



Sustainable Seas
Ko ngā moana whakauka
National Science Challenge
Research and Business Plan

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Glossary

Aligned Core funding — that part of Government funding for CRIs that underpins the Challenge Mission, and which CRI Boards remain responsible for.

Best teams — teams that work together collaboratively to provide quality research to meet the Objective of the Challenge, given availability, Challenge resources, and timeframes.

Blue economy — a sustainable ocean economy that is a result of economic activity being in balance with the long-term capacity of ocean ecosystems, which thus support this activity and remain resilient and healthy. A Blue Economy should have a set of economic practices that work with the dynamics of marine ecosystems to create economic and social values, sustain or enhance the resourcefulness of those environments, and generate short and long-term benefits for investors, communities and marine ecosystems.

Community — a group of people (or organisms) broadly distinguished from other groups by mutual interests, shared environments and institutions, and a common culture.

Contestable funding — funding where there will be a call for proposals to undertake defined projects.

Culture — the characteristics and knowledge of a particular group of people.

Ecosystem Based Management (EBM) — a strategy for the integrated management of land, water and living resources that recognises the full array of interactions, including human, within an ecosystem and promotes conservation and sustainable use in an equitable way.

Ecosystem — a dynamic complex of plant, animal (including humans) and micro-organism communities and their non-living environment interacting as a functional unit.

Ecosystem goods — the tangible, material products derived from ecosystem processes, e.g., oxygen and provisioning services such as seafood, minerals, raw materials, drugs, energy.

Ecosystem services — the multitude of benefits that humankind gains from ecosystems, which are commonly grouped into four broad categories: provisioning (e.g., production of seafood, minerals, raw materials, drugs, energy); regulating (e.g., climate control, carbon sequestration, waste decomposition and detoxification, pest and disease control); supporting (e.g., nutrient cycling, primary production, larval dispersal, habitat provision); and cultural (e.g., spiritual, historical and recreational benefits).

Engagement — the process by which organisations and individuals build ongoing relationships for the purpose of applying a collective vision and building trust in a community.

Innovation funding — an annual \$1.5 million pool of funding for which there will be a call for proposals to respond to a defined Request for Proposals (RfP) that will encourage new innovative research to help achieve the Mission of the Challenge.

Kaitiakitanga — intergenerational responsibility for ensuring the well-being of natural resources for future generations.

Kaupapa Māori — ground rules, first principles, and/or plan of action created within a Māori context, which expresses Māori aspirations, values and perspectives.

Mahinga kai — refers to both the sites and practice of gathering food directly from the environment.

Mapped research — MBIE contestable research projects, the funding for which becomes part of the Sustainable Seas funding envelope.

Marine estate — refers to the ocean and seafloor extending from the coastal margin to the outer boundaries of New Zealand's Exclusive Economic Zone and Extended Continental Shelf (including the Ross Sea), which contains natural resources that New Zealand is entitled to use and over which it has obligations of stewardship and care on behalf of future generations.

Marine resources — a collective term that describes utilisable goods and services in the marine estate.

Manaakitanga — in a sustainable seas context this denotes the role of marine resources in providing for and uplifting the mana of Māori communities.

Māori — For the purposes of this document 'Māori' is taken to mean iwi, hapū, whanau and Māori organisations.

Māramatanga — clarity, illumination, perspective and understanding.

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

Mātauranga Māori — the indigenous Māori knowledge system of Aotearoa New Zealand including knowledge of language, technology, systems of law and social control, the environment, spirituality, cultural practice, systems of property and value exchange, forms of expression, and much more.

Negotiated funding — funding for projects that will be negotiated using a best team approach, in which a project team will be asked to submit a project proposal that addresses the project brief.

Participation — the action of taking part in something.

Rāhui — a customary mechanism often utilised for the closure of an area, in which harvesting of resources is banned to foster regeneration and protection.

Related research — refers to current research, other than aligned CRI core-funded research, that is relevant to the Sustainable Seas programmes.

Resilience — the capacity or ability to recover quickly from an event or series of events.

Social Licence to Operate — the ability of an organisation to carry on its business because society has confidence that it will behave in a legitimate, accountable and socially and environmentally acceptable way (Sustainable Business Council definition).

Society — a collective term that encompasses a group of people sharing the same geographical territory, subject to the same political authority and includes communities, Māori, industry, researchers, regulators and managers of marine resources.

Stakeholders — a person or group that has an interest in any given activity or decision. This includes communities, industry, resource managers, researchers and NGO's.

Stressors — environmental changes that affect particular organisms (including humans). This includes changes in natural conditions (e.g., temperature) as well as human activities (e.g., dredging). A single human activity may consist of more than one stressor (e.g., fin fish farming may decrease

currents and increase nutrients) and different human activities may exert the same stressor (e.g., trawling and port dredging both physically disturb the seafloor).

Te reo — Māori language: an official language of New Zealand.

Tikanga — Māori ethics and ethical behaviour (that derive from Kaupapa); in the context of Sustainable Seas, it is the protocols and customs based around the marine environment.

Tipping-point — a point at which response to stressors changes direction or markedly increases its rate; often it is difficult to reverse the response once this point has passed.

Treaty of Waitangi — an agreement signed by Māori chiefs and representatives of the British Crown in 1840 apportioning sovereignty, ownership and protection rights. Often referred to as a constitutional agreement.

Values — the aspirations that humans hold for ecosystems, here divided into: economic values, which relate to direct use for economic benefit; cultural/spiritual/social values, which express beliefs pertaining to desirable states and/or modes of conduct that transcend specific situations, guide behaviour; and environmental values, which are related to the intrinsic naturalness and integrity of the ecosystem. There is inevitably overlap between the categories, despite different metrics generally being needed to measure them.

Vision Mātauranga — A policy framework developed by the Ministry for Business, Innovation and Employment to guide research in unlocking the innovation potential of Māori knowledge, resources and people.

Whakapapa — a Māori framework (often referred to in genealogical terms) that builds layer upon layer from the past to the present to the future and includes spiritual, mythological and human stories to describe the interconnectedness of all living things. It is the core of Māori identity and the basis of mātauranga Māori.

1. Executive Summary

The National Science Challenges are designed to take a strategic approach to the Government's science investment by targeting a series of goals which will have major and enduring benefits and will answer questions of national significance to New Zealand. The Challenges provide an opportunity to align and focus New Zealand's research on large and complex issues by drawing scientists together from different institutions and across disciplines to achieve a common goal. The Sustainable Seas Challenge is one of 11 National Science Challenges.

The Objective of the Sustainable Seas *Ko ngā moana whakauka* National Science Challenge is to *“Enhance utilisation of our marine resources within environmental and biological constraints”*.

The research and activities of the Challenge are focussed on the development of an ecosystem based approach to the management of our marine resources which will in turn increase the potential for utilisation of our marine resources. Ecosystem Based Management (EBM) is a strategy that integrates management of natural resources, recognises the full array of interactions within an ecosystem, including human, and promotes both sustainable use and conservation in an equitable way.

To achieve the Objective the Challenge will:

- Work collaboratively with Māori and a wide range of stakeholders to develop and trial processes, frameworks and tools to support an EBM approach to managing our marine estate in a holistic way.
- Provide data and information to increase understanding of the marine environment in the wider community to improve/increase participation in resource management decisions.
- Provide processes, frameworks and tools that resource managers can use in an EBM approach to managing increased utilisation of our marine estate.
- Review current legislation and policy to assess how an EBM approach to management could be implemented in New Zealand.

The result will be an EBM approach for managing our marine resources which will:

- Consider all parts of the ecosystem including humans.
- Consider all uses of the marine system simultaneously.
- Be an inclusive process involving Māori and a wide range of stakeholders in resource management decisions.
- Reduce the potential for conflict by moving from an adversarial to a collaborative approach in decision making.
- Include consideration of both monetary and non-monetary values, and find ways to balance these different values in decision making.

Successful implementation of EBM will enhance the sustainability of New Zealand's marine resources and add value to the marine economy through a variety of pathways including product certification and provenance, increased investment, enhanced diversification, and an increased social licence to operate, which will increase the potential use of our marine resources. The Challenge will also develop a blue economy capability to generate short and long term benefits for investors. In addition, the Challenge will support the development of new environmentally sustainable technologies and activities that will add value to the marine economy.

The Challenge draws together eight collaborating parties to implement the research plan which was developed in collaboration with Māori and a wide range of stakeholders. This co-development and co-learning approach will continue throughout the Challenge to ensure that it meets the needs of Māori and stakeholders. The Challenge is composed of 5 programmes: *Our Seas*, *Valuable Seas*, *Tangaroa*, *Dynamic Seas*, and *Managed Seas*. These programmes are interlinked and are drawn together through three cross-programme research projects and the cross-cutting elements, *Vision Mātauranga* and *Communication and Outreach*.

Our Seas will develop and provide mechanisms and tools for societal engagement, collaboration, and participation. *Valuable Seas* will develop world-leading methods of capturing the economic, social, environmental, spiritual and cultural values of New Zealand's marine ecosystems using participatory processes developed in *Our Seas*. The programme will link these to new economic models that focus on developing innovation within the marine economy; adding monetary value while ensuring maintenance or improvement of other values. Māori, industry and society are striving for a balance between guardianship and economic benefit, and this programme, particularly in conjunction with *Tangaroa*, will provide the opportunity to navigate this together. *Tangaroa* will strengthen the resilience of Māori communities by understanding in-depth the mātauranga Māori of whānau, hapū and iwi which is associated with the seas. The programme will also investigate the resilience of important Māori practices, and enable economic growth while restoring and maintaining tikanga approaches. The inclusion of indigenous communities in an EBM approach to managing marine resources will be world leading. *Dynamic Seas* focuses on the science necessary to underpin EBM and will determine the ecological 'footprint' of impacts and activities across habitats and how they influence the delivery of ecosystem goods and services. *Managed Seas* will use the knowledge generated by the other four programmes to develop frameworks and tools to support world-leading governance and integrated management decision making through EBM by marine resource managers. *Vision Mātauranga* is a cross-programme element of the Challenge to assist in achieving the mission of the Vision Mātauranga policy framework that was developed by the Ministry for Business, Innovation and Employment. The framework is designed to explore the use of mātauranga Māori to develop distinctive products, processes, systems and services, as well as identify research areas, that create a better future of New Zealanders. The *Communication and Outreach* cross-programme element will play a major role facilitating a wide range of communication and outreach activities that will be essential to support the engagement in EBM of Māori and a wide range of stakeholders.

In addition to the seven components above, there will be three cross-programme projects. Two will evaluate the potential for EBM to be implemented in the current legislative framework and what policy tools and innovations could be used to enhance the implementation of EBM, while the third will involve processes, frameworks and tools developed in the Challenge being used by Māori, stakeholders and resource managers in an integrated project to trial an EBM approach in the Tasman/Golden Bay case study area.

The Challenge is hosted by NIWA and governed by an independent Board which will ensure the Challenge meets its Objective. An Independent Science Panel will provide the Board with advice and guidance on the science strategy for the Challenge and ensure that the research conducted is innovative and aligned with international best practice. Implementation of the Challenge will be undertaken by the Challenge Director, Manager, and the Science Leadership Team, who will consult with and receive advice and guidance from the Challenge Kāhui Māori and Stakeholder Panel. These interactions ensure that the Challenge responds to, and evolves to meet, the needs of New Zealand society.

2. Introduction

2.1 Objective, Vision and Mission

The Objective of Sustainable Seas *Ko ngā moana whakauka* National Science Challenge is:

Enhance utilisation of our marine resources within environmental and biological constraints.

This Objective is also encompassed within the Ministry of Business, Innovation and Employment (MBIE) Vision statement for Sustainable Seas *Ko ngā moana whakauka* National Science Challenge which is:

New Zealand has a thriving marine economy with active stewardship and well informed protection of our marine ecosystems, reflecting the aspirations, expectations and the agreed rights of New Zealanders now and for generations to come.

To meet the Objective, and reflect the Vision, the following Mission has been developed to guide the research focus, priorities and activities of the Challenge as it progresses:

Sustainable Seas will drive the transformation of New Zealand's marine economy. Through input into resource management, we will realise the value, increase use, and maintain the ecosystem health of our vast oceanic and coastal assets. The Challenge will focus on societal participation in marine governance and management to balance the aspirations and rights of Māori, communities and industry, and build New Zealand's reputation as a world leader in the use and stewardship of its marine estate.

2.2 Background to the Challenge

New Zealand is responsible for the fourth largest Exclusive Economic Zone (EEZ) in the world. With the Extended Continental Shelf, our marine estate is more than 20 times the size of our land area. This vast region supports enormous quantities of natural resources, much of which are yet to be explored. Such resources include petroleum, minerals, and renewable energy. Our marine environment also supports a range of other economic sectors, such as tourism, aquaculture, fishing, shipping, communication and recreation. Significant opportunity exists to grow New Zealand's existing marine economy. Oil production already contributes \$2.5B to the economy (PEPANZ 2014), generates exports of \$1.8B annually (StatsNZ 2013), and has huge potential for future growth. Current production is from a single basin in Taranaki, but there are 17 other basins in New Zealand's marine estate that may contain commercially viable reserves of oil and gas. The Seafood industry, including aquaculture, currently contributes \$1.8B to the economy (MPI 2012) and generates exports of \$1.5B (Seafood NZ 2014). While the wild fisheries sector is well developed and close to capacity (Seafood NZ 2014), opportunity exists for value-addition to products, and there is significant potential for growth and diversification in aquaculture (NZIER 2010) with a sector growth target of \$1B by 2025. Potential new sectors to the marine economy include mining and renewable energy. Seafloor mineral deposits within New Zealand's EEZ are large (Katz & Glasby 1979), and their value has been estimated to be in the order of \$500B (CAE 2001). Offshore mining is yet to take place in New Zealand; consent applications to mine iron sands in the north Taranaki Bight and phosphorite on the Chatham Rise have been recently turned down by the Environmental Protection Authority (EPA). Similarly, companies continue to show interest in, and are trialling, the development of tidal energy generation in our coastal waters.

New Zealand's seas also have significant cultural value. They have been an integral part of the lifestyle and culture of generations of New Zealanders, and continue to be important for food, recreation and spiritual wellbeing. The Māori connection with the ocean permeates many aspects of Māori life (cultural, spiritual, practical and economic), and Māori have specific rights as a Treaty of Waitangi (Treaty) partners. Within Te Ao Māori there are clear tikanga that highlight the interconnectedness of whānau, hapū and iwi to the sea and coastlines. This Māori worldview is expressed through a wide range of practices and knowledge embedded in Māori epistemologies. The link to the environment is one that is maintained through cultural and spiritual frameworks, and reflects relationships of all its components, human and non-human. Māori also have significant marine business interests through ownership of 28% of the fisheries quota and access to marine space for aquaculture, and opportunity exists to grow and diversify these interests. Despite the importance of the seas to Māori, and the obligations enshrined in the Treaty, New Zealand's current marine governance and management is struggling to incorporate Māori rights and aspirations. Active participation and leadership of Māori within the Challenge is essential for developing ways to engage and to transform this context.

About 75% of New Zealanders live within 10 km of the coast, and there is growing conflict among the multiple economic, cultural, spiritual, recreational and conservation values and uses of our marine environment. The critical issues are that these conflicts are beginning to impede development of the marine economy, and there is increasing societal concern that our unique and diverse marine biota, and the general health of our seas, are at risk. The growing resistance by New Zealanders to enhanced use of our marine resources is an area of focus in which the Challenge must engage if, as a country, we are to develop a productive and resilient marine economy.

Resource developers are increasingly finding that their social licence to operate is being challenged. This opposition is currently exemplified by protests over oil and gas extraction and proposed offshore mining, and objection to the allocation of new marine space for aquaculture. Issues that appear to be influencing these societal responses are:

- Concern that New Zealand lacks adequate resource management strategies and systems to prevent serious damage to the marine environment.
- Failure to appropriately acknowledge and accommodate Māori and community concerns, views and values.
- A lack of knowledge of, and trust in, science and how it is used in resource management decisions.
- Poor understanding of the value of the marine economy to New Zealand, and the societal value of the use of our marine resources.

Addressing these issues is fundamental to encouraging investment in our marine economy, adding value to our marine resources already in use, and maintaining, protecting and restoring the health of our seas. There is an urgent need for a paradigm shift in the way New Zealand views, governs and manages its marine estate if it is to achieve a balance between enhanced use of its marine resources and good environmental stewardship, while meeting the aspirations and rights of society. This shift in marine management will need to merge policy, planning, regulation, science, and mātauranga Māori with societal collaboration, as well as accommodate the plethora of national and international agreements, and relevant legislation and management agencies responsible for our coasts and ocean. The aim of the Challenge is to facilitate this paradigm shift through the development of EBM by providing processes, frameworks and tools that can be used to govern and manage our marine resources. Such an approach, incorporating the values and rights of Māori and society, will transform New Zealand into a world-leader in sustainable marine economic development.

2.3 The Ecosystem Based Management Concept

The need to use whole-of-ecosystem based tools to manage the diverse range of activities in New Zealand's marine estate was recognised early in the development of the Challenge as the best approach to overcome the impediments to gaining societal licence for increased use of our marine resources. Ecosystem Based Management (EBM) is a strategy for the integrated management of natural resources (Crowder & Norse 2008, Folke et al. 2004) that recognises the full array of interactions within an ecosystem, including human, and promotes both sustainable use and conservation in an equitable way. For that reason, the development of an EBM 'toolbox' was selected as the focus of the Challenge. The goal of EBM is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services and goods humans want and need, both now and in the future. It differs from many current strategies that manage single species' or sectors, by using an integrated approach that considers all of the activities that affect the marine environment. Engagement between researchers, resource users, managers and regulators, Māori and communities is a key element of EBM. While many countries are attempting to implement an EBM approach to the management of their marine resources, comprehensive working models underpinned with appropriate research have yet to emerge.

Successful implementation of a full EBM approach by marine resource managers within New Zealand represents an enormous opportunity to achieve a global first and provide potential competitive advantage across multiple marine sectors and products. We have been world leaders in sustainable management of our fish stocks (Worm et al. 2009; Alder et al. 2010), marine biosecurity management and marine conservation, but we have lost competitive advantage and a sense of trust by society in our ocean governance. The Challenge provides the opportunity to surpass past successes. We envisage New Zealand being a world leader in sustainable marine economic development, with a reputation that encourages investment in New Zealand's marine estate.

Implementation of EBM will be truly transformative. For EBM to be successful, it will require societal engagement and choices based on shared and contested visions and principles. This will require New Zealanders and marine resource managers to move beyond the traditional sectarian approaches to marine resource use, and reflect on the trade-offs associated with wider economic, social, cultural and environmental considerations. As such, *Ko ngā moana whakauka* Sustainable Seas will support development of an EBM framework that both works with, and fosters, the evolution of current policy. We will trial the application of this framework in collaboration with resource managers, using a range of resource uses and management settings to show a real ability to move beyond the traditional polarising stance of the economy versus the environment. Use of EBM will demonstrate that healthy and growing economies can be achieved in tandem with environmental gains. Inherent in EBM are the key concepts of broad integration (e.g., of science, users, and decision making) and balance (e.g., among uses and between short- and long-term perspectives), and both apply along continuums. As resource management moves from the current state and along these continuums, changes are required in both the science and policy arenas. These changes will sometimes be challenging, but will lead to increasing benefits to society.

2.4 Co-Development of the Sustainable Seas Challenge

The collaborative EBM approach that has been adopted for this Challenge has, by definition, necessitated co-development of each component by the Facilitation Group, Science Leadership Team, Māori, and stakeholders. The Research Plan has been, and will continue to be, developed by an iterative process involving researchers, Māori and a wide range of stakeholders. Responding to the dynamic and collaborative approach of the Challenge in this manner will ensure that the research focusses on the Challenge Objective and achieves the benefits sought for New Zealand. This iterative process (Figure 1) will feed into regular updates of the Research Plan for the Challenge.

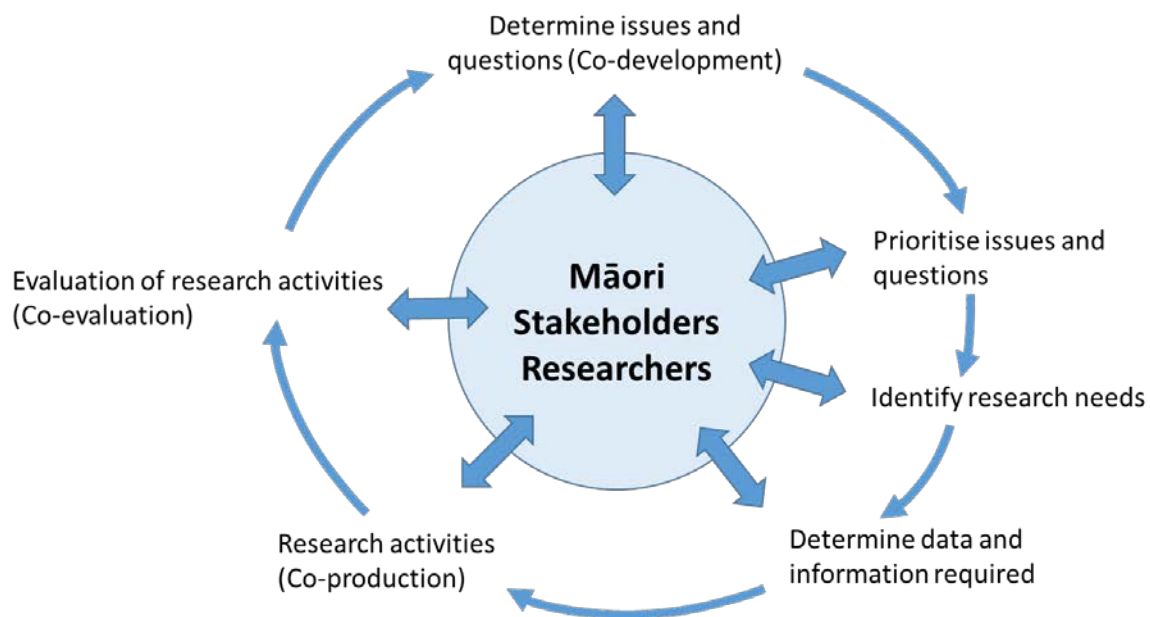


Figure 1. Iterative process for ongoing development of the Sustainable Seas Challenge research plan.

Although time-consuming, this inclusive approach taken at all stages of the Challenge development to date, is achieving a demonstrable change in the focus of parties, from individual interests to the collective delivery of the Challenge Objective. A summary of the Challenge co-development processes can be found in Appendix A.

3. Sustainable Seas Programme focal region and structure

3.1 Focal region

This is a national Challenge and the area of our marine estate is vast as well as ecologically and socio-economically diverse. We therefore selected a focal region for the Challenge to maximise our ability to integrate research initiatives and Māori and stakeholder values with socio-economic needs, activities and management interventions. This focus will allow in depth EBM case studies that facilitate the development and trial of a range of EBM tools, which in the longer term can be applied by managers of marine resources throughout New Zealand's marine estate. The focal region outlined below will be the area of primary focus for the Challenge, although some research will need to be conducted in other areas in particular types of marine environments. Similarly, if important socio-economic conditions are not present in the focal region, or if research can build on activities being undertaken, or which have been undertaken in another area, then some research will be conducted outside the focal region.

A workshop in November 2014 of over 40 science, Māori, and stakeholders, recommended that the best option for a focal region, which met a range of selection criteria, was a broad swath across central New Zealand stretching in a NW-SE direction from North Taranaki to the Chatham Rise and incorporating Tasman and Golden Bays, Marlborough Sounds, South Wairarapa, the Chatham Rise, and Kaikoura (Figure 2). This recommendation has subsequently been approved by the Challenge Governance Board. Within this area, there is potential for significant growth in marine industries such as oil and gas, mining, tourism and aquaculture. There are also known areas of conflict between communities, economic activities and biodiversity conservation values (based on recent EPA decisions), and several communities have expressed concern about the potential impacts on the local marine environment from the growth of marine industries in their area. In short, it provides ample opportunity to tackle the difficult issues currently impeding social licence to operate, and to test EBM in coastal and offshore waters.

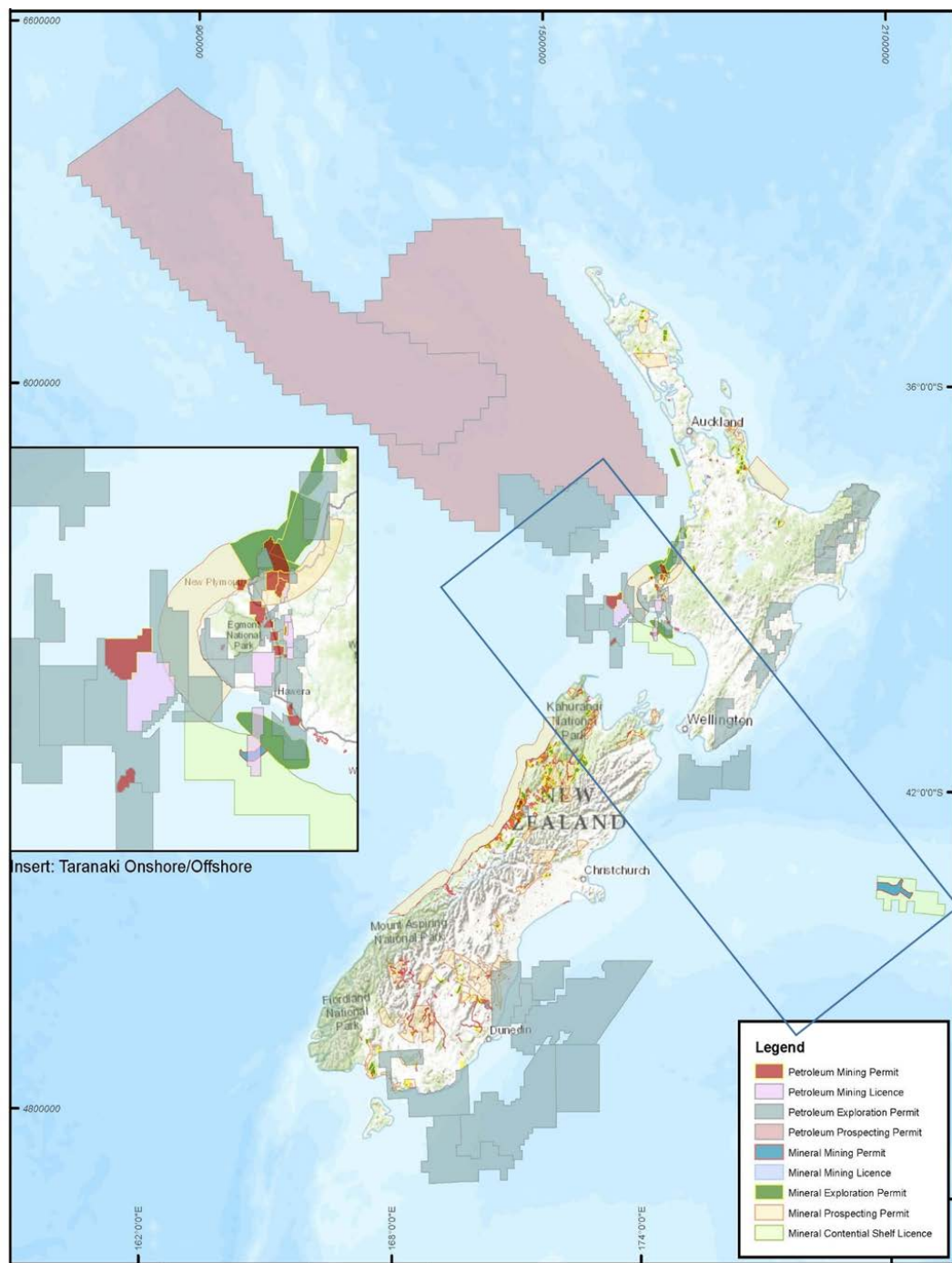


Figure 2. Focal region for research within the Challenge.

3.2 The Sustainable Seas structure

The Challenge is composed of a framework of five interconnected programmes and two cross-cutting elements. Together they will develop the knowledge and processes, frameworks and tools needed to implement EBM for management of our marine resources (Figure 3). A key feature of the Challenge will be the development and trailing of participatory processes which involve Māori and stakeholders, including communities, industry, and central and regional government, in decision making with co-development and co-learning occurring throughout the process.

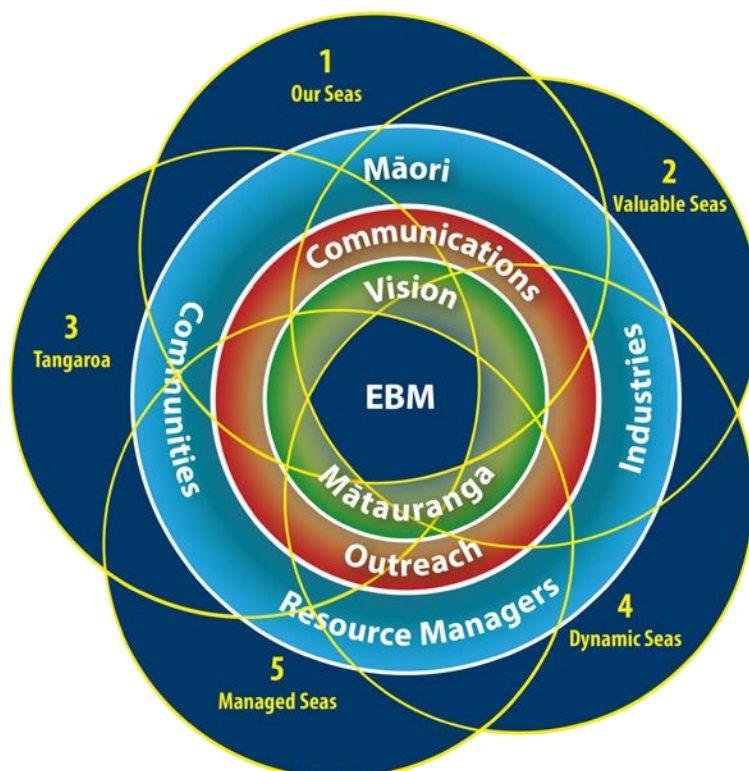


Figure 3. The Sustainable Seas structure.

The programmes and elements are:

Programme 1, Our Seas: This programme will develop mechanisms for societal involvement in a variety of ways across the different scientific disciplines. Participatory processes and frameworks will be designed to enhance engagement across all sectors of society, and result in more efficient and effective decision making that addresses societal and industry concerns, identifies commonalities, and develops trust between science, governance, industry, Māori and society. The programme will consider EBM within economic, investment, policy and decision making frameworks and enhance the ability of industries to understand how social licence to operate is gained and maintained.

Programme 2, Valuable Seas: In this programme, we will develop methods of capturing the economic, social, environmental, spiritual and cultural values of New Zealand's marine ecosystems. Using participatory processes developed in *Our Seas*, we will link these to new economic frameworks that focus on developing innovation within the marine economy, adding monetary value while ensuring

maintenance or improvement of other values. Māori, industry and society are striving for a balance between guardianship and economic benefit, and this programme, particularly in conjunction with *Tangaroa*, focusses on providing the opportunity for us all to navigate this waka together.

Programme 3, Tangaroa: Here we will strengthen the resilience of Māori communities and their unique connection with the sea by exploring with whānau, hapū and iwi the relationship and opportunities posed between mātauranga Māori and EBM. We aim to create innovations that enable Māori to participate as Māori, and as partners in marine management and decision making, providing for the practice and maintenance of tikanga approaches, while supporting economic growth.

Programme 4, Dynamic Seas: This will focus on the biophysical science necessary to underpin new models and tools to quantify the ecological 'footprint' and temporal ecosystem responses of impacts and activities, their synergistic and cumulative effects across habitats, and how they influence the delivery of ecosystem services. New research will examine how habitats function to support ecosystem services, identify ecosystem properties that make them resilient or vulnerable to rapid change, address interdependencies of multiple stressors as drivers of change and determine the critical tipping points that can transform ecosystems into non-desirable states. A key component of the programme will be delineating new ways of measuring how ecosystems are connected across time and space to link local effects to far-field impacts.

Programme 5, Managed Seas: This programme will integrate the knowledge generated by the other programmes in the Challenge, and use these in innovative robust and validated decision support tools and frameworks to ensure the increased sustainable use of our marine resources within environmental and biological constraints. This programme will develop these tools and frameworks to allow uncertainty, risks, and trade-offs between different outcomes (economic, cultural, social and environmental) to be evaluated and assessed. We will develop them by partnering with key policymakers and resource managers, Māori, community and stakeholders — ensuring the tools and frameworks are 'fit for purpose' and integrated into existing management systems.

