National SCIENCE Challenges

SUSTAINABLE SEAS

Ko ngā moana whakauka

Strategy for Phase II (2019–2024)

Contents

Figures

Cover image: Tonga Bay, Abel Tasman National Park
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Glossary

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 — is one that works innovatively with marine resources to add value, improve livelihoods and enhance ecosystem health.

Challenge- The Sustainable Seas National Science Challenge.

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

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

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

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

Ecosystem — a dynamic complex of biotic factors (plants, animals – including humans – and micro-organisms) and abiotic factors (their non-living environment) interacting as a functional unit.

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 active relationships for the purpose of applying a collective vision and building trust in a community.

He Kai Kei Aku Ringa — the Crown-Māori Economic Growth Partnership strategy. He Kai Kei Aku Ringa seeks a new approach to economic growth and development specifically tailored to Māori, an approach that enables and supports Māori to participate as equal partners in New Zealand's economic development.

Hysteresis - the phenomenon in which the value of a physical property lags behind changes in the effect causing it.

Interdisciplinary — across different fields of research, for example bringing together biophysical science, social science and law.

Kaitiaki/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 express Māori aspirations, values and perspectives.

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

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

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

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.

Multidisciplinary — across disciplines within a field of science, for example bringing biology, chemistry and physics together

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.

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

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

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

Stressors — environmental changes that affect particular organisms, habitats, or ecosystems, including human social-ecological systems]. This includes

changes in natural conditions (e.g. temperature) as well as human activities (e.g. dredging). 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).

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

Te Tau Ihu – a region of New Zealand encompassing the top of the South Island.

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

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

Tohunga – skilled or expert person.

Values — the aspirations that humans hold for ecosystems, here divided into: *economic values*, which relate to direct use for economic benefit; *cultural, spiritual and social values*, which express beliefs pertaining to desirable states and/or modes of conduct that transcend specific situations and 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. Values can change over time, often in response to restoration or degradation of ecological systems.

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.

EXECUTIVE SUMMARY

The Sustainable Seas National Science Challenge is now four years into Phase I of a 10-year research programme. The Challenge has been tasked with:

- enhancing the utilisation of our marine resources within environmental and biological constraints; and
- improving decision-making and the health of our seas through ecosystem-based management (EBM).

In Phase I of its research, Sustainable Seas has:

- developed state-of-the-art knowledge about New Zealand's coastal and oceanic ecosystems. For example, our research has advanced scientific knowledge on how to manage the cumulative effects of many different stressors on marine environments.
- produced new management tools for marine decision makers. For example, empirical research on tipping points in ecological function in response to sediment and nutrient loading and compared responses to current management limits;
- built strong collaborations and worked closely with Māori and with stakeholders in the case study region (Te Tau Ihu) and beyond to advance EBM thinking;
- demonstrated its commitments to the Treaty of Waitangi partnership and Vision Mātauranga; and
- generated a strong international reputation for its research.

This document presents the high-level strategy for Phase II of the research programme. It has been developed in close consultation with Māori, stakeholders, the Challenge International Science Panel, and Board, and the New Zealand marine science community. Phase II will:

- extend the research emphasis established in Phase I and develop new projects to address priority issues;
- integrate research into four cross-cutting themes: ***Understanding degradation and recovery in social-ecological systems***; ***Creating value from a blue economy***; ***Addressing risk and uncertainty***; and ***Enhancing EBM practices***.
- maintain the **Tangaroa** Programme to provide for Māori-identified priorities and aspirations to be achieved through a specifically Māori research approach;
- direct a new emphasis to stimulate a blue economy and to trialling EBM approaches with Māori and stakeholders;
- emphasise interdisciplinary and transdisciplinary research that involves the co-design and co-production of research with Māori and stakeholders;
- engage closely across Challenges and internationally to build long-term capability for future Sustainable Seas research; and
- strengthen engagement with Māori and stakeholders.

Sustainable Seas will measure its success by:

- Sustainable Seas research being incorporated into policy frameworks to support EBM;
- Tools and knowledge developed being used in decision-making for the marine environment;

- Proof of concept for an EBM approach to marine management has been successfully demonstrated;
- A vibrant blue economy is developing regionally and nationally, enabled by Sustainable Seas research;
- Māori knowledge, rights, interests and values underpin our outputs; and
- Science from the Challenge has been published high-quality international journals;

Implementation of the research is critical to developing EBM as an approach for marine management in New Zealand. We will achieve this by:

- co-developing proposals with Māori and stakeholders;
- involving Māori and stakeholders, particularly environmental managers, directly in research projects;
- identifying timing of engagement to maximise uptake of research outcomes;
- applying Vision Mātauranga to all themes;
- implementing multiple case studies of EBM approaches to decision-making; and
- ensuring that data collected are widely and freely available.

FUTURE STRATEGY

1. Long-term view

The Challenge's OBJECTIVE is

'to enhance utilisation of our marine resources within environmental and biological constraints'

Our VISION is

'New Zealand has healthy marine ecosystems providing value for every New Zealander'

To achieve this vision, we will see a *'transformation of Aotearoa New Zealand's ability to enhance our marine economy, and to improve decision-making and the health of our seas through ecosystem-based management'*.

Sustainable Seas Challenge sees success as:

- *Sustainable Seas research being incorporated into policy frameworks to support EBM.*
- *Tools and knowledge developed being used in decision-making for the marine environment.*
- *Proof of concept for an EBM approach to marine management has been successfully demonstrated.*
- *A vibrant blue economy is developing regionally and nationally, enabled by Sustainable Seas research.*
- *Māori knowledge, rights, interests and values underpin our outputs.*
- *Science from the Challenge has been published in high-quality international journals.*

The marine environment is important to all New Zealanders, all of whom have their measures of success. In a recent set of workshops long-term success measures for our marine environment were identified by a wide range of Māori and stakeholders. The stakeholders for Sustainable Seas are very varied and include regional and central government agencies, marine industries (oil and gas, fishing, aquaculture, tourism, mining), NGOs and community groups, including youth.

Figure 1: What success looks like as identified by different stakeholder sectors.

2. Introduction and Background

2.1 Our Mission, our Vision, our Challenge

Aotearoa New Zealand has rich and diverse marine environments that allow New Zealanders to derive wide-ranging cultural, social and economic values. Its coasts and oceans number among its greatest cultural, natural, and economic assets. Managing these environments, the resources they offer, and the ways we use them is a major challenge. Sustainable Seas addresses this challenge with a clear vision.

Delivering on this vision requires extensive knowledge of ecological functioning and how it is affected by human activities, the economic potential of marine resources, and the social, cultural and environmental values that must be balanced through effective management and decision-making. Sustainable Seas has been charged with building this knowledge and has been set by the objective.

International science is increasingly pointing to the need to understand the cumulative effects of human action on ecological functioning and the threat of ecological tipping points in dynamic and multi-use marine systems. At a time when human and natural environments are increasingly affected by climate change and when communities everywhere are increasingly concerned with environmental, social and cultural well-being, interdisciplinary research approaches have become essential. The Sustainable Seas National Science Challenge, with its focus on ecosystem-based management, will play a key role in helping define values beyond traditional one-dimensional measures of monetary return.

In Aotearoa New Zealand, the Challenge recognises the context of the Treaty of Waitangi partnership where the rights and perspectives of Māori are central to all questions of healthy and prosperous ecosystems and communities. In addition, local communities increasingly perceive their marine ecosystems to be degraded and demand action to prevent further degradation and to encourage recovery.

At the same time New Zealand is transforming how it defines and understands success, particularly economic success. Many public and private-sector leaders are looking beyond short-term financial targets and reviewing how to safeguard our future prosperity and create sustainable wealth. This is consistent with a mātauranga Māori approach where intergenerational well-being and prosperity is at the heart of decision-making. The Treasury, the Ministry for the Environment and Statistics NZ have been investigating the best way to value our natural capital, and the Government has signalled a ‘wellbeing approach’ to Budget 2019.

2.2 Ecosystem-based management

Drawing on traditional knowledge, international literature and discussions with marine managers, Sustainable Seas determined that the best way to meet its objective and realise its vision is to provide research that will underpin an EBM approach specifically for Aotearoa New Zealand’s unique needs and aspirations (Figure 2). Effectively using an EBM approach will lead to fundamental changes in the way we manage our marine environment.

EBM is a holistic and inclusive approach to managing marine environments and competing uses for them, demands on them and the ways New Zealanders value them. Sustainable Seas will not implement EBM, but will provide underpinning research and tools to support the design and implementation of an EBM approach tailored to Aotearoa New Zealand. Partnering with central and regional government, industry, other stakeholders, and Māori is critical for the implementation of EBM and the success of the Challenge.

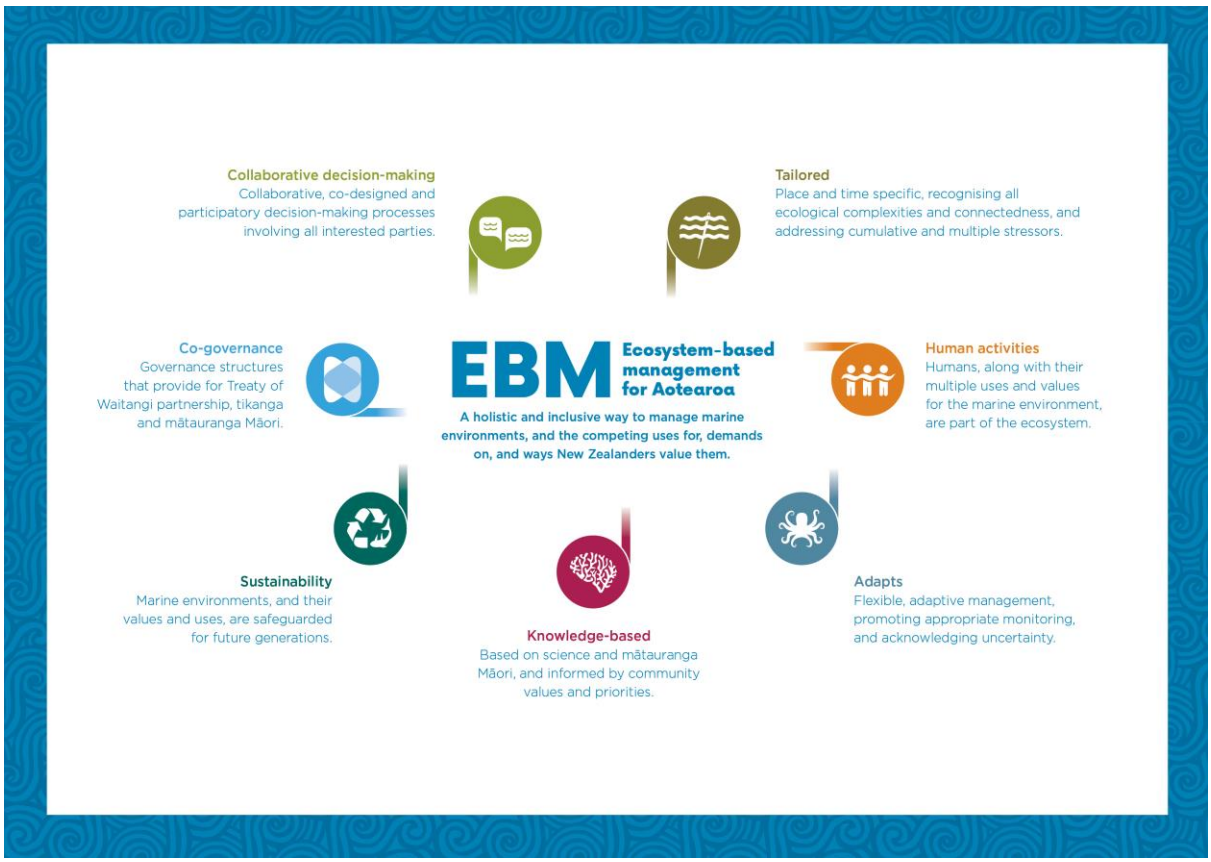

Figure 2: The working definition of ecosystem-based management for an Aotearoa New Zealand context that Sustainable Seas is using. (Note: this will evolve as we co-develop our EBM approach with Māori, and stakeholders.)

