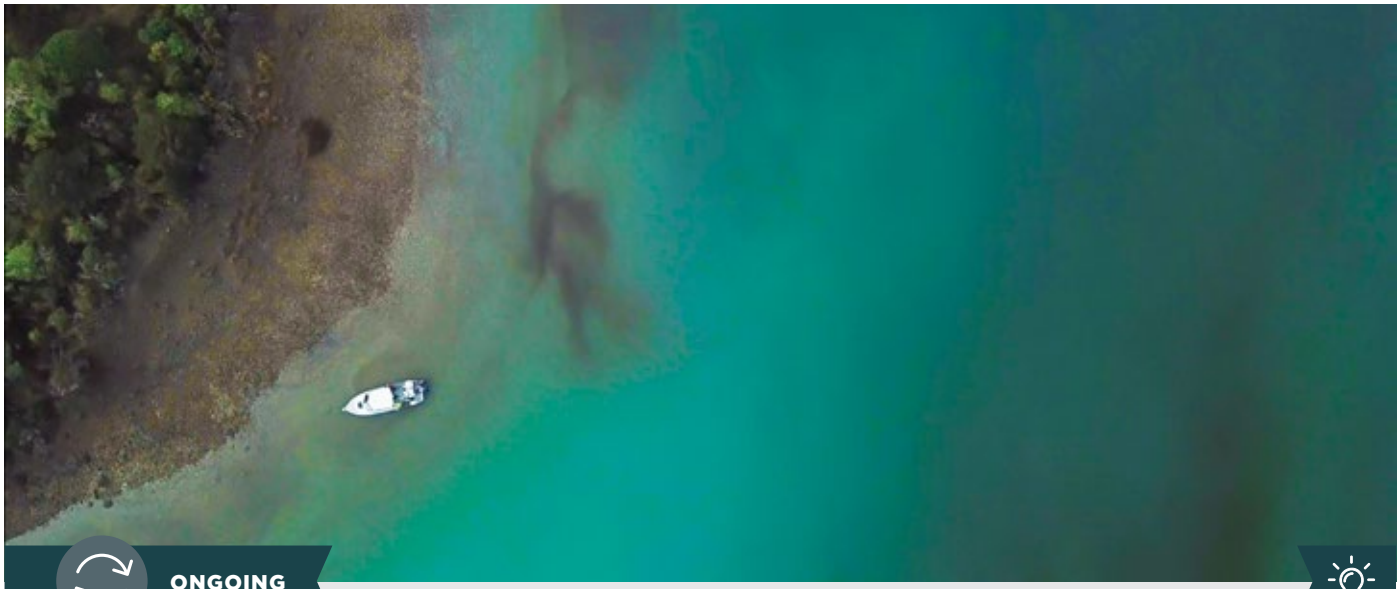
Aotearoa New Zealand already has a reputation in Asian markets for high-quality, sustainable and safe food products. Kina is challenging to export to Asia as a high-value food product, but there is potential to export kina bioactives as a health supplement. Our research is focused on the potential use of the non-edible shell rather than the edible flesh. It is also examining how to reduce waste by using the shell, offal, spines and roe of the kina.

We aim to stimulate economic development in the Tairāwhiti region by developing high-value nutraceutical and functional food ingredient products from kīna (*Evechinus chloroticus*) sourced from the marine areas of East Coast whānau.

We have harvested kina during different seasons and are testing three key oil extracts (echinochrome A, echinenone and bioactive fatty acids). We have been working with local whanau hapū to collect and analyse the results. Once we have collated our results across the four seasons, we will identify the most beneficial bioactives from pre-clinical trials and explore ways to scale-up their extraction.

The phrase 'huataukīna tō iwi e' comes from the waiata 'Hikurangi' composed by Kuini Moeau Reedy, based on an old Ngāti Porou phrase that means: when the kaimoana is abundant and the whanau hapū have strings of kīna, whānau are prosperous and healthy.

*Hikurangi Enterprises



Bloom of toxic algae (*Alexandrium pacificum*) in Nydia Bay, Pelorus Sound. © Lincoln MacKenzie, Cawthron Institute

ONGOING

Early detection of harmful algal blooms

PROJECT LEADER	DURATION	BUDGET
Dr Lincoln Mackenzie, Cawthron Institute	Jul 2017 – Jun 2019	$300,000

We are trialling two innovative technologies to detect and monitor harmful algal blooms in coastal waters.

Harmful algal blooms are natural phenomena that sometimes occur in coastal ecosystems. They can have detrimental effects on human health, seafood harvesting and aquaculture businesses.

We are trialling two new complementary technologies for detecting and monitoring algal blooms. Our aim is to apply new technologies and develop simple, cost-effective and sensitive tests that can be used by public health agencies, the aquaculture industry and communities in Aotearoa New Zealand.

The first method detects and quantifies algal DNA in the water. In mid-2018, we field trialled this method when a major bloom of toxic algae (*Alexandrium pacificum*) occurred in Pelorus Sound. We were able to estimate the amount of the algae present from multiple locations in the area within 90 minutes of collecting samples.

The method was sensitive, simple and practical, and we are now working to improve estimates of the quantities of algae present.

The second method we are evaluating uses a robotic submersible microscope developed by an American company (McLane Research Laboratories). The device, an Imaging FlowCytoBot, can automatically identify and count microscopic algal cells underwater. Before we can start using it, we need to train the software to recognise local species. For this work, we are collaborating with the aquaculture industry and an international expert who has experience with this instrument.

Our aim is to use these technologies as an early warning system so that impacts on shellfish and finfish harvesting are minimised, and risks of recall of contaminated products are reduced.

ONGOING

Energy from tidal currents – Kick-starting a new marine industry with huge potential

PROJECT LEADER	DURATION	BUDGET
Brett Beamsley, MetOcean Solutions	Nov 2017 – Jun 2019	$300,000

We are investigating whether generating electricity from the strong tidal currents within Cook Strait is viable for Aotearoa New Zealand.

Cook Strait, which is in the focal area for the Sustainable Seas Challenge, is potentially one of the best sites in the world for generating power from tidal currents. Tidal currents are a highly predictable renewable energy source. Our research is exploring how many tidal turbines would be enough to generate energy to power a major city like Auckland (about 1000 megawatts).

One major barrier to industry investment in tidal current energy is lack of knowledge about the scale of investment required.

We are using computer models to estimate power output from tidal flows within Cook Strait and determine the best locations within the Strait and the size required for a tidal turbine farm that could generate 1000 megawatts of electricity. We have also developed novel tools and methods to make it possible to rapidly estimate the power output from tidal energy.

Another potential barrier to development is whether farms will affect the natural tidal flows, so we are also analysing their impact on tidal flows.

Our research aims to provide the tools and quantitative data to stimulate industry investment and kick-start a new sector of the marine economy.

Kaikōura coastline. © Dave Allen, NIWA

ONGOING

New blue economy in Kaikōura: a participatory process approach

PROJECT LEADER	DURATION	BUDGET
Dr Nick Lewis, University of Auckland	Feb 2018 – Jun 2019	$110,000

This project aims to help the Kaikōura community and businesses build a sustainable blue economy as they recover from the 2016 earthquakes.

Following the November 2016 earthquakes, Kaikōura's economy is being redeveloped amid huge disruption to marine ecology and everyday social and economic life.

Our project is working with Kaikōura's communities and businesses to develop a practical, long-term 'value proposition' for a sustainable blue economy. We are exploring opportunities that complement other efforts to rebuild the region's economy and balance social, economic and environmental aspirations.

In interviews with members of the Kaikōura community, we found strong support for developing a blue economy and well-supported community organisations empowered to action their vision. Kaikōura has prominent blue economy champions, strong iwi-Council-business linkages, and is in the process of building a platform for a successful blue economy.

Challenges for the Kaikōura community will come from attracting investors, channelling growth to meet community aspirations, and managing the tensions between a sustainable blue economy and a growth-centred model based on quantity not quality.

Tangaroa

PROGRAMME LEADER
LINDA FAULKNER,
DIRECTOR, TUTAIAO LTD

> We recognise that Māori knowledge, practices and interests must be at the heart of an effective ecosystem-based management approach in Aotearoa New Zealand.


© Graham Prentice, mychillybin

SUMMARY

Throughout Māori history the sea has played a dominant role given the ancestral connections and existence of Māori as island peoples for thousands of years. The knowledge established through this connection, alongside the increasingly significant customary and commercial interests held by Māori in the resources of the sea, are contributing to achieving the Challenge's mission.

The Tangaroa programme is dedicated to exploring the development of ecosystem-based management (EBM) that is founded on, and informed by, mātauranga and tikanga Māori. It is looking at mātauranga-inspired innovations that enable Māori to participate as partners and leaders in marine management and decision-making.

Our projects focus on:

- **The practice and maintenance of kaitiakitanga/guardianship in our marine environment.**
- **Understanding the Māori marine economy and future opportunities.**
- **Developing practical resources for Māori to support improved marine management.**
- **Assessing New Zealand's legal and policy frameworks for enabling Māori partnerships and leadership in marine management.**

Our approach recognises that positively supporting Māori partnership and participation in managing our marine resources is important for future generations.

WE ARE:

- Developing an EBM approach that is underpinned and informed by kaitiakitanga.
- Supporting iwi, hapū and whānau understanding and implementation of kaitiakitanga, complemented by EBM science and tools.
- Developing innovatively improved partnership and leadership-based Māori participation in marine management and decision-making.
- Developing an understanding of key components of the Māori marine economy.