Vision Mātauranga is a cross-programme element of the Challenge that will work with each programme to embed the themes of the Vision Mātauranga policy framework. The *Vision Mātauranga* programme is aimed at achieving the aspirations of unlocking the innovation potential of Māori knowledge, resources and people to develop distinctive products, processes, systems and services, while also identifying research areas, to create a better future for New Zealanders.

The *Communication and Outreach* cross-programme element will play a major role in facilitating the reciprocal communication between researchers, Māori, stakeholders and resource managers, that is essential to support EBM and gain social licence for increased economic use of our marine estate.

In addition to the components above, there are three cross-programme projects:

EBM within New Zealand's existing legislative framework will review how EBM is currently implemented within the existing national, regional, and local frameworks, statutes, and institutions that manage New Zealand's estuarine, coastal and ocean ecosystems.

Future EBM frameworks for New Zealand will explore the suite of policy tools and innovations that currently exist, both nationally and internationally, that could be used to enhance the implementation of EBM in New Zealand.

Trialling EBM will build on research conducted in all the Challenge programmes and trial EBM approach to marine resource management in the Tasman/Golden Bays case study area.

Together the programmes of the Challenge will:

- Work collaboratively with Māori and a wide range of stakeholders to develop and trial processes, frameworks and tools to support an EBM approach to managing our marine estate in a holistic way.
- Provide data and information to increase understanding of the marine environment in the wider community to improve/increase participation in resource management decisions.
- Provide processes, frameworks and tools that resource managers can use in an EBM approach to managing increased utilisation of our marine estate.
- Review current legislation and policy to assess how EBM could be implemented in New Zealand.

The result will be an EBM approach for managing our marine resources which will:

- Consider all parts of the ecosystem including humans.
- Consider all uses of the marine estate simultaneously.
- Be an inclusive process involving Māori and a wide range of stakeholders in resource management decisions.
- Reduce the potential for conflict by moving from an adversarial to a collaborative approach in decision making.
- Include consideration of both monetary and non-monetary values, and find ways to balance these different values in decision making.

Successful implementation of EBM will enhance the sustainability of New Zealand's marine resources and add value to the marine economy through a variety of pathways including product certification and provenance, increased investment, enhanced diversification, and an increased social licence to operate, which will increase the potential use of our marine resources. The Challenge will also develop a blue economy capability to generate short and long term benefits for investors. In addition, the Challenge will support the development of new environmentally sustainable technologies and activities that will add value to the marine economy.

The National Science Challenges have been planned as ten year initiatives with initial funding of \$31.3 million supporting the Sustainable Seas Challenge until June 2019. This document covers in detail the projects for Phase 1 of the Challenge (Phase 1 – until June 2019) and outlines the directions for Phase 2 of the Challenge (July 2019 - June 2024).

3.3 Scope of Sustainable Seas

The Challenge will achieve its Objective by funding the critical components of the research required for the development of EBM. In addition, the Challenge will draw on the results of research conducted in aligned CRI core-funded projects, and related research conducted by the collaborating parties and other research providers to support the development of EBM. At present the existing related research is poorly connected and does not support a consistent approach to marine management. Figure 4 highlights the research programmes of the Challenge and the research currently being undertaken by NIWA that will contribute to the Challenge reaching its Objective. The Challenge will also draw on research from academic and other institutes, particularly from social sciences and humanities disciplines, and for indigenous values and management.

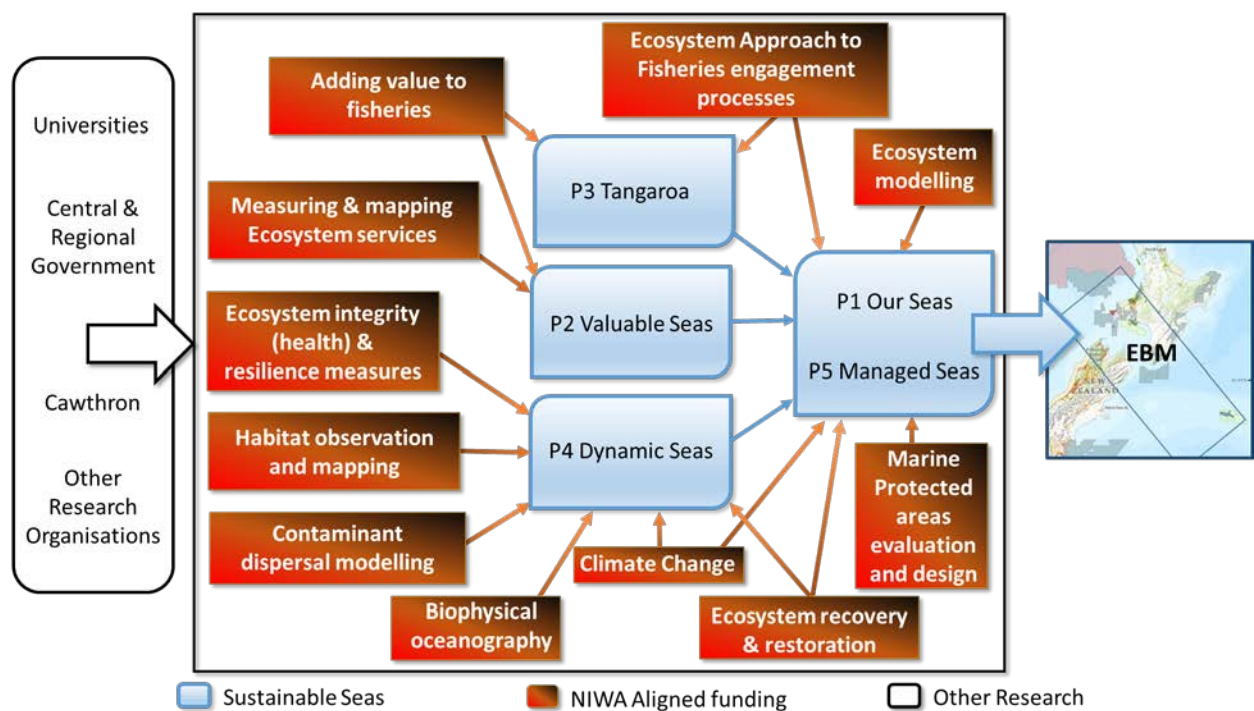


Figure 4. Development of EBM within the Challenge will draw on both aligned research conducted at NIWA, and related research from other organisations to improve the management of our marine resources.

3.4 Out of scope research

The focus of the Challenge on the development of EBM processes, frameworks and tools means that research focusing on locating and quantifying economic ‘goods’ (e.g., fishery stocks, petroleum and mineral resources) is outside of scope of the Challenge. The Challenge will ensure that links with out-of-scope research are maintained to ensure that knowledge of resource quantification and development informs Challenge research.

4. The Sustainable Seas Programmes and cross-cutting elements

4.1 Programme 1: *Our Seas*

Science Programme Leader: Carolyn Lundquist, marine ecologist with experience in biodiversity prioritisation to inform ecosystem management, NIWA and University of Auckland

Programme team members: Richard Le Heron, expertise in trans-disciplinary engagement across science and social science, University of Auckland; Jim Sinner, expertise in agricultural economics, Cawthron Institute; Joe Harawira, expertise in maintaining and progressing partnerships with whanau, hapū and iwi, Department of Conservation; Paula Blackett, expertise in policy implementation, AgResearch. Additional members may be identified following a social science workshop to be held in October 2015.

Scope

The *Our Seas* programme explores the human dimension of the Sustainable Seas Challenge. A better understanding of interactions between ecological and social systems is critical to sustainable management of coastal and marine systems. Most of the changes in our oceans, including loss of biodiversity and taonga species, the modification of seascapes, and climate change, are driven by human activities. At the same time, Māori and civil society are demanding a greater say in how these activities are managed. There have been numerous calls for new marine policy and management frameworks to balance multiple uses, to engage multiple sectors of society in decision making processes, and to transform management to better cope with change (Holling & Meffe 1996; Olsson et al. 2008; Tallis et al. 2010; Ban et al. 2013). *Our Seas* will investigate ways of incorporating diverse stakeholder, Māori, and civil society interests in managing New Zealand's marine estate. New ways of linking science to human values will be developed, building trust in science and making it more responsive to society, and using these new connections to refine marine management and governance.

The Challenge is undertaking frontier transdisciplinary research, particularly in the areas of integration and emergence of knowledge across programmes. These efforts require co-learning and co-development models to guide the work undertaken both internally among the Challenge programmes, and externally in the work that each programme undertakes with Māori and stakeholders. Specifically, efforts must be made to engage a diverse range of knowledge cultures, particularly mātauranga Māori. To enable EBM, science must be created and utilised by all involved, from managers and decision makers, to marine business and industry, to the general public. The paradigm shift from top-down science and management to bottom-up, participatory decision making is unlikely to come easily. New knowledge and methods are often found to be uncomfortable, and individuals tend to favour the status quo (Rayner 2012; Brown et al. 2010). Differences in individual or institutional perception, attitude, motivation, responsibility, accountability, and commitment can be additional barriers to the uptake of new thinking and practices.

This programme includes two interconnected research themes, Theme 1: *Participatory processes*, and Theme 2: *Frameworks for testing social licence*. In Theme 1, EBM requires increased Māori and stakeholder participation in developing frameworks that also acknowledge social and cultural values and aspirations. To achieve this, Theme 1 will involve the various interested parties (including iwi, environmental advocacy groups, local geographic communities, business interests, science providers, resource managers, and other identifiable stakeholders) in the development of these frameworks,

including helping to determine the science and information requirements for decision making and on-going monitoring and evaluation.

Theme 2 is fundamentally about the process of establishing relationships of trust between commercial entities and communities of interest. The presence of multiple communities with diverse interests means that social licence is inevitably multi-faceted and complex. Individual commercial entities will need to demonstrate their ability to work within frameworks that recognise social and cultural values, in addition to other commercial uses of the marine environment. The term “social licence to operate” has been used to describe the acquisition and on-going maintenance of the confidence and trust of local Māori and stakeholders (Pike 2012), generally by an entity in pursuit of private/commercial gain with potential for adverse effects. Social licence is an outcome, not a process, which suggests that there may be many different ways to obtain and maintain it (Quigley and Baines 2014). This theme will investigate cultural, social and economic indicators that underpin social licence, and improve understanding of how risk and uncertainty associated with marine industries are perceived and used to formulate opinions on whether or not social licence should be granted. This theme will build upon learnings from the cross-programme project “*EBM within New Zealand’s existing legislative framework*” which investigates the current framework for decision making and granting of social licence in New Zealand’s marine estate, including legislation, management agency roles and responsibilities, and how science is incorporated into decision making.

Outcomes in 10 years

- A diverse group of stakeholders are participating in decision making and management of New Zealand’s marine estate, and collaborative processes result in efficient decision making that facilitate enhanced use of marine resources within environmental constraints.
- Social, cultural and economic indicators that underpin social licence are developed that complement environmental sustainability and enhance understanding of risks and uncertainties associated with new and existing marine industries, facilitating increased investment in the marine economy.

Programme Deliverables

Phase 1:

- A database of national and international participatory processes, highlighting key attributes that are associated with success in enhancing marine management and decision making.
- A new participatory framework has been developed and trialled in one case study area.
- Social, cultural and economic indicators that build social licence are compiled and used in developing information requirements for marine resource management.
- Insights into how different sectors in society perceive and use science in decision making and how science can be used to inform the decision making processes.

Phase 2:

- Participatory frameworks have been evaluated, revised, and utilised in additional case study areas, fostering effective collaboration in the co-development of marine resource management.
- New techniques are developed to effectively engage society in exploration of marine futures, options and choices that support paths to economic growth, sustainability and resilience.

- Social licence indicators are trialled in decision making processes in the focal region.
- Commonalities, critical issues of context, and unifying principles for navigating sustainable pathways for marine socio-ecological systems are identified.
- Understanding of connections across multiple dimensions in socio-ecological systems is used to inform the development of innovative EBM processes.

Theme 1: Participatory processes

Internationally, the importance of participation as a strategy to engage stakeholders and to make more sense of stakeholder views and intentions continues to be affirmed. In a major stock take of industry submissions on oceans and water policy in the US, the World Ocean Council (2015) found that the most common theme of concern was that stakeholder involvement be increased and encouraged. This is recognised by the Challenge to address societal concerns around the lack of knowledge and information because of poor engagement, often resulting in perceptions that economic interests are given greater weight than environmental, cultural and social values in decision making. Discussions in Māori and stakeholder workshops for the Challenge, and from the Marine Futures programme, emphasise the changing culture of decision making in New Zealand, with new emphasis on involving Māori and stakeholders as participants in agenda setting and decision making fora. Examples include Marine Protected Area stakeholder forum processes by DOC and MPI, regional planning processes (e.g., the Proposed Auckland Unitary Plan), marine spatial planning initiatives such as SeaChange for the Hauraki Gulf Marine Park, and Māori and stakeholder initiatives in Fiordland and Kaikoura. The Marine Futures programme also showed (Le Heron et al. 2015) that participatory processes can open the door to framing relevant research questions that are grounded in multi-use dynamics, confront uncertainties (e.g., economic, cultural, ecological and political surprises), and accommodate multiple value perspectives and their implied choices over engagement with ecology and economy. This theme will design, and engage in, participatory projects that identify commonalities, develop trust between science, governance, industry and society, and develop a platform for enhanced and efficient participatory decision making.

Strong interdependencies exist between this theme and the projects in *Our Seas* Theme 2, as participatory processes are an integral part of developing social licence in the marine environment. Critical links with *Tangaroa* and *Vision Mātauranga* are vital to the success of this theme, as enhanced and effective Māori participation in marine management decision making is a necessary aspect of successful participatory processes in New Zealand. This theme also links directly with *Managed Seas* in the development of tools to support participatory processes, and in other ecosystem management tools that enhance collaborative decision making and the sharing of knowledge to inform management. Participatory processes are also linked to *Valuable Seas* in developing quantitative and qualitative value frameworks that inform collaborative decision making, and with *Dynamic Seas* through identification of trade-offs when assessing the impacts of different management actions and resource uses on these values. Within cross-programme projects, this theme will provide participatory frameworks to support engagement in EBM. Finally, this theme has critical linkages with the *Communication and Outreach* element of the Challenge, within which metrics will be developed to monitor and document engagement with the research in the Challenge and its integration into policy, and to evaluate the social impact of the Challenge.

Theme 2: Frameworks for testing social licence

Critical to effectively navigating pathways to sustainability is a deep understanding of interactions and feedbacks between ecological and social systems. This theme will build directly on *Our Seas* Theme 1 and cross-programme projects, and will incorporate new techniques and capacity to use participatory processes as a mechanism to facilitate dialogue and understanding of societal interactions with marine industries. This theme will build capacity to respond to complex problems associated with high levels of conflict, risk, and uncertainty, and break down barriers of perception, attitude, motivation, responsibility, accountability and commitment. A key challenge that underpins the granting of social licence is acknowledgement and understanding of society's perceptions of risk and uncertainty of environmental impacts and awareness around the rights and interests of Māori and stakeholders. This theme will develop new ways to make science more responsive to human values through collaborative identification of critical knowledge gaps, and prioritising future research to fill these gaps according to their relevance for policy and decision making. New methods for building trust in science will be developed and used to refine marine management and governance. This theme will advance the understanding of complex social-ecological systems and develop guidelines for sustainable marine economic growth practices that complement environmental sustainability, and work in harmony with shared economic, social and cultural uses and values.

This theme will build directly on *Our Seas* Theme 1, recognising that participatory processes are an integral part of developing social licence in the marine environment. Cross-programme projects will provide information on existing frameworks for social licence. Critical links with *Tangaroa* and *Vision Mātauranga* contribute to this theme, through exploration of the aspirations of Māori in new marine industries that require social licence, and building trust between science, industry, governance and Māori. Social licence is directly linked to *Valuable Seas* in developing indicators of social licence, allowing for added value to the marine economy, and with *Dynamic Seas* through assessing risks of the cumulative impacts of multiple marine industries, and how these risks are used in granting of social licence. This theme also has strong linkages with *Managed Seas* in the development of EBM tools that allow for the assessment of risks, enhance sharing of knowledge to decrease information gaps between science, governance, industry and civil society, and facilitate participation and engagement to foster social licence.

Table 1. Linkages between *Our Seas* projects and with other programmes.

<i>Our Seas</i> Projects	Linkages	
	<i>Our Seas</i> Themes/Projects	Sustainable Seas Programmes
Theme 1: Participatory processes		
Project 1.1.1 Review existing Māori and stakeholder engagement in marine science and marine governance participatory processes	1.1.2, 1.2.1, 1.2.2	2,3,4,5
Project 1.1.2 Determine suite of participatory processes for application in multi-use environments	1.1.1, 1.2.1, 1.2.2	2,3,4,5
Theme 2: Frameworks for testing social licence		
Project 1.2.1 Frameworks for achieving and maintaining social licence	1.1.1, 1.1.2, 1.2.2	2,3,4,5
Project 1.2.2 Navigating marine socio-ecological systems	1.1.1, 1.1.2, 1.2.1	2,3,4,5

Theme 1: Participatory processes

Project 1.1.1 Review existing Māori and stakeholder engagement in marine science and marine governance participatory processes

Project Leader: Paula Blackett

Questions:

- How have Māori and stakeholders been involved in participatory management of New Zealand's marine estate?
- What types of participatory processes have been successfully used nationally and internationally to enhance stakeholder participation?
- What aspects of stakeholder involvement are associated with successful outcomes?

This project includes an initial step of mapping, evaluating and synthesising prior and current participatory processes in order to identify which aspects have resulted in successful outcomes for EBM and economic initiatives. Determination of similarities in participatory engagement across different contexts in national initiatives will be complemented by an international evaluation of comparable processes in other regions. All processes will be evaluated to determine how Māori and stakeholders were involved (and how were they identified, contacted, and engaged); how many participated (and how many declined), and what sectors did they represent; whether an appropriate/acceptable level of participation was achieved; how long a process was; whether a process was successful (what were the goals, and were they achieved), and how knowledge gained from participation was utilised to further EBM and economic initiatives.

The importance of *Our Seas* reaching into existing models and initiatives was stressed in Māori and stakeholder consultation workshops held in June and July 2015. To address these interests, both prior regional participatory processes (e.g. Fiordland, Kaikoura) and current processes (e.g., SeaChange, the Hauraki Gulf Marine Spatial Plan; Southeast Marine Protected Area Forum; Marlborough Marine Futures) will be investigated for lessons learnt. If it is within the interests and mandate of these processes, an open dialogue about participatory best practice, aimed at fostering learning and enhancing current and future activities, will be encouraged.

This project will be done collaboratively with *Tangaroa* project 3.3.2 (Innovatively improved pathways), summarising and developing, in partnership, integrated strategies for participatory decision making that facilitate and enhance Māori participation in marine governance, management and decision making. Parallel learnings from *Vision Mātauranga* (project VM2.1) will provide international best practice for indigenous approaches to guardianship and stewardship from a Canadian case study.

Outputs:

- Case studies of current and past New Zealand participatory decision making will be compiled. This will enable us to determine best practice guidelines to develop a participatory decision making framework to trial in the case study area, by December 2016.
- Best practice from international participatory processes will be summarised, and investigated within a New Zealand context. In conjunction with VM2.1, this will enable inclusion of best practice approaches for incorporating indigenous values and frameworks into participatory decision making in the case study area, by June 2017.

- A workshop will be held with international partners to share lessons for participatory processes. This will further inform the participatory framework to be trialled in the case study area, by June 2017.

Participating organisations: AgResearch, NIWA, University of Auckland, Cawthron Institute, EDS, Tūtaiao Ltd, Whetu Consultancy Group. Partners from existing processes (Marlborough Marine Futures, SeaChange, Southeast MPA Forum). Central and regional government partners (DOC, MPI, MfE, regional authorities) provide valuable experience and expertise, and in-kind contributions of their expertise are envisioned as a necessary aspect of this project, to summarise institutional experiences with respect to participatory processes.

Key collaborations: International collaborators will both serve as advisors based on their experiences with participatory processes, and in jointly hosting a workshop to share lessons in optimising success of participatory processes in marine management. Charles Ehler, UNESCO, for collaboration with marine spatial planning initiatives; Eric Poncelet, lead facilitator, California MLPA process; Wendy Foden, South Africa Biodiversity Institute for regional participatory processes and scenario modelling; The Economics of Ecosystems and Biodiversity (TEEB) will be used to enhance two-way learning from international participatory processes and develop new participatory models and approaches for New Zealand.

Funding: Negotiated \$460k (total funds allocated for phase 1)

Project 1.1.2 Determine suite of participatory processes for application in multi-use environments

Project Leader: Richard Le Heron

Questions:

- How can new EBM understandings be introduced, translated, and embedded into other Sustainable Seas programmes, and into societal practices?
- Which EBM processes can benefit from introducing participatory processes?

Key questions identified in project 1.1.1 will be explored further through participatory modelling efforts deployed in a range of marine spaces. Particular attention will be paid to 1) methods that develop durable relations of trust as a foundation for co-learning, co-development, and capacity building, and 2) methods of encouraging the interpretation of different values as a resource rather than a barrier to change. This project will explore ways to 1) break down barriers to communication, engagement, and collaboration, 2) build trust within the Challenge in the value of participatory processes as a means to generate new ideas and common understanding, and 3) enhance societal trust in science. Bottom-up development of priorities and aspirations for the marine environment will drive co-management frameworks, promoting bidirectional learning. Participatory processes will be developed that include different sectors of society, recognising the need to incorporate differing values and experiences of youth, retired persons, the plethora of cultures of recent immigrants to New Zealand, rural and urban residents, and other societal aspects that vary in terms of their relationship with the ocean. Guidelines will be developed to assist in identifying stakeholder representation that is inclusive of broader society beyond historical stakeholder processes that identified and incorporated primarily economic interests.

This project will develop a participatory framework to suit a range of key management contexts for which participatory involvement is envisioned as essential for informed decision making. Within Phase I of the Challenge, we will develop a participatory framework and trial it within one case study area, identified as Tasman and Golden Bays. The participatory framework is expected to incorporate values and trade-offs (linked with *Valuable Seas, Tangaroa*), enhance ecosystem function while managing for

multiple uses (*Dynamic Seas, Managed Seas*), and utilise EBM tools created within *Managed Seas* to enhance engagement, participation and knowledge transfer (*Managed Seas*). We will minimise stakeholder fatigue through coordinated interactions with stakeholders across all the Challenge programmes within the case study area.

Outputs:

- Participatory processes and frameworks for application in multi-use environments have been developed explicitly for use in implementing EBM and re-shaping our marine economy. This will allow engagement of all aspects of society, providing transparent, efficient and effective decision making, by June 2017.
- Methodologies have been proposed to central and regional government, Māori and stakeholders interests. This will allow iteration and refinement of the participatory framework prior to its trial in the case study area, by June 2018.
- Participatory processes and frameworks are developed for, and trialled in the Tasman and Golden Bay case study area, by June 2019. This will allow further refinement of the participatory framework for trials elsewhere during Phase II of the Challenge.

Participating organisations: University of Auckland, NIWA, Cawthron Institute, Tūtaiao Ltd, Whetu Consultancy Group. Central and regional government partners (DOC, MPI, MfE, regional authorities) provide valuable experience and expertise, and in-kind contributions of their expertise are envisioned as a necessary aspect of this project, as partners and management organisations within national and regional participatory processes.

Key collaborations: Ongoing collaboration with TEEB will be used to enhance development of new participatory models and approaches for New Zealand.

Funding: Negotiated \$850k (total funds allocated for phase 1)

Theme 2: Frameworks for testing social licence

Project 1.2.1 Frameworks for achieving and maintaining social licence

Project Leader: Jim Sinner

Questions:

- What are the processes involved in acquiring and maintaining social licence for existing and new marine industries?
- What cultural, economic and social indicators can be identified to underpin social licence?

Some parties have suggested that the concept of social licence is dominated by an industrial discourse and is an attempt to avoid more collaborative processes to determine pathways for sustainable development (Owen & Kemp 2012). As used here, 'social licence' is much broader than this, and concerns the relationships between commercial entities and various Māori and stakeholder interests. Social licence can be gained through participatory processes that involve all stakeholders in the decision making process, including the determination of what science is relevant and how information is collected and assessed. Perceptions of social licence in the New Zealand marine estate are varied; some interest groups view the landscape as welcoming and promoting marine industry at the expense

of the marine environment and societal and cultural values, while others perceive barriers to industry through expensive consent processes and poorly defined requirements. This project will engage with Māori and stakeholders firstly to achieve a shared understanding of the concept and, secondly, to develop frameworks for what social licence comprises and how it can be achieved and maintained.

This project will build on lessons from cross-programme project CP1.1, which will review the existing framework for decision making and granting of social licence in New Zealand. This project links directly with *Our Seas* Theme 1, and will build on strategies to incorporate participatory processes into marine governance and management for fostering social licence. This project will be developed in partnership with *Tangaroa* project 3.2.1 to explore aspirations of Māori in new marine industries that require social licence, and in building trust between science, industry, governance and Māori. This project also directly links with *Managed Seas* project 5.4 in developing the participatory web-based and modelling tools to support participatory processes, with *Valuable Seas* projects 2.2.1 and 2.2.2 in providing social licence indicators to enhance development of the blue economy, and adding value to New Zealand's marine economy, and with *Dynamic Seas* in identifying scientific information requirements to support granting of social licence. *Our Seas* will co-organise a cross-Challenge workshop on the social licence concept with the Land and Water and Biological Heritage Challenges, and DOC, developing cross-ecosystem understanding of how social licence is granted in terrestrial, freshwater and marine resource management.

Outputs:

- Lessons for social licence learned from domestic and international case studies (building on lessons from the cross-programme CP.1.1 project), and from a cross-Challenge joint workshop hosted by DOC on social licence (tentatively scheduled for February 2016) have been documented and used to develop strategies to inform granting of social licence, and enhancement of the marine economy, by June 2017.
- Key determinants of social licence are developed for a range of contexts and uses of the marine environment. Key barriers to social licence are identified, and how these can be managed and addressed in the context of social licence has been documented. This will enable industry to identify and mitigate key barriers that would otherwise prevent investment in the marine economy, by June 2018.
- Social, ecological and cultural indicators that help build social licence have been developed with Māori and stakeholder groups. This will enable industry to understand social licence requirements and target communication and engagement with society toward managing these indicators and enhancing likelihood of social licence being granted, by June 2019.

Participating organisations: Cawthron Institute, Taylor Baines & Associates, University of Auckland, NIWA, Massey University, Lincoln University; additional collaborators may be identified at a Sustainable Seas social sciences workshop scheduled for October 2015 and at the joint workshop on social licence in February 2016.

Key collaborations: Eleanor Sterling, Chief Conservation Scientist, American Museum of Natural History; Stacy Jupiter, Wildlife Conservation Society, Fiji; Kerry Sink, Marine Programme Manager, South African National Biodiversity Institute. These collaborators have extensive experience in the development of social licence indicators, building trust, and incorporation of socio-ecological resilience into ocean management.

Funding: Negotiated \$380k (total funds allocated for phase 1)

Project 1.2.2 Navigating marine socio-ecological systems

Project Leaders: Richard Le Heron, Carolyn Lundquist

Questions:

- How do we build trust in science to inform decision making?
- How do Māori and stakeholders perceive risk and uncertainty associated with marine industries?
- How can we integrate concepts of cumulative impacts into existing decision making frameworks?

Relationship building and issues of building trust between Māori, communities, science, industry and decision makers will be incorporated throughout *Our Seas*, and is a key aspect of granting social licence. The Treaty relationship with Māori is therefore central, as are questions regarding the use of mātauranga Māori. Attention will focus on how to generate durable relations of trust (Davies et al. 2015; Le Heron et al. 2015) as an integral part of developing relations of co-learning and co-development in times of uncertainty and surprise. A vital thread will be probing senses of ‘rights’, ‘privileges’, ‘responsibilities’, and ‘accountabilities’, that are being questioned and re-stated in complex contexts. This theme will also develop strategies for building trust in scientific evidence and providing parity of opportunity and impact assessment in relation to the use of ocean resources (including non-economic). In addition to relationships of trust between science and society, development of trust is also required between science and decision makers, between society and industry, between industry and decision makers and between industry and society.

This project will host a series of non-sectarian thought-experiment workshops, each of which will address key issues in Māori, stakeholder and management understanding of decision making for the marine environment. Workshops will be held to investigate management strategies to address cumulative impacts across multiple scales and from multiple sectors (with the Centre for Ocean Solutions), to build trust between science, government, industry, and society, and to better understand perceptions of risk and uncertainty. Information obtained from these workshops will be used to determine how these factors influence social licence and are used to inform decision making.

Outputs:

- Workshops will explore how Māori and civil society perceive risk and uncertainty, and how this influences perceptions of new and existing marine industries. This will inform development of social licence indicators (*Our Seas* 1.2.1) and encourage investment in the marine economy through identification of potential barriers to social licence, by June 2017.
- Workshops with central and regional government, scientists and stakeholders will explore how decision making, management frameworks and statutory processes contend with cumulative impacts at different temporal and spatial scales. This will inform development of new management frameworks that incorporate EBM, by June 2018.
- Trust between science, governance, industry and society will be developed through workshops held with stakeholders and others involved in the case study. This will enhance support of participatory processes, co-management and co-governance as a model for marine resource management, and build trust within the Challenge in the value of participatory processes as a means to generate new ideas and common understanding, by June 2019.

Participating organisations: University of Auckland, NIWA, Landcare Research, Cawthron Institute; additional collaborators may be identified at a Sustainable Seas social sciences workshop scheduled for October 2015.

Key collaborations: Megan Mach, Melissa Foley, Centre for Ocean Solutions, Stanford University and USGS. These collaborators have extensive experience in the incorporation of socio-ecological resilience into ocean management. Stakeholder workshops will be developed with their involvement on the development of cumulative impacts, risk and uncertainty, and building trust in science.

Funding: Negotiated \$920k (total funds allocated for phase 1)

4.2 Programme 2: *Valuable Seas*

Science Programme Leader: Judi Hewitt, statistical ecologist with expertise in measuring ecosystem services, ecosystem health and analysing multiple measures, NIWA and University of Helsinki.

Programme team members: Shaun Awatere, expertise in economics, Māori values and their perspective on Ecosystem Services, Landcare Research; Nick Lewis, expertise in ecological economics, economic development and measuring the economy, University of Auckland; Chris Battershill, has skills in natural products chemistry, value-add biotechnologies, and in developing commercialisation contracts from a scientific perspective, University of Waikato; Andrew Lohrer, expertise in measuring ecosystem functioning and translating these to ecosystem services; Simon Thrush, expertise in measuring and mapping ecosystem services and relating ecosystem services to management, University of Auckland.

Scope

While our marine estate supports enormous quantities of natural resources, and a range of other economic sectors, it also has significant social and spiritual value, being an integral part of the lifestyle and culture of generations of New Zealanders. This programme recognises that there is a perception that present governance and management systems fail to appropriately acknowledge and accommodate Māori and community concerns, views and values, and aims to contribute to the Challenge Objective at a number of levels. Research conducted within this programme will develop processes and measures for defining the value of our marine environment, and foster connections between multiple societal values, investment and the marine environment. Products of the research will inform the need for specific management tools and will form the link between the understanding of the dynamic environment and the impacts of human activities and the risk to social values (including regional economics). In conjunction with *Our Seas* and *Tangaroa*, the programme will provide a platform for engagement with many different sectors of society from interested individuals through community groups and industry to investors and government organisations.

There are two themes in the programme: 1) Obtaining a better understanding of the way that society values our marine estate, and the relative economic, social, environmental and cultural values we place on its components; and 2) using this knowledge to add value to productive activities. The research conducted in this programme will be a mix of social, Māori, statistical, ecological and economic research.

Understanding the true value of our marine estate is important if we are to realise its full benefits and demonstrate wise stewardship (Moore et al. 2008; Spangenberg & Settele 2010). Currently, we have no stocktake of our natural capital, nor a defined suite of values (social, environmental, cultural and economic) or indicators that fully capture the marine economy (Barbier 2011; 2012). These are an

essential component of *Valuable Seas*, and require an assessment of worth that extends beyond a narrow definition of economic benefits, to a much deeper and richer economic, spiritual and cultural sense (Daily et al. 2000). Quantifying these values will enhance our ability to prioritise management actions, make decisions and choices, and define trade-offs (TEEB 2012; Ruckelshaus et al. 2013). In recent years, the concept of Ecosystem Goods and Services has been developed to assist with understanding the full value that ecological systems provide to humans (Millennium Assessment 2005; Costanza 2008; Tallis & Polasky 2011). Ecosystem services also include the ability of an ecosystem to function, allowing the ecosystem to have an “existence” right.