Sustainable Seas envisages EBM as a platform for realising its twin objective of healthy functioning ecosystems and a thriving blue economy (Figure 3). The blue economy required to sustain *healthy marine ecosystems that provide value for all New Zealanders* is not a 'business as usual' marine economy. Rather, it builds sustainable economic value through investment and production practices that balance growth with a focus on value-add, the long-term ecological health of marine ecosystems, and local, regional and national sustainable development goals. A blue economy recognises all dimensions and beneficiaries of the marine economy, all values that marine environments currently produce, and the open-ended potential of marine ecosystems to create as yet unrecognised value.

This new vision of marine economy is increasingly expected by ethical investors, global consumers and Aotearoa New Zealand's key global economic and political partners such as the European Union and the World Bank. It also resonates closely with a kaitiakitanga-based approach to EBM and the Māori economy, and with other value-added and sustainable economy initiatives currently taking place. Finally, it resonates with the need to define values beyond traditional one-dimensional measures of monetary return.

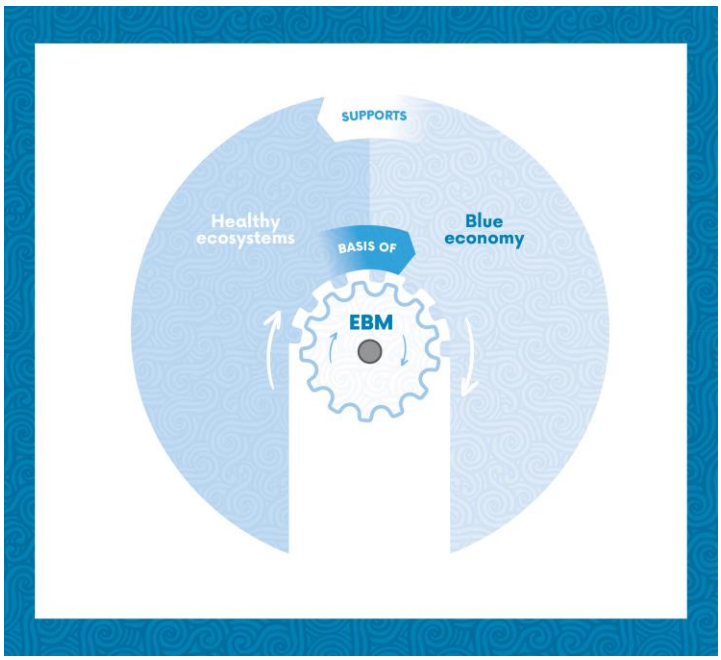

Figure 3: A depiction of the relationship between healthy ecosystems providing the basis for a prosperous blue economy, which in turn supports the maintenance of healthy ecosystems.
Our research provides for EBM to be the critical mechanism for driving this relationship effectively.

2.3 Developing the strategy

Sustainable Seas is now four years into Phase I of a 10-year research programme. To date we have established a strong reputation for collaborative, interdisciplinary research and for engaging openly with Māori and stakeholders. We are recognised as leaders in these areas within the National Science Challenges and are known internationally for leading new directions in interdisciplinary marine research and fostering transdisciplinary approaches that actively involve Māori and stakeholders in co-producing research and knowledge. However, our experience has highlighted opportunities to do even better by more fully integrating research across disciplines and co-designing research with Māori and stakeholders.

We have developed a strategy for Phase II that is consistent with the original research plan for the Challenge and is supported by aligned research that is conducted by the National Institute of Water and Atmosphere (NIWA) our host organisation, and research conducted by the collaborating parties of the Challenge: the Universities of Auckland, Otago, Canterbury, Waikato and Victoria, the Cawthron Institute and GNS Science. They, along with other researchers, provide the skills, knowledge and tools the Challenge relies on to achieve its objective.

The strategy prepared by the Science Leadership Team (SLT) of Sustainable Seas draws together input from a wide range of sources. These include:

- research completed to date;
- Māori and stakeholder input to Phase I research projects;
- specific Phase II planning workshops and meetings held with Māori, key central government ministries (Ministry of Primary Industries (MPI), Ministry for the Environment (MfE), Department of Conservation (DOC), Environmental Protection Agency (EPA), regional councils, marine industries (oil and gas, fishing, aquaculture, tourism, mining), NGOs and community groups, including youth;

- our Board, Kāhui Māori, Stakeholder Panel and the individual programme Technical Advisory Groups (TAGs).

The draft strategy was made available for consultation with, and input from, the above groups, broader research community and our Independent Science Panel (ISP). All the input was considered by the SLT in preparing the final draft of the strategy for approval by the Board.

A number of important research requirements identified during the Māori and stakeholder consultation workshops are not included in this strategy as they are beyond the focused scope of Sustainable Seas. These are: identification and quantification of resources, collection of baseline information, monitoring of our marine environment, and direct interventions intended to restore degraded marine environments. The locating and quantifying economic 'goods' (e.g. fishery stocks, petroleum and mineral resources) is also outside of scope of the Challenge as in Phase I.

2.4 Research programme

To address the Challenge objective and key research priorities identified by Māori, stakeholders and scientists, the strategy is focused around theme-based sets of questions that require both interdisciplinary and transdisciplinary research to answer. These questions are characterised within the following four themes, in partnership with the Tangaroa Programme.

- Understanding degradation and recovery in socio-ecological systems;
- Creating value from a blue economy;
- Addressing risk and uncertainty; and
- Enhancing EBM practices.

The Tangaroa Programme, which provides specifically for Māori priorities and a Māori research approach in Phase I, has been retained in Phase II. This reflects that establishing an EBM framework specific to the needs and aspirations of Aotearoa New Zealand requires explicit recognition of Māori as partners to the Crown, Māori-specific interests and aspirations, and a mātauranga Māori-based approach to EBM. Achieving this requires research anchored in Māori concerns and a Māori worldview. To address these requirements, we will work with iwi, Māori organisations and Māori researchers to identify Māori-focused research questions within the themes, and co-design and develop project structures that provide for a holistic approach, i.e. not compartmentalising mātauranga Māori (Figure 4).

The questions that focus the research are also designed to foster interdisciplinary research, encourage cross-Challenge collaboration and facilitate transdisciplinary research. In addition, we are committed to embedding Vision Mātauranga across all themes. Building on connections made in Phase I and extending our interdisciplinary 'best teams' approach to Māori and stakeholders where appropriate will further enhance integration across the themes and expand implementation pathways.

Phase II will build on the research undertaken in Phase I and develop new projects that address priority issues at local, regional and national scales. The new *Creating value from a blue economy* theme will emphasise transformative economic research, while the *Understanding degradation and recovery* and *Addressing risk and uncertainty* themes will direct an interdisciplinary approach that will build on research conducted under the Our Seas, Valuable Seas, Dynamic Seas, Managed Seas and Tangaroa programmes in Phase 1. The *Enhancing EBM practices* theme will support integrating research from across the challenge and trialling of EBM approaches in partnership with management agencies. Each of the four themes addresses nationally and internationally recognised and prioritised area of research, creating opportunities to support new and ongoing international

collaborations and to showcase Sustainable Seas as cutting-edge science on the global stage. In addition, the provision of an indigenous-led and applied research focus is of considerable interest internationally.

This strategy complements research being conducted in New Zealand and internationally and stretches science significantly in two key directions at the cutting edge of research into the functioning and management of marine ecosystems.

First, it builds on the wealth of biophysical research on New Zealand marine ecosystems by extending knowledge of ecosystem function and connectivity in relation to cumulative effects and tipping points. The biophysical research planned in these fields will continue to lead international science. Second, Sustainable Seas is developing this research in an interdisciplinary/transdisciplinary framework.

Our approach, which is designed to build the new knowledge needed to underpin EBM approaches to the marine environment in New Zealand, is becoming seen as international best practice. The research already underway in this field on participatory practices and valuation frameworks, the EBM principles and methods that we are developing, and the capability we have established in Phase 1, are already regarded as world-leading. The research planned will leverage this reputation to establish stronger linkages with international research groups dealing with similar management problems and aspirations. It will be further boosted by the new themes, which will direct research to the integration of blue economy and risk and uncertainty into decision-making frameworks, efforts that again lie at the edge of socio-environmental research.

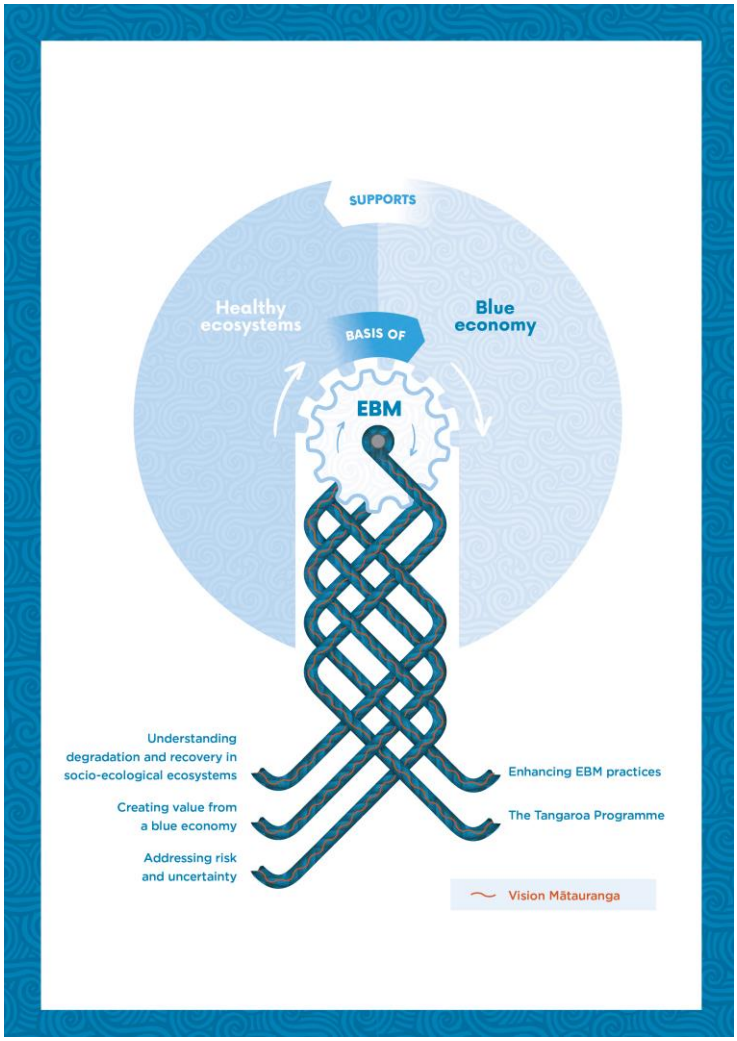

Figure 4: The relationship between the Phase II research themes and ecosystem-based management.