Waka voyage. © Takiwai Russell-Sullivan, University of Otago

COMPLETED

Hui-te-ana-nui: Understanding kaitiakitanga in our marine environment

PROJECT LEADER	DURATION	BUDGET
Dr Anne-Marie Jackson, University of Otago	Jun 2016 – May 2017	$120,000

We have examined mātauranga Māori associated with the marine environment by analysing key texts, historical archives, literature, reports and legislation.

Mātauranga Māori is a complex system of experiential knowledge that comprises intergenerational beliefs, values and practices that contribute to the sustainable management of the marine environment. The ethic and practice of kaitiakitanga (spiritual and physical guardianship) is one expression of mātauranga that Māori continue to observe and draw upon.

Understanding, developing and retaining mātauranga and kaitiakitanga specific to the marine environment is vital for ecosystem-based management (EBM) in New Zealand. It is crucial for developing spiritual, cultural, social, environmental and economic practices, indicators and metrics that are relevant. Prior to this study, there was no single repository or index of marine mātauranga and kaitiakitanga.

For this project, we used Kaupapa Māori and critical discourse analysis to examine mātauranga associated with the marine environment by researching archives and reviewing key texts. Our project was Māori-led, with a Māori research team and advisory group. The overarching kaupapa of our research is the hononga tāngaengae (unbroken connection) between Māori and the marine environment from time immemorial to today.

Our research has identified themes that are important to consider when making decisions about the marine environment. We have referenced mātauranga sources, and signposted where to find the information needed to make informed decisions about use of New Zealand's marine resources. Our research report will be of practical use to anyone with an interest in marine resource management, including iwi and hapū, community groups, environmental NGOs, central and regional government, policy makers, industry and researchers.

Full report at sustainableseaschallenge.co.nz.

ONGOING

He Pou Tokomanawa: Kaitiakitanga in practice in our marine environment

PROJECT LEADER	DURATION	BUDGET
Frank Hippolite, Tiakina Te Taiao	May 2017 – Jun 2019	$1,050,000

We are developing a culturally-relevant pathway to enable mana whenua iwi to evaluate and contribute to management of Aotearoa New Zealand's marine environment.

The application and practice of kaitiakitanga has become increasingly difficult for Māori due to growing pressure, exploitation, and cumulative stressors on marine resources. He Pou Tokomanawa is an iwi-led research project, facilitated by Tiakina Te Taiao and in partnership with Cawthron Institute. Our aim is to enable a pathway for mana whenua iwi, to exercise their kaitiaki role over Te Tai-o-Aorere and Mohua (Tasman and Golden Bays). We are contributing to wider ecosystem-based management (EBM) tools unique to New Zealand through a co-designed approach and robust ethics process to draw on mātauranga Māori expertise specific to our case study area.

We are achieving this by:

- Collating multiple mana whenua iwi perspectives, aspirations and priorities.
- Exploring mātauranga Māori to restore the cultural context of Te Tai-o-Aorere and Mohua.
- Evaluating existing Māori environmental views and models to assist the development of a kaitiakitanga framework.
- Working with the wider Sustainable Seas Challenge research community to initiate a marine EBM 'interface' process referred to as 'Te Wheke Hononga'.

To date, our research has collected information through a series of wānanga with iwi. The wānanga have enabled the research team to establish working relationships with the iwi, to better understand current marine management issues and kaitiaki aspirations in the area. This work will be followed by detailed interviews in late 2018 to enrich and complement material already gathered.

Connecting kaitiaki. © Regan Fairlie, Manaaki Te Awanui

ONGOING

Tāhuhu Matatau Te Ao Tangaroa: Empowering kaitiaki

PROJECT LEADERS	DURATION	BUDGET
Caine Taiapa, Manaaki Te Awanui and Anthony Cole*	Jul 2017 – Jun 2019	$290,000

We are collaborating with Māori communities to review scientific information that may support the expression of kaitiakitanga and other kaupapa tuku iho linked with the domain of Tangaroa.

We are seeking to identify key Western scientific developments in areas like marine ecology, spatial planning, real-time monitoring and aquaculture that can be used to support (1) the work of our frontline kaitiaki and (2) the future development of the Māori marine economy.

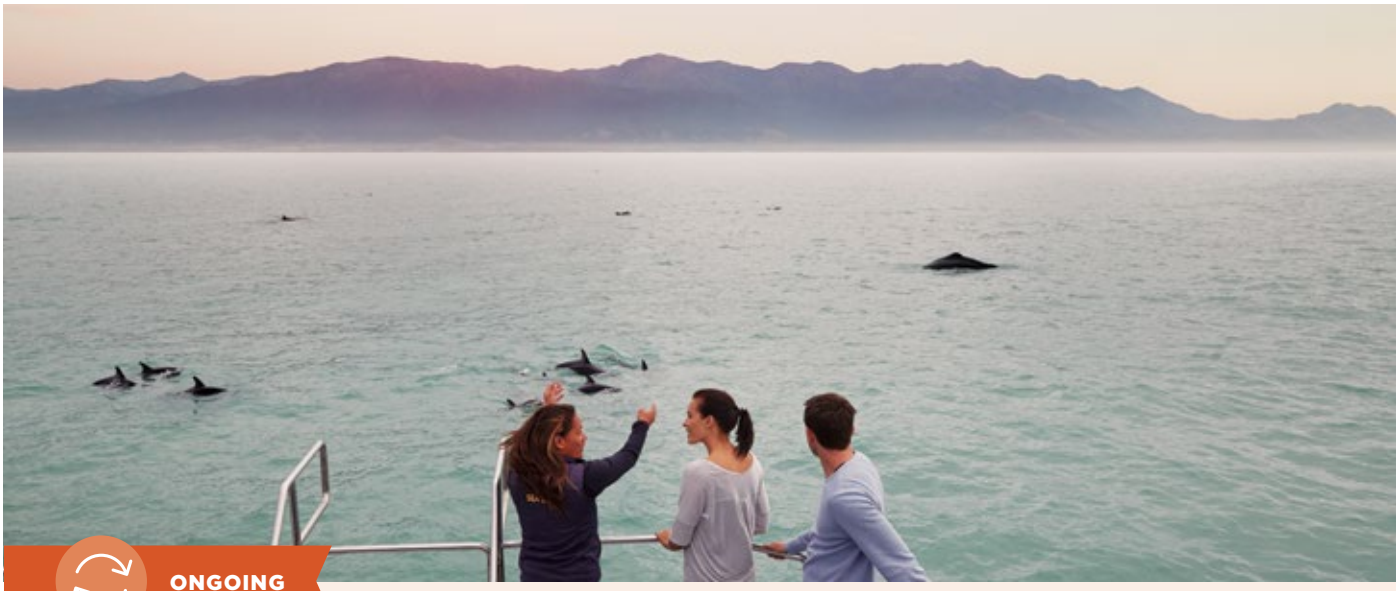
For this project, we are using a newly-developed model of hapū engagement to tailor and develop information we gather into forms that best suit our frontline kaitiaki. This includes developing an online Pataka Mātauranga (digital resource) that frontline kaitiaki and Māori communities can use to support their educational, research, future co-management/ co-governance, and planning activities in the domain of Tangaroa.

We envisage that this Pataka Mātauranga will be customised to differing hapū contexts and will provide a step-by-step approach to exploring emerging knowledge developments in the marine space. We also want to ensure that the presentation of Western scientific knowledge, frameworks, data and tools provides a seamless and intuitive bridge to the language and concepts that our frontline kaitiaki and Māori communities are familiar with.

Progress to date has been guided by participating hapū and kaitiaki of the Tauranga Moana and includes:

- Creation of a prototype, web-based digital resource centre.
- Collection and preparation of digital resources (videos, reports, websites, spatial layers and published papers).
- Creation of graphical user interface and framework for managing metadata.

*iPansophy Limited



Whalewatch Kaikōura. © Sarah Orme, New Zealand Story

ONGOING

Whai Rawa, Whai Mana, Whai Oranga: Creating a world-leading indigenous blue economy

PROJECT LEADERS	DURATION	BUDGET
Dr Jason Mika, Massey University and Dr John Reid*	Feb 2018 – Jun 2019	$500,000

We are working to create a foundation for a world-leading indigenous blue economy in Aotearoa New Zealand.

Māori businesses are on track to be the largest commercial interest in Aotearoa New Zealand fisheries. Māori also have growing customary property rights and governing authority in the management of marine areas. We want to explore regulatory and policy tools to embed mātauranga Māori in sustainable commercial and customary fishing activities.

In this project, we are examining existing models and frameworks of mātauranga Māori used in the management of the marine ecosystem and economy. We are analysing hapū and iwi approaches to integrated management and identifying the structures and operating principles of Māori marine organisations.

Our research aims to:

- Identify policy and regulatory tools that foster marine ecosystem and economic management, and reflect Māori knowledge systems, values frameworks and operating principles.
- Develop kaitiaki business models that embed Māori commercial activity within sustainable ecosystem processes.
- Integrate kaitiaki business models with frameworks for the development of sustainability tracing and authentication systems that will capture premium for Māori marine products.
- Support the commercialisation, extension or adoption of Māori marine management ideas, processes, and products that support economic and ecological development for marine resources and communities.

*University of Canterbury

ONGOING

Tūhonohono: Tikanga Māori me te Ture Pākehā ki Takutai Moana

PROJECT LEADER	DURATION	BUDGET
Dr Robert Joseph, University of Waikato	Nov 2016 – Nov 2018	$195,000

We are investigating how mātauranga and tikanga Māori and New Zealand law can be applied to the marine estate.

The relationship between mātauranga and tikanga Māori, and New Zealand law, and how they apply to Aotearoa New Zealand's marine estate is complex.