Understanding values and integrating them into EBM is not the only way to add value to the marine economy. “Adding Value” to productive activities can be achieved in several ways. Direct economic benefit is derived from fishing, tourism, aquaculture, power generation, mining, and oil and gas extraction; quantifying such resources is not in the scope of the Challenge (but see theme 2 in section below). Substantial indirect economic benefits, however, arise from improving access to international markets, attracting investment, and offering a lifestyle and environment to attract and retain innovative people who grow and diversify our economy. Ensuring that we capture these benefits is within scope of the Challenge, and the second component of *Valuable Seas* will focus on how we can add value to the marine economy through considering: 1) enhancing existing marine industry efficiency, sustainability, security, value and market access, 2) addressing environmental, economic and societal barriers to development and 3) contributing to increased diversification of the marine industry portfolio by promoting innovation.

Outcomes in 10 years

- Non-monetary valuations of NZ’s marine estate are used in conjunction with economic valuations to inform resource management decisions.
- A marine economic framework with a focus on creating value and innovation has been established and is in use.
- Partnerships between this programme, the innovation sectors of Challenge Partners, innovation funding agencies (e.g., Sustainable Business Council, Seafood Innovations, and Callahan Institute) and industries have funded projects that “add value” to the marine economy.

Programme Deliverables

- A framework for measuring and comparing economic, environmental and social values that can be used in economic models and EBM tools. This framework will be developed in the first 2 years of phase 1, tested in the cross-programme EBM project case study area in the final years of phase 1 and, if necessary, refined and validated in phase 2.
- A database of non-monetary values, including Māori values, together with a robust process for collecting such information. The database will be developed and populated in at least two locations during phase 1 and expanded in phase 2. The database will also hold information as to whether individual values are generally held in common or associated with specific sectors of society or locations.
- Standardised methods for measuring selected services and predicting impacts of specific stressors and a process for linking changes in services to perceived changes in values. These will be developed sequentially during both phases and trialled in the EBM case study areas where they will be used both as input to EBM tools and to assess generality of results to different locations.

- A map of the blue economy and its potential in the focal region. This will be developed in the early years of phase 1 and extended into a possibilities-centred model of a blue economy by the early years of phase 2.
- A widening of both the proposers and proposal types received by the third call for innovation funding of “value adding” proposals compared to the first. This will represent an increase in people thinking about the marine economy and an increased diversification of innovators.

Themes

Theme 1: Understanding how New Zealanders value our marine estate

The values New Zealanders place on our marine estate range from direct monetary gain (e.g., extractive industries) and indirect monetary gain (e.g., employment, disposal) to values that have either a very loose or no association with monetary gain (e.g., values associated with cultural identity, spirituality and recreation, henceforth called social values). While economic valuation techniques have been undertaken for a number of years by a number of organisations, New Zealand needs to develop techniques to define and document social values related to marine ecosystems and to allow all values (monetary and non-monetary) to be incorporated in decision making related to the marine estate. Methods by which values measured by different metrics (e.g., monetary and non-monetary) can be compared is a major challenge internationally and will be assessed in this theme.

Within this theme, we use the concept of ecosystem goods and services and, in particular, that of ecosystem services, to provide the connection between nature and human values and to understand the scale of threats to values and the potential for restoring systems to valued states. In order for this to be effective, research on services that are valued at different space and time scales, or that are provided in one place and valued in another will be undertaken.

Theme 2: Adding value to our marine economy

Adding value frequently focusses on enhancing existing industry efficiency, sustainability, security, value, and market access. Successful implementation of EBM will enhance sustainability and thus add value, as well as transforming New Zealand into a desirable location for marine investment. We seek to add value to the marine economy, within the framework of EBM, by developing an economic framework that facilitates opportunities to deliver environmentally sustainable collective and individual benefits from our marine estate. This framework will be based on the concept of “blue economy”, which essentially aims to develop economic practices that work within the dynamics of marine environments to sustain, enhance and, ultimately, create economic and social values. Blue economy practices require recognising all dimensions and beneficiaries of the marine economy and all values that marine environments currently produce. Utilising this concept, we hope to help society and international and national investors navigate our economic-ecological relations and lead to more certainty for action by creating an environment within which societal acceptance of economic activities can be negotiated.

While quantifying resources is out of scope, information on the value of these would be of benefit to the programme. At present, this work is being done within a number of government departments, and this theme will link to the information through interactions with the Natural Resources Council. Similarly, market development, changing markets and supply chains are analysed by national organisations and this theme would seek ways to gain access to the information and to involve these organisations in this theme’s research, within project 2.2.1.

This theme also provides the opportunity to focus on future opportunities and consider whether there are specific scientific solutions that will increase the future use of marine resources. New technologies and activities will be promoted and impediments to development and diversification identified.

Linkages

These two themes strongly link together through the aim of the Challenge to “grow the marine economy by increasing the use and realising the value of New Zealand’s vast oceanic and coastal assets, while maintaining their environmental health”. Theme 1 works to understand the full value of the marine estate and the ecosystem health and services that support these values. The projects in Theme 1 all link strongly together within a framework provided by project 2.1.1 (Development of valuation frameworks and principals). Theme 2 links this understanding to the economy through a specific project focussed on creating value from the blue economy (project 2.2.1).

All projects in Theme 1 are strongly linked to the participatory processes, relationships and understandings developed in *Our Seas* and *Tangaroa* programmes. For Theme 2, full identification of a blue economy framework requires understanding of the role of the Māori economy (*Tangaroa*, Theme 2) and also requires consideration of governance and financial structures (*Our Seas*, Theme 3). However, there are also strong linkages with other programmes, with specific projects requiring information from *Dynamic Seas* (Theme 2) and providing information to *Managed Seas*.

Table 2. Linkages between *Valuable Seas* projects and with other programmes.

Valuable Seas Projects	Linkages	
	Valuable Seas Themes	Sustainable Seas Programmes
Theme 1: Understanding how New Zealanders value our marine estate		
2.1.1 Development of valuation frameworks and principles	1,2	1, 3
2.1.2 Mauri Moana, Mauri Tangata, Mauri Ora - Documenting social values	1	1,3,5
2.1.3 Measuring ecosystem services and assessing impacts	1	1,3,4,5
Theme 2: Adding value to our marine economy		
2.2.1 Creating value from a blue economy	1,2	1,3,5
2.2.2 Methods to increase diversification in marine economies.	1,2	1,3

Theme 1: Understanding how New Zealanders value our marine estate

Project 2.1.1 Development of valuation frameworks and principles

Project Leader: Joanne Ellis

Questions:

- What valuation approaches and frameworks will work best to support EBM for New Zealand?

This project will develop an initial framework for valuation assessment and use of values in EBM, based on ecosystem services, which will be tested and adapted by findings from this project and projects

2.1.2, 2.1.3 and 2.2.1. The project will centre on a series of workshops, combining national and international researchers and users (including representatives of relevant *Tangaroa* and *Our Seas* projects) that will consider environmental, social, cultural and economic valuation methods, metrics and approaches. In particular, it will assess economic valuation of services (including using non-market valuation methods such as contingent valuation, hedonic pricing, replacement cost as well as benefit transfer methods) and methods for combining and comparing values for “fit to purpose” in the New Zealand context. In assessing cultural values, some iwi researchers have concluded that the ecosystem service concept has the potential to enhance the prospect of Māori cultural survival and the mutually interdependent well-being of our people (i.e. tangata) and the natural world (i.e. whenua, moana) (Cole 2014), but have questioned whether monetary valuations of services are compatible with Māori concepts of value. Similarly, previous work with stakeholders has identified that while many accept dollar valuation of productive or extractive services, they do not wish other services to be valued by dollar equivalents. These problems of ecosystem service valuation in the New Zealand context (Tadaki et al. 2015) will be explored in 2016 - 2017. The usefulness of methods which support comparisons of values and services measured by different metrics (e.g., monetary and non-monetary) such as multi-criteria and social network analyses will be started in 2017. At this time, correlations between values and/or services will be assessed in at least two areas to identify closely related values/services and whether these patterns are location-specific (CP2.1).

The project will be assessed toward the end of phase 1 in conjunction with stakeholders to determine whether this project needs to continue in phase 2.

Outputs:

- A synthesis of the learnings and methodological developments available in a variety of formats. This will enable us to provide a summary of international and national work in this area to interested New Zealand organisations annually.
- Clear recommendations for best practice processes and application in both the focal region and other regions of New Zealand. This will enable us to engage with stakeholders through *Our Seas* projects in discussions about how this framework would fit within current policy and management frameworks, by mid-2018.
- A trial of the framework in the CP2.1 case study area. This will enable us to contribute to CP2.1 outputs 1 and 2, by mid-2019.

Participating organisations: Cawthron Institute, Landcare Research, NIWA, University of Auckland, Massey University, private sector.

Key collaborations: K Chan, University of British Columbia, expertise in ecosystem accounting and non-monetary valuation; L Pendleton, Duke University Nicholas Institute for Environmental Policy Solutions and N Hanley, University of St Andrews and Convenor, Marine Alliance for Science and Technology for Scotland, international expertise in Ecosystem service accounting and non-market valuation; and TEEB 40C and Grid Arendal, expertise in quantifying national values and assessing trade-offs; DOC, knowledge of New Zealand work in terrestrial and freshwater environments. Relationships with the Intergovernmental Platform on Biodiversity and Ecosystem Services will also be promoted via Dr Carolyn Lundquist and DOC.

Funding: Negotiated \$300k (total funds allocated for phase 1)

Project 2.1.2 Mauri Moana, Mauri Tangata, Mauri Ora - Documenting social values

Project Leader: Shaun Awatere

Questions

- How are New Zealanders' (including Māori) connected socially, culturally and spiritually to the sea?
- Are these values shared or are there variations with discernible drivers?
- How can tikanga Māori values such as kaitiakitanga (sustainable management), manaakitanga (care for the sea, care for people) and whanaungatanga (familial ties) inform non-monetary valuation of NZ's marine estate?
- What is the process or framework for non-monetary values and Māori values to work in conjunction with monetary valuation?

Holistic decision making for natural resource management is an increasing focus in New Zealand. The implementation of shared natural resource management regimes between iwi/hapū, regional councils, and central government has led to an increasing demand for decision making processes cognisant of meta-physical values like spirituality, aesthetics and social norms. This project will undertake a review of current information and procedures being used to collect non-monetary values (including Māori) in New Zealand (2016 – 2017). It will establish key collaborations within the programme and gain required approvals (e.g., ethics) to collect new data. Throughout the life of the project (2016 – 2019), information will be collected and analysed to determine: the range of values New Zealanders hold for marine systems; and the degree of divergence and potential reasons behind divergence (e.g., ethnicity, age, location). Core Māori values and principles connected to the moana and local variations in Māori values will be identified using case studies, think tanks and other methods of collaboration. Models/framework of ways in which Māori values could work with EBM will be developed and methods to promote uptake of the models/framework developed.

This project has strong links with project 3.1.2 in the *Tangaroa* programme. Funding for these closely aligned projects will mainly come from this project and it is anticipated that a number of the participants will be common to the two projects to ensure linkages and efficiencies. Research participants (including communities) will be identified and recruited in conjunction with *Our Seas* and *Tangaroa*, with the aim of maximising the ability to generalise beyond the Challenge's case study area and focal region.

Outputs:

- Attributes and measures for non-monetary values including Māori values. This will enable layers of values for the case study area in CP2.1 to be developed by the end of 2018.
- Draft framework for non-monetary values and Māori value. This will enable the information collected in this project to be incorporated in project 2.1 by mid-2018.
- Other outputs will be developed in conjunction with iwi/hapū in case study area. These outputs will be designed to enable co-management and will occur throughout the life of the project.

Participating organisations: Landcare Research, NIWA, Māori researchers, iwi/hapū within the case study area.

Key collaborations: TBD

Funding: Negotiated \$675k (total funds allocated for phase 1)

Project 2.1.3 Measuring ecosystem services and assessing impacts

Project Leaders: Andrew Lohrer, Simon Thrush

Questions:

- How can we best measure individual ecosystem services and link them to social values?
- Can we assess risk from human activities to ecosystem services and the social values they underpin?

Measurement and mapping of marine ecosystem services (ES) remains a key challenge, in part because we lack simple indicators or proxy measures and, in New Zealand, we frequently lack spatial data on the ecology that underlies services. To by-pass this, an approach has been developed in New Zealand to map ES 'potential' from a combination of ecological theory and available physical data and expert information (Townsend et al., 2011, 2014). While potential ES is a useful metric, not only does the approach still require validation for a number of services, but utilisation of ES for EBM requires understanding how ES are affected by human activities and consequent effects on values.

This project will continue throughout the life of the Challenge and has two components, both of which require consideration of the space and time scales at which values are held and services are delivered or generated: 1) determining the specific ES that underpin certain values and how changes to these services may affect perceptions of value, and 2) determining best practices for measuring and mapping services and predicting change to service delivery from human activities. Given the number of potential values, services and human activities, the project will focus on a subset of supporting services, chosen in the first 6 months by input from Māori and stakeholders and information generated from other projects in the Challenge. Initially (2016-17), the project will use value information from the MBIE programme MAUX1208. Field measurable surrogates will be developed for the selected ecosystem services and the response of these to gradients in selected stressors will be determined (2016-19) in conjunction with *Dynamic Seas* project 4.1.1. In particular the potential for tipping points in response to stressors (considered under projects 4.1.2 and 5.1.2) will be considered. If a service has been selected for which field measurements cannot be developed, we envisage adapting the Ecosystem Principles Approach (Townsend et al. 2011) to include ecological theories on the effect of specific stressors to create a "first principles" assessment of change to ES potential. In the second half of the project, beginning in 2018, a social assessment of how predicted changes in service delivery would affect perceived values will be conducted, utilising information and personnel gained from project 2.1.2.

In the first half of 2019, new supporting services and activities will be selected for analysis, driven both by Māori and stakeholder input, but also by information derived from project 2.2.1 and CP2.1.

Outputs:

- An initial framework for linking ES to human values. This will enable us to engage with stakeholders in discussions about how this framework would fit within current policy and management frameworks, by mid-2017.
- Standardised methods for measuring selected services and predicting impacts of specific stressors. This will enable us to assess likely impacts of human activities within the CP2.1 case study area by the end of 2018.

- A process for determining effects of changing services on human perceptions of value, trialled in the case study area of CP2.1. This will allow us to provide predictions of changes to services and values associated with activities in the case study area of CP2.1 to all *Managed Seas* projects for use in the EBM toolbox by the end of 2018.

Participating organisations: Cawthron Institute, Landcare Research, NIWA, University of Auckland, University of Otago, University of Waikato.

Key collaborations: TEEB4OC- conduct national surveys and bring economics into the ecological domain; JPI Oceans- linking ecosystem services or functions to values; Nature Conservancy- linking ecological functions to services and mapping ecosystem services; University of Helsinki- field measures of ecosystem functions and services.

Funding: Negotiated \$1020k (total funds allocated for phase 1)

Theme 2: Adding value to our marine economy

Project 2.2.1 Creating value from a blue economy

Project Leader: Nick Lewis

Questions:

- How can we invigorate investors, producers, intermediaries, retailers and consumers to engage in generating new value (and more value) sustainably and in ‘balance’ with nature and society?

The blue economy imagines reworking marine economies into a set of economic practices that work within the dynamics of marine environments to create economic and social values, sustain or enhance the resourcefulness of those environments, and generate short and long-term benefits for investors, communities and marine ecosystems. It requires recognising all dimensions and beneficiaries of the marine economy, all values that marine environments currently produce and the open-ended potential of those environments to create as yet unrecognised values, while acknowledging the environmental and social costs of marine economy activities.

This project will use participation from Māori and stakeholders and co-production techniques to build blue economy capability and foster new forms of entrepreneurship, new economic activities, and innovations. Throughout the project, but particularly in 2016-2017, hui with investors, communities and institutional actors will be used to build blue economy capability and foster a social licence for a sustainable blue economy. Working in the focal region, it will identify, measure and map the blue economy and its potential. Using co-production of knowledge techniques, investment trajectories and value creating initiatives and opportunities (including standards, certification and provenance making) will be identified. In 2017 – 2020, the project will work to create a possibilities-centred ‘resourcefulness’ model of a sustainable blue economy that will be useable by investors, communities, management, and policy makers in their decision making, and will be translatable into (i) EBM and (ii) public science. Given this is a global research agenda we will collaborate with international researchers to advance our project and exchange learnings and applications internationally. To facilitate this we will connect into international networks and establish an International advisory committee.

To link effectively with *Our Seas* and *Tangaroa* projects, research personnel from projects 1.1.2, 1.2.1, 3.2.1 and 3.1.2 will be involved in this project.

Outputs:

- Map of the blue economy and its potential in the focal region. This will enable identification of possible activity trade-offs in the case study area of CP2.1 for use in the *Managed Seas* EBM toolbox by the end of 2018.
- A possibilities-centred model of a blue economy useable by investors, communities, management, and policy makers in their decision making. This will enable us to assess effectiveness and problems associated with different investment and management strategies for adding value to the marine economy by the end of 2020.
- Co-produced collective proposals for innovation funding. This will spread the base of potential proposers and widen the types of proposals received by mid-2018.

Participating organisations: Auckland Tourism, Events and Economic Development, *Motu* Economic and Public Policy Research, NIWA, private sector, University of Auckland and University of Otago.

Key collaborations: International advisory committee, Winder, Ludwig-Maximilian Universität Munich; Mutersbaugh, University of Kentucky; Reid, University of Toledo; McGuirk, U Newcastle, NSW; Poovey, University of Chicago. Workshops on conceptualising and measuring the blue economy and on future potential will utilise experts from Rachel Carson Center for Environment and Society, the Sydney Environment Institute and Australia Pacific Laboratory, University of Sydney; and IMAS Hobart. We will also collaborate with the Future Earth programme and the ZERI Institute for strengthening of linkages.

Funding: Negotiated \$1135k (total funds allocated for phase 1)

Project 2.2.2 Methods to increase diversification in marine economies.

Project Leader: Chris Battershill

Questions:

- Can we add value to the marine economy by supporting innovation?

Valuable Seas will provide the opportunity to focus on future prospects and consider whether there are specific scientific solutions that will increase the future use of marine resources. This project will develop a Request for Proposals (RfP) for innovative proposals to generate added value. This research aim will also assess whether there are new environmentally sustainable technologies and activities that (alongside traditional activities) can add value to the marine economy and overcome impediments to development. The first of these calls will be in early 2016. Scope and potential concepts for the RfP will be sought via a workshop from: Māori and stakeholders that have contributed input on this topic in discussion to date; present marine industries; innovation promoting agencies such as the Sustainable Business Council, Seafood Innovations, Callahan Institute; representatives of the innovation sections of the Challenge Partners and a distinguished internationally recognised marine innovation scientist.

At this stage it is considered that the RfP will generally target:

- Innovative projects that are aimed at reducing stress in the marine environment while enhancing diversification of the economy.

- Projects that develop synergies between land-based activities/industry, coastal environmental remediation and potential genesis of new marine commercialisation prospects, including new energy sources.
- Projects that contribute to fast track harnessing of international research and/or bioinformatics to value add existing marine industry products, ideally also reducing waste flow and environmental burden.

Co-investment by industry or environmental stakeholders will be sought as appropriate as will funnelling potential research ideas to other appropriate funding sources such as the Callahan Institute and Seafood Innovations.

Outputs:

- Formation of working partnerships between this programme, industry, the innovation sections of the Challenge partners and other innovation funding agencies. This will enable assessment of proposals received for the first round of RfPs early in 2016
- Funding uptake (including co-funding development) by successful proposals. This will enable, over the life of the Challenge, increased innovation in, and diversification of, the marine economy.

Participating organisations: All Challenge partners.

Key collaborations: TBD

Funding: \$40k plus Innovation funding

4.3 Programme 3: *Tangaroa*

Science Programme Leader: Linda Faulkner, expertise in incorporating Māori values into decision making and policy development, Tūtaiao Ltd

Programme team members: Shaun Ogilvie, marine ecologist with expertise in embedding Māori values into environmental decision making, Cawthron Institute; others TBC

Scope

The *Tangaroa* programme explores the relationship between mātauranga Māori and EBM to establish pathways for supporting the maintenance of a healthy, productive and resilient marine estate. It is a Māori centred programme focussed on supporting Māori in their effective management and ownership of marine resources, while enabling their place-based knowledge, practices, values and obligations to flourish for future generations. It will also provide information and tools to support decision making related to the increased use of marine resources. This approach recognises that positively supporting Māori in the management of our marine resources, contributes to the enhanced utilisation of those resources.

Throughout Māori history the sea has played an unsurprisingly dominant role given the ancestral connections and existence of Māori as island peoples for thousands of years. For many the deep places of the sea are recognised as holding the origin and source of all life, and with many generations of occupation, Māori and their Polynesian ancestors hold considerable experiential and cultural knowledge of the regions oceans. It is this knowledge alongside the increasingly significant customary and commercial interests held by Māori in the resources of the sea that can contribute to achieving the Challenge Objective and Mission.

In addition, marine management decision making has been hindered by the absence of adequate recognition, understanding and partnership in terms of the role Māori and their indigenous knowledge plays in the marine estate. This creates uncertainty in decision making in the following ways:

- Māori are uncertain about impacts given impacts are often expressed in terms and values that are not always consistent with their own.
- Industry are uncertain and often unable to understand impacts expressed in cultural terms and rarely have the capability or resources to address those impacts adequately.
- In the absence of clear information about impacts (including cultural impacts) statutory decision makers must deal with uncertainty in accordance with legal requirements.

Though the timeframe of the Challenge will not enable these issues to be addressed completely, it will however provide the opportunity for making progress in clarifying uncertainty within the focal region and beyond, thereby supporting enhanced utilisation.

The relationships between the many creatures, geological forms, elements and cultural knowledge and practices, both on land and sea, are articulated in mātauranga Māori - a body of knowledge founded on whakapapa. The waters of the ocean are considered to be an energy possessing numerous characteristics, shapes and natures. It upholds life, yet is able to bring terrible destruction. This energy with all its forms, moods and expressions is called Tangaroa, whose common translation as 'god of the sea' does not adequately convey its full meaning (Royal 2010).

The sea also continues to be of significance to Māori for practical reasons. It is an essential source of food and other resources. The sea connects iwi, hapū and whānau and provides countless benefits that extend well beyond their source, such as cultural identity, spiritual sustenance, the maintenance of well-being and economic benefits. Māori own more than 20% of New Zealand's commercial fisheries assets (including aquaculture space), have a range of customary rights and interests particularly relevant to inshore areas, and hold major tourism interests reliant on marine resources and the marine environment.

The Challenge recognises that Māori, as Treaty partners, play an increasingly significant role in New Zealand's marine estate. This role is recognised in a wide range of statutory measures relevant to the management, use and development of our territorial sea, EEZ and Extended Continental Shelf. The *Tangaroa* programme explores the innovation potential for mātauranga Māori in partnership with EBM, to better inform governance, management, and decision making relevant to our marine environment and economy.

Outcomes in 10 years

- Marine-based sectors, systems and groups of Māori society within the focal region are thriving culturally and economically and are contributing to decision making and management in a positive and proactive way toward enhanced utilisation of their marine resources.
- Their practices and operations are underpinned by kaitiakitanga and are informed or complimented by EBM science and tools to ensure environmental and biological constraints are protected.
- Solutions and options are available for innovatively improved partnership and leadership based Māori participation in marine management and decision making.

Programme Deliverables

Phase 1:

- Accessible mātauranga Māori and kaitiakitanga information relating to the inshore and offshore areas of our marine environment to support more informed environmental management and use.
- EBM solutions and practical support for case study iwi, hapū and whānau that supports flax roots kaitiakitanga.
- Information, resources and tools relevant to marine management and blue economy initiatives tailored specifically for iwi, hapū and whānau.
- An assessment of the quantitative and qualitative value of the Māori marine economy.
- A consolidated database and assessment report of the legal provisions of specific relevance to Māori in the marine environment and their relationship to the application of Māori lore.
- Innovative marine management and decision making frameworks that enhance the partnership and leadership between government, Māori and industry.

Phase 2:

- Completed trials of EBM solutions that support kaitiakitanga within the case study area, and beyond in areas of increasing marine resource pressure.
- A complete suite of trialled tools and information that support decision making by Māori (customary/non-commercial and commercial operators) in the marine environment, that incorporates trade-offs and options for increased economic benefits from our marine estate based on kaitiakitanga and EBM.
- Options and models that enable Māori lore to operate alongside legal frameworks for the improved management of multiple Māori customary/non-commercial and commercial marine interests.
- Frameworks for improved marine management and decision making that embodies the partnership between government, Māori and industry have been successfully trialled in the focal region.
- Agency, iwi and industry support for developing and implementing policy adjustments that enable the innovative new EBM processes, frameworks and tools to be rolled out beyond the focal region.

Themes

The *Tangaroa* programme is made up of three themes that aim to bring together through case study examples, marine management knowledge established in a mātauranga Māori framework, with that developed through EBM science, all against a backdrop of the dynamic between lore and law.

The themes were examined and refined at a workshop held specifically with Māori, as well as two further Māori and stakeholder workshops. It is also likely that more specific engagement with iwi, hapū and whānau in the focal region and case study areas in the future, will further refine the themes, projects and outputs as the Challenge progresses through phases 1 and 2. As a Māori-centred programme the ability to co-create, design and undertake research in close partnership with iwi and hapū will be critical to the delivery of the tangible benefits noted above, as well as other outputs identified during the research itself.

Theme 1: Kaitiakitanga in our marine environment

There is a significant amount of mātauranga Māori associated with the marine environment including numerous cultural narratives, language, practices and values. This knowledge is place based and whānau, hapū and iwi have their own unique approach and examples to maintaining a sustainable sea.

This theme will develop mechanisms that support the investigation, maintenance and development of mātauranga Māori based practices. It will explore existing kaitiakitanga examples of sustainable use and restoration, and test the assumption that kaitiakitanga and EBM theory and practice are consistent and compatible. As a subset of this work, it will also examine the use of mātauranga Māori based indicators to anticipate changing conditions and inform forecasting, planning, restoration and risk management. Ultimately the theme will contribute to the tailoring and development of information and tools to offer practical support to kaitiaki in the design and delivery of effective marine management frameworks.

The information identified in this theme will provide a valuable foundation not just to themes 2 and 3 of the *Tangaroa* programme, but to all of the other programmes in the Challenge both for phase 1 and phase 2 research. In particular, collaborative approaches to projects and case studies identified within *Our Seas* and *Valuable Seas* will be critical to achieving effective and efficient outcomes for both the Challenge and for Māori groups involved in the research. In addition, links to the *Dynamic Seas* programme will ensure that our understanding of ecosystem interdependencies are articulated within a mātauranga Māori framework and support more informed management decision making. The outputs will also inform the models, tools and resources developed through *Managed Seas* to maximise effectiveness for Māori, stakeholders and resource managers.

Theme 2: Kaitiakitanga and economic development

Māori have vested and multiple economic interests in the marine environment that co-exist to varying degrees alongside their cultural values and practices. This theme will model components of the Māori marine economy to clarify complexity and identify opportunities to inform the development of innovative approaches to commercial operation that is consistent with kaitiakitanga and EBM.

This will enable Māori to have informed management strategies and to make decisions about cumulative and complex trade-offs within an EBM approach when seeking to minimise environmental impacts and satisfy cultural, economic and social drivers. Determining the value of EBM for Māori including opportunities to increase productivity will be crucial to uptake and implementation.

Understanding the multiple use limitations and requirements for Māori within our marine environment and economy is critical to developing frameworks and tools that support the achievement of the Challenge Objective. Strong interdependencies exist between this theme and the *Valuable Seas* programme to ensure the accurate and appropriate identification of what and how Māori ‘value’ our marine estate. Links to the *Our Seas* and *Managed Seas* programmes enable the development of integrated models and decision support tools that meet the needs of commercial and environmental decision makers, including Māori.

Theme 3: Bridging the lore and law dynamic

As Treaty partners, Māori rights and values are recognised to varying degrees, and in different ways in New Zealand marine management policy and law. However, given the length of Māori occupation in Aotearoa, a considerable body of indigenous Māori knowledge and lore also exists and its application has been impacted by legal frameworks over time.

This theme examines a range of New Zealand marine policy and legal enablers and barriers with particular emphasis on those specific to Māori. It will also build on the Māori lore principles, values and perspectives (tikanga and kawa) likely to have been identified through themes 1 and 2, to understand the conflicts, overlaps and opportunities for bridging the lore – law divide. It will assess whether the current policy and law frameworks pose consequences for mātauranga Māori and Māori lore, both positive and negative.

Ultimately the theme aims to draw together the findings and resources produced in themes 1 and 2 to identify and develop innovatively improved pathways for Māori to participate as Māori, and as partners in marine management and decision making.

Crucially this theme also has significant interdependencies with the *Our Seas*, *Valuable Seas* and *Managed Seas* programmes and cross-programmes CP 1.1 and 1.2 in terms of ensuring an efficient exploration of legal and management framework case studies. It also links to *Dynamic Seas* in terms of building upon the results, information and engagements with Māori through that programme.

Māori have been significant players in marine management decision making to date, and collaboration across programmes in reviewing case study examples will be important to achieving effective engagement and understanding. In addition, partnerships with local and central government agencies will be vital to the implementation of improved pathways.

Table 3. Linkages between *Tangaroa* projects and with other programmes.

Tangaroa Projects	Linkages	
	Tangaroa Themes	Sustainable Seas Programmes
Theme 1: Kaitiakitanga in our marine environment		
3.1.1 Understanding kaitiakitanga in our marine environment	1,3	1,2,4
3.1.2 Kaitiakitanga in practice in our marine environment	1,3	1,2,4,5
3.1.3 Resources & strategies for Māori marine management	2,3	1,2, 5
Theme 2: Kaitiakitanga and economic development		
3.2.1 Defining the Māori marine economy	1, 3	1, 2, 5
Theme 3: Bridging the lore and law dynamic		
3.3.1 Understanding the dynamic between Māori lore and law	1, 2	1,2,5
3.3.2 Innovatively improved pathways	1,2	1,2,4,5

Theme 1: Kaitiakitanga in our marine environment

Project 3.1.1 Understanding kaitiakitanga in our marine environment

Project Leader: To be determined (RfP to be undertaken Oct-Dec 2015)

Questions:

- How is mātauranga Māori informing values and practices in the marine environment and how can this knowledge better inform decision making for enhanced utilisation?

- Have these values and practices changed over time impacting on the ability of Māori to contribute effectively to marine management decision making?
- What does kaitiakitanga mean in the inshore and offshore areas of our marine environment?
- How is the role of kaitiakitanga expressed and has that expression changed over time?

The role of kaitiakitanga in our onshore environments is relatively well understood and documented in a wide range of publications and in case law largely relevant to Resource Management Act decision making and Waitangi Tribunal claims. However in recent marine management planning and decision making processes relevant to New Zealand's inshore and offshore environments, the availability of such information has been limited.

Researchers will undertake a desktop compilation and review of existing documents, reports, frameworks, papers and articles relevant to mātauranga Māori and kaitiakitanga practices and interests in New Zealand's inshore and offshore environments. This dataset will establish a foundation of understanding from which the remainder of the *Tangaroa* programme, and other programmes can benefit.

Outputs:

- A baseline dataset of accessible existing mātauranga Māori and kaitiakitanga information relating to the inshore and offshore areas of our marine environment. This will enable more informed marine management decision making, at least in the focal region, by December 2016.
- Inputs to the mātauranga Māori repository outlined in project VM 4.1.

Participating organisations: To be determined (RfP to be undertaken Oct-Dec 2015)

Key collaborations: To be determined (RfP to be undertaken Oct-Dec 2015)

Funding: Contestable \$120k (total funds allocated for phase 1)

Project 3.1.2 Kaitiakitanga in practice in our marine environment

Project Leader: To be determined (RfP to be undertaken Oct-Dec 2015)

Questions:

- What are some contemporary/current examples of kaitiakitanga in practice in our marine environment and do they differ in inshore and offshore areas?
- What is the relationship between kaitiakitanga and EBM – are there consistencies and what is the nature of the differences?
- What changes in environment or conditions impact kaitiakitanga approaches and therefore the contribution of Māori to marine management decision making?
- What indicators do kaitiaki use to anticipate changes in the environment and how do those indicators influence changes in approach?
- How do traditional indicators contribute to identifying restoration needs and risk management by whānau, hapū and iwi, and could they influence restoration plans and the risk management strategies of other resource users or decision makers?

Researchers will explore the traditional and contemporary application of kaitiakitanga and its associated mātauranga Māori in sustainable use and restoration of the marine environment. To do this researchers will identify 'in practice' kaitiakitanga approaches that are based on whakapapa and 'place based' mātauranga, values and perspectives.

A core aspect to this work will be the identification and examination of the application of traditional indicators by the case study groups to forecast and anticipate changing conditions. In addition, where such indicators identify degraded ecosystems in the case study area, researchers will work with the relevant iwi and hapū to identify management options.