3. Challenge Themes

3.1 Theme 1: Understanding degradation and recovery in social-ecological systems

Marine ecological function underpins ecosystem services and society values (economic and non-monetary) and is influenced by many interacting stressors resulting from environmental, economic and/or social changes that often overlap in space and time. For example, large-scale stressors such as climate change, alterations in land use that increase sediment and nutrient runoff and localised human activities (e.g. aquaculture, dredging) to influence ecological function. Stressor impacts are often cumulative and the complexity of the social-ecological system means the resulting changes in function are often non-linear, rapid and not directly attributable to variations in stressor loading. These rapid, unexpected changes in ecological function and associated values are called 'tipping points' and surprise managers and society. Often, following a tipping point, hysteresis in the socio-ecological system may stall recovery.

The complexity of marine social-ecological systems and the potential for tipping points to occur mean that a key component of an EBM approach to marine management is the ability to assess the cumulative degradation resulting from human activities in marine ecosystems and whether recovery is possible. Cumulative effects of multiple stressors, including climate change and those originating from land, challenge our ability to spatially plan for a suite of activities that will maintain or allow recovery of ecological function in degraded systems, and increase or decrease the risk of environmental, economic, cultural or social collapse. Current practice typically manages for single stressors or single sectors, but interactions among stressors often generate adverse effects at thresholds well below those anticipated. Similarly, impact assessments rarely focus on the prospective combined effects of multiple projects on the environment, or the flow-on from environmental to social effects.

A greater understanding of cumulative effects on marine ecosystems and how they can be managed to recover ecological function and values was consistently highlighted at stakeholder workshops. It was recognised that many stressors originate in the marine area (e.g. ocean acidification, fishing, mining), but stakeholders also emphasised a 'mountains to the deep sea' approach to incorporate the impacts of land-based stressors such as sediment and nutrient inputs from forestry, farming and urban discharges. This point was a feature of our discussions with Māori who manage and maintain rights and interests across landscape boundaries (i.e. farming, forestry and fisheries). Many stakeholders also recognised challenges in linking science and policy and deriving protective guidelines for combined stressors (e.g. sediment and nutrients) within the dynamics of climate change.

Fundamental questions about how closely ecological and social systems are linked, and how cumulative impacts occur and can be mitigated, demand answers. At the core of this interdisciplinary theme are the biophysical science and modelling tools required to understand how ecological function responds to the cumulative effects of multiple stressors. However, we must also understand relationships between ecological functioning and social systems and values. This must include a better consideration of effects relevant to society in a mātauranga and tikanga Māori context, which are not confined by jurisdictional and ecological boundaries; and an improved understanding of indirect effects on marine social-ecological systems from a society and cultural perspective (i.e. to mauri, the survival and transmission of mātauranga Māori, and the role of Māori as kaitiaki). The theme also needs to address the management of trade-offs in making investment decisions in a blue economy and to better support Māori economic development and kaitiakitanga. Finally, the theme needs to understand what institutional, cultural and social elements drive management options and the time taken to implement these, as this will provide crucial information on feedbacks between ecological, social and economic degradation/recovery pathways. Thus, in this

theme biophysical science will integrate with research addressing cumulative effects on ecosystem services, societal and cultural values, and how stressor management can maintain/improve ecological function and values.

This theme will extend the excellent platform of research developed in Phase I. For example, research in Dynamics Seas has indicated most monitoring programs are incapable of detecting the early warning signs of tipping points; research in Phase II will address management policies and practices to improve linkages between detection and response to tipping points. Phase I empirical studies on tipping points examined the dynamics of ecological change in response to sediment and nutrient runoff, research that will evolve in Phase II to consider hysteresis in the recovery of function in response to stressor management. Similarly, research quantifying stressor dispersal (e.g. of land-derived contaminants by currents and through coastal food webs) in Phase II will extend to quantify footprints of stressor response to better document connectivity between activities and impacts. Linking changes in ecological function to ecosystem services and values will extend Phase I research in Valuable Seas and projects in Managed Seas on spatially-explicit decision support tools. Phase I research in Our Seas on social-ecological systems and inter-agency collaborations to address cumulative effects management will provide an implementation pathway to build upon in order to integrate biophysical and social-ecological information into EBM approaches to manage cumulative effects.

Building on a strong foundation, this theme will produce substantial new and novel research on the impact of cumulative effects on socio-ecological systems that is not 'business as usual'. It will require considerable development of social, cultural and ecological theory, and cutting-edge models and tools to assess cumulative effects. For example, physical-ecological research must generate new methods to gain knowledge of habitat connectivity quickly and cost-effectively to quantify footprints of stressor response. Predicting pathways of ecological change requires innovative models that incorporate multiple spatial and temporal scales of degradation and recovery and can determine the degree of change in ecological function. It is essential that we advance our ability to assess whether thresholds or tipping points will occur in the degradation pathway and whether recovery pathways will lag behind the management changes made. New complex-system models will be necessary to link ecological function and society across different knowledge systems to enable the prediction of the effect of location-specific environmental, ecological, societal and cultural characteristics. Research on links between ecosystem functions, services and human values will also be needed.

Theme 1: Question and sub-questions to be addressed in this theme

What knowledge and processes are needed to predict and manage the effects of multiple activities on marine socio-ecological systems and the values they provide Aotearoa New Zealand?

1. *What drives the dynamics of cumulative effects from multiple activities?*
2. *How do environmental, ecological, social, cultural and economic conditions facilitate or inhibit degradation and recovery occurring and at what scales are these important?*
3. *How do we assess impacts, degradation or recovery from cumulative effects on non-monetary values (including mauri, ecosystem services and taonga species)?*
4. *How do we bring together different knowledge systems of mātauranga Māori, local kaitiakitanga experience and science to halt degradation and promote recovery?*
5. *What policy and practice is required to produce timely management that can prevent tipping points and allow recovery?*

3.2 Theme 2: Creating value from a blue economy

The Challenge objective and vision direct it to support a marine economy that will deliver healthy ecosystems and diverse values of New Zealanders. This will require an economy that is not 'business as usual' but rather stewards and creates value from marine resources in novel ways. This theme is committed to seeing the tension at the heart of sustainable economic development as an opportunity rather than a contradiction. Research will explore how to stimulate and grow a blue economy and develop and use an EBM approach to support investment by providing greater clarity and consistency in environmental management.

A successful blue economy requires innovation in investment, production and market-making; commitments to adding value through sustainable production practices; predictable and trusted regulatory environments that address environmental concerns and invite community participation; responsible business practices; and the strong provenance and credence values that come with all of these factors. It will be made up of ethical investments, sustainability-certified harvesting, production and processing, and value-added products that clearly state their provenance.

A blue economy is one that seeks to realise multi-generational economic, social, cultural and ecological sustainability. As such the idea resonates strongly with Māori. Māori have built a strong commercial marine economy based on their tradeable rights in fisheries. In recent years, Māori investment in sustainable use of resources has sought to align traditional Māori values with a focus on the credence and provenance attributes of products. Supporting this investment trajectory is a pivotal component of this theme, as is research to integrate kaitiakitanga perspectives and culturally based non-financial measures of success and well-being into a diverse blue economy.

Fostering a blue economy requires 'transitioning' economic practices into this vision. Māori and stakeholders agree that new emphases on environmentally sustainable practices, value-added products, regulation and regional development are needed to ensure healthy ecosystems, diverse values and future prosperity. This will require deeper knowledge of the extent and diversity of existing blue-economy initiatives, the ecological impacts, possibilities and capacities that will shape future use of our marine resources, and the management and governance techniques that might encourage blue economy growth.

Research under the blue economy theme will build on Phase I research, which identified the diversity of the marine economy and the need for measures of performance beyond economic growth per se. Phase 1 also deepened our understanding of the values that are held of the marine environment and their role in securing individual and community well-being. We developed an initial framework for identifying and integrating financial and non-financial measures of success. A greater range of investment strategies and fit-for-purpose measures of economic performance (including ecosystem services, uncertainty around risks, and projected economic impacts) now needs to be developed at different scales so as to grow a blue economy.

Māori and stakeholders have emphasised the value of ensuring that the diversity of economic enterprise is recognised in management, that EBM recognises the value of investment and the costs of regulation, and that more attention be directed to future possibilities and demonstrating the value of economic innovation consistent with EBM. They have called for further research focused on identifying and measuring the blue economy, and how present and future economic practices might better balance economic, cultural and environmental interests.

Research in this theme will focus on fostering a blue economy – identifying and cultivating blue-economy practices in production; encouraging innovative and value-adding utilisation of marine resources that understands and seeks to mitigate environmental implications; highlighting novel forms of investment and encouraging new opportunities for Māori and small operators to enter the economy; developing inclusive and supportive management and governance that will encourage

investment, incorporate a full range of values and secure the transition to a blue economy; supporting viable development strategies at local, regional and national scales; and building new measures of blue economy success. This research will identify economic opportunities, concerns and risks in EBM.

This approach to economic development is novel in Aotearoa New Zealand and global contexts, but is increasingly expected internationally as necessary for navigating pathways to better local and global futures. This research will be conducted in association with industry to ensure that real-world applications are identified. Research in this theme will also be supported by the Opportunities and Innovation Fund, which will make funding available to support science for innovative blue economy initiatives.

Theme 2: Question and sub-questions to be addressed in this theme

How do we build a successful blue economy that realises multi-generational economic, social, cultural and ecological sustainability and recognises the full range of values the marine environment provides?

