

Phase II Project Proposal

PROJECT TITLE	T1 Awhi Mai Awhi Atu: Enacting a kaitiakitanga-based approach to EBM
A. SHORT TITLE	Awhi Mai Awhi Atu
B. THEME/PROGRAMME	Tangaroa Programme

C. PROJECT KEY RESEARCHERS			
Role	Name	Institution / company	Email
Project Leader and Iwi Researcher	Kura Paul-Burke	University of Waikato	kura@waikato.ac.nz
Project Leader	Richard Bulmer	NIWA	Richard.bulmer@niwa.co.nz
Iwi Researcher	Shaun Ogilvie	Eco Research Associates Ltd	
Researcher	Conrad Pilditch	University of Waikato	
Community Researcher	Joe Burke	MUSA Environmental	
Iwi Researcher	Megan Ranapia	University of Waikato	

D. CO-DEVELOPED WITH			
Name	Role	Organisation / company / agency	Level of partnership
Wallace Aramoana	Research Partner	Kaumātua, Te Ūpokorehe	Hapū/Iwi co-development partner, Te Rōpū Kairangahau
Trevor Ransfield	Research Partner	Kaumātua, Te Ūpokorehe Resource Management Team	Hapū/Iwi co-development partner, Te Rōpū Kairangahau
Tuwhakairiora O'Brien	Research Partner	Deputy Chair, Te Rūnanga o Ngāti Awa	Hapū/Iwi co-development partner, Te Rōpū Kairangahau
Joseph Burke	Research Partner	Technical marine field research leader, MUSA Environmental	Community co-development partner, Te Rōpū Kairangahau
Tim Senior	Ōhiwa Land Management	Bay of Plenty Regional Council	Watching brief /support partner
Gina Mohi	Mātauranga Māori & Science	Bay of Plenty Regional Council	Watching brief /support partner
Josie Crawshaw	Coastal Scientist	Bay of Plenty Regional Council	Watching brief/support partner
Stephen Park	Senior Coastal Scientist	Bay of Plenty Regional Council	Watching brief/support partner
Pim DeMonchy	Catchment Manager	Bay of Plenty Regional Council	Watching brief/support partner
Helen Kettles	Technical Advisor Marine	Department of Conservation	Watching brief
Tipene Marr	Chairperson – Māori Councillor, Bay of Plenty Regional Council	Ōhiwa Harbour Implementation Forum (OHIF)	Co-Management partner
Lyn Riestrer	Deputy Chair – Mayor, Ōpōtiki District Council	Ōhiwa Harbour Implementation Forum (OHIF)	Co-Management /watching brief
Andrew Iles	Elected Member - Whakatāne District Council	Ōhiwa Harbour Implementation Forum (OHIF)	Co-Management /watching brief
Matt Te Pou	Mandated Iwi Partner - Waimana Kaakū Authority	Ōhiwa Harbour Implementation Forum (OHIF)	Co-Management /watching brief
Bruce Pukepuke	Mandated Iwi Partner - Te Whakatōhea Māori Trust Board	Ōhiwa Harbour Implementation Forum (OHIF)	Co-Management /watching brief
Trevor Ransfield & Maui Manuel	Mandated Iwi Partner - Te Ūpokorehe	Ōhiwa Harbour Implementation Forum (OHIF)	Co-Management /watching brief
Charlie Bluett & Tuwhakairiora O'Brien	Mandated Iwi Partner Te Rūnanga o Ngāti Awa	Ōhiwa Harbour Implementation Forum (OHIF)	Co-Management /watching brief

Additional co-developers, including iwi and hapū groups, have been withheld by request.

E. ABSTRACT

T1 Awhi Mai Awhi Atu: Enacting a kaitiakitanga-based approach to EBM aims to combine mātauranga Māori (Māori knowledge systems), western science and local kaitiakitanga (active guardianship) to better understand degradation, assist recovery, and generate common management approaches and responses for the culturally and ecologically important shellfish in the soft-bottomed Ōhiwa harbour. It is intended that the project will enable a kaitiakitanga based and site-specific cultural context to contribute to and assess the development and application of an EBM approach relevant to both the aspirations of hapū, iwi and the Challenge objectives.