Tūhonohono is a cohesive vision of New Zealand jurisprudence – the theory and philosophy of law relating to the marine estate. We are exploring how laws and institutions in New Zealand could evolve to reflect the best values and concepts of New Zealand's founding peoples – Māori and European.

We are:

- Assessing the compatibility of marine policy and law with the mātauranga and tikanga Māori of specific iwi, hapū and whānau within Te Tau Ihu o Te Waka-a-Māui (top of the South Island).
- Investigating how mātauranga and tikanga Māori are applied in the marine environment.
- Exploring what the enablers and/or barriers in New Zealand marine policy and law are when applying mātauranga and tikanga Māori, and what effect this has when making decisions about increased use of marine resources.
- Exploring how legal and regulatory systems could be modified to enable them to work more cohesively with mātauranga and tikanga Māori, to achieve kaitiakitanga and ecosystem-based management outcomes specific to Māori.
- Building on international indigenous examples that have successfully applied indigenous customary law and mainstream law to marine environments.
- Exploring innovative marine management models that implement cohesive jurisprudence and reflect the best values and concepts of both founding peoples.

ONGOING

Whaia te Mana Māori Whakahaere Tōtika ki Tangaroa – in pursuit of Māori governance jurisdiction models over marine resources

PROJECT LEADER	DURATION	BUDGET
Dr Robert Joseph, University of Waikato	Sep 2017 – Jun 2019	$530,000

We are exploring and developing innovative governance tools for the marine environment while enhancing relationships between Māori, the Government and industry.

Our aim is to co-develop and produce research on 21st century Māori governance jurisdiction models, frameworks and best practices, to support ecosystem-based management (EBM) for our marine resources that is consistent with Māori tikanga and mātauranga.

Māori governance jurisdiction describes the right and responsibility of Māori to govern themselves; to make decisions for the future; and to exercise a full range of political and legal power and authority over their people, land and resources including marine resources. There are several forms of jurisdiction that are relevant to the governance of marine resources:

- Regulatory jurisdiction – the regulation of health and safety standards, customary rights, zoning and environmental hazards.
- Territorial jurisdiction – the authority to enact laws and regulations that apply solely within a specified territory.
- Personal jurisdiction – the authority to pass laws in relation to particular persons due to characteristics of those persons.
- Subject matter jurisdiction – the authority to pass laws on specified subjects, eg. customary fishing rights and customary marine title.

This project is a collaboration between the University of Waikato Te Mata Hautū Taketake Māori and Indigenous Governance Centre (MIGC) and Te Tau Ihu o Te Waka-a-Māui (top of the South Island) Māori groups in the Tasman and Golden Bays area.

Dynamic Seas

PROGRAMME LEADER
PROF CONRAD PILDITCH,
UNIVERSITY OF WAIKATO

> Effective ecosystem-based management relies on a thorough understanding of marine ecosystem function, and how it responds to changes.

Land-based activities are an important driver of change in coastal habitats (Waimea Inlet, Nelson). © Rob Suisted, New Zealand Geographic

SUMMARY

We are investigating how human activities and environmental change can affect marine ecosystems. Understanding the biophysical response to these stressors is key to developing robust ecosystem-based management tools for Aotearoa New Zealand waters.

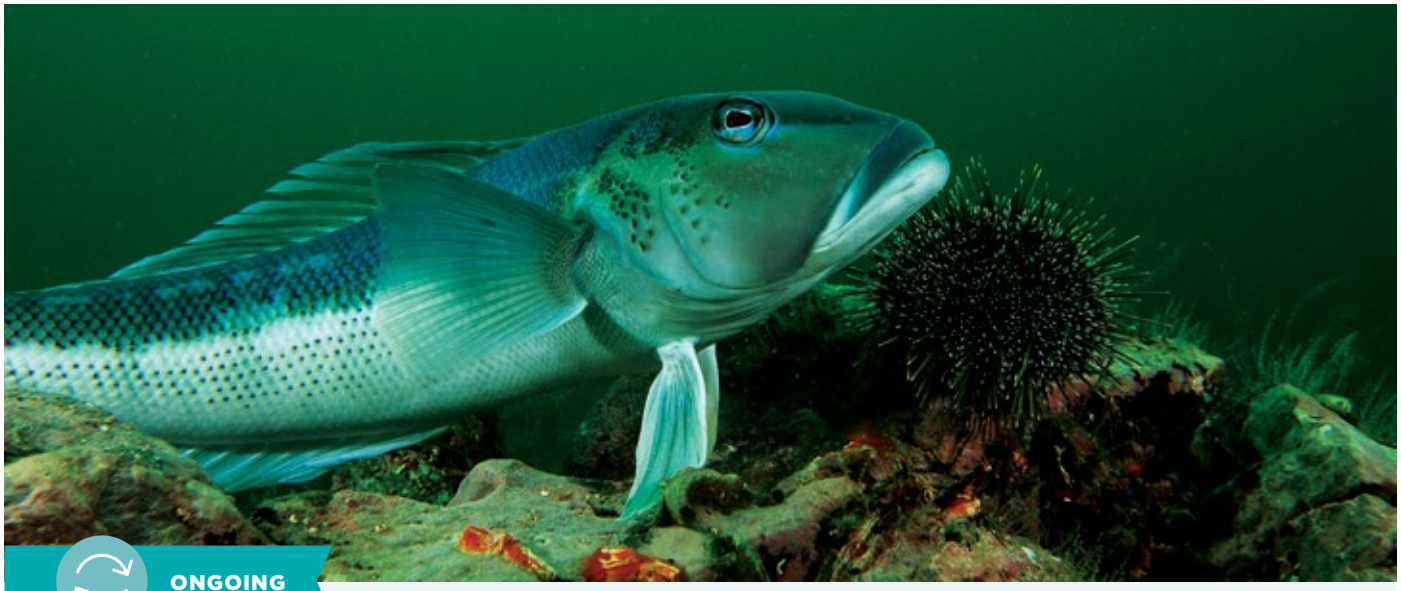
Our research is exploring how marine ecosystems are connected, from coastal waters to deep offshore canyons. We are collecting high-resolution oceanographic data and examining ecosystem connectivity through the movement of contaminants, nutrients and sediment. Using novel biochemical tracking techniques, we are unravelling marine food webs, identifying sources of organic matter and investigating how contaminants are processed. This research will inform the extent or 'footprint' that stressors have on the oceans.

We are also helping to predict when an ecosystem might lose its ability to cope with multiple stressors and reach a 'tipping point' at which rapid transformation occurs. Tipping points can lead to a loss of valuable marine resources and ecosystem services. We are addressing three key questions:

- How do nutrients and sediments from the land contribute to tipping points?
- When is a marine ecosystem likely to reach a tipping point?
- How does seabed disturbance and sedimentation affect coastal organisms and reefs?

WE ARE:

- Developing new modelling approaches for determining ecosystem connectivity and contaminant dispersal.
- Enhancing knowledge of marine food webs and responses to human stressors and environmental change.
- Improving our understanding of tipping points in coastal ecosystems.
- Providing information for decision-makers to support and inform ecosystem-based management of marine environments.



We are investigating the diet and productivity of key coastal fish species such as blue cod. © Steve Wing, University of Otago

ONGOING

Ecosystem connectivity: tracking biochemical fluxes to inform ecosystem-based management

PROJECT LEADER	DURATION	BUDGET
Prof Steve Wing, University of Otago	Apr 2016 – Jun 2019	$1,055,000

We are studying the connections within marine ecosystems and how they are affected by human activities.

Effective restoration and recovery of Aotearoa New Zealand's coastal ecosystems relies on accurate information about their function and the influence of human activities. Our research will help guide effective decision-making by providing information on the connections that are vital for productive, healthy ecosystems.

Our team uses advanced forensic chemistry to understand ecosystem connectivity. We are tracing movement of organic matter, nutrients, metals and contaminants through marine food webs and investigating how they are processed and channelled. Changes in these biochemical fluxes can shape ecological function and the provision of ecosystem services.

We are focussing on three systems where human activities have changed, and are continuing to change ecological function:

1. Coastal and offshore fisheries – we are studying the effects of environmental change and removal of marine resources on the food web structure of coastal and offshore fisheries from pre-industrial to present times.
2. Shellfish survival – we are studying how changes in land-use have influenced uptake of organic matter and contaminants by bivalve populations (including cockles, mussels, scallops and horse mussels).
3. Commercial fish farms – we are studying how waste materials from salmon farming operations are taken up and processed by natural food webs.

A team set up a tipping points experimental site in Manukau Harbour, one of 24 across New Zealand. © Simon Thrush, University of Auckland

ONGOING

Tipping points in ecosystem structure, function and services

PROJECT LEADER	DURATION	BUDGET
Prof Simon Thrush, University of Auckland	Apr 2016 – Jun 2019	$3,470,000

We are investigating how marine ecosystems respond to change, and identifying tipping points, risks and ways of managing them.

We are investigating the effects of multiple stressors and cumulative impacts on marine ecosystems. Stressors can be caused by unexpected events (such as earthquakes) or impacts of human activities (such as increased sediment, nutrients or contaminants in the water), or climate change. These stressors can lead to 'tipping points' when rapid transformations occur, and an ecosystem loses its capacity to cope with change. Tipping points often involve the loss of valuable marine resources, or ecosystem services.

This is the first nationwide assessment of how estuaries and harbours in Aotearoa New Zealand respond to change. Our results show that as coastal waters become more turbid and nutrient levels increase, biodiversity and ecosystem function decline. Rocky shores and kelp forests are also affected, with elevated turbidity decreasing the ability of these systems to respond to change and recover from disturbance.