The project will be undertaken in partnership with two case study iwi, hapū or whānau groups from within the focal region. The project will also be conducted collaboratively with project 2.1.2 (Mauri Moana, Mauri Tangata, Mauri Ora) in terms of identification of, and engagement with case study groups, development of project objectives and methodologies, sharing of information and resources, and project reporting. Together the projects will assess the relationship between the knowledge and application of kaitiakitanga and EBM principles and science. This approach will enable the identification of Māori examples of EBM tools and frameworks and provide the opportunity to develop innovative new EBM approaches based on a mātauranga Māori foundation.

To achieve mutual benefit researchers and iwi partners will co-design and co-develop the framework for undertaking the work including identifying successes, impacts, inhibitors, lessons learned and enablers for ongoing kaitiakitanga and EBM practice. In addition researchers will take every opportunity to offer practical support to kaitiaki initiatives to support their management of risks to customary resources and implement responsive actions. Such support might include directly or indirectly providing information and expertise to specific management issues (e.g. restoration).

In Phase 1 of the Challenge, this project will organise, in collaboration with project 2.1.2, annual wānanga in the case study regions to workshop and share project progress and lessons with iwi beyond the case study groups themselves. Phase 2 of the Challenge will see this work extended and tested across the broader focal region, and nationally to iwi and hapū with growing marine resource pressures. This will require engagement and partnerships with groups beyond the focal region and the development of effective ways for sharing information and tools.

Outputs:

- A suite of EBM solutions for use by case study groups in their management of focal region inshore and offshore resources (developed in collaboration with project 2.1.2). This will enable better informed decision making in the focal region regarding increased resource use by June 2019.
- Expertise and practical support provided to case study group kaitiakitanga initiatives and issues to enable the identification and protection of culturally significant environmental and biological constraints by June 2019.
- Annual wānanga with iwi groups in the case study regions. This will facilitate the dissemination and sharing of information to encourage active participation and more informed marine management decision making by June 2019.

Participating organisations: To be determined in collaboration with the research team for project 2.1.2, and with input from the Kāhui Māori.

Key collaborations: S Awatere, Landcare Research.

Funding: Contestable \$1050k (total funds allocated for phase 1)

Project 3.1.3 Resources and strategies for Māori marine management

Project Leader: To be determined (RfP to be undertaken late 2016)

Questions:

- Of the considerable scientific and other information already available with regard to the marine environment, what is of most value to the work and approach of kaitiakitanga?
- Are there gaps that need filling, and how might they be better tailored to support kaitiaki at a flax roots - 'in practice' level to support improved marine management decision making toward enhanced utilisation?
- What tools might better support Māori, and the use of EBM approaches, in undertaking kaitiakitanga responsibilities?

There is currently a swath of existing scientific and marine management information available, much of which is inaccessible to Māori for a variety of reasons (e.g. focus, awareness, language, delivery mechanism etc). Researchers will work with kaitiaki to assess this information to develop, validate and compare frameworks and tools that can support kaitiaki in determining the most appropriate approach for given situations. The critical difference between this work and that posed by other programmes, is that the available information will be assessed based on kaitiaki needs and relevance to mātauranga Māori.

A close working relationship with a range of kaitiaki and iwi resource managers to undertake this work will be critical, as well as working with the Challenge *Communication and Outreach* team in the development of resources. Researchers will benefit from information obtained through the *Our Seas* and *Dynamic Seas* programmes in terms of the assessment of currently available information of relevance. In addition, researchers will need to work alongside research teams for projects 5.1, 5.2 and 5.5 of the *Managed Seas* programme to maximise the relevance to kaitiaki of the development of ecosystem models, decision support tools and participatory tools.

The information and models will need to be tailored and packaged in a way that enables meaningful access and use by Māori and will become a resource for raising awareness, building capability and informing kaitiakitanga leadership, decision making, participation and uptake.

In Phase 2 of the Challenge researchers will work with partnering Māori groups to trial the resources, models and frameworks developed before extending their availability and use beyond the focal region. This will involve working with iwi and hapū groups in other regions to determine their applicability and relevance.

Outputs:

- Information and resources tailored for iwi, hapū and whānau kaitiaki that raises awareness of what we already know about our marine environment, alongside currently available scientific and management frameworks and tools. This will support improved Māori participation and partnership in marine management decision making for enhanced utilisation by June 2019.
- Results and expertise provided to the development of models and tools by the *Managed Seas* programme that are specifically relevant and accessible to kaitiaki Māori.

Participating organisations: To be determined (RfP to be undertaken late 2016)

Key collaborations: To be determined (RfP to be undertaken late 2016)

Funding: Contestable \$290k (total funds allocated for phase 1)

Theme 2: Kaitiakitanga and economic development

Project 3.2.1 Defining the Māori marine economy

Project Leader: To be determined (RfP to be undertaken late 2017)

Questions:

- What are the multiple economic interests held by Māori in our marine environment, and what value do they hold specifically for Māori both in financial and non-financial terms?
- How do these compare with the interests Māori will have had in the marine economy traditionally?
- How do cultural values and practices (kaitiakitanga) interact or inform Māori business models in the marine estate and what conflicts exist (including spatially)?
- What existing models or tools are there for sustainable commercial practice in marine environments that are based on kaitiakitanga and/or EBM?
- What, if any, are the barriers and enablers to basing commercial practice in the marine environment on kaitiakitanga and/or EBM to enhance utilisation or resources use by Māori?
- How might kaitiakitanga and EBM be applied to a range of business models, and what trade-offs occur to minimise environmental and biological impacts?
- What are innovative ideas or strategies that can be developed to improve economic well-being for Māori toward enhanced utilisation of the marine estate?

Māori maintain a wide range of marine economic interests, both cultural/non-commercial and commercial but the collective 'value' or contribution of these interests has not been well quantified in terms of their specific value to Māori.

This project has links to *Valuable Seas* (project 2.2.1), but goes further to specifically identify and understand the complexity and opportunities posed by the unique features inherent in the Māori marine economy. Using case studies, researchers will focus on defining model components of the Māori marine economy including kaitiakitanga, multiple interest ownership, spatial conflicts (between cultural and commercial imperatives) and direct and indirect impacts to mana whenua/mana moana (e.g. the 'pataka' fisheries system).

The interaction between those components will be assessed to identify the barriers and enablers they pose to supporting sustainable practice within a kaitiakitanga and EBM framework. This will include reviewing available models and tools to determine gaps, issues and options for improvement. Researchers will work closely with the *Valuable Seas* programme (project 2.2.1), and in particular will collaborate in the development of a possibilities centred resourcefulness model and the consideration of iwi based initiatives for concept funding.

Finally researchers will draw together information gained in the project to develop tailored resources and tools that respond to challenges faced by participants in the Māori marine economy. The resources will provide solutions for the conflicts, uncertainty and trade-offs of use and impacts, and will aim to

support the integration of Māori interests and the application of qualitative and quantitative evaluation methods. Where possible it will also guide the weighting of different characteristics of importance to Māori, inform the development of management strategies and raise awareness of the potential for cumulative and complex trade-offs. Although researchers will be able to initiate this work, it is likely that its completion will be carried over to phase 2 of the Challenge.

Outputs:

- A summary and assessment of the quantitative and qualitative value of the Māori marine economy, including outlining the unique and defining features of this economy both direct and indirect. This improved understanding will enable more informed decision making for Māori, industry and resource managers by June 2019.
- A modelling tool and information that supports informed decision making by Māori customary/non-commercial and commercial operators in the marine environment that incorporates trade-offs (cultural-commercial, environmental-commercial); options for improved productivity based on kaitiakitanga and EBM; multiple ownership management; and impacts. (To be completed in phase 2 of the Challenge.)

Participating organisations: To be determined (RfP to be undertaken late 2017)

Key collaborations: To be determined (RfP to be undertaken late 2017)

Funding: Contestable \$405k (total funds allocated for phase 1)

Theme 3: Bridging the lore and law dynamic

Project 3.3.1 Understanding the relationship between Māori lore and law

Project Leader: To be determined (RfP to be undertaken Oct-Dec 2015)

Questions:

- How compatible is marine policy and law in New Zealand, with the indigenous lore of iwi, hapū and whānau?
- How is Māori lore applied in our marine environment?
- Are there enablers or barriers in policy and law that pose consequences for the application of Māori lore and for the expression of mātauranga Māori and what impact does this have on uncertainty relating to decision making for increased use of resource?
- Can modifications be made to existing systems to enable Māori lore and law to work together to achieve kaitiakitanga and EBM outcomes?
- Are there international indigenous examples of the successful application of lore and law?
- Are there new and innovative models that can be proposed?

This project is in part aligned to the cross-programme project CP1.1 and researchers will both benefit from and contribute to the outputs of that work. However this project diverges by focussing specifically on the impacts (positive and negative) of policy and legislation to the ability of Māori to apply their own

tikanga and mātauranga Māori based lore in the sustainable management of marine areas and resources.

Researchers will review existing policy and legislative requirements and implementation on the management of customary/non-commercial and commercial marine interests and activities of specific relevance to Māori. Building on the work completed in 3.1.1, 3.1.2, 2.1.2 and 2.2.1 researchers will then assess whether the ability of Māori to apply or express their mātauranga Māori is inhibited or enabled by policy and legal requirements. For example, the application of rāhui is now reasonably commonplace in coastal management and fisheries, but are there other mechanisms founded in Māori lore that are enabled or limited by legislation.

Overall the project aims to create options and models to better support the management of Māori marine interests and activities in a manner that integrates Māori lore and law.

Outputs:

- An improved understanding of the Māori lore pertaining to the marine environment.
- A database of the legal provisions of specific relevance to Māori in the marine environment including in the areas of environmental, fisheries, energy, Treaty settlement, aquaculture law as well as international obligations.
- An assessment report of existing legal and policy enablers and limitations specifically relevant to the management of Māori customary/non-commercial and commercial marine interests and activities.
- The development of options and models that enable Māori lore to operate alongside legal frameworks for the improved management of multiple Māori customary/non-commercial and commercial marine interests.

These outputs will clarify an area of uncertainty for regulatory decision makers in the marine environment by June 2019, and lead to options for framework improvements in phase 2.

Participating organisations: To be determined (RfP to be undertaken Oct-Dec 2015)

Key collaborations: To be determined (RfP to be undertaken Oct-Dec 2015)

Funding: Contestable \$195k (total funds allocated for phase 1)

Project 3.3.2 Innovatively improved pathways

Project Leader: To be determined (RfP to be undertaken late 2016)

Questions:

- Can our marine management and decision making frameworks be improved through the development of innovative solutions that enhance the partnership and leadership between the government, Māori and industry?

This project will identify and develop innovatively improved pathways for Māori to operate and participate as Māori, and as leaders and partners in marine management and decision making. Researchers, iwi and hapū will bring together information and ideas from across the programme and

Challenge, to develop innovative approaches for improved Māori partnership and participation in marine governance, management and decision making.

In particular information obtained in the *Our Seas* and *Valuable Seas* programmes, as well as themes 1 and 2 of *Tangaroa*, and project VM1.1 and VM2.1 will be analysed to develop workable models to trial. This work will be conducted in partnership with iwi and hapū in the case study area, as well as the relevant agencies and authorities in their regions. Although the analysis and development work will be undertaken in the two years June 2017 – June 2019, trial application of the frameworks will be undertaken during phase 2 of the Challenge, beyond 2019.

Outputs:

- The development of innovative marine management and decision making frameworks that enhance the partnership and leadership between government, Māori and industry. This will create options for improved and well supported decision making models which will enhance increased sustainable utilisation of marine resources.
- Confirmed trial regions and partners.

Participating organisations: To be determined (RfP to be undertaken late 2016)

Key collaborations: To be determined (RfP to be undertaken late 2016)

Funding: Contestable \$530k (total funds allocated for phase 1)

4.4 Programme 4: *Dynamic Seas*

Science Programme Leader: David R Schiel, marine ecology, specialising in rocky shore ecology, Canterbury University

Programme team members: Conrad Pilditch, coastal processes, Waikato University; Steven Wing, food web analysis – isotopic studies, Otago University; Simon Thrush, estuarine ecology, marine spatial planning, Auckland University; Craig Stevens, oceanography, stratification, NIWA

Scope

Dynamic Seas focuses on the science necessary to underpin the Challenge Objective by understanding the critical ecosystem functions that interact with, and are affected by, human activities, thereby informing the societal interactions and development of new management tools. The research programme provides a unique opportunity for cross-ecosystem studies and collaboration, to interrogate existing data in new ways, and to generate the new knowledge required to realise sustainable and increased resource use. The marine estate of New Zealand is vast and so projects within *Dynamic Seas* are targeted to be effective and contribute towards achieving the Challenge Objective. This programme will also address key questions that must be answered for effective EBM: in what ways are marine values and services supported by structural and functional components of habitats; how do these components interact; what are the critical tipping points that can transform ecosystems into non-desirable states; what are the inter-dependencies relating to multiple stressors and cumulative effects as they impinge on functions, values and services; and how are these affected by oceanographic processes?

Dynamic Seas provides biophysical science to understand the potential spatial and temporal extent of impacts and activities within and across ecosystems (i.e., their ‘footprints’) underpinning new models and decision tools that will foster sustainable use of the marine environment. For EBM, our science is in the mix of decision making; it informs discussions around ‘social licence to operate’, underpins management goals and targets, and intersects with and builds capacity in Māori and stakeholders as they become increasingly involved in decision making. Questions arise about what science is needed for sound decisions, are there better ways of doing it, and to what extent science can overcome societal fears of risk and uncertainty as new or more intensive use of marine resources are proposed. *Dynamic Seas*, therefore, makes use of a wide range of existing and new data to identify and quantify how key indicators of ecosystem structure and function (e.g., resilience, diversity, primary production, food web structure, and nutrient cycling) change across gradients of stressors related to human activities (e.g., increased sediment and nutrient inputs, tourism, aquaculture, fishing and incursion of invasive species). A key goal will be identifying indicators of tipping points and ecosystem attributes that confer resilience to undesirable change, interacting with programmes 1, 2 and 3 to determine how these relate to risks and threats to values.

Decision making invariably involves an understanding of the connectivity among different marine habitats. *Dynamic Seas* will investigate flows of organic matter and nutrients from the nearshore zone (estuaries and coastal reefs) through to continental shelves and the deep sea, providing the necessary land-to-deep sea perspective. When coupled with our biophysical studies and *Valuable Seas*, this research will reveal key linkages between service and value provision. Understanding how critical species and functions are affected across stress gradients has a direct bearing on development of targets for management improvements. This is especially challenging as the EBM framework requires acknowledgment of, and solutions to, cumulative and multiple stressors. Connectivity is also central to EBM, and this too involves stressors and how responses to them interact over space and time. Again, interactive studies across the programme within the focal region and case study areas will be done to understand how stressors in one habitat may affect functions in other habitats. Physical processes that connect stressors and functions, especially in a changing climate, further inform integrated biophysical studies.

The 10-year scope is for a time-staged, highly integrated programme that will provide the targeted science, new tools and new approaches needed to underpin EBM and the Objective of the Challenge. It will be aligned with numerous existing research programmes and will serve as a vehicle for co-funding.

Outcomes in 10 years

- Management and decision making about marine resource use and ecosystem services are significantly informed by in-depth knowledge of ecosystem connectivity, food web architecture and energy flows that underpin the environmental and biological constraints of marine systems.
- An ecosystem-wide understanding of near- and far-field effects of environmental stressors within the focal region significantly informs decision making to enhance marine resource use.
- A deep understanding of ecosystem tipping points, cumulative impacts, multiple stressors and resilience, informs EBM with the tools necessary to ensure marine resource utilisation, provision of services, conservation, and improvements in habitat quality within natural constraints.

Programme Deliverables

Phase 1:

- Knowledge about key food web connections in the focal region and case study area.
- Preliminary models about tipping points, gradients and thresholds of responses of key organisms and functions, based on existing data from a wide variety of sources.
- Initiation of experiments to test synergistic effects of multiple stressors across environmental gradients.
- Preliminary oceanographic model of near- and far-field footprints of stressors and contaminants in a case study area.
- Provision of data to support models developed in *Managed Seas*.
- In tandem with programmes 1, 2, and 3, co-learn in translating the language of science for more effective interactions with and understandings of, Māori and stakeholders.

Phase 2:

- Models of near- and far-field effects as they relate to energy flux, detrital flows, food web structure across the land-to-shelf domain, that will directly underpin assessments of human impacts and threats.
- Empirically supported models about gradients, thresholds and tipping points relating to multiple stressors that will be of direct use to setting management targets and goals.
- Models of oceanographic effects on stressors across the focal region that will directly support sustainable management.

Themes

The interlocking themes of *Dynamic Seas* are based on understanding how ecosystem functions are affected by varying magnitudes of natural and anthropogenic stressors, how the physical environment influences stressor footprints from the land-sea interface to deeper waters, how critical habitats are functionally connected and finally how all of these dynamic elements can be combined in EBM to deliver a sustainable marine economy. Projects are embedded within themes, but all of them cross and interact with many elements of *Dynamic Seas* and the other programmes within the Challenge.

Theme 1. Connectivity across ecosystems

‘Connectivity’ is a key word in studies providing crucial links for structure, function and impacts. We often have knowledge about direct impacts of activities, but understanding their wider effects has often proved challenging. This theme focusses on understanding connectivity in key ecological processes that are the drivers of habitat quality, primary productivity, nutrient cycles and organic matter fluxes across the domain from the land-sea interface to deeper waters. The focus is on the structure and functioning of the basic building blocks of critical habitats and the processes that support them, knowledge that is crucial to sustainable use and management.

Theme 2. Stressor footprints, impacts and ecosystem dynamics

This theme addresses the dynamics of interactions between stressors, ecosystem components and functions. The theme will focus on understanding 1) the relationships and vulnerabilities of key structural components of habitats and key functions with respect to different magnitudes of natural and anthropogenic stressors, 2) how potential ecological ‘tipping points’ relate to management limits that often deal with single stressors, thereby generating new models relating to use, impacts and resilience relevant to EBM, and 3) the physical and ecological transport processes that connect stressor sources and their impacts, and other materials relevant to EBM, generating process models of connectivity. We will identify spatial and temporal domains of stressors and gradients of impacts resulting from multiple stressors within the context of long-term, cumulative environmental change of key habitats and processes. In conjunction with theme 1, this will provide the spatial and temporal context for understanding ecosystem tipping points, habitat inter-dependencies and resilience within the context of a changing environment.

Linkages

Dynamic Seas consists of three projects and links closely with: *Our Seas* through public engagement and participation, with increased understanding of ecosystem function and dynamics, as well as informing participatory processes and outreach; *Valuable Seas* through understanding connectivity of values and services, how changes in ecosystem function and intensification of marine activities may translate into changes in values and ecosystem services; *Tangaroa* through cross-linkages of important cultural and economic activities, and associated values and aspirations, as well as in co-learning in better relating science to traditional learning and experience; and *Managed Seas* through development and validation of EBM tools. Collectively, *Dynamic Seas* will capitalise on aligned research that strengthens the foundational science to support, inform and augment other programmes.

Dynamic Seas	Linkages	
	Dynamic Seas Projects	Sustainable Seas Programmes
Theme 1. Connectivity across ecosystems		
4.1.1 Tracking biogeochemical fluxes to inform EBM	4.2.1, 4.2.2	2, 3, 5
Theme 2. Stressor footprints, impacts and ecosystem dynamics		
4.2.1 Tipping points in ecosystem structure, function & services	4.1.2, 4.2.2, 4.3.1	1, 2, 3, 5
4.2.2 Stressor footprints and dynamics	4.1.2, 4.1.3, 4.2.1	2, 3, 5

Theme 1: Connectivity across ecosystems

Project 4.1.1: Tracking biogeochemical fluxes to inform EBM

Project Leader: Stephen Wing

Questions:

- How does the processing of energy and materials in one habitat affect other habitats through the movement of detritus, nutrients and contaminants?

- How does our use of marine environments affect biogeochemical fluxes and influence natural environmental constraints?
- How are the fates of nutrients and contaminants influenced by food web architecture and connectivity across the ecosystem?
- What are the roles of biological vectors in maintaining critical connections across habitats and environments?

Quantifying how biogeochemical processes connect across ecosystems is fundamental to understanding near- and far-field effects of marine activities. The adoption of an EBM approach to the development of the marine economy requires increased understanding and resolution of biochemical processes and connectivity across habitats (Wing and Jack 2014). Changes in community structure in one habitat can dramatically alter material flows and send ripples of change through the entire system (Wing et al. 2014). We therefore need to know the consequences of changes in marine communities and the subsequent reconfiguration of food webs to the flow and fate of organic matter (Jack et al. 2009), nutrients (Boyd et al. 2000, Middag et al. 2013), metals (Frew and Hunter 1992, Middag et al. 2015) and contaminants (Shahpoury et al. 2013, Ghosh et al. 2013). In resource-rich areas within the focal region (e.g. Kaikoura, Marlborough, Tasman and Golden Bay, and Chatham Rise) we will focus on how anthropogenic activities alter biogeochemical flows (Schiel 2013, Simon et al. 2004). Specifically, we will:

- Track the flow and fate of nutrients and contaminants from diffuse and point sources such as industry (Muhammad et al. 2013), aquaculture (e.g., Frew et al. 1989), mining and land-based runoff across habitats and through food webs (Shahpoury et al. 2013).
- Understand how changes in the pattern of biogeochemical flows interact with changes in community structure/food web architecture by comparing 'natural' and 'degraded/impacted' systems making use of reference sites in the case study area (Simon et al. 2004, Jack et al. 2009).
- Understand the role of biological vectors by analysing key species (e.g., large fish, birds) that traverse habitats and contribute to the flux of materials (Wing et al. 2014).

We will use new developments in isotopic chemistry (e.g., compound-specific isotopic signatures in essential fatty and amino acids (GC-C-IRMS)) and contaminant analysis (e.g., high resolution GC and sampling of trace element concentrations by MC-ICPMS) available at partner institutions. Our work will be aided by development of flux and chemical fate models designed to provide strategic advice about alternate management strategies to both insure maintenance of ecosystem function and services and to minimise impacts of chemical and biological pollutants.

Outputs:

- Detailed information of how the movement of nutrients and contaminants associated with marine resource-use and land-based activities cascades through marine food webs. Links with 4.2.1 (tipping points), *Our Seas, Valuable Seas* (provision of services), and *Tangaroa*, by June 2019. This information will be critical to resolving connectivity and modifications in food web architecture, enabling better decision making about natural constraints of marine resource use.
- New models for predicting changes in biochemical flows and fates under contrasting resource-use schemes (e.g., monocultures of mussels, monocultures of salmon, polycultures of finfish, bivalves, marine algae and detritivores). Links with 4.2.2 (stressor footprints). This will enable engagement

with stakeholders in understanding and ameliorating resource use effects within environmental constraints, by June 2019.

- Resolved key pathways for biochemical fluxes and critical connections maintained by the movement of animals among habitats and environments. Links with 4.2.1. This will enable informed cultural, societal and stakeholder engagement about biological constraints of resource use, by June 2019.

Participating organisations: University of Otago, Victoria University, University of Canterbury.

Key collaborations: Prof James Leichter (Center for Integrative Oceanography, Scripps Institution of Oceanography) will provide expert advice on nutrient dynamics in coastal ecosystems; Prof Simon Thorrold (Woods Hole Oceanographic Institution) will provide expert advice on tracking biological vectors in coastal and deep-sea environments. Dr Len Wassenaar, International Atomic Energy Agency, is an isotope ecologist and internationally recognized leader in using stable isotopes in food web studies.

This project is intended to extend past 2019. Full resolution of biogeochemical pathways, critical components and pathways of connectivity, and the relative influences of natural and anthropogenic stressors on sustainable marine resource utilisation requires experimentation and refined models both within case study areas and across focal regions. Based on the Outputs from Phase 1, this project will deliver such models as they relate to energy flux, detrital flows, food web architecture across the land-to-shelf domain, which will integrate with programmes 1, 2, 3, 5 and underpin engagement on enhanced resource use.

Funding: Negotiated \$1055k (total funds allocated for phase 1)

Theme 2: Stressor footprints, impacts and ecosystem dynamics

Project 4.2.1: Tipping points in ecosystem structure, function and services

Project Leaders: David Schiel, Conrad Pilditch, Simon Thrush

Questions:

- Can environmental tipping points and vulnerabilities be identified for a range of habitats and ecosystems?
- Do cumulative effects and multiple stressors within changing climate scenarios (e.g., temperature, wave forces, nutrients, light) increase the potential for resilience and abrupt change?
- To what extent do tipping points affect the provision of services, scientific advice to managers, investors and society, and a sustainable marine economy?
- How do tipping points relate to current management limits, improved EBM and governance?

This project will develop indicators of significant transitions in the structure and function of marine ecosystems (tipping points) and assess consequences of rapid change for effective EBM. There are policy, management and scientific needs to provide evidence to identify indicators of rapid change and support the implications of change (Folke et al 2004, Thrush et al 2009). The project will analyse existing data and undertake new research to identify and quantify changes in key ecosystem functions

across gradients of stressors to reveal potential regime shifts – knowledge that is currently lacking but is crucial to the Challenge. Key components of the research are:

- Develop criteria to screen available data and merge data sets from different sources to search for tipping points (Karr et al 2015). Employing state-of-the-art numerical and statistical methods (e.g., genetic programming (Tinoco et al 2015), break points (Thrush et al 2012)), CART models (Fairweather and Lester 2010) and indicators of shifts variance (Dakos et al 2015) or spatial structure (Weerman et al 2012) we will investigate the occurrence, underpinning processes and implications of tipping points.
- Field experiments will test how different combinations of stressors (e.g., physical disturbance, nutrient loading, turbidity or loss of ecological connectivity) tip ecosystems, as indicated by changes in attributes of communities (e.g., key species, redundancy, diversity) and functions (e.g., productivity, nutrient cycling) (Thrush et al 2014, Tait et al 2014).
- Management limits are currently set in isolation (e.g., quota, contaminant loads) despite the occurrence of multiple stressors, cumulative effects, repeated disturbances and environmental change. This is a potential source of tipping points. An assessment of current management limits in relation to multiple stressors and cumulative impacts will be used to determine the potential for ecological surprise and its implications for sustainable resource use.
- We will conceptualise key ecosystem interactions (e.g., trophic or those associated with biogeochemical-physical interactions) and test for changes in ecosystem networks using quantile regression and Structured Equation Models (Thrush et al 2014). This will lead to simple complex-system-models of high heuristic value in revealing possible surprise to participants in EBM and inform decisions about the provision of ecosystem services, and sustainability of the marine economy (linking to *Our Seas & Valuable Seas*).

Outputs:

- A systematic framework to define data requirements for assessing tipping points is achieved by December 2017.
- Assessment of vulnerability of different components of the ecosystem to abrupt change. We will investigate applications in estuaries, rocky reefs, and shelf ecosystems considering gradients of effects (and potential tipping points) associated with specific uses and environmental change, by June 2019. This will enable engagement with marine resource users and managers on vulnerabilities and effects of resource use.
- Analysis of the implications of multiple stressors and cumulative effects for management thresholds, targets and goals, thereby enabling informed engagement on EBM, by June 2019.
- Capacity building with EBM partners (in conjunction with programmes 1, 2, 3, 5) and the potential for surprise is incorporated into planning and management tools based on this work, by June 2019.

Participating organisations: Universities of Auckland, Canterbury, Waikato, Otago, NIWA, Cawthron.

Key collaborations: This project will cross-link with the tipping points project of the NSC Biological Heritage (Prof J Tylianakis); Profs Sally Woodin and Dave Wethey, University of South Carolina, Dr Nils Volkenborn (Stoney Brook, SUNY, USA) are collaborating with us in the role of seafloor organisms in modifying the rate and nature of benthic-pelagic coupling, nutrient release and the role of environmental change.

This project is intended to extend past 2019. Critical experiments across the focal region and case study areas will better define the occurrence, magnitude, vulnerabilities, variability and resilience of ecosystems, the potential for ecological surprises and potential constraints on resource use because of multiple and cumulative stressors. This project in Phase 2 will provide refined, empirically supported models about gradients, thresholds and tipping points that will be of direct utility in setting management targets and goals, and providing the necessary underpinning science for effective engagement and decision making.

Funding: Negotiated \$3470k (total funds allocated for phase 1)

Project 4.2.2: Stressor footprints and dynamics

Project Leader: Craig Stevens

Questions:

- How can we measure the spatial and temporal footprint and interactions of overlapping stressors?
- How do multiple stressors interact, accumulate and dissipate within and across the nearshore-offshore gradient?
- What large-scale bio-physical processes enhance the ability of ecosystems to recover from, or alternatively, increase sensitivity to multiple stressors?

Quantifying how the intensity of multiple stressors varies across space and time is crucial to predicting impacts of new activities on marine ecosystems. This project will develop tools to enable footprints of activity to be identified, quantified, and through oceanographic biophysical process understanding, determine cumulative and displaced footprints in the focal region. It will also provide the biophysical oceanographic context for the focal region, which is critical to multiple projects across the Challenge. There are three components to this project:

- *Footprint* determination requires a multi-scale approach. We will focus on sea bed disturbances (e.g., mining/trawl plume dispersion, sedimentation) but local disturbances need to be then placed in a mid-field (e.g., embayment scale) and regional (Challenge focal region) context. Each of these spatial scales has accompanying time scales (Gillespie et al 2011, Plew and Stevens 2013, Stevens et al. 2012, Zeldis et al. 2013, Hessner et al. 2014, Gorman et al. 2003). This component will involve understanding the activity-scale transformations in terms of dilution and energy and then develop models around how this spreads. This study will integrate with other projects in *Dynamic Seas* (4.1.1, 4.2.1) as it seeks to cover many systems from fate of riverine sediment plumes through to deep sea disturbances of the sea bed.
- *Physical transport* is readily understood and modelled but substantial challenges remain around sub-grid scale processes (i.e., current models do not capture key elements of the dispersive nature of the focal region) which generates considerable uncertainty in estimating dispersal/connectivity (Chiswell and Stevens 2010, Stevens 2014). Once these sub-grid scale processes have been evaluated through new data collection and model refinement, results will provide information at a scale relevant to a range of stakeholders. This understanding is also vital as we explore in concert with other projects in *Dynamic Seas* perspectives on connectivity.
- A *bio-geo-physico-chemical* context is required to support footprint and larger-scale understanding of ecosystem dynamics and ability to recover from stressors. Without an adequately understood

overarching framework for the oceanography (Chiswell et al. 2015, MacDiarmid et al 2013, Rowden et al. 2012, Lamarche et al. 2011, Mountjoy et al. 2014), work within the focal region will be compromised. This work is separated because it will be resource-intensive, partly supported from aligned research from NIWA, and is critical to multiple parts of the Challenge. There will be significant innovation as we incorporate new data acquisition technologies (e.g., gliders (Stevens and O’Callaghan 2015)) and recent modelling advances (both primarily supported and elsewhere).

Outputs:

- Process models for contextualising and forecasting individual and combined stressor footprints. This connects stressors to the oceanographic regime in the focal region and enables informed engagement with stakeholders on wider potential impacts of resource use, by June 2019.
- Tools for forecasting physical connections of stressors affecting different habitats, that provides a basis for planning of marine resource utilisation, by June 2019.
- Quantitative biophysical setting to contextualise observed ecosystem dynamics, thereby enabling wider consideration by EBM partners of potential connectivity, and near- and far-field impacts and constraints of resource use across the ecosystem, by June 2019.

Participating organisations: NIWA, Otago University, Auckland University, MetOcean, Cawthron

Key collaborations: Dr Claire Spillman, Australian Bureau of Meteorology, seasonal predictive tools for ocean temperature, and Drs John Middleton (SARDI)/Chari Pattiarachi (UWA), IMOS, shelf seas ocean observing systems.

This project is intended to extend past 2019. Quantitative biophysical studies are complex, often with spatial and temporal specificity because of currents, topography, stratification, weather, etc., that affect models of connectivity. Refined models will be developed, supported by a growing nexus of biogeochemical understanding from other elements of *Dynamic Seas* and provision of other services (e.g., from *Valuable Seas* and *Tangaroa*). These will underpin new EBM-based models of resource utilisation and enhancement, which must be placed within relevant biophysical contexts.