The research will bring together mātauranga Māori and western science to investigate habitat connectivity as it applies to the unique social, cultural and ecological context of Ōhiwa Harbour. This will include understandings of tohu or ecological signs, signals, indicators of the natural world; what drives the dynamics of cumulative effects; how do we assess degradation or recovery from cumulative effects on non-monetary values (including mahinga kai or food harvesting areas, ecosystem services and taonga species or culturally important species), and how we can co-develop opportunities to engage in a blue economy informed by mātauranga Māori principles of whanaungatanga (relational connectivity), kaitiakitanga, manaakitanga (generosity) and rangatiratanga (authority). Further, this project will foster co-developed opportunities to better estimate and communicate risks and uncertainties of a dynamic and complex Ōhiwa system, including new policies and tools to assist the application of a kaitiakitanga based approach to EBM in the planning and implementation of management for the harbour.

F. RELEVANCE TO CHALLENGE OBJECTIVE

The key aim of *T1 Awhi Mai Awhi Atu* is to co-develop and co-produce marine research that actively positions tikanga and mātauranga Māori as a fundamental approach alongside western science to better understand degradation and assist recovery of marine mahinga kai, taonga species, and rohe moana (traditional marine area) for present and future generations. This is consistent with the principle of kaitiakitanga or active guardianship for the improved health of our seas, including an enhanced blue economy and the identification of benefits, costs and opportunities for Aotearoa New Zealand. The bringing together of different knowledge systems to improve decision-making capabilities using a kaitiakitanga based approach to EBM actively supports the Challenge objective: *To enhance utilisation of our marine resources within environmental and biological constraints.*

This section provides an overview of the outputs described in Section G. It can be assumed that all outputs for this project will be grounded in mātauranga Māori as a normalised approach to research, kaitiakitanga, mana moana and EBM. All **MANUSCRIPTS/PAPERS** will be peer reviewed with a strong focus on a dual knowledge approach (mātauranga Māori with Western science). **REPORTS** will be peer reviewed and submitted to the OHIF for endorsement. Once approved the reports will be uploaded onto the Bay of Plenty Regional Council Ōhiwa Harbour webpage. **MODELS, TOOLS, FRAMEWORKS** will be co-developed and co-implemented with hapū, iwi and regional council. **MAPS/PRESENTATIONS** will be co-developed with hapū, iwi and used to share information, communicate and promote mātauranga Māori with Western science and a kaitiakitanga based approach to EBM (locally, regionally, nationally and internationally). NB: all outputs are inclusive of mātauranga Māori and Western science.

G. OUTPUTS	This project will produce the following Outputs:	Linked to which Theory of Change Outputs:	Explain briefly your plan to ensure uptake by iwi and stakeholders:
	<ol style="list-style-type: none"> 1. A co-developed, co-implemented tool using mātauranga Māori plant waste biotechnology is trialled with hapū/iwi and used to assist shellfish recovery in the harbour. 2. A 2D hydrodynamic model developed in collaboration with Regional Council to inform habitat suitability index (HIS) for shellfish recovery in the harbour. 3. Report identifying seastar management options to assist decision-making of hapū/iwi and OHIF. 4. A series of maps, visual distribution of 1) contemporary mussel recovery sites; 2) mātauranga Māori and Western science baselines of traditional and contemporary shellfish distribution; and 3) seastar distribution to assist science communication, visual aids to inform decision-making for hapū/iwi, OHIF and stakeholders. 5. Four short reports submitted to the Bay 	<p>a) Biophysical and socio-ecological knowledge that supports the development of understanding and tools that underpin EBM as a viable approach to managing Aotearoa New Zealand's marine environment developed and accessibly packaged.</p>	<ul style="list-style-type: none"> • All manuscripts and reports will be co-developed with hapū, iwi, regional council and will provide peer reviewed information to assist practical examples of a kaitiakitanga based approach to EBM. • Models and tools will be co-developed with hapū, iwi and in collaboration with regional council and used by council staff and hapū/iwi kaitiaki. • Maps will be used to communicate science knowledge and assist decision-making for the OHIF, te rōpū kairangahau, hapū/iwi, regional council and stakeholders. • Presentations will be used to 1) disseminate information learned; 2) assist co-development conversations for next stage actions and problem posing; 3) share learnings with hapū/iwi, councils, te ropu kairangahau, stakeholders; 4) share information a locally, regionally, nationally, internationally.