Coastal and marine ecosystems deliver multiple benefits and services, so it is important to deal with the cumulative impacts of stressors and develop management strategies to reduce their impact. Our research suggests there is a growing need to apply an ecosystem-based management framework to manage risk and sustain New Zealand's coastal ecosystems. This is even more important given the ongoing impacts of climate change.

Fiona Elliott and Joanne O'Callaghan with one of NIWA's ocean gliders used to remotely map the structure of the coastal ocean. © Dave Allen, NIWA

ONGOING

Stressor footprints and dynamics

PROJECT LEADER	DURATION	BUDGET
Dr Craig Stevens, NIWA/University of Auckland	Apr 2016 – Jun 2019	$1,195,000

We are investigating how coastal waters and oceans mix and transport materials that can stress marine ecosystems.

We are investigating the connection between open ocean processes and the movement of stressors, such as contaminants, nutrients or sediment. The information we collect tells us about the potential 'footprint' of a stressor in Aotearoa New Zealand waters.

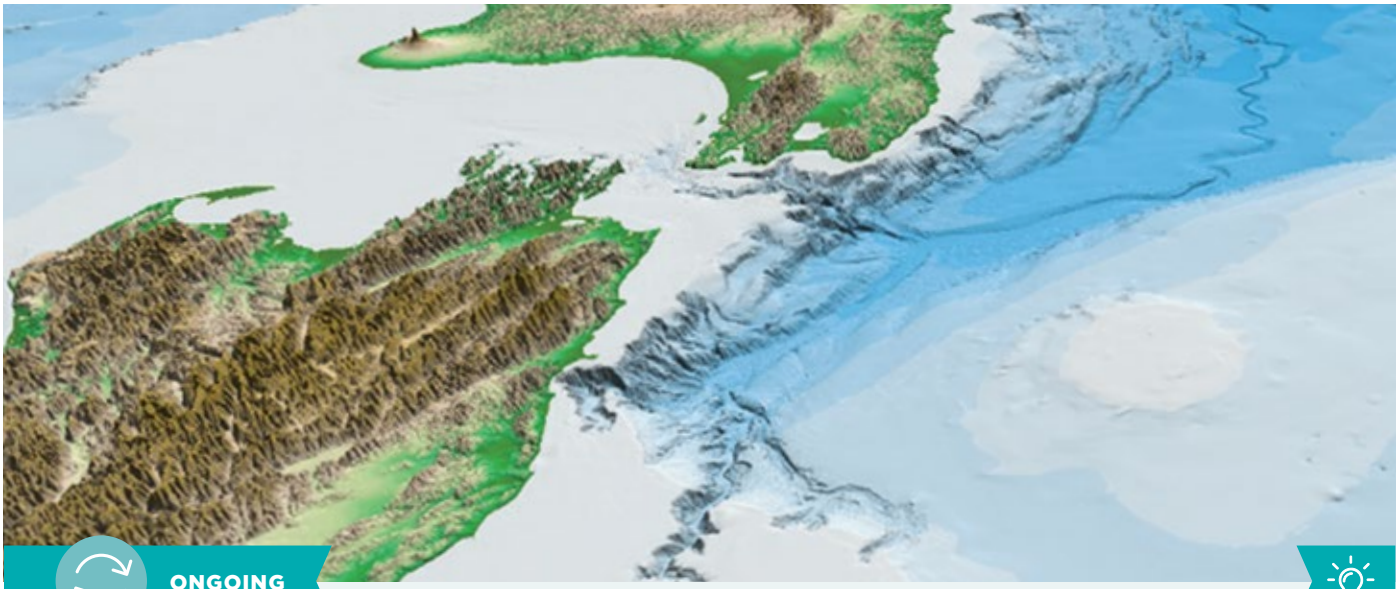
Our research is investigating how stressors from land use or coastal ecosystems connect with the wider marine environment. We are particularly interested in how the coastal areas of Tasman and Golden Bays connect with the open ocean of Cook Strait.

We are using cutting-edge technology – including ocean gliders, drifters and met-ocean buoys – to measure biological and physical properties, and track movement and dilution of water between coastal bays and oceans.

A NIWA ocean glider has now made over a dozen missions through the focal region to measure stratification, layers of varying temperature and salinity in the ocean. This field data is integral to the development of predictive numerical models of stressor dispersal.

We have also used drifters to gather information about the provenance and fate of materials, such as suspended sediment, and bacteria or macroalgal larvae in Tasman and Golden Bays. For one experiment, we released four long-distance drifters. Their satellite positions over two months show that parcels of water that started out 30 kilometres apart ended up many hundreds of kilometres apart.

A better understanding of how biophysical factors can influence or alter these processes, and how these systems interlink is critical for ecosystem-based management.



Bathymetry of central New Zealand region, showing Kaikōura Canyon on the east coast the South Island and Cook Strait canyon south of Wellington. © NIWA

ONGOING

Submarine canyons: connecting coastal and deep-sea ecosystems

PROJECT LEADER	DURATION	BUDGET
Dr Daniel Leduc, NIWA	Oct 2016 – Jun 2019	$300,000

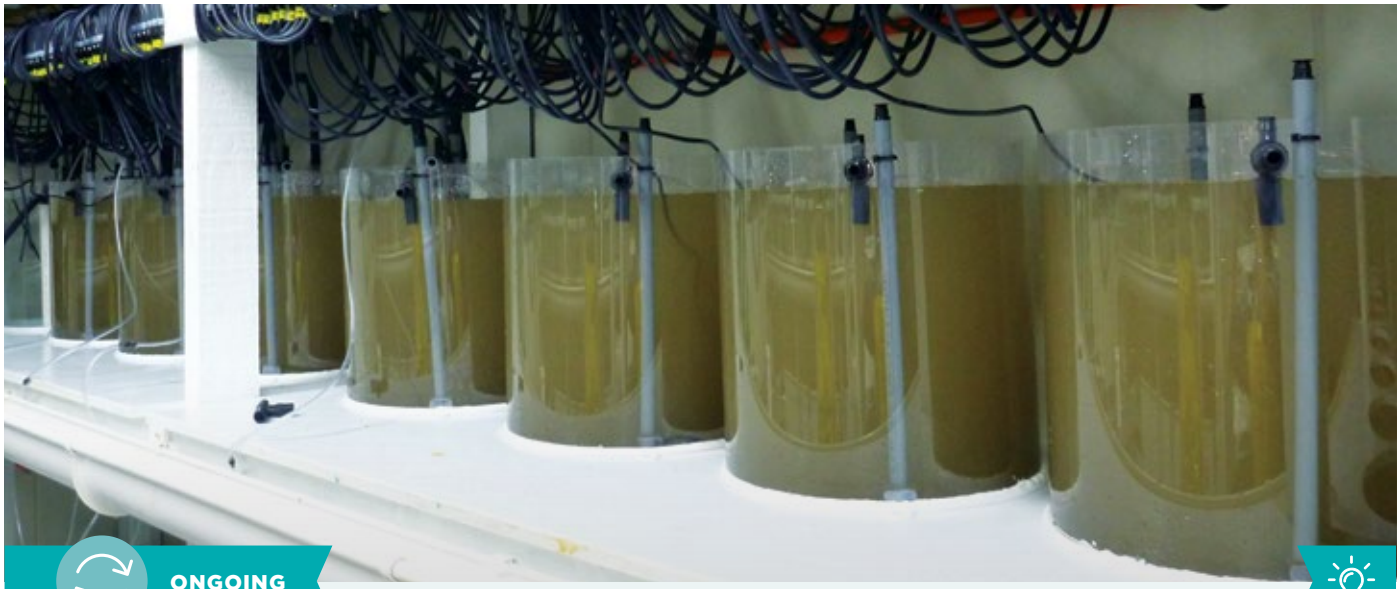
We are investigating how well submarine canyons transport materials from the land into deeper waters surrounding Aotearoa New Zealand.

About 200 million tons of suspended particles wash down our rivers each year. Until recently it was assumed most of this organic material either accumulated or was consumed/decomposed in shallow coastal areas.

Our research shows that Aotearoa New Zealand's environmental footprint goes much further into its marine Exclusive Economic Zone (EEZ) than previously thought. We now understand that submarine canyons can connect the water run-off from an area with fragile deep-sea ecosystems. Until our research, it was assumed that human activities on land were too far away from deep-sea canyons to have any impact on their ecosystems.

Earlier this year, we analysed mud samples from the Kaikōura and Hokitika submarine canyons to determine where land and coast-derived organic matter ends up. Isotope analysis of the sea bed revealed that organic material from nearby rivers was able to reach the deep sea via both the Kaikōura and Hokitika canyons. The narrow Hokitika Canyon transports land-derived organic matter over 200 km away from the coast and to depths of 2000 m, whereas in the wider, steeper Kaikōura Canyon this material does not get transported as far or as deep.

We are now developing a canyon classification scheme combining physical, environmental and biological variables. This scheme will help to predict to what extent the other 270-odd Aotearoa New Zealand canyons act as shortcuts between the land and sea, and which deep-sea ecosystems might be affected by human activities.



Sediment tolerance chambers in the Marine Environmental Manipulation Facility at NIWA Wellington. © Jennifer Beaumont, NIWA

ONGOING

Sediment tolerance and mortality thresholds of benthic habitats

PROJECT LEADER	DURATION	BUDGET
Dr Malcolm Clark, NIWA	Oct 2016 – Jan 2019	$300,000

We are investigating the effects that suspended sediment from human activities has on the health and survival of deep-sea species in the South Taranaki Bight.