Funding: Negotiated \$1195k (total funds allocated for phase 1)

4.5 Programme 5: *Managed Seas*

Science Programme Leader: Alistair Dunn, fisheries and ecosystem modelling, NIWA

Programme team members: Chris Cornelison, coastal and oceanographic processes, Cawthron; Ian Tuck, fisheries scientist, ecosystem effects of fishing, NIWA and University of Auckland; Graeme Inglis, risk assessment, NIWA; Matt Dunn, fisheries ecology, Victoria University of Wellington; and Carolyn Lundquist, marine ecologist and ecological modeller, NIWA and University of Auckland

Scope

In order to successfully employ EBM, New Zealand requires models and tools that integrate the impacts of all activities that affect the marine environment to support decisions that maintain ecosystem resilience and a healthy prosperous marine economy. The *Managed Seas* programme will integrate the key ecological and socio-economic components together and provide innovative integrated decision support tools that meet the management requirements of government, Māori, and stakeholders to address New Zealand’s societal and economic aspirations. To successfully evaluate potential ecosystem

interactions and socio-economic trade-offs from different management scenarios, we will build robust and validated decision support tools that will ensure the maintenance of ecosystem resilience and a healthy prosperous marine economy. These tools will be developed in partnership with the key policy and management practitioners in government, Māori, community and stakeholder organisations and institutions. By integrating the practitioners into each of the projects we will ensure the tools and frameworks are ‘fit for purpose’ and are fully integrated and tested within the existing management systems. The *Managed Seas* programme brings together the key EBM components from all of the other programmes within the Challenge, integrates these into decision support tools, and will deliver the systems required by Māori, stakeholders and resource managers to ensure that New Zealand maintains its marine estate in a healthy, productive and resilient state while increasing the utilisation of marine resources.

Ecosystems are highly variable, complex networks between interacting species and the physical environment. These are dynamic in both time and space, where changes in one part of the ecosystem may have cascading system-wide effects, and the relationships between components are often not well understood and can be highly uncertain. As well as these bio-physical aspects of an ecosystem, management must also consider socio-economic trade-offs, where interactions between agencies, organisations, and individuals involved in management influence the system dynamics. The consideration of such large and highly connected socio-ecological systems is a key challenge for management, and an understanding of the scientific uncertainties are essential for accurate evaluation of potential outcomes and trade-offs. Given the uncertainty in our knowledge of ecosystem functional relationships and ecosystem responses to management, the development of management tools and frameworks in this programme will explicitly consider uncertainty. Hence, the management of such systems is a socio-economic process that must take into account the key ecological processes, as well as being robust to information gaps and scientific uncertainty.

Managed Seas has one theme — to develop, validate and compare a suite of EBM tools and frameworks across the range of approaches and complexities, to determine the most appropriate approach for given situations. This will include developing and evaluating “end-to-end” ecosystem models; developing and evaluating spatially explicit decision support tools; developing and evaluating risk and uncertainty tools; and developing and evaluating participatory and engagement tools using case study areas in the New Zealand marine estate.

The programme links closely with the other programmes within the Challenge. Engagement with key agencies, Māori, and stakeholders will be linked closely with the *Our Seas* and *Tangaroa* programmes, and will inform societal and ecological values for these tools in *Valuable Seas*. The programme links to *Dynamic Seas* through its provision of data to determine functional relationships assumed in models, as well as undertaking scientific studies to carry out model validation and robustification testing. The Integrated Coastal Zone Management (ICZM) aspects of this programme also link strongly with the *Our Land and Water Science Challenge*, in relation to primary sector impacts on rivers flowing into the coastal zone. Moreover, different management goals, requirements and approaches are currently used and will be required by key agencies, Māori, and stakeholders across New Zealand. In addition to the Māori and stakeholder engagement processes, we will also work in partnership with key science advisors, policy analysts, and operational managers on each of the key projects to ensure that the *Managed Seas* outcomes are relevant and effective.

Outcomes in 10 years

- New Zealand enhances its economic utilisation of the marine economy by employing a suite of EBM tools to manage its marine estate. These tools will provide both strategic and tactical information, allowing an appropriate ecological and socio-economic evaluation of alternative management scenarios that includes consideration of associated uncertainty.
- New Zealand has improved the incorporation of risk and scientific uncertainty into its management decision making processes in a manner that allows for evaluation of consequences of such decisions; thus ensuring that industries are not needlessly hindered, and can maximise their economic and social utilisation of marine resources while working within the environmental capacity of the ecosystems.

Programme Deliverables

Phase 1:

- Active and positive relationships with New Zealand and international researchers, institutions, agencies, Māori and stakeholders to provide EBM solutions and practical support for resource managers within the focal region.
- Partnerships with key Māori, stakeholder and resource practitioners within the focal region to allow informed decision making and governance.
- Development of ecosystem models in case study areas within the focal region, including an end-to-end Atlantis model for Tasman and Golden Bays and participatory tools, and evaluation of comparative model performance, providing methods and solutions for the implementation of EBM.
- Development of spatially explicit models that incorporate multiple scales and intensities of disturbance in the focal region, including development of methods to allow comparative assessments of approaches.
- Initial development of techniques that incorporate uncertainty into decision making and governance within the focal region.

Phase 2:

- Completed development of multiple scale ecosystem models and participatory tools for more than one case study area so that they can be applied in New Zealand to areas outside the focal region for use by Māori, stakeholders and resource managers to provide solutions for the implementation of EBM.
- Completed assessment of alternative spatially explicit models incorporating multiple scales and intensities in case study areas so that they can be applied in New Zealand to areas outside the focal region for assessing impacts and trade-offs for use by Māori, stakeholders and resource managers in the implementation of EBM.
- Developed techniques that incorporate uncertainty into decision making and governance and applied these to the case study area key ecosystem model and spatially explicit model outputs.

Themes

Theme 1: The development and validation of ecosystem model tools and frameworks

EBM advice is required across a range of spatial scales to address a variety of issues or trade-offs, including spatial planning, with different spatial and temporal scales and levels of system complexity. No single approach will be suitable in all circumstances, and so different EBM tools and frameworks are required. This theme will develop, validate and compare EBM decision support tools and frameworks, including methods to incorporate scientific uncertainty. The programme will include modelling tools that range from “end-to-end” ecosystem models that build on models of trophic connectivity and flow that generally provide strategic advice (e.g., Atlantis, Ecopath with Ecosim), to more focused single and multiple component quantitative models that provide more tactical advice (e.g., impact models, spatial allocation models), and qualitative decision support and participatory tools (e.g. Bayesian decision support tools, Bayesian Belief Networks, and loop analyses), to compare, evaluate and determine the most robust and appropriate approaches.

The key is to develop tools and identify which are most appropriate and useful for different questions and situations. We will develop methods and approaches for validating these models and undertake cross-model comparisons using comparative case studies to evaluate each approach. We will work in partnership with key science advisors and policy analysts from different agencies to ensure that the outcomes are relevant and effective.

In phase 1, we will develop ecosystem and spatially explicit decision support frameworks and tools and apply these to case study area within the focal region. For these, we will develop approaches to include risk and uncertainty into decision making, and develop the means to allow practitioners in key agencies and organisations to interact and use the tools. In phase 2, we will extend the development of ecosystem models and spatially explicit tools to other locations/systems within the focal region, and fully integrate these tools across the programme projects. The outputs will inform decision making to maximise effectiveness for stakeholders, Māori, and resource managers and use of marine resources.

Linkages

Projects will draw on and feed into each of the other Challenge programmes, particularly in relation to Māori and stakeholder engagement (*Tangaroa, Vision Mātauranga, Our Seas*), and also have critical linkages with the *Communication and Outreach* element, values (*Valuable Seas*), and in identifying and filling key knowledge gaps (*Dynamic Seas*). Each project will involve high levels of engagement with Māori and stakeholders which will be coordinated through the *Our Seas* programme. Key stakeholders will also collaboratively participate within the project teams (partnerships) to ensure tools are “fit for purpose” and meet their needs. In addition, the *Managed Seas* projects link closely with NIWA aligned funding which will provide some supporting science in the development of ecosystem models, and in identifying and filling key knowledge gaps.

Table 4. Linkages between *Managed Seas* projects and with other programmes.

Managed Seas Projects	Linkages	
	Managed Seas Themes	Sustainable Seas Programmes
Theme 1: The development and validation of ecosystem model tools and frameworks		
5.1.1 Ecosystem models	1	1, 2, 3, 4
5.1.2 Spatially explicit decision support tools	1	1, 2, 3, 4
5.1.3 Risk and uncertainty	1	1, 3, 4
5.1.4 Participatory Tools	1	1, 2, 3

Theme 1: The development and validation of ecosystem model tools and frameworks

Project 5.1.1 Ecosystem models

Project Leader: Ian Tuck

Questions:

- What are the best EBM frameworks and tools that enable resilience and can be used to achieve a healthy marine environment, prosperous marine economy in the context of social, economic and environmental change?
- How can we best utilise these tools to provide clear advice to resource managers, Māori, and stakeholders?

Ecosystem models provide a framework for consolidating and integrating data and knowledge, for explicitly recognising links and trade-offs, and for ultimately providing quantitative advice on EBM. Ecosystem models such as EcoPath with EcoSim (EwE) and Atlantis have revolutionised EBM worldwide, and are now being extended to include not only the biophysical realm, but also social and economic components (Fulton 2010, Fulton et al. 2004, Fulton et al. 2007, Fulton et al. 2010, Fulton et al. 2012, Frank 2014, Kaplan, 2010). This project will compare and evaluate the different ecosystem model frameworks and assumptions to inform their use as tools to develop ecosystem, social, and economic management advice in the EBM process.

Studies will initially focus on the Tasman and Golden Bay area and will be later expanded into the Chatham Rise region, and to other case study areas (e.g., Marlborough Sounds) in phase 2. The project builds on and integrates with aligned funding (NIWA Fisheries and Coasts & Oceans centres), which has already developed a base Atlantis model for the Tasman and Golden Bay region, non-dynamic balanced food web model for the Chatham Rise, and will start the development of a Chatham Rise Atlantis model in 2015/16.

This initial phase of the Challenge will further develop two initial Atlantis models, linking with *Our Seas* through engagement processes to work with stakeholders on development of scenarios and potential management actions to investigate. The project will also link with development of a dynamic food web (Ecopath with Ecosim like) model for the Chatham Rise (from the existing balanced food web model) being undertaken with aligned funding. Phased in over time, the project will also develop stochastic

food web (“Null” models, see Planque et al. 2014, and Mullon et al. 2009) and size based (allometric, see Bogstad et al 1997, Stefansson & Pálsson 1998) models for both the Tasman and Golden Bays and other case study areas, and examine model evaluation, comparison and validation approaches between all of these approaches.

Outputs:

- A single end-to-end ecosystem model has been developed and applied across a set of scenarios within a case study area to support key practitioners, decision makers, Māori, and stakeholders, by June 2017.
- Multiple ecosystem models have been developed and applied within one of the case study areas to support key practitioners, decision makers, Māori, and stakeholders. This will enable more informed marine management decision making for the case study area, by June 2019.
- Approaches developed to evaluate, compare and validate different ecosystem models and ecosystem model outputs to ensure that the best utilisation of these models. This will enable advice to be developed on how to best use the tools for decision makers for case study area focal region, by June 2019

Key participants: NIWA, University of Auckland, University of Canterbury and Victoria University.

Key collaborations: Elizabeth Fulton, CSIRO, the developer of the Atlantis modelling package, and a wide range of European research institutes within the MareFrame and ClimeFish projects, which are examining approaches to removing the barriers to widespread implementation of EBM, and the effects of climate change on fisheries and aquaculture.

Funding: Negotiated \$1495k (total funds allocated for phase 1)

Project 5.1.2 Spatially explicit decision support tools

Project Leader: Carolyn Lundquist

Questions:

- What are the most appropriate spatial tools to support decision making?

This project will consider what spatially explicit decision-support tools will work best to support EBM, within the New Zealand context? Spatially explicit decision support (SEDS) tools focus on spatial management and decision making. These tools encompass a range in iterative complexity from those that enable visualisation of spatially explicit datasets (e.g., NABIS, eAtlas, DOC GeoPortal), to those that provide for simple scenario analysis combined with mapping to inform decision making (e.g., SeaSketch, NIWA’s SCP plugin of the Quantum Map tool), to tools that analyse implications of different management scenarios (e.g., NIWA’s benthic disturbance/recovery models), and optimise management across potentially conflicting uses, or across different ecosystem services (e.g., Zonation, Ball and Possingham, 2000; Possingham et al., 2000; Marxan, Moilanen et al., 2009).

Recent New Zealand marine applications include the Chatham Rock Phosphate EPA application; the Ross Sea, Antarctica MPA application; the SPRFMO VME taxa analysis; the Department of Conservation’s Ecosystems of Significance project, and the Hauraki Gulf Marine Spatial Plan. This project will further develop and adapt these SEDS tools, creating new applications that suit the evolving world of EBM.

Case studies (identified through engagement) for tool developments will focus on key spatial management design challenges: 1) guiding methodologies for weighting different spatial management or resource uses and their impacts on biodiversity within a cost-benefit analysis (i.e., multiple extractive uses with different scales and intensities of impact; different types of biodiversity protection with unequal benefits across species or habitats); 2) incorporation of both quantitative and qualitative ecosystem services; and 3) improving incorporation of uncertainty in the use of species distribution models and habitat suitability predictions. Case studies will be prioritised based on concurrent work throughout the Challenge programmes, and also be aligned with the two case study areas identified in the initial phase of project 5.1.1.

The key aim is to identify and further develop a suite of SEDS tools suitable for a range of spatial management situations. These will provide the basis for economic development and environmental protection through facilitating risk and trade off (economic, cultural, social, environmental) assessments.

This project links across all *Managed Seas* projects and a number of projects within the other Challenges, as well as NIWA aligned funding. This project will draw on and feed into various *Dynamic Seas* projects, identifying and filling in key knowledge gaps, and also link closely with *Our Seas* and *Tangaroa* and *Valuable Seas*.

Outputs:

- Techniques have been developed that incorporate uncertainty in modelled species distribution layers into spatial prioritisation exercises. This will enable consideration of risk and uncertainty in advice to be incorporated by resource managers, Māori and stakeholders into decisions on resource management use, by June 2017
- Spatially explicit disturbance/recovery models that incorporate multiple scales and intensities of disturbance (e.g., natural disturbance, mining, benthic fishing) will be developed for the case study area. This will enable more informed marine management decision making in the case study area, by June 2019.
- Approaches developed to evaluate, compare and validate spatially explicit decision support tools. This will enable advice to be developed on how to best use the tools for decision makers, by June 2019

Key participants: NIWA and University of Auckland.

Key collaborations: DOC and the Ministry for Primary Industries (relevant stakeholders); John Leathwick, private consultant; the University of Helsinki, host of Zonation software; University of Queensland, host of Marxan software; James Thorson, NMFS.

Funding: Negotiated \$570k (total funds allocated for phase 1)

Project 5.1.3 Risk and uncertainty

Project Leader: Graeme Inglis

Questions:

- How do we incorporate risk and uncertainty into decision making?

A range of risk assessment tools are available that can be used to estimate the likelihood of effects from specific stressors on individual ecosystem components, such as single species assessment and impact models. However, integrated frameworks are not available that incorporate assessment of cumulative and indirect effects from multiple stressors, risks across multiple ecosystem components or to biodiversity, or that can estimate likelihood of transitions from desirable to undesirable ecosystem states (“tipping points”).

Scientific understanding of ecosystem stress and associated response relationships can be poor, often with only a limited understanding of the interactive processes that may drive changes across multiple ecosystem components. An awareness of the uncertainties in scientific understanding are essential for accurate evaluation of potential outcomes and trade-offs. Although projects within the Challenge are tasked with improving knowledge of these processes (e.g., 4.1.1 and 4.2.1, 4.2.2) and of the services and values affected by them (e.g., 2.1.3), the underlying complexity of ecosystems means that we are unlikely to attain complete understanding. The quantification and communication of this uncertainty are key components of risk assessment and decision making under EBM.

This project will develop methods to integrate assessment of risks from multiple, interacting stressors across larger ecosystem units and processes, and establish how best to quantify and incorporate uncertainty into decision making.

In phase 1 we will review and begin to develop methods to adapt contemporary frameworks for risk assessment for application to these problems. We will use this to consider and, where appropriate, further develop methods such as *Imprecise probability theory* (Walley 2000) as a framework for capturing the bounds of subjective expert beliefs about the likelihood of uncertain events, bioregional risk assessment for multiple stressors, and the use of conceptual tools (e.g., *Loop Analysis* (Melbourne-Thomas et al 2012)) to develop and portray complex stress-response scenarios for multiple stressors and ecosystem components. We will look at how these methods can be applied in case study areas. In phase 2 we will further develop these methods in the case study area and consider their application more generally in the focal region comparing and evaluating results with those from the case study ecosystem models and the SEDS tools projects.

Outputs:

- Completed a review of frameworks and tools for the incorporation of risk and uncertainty into decision making, by June 2018.
- Review and evaluate frameworks and tools for the incorporation of risk and uncertainty into decision making, and apply these to selected components within a case study area. This will enable advice on ‘best practice’ approaches to incorporating risk and uncertainty in marine decision making, with application to the case study area, by June 2019.

Key participants: NIWA

Key collaborations: CSIRO, Bioregional risk assessment.

Funding: Negotiated \$270k (total funds allocated for phase 1)

Project 5.1.4 Participatory tools

Project leader: Chris Cornelison

Questions:

- What tools best communicate EBM concepts, and facilitate stakeholder engagement in the EBM process?

This project works at the boundary of science and society, and will develop and implement the tools that can be used to assist in decision making and communicating complex concepts. This project aims to evaluate and develop innovative tools that enable wide participation of Māori and stakeholders. The outputs of this project will help in the participatory processes and frameworks developed in *Our Seas*; aiding the facilitation of community involvement in decision making in complex situations where there is actual and/or perceived risk and uncertainty. These tools will help serve as gateways into the Challenge research and be developed to enable users to sit in the ‘driver’s seat’ to engage with the Challenge’s complex outputs.

The participatory tools will enhance understanding of 1) the interdependencies and connectivity within and across complex marine ecosystems, 2) the effects of different stressors, including cumulative effects of multiple stressors, on ecosystem components, and 3) the consequences of alternative scenarios and management decisions. In order to maximise efforts and efficiencies and ensure the tools are as effective as possible for use by Māori and stakeholders, this project will integrate across the Challenge and in particular with *Our Seas* and *Valuable Seas* and with *Communication and Outreach*. Outputs will assist in identifying gaps and prioritising future research under *Dynamic Seas*. In turn, the participatory tools will enable translation of complex datasets from *Dynamic Seas* and model outputs from *Managed Seas* in visually accessible ways for Māori and stakeholders.

This project includes two strands: 1) underlying probabilistic network models and tools for decision support and scenario testing, and 2) platforms for communicating, visualising and evaluating complex problems and systems. The first strand will involve heuristic approaches, and construction of Bayesian network models, leading to dynamic influence diagrams and visualisations that allow participants to experience decision making under various scenarios and with differing levels of uncertainty. The second strand will leverage off the latest communication platforms and mobile devices to collect qualitative data and information that can contribute to the first strand, and in turn enable participants to visualise and interact with the inner workings and outputs of the Challenge.

This project will initially review and identify tools to be developed, and coordination/planning with participatory and engagement processes in other projects across Challenge. This will be followed by the development of decision support tools based on qualitative networks (e.g. Bayesian decision support tools and Bayesian Belief Networks) for use in the case study area. Key tasks include identification of values and objectives, network construction, development of probability tables and cause-effect relationships between values, performance indicators, and management options. Further, the project will work with existing mobile application and programming platforms (e.g., shiny in R) to develop applications for canvassing participants input and relaying complex model output.

Outputs:

- A review and evaluation of participatory models and tools that can be used by resource managers, Māori and stakeholders that aids the use of ecosystem tools into decisions on resource management use and EBM, by June 2017.
- An initial set of participatory frameworks and tools developed and applied for use by key participants, resource managers, Māori and stakeholders to interact with ecosystem models and spatially explicit decision support tool outputs within the case study areas, by June 2019.

Key participants: Cawthron Institute and NIWA.

Key collaborations: CSIRO and University of British Columbia for international best practice in participatory models and tools.

Funding: Negotiated \$580k (total funds allocated for phase 1)

4.6 *Vision Mātauranga*

Programme Leader: James Whetu, policy and planning (Māori perspectives), Whetu Consultancy Group Ltd

Programme Team Members: Shadrach Rolleston, cultural engagement and Māori perspectives in resource management, Rolleston Advisory Services Ltd; Thomas Gibbons, legal advisory, McCaw Lewis Lawyers Ltd; TBC

Scope

This Challenge will respond to MBIEs policy framework for Vision Mātauranga by collaborating with each Science Leader and their programme team, to mutually discover measures and outcomes that “unlock the innovation potential of Māori knowledge, resources and people to assist New Zealanders to create a better future”. Each Challenge programme has developed research questions and projects to investigate within their specific areas how to support the development of an EBM approach for New Zealand’s marine resources. The four research themes of Vision Mātauranga (VM) were used, and will be continued to be used, as an analytical tool to measure the effectiveness, efficiency and appropriateness of each project identified in those five programmes, to achieve the outcomes sought by VM.

To support the Objective of the Challenge, the VM programme aims to seek out Māori knowledge, resources and people to support, and where appropriate, lead existing and new research, develop new and innovative initiatives, and policy proposals to change statutory and non-statutory frameworks. The VM programme will ensure the use of mātauranga Māori is appropriate and in agreement with local Māori.

Outcome in 10 years

- Ensure mātauranga Māori is sought from appropriate sources when thinking about developing distinctive products, processes, systems and services, such as engagement, governance, processes, policy development, and modelling, to enhance the utilisation of New Zealand’s marine resources, while also improving the health and wellbeing, and kaitiakitanga responsibility, of Māori in the focal region.

- Learn from and, where possible, use international examples where indigenous knowledge, resources and people assisted in developing a framework for sustainability and managing natural resources within environmental and biological constraints.

Programme Deliverables

Phase 1:

- Engagement with Māori (iwi, community, businesses) who have interests in the focal region.
- Agreement with local Māori to develop a repository of mātauranga Māori.
- Active and positive relationships with New Zealand and international researchers, institutions, agencies and indigenous people(s).
- Integration of mātauranga Māori with projects in *Valuable Seas* and *Dynamic Seas*.
- Incorporation of mātauranga Māori in projects implemented by *Our Seas*, *Tangaroa*, and *Managed Seas* identified in the Vision Mātauranga policy framework.
- Understanding iwi preparedness for a blue economy.
- International case study of indigenous involvement in the development of products, processes, systems and services in the sustainable management of natural resources within environmental and biological constraints.

Phase 2:

- A repository of mātauranga Māori gathered over the course of the Challenge.
- Distinctive products, processes, systems and services that reflect the use of Māori knowledge, resources and people, to improve the health and wellbeing of Māori (iwi, community, businesses) and New Zealand.

With guidance, every Challenge programme will give effect to the mission statement of VM. In addition to this, the projects identified below have embedded VM within them and/or are working closely with the VM programme to ensure synergies are identified and mutually beneficial outcomes are achieved.

Programme 1: *Our Seas*

The participatory process within the programme is an important element of the Challenge to ensure communities are engaged, informed, and supportive of Challenge outcomes. Integral within this process is ensuring Māori as tangata whenua and kaitiaki are engaged and involved so that values, interests and mātauranga Māori are identified to support the purpose of the programme as well as achieve the aspirations of VM. *Our Seas* has identified team members with the appropriate skills, knowledge and experience to ensure effective engagement with Māori will be undertaken.

All projects in the programme will achieve, in their individual capacity, the outcomes sought by VM. Each project will be monitored by the VM programme, however particular attention will be on the following projects:

Project	<i>Project 1.2.1: Frameworks for achieving and maintaining social licence</i> <i>Project 1.2.2: Navigating marine socio-ecological systems</i>	
VM Programme Task	<p><i>The concept of social licence for the Challenge and the task for Our Seas is inclusive of seeking licence from iwi, an “iwi licence”, to sustainably manage and develop the marine/ocean environment.</i></p> <p><i>Appropriate engagement, communication and outreach methods are key to ensuring tangata whenua are actively involved in the Challenge. It is important to the Challenge that tangata whenua/iwi Māori are aware that a key outcome is social licence. It is important that any potential social licence is not in conflict with aspirations and existing approaches of tangata whenua/iwi Māori. Participation in the Challenge will ensure that their mātauranga, culture and experiences are reflected in new frameworks.</i></p>	
Anticipated Results	<u>Discover</u>	<ul style="list-style-type: none"> • <i>Distinctive processes, systems and services as a result of Māori knowledge and its people</i> • <i>Approaches (distinctive and/or successful) to environmental sustainability</i> • <i>Mātauranga Māori</i>
	<u>Outcome</u>	<p><i>Māori confidence in social licence, and</i></p> <p><i>Framework that supports:</i></p> <ul style="list-style-type: none"> • <i>Māori businesses and other enterprises to uplift productivity and performance</i> • <i>The role of Māori as tangata whenua and kaitiaki</i> • <i>The use and application of mātauranga Māori</i>

Programme 2: Valuable Seas

Obtaining a better understanding of the way that society values our marine estate, and applying these values to “add value” to activities that derive economic benefits, is the overall scope for the programme. Included within societal values are the values of Māori.

Projects	<p><i>Project 2.1.2: Mauri Moana, Mauri Tangata, Mauri Ora - Documenting social values</i></p> <p><i>Project 2.2.1: Creating value from a blue economy</i></p> <p><i>Project 2.2.2: Methods to increase diversification in marine economies.</i></p>	
VM Programme Task	<p><i>Understanding Māori values, and more importantly, the expression of those values by the respective iwi or hapū/marae/whānau in their role as kaitiaki, requires the support and commitment of Māori and researchers involved in the Challenge, and this will potentially create trust in the Challenge that their values are used appropriately.</i></p> <p><i>Equally, ensuring Māori as investors are prepared and positioned to participate in economic activities out in the ocean is an important outcome.</i></p>	
Anticipated Results	<u>Discover</u>	<ul style="list-style-type: none"> • <i>Distinctive processes, systems and services as a result of Māori knowledge, resources and people</i> • <i>Approaches (distinctive and/or successful) to environmental sustainability and Māori health and social needs</i> • <i>Mātauranga Māori</i>
	<u>Outcome</u>	<p><i>A document that :</i></p> <ul style="list-style-type: none"> • <i>Outlines the experience of Māori as tangata whenua and kaitiaki to achieve a sustainable environment and healthy communities</i> • <i>Traditional Māori knowledge applied by tangata whenua in the focal region</i> <p><i>Framework that supports:</i></p> <ul style="list-style-type: none"> • <i>Māori businesses and other enterprises to uplift productivity and performance</i> • <i>The role of Māori as tangata whenua and kaitiaki</i> • <i>The use and application of mātauranga Māori</i>

Programme 3: *Tangaroa*

To transform New Zealand's ocean economy, it is important to understand the relationship of Māori with te Taiao, and the constitutional framework of Te Tiriti o Waitangi/Treaty of Waitangi in New Zealand's resource management institutions and property rights. The stand-alone nature of both VM and *Tangaroa* as separate entities within the Challenge is important. Both look to achieve outcomes that are linked but independent of each other. Although there are synergies between the two programmes, there are key differences which will broaden the investigation and identify the responsiveness of the Māori community to achieve the Objective of this Challenge.

Projects	<p><i>Project 3.1.2: Kaitiakitanga in practice in our marine environment</i></p> <p><i>Project 3.1.3: Resources & strategies for Māori marine management</i></p> <p><i>Project 3.3.2: Innovatively improved pathways</i></p>	
VM Programme Task	<p><i>Vision Mātauranga is inherent in all the projects of Tangaroa, however a full understanding of Māori as tangata whenua (who hold mana motuhake (rights)) and as kaitiaki in the marine environment, is essential for the VM programme to achieve its mission of "unlocking" the potential of mātauranga Māori.</i></p> <p><i>Focus will be on the intended outcome of project 3.3.2 to develop innovate tools and pathways that explore capabilities for Māori in the sustainable use and governance of the marine economy. Embedding VM in the project will ensure that Māori knowledge is sourced and used to develop distinctive processes, systems and/or services.</i></p>	
Anticipated Results	<u>Discover</u>	<ul style="list-style-type: none"> • <i>Distinctive products, processes, systems and services as a result of Māori knowledge, resources and its people</i> • <i>Approaches (distinctive and/or successful) to environmental sustainability and Māori health and social needs</i> • <i>Mātauranga Māori</i>
	<u>Outcome</u>	<p><i>For project 3.1.2</i></p> <ul style="list-style-type: none"> • <i>A database of traditional indicators</i> • <i>Repository of mātauranga Māori</i> <p><i>For project 3.3.2 – New initiatives and innovative tools that:</i></p> <ul style="list-style-type: none"> • <i>Prepare Māori businesses and other enterprises to uplift productivity and performance</i> • <i>Support the role of Māori as tangata whenua and kaitiaki</i> • <i>Use and apply mātauranga Māori of tangata whenua (in any location)</i>

Programme 4: *Dynamic Seas*

To inform potential changes in management policies (including guidelines) for the marine environment, and to support innovative initiatives to encourage investment in the ocean economy, technical evidence is necessary to support the recommended tools and changes to the institutional landscape (regulatory, business, governance) in New Zealand. The *Dynamic Seas* programme will lead the biophysical science in the Challenge with the intent to understand the ecosystem and its interaction with human activities, as well as provide the technical evidence base to any future recommendations to enhance the utilisation of the marine environment. In this programme, exploring the integration of western science and mātauranga Māori is a key aspiration of the VM programme.

Projects	<p><i>Project 4.1.1: Tracking biogeochemical fluxes to inform EBM</i></p> <p><i>Project 4.2.1: Tipping points in ecosystem structure, function and services</i></p> <p><i>Project 4.2.2: Stressor footprints and dynamics</i></p>	
VM Programme Task	<p><i>Due to the technical nature of Dynamic Seas, the challenge for the VM programme will ensure that an appropriate level of recognition is given to tracking and obtaining mātauranga Māori when investigating the connectivity of the marine environment. Additional to the investigation, is concerted effort by Dynamic Seas to integrate mātauranga Māori when developing and outputting base information (technical) to inform frameworks, management approaches and decision making. It is anticipated that extensive collaboration between Dynamic Seas and VM programme will be undertaken.</i></p> <p><i>Participation in each of these three projects will ensure appropriate engagement and communication is undertaken to inform tangata whenua on the science of the Challenge (accessible science) and for tangata whenua to inform the science of the Challenge. Conversely, the engagement process will inform the science to develop new knowledge and management tools.</i></p> <p><i>Involvement in project 4.2.1 will primarily be to advise and support the programme to access and use mātauranga Māori to fill information gaps and to apply it in the development of potential new research.</i></p>	
Anticipated Results	<u>Discover</u>	<ul style="list-style-type: none"> <i>Distinctive products, processes, systems and services as a result of Māori knowledge, resources and its people</i> <i>Approaches (distinctive and/or successful) to environmental sustainability and Māori health and social needs</i> <i>Mātauranga Māori, and whether its interface with western science in these projects is effective</i>
	<u>Outcome</u>	<p><i>For project 4.2.1</i></p> <ul style="list-style-type: none"> <i>New research to increase knowledge and understanding of tangata whenua and their resilience to changes within the marine ecosystem. This will help to identify consequences for ecosystem services and values.</i> <i>Repository of mātauranga Māori</i> <i>Mātauranga Māori incorporated into frameworks and models developed in the project that evaluate impacts on ecosystems</i>

Programme 5: *Managed Seas*

In order to successfully employ EBM, New Zealand requires tools and decision frameworks that integrate the impacts of all activities that affect the marine environment to support decisions that maintain ecosystem resilience and a healthy prosperous marine economy. This programme will enable risks and trade-offs, economic, cultural, social or environmental, to be assessed, thereby providing a basis for economic development and environmental protection.

Projects	<i>Project 5.1.2: Spatially explicit decision support tools</i> <i>Project 5.1.4: Participatory Tools</i>	
VM Programme Task	<p><i>In various capacities, all projects identified in the programme align with the aspirations of VM.</i></p> <p><i>Project 5.1.2 has the potential to support the role of kaitiaki by providing a management tool spatially specific to their area of interest or mana motuhake, while at the same time, providing a tool which can be used by Māori investors to support investment decisions.</i></p> <p><i>Embedding VM in project 5.1.4 will ensure that innovative tools that are developed to guide decision making and public participation in the marine environment, incorporates mātauranga Māori during its development.</i></p>	
Anticipated Results	<u>Discover</u>	<ul style="list-style-type: none"> <i>Distinctive products, processes, systems and services as a result of Māori knowledge, resources and its people</i> <i>Approaches (distinctive and/or successful) to environmental sustainability and Māori health and social needs</i> <i>Mātauranga Māori</i>
	<u>Outcome</u>	<p><i>An interactive environmental and economic spatial tool that :</i></p> <ul style="list-style-type: none"> <i>Assists Māori businesses and other enterprises to uplift productivity and performance</i> <i>Recognises the role of Māori as tangata whenua and kaitiaki</i> <i>Incorporates the use and application of mātauranga Māori</i> <p><i>Recommendations that support:</i></p> <ul style="list-style-type: none"> <i>Māori businesses and other enterprises to uplift productivity and performance</i> <i>The role of Māori as tangata whenua and kaitiaki</i> <i>The use and application of mātauranga Māori</i> <i>The use of traditional indicators to measure success of statutory and non-statutory methods to manage the marine environment</i>

Vision Mātauranga Projects

All Challenge programmes will be responding to Vision Mātauranga, however gaps in research were identified by the VM programme which did not appropriately sit with any one of the five Challenge programmes. With the themes for the VM programme clearly established in the Vision Mātauranga policy framework, these gaps are covered in the following VM themes:

- **Theme 1: Indigenous Innovation** – Contributing to economic growth through distinctive research and development.
- **Theme 2: Taiao/Environment** – Achieving environmental sustainability through iwi and hapū relationship with land and sea.
- **Theme 3: Hauora/Oranga** – Improving health and social wellbeing.
- **Theme 4: Mātauranga** – Exploring indigenous knowledge and science and innovation.