	<p>of Plenty Regional Council, uploaded to the Ōhiwa Harbour webpage for agreed public access.</p> <p>6. Three marae based wānanga to promote the sharing of knowledge, capability building between researchers, regional council and hapū/iwi partners.</p> <p>7. Ten presentations via: conferences, wānanga, OHIF co-management forum, seminars, symposiums, hui-ā-iwi, kōmiti marae, lectures, invited speakers to share research learnings, assist and support other hapū/iwi and coastal communities access to pragmatic, hands-on examples of a kaitiakitanga based approach to EBM.</p> <p>8. Three indigenous / scientific manuscripts/papers co-written with hapū/iwi providing detail on the findings of seastars, shellfish habitat suitability index, shellfish management action plan, natural plant waste biotechnology, shellfish distribution and abundance including a popular article for the Challenge website to promote wider access for any interested parties and replicate, as appropriate.</p> <p>9. A tool that integrates and communicates mātauranga Māori with current understandings and assessments of risk and uncertainty to assist decision-making for Ōhiwa Harbour.</p>		
	<p>10. One indigenous / scientific manuscript/paper detailing the co-development of mātauranga Māori and Western science research methods and methodologies of learnings and lessons from the research project, to promote wider access for interested parties and replicate, as appropriate.</p> <p>11. One co-developed mātauranga Māori and ecological shellfish management action plan (SMAP) presented to OHIF for endorsement into Bay of Plenty Regional Council annual workplan for Ōhiwa harbour.</p>	<p>(b) Traditional, local and other cultural knowledge that supports EBM is captured, understood, recognised.</p>	<ul style="list-style-type: none"> • Wānanga, hui-a-iwi, presentations • Mātauranga Māori and ecological shellfish management action plan (SMAP) used by Bay of Plenty Regional Council to assist decision-making and action management priorities for the Ōhiwa harbour, consistent with the Number One priority management action in the Ōhiwa Harbour Strategic Plan 2014 (refreshed).

<p>H. OUTCOMES</p>	<p>This project will contribute to the following Theory of Change Outcomes:</p> <ul style="list-style-type: none"> • (2) Decision making practices are more inclusive, multi-sectorial and account for the effects from cumulative and multiple activities are adopted • (4) The complementarity of local expressions of Kaitiakitanga and EBM are well understood and enabled • (6) EBM practices are understood and accepted as a viable approach by decision makers, stakeholders and iwi • (8) Researchers and iwi and stakeholders involved during the life of the Challenge continue to actively promote, research in, and use knowledge from the Challenge
--------------------	---

I. INTRODUCTION

For coastal Māori there is a growing demand to investigate alternative ways of engaging with western science to better understand degradation and assist recovery initiatives for culturally and ecologically important shellfish species in soft-bottomed harbours. Māori aspire to live in sustainable communities with access to up-to-date evidence-based information to assist decision-making and marine management actions. Identifying ways in which hapū/iwi driven scholarship and place-based participatory practice can be captured

and incorporated through co-developed transdisciplinary tools to assist culturally important rohe moana (traditional marine areas), is a high priority.