1. *What strategies can be developed at different scales to encourage investment in, and promotion of, a blue economy?*
2. *What measures of performance (including non-monetary measures) need to be developed to grow a blue economy at national, regional, and sectoral scales, including supporting consideration of trade-offs and competing uses?*
3. *How can we better utilise science and innovation to develop blue economy initiatives?*
4. *How can we grow a blue economy informed by mātauranga Māori principles, and what are the benefits, costs and opportunities for Māori and Aotearoa New Zealand?*
5. *What management tools and approaches can be developed to foster transitions to support greater sustainable value from a blue economy through EBM, (e.g. waste-processing techniques, improved impact assessment measures, and marine spatial planning)?*

3.3 Theme 3: Addressing risk and uncertainty

The ability to estimate risks associated with actions is necessary for any management regime, whether it be managing the economy, a business or the environment. When managing multiple strands, having robust methods and understanding of both the uncertainties and the effects of those uncertainties increases exponentially in importance. This is particularly true for EBM in the marine environment as uncertainty levels are often very high, mainly due to difficulties in collecting knowledge of what is out there, and in understanding how ecological functioning responds to stressors against a background of environmental variability and climate change.

In addition, indirect and cultural risks are frequently not accounted for within a contemporary science or business framework, but are regularly highlighted in resource-management decision-making. Risks articulated and defined from a mātauranga Māori perspective are extremely difficult to navigate using standard risk management strategies. There are also differences in risk assessment methods used by business, environmental scientists, and fisheries and threatened species scientists, and differences between how institutions and people perceive and respond to social and ecological risks. Environmental decision-makers frequently find themselves caught between these different methods and perceptions.

Interactions with Māori and stakeholder and recent workshops have clearly communicated the need for Sustainable Seas to focus on risk and uncertainty. The need for methods that can predict ecological, social, cultural and economic risks associated with multiple activities accumulating over space and time was emphasised. Uncertainty in the decision-making process has also been suggested as contributing to environmental, social, cultural and business risks. It is also important to understand the differences and similarities in how risks and uncertainties are perceived and responded to by different sectors of society. How businesses perceive economic risk (to investment and capital) may prove to be a deterrent to uptake of blue-economy ideas, but conversely the development of blue economy accounting may provide investment certainty and incentive.

The *Addressing risk and uncertainty* theme opens the possibilities of new interdisciplinary research within a framework of questions and testing co-designed with Māori and management agencies. For ecologists, development of new theories, models and tools must underlie a framework that incorporates assessment of cumulative and indirect effects from multiple stressors within the dynamic context imposed by climate change. These models need to upgrade our capacity to integrate the spatial footprint of the response rather than the stressor or the activity generating the stressor. They also need to address risks to multiple ecosystem components, ecosystem services or values rather than single-species responses. Tools that can communicate the degree of uncertainty associated with specific aspects of the risk predictions are needed.

Research is needed on how best to consider and communicate these risks, and develop a general capacity to understand problems posed by uncertainties at different points in the risk assessment process. Developing new social-ecological models will allow integration of ecological, social (including institutional), cultural and economic risks of decision-making, based on information on the different perceptions of risk and uncertainty held by iwi, hapū, business, investors, policy-makers, environmental managers, and local communities and whānau.

This theme will produce risk assessment methods based on knowledge produced from other themes on how social-ecological systems respond to different combinations of stressors and how blue economy enterprises consider uncertainty and assess and respond to risk. The ability of business to collect data or contribute to research that decreases uncertainty around prediction of risks to socio-ecological systems is also important. The risk assessment models produced and the understanding of differences in how risks and uncertainties are perceived will inform development of EBM policies and practices at different scales, and will be particularly important in defining when and where the precautionary principle should be invoked.

This theme is an extension for Sustainable Seas as Phase I research on risk and uncertainty that was limited to: a review of methods to progress management when presented with the ‘deep uncertainty’ associated with extreme data limitations; and social-ecological research focused on gathering information on societal perceptions of risk in the marine environment. The theme will use information on uncertainty from models built in Managed Seas and risk factors associated with tipping points that were beginning to be collated under the Tipping Points project in Dynamic Seas. It will also build on an improved understanding of kaitiakitanga in a marine context established in Phase I of the Tangaroa programme, and research to understand the application of mātauranga Māori in decision-making.

Theme 3: Question and sub-questions to be addressed in this theme

How should we better estimate and communicate the risks and uncertainties associated with climate change, environmental variability and human actions on ecological health, social and cultural values and the blue economy?

1. *How can we best consider risks associated with multiple stressors into assessments of ecological health?*
2. *How can we integrate mātauranga Māori into our understanding and assessment of risk and uncertainty?*
3. *How do we develop tools that allow for different perceptions of risk and the consequences of uncertainty for ecological health, social and cultural values and business?*
4. *What ecological, social and cultural risks affect new investment practices and contribute to business risks?*
5. *How does uncertainty in decision-making processes contribute to environmental, social, cultural, institutional and business risks?*

3.4 Theme 4: Enhancing EBM Practices

Achieving an EBM approach to management of our marine environment will require institutional and regulatory arrangements tailored specifically to the Aotearoa New Zealand context. It will also require a widespread understanding of what EBM involves, and adoption of EBM-supportive practices. Ultimately our research findings will need to be taken up and actioned by Māori and by stakeholders such as central and regional government, marine industries and communities (see Outcomes Diagram Appendix 1).

This theme involves two sets of related activities that change in emphasis over the five years of Phase II. Initially (first two years) there will be a stronger focus on identifying the governance and practices that will be needed to support a widespread development of EBM. This will be followed by a stronger focus on integrating the research from the other themes and on enabling the implementation of EBM, particularly in pilot projects with Māori and stakeholders.

Governance and practices for EBM

The focus will be on institutional arrangements and practices to support EBM at multiple scales, from local to national. This includes: finding ways to ask appropriate science questions and incorporate scientific knowledge and mātauranga Māori, values and worldviews, rights and responsibilities into policy and management; and finding potential mechanisms for transition from existing management arrangements to those necessary for successful EBM. Efforts will align with parallel policy programmes proposed by central government, including MPI's future implementation of ecosystem-based management of fisheries through its Fisheries Change Programme and the emerging Marine Futures initiative led by MfE, in collaboration with "marine hub" which includes DOC and MPI.

The implementation of an EBM approach will look different depending on context. Some aspects of EBM may need to be generic at larger scales (e.g. underpinning legislation, national priorities etc), though issues arising at more local and regional scale will require some tailoring of approach. Achieving effective EBM therefore requires understanding the spatial and temporal scales at which resource use occurs; the relationship of local people to their environment; how social networks form; the way ecological systems function and how key species interact with habitats; and

management initiatives. It also requires developing approaches to integrate these different scales and interactions.

Phase I investigated how well Aotearoa New Zealand's current governance and policy frameworks are aligned with EBM. Phase II will focus on identifying new forms of governance and practice needed for EBM to become more effectively embedded into our marine management. This will include a focus on how mātauranga Māori and science can both inform decision-making and management, and how defined and non-defined Treaty of Waitangi rights and responsibilities can be incorporated. This work-stream will be informed by research generated in the *Addressing risk and uncertainty* and *Understanding degradation and recovery* themes as well as by research undertaken in the Tangaroa Programme. The research will identify strategies for ensuring that EBM is widely understood and implemented, and is adaptive to social and ecological changes, including changes in the types of activities undertaken in the marine domain.

We will also identify the social, ecological, cultural and economic elements and institutional arrangements necessary to support diverse blue economy activities within an EBM regime. The ability to pursue diverse economic activities and generate value from the blue economy provides opportunities to strengthen regional and national economies and stimulate quality employment opportunities, but will rely on enabling conditions to support economic innovation. A supportive policy environment for EBM will provide greater certainty in decision-making for Māori and stakeholders to reduce conflict, build trust and encourage new forms of investment. This work will underpin the second focus on enhancing uptake of the research and providing an implementation pathway.

Implementing and evaluating EBM

The second phase of work in this theme will focus on activities to support the implementation of EBM by multiple parties. The research in this phase will increase over the five years as it builds on and integrates the research results of the Challenge. A strong focus will be on implementation pilot trials of EBM approaches with Māori, regional and central government, businesses and community groups.

While we will build on the Challenge's strong existing Māori and stakeholder relationships (e.g. through the Board, Kahui Māori, Stakeholder Panel, Technical Advisory Groups and existing research collaborations) we will seek parties that may be interested in undertaking pilot projects and/or adopting aspects of the findings. The workshops undertaken to form the basis of our strategy revealed that many organisations were either involved or planned on becoming involved in applying an EBM approach and would welcome engagement with the Challenge. The details of how we would be involved will depend on how Sustainable Seas can add value to the process. Pilot projects will be co-designed and we will seek to establish arrangements that will allow the Sustainable Seas researchers to evaluate the implementation process and its outcomes, including implications for the blue economy.

This work will facilitate clear pathways and partnerships for realising an effective and widespread EBM approach for marine management in the long term.

Theme 4: Question and sub-questions to be addressed in this theme

What actions are required to enhance the implementation of EBM in Aotearoa New Zealand?

1. What forms of governance, policy and practices, and integration of work programmes could accelerate and strengthen uptake of EBM over time?
2. How can EBM provide effectively for Treaty partnership, be informed by mātauranga Māori-based models and frameworks and incorporate existing rights and interests?
3. What approaches to implementing EBM can maximise benefits and minimise costs?
4. At what scales do ecological function, social and cultural expectations, and management practices operate, and what is needed to integrate these different scales in EBM?
5. What knowledge, data, approaches, tools, models and partnerships best support EBM implementation?

The questions for the 'Implementing and evaluating EBM' section of this theme will be co-developed with Māori and stakeholders in the first year of Phase II.

3.5 The Tangaroa Programme

Māori maintain a unique and longstanding connection with the ocean that continues to permeate aspects of Māori life, including cultural, spiritual and economic. This connection is recognised through specific rights and interests as Treaty of Waitangi partners. The Tangaroa Programme in Phase II provides a vehicle for Sustainable Seas to contribute to addressing the specific aspirations and needs of Māori, where they align with the Challenge objective, and to do this in a manner consistent with kaupapa and mātauranga Māori. It places Māori at the centre of the research, and aims to promote and support Māori-led or partnered projects to enable direct benefits to those iwi, hapū or commercial groups involved.

The Tangaroa Programme in Phase I focused on research that sought to improve our understanding of:

- the historical and contemporary knowledge and practice of kaitiakitanga relating to the marine environment;
- the availability and accessibility of existing resources to support iwi decision-making and planning;
- the nature of the Māori marine economy; and
- enablers and barriers to greater Māori relevance and involvement in policy, governance and marine-management frameworks and decision-making.

These features will all be important to establishing an EBM and blue economy framework and relationship that works in our unique cultural and Treaty of Waitangi context.