The following projects have been developed to help inform the VM programme and ensure Māori responsiveness to the Challenge and its outcomes.

Theme 1: Indigenous Innovation

Project VM1.1 Iwi preparedness for a blue economy

Project Leader: To be determined (RfP to be undertaken June 2016)

Questions:

- Which Māori groups and organisations are using mātauranga Māori to guide and/or implement distinctive products, processes, systems and services?
- How are these groups and organisations using mātauranga Māori to be innovative and unique with their product, processes, systems and services?
- What are the challenges (constraints) that these groups and organisations face while seeking to implement the innovative potential of mātauranga Māori?
- What may have prohibited market entry and/or growth for Māori groups and organisations, and constrained their own ability to unlock the innovative potential of mātauranga Māori? What are the key needs or issues to be addressed, to ensure VM can be achieved within this Challenge?

The purpose of the project is to identify Māori groups, businesses and organisations that implement, and/or seek to implement, mātauranga Māori through the current services they provide and mode of operation. The intent is to review and analyse existing examples to:

- See how they use mātauranga Māori.
- Ascertain what challenges they have faced.
- Understand the changes that were required within the organisation and institutions to enable their product, process, system, and/or service to be delivered.
- Identify current and future constraints that exist and are likely to inhibit growth.

Information from the research in this project will support the development of distinctive products, processes, systems, services (e.g. frameworks, modelling, policy proposals) to enhance Māori involvement in the utilisation of marine resources.

Outputs:

- A case study report which will enable the Challenge to understand the current position and circumstances that Māori organisations (iwi, business, commercial ventures, research institutes, tāngata whenua) operate in for iwi to participate in a blue economy, by June 2017.
- Recommendations that support the development of the policy innovation framework to enable Māori groups and organisations to prepare for the outcomes of the Challenge. It is anticipated that recommendations will recognise the different roles Māori have in resource management in New Zealand, specifically how Māori participate in an EBM approach, while also participating in a blue economy, by June 2017.

Key participants: Whetu Consultancy Group and others to be determined through RfP (to be undertaken June 2016)

Key collaborations: Iwi organisation, hapū and whānau and others to be determined through RfP (to be undertaken June 2016)

Funding: Contestable \$175k (total funds allocated for phase 1)

Theme 2: Taiao/Environment

Project VM2.1 International comparative study: Incorporation of indigenous approaches to guardianship and stewardship in Canada's resource management policy framework(s)

Project Leader: To be confirmed (RfP to be undertaken in Oct-Dec 2015).

Questions:

- What can we learn from the engagement process during the development of Canada's resource management policy framework(s), where indigenous perspectives were sought and identified?
- If applicable, how did Canada resolve the indigenous rights and interests in developing and establishing their resource management policy framework(s)? What can we learn from that resolution process?
- What are the distinctive products, processes, systems and services that empower the indigenous people of Canada in the resource management policy framework(s)?
- What are the indicators of, and measurements for, success for indigenous perspectives (knowledge, approaches, culture and identity) in Canada's resource management policy framework(s)?
- Which areas in Canada's resource management policy framework(s) are closely aligned with the EBM concept?

The intent of the project is to review, summarise and evaluate international examples where indigenous environmental and economic approaches were incorporated into a resource management

policy framework similar to the EBM concept. This will provide the opportunity to learn from the approaches undertaken by countries such as Canada who have a similar colonial history with an indigenous population, similar environmental concerns, and that have been working in this indigenous knowledge space. The aim is to identify any processes and frameworks developed in response to utilising indigenous knowledge in the management of natural resources (whether on land or at sea) within environmental and biological constraints.

Outputs:

A document that outlines the following matters to assist with the development of any new distinctive product, process, system and service, by the Challenge:

- Engagement Process.
- Resolution of Indigenous Rights and Interests.
- Frameworks or processes.
- Implementation of EBM.

This document will be complete by June 2016, and will be used by to inform the Challenge of international successes in engagement and resolution of rights and interests with indigenous peoples. It will outline opportunities to the Challenge as a result of lessons learnt from international examples. The comparative study will also identify frameworks and processes that were developed in recognition of indigenous peoples rights and interest, and where possible, the involvement of those peoples, while implementing an EBM approach to resource management.

Key participants: Waikato-Tainui College for Research and Development, Whetu Consultancy Group, Tūtaiao Ltd, NIWA and other organisations to be confirmed.

Key collaborations: Marine Plan Partnership for the North Pacific Coast (MaPP).

Funding: Contestable \$185k (total funds allocated for phase 1)

Theme 3: Hauora/Oranga

By working collaboratively with the Challenge programmes, it was identified that no project specifically for Theme 3 was necessary. This is a reflection of *Vision Mātauranga* being embedded in programmes and their respective projects where outcomes for Māori will be achieved.

Theme 4: Mātauranga

Project VM4.1 A repository of knowledge: Mātauranga Māori

Project Leader: James Whetu

Questions:

- How do we safeguard the knowledge of tangata whenua, kaitiaki, and Māori for future generations which has been sought, obtained, collected and used as part of the Challenge?

The purpose of this project is to create a repository of knowledge for all information identified as mātauranga Māori. Having this knowledge recorded and collected within the Sustainable Seas Challenge will help identify where mātauranga Māori has been used to integrate with other knowledge frameworks, and how it contributed to the distinctive products, processes, systems and services of the Challenge. Other factors that would be captured:

- The source of the mātauranga Māori (who the knowledge came from).
- The origin of the mātauranga Māori (where and how the knowledge was derived).
- Research and commentary addressing how mātauranga Māori evolved (if applicable) over the centuries, to demonstrate its, and the peoples, adaptability to changes.

Outputs:

- By June 2019, an appropriate agreement with Iwi Māori to use and publish their mātauranga Māori. This output will ensure the integrity of the Challenge with local Māori, MBIE, New Zealand law fraternities and institutions, and international agencies such as the World Intellectual Property Organisation, by having a formal and appropriate agreement in place prior to any publication.
- A digital and printed publication by June 2019. This will be available to MBIE, and the public, as an output of the Challenge where indigenous knowledge was explored, and applied within Challenge, to develop distinctive products, processes, systems and services.

Key participation: Whetu Consultancy Group and McCaw Lewis Lawyers

Key collaborations: Iwi organisations, hapū and whānau, MBIE and NIWA

Funding: Negotiated \$350k (total funds allocated for phase 1)

4.7 Cross-Programme Projects: Enabling and using EBM

To achieve the Challenge Objective of enhancing utilisation of our marine resources within environmental and biological constraints, understanding of the current frameworks under which decision making is made within New Zealand's marine estate is required. Recent decision making for both regional and EEZ scale consents highlight the breadth of legislation used to manage New Zealand's marine resource sector, and the numerous institutions that interact at local, regional and national scales, with varying mandates from resource enhancement to environmental sustainability. The first cross-programme project will summarise New Zealand's existing legislative and decision making frameworks. The second will explore international examples and policy innovations that could be used to enhance the use of EBM in New Zealand. It is also critical to the success of the Challenge that the research from all the programmes comes together in case studies to trial an EBM approach to the management of marine resources. A third cross-programme project 'Trialling EBM' will involve integrated research activities to develop EBM tools that combine participatory processes, incorporate Māori and stakeholder values, and include ecological information to improve decision making. The first of these EBM trials will be undertaken in phase 1 of the Challenge in the Tasman/Golden Bays case study area.

There are two cross-programme projects that address Enabling EBM. The first will review a number of recent marine resource use applications and the associated decisions which have occurred under a variety of legislative frameworks to identify impediments to the utilisation of New Zealand's marine resources. In addition we will review how management is implemented within the existing national, regional, and local frameworks, statutes, and institutions that manage New Zealand's estuarine, coastal and ocean ecosystems, and determine similarities, inconsistencies and limitations to implementing EBM (if any) in the existing frameworks. In the second project we will explore the suite of policy tools and innovations that currently exist, both nationally and internationally, to enhance the implementation of EBM. Potential policy innovations based on national and international best practice, both within and outside of the current framework, will be explored and potential consequences of each scenario for EBM will be investigated for suitability within a New Zealand framework.

The third project 'Trialling EBM' includes one cross-programme project which aims to trial EBM using a case study area, Tasman and Golden Bays, within the Challenge focal region. The practice of EBM in New Zealand must involve decision makers, Treaty Partners, and stakeholders (Arkema et al 2006), and therefore requires balancing of conflicting values and aspirations. The programmes within the Challenge provide the critical research necessary to test the validity and utility of the EBM approach to sustainable management within this cross-programme project. This project will provide effective processes for managing ecosystems subject to multiple and cumulative stressors, is capable of accommodating uncertainties in risk assessment, and considers the values of all sectors of society in decision making. EBM does not self-assemble, but is an active and adaptive process. It is therefore anticipated that there will be ongoing iterations of process in the development of EBM and how it can be effectively applied in other case studies and areas. This will be explored in page 2 of the Challenge.

Project CP1.1 EBM within New Zealand's existing legislative framework

Project Leader: Carolyn Lundquist

Questions:

- To what extent do New Zealand's current legislative and institutional frameworks support EBM?
- How similar are requirements to obtain resource consents across different marine resource sectors?
- How is risk and uncertainty interpreted and incorporated into statutory frameworks and decision making?
- How are environmental impacts and cumulative effects documented and evaluated within different statutes, and for different institutions and sectors?
- How is 'best available science' defined across different statutes and sectors?

This project will review and summarise the national, regional, and local frameworks, statutes, and institutions within which decision making occurs with regard to New Zealand's estuarine, coastal and ocean ecosystems, from an EBM perspective. Case studies will be chosen (with stakeholder input) of EEZ and RMA consent processes, and will be used to evaluate how decision making is currently implemented across a range of potential uses of the marine environment. For each case study, key decision makers, stakeholders and Treaty partners will be interviewed, and the way in which statutory frameworks have been applied will be evaluated from a legal and policy perspective. Statutory and case

study comparisons will evaluate the extent to which decisions have utilised an EBM perspective with respect to: incorporation of cumulative impacts from multiple direct and indirect impacts; the application of the precautionary principle; definition and requirements for 'best available science'; scale of application and of relevant impacts; and stakeholder and public involvement. The repository and accessibility of any data collected or used within each application will be investigated to determine whether case study information is providing ongoing benefit through availability for application elsewhere. The limitations of 'best available science' in providing necessary information to satisfy precautionary decision making will be evaluated across case studies to demonstrate whether existing frameworks can allow for enhanced resource use without significant investment to overcome critical gaps in information.

This cross-programme project includes coordinated research that links across all Challenge programmes. Within *Our Seas* it will identify how science, stakeholders and policy makers engage with policy and management, and the underpinning policy and legislative frameworks under which the oceans are currently managed; within *Valuable Seas* it will identify barriers to the development of commercial activities, and in the identification and mitigation of environmentally detrimental effects. Within *Tangaroa* and *Vision Mātauranga* it will determine how Māori values and perspectives are integrated into decision making frameworks, and whether Māori capacity allows participation within decision making and management. Key linkages to further explore Māori perspectives in this marine governance and decision making will be provided through projects 3.1.1, 3.1.2, 3.3.1 and 3.3.2. Within *Dynamic Seas* it will identify data requirements and the uncertainty related to insufficient data availability, and how this influences EBM decision making. Within *Managed Seas* it will analyse links between the policy framework and the decision making tools being developed within *Managed Seas*.

Outputs:

- Case studies of EEZ and RMA consents will be reviewed and documented (at least 4 case studies, including resource consents that consider aquaculture, minerals, oil and gas, natural character,). This will enable evaluation of whether existing decision making processes and statutory frameworks support EBM, by June 2017.
- In conjunction with *Tangaroa* (projects 3.1.1 and 3.3.1) and *Vision Mātauranga*, case studies, and national, regional, and local lore and legal frameworks, statutes, and institutions will be reviewed and documented with respect to their incorporation of Māori/indigenous values and perspectives, and the commonalities and differences that support or hinder the maintenance of Māori lore/principles, including capacity to allow participation by Māori in EBM and decision making. This will provide understanding of existing barriers for integrating Māori values and perspectives in EBM, by June 2017.
- General principles for determining and acquiring 'best available science' to inform resource management decisions will be produced. This will allow information requirements to be determined regarding a proposal's environmental effects, without unreasonable cost, effort, or time, and encourage investment in the marine economy, by June 2017.
- An open access database will be developed for sharing case studies and other relevant socio-ecological research. This will allow transparent sharing of information to enhance and inform innovation in EBM, by June 2017.

Participating organisations: NIWA, University of Auckland, Cawthron Institute, EDS, Motu, Tūtaiao Ltd, Whetu Consultancy Group.

Key collaborations: Decision makers from agency partners (DOC, MPI, MfE, EPA, regional authorities) provide valuable experience and expertise to inform this project, and in-kind contributions of their expertise are envisioned as a necessary aspect of this project, to both identify and summarise institutional frameworks, and experiences with respect to RMA and EEZ decision making contexts.

Funding: Negotiated \$725k (total funds allocated for phase 1)

Project CP1.2 Future EBM frameworks for New Zealand

Project leader: To be determined in 2016.

Questions:

- What are examples of national and international governance frameworks that encourage investors, producers, intermediaries, retailers and consumers to engage in the development of new, or enhancement of existing, marine industries, while maintaining a sustainable balance with both ecological and societal requirements?
- What national and international policy innovations could be applied in a New Zealand context to enhance implementation of EBM across different marine resource sectors?
- How can marine management and decision making frameworks be improved to enhance the partnership between the government, Māori, industry and communities to support EBM?

As ocean policy is continually evolving through case law, regulation, Treaty settlements and regional policies, this project will extend our policy review to explore innovative approaches to enhance EBM in New Zealand ocean management. International approaches, such as those being implemented within the TEEB4OC programme in five case study nations, will be evaluated for suitability in New Zealand.

This project will then explore different policy scenarios, both within and outside of the current framework, and discuss consequences of each scenario for EBM in New Zealand. Guiding principles will be developed based on national and international best practice, providing recommendations for a systematic framework for decision making that provides clear and transparent processes and requirements, and parity between users for impact assessment and information needs. Innovative pathways to integrate indigenous values and knowledge systems in decision making frameworks will be explored. Further development of the marine economy requires both economic practices and governance frameworks that are compatible with socio-economic values and with ecological dynamics of marine environments. Governance frameworks will be identified that support development and enhancement of the economic benefits from marine environments, concurrent with the development of market frameworks in project 2.2.1. These governance frameworks should generate both short and long-term benefits for investors, while acknowledging and mitigating potential social, cultural and environmental costs of marine economic activities. This project will draw on findings from CP1.1 and from Themes 1 and 2 in *Our Seas*.

Outputs:

- Potential policy innovations to enhance EBM will be explored and their consequences assessed within the context of existing national, regional and local frameworks and management institutions. This will allow exploration of future scenarios for EBM under different policy regimes, by June 2019.

- Guiding principles will be identified based on national and international case studies that could be used to implement a systematic decision making framework for management of New Zealand's estuaries, coasts and oceans. This will provide a broad review of EBM options through which EBM in New Zealand can be enhanced, by June 2019.
- A range of governance structures will be explored that provide fair, transparent and trustworthy procedures for the evaluation of investment in resource use within multi-use marine settings. This project will be carried out in conjunction with projects 1.2.1 and 1.2.2 on social licence and projects 1.1.1 and 1.1.2 on participatory processes in *Our Seas*. This will enhance investment in the marine economy, by June 2019.

Participating organisations: NIWA, University of Auckland, Motu, ATEED, Cawthron Institute, EDS, University of Otago, Tūtaiao Ltd, Whetu Consultancy Group. Decision makers from agency partners (DOC, MPI, MfE, regional authorities) provide valuable experience and expertise to inform this project, and in-kind contributions of their expertise are envisioned as a necessary aspect of this project, to identify suitable policy options that are compatible with existing frameworks.

Key collaborations: Collaborations with TEEB and the Future Earth programmes will allow learnings from international innovations and best practice to be easily accessible to determine suitability within a New Zealand context. A long term partnership with the Centre for Ocean Solutions, Stanford University will also contribute to identification of international best practice, in addition to formulation of potential innovations in EBM policy and management that could be implemented in a New Zealand context.

Key collaborations:

Funding: Negotiated \$755k (total funds allocated for phase 1)

Project CP2.1 Trialling EBM

Project leader: To be determined in 2016.

Questions:

- How can EBM be best practiced in the case study area?
- How best can co-learning, Vision Mātauranga and EBM be fully utilised, incorporating cultural, economic, social and environmental drivers?
- How does EBM in the case study area inform applications in other regions?
- Which elements are required within a fully integrated programme of EBM to achieve sustainability and meet Māori and stakeholder aspirations?

The case study area for trialling the implementation of EBM in phase 1 of the Challenge will be Tasman and Golden Bays. This region encompasses pristine to degraded estuaries and expansive bays that are strongly influenced by riverine inflow and oceanic exchange and has a collapsed scallop fishery. It has an important existing marine economy based on fishing, aquaculture, recreation and tourism that has potential for significant growth. The area is affected by multiple, overlapping stressors that operate over a variety of spatial and temporal scales. These include direct physical disturbance of habitat and the transport and resuspension of land-based sediments, nutrients and contaminants. Closures of

shellfish harvests are frequent (in some cases semi-permanent) and industry expansion, including the rehabilitation of degraded fisheries, appears compromised by large-scale change in ecosystem function. Importantly, engagement with iwi, stakeholders and management agencies has been initiated in this region (e.g., Nelson Biodiversity Forum), enabling a pathway for including Māori and stakeholders in the development of an EBM framework.

This case study project will use EBM to help resolve land-to-sea impacts, reversal of degradation to fisheries (e.g., scallops), and develop better models to track stressors and their impacts on cultural values and economic activities. As the project develops, we will gain a better understanding of biophysical processes and more effective ways to engage in ecosystem improvements, resulting in better environmental forecasting, enhanced use and development of the marine economy within environmentally sustainable limitations, and improved decision making frameworks. This project will build on existing data sets (from past FRST/MBIE research, aquaculture, fisheries) and data collected by the Challenge to address information gaps for EBM management, and apply a range of methods to evaluate the effects of present and potential human activities in the area on ecosystem function, services and values.

This project links across all Challenge programmes. Within the case study area, it will trial participatory processes and the understanding of social licence developed in *Our Seas*, and incorporate research in *Valuable Seas* and *Tangaroa* to assess the potential effects on values, the local economy and Māori. This project will incorporate information from *Dynamic Seas* about thresholds and cumulative impacts, and how connectivity may extend impacts of human and natural stressors. This project will utilise and further develop frameworks and tools in the *Managed Seas* programme to incorporate ecosystem dynamics in whole of ecosystem models, incorporate risk assessment and uncertainty, and balance trade-offs between different values and aspirations.

Areas for consideration for further case studies in phase 2 of the Challenge are the Marlborough Sounds, the Chatham Rise, and the Kaikoura region.

Outputs:

- An understanding of how best to apply EBM and the participatory processes required in the case study area, by June 2019. This will then be applied in other case study areas in Phase 2 of the Challenge.
- Determination of likely impacts of the multiple activities present in the Tasman and Golden Bay areas on ecosystem services and the values held by the communities and hapū of the area and evaluation of the potential for further development of marine resources, by June 2019.
- Demonstration of a variety of management tools from the EBM toolbox; capacity building in public use of these tools and lessons to the Challenge on the effectiveness of these tools within the EBM process. This will provide feedback to direct improvements in these tools for use in Phase 2 of the Challenge, by June 2019.

Funding: \$400k plus funding from all projects involved in trialling EBM.

Table 5. Linkages between cross-programme projects and with other programmes.

Cross-Programme Projects	Key Linkages	
	Cross-Programme Projects	Sustainable Seas Programmes
CP1.1 EBM within New Zealand's existing legislative framework	CP.1.2	1,2,3,4,5
CP1.2 Future EBM frameworks for New Zealand	CP.1.1	1,2,3,4,5
CP2.1 Trialling EBM		1,2,3,4,5

4.8 Communication and Outreach

The *Communication and Outreach* element is a critical component of the Challenge, providing co-ordination across the programmes and projects, supporting the collaborative style of working expected of the Challenge, and ensuring the Challenge links to a wide range of audiences including Māori, stakeholders and the public. An annual plan set in a longer term strategy for unified communication and outreach will be prepared by the Leader of *Communication and Outreach* for the Challenge. This plan will build on, complement and collaborate with the activities and initiatives of other organisations such as the Science Media Centre, museums, other National Science Challenges, Regional Councils and Central Government agencies, iwi organisations, and educators. The strategy will cover internal and external communication and outreach for the Challenge and will include methods of monitoring and evaluation that will be linked to the Challenge and Key Performance Indicators for the Challenge.

Communication within the Challenge, between Māori, stakeholders and researchers and with the public are all key components for the overall strategy. Within the Challenge communication among projects and programmes will be critical, and will be facilitated by regular Challenge updates, an annual conference and associated workshops which will bring those involved in projects, plus Māori and stakeholders together to exchange ideas, concepts and strategies. The aim of the conference will be to share knowledge, approaches, methodologies and tools, ensuring that cross-programme initiatives are working effectively and that the ideas and concerns of Māori and stakeholders are being heard. Bringing the project teams together will provide opportunities to facilitate and support multi and transdisciplinary discussions and ongoing development of the Challenge and to revisit research priorities. Every second year the Independent Science Panel members will attend this conference to facilitate interaction with the wider international community and to provide an opportunity for the panel members to review the progress of the Challenge and contribute to the review of priorities for the Challenge. Bringing the teams together also gives an opportunity to provide training to those involved in the Challenge. Initially this will focus on building skills in communication and engagement to ensure those involved in the Challenge are able to develop great science stories from their work and engage effectively in participatory processes of EBM with Māori and stakeholders. In order to minimise 'participant fatigue', projects that require Māori and stakeholder participation will be co-ordinated across the projects and programmes. Where possible, the Challenge will leverage off centralised efforts of the other Challenges and CoREs and will coordinate with the Science Media Centre.

To enable and support the participatory processes needed for successful implementation of EBM, Māori and stakeholders need to be ready, willing and able to participate. To support this we will build a community of people who are aware of the Challenge and want share their knowledge and ideas and learn more about the marine environment and EBM. An external communication strategy needs to be developed that will support activities to achieve this and build on current and ongoing activities of the Challenge parties and other organisations. The strategy will ensure that the Challenge makes effective use of the skills and abilities of the staff of the Challenge parties for the benefit of both the Challenge and the parties. A workshop involving the parties to the Sustainable Seas and Deep South Challenges was held in late July to develop procedures for this collaboration. The Communication Strategy will include, Māori, stakeholders, communities and researchers and will involve a wide range of participatory tools and activities.

Outreach and education will be an essential component of this element because science-based information provided in easily understood and appropriate formats will be crucial to gaining trust in the science that underpins EBM, and will support decision making and inform decisions regarding social licence to operate. It will also be important for building capability and capacity to support the active participation of Māori and stakeholders in the EBM process. These activities will include innovative activities that are sector and audience dependent and may include e-learning, museum displays and activities, magazine articles, newsletters, citizen science projects, development of data visualisation tools and use of social media. It is critical that the strategy for outreach and education builds on and complements the activities and initiatives of other organisations who have specialist expertise in outreach and education; for example museums, aquaria, and specialised education programmes.

4.9 Programme timelines

ID	Task Name	2015	2016				2017				2018				2019
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
1	Programme 1: Our Seas														
2	1.1.1 Review existing Māori and stakeholder engagement in marine science and marine governance participatory processes														
3	1.1.2 Determine suite of participatory processes for application in multi-use environments														
4	1.2.1 Frameworks for testing social licence														
5	1.2.2 Navigating marine socio-ecological systems														
6	Programme 2: Valuable Seas														
7	2.1.1 Development of valuation frameworks and principles														
8	2.1.2 Mauri Moana, Mauri Tangata, Mauri Ora - Documenting social values														
9	2.1.3 Measuring ecosystem services and assessing impacts														
10	2.2.1 Creating value from a blue economy														
11	2.2.2 Methods to increase diversification in marine economies														
12	Programme 3: Tangaroa														
13	3.1.1 Understanding kaitiakitanga in our marine environment														
14	3.1.2 Kaitiakitanga in practice in our marine environment														
15	3.1.3 Resources and strategies for Māori marine management														
16	3.2.1 Defining the Māori marine economy														
17	3.3.1 Understanding the dynamic between Māori lore and law														
18	3.3.2 Innovatively improved pathways														
19	Programme 4: Dynamic Seas														
20	4.1.1 Tracking biogeochemical fluxes to inform EBM														
21	4.2.1 Tipping points in ecosystem structure, function and services														
22	4.2.2 Stressor footprints and dynamics														
23	Programme 5: Managed Seas														
24	5.1.1 Ecosystem models														
25	5.1.2 Spatially explicit decision support tools														
26	5.1.3 Risk and uncertainty														
27	5.1.4 Participatory tools														
28	Vision Mātauranga														
29	VM.1.1 Iwi preparedness for a blue economy														
30	VM.2.1 International Comparative Study														
31	VM.4.1 A repository of knowledge: Mātauranga Māori														
32	Cross Programme														
33	CP.1.1 EBM within New Zealand's existing legislative framework														
34	CP.1.2 Future EBM frameworks for New Zealand														
35	CP.2.1 Trialling EBM														

Figure 5. Indicative project timelines

5. Building on existing research

This section outlines the research currently being undertaken by parties to the Sustainable Seas Challenge that supports the Challenge Objective. Such research falls into three categories:

1. **Mapped** — MBIE contestable projects that have been formally associated with the Challenge, which will continue according to the timeline of their existing MBIE contracts, and whose funds have been mapped into the Challenge funding envelope.
2. **Aligned** — research undertaken by NIWA, as outlined in their Statements of Corporate Intent, which is will support achieving the Challenge Objective.
3. **Related** — research which, although not designed to deliver Challenge components directly, provides contextual (background) information. This research is often difficult to quantify, especially if undertaken within the universities where it may encompass numerous projects undertaken by staff and students using a variety of internal funding mechanisms. Stakeholders such as Government Ministries also undertake or fund research relating to their own missions, such as oil and gas prospectivity (MBIE), marine biodiversity and fish stock assessments (MPI) and marine protected areas and species (DOC). As well, the private sector (for example the aquaculture, petroleum, and fisheries industries) commissions research to address site-specific or commodity-specific problems. The latter cannot, for privacy reasons, be detailed or the funding quantified, but when the research results become openly available, they offer some additional value to the Challenge.

Overall, there is a considerable amount — in the order of at least \$75M per year — of research currently being undertaken that may be considered relevant to the Challenge Objective and this is likely to remain the case over the course of the Challenge. However, detailing the true research landscape, beyond the Government-funded (vote Science) components (about 30% of the total) is difficult for the reasons stated above, making the task of devising a research strategy and work plan that avoids excessive and unnecessary overlap a challenge in itself. There is also the issue that the application of MBIE (contestable), RSNZ (Marsden) and PBRF (universities) research funds, as well as those operated through Ministries and private interests will continue to work within their own terms of reference and in accord with their own sets of goals and priorities. Given the relatively small amount of funding to address the multiple research needs within New Zealand's vast EEZ, good communication is needed to ensure complementarity and, ultimately, commonality of purpose, and avoid too much 'reinvention of the wheel'.

Mapped projects: There are two existing and one recently completed MBIE contestable contracts led by NIWA that have been mapped into Sustainable Seas.

- *Enabling management of offshore mining through improved understanding of environmental impacts* (\$395k pa). Terminates in September 2016. This programme, in partnership with the mining industry, government agencies, iwi and NGOs, is developing, validating and implementing science-based guidelines for effective environmental management of off-shore mineral and petroleum extraction; the guidelines will be based on both Environmental Risk Assessment and Environmental Impact Assessment processes, and the results will assist development of effective environmental management plans. [Supports *Managed Seas*]

- *Vulnerable marine ecosystems* (\$869k pa). Terminates in September 2015. Here, two different modelling approaches are being used to predict the location of 'vulnerable marine ecosystems' (VMEs) in New Zealand's EEZ and adjacent areas. Direct sampling is being used to validate the models and assess their accuracy. The models will inform spatial management and conservation planning to protect VMEs from the adverse effects of fishing and other human activities. [Supports *Dynamic Seas*]
- *Marine Futures* (\$965k pa). Completed in September 2014, Marine Futures (which included key scientists from UoA and UoC, will play a foundation role in *Our Seas*. This project has explored options for societal engagement that will provide an important springboard for advances in co-learning, model development and governance that are needed to underpin the Challenge Objective. Outcomes from workshops held in the project focused on the future of two very different but economically important marine systems, the Chatham Rise and Hauraki Gulf. Focused on improving participatory decision making models, the workshops used environmental future scenarios to help rapidly build trust and identify shared values. [Supports *Our Seas*]

NIWA Aligned Research: NIWA has aligned \$4.35M of its core funding to the Challenge. This funding sits within four Coasts and Oceans Centre programmes, one Fisheries Centre programme, one Climate Centre programme, and aligns with several of the Challenge programmes:

- *Marine Biological Resources.* Objectives include the description and prediction of biogenic habitats, and characterisation of the diversity and distribution of the marine biota in NZ's territorial waters, EEZ and Southern Ocean, over a variety of space and time-scales. [Supports *Dynamic Seas*]
- *Ocean flows and productivity.* Definition of the spatial and temporal variation in New Zealand's ocean current flows, primary and secondary production, and determination of how biogeochemical and physical oceanographic processes influence biotic variability. [Supports *Dynamic Seas*]
- *Ecosystem structure and function.* Determining the structure of marine ecosystems, the interactions amongst their components that affect ecosystem stability, and developing ecosystem models that can inform management of New Zealand's marine estate. [Supports *Dynamic Seas*]
- *Managing marine ecosystems.* Determining the characteristics and vulnerability of marine communities, habitats and ecosystems; linking basic knowledge of how marine ecosystems work to how they are affected by human activity and addressing major strategic issues including limits to capacity; interactions among multiple stressors; the dynamics of cumulative effects; and the underlying controlling factors of ecological recovery. [Supports *Dynamic Seas*]
- *Developing the language of ecosystem services* for management and valuing marine resources including developing techniques for mapping services and developing terms that use ecosystem services as a common language to understand the links between societal values and ecosystem function. [Supports *Valuable Seas*]
- *Developing models to understand disturbance – recovery dynamics.* [Supports *Managed Seas*]
- *Ecosystem approaches to fisheries management* is developing tools and approaches that will inform New Zealand's ecosystem approach to fisheries management (EAF). This includes Māori and stakeholder engagement and collaboration on the development of management actions and simulations. It also includes development of end-to-end ecosystem modelling frameworks, tactical and strategic model components. [Supports *Managed Seas*]

The details of the NIWA aligned research are still to be confirmed. There will be detailed discussions between NIWA and the SLT regarding both the scientific and geographical focus of the aligned research to ensure the maximum benefit of the research to the Challenge and NIWA. The first opportunity for greater alignment will be at the start of the 2016/17 financial year.

GNS Aligned Research: With no significant capability in marine biology or marine environmental science, GNS Science is no longer in a position to align any of its core funding to this Challenge. It will continue to use core funds to support its marine geoscience work associated with the petroleum and mineral sectors, as per its Strategic Plan, since both are integral to delivering the Government's Business Growth Agenda. In so doing, GNS Science will provide peripheral support to the Challenge in its efforts to achieve the 'realising the value and increased use of our vast oceanic and coastal assets' part of its Objective.