Situated in the Eastern Bay of Plenty, Ōhiwa Harbour is regarded as one of the most natural harbours in Aotearoa New Zealand with high conservation and outstanding wildlife values. With its geographical location, geological history and range of important ecological habitats and cultural sites of significance, Ōhiwa Harbour is recognised as having outstanding natural features and landscape values (ONFL). It is recognised locally, regionally and nationally as an area of significant ecological and cultural importance (BOPRC, 2013). Situated within the ancestral homelands of Ngāti Awa, Te Ūpokorehe, Te Whakatōhea and Waimana Kaakū, Ōhiwa is steeped in the significant history of Māori who have lived and harvested from the harbour and its environs for centuries. For Māori, the harbour is an important mahinga kai (food harvesting area) for shellfish and seafood (Morrison 2007). It is widely understood that Māori knowledge of the abundant food resources of Ōhiwa have endured for many consecutive generations (BOPRC 2008).

Unfortunately, throughout the years increased harvesting pressures, seastar predation, sedimentation and other changing environmental conditions have taken its toll on the harbour's shellfish (MacKenzie 2013; BOPRC 2014). In particular, the traditional green lipped mussel (*Perna canaliculus*) have struggled to maintain their existence in the once abundant food basket of Ōhiwa. Mussels are an important intergenerational source of mātauranga Māori and food resources for Māori. The mussels occur in dense beds, creating large reefs on soft bottom environments which increase diversity by providing habitat for a number of species including fish; and food availability for predators such as the eleven-armed sea star. As filter feeders, mussels help improve water clarity and quality by removing detritus from the water column, reduce sediment re-suspension by reproducing biodeposits and improve light availability (McLeod 2011; McLeod et al. 2013). Mussel reefs also help control nitrogen from land derived sources by promoting denitrification (MacKenzie 2013). They are an important socio-cultural-ecological species and are considered a significant marine taonga for Māori. However, over the years there has been increasing concern about the state of the mussels in Ōhiwa Harbour. For hapū/iwi the practice of kaitiakitanga and the need to actively combine and implement mātauranga Māori with western science to better understand a degrading harbour and assist recovery of shellfish/mussels has become a priority (Paul-Burke et al, 2018). This priority has resulted in strong support from surrounding communities and government agencies promoting shellfish as the number one management action in the refreshed Ōhiwa Harbour Strategy 2014.

J. AIMS

- RA1. How do we bring together mātauranga Māori and science to better understand habitat connectivity as it applies to the unique social, cultural and ecological context of Ōhiwa Harbour?
- RA2. How can we co-develop opportunities to grow a blue economy informed by mātauranga Māori principles of whanaungatanga, kaitiakitanga, manaakitanga, rangatiratanga and whai rawa?
- RA3. How do we better estimate and communicate the risks and uncertainties of a dynamic and complex Ōhiwa system?
- RA4. What frameworks, policies and tools do we need to apply a kaitiakitanga based approach to EBM in the planning and implementation of management for Ōhiwa Harbour?

K. PROPOSED RESEARCH

Previous research in Ōhiwa Harbour includes: In 2007, mātauranga Māori was used as the baseline to assist western science sub-tidal surveys of the traditional mussel population in the western side of Ōhiwa Harbour. A mussel reef nearly 2 km in length was observed with an estimated 112 million mussels present and 90% of the population identified as new recruits. Between 2007 and 2013 the mussel population in the western side declined from 112 million to 2 million (Paul-Burke & Burke 2014). In 2016, the western side was re-monitored and for the first time the traditional beds on the eastern side were mapped and surveyed using the same mātauranga Māori and western science methodology as 2007. Results found that 2 of 3 traditional beds in the eastern side were no longer present 99% of the original 2007 mussel bed had disappeared with an estimated 485,000 mussels in the harbour (Paul-Burke et al 2018). In 2019, an estimated 78,000 mussels remained in the harbour. In 2009, 672 tonnes or 1.2 million *Coscinasterias muricata*, eleven-armed sea star were observed with mussels in the western side (Paul-Burke 2012, Paul-Burke and Burke 2014). In 2019, 100,000+ sea stars were observed in a 2 ha traditional pipi bed in the harbour. Sea stars are voracious predators of mussels and other shellfish (Paine 1966, 1971; Paine et al. 1985; Paul-Burke & Burke 2015; Wilcox 2017) and are thought to be the main cause of decline in mussels, pipi and cockles in the harbour (Paul-Burke et al 2018; Wilcox & Jeffs 2019, Bay of Plenty Regional Council, 2014).