Human activities, such as mining and fishing, can generate suspended sediment that affect the health and survival of deep-sea species. We are using innovative laboratory experiments to understand how resilient species are, and how quickly they can recover.

We have completed trials on two deep-sea animals: dog cockles (*Tucetona laticostata*) and a sponge (*Crella incrustans*) found in the Taranaki Bight area. We put collected specimens in seawater to see how they responded to different conditions.

The seawater ranged from clean to very murky with a high concentration of suspended sediment. We measured their survival, feeding, respiration, buoyant weight, tissue condition, internal sediment accumulation, and various stress responses such as budding and mucous production over time. After four weeks, we returned the specimens to normal seawater and monitored how well they recovered from our experiment.

Our research will determine the level of suspended sediment that has an impact on these deep-sea species. From these results, we can predict when management or mitigation strategies will be needed to protect them.

Gert-Jan Jeunen gathering marine water samples for eDNA analysis. © Michael Knapp, University of Otago

ONGOING

Quantifying marine biodiversity using environmental DNA

PROJECT LEADERS	DURATION	BUDGET
Dr Michael Knapp and Prof Neil Gemmell, University of Otago	Oct 2016 – Jun 2019	$300,000

We have developed an innovative way to detect species in the sea using environmental DNA (eDNA) extracted from water samples.

Measuring whether species are present in a region is important for developing efficient, ecosystem-based management of marine resources. Current methods to measure biodiversity are costly, labour-intensive, and rely on indicator species or sites. Consequently, they don't always capture the complexity of marine ecosystems and their usefulness is limited.

We have established and tested an innovative, high-throughput and cost-efficient way to quantify marine biodiversity using eDNA extracted from marine water samples. Our results show the power of this new tool.

We were able to identify more groups of organisms than traditional monitoring methods at the same sites, and our data is highly habitat-specific.

Our study highlights the limitations of both traditional and eDNA monitoring. Traditional surveys are more likely to miss cryptic or rare organisms, while eDNA data relies on genetic data available in reference databases. At this stage, we recommend the best way to measure marine biodiversity is to combine traditional and eDNA monitoring approaches.

To make our monitoring system user-friendly, we have established a process where the eDNA sequence data is translated into a list of the types of organisms present in a given seawater sample.

Our new approach significantly reduces the cost of marine biomonitoring. It may be of interest to a range of users.

Soft sediment from outside the SPEZ. © Sean Handley, NIWA

ONGOING

Estimating historic effects from sedimentation and fishing

PROJECT LEADER	DURATION	BUDGET
Dr Sean Handley, NIWA	Jul 2017 – Jun 2019	$300,000

We are investigating how historical and contemporary changes to sedimentation and bottom contact fishing may influence fisheries in Tasman Bay.

Tasman and Golden Bays used to support productive green-lipped mussel, oyster and scallop fisheries, but these have been in severe decline for the last ten years. Our research is investigating whether sedimentation and bottom contact fishing have contributed to the decline.

We are measuring sediment structure and accumulation in Tasman Bay in a unique study area, the Separation Point Power Fishing Exclusion Zone (SPEZ). This area has been protected from the use of synthetic nets and shellfish dredges for more than 30 years.

In this project, we have measured how much sediment has accumulated in Tasman Bay and where it has come from. We have sampled sediment cores across three depths inside and outside the SPEZ and calculated the rates of surface sediment accumulation using bomb-radioisotope signatures. We are now using a sediment 'fingerprinting' method developed by NIWA to determine the historic land-use the sediment came from. We are also estimating the rates of sediment accumulation before human disturbance by carbon-dating shells from the base of selected cores.

We are investigating the effects of bottom contact fishing on the sediment structure by comparing the environmental responses to undisturbed sediment (inside the SPEZ) and sediment disturbed by fishing (outside the SPEZ). To do this, we will analyse mollusc shell remains in the cores.

Dr Roberta D'Archino and Dr Leigh Tait studying the intertidal reef area in Kaikōura. © Dave Allen, NIWA

ONGOING

Defining rocky reef tipping points associated with the Kaikōura earthquake

PROJECT LEADER	DURATION	BUDGET
Dr Leigh Tait, NIWA	Jul 2017 – Jun 2019	$300,000

We are investigating the recovery and resilience of kelp forests associated with the 2016 Kaikōura earthquake.

The uplift of Kaikōura's coastline following the November 2016 earthquakes caused an unprecedented loss of kelp forests, which provide many important ecological services.

We are investigating how the loss of kelp has modified the coastal environment. Kelp are a dominant species with several important roles: they fix carbon, provide habitat and food for sea creatures including taonga species like paua, buffer wave disturbance and increase dissolved oxygen. Loss of kelp has greatly reduced these ecosystem services along the Kaikōura coast.

We are using gradients of kelp loss to understand the alteration of ecosystem services across the Kaikōura coast. The magnitude of kelp loss across coast-wide gradients of turbidity will also inform us about the critical needs for kelp forests to survive, sustain ecosystem services and maintain biodiversity.

We are assessing:

1. Wide-scale kelp bed survival using drone images.
2. Changes in ecosystem services.
3. Small-scale recovery of kelp species.

We have found that areas with significant kelp loss are vulnerable to suspended sediments because it reduces the light available for the plants to thrive. Pre-earthquake sediment levels had already restricted kelp to shallow waters. Post-earthquake, additional sediment associated with landslips may compromise recovery where ecosystem services are diminished.

Our research is providing a whole-coast assessment of potential kelp loss and identifying critical tipping points that have caused a loss of ecosystem services. This will inform sustainable management of kelp forests in the region by highlighting areas where recovery is likely, unlikely or may require intervention.

Managed Seas

PROGRAMME LEADER
DR CHRIS CORNELISEN,
CAWTHRON INSTITUTE

> "Effective ecosystem-based marine management relies on a well-equipped tool box for making informed decisions."

Tangaroa voyage to the Campbell Plateau Moorings. © Sarah Searson, NIWA

SUMMARY

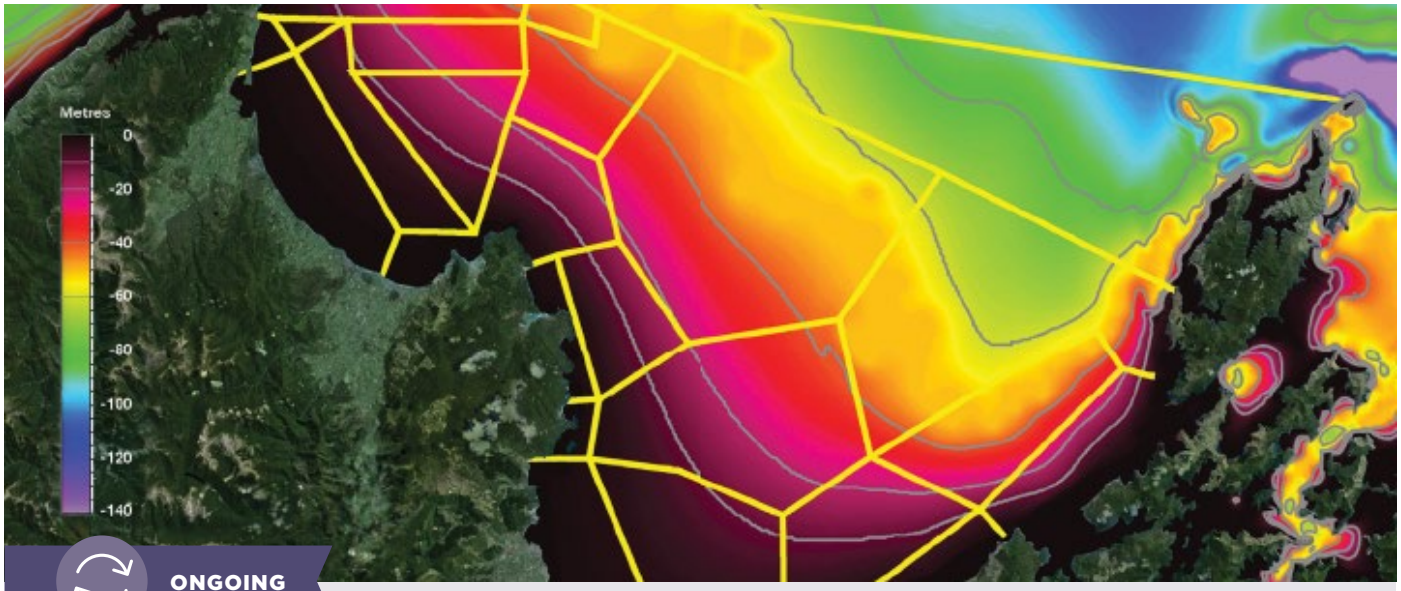
We are developing and trialling tools that will support ecosystem-based management (EBM) by helping decision-makers and interested groups understand how management decisions will affect marine environments. These tools will also help us understand the impacts of changing environmental conditions associated with marine activities and climate change.

Our research includes developing ecosystem models to enable decision-makers to weigh up 'what if' scenarios; spatial models to explore trade-offs between different resource uses; new risk assessment tools and frameworks that incorporate mātauranga Māori; and software applications for encouraging participation.

We are working across the Challenge programmes to develop these tools, and liaising with government agencies, Māori, community and stakeholder organisations, institutions, and industry representatives in Tasman and Golden Bays. They have provided insights and guidance that are helping us refine the tools and build future scenarios.