Related Research:

As noted above, there are significant areas of existing research being undertaken by the wider New Zealand science community on our marine ecosystems and marine resources. Much of this research is world class, linked to international programmes and initiatives, and will serve to underpin the research plan to some degree. The more important of these are:

- The Sustainable Business Council's Social Licence project, which aims to increase awareness and understanding of the term 'social licence to operate' in a New Zealand context—what it encompasses and how to earn or maintain one. The project is examining what a societal licence to operate involves, what existing surveys and research suggest are risks to New Zealand businesses, and what companies engaging successfully with communities are doing. [relates to *Our Seas*]
- The University of Waikato and the University of Bremen's INTERCOAST multi-disciplinary projects are focused on environmental law and social licence linked to extractive industries (fisheries and petroleum), and on environmental elements of commercial port development. 'Blue economy' research is examining Integrated Multi-Trophic Aquaculture with a number of iwi and iwi-owned seafood processing industries. [relates to *Valuable Seas*]
- MBIE-funded *Mātauranga Māori and sustainable management of New Zealand fisheries* is assisting tangata whenua to bring together different, yet complementary knowledge systems—distinct Māori knowledge and conventional fisheries and ecosystem information. [relates to *Tangaroa*]
- MBIE-funded *Manaaki Taha Moana* is providing a working example of integrating science and mātauranga Māori to gain better knowledge of coastal ecosystems and the degradation processes that affect them. Using case studies with Ngāti Raukawa and Tauranga Moana iwi, the project is addressing the issue of multiple stressors in coastal environments and involves the development and comparison of cultural indices with scientific approaches for measuring estuarine and coastal health. [relates to *Tangaroa*]
- *Ka Hao te Rangatahi* – Revolutionising the Scampi Fishery is investigating alternative, more sustainable and profitable methods grounded in Māori knowledge for harvesting Māori-owned scampi quota. [relates to *Tangaroa*]
- Te Kotahi Research Institute and Waikato-Tainui Research and Development College are developing kaupapa Māori theory and research across a wide range of areas including both social and physical sciences. [relates to *Tangaroa*]

- The multi-institutional and cross-disciplinary Rena Oil Spill recovery programme including stakeholders, governmental agencies, 17 iwi and scientists, is providing a valuable model of a very diverse community coming together in a common cause, and the value of interactions and feedbacks between all parties. This has spun off into outreach programmes, citizen science, and a wider ambit of assessing marine impacts in the Bay of Plenty. [relates to *Dynamic Seas, Our Seas*]
- Technological advances are emerging from transport and connectivity models being developed for MPI to assess biosecurity risks around New Zealand, the development of remote sensing and real-time coastal observation systems (funded through MPI Aquaculture Planning fund and internal funding by Challenge parties), and the development of molecular technologies for rapid characterisation of biological assemblages in response to stressors. [relates to *Dynamic Seas*]
- A model of disturbance and recovery dynamics for marine benthic ecosystems has been developed by a NIWA-led team for MPI. This has been designed to assist MPI in assessing operational management strategies, based on their likelihood of minimising or mitigating the adverse effects of bottom trawling and dredging on benthic communities. The model also provides a framework for working with resource managers and society to define thresholds for disturbance that can assist the management of the environmental effects of fishing. [relates to *Managed Seas*]
- A range of current MPI/regional council projects provide tools (forecasting models, frameworks) for underpinning integrated management of marine resources; a focal point is enabling sustainable development of aquaculture in key economic regions such as the Hauraki Gulf and Marlborough Sounds. [relates to *Managed Seas*]

Research projects funded in the recent MBIE, 2015-16 contestable round, which have some relevance to this Challenge are:

- Oranga Taiao, Oranga Tangāta - Knowledge and toolsets to support co-management of estuaries (Massey University).
- Coastal acidification: rate, impacts and management (NIWA).
- What's at stake? - Enabling decision making through better measurement, forecasting and evaluation of the impacts of non-native organisms in NZ's changing ocean (NIWA).
- Understanding petroleum source rocks, fluids, and plumbing systems in New Zealand basins: a critical basis for future oil and gas discoveries (GNS).

Co-funding:

Co-funding from external partners is yet to be secured by the Challenge. Based on the history of the parties to the Challenge, significant levels of co-funding can be anticipated as the Challenge develops. At the Māori and stakeholder workshops we have gathered information sheets from participants that had research activities that will contribute to the Challenge. These lists will be given to Programme and Project Leaders to enable them to identify organisation who have projects which could contribute to their research within the Challenge through co funding. The case study approach will provide opportunity to leverage cash and in-kind co-funding from industry, and central and/or local government. The parties have a track record in attracting international support, and overseas research connections have resulted in considerable co-funding (e.g., in-kind support from visits of overseas research vessels and associated technologies such as submersibles). Commercial co-funding is expected to be closely aligned to technology transfer within the Challenge and also expected to grow as the Challenge evolves. Based on the track record of the parties to the Challenge, direct and related co-

funding in excess of \$2M per year is expected once the Challenge is established. The Department of Conservation has already indicated it will contribute co-funding to the Challenge.

5.1 Fit with sector and research strategies

Achieving the Challenge Objective aligns with and will address a range of needs identified in key national strategies. These include:

- Building the Natural Resources component of the Business Growth Agenda (BGA) (December 2012), in particular the initiative to *“Realise greater value from our marine and aquaculture resources”*. We believe that the EBM approach will assist the Government to *“Make the most of the considerable opportunities for New Zealand to gain much greater value from its extensive marine [...] resources”*. The BGA also seeks to *“Derive greater value from our fisheries resources”* through *“Increasing the productivity and efficiency of the wild capture fisheries sector”* and *“Promoting sector innovation to reduce operational costs and enhance value-added export opportunities”*. Sustainable Seas can add value to exports of our wild fish products through contributing to the environmental sustainability requirements of accreditation systems such as the Marine Stewardship Council.
- Te Pūtea Whakatupu Trust 2014 *Strategy for the Māori Fishing Industry* proposes a strategic vision and options for increasing the benefits from Māori fisheries and assets in order to fulfil the potential offered through the Māori fisheries settlement. The strategy identifies the clear opportunities for increasing benefits for Māori from their fisheries, based on Māori values such as Rangatiratanga, Kaitiakitanga, Māramatanga and Manaakitanga. The development of the EBM approach, building on these values, will contribute to a number of elements within this strategy that aim to increase the value of fisheries export products. These include ‘the story’ of the origin of the fish as a critical factor of quality in the market place; a supply chain approach that is able to meet all aspects of product certification, including environmental sustainability; and a systems approach whereby the supply chain is managed within a wider ocean economy.
- The recently passed Exclusive Economic Zone (EEZ) and Continental Shelf (Environmental Effects) Act 2012 *“...introduced regulations to maximise economic opportunities while better managing the environmental effects of activities within it”*. The Act provides for a *“comprehensive environmental management regime for the EEZ and extended continental shelf”*, which this Challenge will underpin and inform. Implementing the legislation, supported with appropriate EBM-based research will result in achieving the desired *“... greater certainty for new ventures in energy generation, seabed mining, some aspects of petroleum activities, carbon capture and storage and marine farming to proceed with appropriate environmental controls”*.
- The Government’s Aquaculture Policy Strategy & Action Plan, which *“seeks to embed the benefits of legislative reform while promoting the continued growth of a sustainable aquaculture industry, enabling it to become a \$1B contributor to the economy”* will also be underpinned by Challenge research. The Government’s desire to *“... manage the cumulative effects across uses of the marine space”* and *“... improve information sharing across industry sectors”* are both priorities within Sustainable Seas.
- New legislation to protect marine habitats and ecosystems in the Territorial Sea and EEZ is aimed at *“assisting NZ to meet international undertakings for biodiversity conservation and the sustainable management of marine ecosystems and resources”*. The Challenge will materially contribute to

substantiating the assertion that “*well-designed marine reserves benefit the economy as tourist destinations and marketing tools, and provide a range of ecosystem services to the economy including associated service industries, and spill over benefits for fisheries and coastal protection*”.

- The Government’s *A Marine Research Strategy for New Zealand, 2012-2035* highlights a range of priorities to which the Challenge will contribute, including the need for collaboration across all levels of society with science to set research priorities, and the need to better incorporate Vision Mātauranga. Sustainable Seas will contribute to key priorities: characterisation and determining natural capital and services within our marine environment; increased understanding of the dynamics and functioning of marine ecosystems, and their resilience; and development of an EBM approach to marine resource use.

5.2 Linkages to other Challenges

The National Science Challenge framework offers an unprecedented opportunity for science and systems-oriented linkages to be built, and we have had initial discussions with those parties preparing other environmental-based Challenges on areas of potential collaboration. Some key areas of commonality and linkage are:

- *Governance*—for this Challenge there is opportunity to share the Governance Group with the Deep South Challenge, given that NIWA is the common Host organisation, overlapping science teams and outcomes, and common interests of Māori and stakeholders. We are sharing ‘best practice’ in the governance of the Challenges (e.g., regular meetings of Challenge Chairs and sharing of practices and organisational activities among Challenge Directors/Managers/Leaders).
- *Vision Mātauranga*—all National Science Challenges aim to involve, collaborate with, and deliver benefit to Māori and Vision Mātauranga. Therefore, learning from approaches, or combining engagement activities and capability and capacity building initiatives, will help ensure all Challenges are more effective in this area. Across Challenge Vision Mātauranga activities have been undertaken and more are planned.
- *Communication*—this will be an essential element of all Challenges, so significant opportunities exists to share relevant communication activities (e.g., joint stakeholder workshops), resources and best practice and evaluation methodology. A pan Challenge workshop has already been held to initiate cross-Challenge collaboration and a workshop co-hosted by the Sustainable Seas and Deep South Challenges has been held with the Communication teams of the Collaborating Parties to identify working protocols and best practices.
- *Societal outreach and engagement*—integration of science and society is a common principle and prerequisite of the National Science Challenges, so there will be substantial benefit from sharing approaches and learnings between Challenges. Initial discussions between the natural environment focussed Challenges are identifying potential joint initiatives, and these will be further developed over the next 12 months (e.g., recent proposal by key museums to co-fund outreach activities relevant to the Challenges could be progressed as a cross-Challenge initiative. Initial discussions for outreach initiative have been held between the Sustainable Seas, Deep South and Our Biological Heritage Challenges).
- *Causal factors in environmental change*—climate stressors (such as ocean acidification and sea level rise) that stem from changes in ocean climate are relevant to the Sustainable Seas Challenge, but dealing with causation processes is out of scope. These are likely to be important components

of the second phase of the Deep South Challenge, so integrating inter-related research threads between these Challenges will be important in later phases of the research.

- *Terrestrial linkages*—key stressors of coastal marine ecosystems are sediment and nutrients and contaminants delivered by rivers. Linking cause and effect will require close liaison with the Our Land and Water Challenge as well as Regional government. We will collaborate to create conceptual frameworks that take the consequences of land use decisions from ‘mountain to sea’. There is also potential for some concepts of natural capital and ecosystem services to use a common methodology, both within the Our Land and Water and Biological Heritage Challenges.

To ensure that interfaces between the Challenges are maintained, we propose that regular meetings of the Challenge Directors/Managers/Leaders take place, a programme of joint seminars be undertaken where this would further the aims of various Challenges, and cross-fertilisation of researchers between Challenge research teams takes place. Specific linkages will be forged with other Challenges, particularly those focussed on the natural environment.

5.3 Research team and skills

Composition of research teams

Meeting the Objective of the Challenge will require a diverse array of skills. The Challenge Parties and their existing collaborators comprise New Zealand’s leading capability in the required areas and so will be able to address the needs of the Challenge as it evolves. These teams will be formed using a ‘best team’ approach, whereby individuals with the wide range of skills required to meet the Challenge research and related activity priorities, regardless of institution, will be chosen. Specific research teams for Challenge programmes and projects will be assembled by the Science Leadership Team on a ‘best teams’ basis (for the whole of project outcomes) when negotiating research projects in the Challenge.

Collectively, the Challenge Parties have specific expertise in the following areas:

Human systems capability:

- *Vision Mātauranga*—the Parties have staff with expertise in undertaking research in partnership with iwi/hapū and Māori businesses including building Māori research capability, developing tools/decision systems for Māori to aid kaitiakitanga, and providing information, data and knowledge for Māori. Involved in the Challenge are key Māori researchers and research organisations that are leaders in the area of kaupapa Māori research and have direct links to whānau, hapū, iwi and national Māori organisations who will be critical to the success of Māori engagement and collaboration in the Challenge.
- *Science communication*—the Parties, and a number of their collaborators, employ teams of specialist communication personnel that have expertise in covering different media types (publications, film, web etc.), journalism and education. We expect that our communication capability will need to evolve throughout the life of the Challenge to keep pace with innovative new ways of engaging with society.
- *End-user engagement*—networks, interactions and active collaborative research already exists with key industry sectors (e.g., fisheries, aquaculture, petroleum and minerals, and seafood), and with all central and local government regulatory and management agencies.

- Legislative and management frameworks—expertise and experience in research relating to marine law, policy and management exists within the parties however we need to engage with these staff and staff from other organisations to strengthen this area of expertise in the Challenge. Specific activities are being developed to engage people with this expertise in the Challenge.
- Complex science management—considerable experience in managing and participating in complex science programmes, including very successful OBIs, and large international science programmes (e.g., SOLAS, IMBER, LOICZ).
- Outreach and engagement—while the parties have expertise in societal engagement and social science, the Challenge will need to further develop and find capability to advance areas such as community translation of science, especially in quantifying and communicating risk and uncertainty. This is an area of cross-Challenge learning.

Bio-physical research capability:

- Marine science—ecology, genetics, marine geology, chemistry, physical and biological oceanography, taxonomy.
- Data management—federated data systems, data quality assurance, data standards.
- Monitoring—field-based, moorings, and remote sensing.
- Marine Resources—fisheries, aquaculture, biotechnology, petroleum and minerals, seafood production value chains.

Where similar capability exists across provider organisations we will draw on the expertise of all Parties, and seek to use cross-organisational learnings.

Skills development

Building science capability and skills within communities, Māori, central and local government, industry and research providers in EBM approaches to marine resource management will be an important outcome of the Challenge. This will be achieved through joint research projects, alignment of university graduate training with Challenge activities and projects, and support for students. The development of participatory EBM approaches in *Our Seas* will result in co-learning for all parties involved and will be implemented throughout the Challenge.

While the Challenge will aim to use and support existing expertise, there are some areas of science where New Zealand capacity is small and will need to be developed. The primary area of specific skill development and initiatives will be in social science including policy and governance and economics with a focus on marine systems. The engagement of researchers with these skills with the Challenge has been limited to a small number of researchers to date. A workshop is planned for October 8th 2015 that will showcase the Challenge to this community with the aim of generating interest in the research being undertaken in the Challenge and identifying researchers who are interested in participating. The workshop will also be used to identify areas of research that could be included in the RfP for the Innovation Research Fund and to facilitate involvement of this community in the Challenge.

Infrastructure

The Challenge will not directly invest in infrastructure. Through the partner institutions and international collaborations, researchers will have ready access to all the infrastructure, facilities, laboratories, equipment and data required to support the planned research activities. Within New

Zealand, research providers and stakeholders have a broad range of relevant infrastructure to support the research and activities of the Challenge ranging from laboratory facilities to field equipment, research vessels and marine research field stations. Examples of key specialist facilities include:

- Field stations and seawater systems (Bream Bay Research Facility, NIWA; Leigh Marine Laboratory, University of Auckland; Tauranga Marine Research Facility, University of Waikato; Victoria University of Wellington Coastal Ecology Laboratory; Cawthron Aquaculture Park; University of Canterbury's Kaikoura Field Station; Portobello, Stewart Island and Doubtful Sound field stations, University of Otago).
- Chemistry/isotope/nutrient laboratories and equipment (GNS Science, NIWA, Cawthron, universities).
- Oceanographic surveying/sampling equipment (universities, NIWA, GNS Science, Cawthron).
- Oceanographic research vessels (Polaris II, University of Otago; RV Tangaroa, RV Kaharoa, NIWA) and coastal and small research vessels (NIWA, Cawthron, universities).
- High performance computing (University of Canterbury, NIWA).
- Kaupapa Māori research capability and mātauranga Māori (Te Kotahi Research Institute, Waikato-Tainui Research and Development College; Te Kūwaha - Māori Environmental Research Centre, NIWA; Landcare Research, Nga Pae O Te Māramatanga).

The partners also host, maintain and develop a wide range of databases specific to the marine estate (e.g., Cawthron's national micro-algae culture collection, and CADDIS data system; GNS Science marine geological records and chemical data; and NIWA's marine biological, physical and geological databases, including bathymetry, biodiversity, sediments, ocean chemistry, nutrients, productivity, and monitoring networks, including satellite data collection and the Marine Invertebrate Collection).

5.4 Links with Māori and stakeholders

The Challenge has been developed with input from Māori and stakeholders. However, with regard to Māori, it is important to outline and recognise that there are different aspects of who Māori are in the context of involvement and input in this Challenge. These have been identified below as:

- Māori as tangata whenua and kaitiaki.
- Māori as Treaty Partners.
- Māori as Stakeholders.
- Māori as a group within society and communities.

Māori as tangata whenua (iwi, hapū, whanau) have a living relationship with the marine environment that is founded in whakapapa and occupancy. The application of their mātauranga informs their practices (tikanga and kawa) to be guardians of the cultural, environmental, social and economic wellbeing of the people, the essence of the role of tangata whenua as kaitiaki.

The nature of this relationship with the marine environment, and their occupancy therein, is also the basis of iwi rights and interests. The rights and interests of Māori are recognised through the Treaty of Waitangi/Te Tiriti o Waitangi where the spirit of partnership between Māori and the Crown is expressed. This principle of partnership, and awareness of the assertion by Māori as Treaty Partners,

will be recognised and acknowledged when and where appropriate. However primarily any redress and settlement of iwi rights and interests will be with the Crown. This will not be an outcome of the Challenge.

It is imperative to note that Māori also have commercial interests in the marine environment. This could be Māori business organisations that manage fisheries operations or other forms of commercial operations. It would be appropriate in these situations to identify Māori as stakeholders. Similarly, Māori are represented as a group within society and our individual communities. In this context of Māori, the Challenge has prepared the following mechanisms to ensure the input from Māori and stakeholders are collected and considered. The Kāhui Māori and a Stakeholder Panel have been formed and will meet regularly to ensure on-going engagement and input into the priorities and uptake of the Challenge research. Additionally each programme will establish a Technical Advisory Group (TAG) which will provide stakeholder input at the programme level. In addition to these groups, the Challenge undertakes to liaise and collaborate with central and regional government, Māori, maritime and marine linked industry, marine resource managers, guardian groups, environmental interest groups and the wider community by:

- Regular consultation with the Kāhui Māori, Stakeholder Panel and Technical Advisory Groups.
- Regular consultation, and dissemination of research findings, with central and local governments; the former through liaison with senior key Ministerial advisors (MBIE, MPI, MfE, DoC), and the latter through regional council science liaison structures. Where relevant for the focal region, there will also be liaison with senior District Council advisors.
- Regular consultation with Tangata and Mana Whenua fora, with a whānau, hapū, iwi and Māori entities focus where relevant.
- Incorporating a one day session at the Challenge annual conference focused on Māori and stakeholders input, and ensuring that the conference is open to all interested parties.
- Annual dissemination of research findings and progress to key marine environment and industry stakeholders with follow up presentation and consultation where appropriate or requested.
- Dissemination of findings and progress updates through lay language reports, multi-media, social media and responses to requests from key interest groups. A website and Facebook page will be established and maintained.
- Highlight of the Challenges research in appropriate national and international professional and industry and environmental group meetings and conferences.
- Through partnered and co-invested funding build on the Challenge Objective through demonstrations of best practice initiatives in realising wealth while improving environmental health and performance.

Communication and engagement with Māori, public and sector stakeholders is implicit throughout the Challenge and is a fundamental feature of each programme. In addition an overarching and cross-cutting *Communication and Outreach* element will facilitate information transfer and feedback throughout the Challenge's life. Indeed this is one of the prime outcomes of the Challenge itself, to enhance understanding of the options available to New Zealand to enhance wealth creation from the marine economy while improving our marine ecosystems health and resilience.

5.5 Research prioritisation and quality

Prioritisation

The research priorities outlined in the above Challenge programmes have been established with input from Māori, stakeholders and researchers through a series of workshops and hui, and reflect the key priorities for achieving the Challenge Mission (Appendix A).

Reprioritisation

The ability to reprioritise projects will be critical to the Challenge meeting its Objective as we move down the path of co-development, co-learning and co-production of research. This creates an iterative process that will develop the skills, knowledge and understanding of all the participants in the Challenge and is likely to result in changing priorities over the period of the Challenge. We will respond to the iterative process as new questions and priorities are identified for the Challenge. This reprioritisation will be undertaken by the programme teams and the SLT in consultation with the Kāhui Māori, Stakeholder Panel and the Independent Science Panel, and will result in recommendations to the Governance Board for changes in priorities within the research portfolio of the Challenge.

The SLT will also consider the status of external strategies and Government policies and how they impact the Challenge. Where change is needed, we will balance the gains to be made in continuing work in one area, against redirecting resources into another. The Governance Board will make a decision on any recommendations from the SLT e.g., divert more resources into higher priority or new areas, stop/start a new area etc.). The SLT will be responsible for implementing any reprioritisation. Where decisions affect providers (e.g., their use of Core Funding), the Challenge Director will discuss options with the affected provider parties.

In addition each year, the Director and the SLT will evaluate the performance of each project in the Challenge based on three criteria—the completion of milestones, progress toward the outcomes, and proposed plan of action for the year to come. The SLT will also discuss with the project team any suggestions for refocussing research priorities. Based on this review the SLT will recommend to the Board if there needs to be any redirection, reduction, or withdrawal of funds to the project.

Science Quality

The Independent Science Panel will help ensure that the science is innovative and meets international best practice. Reviews will occur annually, and will be one of two types. First, independent science reviews (e.g., utilising expertise external to the Challenge including the Independent Science Panel) will evaluate research quality within the Challenge, and reports will be provided to the Governance Board. Second, independent reports by the Kāhui Māori and Stakeholder Panel will be provided annually to the Governance Board to ensure that the Challenge is making progress towards its Objective. The main responsibility to organise and participate in these reviews will be with the Director and SLT, while the Governance Board will provide oversight of the review process, and provide direction on actions to be taken as a result of reviews.

Dynamism

To ensure that the research within the Challenge is regularly refreshed with new approaches and ideas, skills and expertise, the Challenge has allocated approximately \$1.5M per annum to a funding pool to support Innovation Projects. These projects will introduce new approaches, capability, research and/or researchers to the Challenge, and will be funded for a maximum term of two years, and will generally be no more than \$150k per year. Proposals will be sought twice during the funded period of the Challenge through an open call and will be based on issue of a Request for Proposals focussed on the

Challenge priorities. The Director and the SLT will be responsible for setting the Request for Proposals with advice and guidance from the Kāhui Māori and Stakeholder Panel. The Director and the SLT will also develop a proposal template, the assessment criteria, and administer the process. Assessment criteria will include science excellence and ability to achieve, potential for impact and alignment with the Challenge Objective, integration and synergy with other projects in the Challenge, inclusion of Vision Mātauranga, and co funding opportunities. The assessment of proposals will be undertaken by the SLT taking into account external reviews, and advice and guidance from the Kāhui Māori and Stakeholder Panel. Funding recommendations for the projects will be submitted to the Board for approval.

5.6 The evaluation framework and indicators

The participatory emphasis of the Challenge, coupled with its focus the complex interactions involved in increasing utilisation of marine resources while protecting the environment, requires new performance monitoring and evaluation processes. We will implement an impact-capturing framework that is systematic (giving the process rigour) and synthesis-oriented (integrating multiple streams of information). This is a new direction for research evaluation, and operational evaluation frameworks such as this are lacking (Wiek, Talwar, O'Shea & Robinson, 2014). Also, there is little programme theory to guide the evaluation of large research initiatives. We will utilise a framework that builds on the latest evaluation research and is linked with the Key Performance Indicators agreed with MBIE. It is expected that evaluation processes will need to be refined, particularly in Year 1 of the Challenge, as we determine the framework and processes that are most appropriate, and as learnings are shared among the Challenges.

Principles of the framework

The guiding principle is that Challenge success is predicated on the twin pillars of participation and relationships. The MBIE performance framework for National Science Challenges, and the New Zealand science system, is based on a highly simplified, linear research-to-outcome logic model. For the model to work, it requires a complex and effective network of relationships and information flows among multiple stakeholders. Therefore, an effective evaluation framework needs to focus on such relationships and on the behavioural change in actors that is a precursor of wider outcome-oriented change.

Participation by Māori and stakeholders, within reason and according to what is tractable, is another key principle—the Challenge takes the view that much of the information pertinent to evaluation on impact resides in the Māori and stakeholder community. Other principles include the use of a wide body of evidence (information from multiple sources), a system approach (ongoing learning, not single-event evaluations), cost-effectiveness and integration with MBIE Challenge frameworks.

The evaluation framework and indicators

The evaluation framework has four elements—assessment of: 1) the Challenge as an entity, 2) the research as a research endeavour, 3) relationships with all stakeholders and 4) impact. Each element of the framework has associated indicators that allow monitoring on progress in important aspects of the Challenge.

Table 6. Evaluation framework for the Challenge

1. Challenge entity assessment

Desired effects	Category	Example indicators
<p>The Challenge is effectively managed and has appropriate processes in place to manage the initiative.</p> <p><u>Assumption:</u> Internal management and governance processes that are fit-for-purpose and efficient will enhance the likelihood that the Mission will be delivered in a timely, effective manner.</p>	Governance (effectiveness of governance processes)	<ul style="list-style-type: none"> • Cost vs budget of governance activities • Decisions made and implemented
	Operational functions (appropriate financial and project management)	<ul style="list-style-type: none"> • Annual budget met • Delivery of milestones (timeliness) • Efficiency in processes (e.g., time to respond, low administration burden)
	Strategic (effectiveness of strategic planning and prioritisation processes)	<ul style="list-style-type: none"> • Stakeholder involvement in prioritisation • Feedback processes operating • Identification and management of risk

2. The research endeavour

Desired effects	Category	Example indicators
<p>The Challenge has world-leading research that is dynamic and responsive to disciplinary advancements, and produces high-quality knowledge and products.</p> <p><u>Assumption:</u> High-quality science that is delivered in a timely manner is a necessary prerequisite to delivery of fit-for-purpose information to stakeholders, and subsequent uptake and application.</p>	Professional validation (research quality, impact on advancement of science)	<ul style="list-style-type: none"> • International recognition (awards, keynote invitations, editorial boards) • Bibliometric (citation) measures • Independent Science Panel assessments • Peer-review metrics (assessor comments, submission to acceptance timeframe)
	Dynamism and capacity (research is dynamic and delivered by high-quality “best” teams)	<ul style="list-style-type: none"> • Incorporation of new ideas and approaches (portfolio analysis) • Flow of researchers (new staff, experience profile of teams) • Collaborative projects (number, proportion of Challenge) • International collaborations
	Useable products (knowledge is produced and codified in such a way that it is used in science fields and is fit-for purpose for stakeholders)	<ul style="list-style-type: none"> • Produced products, processes, services • Guidelines, manuals, handbooks • innovative technologies • Data and models used by the international science community

3. Relationships - productive interactions

Desired effects	Category	Example indicators
<p>“Exchanges between researchers and stakeholders in which knowledge is produced and valued that is both scientifically robust and socially relevant” (Spaapen & van Drooge, 2011,p. 212)</p> <p><u>Assumption:</u> Productive interactions will lead stakeholders to use or otherwise apply the results of the research.</p>	Direct (person-to-person interactions, which may be mediated by technology).	<ul style="list-style-type: none"> • Membership in advisory/expert panels (type, scale, frequency of meeting) • Presentations (type, audience) • Media releases (media, audience, measures of interest, follow-up requests) • Nature and scale of community involvement in Challenge • Collaborative projects with Māori and stakeholders (number, diversity, scale)

	Indirect (exchanges based on an independent carrier of information, such as texts, models, publications)	<ul style="list-style-type: none"> • Publications (by category, rates per FTE) • Products and services (type, community of interest) • Web information services (pages, views)
	Financial interactions (e.g., co-funding)	<ul style="list-style-type: none"> • Co-funding (origin, amount) • In-kind support (origin, amount)

4. Impact- behavioural and functional change

Desired effects	Category	Example indicators
<p>Persistent change in what the stakeholders are doing and how they are doing it, whereby this change is attributable to the research programme (freely adapted from Gök & Edler, 2012).</p> <p>Assumption: The successful implementation of research to achieve outcomes requires behavioural changes among both researchers and end-users.</p>	Uptake (indications of uptake and assimilation of information)	<ul style="list-style-type: none"> • Novel tools to measure uptake (e.g., contextual response analysis) • Follow-up queries based on information (research results) provided • Joint publications with Māori and stakeholders (number, range of stakeholders) • Changes in language used by stakeholder community (e.g., quotes from research publications, word analyses)
	Capacity and network effects (increased information exchange, joint learning, skill development, stakeholder network development)	<ul style="list-style-type: none"> • Changes in Māori and stakeholder networks (e.g., creating alliances) • Boundary-crossing collaboration • Changes in Māori capability/capacity • Implementation of training programmes • Social network analysis (matrix definition)
	Use/implementation (actual application and use of developed products, processes or services)	<ul style="list-style-type: none"> • Developed products in use • Implemented guidelines/processes • Changed stakeholder processes • New Māori and stakeholder action plans • Changed business models or processes • New institutional frameworks

Key Performance Indicators

MBIE requires a set of Key Performance Indicators (KPIs) that are directly relevant to the Challenge and will be used to evaluate the Challenge on an annual basis. The KPIs required are in 7 categories; category 1 is specific to the Sustainable Seas Challenge, the others are common to all the National Science Challenges. Challenge-specific indicators will answer the question *“To what extent has progress been made towards achievement of the Challenge Objective?”*

These indicators should show progress toward increased utilisation of marine resources within environmental constraints, and the scope is that they should cover all Challenge activities. In essence, the KPIs will cover any elements that must be in place for the Challenge to be a success. It is anticipated that there will be approximately 6 Challenge-specific KPIs that are reported to MBIE (though there will be more under the evaluation framework for internal management purposes).

The Challenge KPIs are currently being developed by the SLT in collaboration with MBIE. The SLT plan to develop these in time for them to be recommended for acceptance to the Governance Board at their December 2015 meeting.

5.7 Risks

We are confident that we can provide the research that will underpin increased utilisation of marine resources, thus meeting the Objective of the Challenge. The teams and organisations associated with this Challenge have extensive experience in working with Māori and stakeholders to deliver research, that will guide marine resource managers, Māori and stakeholders on the uptake of EBM approaches, processes, frameworks and tools to marine resource use, and we are confident we can do this efficiently and effectively.

The management of risk within the Challenge is important and to ensure that risk are identified and mitigations in the place to reduce or remove these risks. A risk register will be kept by the Challenge Manager who will record risks identified by either the SLT, the Board, Kāhui Māori, Stakeholder Panel, Project Leaders or participants in the Challenge. As risks are identified, they will be brought to the attention of the Director and the SLT, who will determine any mitigation actions required. If after the mitigations are in place the risk remains high then the risk will be reported in the monthly report prepared by the Director for the Board.

Risks will be graded as A, B, C, D according to the following matrix: Likelihood Seriousness Low Medium High, Low N D C A Medium D C B High C B A. The ratings for likelihood and seriousness determine a current grading for each risk that in turn provides a measure of the project risk exposure at the time of the evaluation. Once analysed, risks will be evaluated to determine the likelihood of a risk or threat being realised and the seriousness, or impact, should the risk occur. 'Likelihood' is a qualitative measure of probability to express whether the threat will emerge (generally ranked as Low, Medium or High).

Likelihood (L)	Seriousness (S)		
	Low	Medium	High
Low	N	D	C
Medium	D	C	B
High	C	B	A

Generally the impact of a risk will translate into one or any combination of the following consequences:

- Project outcomes are delayed or reduced
- Project output quality is reduced
- Timeframes are extended and deadlines are missed
- Costs are increased or funds are cut.