T1 Awhi Atu Awhi Mai has arisen from the needs, issues, aspirations and priorities of Māori for Ōhiwa Harbour. It will employ a collaborative, transdisciplinary approach, with hapū/iwi and researchers to answer specific questions co-developed and designed by Māori and supported by the co-management Ōhiwa Harbour Implementation Forum. This includes combining mātauranga Māori, local kaitiakitanga and western science to better understand the degrading harbour and promote recovery, in particular but not limited to, the once abundant but now severely reduced mussel reefs and shellfish of Ōhiwa Harbour. This is to be achieved by the following research aims (RA) below:

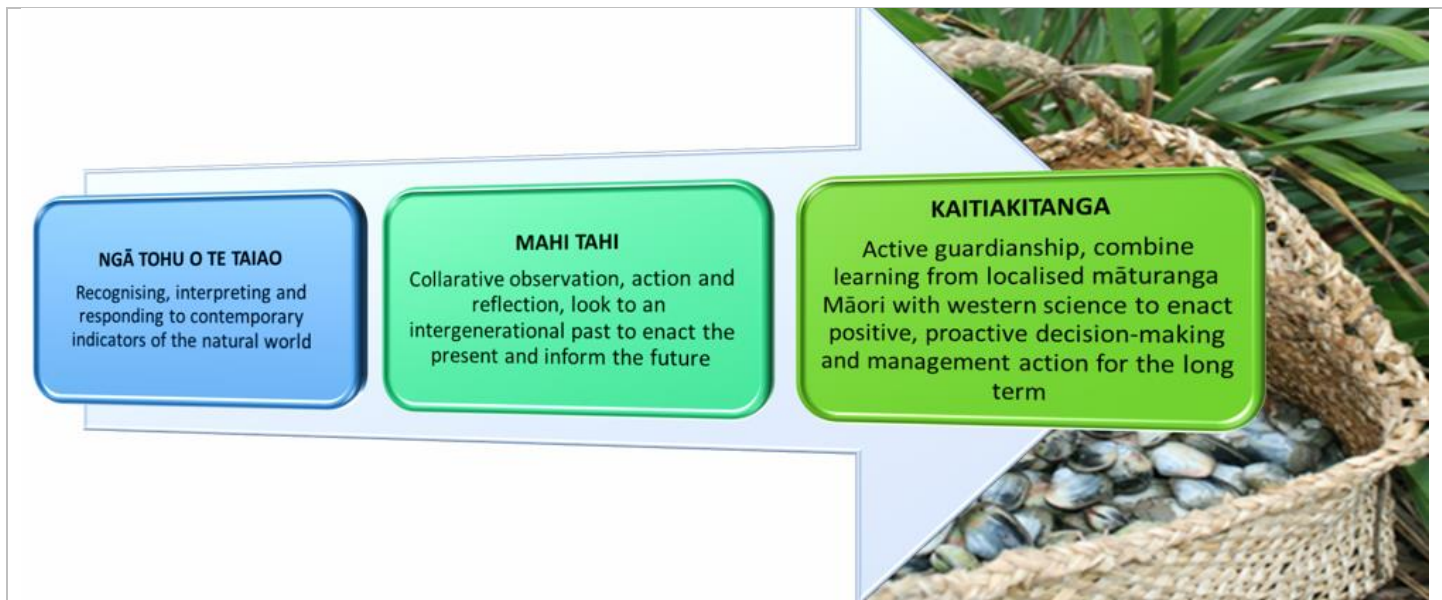


Figure 1. Ngā tohu o te Taiao, visual representation of the co-developed research aims for Awhi Mai Awhi Atu.

NGĀ TOHU O TE TAI AO: Recognising, interpreting and responding to contemporary tohu or environmental signs, signals and indicators of the natural world.