The focus of the Tangaroa Programme research in Phase II has been informed by our interactions with Māori during Phase I as well as workshops and discussions in planning for Phase II. Specific research questions are identified within each theme that reflect key issues and priorities identified by Māori and build upon the Tangaroa Programme research undertaken in Phase I. These questions

will be answered within the Tangaroa Programme and in partnership with the relevant themes, and will include:

- Addressing the aspirations of Māori in halting ecosystem degradation and supporting improved ecosystem recovery including through the development of a model that embodies a harmonisation of mātauranga Māori and western science, and that enables tangata whenua and rohe specific approaches and outcomes;
- Encouraging investment by profiling and supporting Māori innovation in blue economy initiatives to enable further development founded on the mātauranga Māori principles of kaitiakitanga, manaakitanga, whanaungatanga, wairuatanga and whai rawa;
- Understanding the needs of Māori in achieving a marine decision-making and management framework that addresses risks and uncertainty within a Māori cultural and commercial context that recognises intergenerational well-being, including through the exploration of traditional approaches to decision-making; and
- Providing for the development and implementation of an EBM approach that is informed by mātauranga Māori, enables innovative governance and jurisdiction models at different scales, and recognises Māori rights and interests through greater partnership.

The themes will feed into, and be informed by, the Tangaroa Programme research as it provides a visible recognition of the Treaty of Waitangi partnership and cultural relationship of Māori to the marine environment. Undertaking these areas of research focus under the Tangaroa Programme recognises that achieving Māori priorities and needs may require a holistic approach to project structure and management (i.e. projects may address more than one of these areas of focus and so be cross-theme in delivery and outcome). In addition, they will be Māori-led or partnered, and the ability of the Māori researchers involved to work collaboratively, cohesively and in a culturally appropriate manner will be important.

This approach also enables us to explore value-add or extension opportunities to specifically support a range of relevant initiatives undertaken by our Māori partners. For example, this could involve incorporating existing networks or projects to maximise our reach and relevance among Māori. It also enables us to leverage off the valuable cohort of Māori researchers and the relationships established with Māori groups and organisations in Phase I. Project proposals will be co-designed and developed between Māori researchers and Māori partners with capacity, capability and experience of relevance to the areas of research focus. This will include building on existing research partnerships with Māori, as well as having the potential to explore a greater offshore, customary management and commercial focus.

3.6 Vision Mātauranga

The Vision Mātauranga Programme within Sustainable Seas will continue to provide oversight, assistance and active guidance to science leaders and researchers in the application of the Vision Mātauranga Policy. In doing so, it will also support effective pathways for the delivery and uptake of research outcomes for Māori. The focus of Vision Mātauranga in Phase II is to ensure that projects across the Challenge are supported so that the ability of our research to unlock Māori innovation potential is maximised. The primary method of delivery is for the Vision Mātauranga leader to collaborate with each Theme Leader and project team(s) to identify criteria, measures and outcomes for Māori. In addition, the Vision Mātauranga leader will assist in ensuring the balance and mixture of interdisciplinary and transdisciplinary approaches to support their achievement. This approach differs from that outlined in the Tangaroa Programme research which places Māori at its

centre. Instead, Vision Mātauranga looks more broadly across the Challenge to support any project within each of the four themes that has science and innovation potential to ensure benefits to Māori and therefore New Zealand generally. For example:

- *Understanding degradation and recovery in socio-ecological systems* — the Vision Mātauranga thread will ensure this research recognises a holistic, interconnected and multi-faceted approach in stressor management and decision-making.
- *Creating value from a blue economy* — a key aspect of the research will require new and innovative approaches to managing, growing and measuring the blue economy, aligned with the goals of He Kai Kei Aku Ringa, the Māori Economic Strategy.
- *Addressing risk and uncertainty* — as well as a better understanding of Māori concepts of risk, Sustainable Seas will explore Māori community experiences in navigating multiple legislative arrangements for resource management, and the lack of certainty around agency responsibility in the coastal marine environment (as highlighted in Motiti Rohe Moana Trust v Bay of Plenty Regional Council).
- *Enhancing EBM practices* — Vision Mātauranga will ensure that projects are well supported with mechanisms and guidance, and that there are opportunities for Māori to be engaged actively as leaders and partners in discussions, projects and case studies.

The Vision Mātauranga Implementation Plan from Phase I will be updated to give a structured approach in giving effect to Vision Mātauranga within Sustainable Seas. Phase II will continue to develop Vision Mātauranga capacity and capability within Sustainable Seas and Māori communities, to support improved partnership and participation in our research. To achieve this, we will work with and commission specialists in kaupapa Māori and Māori-centred research, and in mātauranga Māori and science interaction, to support skill development in research areas and projects that have the potential to unlock the science and innovation of Māori. The Vision Mātauranga leader will assist in identifying and securing the involvement of such capability, but their involvement in specific projects will be funded by the projects.

The Implementation Plan also acknowledges that, although the mission of Vision Mātauranga is to 'unlock the science and innovation potential of Māori knowledge, resources and people to assist New Zealanders to create a better future', the engagement with Māori communities is an important requirement. The plan outlines Challenge-wide measures to build Māori communities' trust and confidence in our science and research, while also aligning with Māori economic strategy He Kai Kei Aku Ringa, and the writings of leading Māori academics and tohunga. To support this, we will be proactive in taking our research to Māori communities through wānanga organised in settings local to our research. This is a more familiar and appropriate forum for Māori communities to engage with researchers and contribute towards raising awareness and uptake of Sustainable Seas research. Additionally, we will take an active approach to supporting Māori educational achievement by providing scholarship opportunities and a programme of internship and mentoring to support Māori learners and practitioners.

Our overall intention is to unlock Māori knowledge, people and resources through the development of our researchers, and in a manner and pace comfortable to Māori communities who perform roles as kaitiaki and/or as iwi organisations seeking to build their commercial capacity.

3.7 Innovation and Opportunities fund

In addition to the research undertaken in the four themes and the Tangaroa and Vision Mātauranga Programmes, we will have an Innovation and Opportunities fund which will be used to support:

- the introduction of new researchers and ideas;
- higher-risk research projects;
- projects that focus on blue-economy initiatives;
- opportunities to trial EBM approaches in partnership with management agencies;
- research initiatives with other National Science Challenges; and
- research on high priority emerging national issues.

All proposals considered for this fund will be peer-reviewed and be reviewed by the Stakeholder Panel and Kāhui Māori. Projects funded will be identified by negotiation or by a call for proposals that will be widely circulated.

4. Linkages with other Challenges

The four Phase II themes all have synergies with research in other National Science Challenges (NSCs). The Our Land and Water Challenge is developing maps of land-based inputs of sediments and nutrients to freshwater and considering regulations and policies for land-use activities. This links directly to research in the *Understanding degradation and recovery* theme on how these inputs affect the marine domain, which is the ultimate receiving environment for land-derived contaminants. The *Enhancing EBM practices* theme provides opportunities for collaboration on the management of land-use impacts on marine ecosystems, and will develop tools that enable integration of impacts across the land-sea interface into marine-ecosystems management. The *Blue economy* theme will further connect green economies involving primary production in terrestrial settings with their impacts on marine ecosystems and marine economies.

The Biological Heritage Challenge provides a cross-system comparison in approaches to studying ecosystem responses to stressors within a terrestrial tipping-points project. Biological Heritage is also likely to incorporate marine biosecurity into its scope, which has not previously been covered directly by any of the NSCs. Invasive species and their associated threats and risks are an important consideration within EBM, and are considered within Sustainable Seas as one of many potential multiple stressors. Aligning with work underway within Biological Heritage, an additional MBIE-funded Marine Biosecurity programme, and work underway by other stakeholders (e.g. MPI, regional councils) will assist in incorporating potential impacts of marine bio invasions into the *Understanding degradation and recovery* theme and the *Blue economy* theme, and to develop tools to include biosecurity risk and uncertainty in an EBM framework.

Resilience to Nature's Challenges and the Deep South are quantifying the impacts of environmental change (e.g. flooding, sea-level rise, climate) that have an important (but not necessarily manageable) influence on how marine ecosystems respond to human stressors. Both NSCs as well as Our Land and Water will provide information that informs the *Understanding degradation and recovery* and *Addressing risk and uncertainty* themes' research, as well as quantifying broad scale change that will inform the visioning and development of potential future scenarios in the *Enabling EBM* theme.

Risk and uncertainty are being investigated across the above-mentioned NSCs and sharing research approaches will be useful despite differences in underlying objectives. Challenges in managing for

risk and uncertainty have surfaced in several Board of Inquiry decisions involving use of offshore resources, so our research will be applicable to the EPA and a range of marine industries.

We will continue to develop links between the Science for Technological Innovation (SfTI) Challenge and our *Blue economy* theme. SfTI's Spearhead project *Precision Farming Technologies for Aquaculture* aims to develop technologies that accelerate sustainable growth of the aquaculture sector. This includes prototyping sensor arrays and communication and visualisation of data across local (bay-wide) to regional (sound-wide) scales, in turn promoting the ability to optimise aquaculture activities within an EBM framework.

5. Approach to ensure research quality

5.1 Research focus

The proposed themes and Tangaroa Programme are recognised by Māori and stakeholders as addressing key issues aligned with daily and strategic concerns. The themes are also recognised within the research community domestically and internationally. Aligning research themes to expertise and aspirations within Aotearoa New Zealand and to international research programmes provides: a basis for building stronger teams; a stronger identity for Sustainable Seas; and enhanced opportunities for engagement, uptake and collaboration and greater relevance of the research.

Each of the themes is assembled around research questions that address specific ecological, social, economic and cultural dimensions of ecosystem health, the blue economy and EBM, and address priorities identified by Māori and stakeholders during the consultation workshops held to develop the strategy for Phase II. Answering these questions will require practices that integrate western and mātauranga Māori knowledge. We will build on the relationships established in Phase I to foster the transdisciplinary research teams necessary to co-develop research across multiple disciplines and in partnership with Māori and stakeholders.

The research will continue to be targeted in the Focal Area (Figure 5), but opportunities to expand the geographic focus to co-develop projects in other areas will be supported. Opportunities to work with communities that are keen to embrace the Challenge objective and contribute to co-design, research implementation and real-world application of outputs are already emerging. Case studies that include EBM research relevant to the deep ocean will be encouraged. Prospective case studies will be assessed on how they will contribute to the Challenge objective, the level of interest from Māori and stakeholders, and the value the case study would add to the implementation of an EBM approach to marine management.

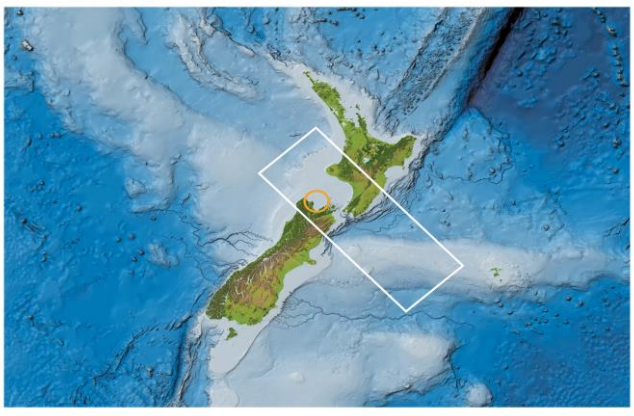

Figure 5: The 'focal area' (white rectangle) and 'case study area' (orange circle) for Phase I research.