WE ARE:

- Developing models for improving management of marine resources in Tasman and Golden Bays.
- Developing spatial models for managing disturbance and recovery of seafloor communities.
- Identifying novel risk assessment tools and frameworks that incorporate mātauranga Māori and support EBM.
- Providing software applications for engaging the public with knowledge that the Challenge is generating.



Depth layer mapping of Tasman and Golden Bays. © Vidette McGregor, NIWA

ONGOING

Ecosystem models

PROJECT LEADER	DURATION	BUDGET
Dr Ian Tuck, NIWA	May 2016 – Jun 2019	$1,495,000

We are developing simulation models for the Tasman and Golden Bays marine ecosystem to test what is likely to happen in different scenarios.

We have put together and validated an ecosystem model using the Atlantis framework. The Atlantis model is a computer representation of the Tasman and Golden Bays area that can be used to mimic, and help understand, dynamics and flow-on effects from changes in the environment or its management. It encompasses everything from sunlight and nutrients through to predators and fisheries. It allows researchers and decision-makers to test different scenarios to understand effects on the whole ecosystem.

We have engaged with regional council representatives, Māori, marine managers, and a range of stakeholders, to understand their concerns relating to the marine environment in Tasman and Golden Bays.

The model has been used to explore the implications of a range of environmental and management scenarios. For example, our results suggest that the collapse of scallop populations in the region is not associated with scallop harvesting, but changes in habitat suitability.

We have also built a food-web model and are developing a size-based ecosystem model for exploring scenarios. We will investigate ways to compare these modelling approaches and explore which are the most useful to answer specific questions. When our project is complete we will be able to advise which model to use depending on the criteria.

This work is strongly linked with the Participatory Tools project (page 53), which is developing web-based tools so people can interface with model outputs to support decision-making.

John Dory cruising the Northern Arch, Poor Knights Islands. © Crispin Middleton, NIWA

ONGOING

Spatially-explicit decision support tools

PROJECT LEADER	DURATION	BUDGET
Dr Carolyn Lundquist, NIWA/University of Auckland	Apr 2016 – Jun 2019	$570,000

We are developing tools to help decision-makers explore how best to use and share marine spaces.

We are using two modelling approaches to help predict how best to manage ocean spaces in Aotearoa New Zealand. The models consider multiple resource uses, needs, Māori and stakeholder values, and the implications these have for biodiversity and ecosystem health.

The first model evaluates trade-offs between preserving and using marine resources. On one hand, conserving and protecting biodiversity, while on the other, using or taking resources through activities such as fishing, tourism, and aquaculture. The model needs accurate biodiversity data, so we have built a tool that predicts the number of species and their distribution in an ecosystem. For example, the tool can predict the distribution of John Dory in an ecosystem using information about the kind of environments that John Dory live in, including tidal current speeds, temperature and sediment type.

The second model examines cumulative effects of multiple disturbances (such as fishing and sedimentation) on animals living on the seafloor. This model is informed by current and historical disturbances in Tasman and Golden Bays, and how these disturbances overlap in space and time.

A key challenge in large-scale management of the marine environment is evaluating uncertainty associated with the data. With both models, we are developing techniques to assess whether uncertainty – in data from biological (living) and physical (non-living) parts of an ecosystem, or socio-cultural values – will affect model outcomes.

We are developing these tools with involvement from managers in central and local government, Māori, and community and stakeholder organisations to ensure they are 'fit for purpose' and applicable within existing management systems.

Guiding a ship into the port of Lyttelton. © Graeme Inglis, NIWA

ONGOING

Novel risk assessment tools for ecosystem-based management

PROJECT LEADER	DURATION	BUDGET
Dr Graeme Inglis, NIWA	Dec 2017 – Jun 2019	$270,000

We are reviewing new methods to help assess and manage risks to Aotearoa New Zealand's marine ecosystems.

To manage marine ecosystems sustainably, decision-makers need to be able to predict how they will respond to changes or threats. Risk assessment can help by identifying possible changes caused by an activity, the environmental and social consequences, and the likelihood of each outcome.

We are reviewing new methods for risk assessment to see if they can be applied to ecosystem-based management of marine areas. We are focussing primarily on methods that deal with uncertainty and looking for the best methods to assess and manage risks to the marine environment from changing patterns of human use. This is challenging as multiple stressors from human activities can interact, leading to significant consequences when the ecosystem can no longer cope, and a tipping point is reached.

We are also exploring how mātauranga Māori can be incorporated into risk assessments and management.

Our research aims to enable New Zealanders to participate in developing plausible threat scenarios and to evaluate the risks associated with them. We want decisions about future risks to be informed by the best available information and methods.

Our research will help to optimise methods for choosing among a set of alternative policy strategies, evaluate combinations of stressors, and determine management strategies that are most 'robust' to threats. The findings of our research will be useful for decision-makers in the marine environment, including central and regional government, and Māori.

ONGOING

Participatory tools

PROJECT LEADER	DURATION	BUDGET
Dr Ross Vennell, Cawthron Institute	Apr 2016 – Jun 2019	$580,000

We are developing web-based tools to enable New Zealanders to interact with and use knowledge generated by the Sustainable Seas Challenge.

We are developing interactive web-based applications that will help inform management and decision-making in the marine environment. These tools will potentially be used by regional councils, government policy-makers, iwi and commercial fisheries.

The first tool under development shows how management decisions in the Tasman and Golden Bay region may affect the marine environment and influence the scallop fishery. It will help users understand how their management decisions could impact the productivity and quality of the marine environment.

The application uses a 'Bayesian Network' to connect environmental management strategies with ecosystem properties.

The second tool allows users to explore how the ocean and coast are connected by ocean flows. It is based on ocean modelling data. Online users will be able to drop virtual plastic into the ocean and discover where it will end up. We have data for the Cook Strait and Tasman and Golden Bays, which shows how well areas within the regions are connected. For example, plastic from Tasman Bay is predicted to end up on Kapiti Coast after 15 days, with some passing through Cook Strait and reaching the Wairarapa Coast in 20 days.

These web-based tools are currently undergoing testing and development. They are expected to be available online in 2019.

Campbell albatross and chick. © David Thompson, NIWA

ONGOING

Defining marine habitat use by seabirds

PROJECT LEADER	DURATION	BUDGET
Dr David Thompson, NIWA	Apr 2017 – Mar 2019	$300,000

We are investigating whether a range of different mathematical models accurately reflect seasonal seabird distributions in Aotearoa New Zealand waters.

Aotearoa New Zealand waters support the greatest diversity of seabirds on Earth, including rare and endangered species such as albatrosses, petrels and shearwaters.

It is critical that we know the number of birds, where they live and their migration patterns.

Using boats to survey bird populations and collect detailed data about seabird distributions is expensive. We are investigating whether cheaper, modelling methods can produce accurate estimates of which areas of the ocean are important for seabirds and how many there are. Our model uses information about the types of environments where seabirds live. For example, we know that some species prefer coastal habitats and others prefer ocean habitats.

We are comparing these species-specific relative environmental suitability models with models that are built on location data from seabird sightings or electronic tags.

In preparation for model development, we have processed large volumes of seabird tracking data. Campbell albatrosses are a New Zealand endemic species that breed only at Campbell Island. We have discovered that their migration range is much further than we thought. Some migrate to South America following breeding, while others remain close to New Zealand or Australia. This new information about albatross migration patterns has significant implications for assessing the risk of fishing activity to this species. For example, birds choosing to migrate to South America will be exposed to different levels of fishing risk compared to birds remaining in Australasia.

Our novel approach has the potential to produce new information about how seabirds use the marine environment. This could help us gauge how threats in the marine environment may affect high-profile species and inform New Zealand Government policies.

Cape Reinga (Te Rerenga Wairua). © Ayushi Kachhara, NIWA

Vision Mātauranga

PROGRAMME LEADER
JAMES WHETU,
WHETU CONSULTANCY GROUP

> We want to empower traditional and contemporary mātauranga Māori to support management of marine resources in Aotearoa New Zealand.

SUMMARY

We are working with Māori to capture their needs and aspirations for marine management, and to unlock the potential of mātauranga Māori resources and people.

Our goal is for Māori communities to participate in Sustainable Seas Challenge research. We want our research outputs and outcomes to empower both traditional and contemporary mātauranga Māori in any ecosystem-based management approach in Aotearoa New Zealand's marine environment.

The Challenge's Vision Mātauranga programme provides oversight, assistance and active guidance to science leaders and researchers in the application of the New Zealand Government's Vision Mātauranga policy, and pathways for the delivery and uptake of research outcomes for Māori. To achieve this the programme has an implementation plan, an iwi engagement plan, a mātauranga in science plan, and a fund that enables Māori communities to participate in the research of the Challenge.

WE ARE:

- Developing and enhancing relationships with iwi, with a particular focus on iwi in Te Tau Ihu (top of the South Island).
- Supporting the involvement of Māori in research projects.
- Seeking, gathering, incorporating and integrating mātauranga Māori into research projects.
- Understanding how kaupapa Māori research is carried out within transdisciplinary/multidisciplinary research.
- Seeking to develop distinctive and innovative approaches to manage our marine environment.

Great Bear Rainforest Conservation Agreement Press Conference in Vancouver. Dallas Smith, President of the Nanwakolas Tribal Council stands at podium. © Greenpeace

COMPLETED

Incorporation of indigenous approaches to guardianship in Canada

PROJECT LEADER	DURATION	BUDGET
Dr Sarah-Jane Tiakiwai, Waikato-Tainui College*	Apr 2016 – Sep 2016	$185,000

We have evaluated how indigenous approaches have been incorporated into Canada's marine resource management policies.