RA1: Combine a novel kaupapa Māori-based 4-dimensional (4D) approach with western science to assist understandings of the harbour. This research aim **focuses on the cumulative effects, multiple use stressors to support increased attention on land-sea interactions and the impacts of/on human socio-cultural-ecological connectivity.** It is strongly aligned and will work in cohesion with *1.1 Understanding ecological responses to cumulative effects* and *T3 Ngā tohu o te Ao*. This aim has two parts. **Part One**, focuses on an over-abundant predator *Coscinasterias muricata*, eleven-armed sea star as a contemporary tohu of a degrading Ōhiwa system. Local kaitiaki are clear when they ask why are there so many sea stars, how can we manage them? Sea stars are important keystone predators in many marine ecosystems (Menge & Sanford 2013) and have been identified as a species whose feeding activities often controls the distribution of associated species within an ecosystem (Lamare et al 2009). They play a major role in structuring subtidal benthic communities like mussels and other shellfish. The role of sea stars in benthic communities depends not just on the abiotic environment and characteristics of the predators themselves but also on prey characteristics (Menge & Sanford 2013). Sea star predation is a stressor that has potential to impose a significant limitation on the success of shellfish recovery efforts (Wilcox & Jeffs 2019). As a key component of tohu (recognising, interpreting and responding to ecological indicators/stressors) and kaitiakitanga (active guardianship), this research aim will quantify: the distribution and abundance of the sea star inside and outside of Ōhiwa; population dynamics (size frequency), reproduction, settlement, recruitment rates and behaviour as it relates to migration or movement about the harbour; relationships between feeding efficiency and predator/prey size and increased predation in a stressed Ōhiwa system. Finally, RA1 will identify and provide seastar management options and recommendations for the long term. All field work will be co-developed and co-implemented with hapū/iwi inclusive of wānanga to capture localised mātauranga Māori understandings of sea stars, to better understand degradation, identify seastar control options, assist recovery and manage threats that limit the recovery of traditional shellfish/mussel reefs (Jeffs & zu Ermgassen 2019) in Ōhiwa Harbour. Other hapū/iwi around the country have expressed similar concerns in their rohe moana with a keen interest in this research aim. Under the principal of manaakitanga, it is anticipated that the findings will be shared via hui (tribal meetings), wānanga, scientific and indigenous publications and conferences.

Part Two, builds on from part one and the previously discussed research (above) undertaken in the harbour between 2007-2019. Currently, 3 of the 4 traditional intergenerational mussel beds have disappeared from the harbour. If hapū/iwi were to initiate recovery efforts of mussels and other taonga shellfish species such as; pipi; cockle (*Austrovenus stutchburyi*), in the harbour, what/where are optimal sites to improve shellfish recovery success and at the same time promote recovery of the harbour. To assist these questions, this aim will co-develop a 2D hydrodynamic model at the request of and in collaboration with the Bay of Plenty Regional Council to assist better understanding of the distribution and movement of nutrients (food), sediments, shellfish larvae (Butman et al 1994; Cancino & Neves 1999, McQuaid & Phillips 2000) and the role of local tidal patterns as regulating food and larval supply to assist site predications for shellfish recovery [Lundquist et al 2009; Elasher et al 2013]. The 2D hydrodynamic model will be created using interpolated bathymetric and environmental data, this requires carrying out a hydrographic survey (to create a bathymetric grid) and instrument deployment (environmental data). *This is new information, as it will be the first time this type of work has been carried out in Ōhiwa Harbour.* The second phase of the research will be to co-develop a natural-history-based mussel habitat suitability index (HSI) model for the harbour. This will be achieved by combining localised mātauranga Māori with western science literature to define habitat variables important for mussel survival, growth and recruitment (Aswani 2006; Wehi et al 2009; Pollack et al 2012; Lewis et al 2019). Collection of environmental spatial data will be sourced from field work and already collected

data of which sediment samples are included. The third phase will be to validate the predicted outputs from the models (locations that the models predict, from unsuitable to highly suitable habitats for mussels and other shellfish such as pipi and cockle, by translocating mussels collected within the Harbour, to various locations, reviewing and analysing mussel growth against predicted outputs. This may include employing a combination of cages and sea star relocation methods, as required. The final outcome will be a habitat suitability map informed by localised mātauranga Māori and western science to assist decision-making and management strategies for marine taonga shellfish species in the Harbour.