5.2 Best teams and research capability

In Phase I we assembled best teams for research from aligned disciplines. For example, Our Seas primarily undertook social research, while Dynamic Seas focused on biophysical sciences. Best teams in Phase II will be assembled under the strongly interdisciplinary theme structure. We will draw on a community of more than 200 researchers funded by the Challenge in Phase I, which includes leading domestic researchers in the field as well as the network of partner/advisor experts who are directly involved with Sustainable Seas. We also will provide opportunities for other researchers to join what is now a well-connected community through the theme workshops which will develop the research projects (see section 5.4) and through research opportunities from the Innovation and Opportunities fund.

Sustainable Seas will continue to work with the understanding that 'best team' does not automatically mean a team of people with the strongest CVs or track records. Rather, each best team will be a set of people who together will provide the 'best' results and outcomes supporting a transdisciplinary approach to the research. This will include partners from Māori and stakeholder groups. The 'best team' approach also will create opportunities for team members in one project to participate in other projects through specialised contributions. To maximise connections across themes and integration of the research, a subset of researchers will work across multiple themes.

Phase II will place a priority on capability building and the integration of researchers across disciplines, themes and projects to ensure that new connections are made and transdisciplinary research skills are honed. We will include emerging researchers in all major projects, supporting them to develop research skills and gain experience of working in collaborative transdisciplinary teams. We will develop a strategy for early-career researchers which will include mentoring programmes in both research practices and project leadership. We will support graduate and PhD students where appropriate as in Phase I. To further support integration of Sustainable Seas research, we will fund 2–3 postdocs to work across the themes.

Building capability in Māori research will also be a priority with targeted investment and scholarship opportunities. Māori researchers will be included in the early co-development phase for all research projects to facilitate collaboration. We will continue to support Māori-led and Māori-centric research within the Tangaroa Programme. Cross-theme collaboration and co-development of theme projects will ensure that Māori research is integrated within the Challenge. The Tangaroa Programme also will ensure that early-career Māori researchers have opportunities to develop kaupapa Māori projects and will be mentored by the network of Māori researchers established in Phase I.

5.3 Leveraging international researchers and research organisations

We will leverage international researchers and organisations by drawing on our existing international networks and building further collaborative relationships in Phase II. Examples include engaging across research programmes on cumulative effects in marine ecosystems in Australia (e.g. the Australian Institute of Marine Science), Europe and North America (e.g. EU Marine Framework Strategy Directive, Center for Ocean Solutions and Natural Capital Project, Stanford University), as well as centres for research on the blue economy (e.g. Middlebury Institute of International Studies at Monterey, and the global Coastal Transitions Network). We will continue our collaborations with interdisciplinary programme funders such as JPI Oceans and The Economics of Ecosystems and Biodiversity (TEEB), and will continue to build collaborative relationships with large interdisciplinary projects such as the Canadian Healthy Oceans Network (CHONe) project in Canada and projects led by the Norwegian Institute for Nature Research. In addition, through international collaborations, we will better align research to international obligations such as the Sustainable Development Goals (SDGs), and connecting Challenge outputs and modelling tools to Aichi biodiversity targets associated with the SDGs.

5.4 Project development and funding process

The majority of projects in Phase II will be negotiated rather than by an open call for proposals (the exceptions being some projects within the Innovation and Opportunities fund). Negotiated core projects will be co-designed with guidance from the SLT and input from researchers, Māori and stakeholders, and technical advisory groups through a series of workshops.

The SLT will scope possible projects based on the research questions in each theme. Theme leaders will then hold theme-centred workshops to co-develop preliminary project descriptions that identify possible research locations, methodology and research design, personnel requirements and indicative budgets. The workshops will ensure that best ideas are canvassed from across the research community, Māori and stakeholders. To ensure that links between the themes are maximised, all theme leaders and key researchers involved in the integration across themes will attend all workshops. The portfolio of project descriptions will be reviewed by the Kāhui Māori, Stakeholder Panel and TAGs to identify overlaps, to maximise the diversity of case studies and people in teams, and to ensure the portfolio of projects will deliver on the Challenge objective. The SLT will make recommendations on the project portfolio to the Challenge Independent Science Panel and Board. This will lead to the identification of project leaders, who will lead the writing of full proposals.

A key difference in Phase II is the introduction of a 2+3 year proposal funding model that builds in a review in Year 2. This review is timely as the Challenge enters the final three years of a 10-year programme to ensure it meets its objective. Core project proposals will be for up to five years, with researchers required to provide detailed milestones for the first two years. The Kāhui Māori, Stakeholder Panel, ISP, SLT and programme TAGs will evaluate progress towards completing research milestones and achieving the Challenge objective prior to funding being granted for further research. Projects will be continued, refocused, or have funding reallocated to new projects, depending on progress and Challenge priorities. The review will help to ensure that ongoing projects continue to deliver high-quality research that contributes to meeting the Challenge objective. This model will also allow the Challenge to respond to nationally important issues in the marine environment that may emerge. Throughout Phase II, the SLT will actively support project leaders on a routine basis, providing proactive guidance and coordination of cross-theme collaboration to ensure that research is integrated and high quality at project, theme and Challenge levels.

The negotiated funding model allows for ‘science stretch’ and the pursuit of high-risk/high-return science. The 2+3 proposal model is one of a suite of management-level changes that will give projects the flexibility to build on successful high-risk opportunities, and also to modify research plans when high risk-opportunities are not successful. The Innovation and Opportunities fund will provide further opportunities to support novel high-risk research, including those proposed by Māori and stakeholders. This fund also will provide for co-funded stakeholder-driven projects such as blue economy initiatives and case studies. This more focused approach, combined with a clearly articulated direction to researchers to develop projects that target the Challenge objective, will improve project quality and relevance to Māori and stakeholders.

Phase I of Sustainable Seas received substantial amounts of aligned funding, representing significant additional investment. NIWA and Cawthron provided funding in a range of forms, as did regional councils. Auckland, Waikato, Canterbury and Otago universities provided student MSc and PhD scholarships. We anticipate that the strength of relationships forged in Phase I will see this level of support grow and the shift to a thematic focus in research promises to provide new opportunities for aligned and co-funding. The adoption of a multiple case study approach will increase opportunities for co-development of research, allowing Sustainable Seas to target win-win situations that maximise benefits for the Challenge, Māori and stakeholders. This approach will also provide

opportunities to grow the amount of co-funding that is provided to support Challenge research by widening the potential research partners.

6. Meeting the needs of Māori and stakeholders

The Kāhui Māori and Stakeholder Panel as well as TAGs at the theme level will provide guidance, review projects and progress from a Māori and stakeholder perspective, and consolidate relationships. The TAGs will comprise representatives from iwi, regional councils, government agencies, NGOs and industry to ensure that transdisciplinary projects remain genuinely so and realise benefits to Māori and stakeholders. The ISP will provide expert advice on research design and review of research progress, and also advise on networking opportunities that could be enhanced at the international level.

Our research portfolio aligns strongly with Māori and stakeholder needs, based on their participation in recent consultation workshops to develop this Phase II strategy, and from the engagement with resource management agencies, marine-based industries, Māori and community groups throughout Phase I of the Challenge. This research portfolio also aligns closely with high-level government and industry strategies.

The focus on an EBM approach to marine management is clearly aligned with Fisheries Change Programme being undertaken by MPI and supports recent announcements by Minister Nash (Minister of Fisheries) to build on current management practices and to move fisheries management to a more EBM approach. It is also closely aligned with MfE's Marine Future initiative which is focused on EBM and with the NZ Treasury's Living Standards framework, in particular the focus on environmental sustainability, participatory decision-making and the role of cultural and social values. The regional councils' Coastal Special Interest Group (C-SIG) Research Strategy specifically mentions contributing to an effective understanding of EBM and its implementation, and the Primary Sector Science Roadmap highlights the need to integrate people and values within resource management.

The *Understanding degradation and recovery in social-ecological systems* theme is tightly aligned with building resilience to cumulative and interacting stressors from resource use, land-based stressors, climate change and biosecurity risks, which are key components of strategic documents from both government and marine-based industries (e.g. Our Environment 2016, Business Growth Agenda 2017, Conservation and Environment Roadmap, and regional councils' C-SIG Research Strategy). Industries recognise the need to understand their impacts on habitat degradation, water quality and ecosystem health (e.g. Petroleum Exploration and Production Association of New Zealand (PEPANZ), Business Growth Agenda 2017, Aquaculture 2012). This theme also supports the future-proofing of ecosystem health and resilience, and the resources that are integral in stakeholder strategies to enhance resilience and prepare for environmental, social and economic change (e.g. Our Environment 2016, Primary Sector Science Roadmap, C-SIG, Conservation and Environment Science Roadmap).

The *Creating value from a blue economy* theme supports references to development of a blue economy, which appear throughout government and industry strategies in various ways from adding value and achieving greater profitability across the supply chain, to a greater diversity of high-quality products and services and diversified and multifunctional complex systems (Primary Sector Science Roadmap, Business Growth Agenda 2017, Aquaculture 2012). Aspects that were highlighted particularly include:

- increasing economic resilience, including through diversification (e.g. PEPANZ with respect to energy security, Business Growth Agenda 2017, Aquaculture 2017);

- dependence of the blue economy on efficient governance systems with respect to the regulatory environment and efficient, fair allocation processes, sound governance, and coordination between industry and central and local government (e.g. Aquaculture 2012, PEPANZ, Business Growth Agenda 2017); and
- Treasury, MfE and Statistics NZ's intentions to include natural capital in the 2019 Investment Statement.

The *Addressing risk and uncertainty* theme aligns closely with the understanding of risk, vulnerability and uncertainty that underpins the ability to manage multiple stressors in the marine environment. Research will also develop tools to support natural-resource management, and building resilience to natural events and climate change (e.g. C-SIG, Business Growth Agenda 2017).

The Tangaroa programme enables the Challenge to specifically contribute to the Treaty of Waitangi partnership outcomes through its focus on research that recognises and provides for Māori interests. It is informed by a growing body of mātauranga Māori-inspired research, and aims to re-establish mātauranga Māori-based models and frameworks in marine management. In addition, by placing Māori at the centre of its research, the Tangaroa Programme enables more effective pathways for the uptake of Challenge outputs.

The implementation of Vision Mātauranga will support a kaupapa Māori approach informed by tikanga Māori. It also enables the appropriate use of mātauranga Māori both alongside and integrated with other approaches, enabling Māori to exercise kaitiakitanga and other roles and enhancing Māori economic development (Primary Sector Science Roadmap, Conservation and Environment Science Roadmap, He Kai Kei Aku Ringa, Treasury Living Standards framework).