Table 7. Risk Management Framework

Risk Category & Description	Potential Impact	L & S	Risk Management Strategy
Loss of key personnel	Slower than anticipated progress and failure to achieve objective and proposed outcomes. Loss of Challenge knowledge. Missed deadlines	C	Create robust filing systems and share knowledge, results and information equitably
Lack of social scientists and economists to join project teams	No capacity to meet project outcomes	D	Make connections with the social science, economics and legal sectors of research and establish community of practice
Delays in drafting contracts	Missed deadlines	C	Careful planning in contracting phases. Not bottle-necks and resource appropriately
Non-delivery of contractual outputs	MBIE cuts funding.	C	Regular SLT meetings with stop/go reporting on projects to enable the Challenge to front-foot problems, and change direction if required
Poor or inappropriate engagement with Māori and/or stakeholders	Appropriate people are not engaged in the Challenge	C	Regular hui and communication/outreach to ensure that people who are ready, willing and able are included in the Challenge
Personnel overburdened with work and spread too thin	People burn-out and commitments are not met Represents inefficiency and there is insufficient “buy-in” to projects and to the Challenge	B	Prioritise projects “Best Teams” approach Provide support networks to researchers
Stakeholder fatigue	Frustration with the Challenge. Complaints. Lack of useful information available	D	Communication co-ordinated across programmes
Too many postgraduate students assigned to projects	Projects not up to standard. Projects not completed on time	D	Programme and Project Leaders to report to SLT on student numbers and progress regularly so that work is standardised. Fall-back delegate so that deliverables are achieved
Ineffective communications and outreach	Improper cross-programme communication and insufficient community engagement	D	A dedicated Comms and Outreach manager appointed to the Challenge
Re-inventing the wheel	Overlap of existing research so that the Challenge is not good value for money	B	Use existing research links, information networks and communities of practice to limit vulnerability
Providing unusable information	Māori and stakeholders reduce engagement or withdraw participation	D	Comms and Outreach manager reviews external communication to ensure it is in plain English

5.8 Open data

The Challenge is committed to the principles of open access to publicly funded research data and information. Subject to ethical, privacy or cultural reasons, or issues of commercial sensitivity, publicly funded research data from the Challenge will be made open for public access and re-use. The Challenge will act in accordance with the *New Zealand Government Open Access Licensing framework* (NZGOAL) and the *New Zealand Data and Information Management Principles* (NZDIMP). Projects undertaken in the Challenge that generate data and/or information will be required to give effect to the application of open access principles, standardised data and metadata management, and data federation and interoperability techniques.

5.9 IP management

The management, ownership and commercialisation of Intellectual Property (IP) associated with the Challenge is defined within the Collaboration Agreement between the Parties. These encompass the following principles:

- All background IP belonging to any Party will remain vested in that Party.
- Ownership of Challenge IP will vest in the Party or Parties that creates the IP.
- Where a project involves Māori traditional knowledge, the appropriate Parties will obtain necessary approvals for its use from the relevant whanau, hapū or iwi.
- Protection and commercialisation of any Challenge IP will be the responsibility of the Party owner(s). In addition, if the knowledge contributes to the development of products or information to be utilised for commercial or pecuniary purposes, agreement must first be reached with the relevant iwi, hapū, whānau.
- Owners of Challenge IP, and background IP where appropriate, will provide a non-exclusive royalty free licence to use of the IP for the purposes of meeting the delivery of the Challenge Objective and Mission.
- All Parties will promote the sharing of information generated by the Challenge and participate in joint initiatives to publish, present and disseminate research results.

References

- Alder, J., Cullis-Suzuki, S., Karpouzi, V., Kaschner, K., Mondoux, S., Swartz, W., Trujillo, P., Watson, R., Pauly, D. (2010). *Marine Policy*, 34:468-476.
- Arkema, K., Abramson, S., Dewsbury, B. (2006). Marine ecosystem-based management: from characterisation to implementation. *Frontiers in Ecology and the Environment* (2006); 4(10):525–32.
- Ball, I., and Possingham, H. P. (2000). Marxan (v1.8.2) Marine Reserve Design using Spatially Explicit Annealing. University of Queensland, Brisbane, Australia. 69 pp.
- Ban, N., Mills, M., Tam, J., Hicks, C., Klain, S., Stoeckl, N., Bottrill, M., Levine, J., Pressey, R., Satterfield, T., Chan, K. (2013). A social–ecological approach to conservation planning: embedding social considerations. *Frontiers in Ecology and the Environment* 11 (4): 194–202.
- Barbier, E. B. (2011). The policy challenges for green economy and sustainable economic development. *Natural Resources Forum*, 35: 233–245.
- Barbier, E. B. (2012). Progress and challenges in valuing coastal and marine ecosystem services. *Review of Environmental Economics and Policy*, 6: 1–19.
- Bogstad, B., Hauge, K.H. and Ulltang, O. (1997). MULTSPEC: a multi-species model for fish and marine mammals in the Barents Sea. *J. N. Atl. Fish. Sci.*, 22: 317-341.
- Bohmann, K. et al. (2014). Environmental DNA for wildlife biology and biodiversity monitoring. *Trends Ecol Evol* 29, 358–367.
- Boyd, P. W., Watson, A., Law, C.S., Abraham, E., Trull, T., Murdoch, R., Bakker, D. C. E., Bowie, A. R., Charette, M., Croot, P., Downing, K., Frew, R. et al. (2000) Mesoscale iron fertilisation elevates phytoplankton stocks in the polar Southern Ocean. *Nature*, 407(6805), 695–702.
- Brown, V., Harris, J., Russell, J. (2010). *Tackling Wicked Problems: Through the Transdisciplinary Imagination* (pp. 69–70). Taylor and Francis. Kindle Edition.
- CAE. (2001) *Our Oceans: a journey of understanding*. Comments derived from papers presented at Centre for Advanced Engineering (CAE) conference, Wellington, October 1999. CAE Comments Series. <http://cae.co.nz/>
- Chiswell, S. M., Bostock, H. C., Sutton, P. J., & Williams, M. J. (2015). Physical oceanography of the deep seas around New Zealand: a review. *New Zealand Journal of Marine and Freshwater Research*, (ahead-of-print), 1–32.
- Chiswell, S. M., Stevens, C. L., (2010). Lagrangian and Eulerian estimates of circulation in the lee of Kapiti Island, New Zealand, *Continental Shelf Research*. 30, 515–532.
- Cole, A. O., (2014). He kupu whakataki mō te Atua ki nga tangata ki te whenua tētahi ki tētahi mōte hapū: An Introduction to Ecosystem Services for the hapū of iwi. Research Monograph#4: Integrated Valuation of Coastal-Marine Ecosystem Services, Massey University and Cawthron Institute.
- Costanza, R. (2008). Ecosystem services: Multiple classification systems are needed. *Biological Conservation* 141:350–352.
- Crowder, L., Norse, E. (2008) Essential ecological insights for marine ecosystem-based management and marine spatial planning. *Marine Policy*, 32:772-778.
- Daily, G. C., Soderqvist, T., Aniyar, S., Arrow, K., Dasgupta, P., Ehrlich, P. R., Folke, C., Jansson, A., Jansson, B. O., Kautsky, N., Levin, S., Lubchenco, J., Maler, K. G., Simpson, D., Starrett, D., Tilman, D., Walker, B. (2000). Ecology - The value of nature and the nature of value. *Science*, 289:395-396.

- Dakos, V., Carpenter, S. R., van Nes, E. H., Scheffer, M. (2015). Resilience indicators: Prospects and limitations for early warnings of regime shifts. *Philosophical Transactions of the Royal Society B: Biological Sciences* 370, 1–10.
- Davies, K. K., Fisher, K. T., Dickson, M. E., Thrush, S. F., and Le Heron, R. (2015). Improving ecosystem service frameworks to address wicked problems. *Ecology and Society* 20 (2): 37. <http://dx.doi.org/10.5751/ES-07581-200237>.
- Fairweather, P. G., Lester, R. E. (2010). Predicting future ecological degradation based on modelled thresholds. *Mar. Ecol. Prog. Ser.* 413, 291–304.
- Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., Holling, C. S. (2004). Regime shifts, resilience and biodiversity in ecosystem management. *A. Rev. Ecol. Syst.* 35, 557–581.
- Frank, K.T. (2014). The Atlantis Ecosystem Model in support of ecosystem-based fishery management in the California Current large marine ecosystem. An external independent peer review prepared for the Center for Independent Experts. 39 p. Available at: https://www.st.nmfs.noaa.gov/Assets/Quality-Assurance/documents/peer-review-reports/2014/2014_08_11%20Frank%20NWFSC%20Atlantis%20ecosystem%20model%20review%20report.pdf
- Frew, R. D., Hunter, K.A., and Beyer, R. (1989). Cadmium in the dredge oyster *Ostrea lutaria*—dependence on age, body weight and distribution in internal organs. *Marine Pollution Bulletin* 20: 463–464.
- Frew, R.D., and Hunter, K. A. (1992). Influence of Southern Ocean waters on the cadmium-phosphate properties of the global ocean. *Nature*, 360: 144–146.
- Fulton, E.A. (2010). Approaches to end-to-end ecosystem models. *Journal of Marine Systems* 81: 171–183.
- Fulton, E.A.; Link, J.S.; Kaplan, I.C.; Savina-Rolland, M.; Johnson, P.; et al. (2012). Lessons in modelling and management of marine ecosystems: the Atlantis experience. *Fish and Fisheries* 12: 171–188.
- Fulton, E.A.; Smith, A.D.M.; Johnson, C.R. (2004). Effects of spatial resolution on the performance and interpretation of marine ecosystem models. *Ecological Modelling* 176: 27–42.
- Fulton, E.A.; Smith, A.D.M.; Smith, D.C. (2007). Alternative Management Strategies for Southeast Australian Commonwealth Fisheries: Stage 2: Quantitative Management Strategy Evaluation. Australian Fisheries Management Authority, Fisheries Research and Development Corporation Report. 378 p.
- Ghosh, R., Lokman, P. M., Lamare, M. D., Metcalf, V. J., Burritt, D. J., Davison, W.D., and Hageman K. J. (2013). Changes in physiological responses of an Antarctic fish, the emerald rock cod (*Trematomus bernacchii*), following exposure to polybrominated diphenyl ethers (PBDEs). *Aquatic Toxicology* 128–129, 91–100.
- Gillespie, P. A., Forrest, R. W., Knight, B. R., Cornelisen, C. D., & Young, R. G. (2011). Variation in nutrient loading from the Motueka River into Tasman Bay, New Zealand, 2005–2009: implications for the river plume ecosystem. *N.Z. J. Mar. Fresh. Res.* 45:497–512.
- Gök, A. & Edler, J. (2012). The use of behavioural additionality evaluation in innovation policy making, *Research Evaluation* 21, 306–318. doi:10.1093/reseval/rvs015.
- Gorman, R. M., Bryan, K. R., & Laing, A. K. (2003). Wave hindcast for the New Zealand region: nearshore validation and coastal wave climate. *New Zealand Journal of Marine and Freshwater Research*, 37(3), 567–588.
- Hessner, K., Reichert, K., Borge, J. C. N., Stevens, C. L., & Smith, M. J. (2014). High-resolution X-Band radar measurements of currents, bathymetry and sea state in highly inhomogeneous coastal areas. *Ocean Dynamics*, 64(7), 989–998.
- Holling, C. S., Meffe, G. K. (1996). Command and control and the pathology of natural resource management. *Conservation Biology* 10: 328–37.
- Melbourne-Thomas, J., Wotherspoon, S., Raymond, B., and Constable, A. (2012). Comprehensive evaluation of model uncertainty in qualitative network analyses. *Ecological Monographs*. 82(4). pp 505–519.

- Jack, L., Wing, S. R., and McLeod, R. J. (2009) Prey base shifts in rock lobsters *Jasus edwardsii* in response to habitat conversion in Fiordland marine reserves: implications for effective spatial management. *Marine Ecology Progress Series* 381:213–222.
- Kaplan, I.C.; Levin, P.S.; Burden, M.; Fulton, E.A. (2010). Fishing catch shares in the face of global change: A framework for integrating cumulative impacts and single species management. *Canadian Journal of Fisheries and Aquatic Sciences* 67: 1968–1982.
- Karr, K. A., Fujita, R., Halpern, B. S., Kappel, C. V., Crowder, L., Selkoe, K. A., Alcolado, P. M., Rader, D. (2015). Thresholds in Caribbean coral reefs: Implications for ecosystem-based fishery management. *J. appl. Ecol.* 52, 402–412 (2015)10.1111/1365-2664.12388).
- Katz, H.R., Glasby, G.P. (1979). Mineral resources of the New Zealand offshore region. CCOP- SOPAC South Pacific marine geological notes, Vol 1(9). <http://ict.sopac.org/VirLib/GN0009.pdf>
- Lamarche, G., Lurton, X., Verdier, A. L., & Augustin, J. M. (2011). Quantitative characterisation of seafloor substrate and bedforms using advanced processing of multibeam backscatter—Application to Cook Strait, New Zealand. *Continental Shelf Research*, 31(2), S93–S109.
- Le Heron, R., Lewis, N., Fisher, K., Thrush, S., Lundquist, C., Ellis J. Non-sectarian scenario experiments in socio-ecological knowledge building for multi-use marine environments, *Marine Policy*, submitted.
- MacDiarmid, A. B., Law, C. S., Pinkerton, M., & Zeldis, J. (2013). New Zealand marine ecosystem services. *Ecosystem services in New Zealand—Conditions and trends*, 238–253.
- Middag, R., De Baar, H. J. W., Klunder, M. B., Laan, P. (2013). Fluxes of dissolved aluminum and manganese to the Weddell Sea and indications for manganese co-limitation. *Limnology and Oceanography* 58 (1), 287–300.
- Middag, R., van Hulten, M. M. P., van Aken, H. M., Rijkenberg, M. J. A., Gerringa, L., Laan, P. and de Baar, H. J. W. (in press). Dissolved aluminium in the Ocean Conveyor of the West Atlantic Ocean: effects of the biological cycle, scavenging, sediment resuspension and hydrography. *Marine Chemistry*, doi:10.1016/j.marchem.2015.02.015.
- Millennium Assessment. (2005). *Ecosystem and Human Well-Being: Current State and Trends*. Island Press, Washington DC. <http://www.millenniumassessment.org/documents/document.429.aspx.pdf>.
- Moilanen, A., Kujala, H., and Leathwick, J. R. (2009). The Zonation framework and software for conservation prioritization. In *Spatial Conservation Prioritization: Quantitative Methods and Computational Tools*, pp. 196–210. Ed. by A. Moilanen, K. A. Wilson, and H. P. Possingham. Oxford University Press, Oxford, UK. 320 pp.
- Moore, A. L., Hauser, C. E., McCarthy, M. A., Stralia. (2008). How we value the future affects our desire to learn. *Ecological Applications*, 18:1061–1069.
- Mountjoy, J., Micallef, A., Stevens, C., Stirling, M. (2014). Holocene activity in a non-terrestrially-coupled submarine canyon: Cook Strait, New Zealand, *Deep Sea Research II*. 104: 120–133.
- MPI. (2012). The New Zealand Fishing Industry. 16 October 2012. <http://www.fish.govt.nz/en-nz/Commercial/About+the+Fishing+Industry/default.htm>
- Muhammad, S.A., Frew, R. D., Hayman, A R. (2013). Forensic differentiation of diesel fuels using hydrocarbon isotope fingerprints, *Central European Geology*, 56(1), 19–37, doi: 10.1556/CEuGeol.56.2013.1.3.
- Mullon C, Fréon P, Cury P, Shannon L, Roy C. (2009). A minimal model of the variability of marine ecosystems. *Fish and Fisheries* 10: 115–131. doi: 10.1111/j.1467-2979.2008.00296.x
- NZIER. (2010). The net economic benefit of aquaculture growth in New Zealand: Scenarios to 2025. 44p. <http://www.epa.govt.nz/Publications/Day%2018%20NZIER%20Net%20Economic%20Benefit%20of%20aquaculture%20growth%20in%20NZ%20June%202010.pdf>
- Olsson, P., Folke, C., Hughes, T. P. (2008). Navigating the transition to ecosystem-based management of the Great Barrier Reef, Australia. *Proceedings of the National Academy of Science* (2008); 105: 9489–9494.

- Owen, J. R., Kemp, D. (2013). Social licence and mining: a critical perspective. *Resources Policy* 38(1): 29–35.
- Patterson, M.G., Cole, A.O. (2013). "Total economic value" of New Zealand's land-based ecosystems and their services. In Dymond, JR ed. *Ecosystem services in New Zealand – conditions and trends*. Manaaki Whenua Press, Lincoln, New Zealand (pp.496–510).
- PEPANZ. (2014). Downloaded from <http://www.pepanz.com/news-and-issues/issues/economic-contribution-to-nz/> on 2 April 2014.
- Pike, R. (2012). Social Licence to Operate: The Relevance of Social Licence to Operate for Mining Companies. <https://www.schroders.com/staticfiles/Schroders/Sites/Americas/US%20Institutional%202011/pdfs/Social-Licence-to-Operate.pdf>.
- Planque B, Lindstrom U, Subbey S. (2014). Non-Deterministic Modelling of Food-Web Dynamics. *PLoS ONE* 9(10). DOI: 10.1371/journal.pone.0108243
- Plew, D., Stevens, C. (2013). Numerical modelling of the effect of turbines on currents in a tidal channel – Tory Channel, New Zealand. *Renewable Energy*, 57:269–282.
- Possingham, H. P., Ball, I., and Andelman, S. (2000). Mathematical methods for identifying representative networks. In *Quantitative Methods in Conservation Biology*, pp. 291–306. Ed. by S. Ferson, and M. A. Burgman. Springer, New York. 322 pp.
- Quigley, R., Baines, J. (2014). How to improve your social licence to operate: A New Zealand Industry Perspective. MPI Information Paper No: 2014/05. Prepared for Aquaculture Unit, Ministry for Primary Industries, Wellington.
- Rayner, S. (2012). Uncomfortable knowledge: the social construction of ignorance in science and environmental policy discourses. *Economy and Society* 2012; 41 1107–125.
- Royal, Te Ahukaramu Charles. (2010). 'Tangaroa the Sea', in *Te Taiao Māori and the Natural World*, Te Ara – the Encyclopedia of New Zealand.
- Ruckelshaus, M., Doney, S. C., Galindo, H. M., Barry, J. P., Chan, F., Duffy, J. E., English, C. A., Gaines, S. D., Grebmeier, J. M., Hollowed, A. B., Knowlton, N., Polovina, J., Rabalais, N. N., Sydeman, W. J., Talley, L. D. (2013). Securing ocean benefits for society in the face of climate change. *Marine Policy*, 40:154–159.
- Schiel, D. R. (2013). The other 93%: trophic cascades, stressors and managing coastlines in non-marine protected areas. *New Zealand Journal of Marine and Freshwater Research* 47: 374–391.
- Seafood NZ. (2014). http://www.seafoodnewzealand.org.nz/fileadmin/documents/Economic_review/Economic_Review_edition_7_March_2014.pdf
- Shahpoury, P., Hageman, K. J., Matthaei, C. D., and Magbanua F. S. (2013). Chlorinated pesticides in stream sediments from organic, integrated and conventional farms. *Environmental Pollution* 181, 219–225.
- Simon, K. S., Townsend, C. R., Biggs, B. J. F., Bowden, W. B., and Frew, R. D. (2004). Habitat-Specific Nitrogen Dynamics in New Zealand Streams Containing Native or Invasive Fish. *Ecosystems*, 7(8), 777–792.
- Spaapen, J., & van Drooge, L. (2011). Introducing 'productive interactions' in social impact assessment, *Research Evaluation*, 20(3), 211–218. doi: 10.3152/059820211X12941371876742.
- Spangenberg, J. H., Settele, J. (2010). Precisely incorrect? Monetising the value of ecosystem services. *Ecological Complexity*, 7:327–337.
- StatsNZ. (2013). http://www.stats.govt.nz/browse_for_stats/industry_sectors/imports_and_exports/OverseasMerchandiseTrade_HOTDec13.aspx
- Stefansson, G. and Palsson, O.K. (1998). The framework for multi-species modelling of Arcto-boreal systems. *Rev. Fish Biol. Fish.*, 8: 101-104.

- Stevens C. (2014). Residual Flows in Cook Strait, a Large Tidally Dominated Strait. *J. Phys. Oceanogr.*, 44, 1654–1670.
- Stevens, C. L., Smith, M. J., Grant, B., Stewart, C. L., Divett, T. (2012). Tidal Stream Energy Extraction in a Large Deep Strait: the Karori Rip, Cook Strait, *Continental Shelf Research*, 33: 100–109.
- Stevens, C., & O’Callaghan, J. (2015). When the holiday is over: being clever in New Zealand's marine domain. *Journal of the Royal Society of New Zealand*, 45(2), 89–94.
- Tadaki, M., Allen, W., Sinner, J. (2015). Revealing ecological processes or imposing social rationalities? The politics of bounding and measuring ecosystem services. *Ecological Economics* 118: 168–176.
- Tait, L. W., Hawes, I., Schiel, D. R. (2014). Shining Light on Benthic Macroalgae: Mechanisms of Complementarity in Layered Macroalgal Assemblages. *PLoS ONE* 9(12): e114146. doi:10.1371/journal.pone.0114146.
- Tallis, H., and Polasky, S. (2011). Assessing multiple ecosystem services: an integrated tool for the real world. in Kareiva, P., Tallis, H., Ricketts, T. H., Daily, G. C. and Polasky, S. editors. *Natural Capital: Theory and Practice of Mapping Ecosystem Services*. Oxford University Press, Oxford.
- Tallis, H., Levin, P. S., Ruckelshaus, M., Lester, S. E., McLeod, K. L., Fluharty, D. L., Halpern, B. S. (2010). The many faces of ecosystem-based management: Making the process work today in real places. *Marine Policy*; 34: 340–348.
- TEEB. (2012). Why value the oceans: a discussion paper. Discussion paper prepared by UNEP/GRID-Arendal in collaboration with Duke University's Nicholas Institute for Environmental Policy Solutions, 33p.
- Thrush, S. F., Hewitt, J. E., Lohrer, A. M. (2012). Interaction networks in coastal soft-sediments highlight the potential for change in ecological resilience. *Ecol. Apps* 22, 1213–1223.
- Thrush, S. F., Hewitt, J. E., Dayton, P. K., Coco, G., Lohrer, A. M., Norkko, A., Norkko, J., Chiantore, M. (2009). Forecasting the limits of resilience: integrating empirical research with theory. *Proceedings of the Royal Society B-Biological Sciences* 276, 3209–3217.
- Thrush, S. F., Hewitt, J. E., Parkes, S., Lohrer, A. M., Pilditch, C., Woodin, S. A., Wethey, D. S., Chiantore, M., Asnaghi, V., De Juan, S., Kraan, C., Rodil, I., Savage, C., Van Colen, C. (2014). Experimenting with ecosystem interaction networks in search of threshold potentials in real-world marine ecosystems. *Ecology* 95, 1451–1457.
- Tinoco, R. O., Goldstein, E. B., Coco, G. (2015). A data-driven approach to develop physically sound predictors: Application to depth-averaged velocities on flows through submerged arrays of rigid cylinders. *Water Resources Research* 51, 1247–1263.
- Townsend, M., Thrush, S.F., Carbines, M. (2011). Simplifying the complex: an ‘Ecosystem Principles Approach’ to goods and services management in marine coastal ecosystems. *Marine Ecology-Progress series*, 434, 291–301.
- Townsend, M., Thrush, S.F.; Lohrer, D., Hewitt, J.E., Lundquist, C., Felsing, M., Carbines, M. (2014). Overcoming the challenges of data scarcity in mapping marine ecosystem service potential ecosystem services. *Ecosystem Services* 8: 44–55.
- Walley, P. (2000). Towards a unified theory of imprecise probability. *International Journal of Approximate Reasoning*. 24. pp 125–148
- Weerman, E. J., Van Belzen, J., Rietkerk, M., Temmerman, S., Kéfi, S., Herman, P. M. J., de Koppel, J. V. (2012). Changes in diatom patch-size distribution and degradation in a spatially self-organized intertidal mudflat ecosystem. *Ecology* 93, 608–618; published online Epub2012/03/01 (10.1890/11-0625.1).
- Wiek, A., Talwar, S., O’Shea, M., and Robinson, J. (2014). Toward a methodological scheme for capturing societal effects of participatory sustainability research, *Research Evaluation* 23, 117–132. doi:10.1093/reseval/rvt031.
- Wing, S. R., and Jack L. (2014). Fiordland: the ecological basis for ecosystem management. *New Zealand Journal of Marine and Freshwater Research* 48(4):577–593 (invited).

- Wing, S. R., Jack, L., Shatova, O., Leichter, J.J., Barr, D., Frew, R. D., and Gault-Ringold M. (2014). Seabirds and marine mammals redistribute bioavailable iron in the Southern Ocean. *Marine Ecology Progress Series* 510:1–13 (Feature Article).
- Worm, B., Hilborn, R., Baum, J.K., Branch, T.A., Collie, J.S., Costello, C., Fogarty, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jensen, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A.A., Watson, R., Zeller, D. (2009). Rebuilding global fisheries. *Science*, 325:578-585.
- WOS. (2015). World Ocean Summit Briefing Paper “The Blue Economy: growth, opportunity and a sustainable ocean economy” Gordon & Betty Moore Foundation. The Economist Intelligence Unit Limited (2015). 20pp.
- Zeldis, J. R., Hadfield, M. G., & Booker, D. J. (2013). Influence of climate on Pelorus Sound mussel aquaculture yields: predictive models and underlying mechanisms. *Aqua. Env. Int.* 4:1-15.

Appendix A: Development of the Research and Business Plan

The inter-dependent nature of the key steps in development of the Challenge Research Plan (i.e., agreement on the Focal Area, identifying the Research needed to develop and test EBM in that area, and the Business plan based on the research plan) has necessitated sequential development of each component. This has been achieved via a series of targeted collaborative workshops summarised in this section, the nature of which will continue to evolve throughout the life of the Challenge.

The co-development process to date has included:

Pre proposal stage

- A MBIE-convened workshop on 18 June 2013 with relevant sectors to identify the key societal issues associated with New Zealand marine management that could be addressed by the Challenge. A science-led Facilitation Group was subsequently established to advance development of the Challenge proposal. This group consisted of Prof Chris Battershill (University of Waikato), Dr Chris Cornelison (Cawthron Institute), Dr Ian Graham (GNS Science), Dr Barbara Hayden (NIWA), Dr Anne-Marie Jackson (University of Otago), Danette Olsen (Plant & Food), Dr Rob Murdoch (NIWA, Chair), Dr Shaun Ogilvie (Eco Research Associates), Prof David Schiel (University of Canterbury), Assoc Prof Jeff Shima (Victoria University of Wellington), Prof Simon Thrush (University of Auckland), Dr Susan Waugh (Te Papa), and Prof Stephen Wing (University of Otago).
- Two workshops (October and December 2013) at which the Facilitation Group agreed on the need for development of an EBM approach to the governance and management of New Zealand's marine estate in order to meet the Challenge Objective.
- A January 2014 hui with Māori strategists and Facilitation Group members was held to discuss the potential focus of Sustainable Seas. This meeting covered both the cultural and economic interests of Māori, and mechanisms for future engagement and collaboration with Māori in the Challenge.
- A workshop in March 2014, attended by over 40 participants with science/strategic insight from a range of relevant organisations and sectors, along with the Facilitation Group, was used to establish priority science questions that would need to be addressed to develop an EBM framework for management of New Zealand's marine environment. Eight components of a potential EBM framework were work-shopped and informed development by the Facilitation Group of the Challenge programme structure.

CPA1 phase

- The Sustainable Seas proposal was submitted in April 2014 and its success announced in August 2014. The First Challenge Performance Agreement (CPA1) was subsequently negotiated with MBIE with the end-date extended by Contract Variation to 30 September 2015. Progress to date on the CPA1 deliverables are:
 - CPA1 deliverable 1: *Confirm the case study area(s)*. Achieved. A stakeholder/science workshop was held in November 2014 and a focal study area selected. The workshop process and outcome has been ratified by the Sustainable Seas Board.
 - CPA1 deliverable 2: *Appointment of governance group members*. Achieved. Chair: Dr Rob Fenwick; Deputy Chair: Roger France; Board members: Dr Bruce Mapstone (ex Chief CSIRO Marine and Atmospheric Research, Australia); James Palmer (Deputy Secretary Strategy MfE),

John Morgan (CEO NIWA, providing link to host Board), Rebecca Mills (Founding curator World Economic Forum NZ Hub; founding strategist & advisor to B Team), Sir Mark Solomon (Kaiwhakahaere Te Rūnanga o Ngāi Tahu); Shelley Campbell (Chief Executive Sir Peter Blake Trust); Rob Jager (Chairman Shell Companies in New Zealand & General Manager Shell Todd Oil Services); Volker Kuntzsch (CEO/Managing Director Sanford Ltd). The Sustainable Seas Board held its first meeting in May 2015.

- CPA1 deliverable 3: *Completion of the Collaboration Agreement signed by all Challenge Members*. Partially achieved. A final draft of the Collaboration Agreement between the Sustainable Seas parties has been completed, and feedback from the majority of the parties received. A copy has also been forwarded to MBIE.
- CPA1 deliverable 4: *Development of a research plan*. Achieved as outlined in this document.
- CPA1 deliverable 5: *Development of a business plan*. Achieved as outlined in this document.
- A science workshop attended by the Facilitation Team and other members of the science community was held on 24 March 2015 to communicate the results of the Focal Region workshop, discuss and confirm the programme structure and the themes under each of the proposed programmes, and confirm the structure of the Kaupapa Māori programme and the Vision Mātauranga (VM) components of the Challenge. It was agreed that VM would be incorporated into all of the Challenge programmes.
- During March, project concept ideas were requested from the wider science community in the Challenge partner institutions and 89 proposals received. These were assessed by the Facilitation Team using several criteria including Contribution to Mission, Science Excellence, Quality of 'best team', Collaboration, Links to national and international EBM initiatives, Capability Development, and Vision Mātauranga.
- Early in April and June 2015, the extended facilitation team held 3 days of workshops to finalise the themes in each programme. All of the project concepts were retained to inform further project development and to assist in identification of 'best teams'. Small writing teams were assembled to further develop the priority projects within each programme.
- In May, Dr Julie Hall was appointed as Director of the Challenge, taking over from Interim Director Dr Barbara Hayden.
- On 12 June 2015, a 'Māori engagement with the Mining Industry' workshop was convened by the UoA Law faculty and attended by a member of the Sustainable Seas Facilitation Group. Contacts made with international researchers and presentations were of direct relevance to *Our Seas*.
- The Challenge held a Māori workshop on June 25th 2015, to examine foundational thinking of the Challenge research bid by the interim Māori Science Leadership Group. The interim group includes Dr Shaun Ogilvie, Dr Sarah-Jane Tiakiwai, Associate Professor Leonie Pihama, Dr Anne-Marie Jackson, and Kelly May. The invitees list was based on Māori representatives who attended the November 2014 Challenge focus area stakeholder workshop, and a range of senior Māori leaders with diverse strategic interests, experience and expertise. The participants convened to discuss and collectively strengthen Māori perspectives on Challenge governance, research needs, knowledge, communication, and the embedding of Vision Mātauranga within the Challenge. Those who attended were supportive of the kaupapa that was set out in the draft. However, they requested explicit discussion of Challenge governance and Māori guidance and input mechanisms, refinement of the programme name, research themes and to also include a *Vision Mātauranga* and *Tangaroa*

programme Request for Proposal process. Aspects of this feedback were negotiated within the Challenge, and updated to present to the Māori and stakeholder workshop, held on 30th June 2015. Feedback from both workshops were consolidated to develop *Vision Mātauranga* and *Tangaroa*. Future engagement and research implementation with Māori society research partners (whānau, hapū, iwi, and Māori entities) will conform to Māori ethical guidelines recognising the principles, tikanga, and the rights, roles and responsibilities of Māori. As a result of this workshop the decision was made to have a Leader *Vision Mātauranga* in addition to the *Tangaroa* Programme Leader within the SLT of the Challenge.

- A day-long Māori and stakeholder workshop was held on 30 June 2015, where the Facilitation Group outlined the proposed Research Plan to stakeholders and sought their input via a series of small group discussions on (i) key issues of relevance to their sector, (ii) activities and projects they may be doing or planning related to the Challenge Mission, and (iii) potential co-funding opportunities. The Facilitation Group met the following day to synthesise the outcomes from the workshop and incorporate the learnings into the Research plan where appropriate.
- A 2-day workshop to address some of the socio-economic science required to advance ecosystem-based management approaches involving international members of The Economics of Ecosystems and Biodiversity (TEEB) initiative and national expertise including members of the Sustainable Seas interim Science Leadership Team was held immediately after the NZ Marine Sciences Conference (Auckland, July 2015). A special session on the Sustainable Seas Challenge was also included in the NZMSS conference.
- The Programme Leaders and Challenge Manager roles were advertised, preferred candidates selected and Board approved these appointments in July.
- The Independent Science Advisory Panel membership was approved by the Board in July.
- A draft Research Plan was prepared by the Facilitation Group and was made available for comment on 20 July 2015.
- A further Māori and stakeholder workshop was held on 29 July 2015 to seek input into the draft Research Plan via a series of small group discussions focussed on each programme in the plan.
- The input from the written comments and the Māori and stakeholder workshop were considered by the Science Leadership Team during a two day meeting July 30 and 31st.
- The Research and Business Plan was circulated to the Board and independent Science Panel on 28 August 2015 for consideration prior to the Board Meeting on 16 September 2015.