MAHI TAHI: Collaborative observation, action and reflection, look to an intergenerational past to enact the present and inform the future.

RA2: This research aim works in tandem with RA1. It seeks to **enable and empower Māori co-innovation initiatives with the co-development and co-production of a mātauranga Māori process for a bio-technological resource/product to assist shellfish recovery in soft-bottom harbours.** This research aim is linked to *1.1 Understanding ecological responses to cumulative effects* and *T2 Huataukina o hapū e!* It investigates the co-production of a mātauranga Māori tool using natural plant waste materials to promote shellfish recovery; enhance a bio-circular economy and reduce plastic pollution in the Harbour. The research will provide tangible examples of how Māori innovation can contribute to a circular economy informed by mātauranga Māori principles, and seek to identify the benefits and opportunities for Māori and Aotearoa New Zealand. The stocks of mussels within Ōhiwa harbour will be enhanced through the deployment of both artificial (commercial) and mātauranga Māori (natural fibres based) spat settlement lines. Mātauranga Māori lines naturally biodegrade through time, ultimately falling to the seafloor to enhance seafloor mussel stocks and provide structure for further spat settlement. A number of mussel lines have already been successfully trialled in the harbour, where spat from the harbour has settled and grown through to adult mussels, on both artificial and mātauranga Māori lines. These efforts will be ramped up throughout the duration of this project. This will involve not only the deployment of additional lines, but also the analysis of the number and characteristics of mussels each line supports. This will assist with determining whether this approach is a viable interim solution to enhance and retain natural mussel stocks in Ōhiwa harbour. A combination of mātauranga Māori and western science will be used to inform where the spat lines are deployed, and ultimately where the adult mussels are redistributed to the seafloor. Other coastal hapū/iwi have expressed keen interest in the findings of this research aim, the results will be shared consistent with RA1.

RA3 will co-design a tool/model that integrates and communicates mātauranga Māori with current understandings and assessment of risk and uncertainty to assist decision-making for Ōhiwa Harbour. RA3 builds on from the previous 2 research aims and will investigate how we could assist decision-making by better estimating and communicating the risks and uncertainties of a dynamic and complex Ōhiwa system. This will be achieved with the co-development of a tool/model that integrates mātauranga Māori into current understandings and assessments of risk and uncertainty. Using a combination of wānanga/workshops, this project will work with local kaitiaki and pūkenga (traditional environmental experts) to investigate a range of modelling approaches (e.g. bayesian networks, regression modelling, structural equation modelling, species distribution models) to generate combined mātauranga Māori and ecological based tools to inform management decisions for the harbour and assist enhancement of mussel stocks in the future. (Lamb et al. 2014, Ban et al. 2015, Mantyka-Pringle et al. 2017, Stephenson et al. 2018, Bulmer et al. 2019, Lewis et al. 2019, Lohrer et al. 2019). This RA will work with closely *3.2 Communicating risk and uncertainty to aid decision-making* and *1.2 Tools for incorporating ecological responses to cumulative effects into management action.*

KAITIAKITANGA: Active guardianship, combine learnings from localised mātauranga Māori with western science to enact positive, proactive decision-making and management action for the long term.