7. Delivering impact

The key path to impact will be trialling EBM implementation with interested regional or central-government agencies, to establish proof of concept and learn key lessons about putting theory into practice. To support this, we will build on Phase I to deliver a globally unique portfolio of integrated socio-ecological research designed to provide robust solutions of environmental, social, cultural and economic benefit. This will lead to far-reaching benefits for Aotearoa New Zealand, with some quantified forms of sustainable economic growth, and enhanced non-monetary societal and cultural values supported by healthy marine ecosystems.

Phase I research has confirmed that an EBM approach to marine management represents a credible pathway to enhancing ecological and societal health while growing the value generated from the marine environment. In Phase II our strategy strengthens our ability to deliver on the Challenge mission and to maximise research accessibility, community relevance, use and uptake.

The themes, many of which are here-and-now management challenges, require interdisciplinary collaborations and strong engagement, and will provide comprehensive solutions for Māori and stakeholders. Examples include a focus on cumulative effects and increased attention to land-sea interactions, which will be enhanced through partnerships with the Our Land and Water Challenge and central and regional government.

Opportunities for increased additionality and benefits from Sustainable Seas are especially apparent through the inclusion of the *Creating value from a blue economy* theme. This focuses on identifying, cultivating, and realising blue economy values. Integrating the blue economy with EBM will lead to the best possible outcomes for Aotearoa New Zealand in terms of ensuring that marine ecosystems are healthy while supporting a resilient and thriving marine economy. Achieving this theme's outcomes will allow for enhanced value in the marine economy, reduced compliance costs, new

opportunities for small operators, and collective forms of investment to be developed across a range of sectors.

Active involvement of Māori and stakeholders will establish trust and confidence in the research and ensure relevance (including culturally, spatially and temporally), thereby providing certainty for its future applications. The active embedding of mātauranga Māori within our research will also be a feature of the outputs and outcomes produced by Sustainable Seas. Furthermore, mātauranga Māori and its application and partnership with other knowledge systems and practices (e.g. biophysical-ecological science) will open opportunities to highlight Aotearoa New Zealand's uniqueness.

Extensive consultation while developing the Phase II strategy has identified individual and collective priorities, opportunities and challenges, which have shaped the way we will implement the research and in turn form the pathways to impact. This inclusive approach to developing our strategy reflects the way we will work in Phase II and demonstrates the pathway required for implementation that will lead to its uptake and application in real-world EBM.

To ensure a credible pathway to impact, we will:

- Co-develop core project proposals in each theme using a workshop process which increases co-design and implementation opportunities with Māori and stakeholders. Bringing people outside the science community into the Challenge as active participants and/or partners will grow the wider Sustainable Seas community and ensure relevance and uptake of outputs.
- Include Māori and stakeholders in projects, encourage secondments or exchanges of relevant personnel between Sustainable Seas and government agencies, and support early-career researchers who work across Sustainable Seas. Those involved will ultimately become Aotearoa New Zealand's EBM professionals, thereby extending the impact of EBM implementation beyond the life of the Challenge. This could include resource management and policy fellowships aimed at strengthening links between agencies, marine industry sectors, Māori and Sustainable Seas research.
- Develop project plans that include timelines identifying where and when engagement will be most effective to maximise uptake of research deliverables. The theme TAGs will be involved from start to finish and provide a platform for active participation of key stakeholders and Māori.
- Maintain the Tangaroa Programme as a separate component to facilitate research specifically aimed at contributing to the needs and aspirations of Māori where they are relevant to the Challenge objective. This includes promoting specifically Māori-led or partnered research that enables the direct uptake of research outputs designed and delivered by Māori.
- Apply a Vision Mātauranga approach across all themes to maximise the innovation potential of Māori people, resources and knowledge and ensure that our research (not just that undertaken in Tangaroa) creates specific benefits for Māori.
- Implement multiple case studies that differ in place, issues, communities and segments of society. This will diversify stakeholder involvement and lead to demonstrations of different models of EBM in varied communities and locations. These will be in the form of pilot projects that will provide templates for implementation of EBM across Aotearoa New Zealand beyond the life of Sustainable Seas.

- Ensure that data collected by Sustainable Seas are widely available now and in the future by implementing a metadata catalogue which is interoperable with other national metadata initiatives.
- Ensure that tools, models and products created by the Challenge remain available and accessible for use by Māori and stakeholders after the completion of the research in 2024.

In Phase II we need to address the critical interface between the Challenge research and resource management and policy. This will be achieved by integrating Sustainable Seas projects with parallel programmes proposed and/or signalled by central government agencies. Two exciting opportunities for this include the future implementation of ecosystem-based management of fisheries through the MPI Fisheries Change Programme and the emerging Marine Futures programme supported by MfE.

There is significant commonality between Sustainable Seas and the Marine Futures policy initiative. MfE, MPI and DOC have policy aspirations to develop a more integrated marine-management regime, and all have expressed interest in progressing this work through the 'Marine hub', a cross-central-government group. Key thematic areas of interest to the 'Marine hub' are closely aligned to Sustainable Seas and narratives for communicating the concept and structure of integrated management systems such as EBM.

Working in collaboration with the 'Marine hub', we propose to build a common understanding of the elements of an EBM system and co-develop collaborative projects where Sustainable Seas acts as the platform for science provision and case studies, and Marine Futures agencies lead the policy delivery of the research. Work at the interface of the two programmes will be facilitated through collaboration with Sustainable Seas projects and pilot studies. This will provide opportunities to strengthen integration for example through secondments between research organisations and participating agencies. This represents a highly credible and coordinated way to deliver our research in a manner that leads to implementation of EBM and long-term benefits for Aotearoa New Zealand.

8. Communication, outreach and engagement

In Phase II effective communication and engagement will support delivery of the Sustainable Seas objective. We are in a strong position for Phase II in terms of communication, outreach and engagement. High-quality and effective communication channels (e.g. the website, newsletter, internal researcher update, Twitter) and outreach projects (e.g. LEARNZ virtual field trip, Science Learning Hub resources) have been established and new ones are being developed (e.g. Art+Oceans 2018 collaborative Sci-Art project, Māori Secondary School Marine Science Wānanga). Strategies for Māori and stakeholder communications and engagement plans from Phase I will be reviewed and updated, ensuring that the diverse audiences with their different communication needs will have tailored communication plans.

High-level strategic engagement with central and regional government, iwi chairs, industry bodies and community groups will continue to be led by the Director and SLT and supported by the Board, Kāhui Māori, and Stakeholder Panel. At the theme level, the active engagement of TAGs across all stages of research development and implementation will ensure relevance of research and uptake of deliverables.

We will continue to use a range of communication and outreach formats, mediums and approaches for engaging the Challenge community and sharing Aotearoa New Zealand's EBM stories with wider society. We will seek to socialise the science, models and tools generated to increase underlying confidence and trust in science and EBM. We will also explore novel ways to communicate the complexities associated with EBM with youth.

Our communications, outreach and engagement in Phase II will:

- continue to use face-to-face communication and personal relationships to engage with Māori, and stakeholders;

- ensure that communications and engagement planning is included in projects' plans;
- continue to provide support for researchers through a dedicated resource – the Senior Communications Advisor and associated central communications, outreach and engagement budget;
- appoint an iwi engagement coordinator;
- continue to use proven channels such as the Research Book and newsletter to share our research with Māori and stakeholders;
- develop innovative accessible resources with and for Māori and stakeholders;
- deliver widely accessible webinars, as well as focused 'master classes' on the use of knowledge and tools for managers and decision-makers; and
- use some of the methods that were successful in Phase 1 including Sci-Art projects, secondary-school Wānanga and LEARNZ virtual field trips to increase accessibility of research results and to build trust in science.

9. Decision-making and accountability

The governance, management and financial structures, decision-making and accountability arrangements have worked effectively in Phase I. There is a good flow of information and knowledge from the Stakeholder Panel and Kāhui Māori to the SLT and Board, and between the Board and SLT. The ISP has provided excellent feedback on the research to date and on the Phase II strategy to the SLT and Board.

Prior to decisions regarding research project funding, project proposals are peer-reviewed, including by relevant ISP members. The proposals and peer reviews are then considered by the Kāhui Māori and Stakeholder Panel who provide input on the relevance and impact of the proposals. The reviews, and comments from the Kāhui Māori and Stakeholder panel, are considered by the SLT prior to making recommendations to the Board regarding funding. Proposal revisions are frequently requested in response to the reviewer's comments prior to funding being approved. The Board also reviews and approves the iwi and stakeholder engagement strategies and the communications and outreach strategy prior to considering funding recommendations for these work streams from the SLT. There are no proposed changes to the management and governance structure in Phase II other than Theme Leaders replacing Programme Leaders (Figure 6).

To ensure effective monitoring of project progress, quarterly milestones are incorporated in all research contracts and are reviewed annually between the Director, programme leader and project leader. This, along with quarterly reporting by each project against milestones and identification of risks and issues, gives good visibility of project progress. The financial management, delegations and project management of the Challenge is undertaken using the excellent systems of our host organisation, NIWA. Publications are reviewed by team members and the programme leaders prior to submission.

The Board reviews its performance on an annual basis and the performance of the Director is reviewed annually by the Board Chair and NIWA. The performance of the SLT members is reviewed annually by the Director.

In Phase II we will use a 2+3 year funding model approach that will allow for effective and timely reviews of progress and direction of research by the SLT and ISP after two years and prior to approval of further project funding. The SLT and Board consistently watch for national important emerging issues for the marine environment. This model allows the Challenge to respond to these demands.

The SLT and Board are aware of areas of risk to the delivery of the Challenge and identify and monitor these on a quarterly basis with identification of actions required to minimise them. Key risks for Phase II that have been identified and will need to be proactively managed are:

- Failure to increase the depth of interdisciplinary research: Risk minimised by Theme structure (section 3), building research capability (section 5.2)
- Lack of capacity of our Māori researchers: Risk minimised by building research capability (section 5.2)
- Lack of engagement of Māori and stakeholders resulting in a low level of transdisciplinary research being developed: Risk minimised by collaborative implementation (section 3.4 Theme 4); Māori-led research (section 3.5 Tangaroa), and the focus on meeting the needs of Māori and stakeholders (section 6)
- Lack of engagement with Māori and stakeholders resulting in reduced uptake of research findings and implementation of EBM: Risk minimised by the focus on meeting the needs of Māori and stakeholders (section 6), and communication and engagement (section 8)

The SLT was expanded with an additional position being added to the team during Phase I to ensure that there was a broader discipline balance. This has benefited Sustainable Seas, and the expanded membership of the SLT will be maintained in Phase II.