We studied two examples of ecosystem-based management (EBM) in Canada: the Marine Plan Partnership for the Pacific North Coast and the Great Bear Initiative. These are two distinct, yet linked, examples of resource management and economic development that use EBM in a way that incorporates indigenous perspectives and aspirations. Canada, like Aotearoa New Zealand, has an indigenous population, environmental concerns, and has been actively working in the indigenous knowledge space.

We reviewed literature on the Canadian case studies and engaged with First Nation peoples. We identified five elements to consider when developing EBM approaches that successfully incorporate indigenous perspectives and aspirations. The following elements could be applied to Aotearoa New Zealand's marine management:

1. Power dynamics – Canada's 'enabling' legal framework supported transformative shifts in policy making, engagement between First Nations and Government, and decision-making.
2. Jurisdiction – Any party that has jurisdiction over the location, resource and/or activities should be involved in developing EBM otherwise there is a risk of conflict and ineffective co-governance.
3. Adaptive management – 'Learning by doing', i.e. an iterative process that feeds back into future decision-making and adapts to uncertainty and/or changes in the ecosystem.
4. Agency – Ensuring indigenous people can participate in decision-making.
5. Recognition – Acknowledging indigenous knowledge as legitimate and using it alongside Western science through shared governance and participative bottom-up planning processes and monitoring.

*Waikato-Tainui College for Research and Development

Whaowhia te kete mātauranga – fill the basket of knowledge. © chameleonseye, iStock

COMPLETED

Repository of knowledge: mātauranga Māori

PROJECT LEADER	DURATION	BUDGET
James Whetu, Whetu Consultancy Group	Jul 2016 – Jun 2017	$185,357

We investigated the concept of a digital repository to manage mātauranga Māori gathered by the Sustainable Seas Challenge.

For this project, we reviewed measures to protect, preserve and record the whakapapa of mātauranga Māori gathered across the Challenge. We also explored the appropriateness of holding the information in a digital repository.

We investigated similar repositories used overseas and developed templates and forms for participant and researcher consent, data collection and repository information for participants.

Our research explored the legal standing and best approach for the development of a digital repository for the Challenge and considered the design and digital elements required.

We collaborated with Te Tāhū o te Pātaka Whakairinga Kōrero: Next Generation Indigenous Knowledge Project within the Science for Technological Innovation National Science Challenge to develop a process diagram for use by research institutes in collection of mātauranga Māori and recommendations around ethical protocols.

We concluded that establishing a repository for mātauranga Māori required support from Māori who would be contributing their individual or collective knowledge (traditional and contemporary) on behalf of their whānau, hapū, group/organisation, and/or iwi.

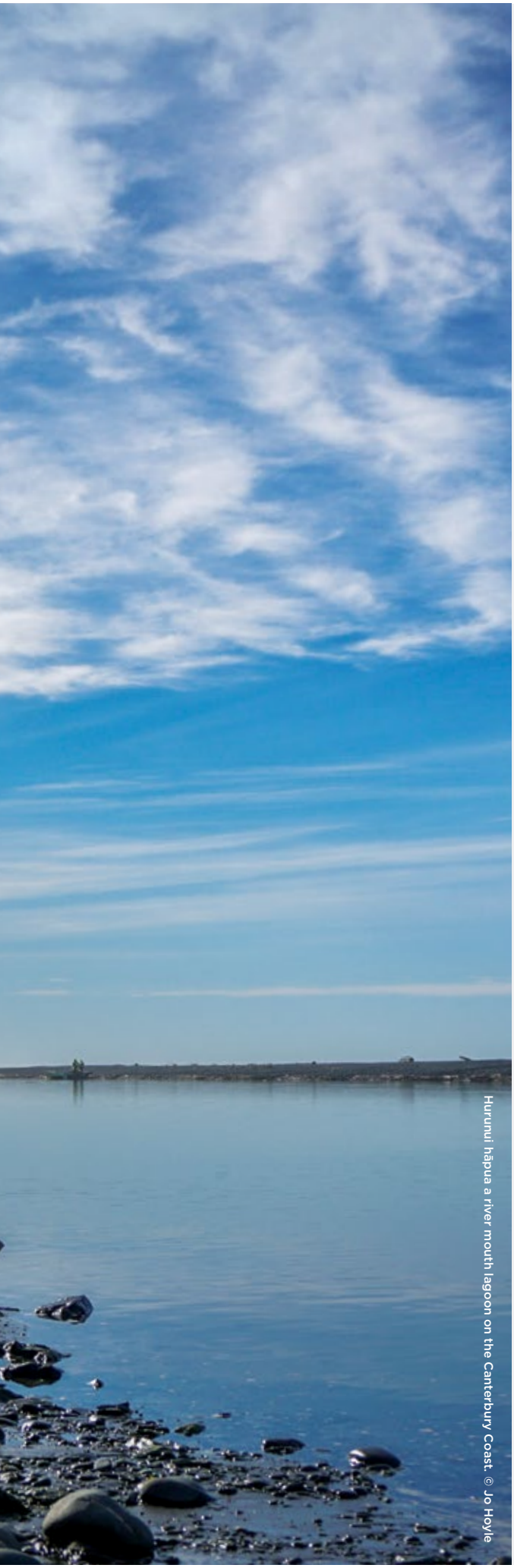
We also identified the importance of improving understanding and guidance for Challenge researchers who are sourcing and using mātauranga Māori.

Full report at sustainableseaschallenge.co.nz.

Enabling Ecosystem-Based Management

PROGRAMME LEADER
DR JANET STEPHENSON,
UNIVERSITY OF OTAGO

> We're working on the key ingredients for enabling ecosystem-based management: a widespread appreciation of what it means, consistent policy settings, and supportive tools.



Hururui hāpua a river mouth lagoon on the Canterbury Coast. © Jo Hoyle

SUMMARY

Our aim is to improve decision-making in the marine environment and the health of our marine ecosystems through an ecosystem-based management (EBM) approach. This programme is:

- Investigating whether Aotearoa New Zealand's laws and governance arrangements for the marine environment are consistent with EBM.
- Reviewing current EBM-like arrangements for managing the marine environment.
- Working with communities to explore how the tools and techniques we develop can underpin initiatives for improving marine ecosystem health.
- Producing narratives about EBM that describe what it means in practice and how it will affect the lives of New Zealanders.

Aotearoa New Zealand has a complex set of laws and governance arrangements for the marine environment with different purposes and mandates. We are researching how EBM might be implemented under current legislation, and what changes might be needed to implement EBM in the future. We are also learning from the experience of communities, iwi, businesses, NGOs, and local authorities that have worked together to establish innovative marine management regimes.

Across the Challenge, we are developing tools and approaches to incorporate Māori and stakeholder values, and ecological modelling in marine management. We are exploring how bringing these approaches together can improve decision-making and support the implementation of EBM. Our research findings are being trialled in the Tasman and Golden Bays case study area.

WE ARE:

- Improving public and stakeholder understanding of EBM.
- Investigating whether changes will be needed to current regulatory frameworks governing marine resources to support EBM.
- Demonstrating how tools developed by our research projects can help improve marine ecosystem health.
- Empowering interested parties to move towards implementing EBM.

Guardianship of what's ours. © Chris Williams, New Zealand Story

ONGOING

Ecosystem-based management within Aotearoa New Zealand's existing legislative framework

PROJECT LEADER	DURATION	BUDGET
Dr Alison Greenaway, Manaaki Whenua – Landcare Research	Apr 2016 –Jan 2019	$725,000

We are investigating how well ecosystem-based management (EBM) aligns with Aotearoa New Zealand's legislation, policy and governance relating to the marine environment.

Our project aims to improve understanding of the opportunities and constraints for EBM under current legislation and in decision-making processes. In Aotearoa New Zealand, there are laws that cover different geographic areas, resources, species and activities in the marine environment, such as the Resource Management Act 1991, Fisheries Act 1996, and Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act. There are also several decision-making bodies with different mandates and responsibilities.

Our team of law, policy and governance experts has found that current policies and laws are already partially consistent with most of the principles of EBM.

One of our studies looked at how well the current policy and legislation supports rāhui (customary prohibitions). EBM aligns well with Māori customary management, as both are holistic concepts aiming to care for and sustainably use marine resources. We found that there is limited provision for rāhui to be practised and, even where it is provided for in law or policy, it is disconnected from the tikanga Māori on which it is based.

We are currently investigating the extent to which EBM is enabled by current legislative and decision-making frameworks, and potential ways to improve this.

View of Okiwi Bay, Marlborough Sounds. © Leigh Tait, NIWA

ONGOING

What could ecosystem-based management look like in Tasman and Golden Bays?

PROJECT LEADER	DURATION	BUDGET
Dr Judi Hewitt, NIWA	Jul 2017 – Jun 2019	$400,000

We are investigating how to successfully put ecosystem-based management (EBM) into practice in Aotearoa New Zealand's marine environment.

We are applying the knowledge, tools and processes from other Sustainable Seas Challenge projects to a case study focused on the health of the seafloor in Tasman and Golden Bays.

We are working with researchers in the Managed Seas Programme (page 48) to trial several modelling tools which will help us predict how animals and plants living on the seafloor respond to different management scenarios. We are exploring which tools are easy to use by non-modellers and provide the best information to make management decisions.

We will trial a decision-making framework which includes non-monetary values, such as social, cultural or ecological values. We will also trial the use of system mapping in EBM for the marine environment. This will help build shared understandings of how financial, social, management, environment and ecology connect.