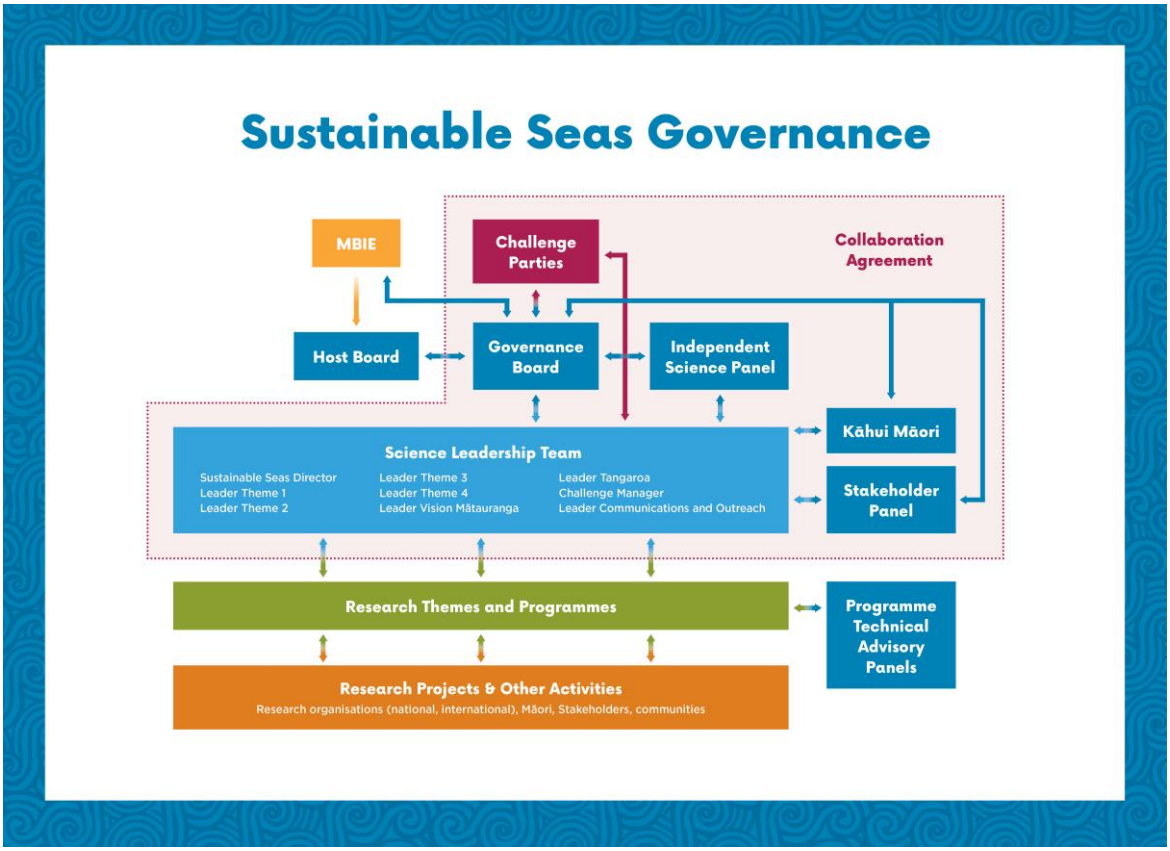

Figure 6: Governance and management structure for Phase II.

10. Indicative budget

The following is an indicative budget for the five-year strategy, indicating the distribution of funds across the Challenge. As projects focused on the questions identified in each theme will be identified and refined through a series of co-development workshops with Māori and stakeholders in 2018 we are unable to accurately cost each of the themes at this stage.

	$*
Theme 1: Understanding degradation & recovery in socio-ecological systems	7,000
Theme 2: Creating value from a blue economy	4,500
Theme 3: Addressing risk and uncertainty	3,500
Theme 4: Enabling ecosystem-based management	5,500
Tangaroa	5,500
Vision Mātauranga	1,600
Innovation and Opportunities fund	5,000
Communications and engagement	3,300
Postdoctoral fellowships	900
Science Advisory Panel and Science Leadership Team	3,200
Governance and advisory	900
Management	1,600
Contingency	500
Total	**41,000**

** in thousands*

The Innovation and Opportunities fund will be used for research which will support potential blue-economy initiatives and opportunities to trial EBM or parts of EBM where partnerships with marine-management agencies are identified. The fund may also be used to support joint initiatives that are identified with other Challenges.

Communications and engagement are critical to the success of the Challenge: this budget covers staff time and activities (multimedia, videos etc) to support communications and engagement with our wide range of stakeholders as will be outlined in the 'Communication and outreach' and 'Engagement' strategies for phase II.

The postdoctoral fellowships will be used to support post-PhD early-career researchers who will work across themes and projects and support the SLT in integrating the research across the Challenge.

The funds within Vision Mātauranga will be used to support engagement with Māori as outlined in the iwi-engagement strategy that will be prepared for phase II and to support Māori involvement in Challenge research activities.

11. Scenario planning

If increased funds were allocated to Sustainable Seas for Phase II, we propose an additional Theme on *Enhancing Ecosystem Health*. This topic emerged as being of strong interest to Māori and stakeholders during our Phase II planning workshops.

11.1 Enhancing ecosystem health

Actively enhancing the values that New Zealanders hold for the marine environment is a fundamental component of EBM, especially for ecosystems perceived as degraded (i.e. not supporting previous uses or of less value than before). Aspirations to restore the health and abundance of local coastal ecosystems are widespread across communities and organisations. Additionally, the Resource Management Act and EEZ Act allow for mitigation of activities, generally interpreted as enhancing some aspect of the environment to compensate for the impacts of an activity.

We use the term 'enhancement' to mean the return to a previous state or the recovery to another state with increased ecological function, cultural and social benefits. *Enhancing ecosystem health* builds on Phase I and is complementary to the four Themes in Phase II. In particular, it allows an important extension of the research from understanding the passive recovery that should occur as stressors are better managed (*Understanding degradation & recovery in socio-ecological systems* to identify active interventions that will accelerate this process).

Recent years have seen rapid growth in the perception and documentation of the degradation of our marine environment, paralleled by increasing interest in reversing this decline. This interest was emphasised in Phase II planning workshops involving Māori and stakeholders. Restoration was also highlighted as an important Phase II research priority by regional councils, central government agencies and community groups.

Enhancement efforts at present are generally driven by communities with strong interests in their local coastal marine areas. Enhancement has increasingly become a focus for Māori and a common feature in the long-term plans and strategies of Māori organisations. Present efforts often occur in an ad-hoc manner, without the support of robust scientific analysis or evaluation of what is required to achieve success and wider social goals. Efforts often are focused on a particular species, although opportunities for enhancement can include interventions that result in increased health and functioning of whole systems. For example, seeding of multiple species of suspension-feeding shellfish can increase water clarity, stabilise seafloors, increase biodiversity and support cultural, recreational and commercial activities.

Enhancement also offers regional economic opportunities, for example development of larval - production facilities or coastal engineering work, as well as the development of mitigation strategies that could be used by industry in a blue economy. Terrestrial industries often propose enhancement activities as part of their intended work-and-mitigation programme but this is not the norm in the marine environment. The proposed research would assist in identifying enhancement strategies and assessing the likelihood of success of proposed actions. This greater certainty for enhancement actions could contribute to win-wins with new opportunities for economic growth. Indirect effects of active enhancement projects also include building capacity in understanding of ecosystem dynamics; articulating values, partnership and co-governance; and using restoration to support kaitiakitanga activities and enhance mauri.

Research would be conducted primarily by a case-study approach, working with local communities, Māori and other stakeholders to trial and evaluate enhancement. However, there is huge potential to derive generalities that could aid nationwide enhancement efforts. This is partly driven by commonalities of desired outcomes and underpinning ecological knowledge, but also reflects our

likely ability to develop models that can predict the temporal and spatial scales required for successful enhancement.

Funding for an *Enhancing ecosystem health* theme would support a step-change in our ability to increase the ecological health, mauri, value and uses of marine ecosystems, and align Aotearoa New Zealand with substantial research-led restoration programmes in many other countries.

Question and sub-questions to be addressed in this theme

How do we actively reverse cumulative effects on ecological function and ecosystem health?

1. How can we best use kaitiakitanga, tikanga and ecological science to design, prioritise and implement enhancement projects to improve ecosystem health and values?
2. How do we assess enhancement success on non-monetary values, including mauri, ecosystem services and taonga species?
3. How can we define the enhancement objectives of Māori and stakeholders such that they can be incorporated in decision-making?
4. What are the major social, cultural, environmental and ecological dependencies that determine enhancement success?
5. Is mitigation in the form of enhancement a viable strategy for businesses to pursue when seeking consents/social licence to operate?

Appendix 1. Outcomes

Long-term outcomes 2030 -

Sustainable Seas Challenge Objective: to enhance utilisation of our marine resources within environmental and biological constraints

Medium-term outcomes 2024 - 2030

- Shared national objectives based on understanding the diversity of values NZers hold for the marine environment
- Perceived increase in equitability, transparency, and efficiency of evidence-based decision making
- A sustainable blue economy creates certainty in investment and promotes diversity and ecosystem health

Short-term outcomes 2023 - 2024

- EBM is used to improve management
- NZers understand the benefits of a blue economy
- NZers (including managers and industry stakeholders) have tools to maintain or enhance ecosystem health
- Management strategies routinely involve tikanga and mātauranga Māori

Outputs 2019 - 2024

- Guidelines for participation in EBM decision-making processes
- A Treaty-based EBM approach
- Tools for assessing and managing cumulative and multiple stressors
- Frameworks that consider multiple values and blue economy activities
- Increased understanding of cumulative effects of selected stressors
- Effective partnership models for decision-making and management

Enablers and inputs

- Sustainable Seas research funding and research conducted by others
- Central and regional government adopting EBM as best management option
- Partnerships and strong engagement with Māori and stakeholders allows for co-production of research and focus on implementation

Opportunities

- A marine environment with resources that can support an economy and greater well-being
- Innovative people
- The Treaty of Waitangi requirement for partnership
- EBM principles link healthy ecosystems and a blue economy

Problems

- Some marine ecosystems are modified by marine and land-based activities
- Lack of integration and optimisation across central and regional agencies and regulatory frameworks
- There are increasing social licence issues for marine industries
- Some current practices may not be sustainable in the long term
- Lack of tools and understanding to maintain ecological functioning in complex, multi-use systems
- People feel divorced from decision-making, that local values aren't considered, and that equity is lacking

Difficulty in making trade-offs in areas of competing use; enhanced use is hindered by lack of decision-making tools where information is limited

Additional benefits

- *New Zealand's reputation for marine management is enhanced*
- *Increased skill base in transdisciplinary research*
- *Cross-sector/community appreciation of other values*
- *Broad understanding of diversity of values of blue economy*
- *Increased capacity of Māori researchers and decision-makers*
- *Stronger, more resilient, high-value export industries*
- *Revitalisation of cultural context*
- *Increased knowledge accessibility*