Finally, we will use SeaSketch (a collaborative marine planning tool) to store information about the Bays and use it, the models and the system mapping approach to identify knowledge and relationship gaps and prioritise them for future work. Councils, central government agencies, universities and Crown Research Institutes will then be able to use our findings to inform and prioritise science research strategies.

Navigating on the Steadfast. © New Zealand Story

ONGOING

EBM-enabling narratives for New Zealand

PROJECT LEADER	DURATION	BUDGET
Dr Alison Greenaway, Manaaki Whenua – Landcare Research	Mar 2018–Jun 2019	$755,000

We want to show what ecosystem-based management (EBM) of marine environments in Aotearoa New Zealand looks like now and how it could look in the future.

Story-telling, as spoken or written narratives, is an effective way to convey complex or abstract ideas. We are developing narratives about different ways of achieving EBM, based on real examples where New Zealanders have come together to manage their marine environment. We aim to show what the practice of EBM looks like now – and could look like in the future.

Our research has gathered a range of perspectives from case studies, interviews and workshops. We identified local initiatives that already had some elements of EBM and identified who was involved, the EBM-like practices and processes, and the successes and challenges. Out of these we are developing a range of different narratives that will reflect the kinds of situations in which we think we are likely to see EBM flourish in the future. We are planning to develop and test our narratives with representatives from government, industry, local communities and Māori.

We also produced the *Oceans Mesh* sci-art installation at Light Nelson Festival in July 2018 (page 65) which engaged with New Zealanders on marine management issues and encouraged their feedback.

Using sci-art to engage people in science

This year Sustainable Seas researchers have collaborated with artists to produce art inspired by science.

ART + OCEANS

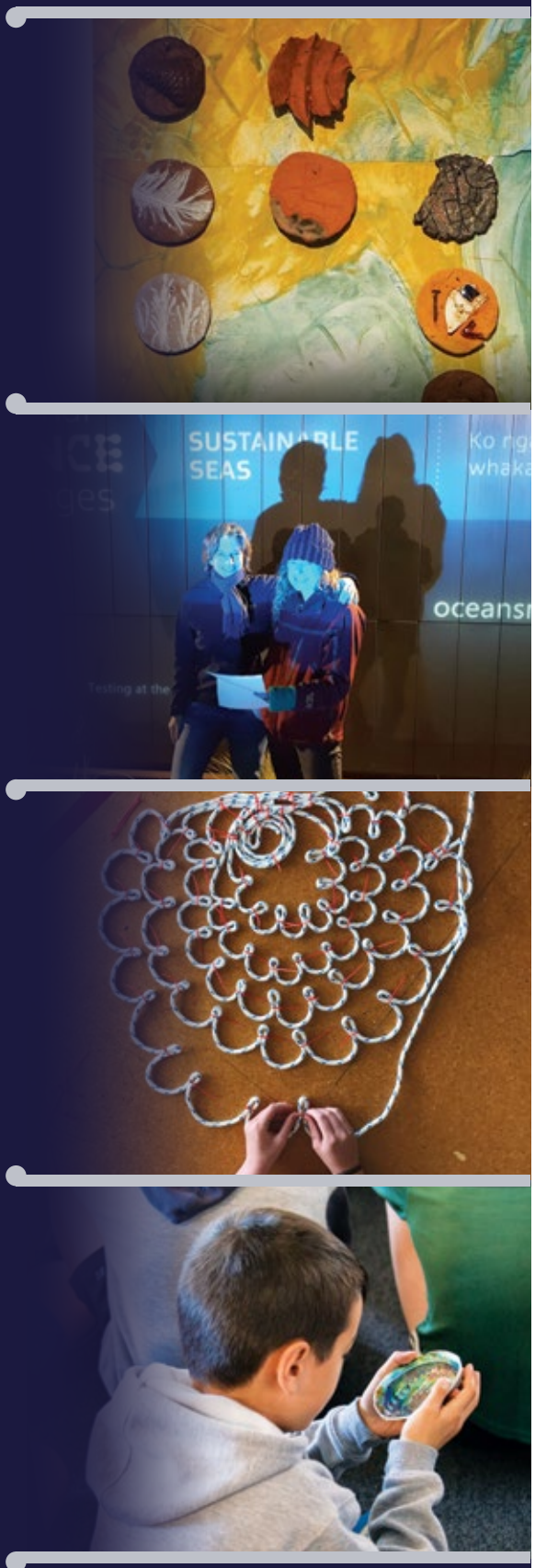
Sustainable Seas researchers Candida Savage and Anne-Marie Jackson (University of Otago) collaborated with artists from the Dunedin School of Art for the Art + Oceans exhibition in July/August 2018. Artists drew inspiration from Anne-Marie's work on understanding kaitiakitanga in our marine environment (page 32) and worked with Candida to incorporate flux experiments from her tipping points research (page 41).

OCEANS MESH

Sustainable Seas researcher Dr Charlotte Šunde (Cawthron Institute) collaborated with artist Vicki Smith, to produce an interactive light installation *Oceans Mesh* at Light Nelson in July 2018. The aim was prompt public conversations about ecosystem-based management (page 64).

THE UNSEEN

Gabby O'Connor (NIWA) worked with communities and over 1600 school children to explore the risks associated with environmental and climate change and how that affects marine ecosystems. The collaborative work *The Unseen* was exhibited at the Suter Art Gallery in Nelson. It was created out of rope and cable ties by students of 16 primary and secondary schools in Nelson and Marlborough. Gabby's work is part of a Sustainable Seas project investigating the institutional, social and cultural factors that are needed for successful ecosystem-based management in Aotearoa New Zealand (page 12).



Images (top to bottom): Art + Oceans, Becky Cameron/ Candida Savage; *Oceans Mesh*, Gabby O'Connor; *The Unseen*, Hamish McCormick, Cine Timore Productions.

Glossary

Atua
Deity, god or spiritual entity.

Aotearoa
The Māori name for New Zealand.

Blue economy
Works innovatively with marine resources to add value, improve livelihoods and enhance ecosystem health.

Challenge
The Sustainable Seas National Science Challenge.

Cumulative effects
Collective effects on the marine environment that are associated with human activities and natural processes from the past, present and future.

Ecological function
The functioning of the biological, chemical and physical components of an ecosystem.

Ecosystem-based management (EBM)
A holistic and inclusive way to manage marine environments and the competing uses for, demands on, and ways New Zealanders value them.

Ecosystem
A dynamic complex of living (plants, animals and microorganisms) and non-living components (e.g. water, climate, minerals, sunlight) interacting as a functional unit.

Ecosystem services
The benefits that humans gain from ecosystems, including provisioning (e.g. supply of seafood, minerals and energy); regulating (e.g. control of climate, waste and disease); supporting (e.g. nutrient cycling and habitat provision); and cultural (e.g. spiritual, historical and recreational).

Environmental DNA (eDNA)
DNA collected from the environment, such as seawater or air, rather than directly from an organism.

Hapū
A group of whānau sharing descent from a common ancestor.

Iwi
Descendants from a common ancestor associated with a distinct territory.

Kaitiaki/Kaitiakitanga
A steward or guardian with intergenerational responsibility for ensuring the well-being (e.g. of natural resources) for future generations.

Kaupapa Māori
Māori approach, topic, customary practice, institution, agenda, principles or ideology.

Kaupapa tuko iho
Māori approaches, practices, principles or ideology handed down through generations.

Marine resources
Usable goods and services from the marine environment.

Māori
For the purposes of this document 'Māori' is taken to include Treaty of Waitangi partners, iwi, hapū, whānau and Māori organisations.

Mauri
The essential quality and vitality of a being or entity. Life principle or force.

Moana
The sea and ocean.

Model
A representation, potentially a mathematical one, of a natural phenomenon or an ecosystem.

Mātauranga Māori
Indigenous Māori knowledge and/or system of knowledge.

Pataka Mātauranga
A knowledge or resource repository.

Rāhui
A temporary prohibition or restriction placed on an area e.g. a restriction on the collection of shellfish from a specific area being harvested to enable the restoration of stocks.

Stakeholder
A person or group that has an interest in any given activity or decision. This includes central and local government, communities, industry, resource managers, researchers and non-government organisations (NGOs).

Stressors
Environmental changes that affect organisms, habitats, or ecosystems, including human social-ecological systems. This includes changes in natural conditions (e.g. temperature) as well as human activities (e.g. dredging).

Tangaroa
Māori ancestor, deity or god of the marine environment.

Taonga
Anything prized. Applied to anything considered to be of value including socially or culturally valuable objects.

Te Tau Ihu
Short for 'Te Tau Ihu o te Waka ā Maui' meaning the prow of the waka of Maui, is the name given to a region of New Zealand encompassing the top of the South Island.

Transdisciplinary
Bringing together interdisciplinary teams with Māori and stakeholders to co-design and co-develop research.

Tikanga
Māori ethics, protocols and ethical behaviour (that derive from kaupapa). In the context of Sustainable Seas Challenge, it is the protocols and customs based around the marine environment.

Tūhonohono
Joining or binding together.

Vision Mātauranga
New Zealand Government science policy framework to encourage research that unlocks the innovation potential of Māori knowledge, resources and people to assist New Zealanders to create a better future.

Whānau
Extended Māori family or kinship group.

Whakapapa
Lineage or genealogy.

Challenge research area

We are developing tools and knowledge to support ecosystem-based management (EBM) in Aotearoa New Zealand. Many of our research projects take place in the **focal area** (white rectangle) as it includes:

- A range of marine environments.
- Different (and competing) uses, activities and interests.

Our first **case study area** (blue circle), where we are trialling EBM, encompasses Tasman Bay (Te Tai-o-Aorere) and Golden Bay (Mohua).