RA4: will bring together the learning/tools/models from RA1, RA2 and RA3 with a **co-developed kaitiakitanga based approach to EBM marine management plan for Ōhiwa Harbour to inform and influence policy frameworks and work programmes of the Bay of Plenty Regional Council.** Using wānanga/workshops and field activities, this research aim will work with te rōpū kairangahau to co-develop a shellfish management action plan (SMAP) for the harbour. The SMAP will focus on identified taonga shellfish species; mussels, pipi and cockle, as species most under threat from seastar predation. This will include using localised mātauranga Māori as the baseline with which to map taonga pipi and cockle distribution in the harbour, consistent with previous mussel maps/surveys and as per the identified priorities of hapū/iwi and Regional Council. The purpose of the SMAP will be to provide a practical, action-oriented roadmap to support knowledge management, information sharing and decision-making capabilities of Māori and Governmental representatives in an accessible, easy to understand and culturally appropriate manner (Sarka 2014). The SMAP will be presented to the OHIF for feedback, final approval and endorsement, resulting in the SMAP being implemented into the Bay of Plenty Regional Council annual workplan for Ōhiwa Harbour and consistent with the management actions/visions of the non-statutory Ōhiwa Harbour Strategic Plan 2014 (refreshed) It is intended that the combined 4 research aims of *T1 Awhi Mai, Awhi Atu*, will culminate in a positive, proactive exemplar of a kaitiakitanga based approach to EBM marine management in practice.

L. LINKS TO PHASE I RESEARCH

This project has synergistic connections with many projects in Phase I, these include:

- 1.1.1 Testing EBM-supportive participatory processes for marine management
- IF 1.3.2 Enabling inter-agency collaboration on cumulative effects

- 2.1.2 Mauri moana, mauri tangata, mauri ora – Documenting social values
- 2.2.2 Huataukina tō iwi e: Developing marine bioactive economic opportunities from Tairāwhiti kina to combat diabetes, heart disease and inflammation.
- 3.1.1 Hui-te-ana-nui: Understanding kaitiakitanga in our marine environment
- 3.1.3 Tāhuhu Matatau Te Ao Tangaroa: Empowering kaitiaki
- 3.3.2 Whaia te Mana Māori Whakahaere Tōtika ki Tangaroa: In pursuit of Māori governance jurisdiction models over marine resources
- 4.2.1 Tipping points in ecosystem structure, function and services

M. LINKS TO & INTERDEPENDENCIES WITH PHASE II RESEARCH PROJECTS

- 1.1 Understanding ecological responses to cumulative effects – especially with respect to the hysteresis in recovery of shellfish populations and recovery potential of disturbed habitat and including tohu to assist recovery.
- 1.2 Tools for incorporating ecological responses to cumulative effects into management action – with respect to marine spatial management tools that incorporate cumulative effects.
- 3.2 Communicating risk and uncertainty to aid decision-making – co-developing mātauranga Māori and ecological model of risk and uncertainty to assist decision-making for hapū/iwi and co-management forum.
- 4.1 Treaty Relationships and EBM – kaitiakitanga based approach to EBM, giving effective to Treaty partnership, rights and responsibilities.
- 4.2 Options for policy and legislative change to enable EBM, especially with the development of the SMAP with direct linking to the non-statutory Ōhiwa Harbour Strategic Plan 2014.
- 4.3 EBM and Kaitiakitanga, enabling and supporting the application of kaitiakitanga – pragmatic exemplars of practices/approaches to marine management that are underpinned by EBM principles and te ao Māori concepts.
- T2 Huataukina o hapū e! – knowledge communication, transfer and sharing, co-joint wānanga between rohe/kaitiaki to assist whanaungatanga, kaitiakitanga, manaakitanga, rangatiratanga and blue economy initiatives.
- T3 Ngā tohu o te ao – this project provides an example of how western science can be co-developed/communicated with/by kaitiaki.

N. VISION MĀTAURANGA (VM)

This project gives effect to Vision Mātauranga through direct incorporation of Māori knowledge, resources and people to generate a distinctive direction and contribution to research. Using two-way knowledge sharing, capability building wānanga/workshops, hui-ā-iwi/marae and meetings with Regional Council and OHIF the project is founded on partnerships and the reciprocal exchange and expression of capability development. To this end, *T1 Awhi Mai Awhi Atu* involves a team of Māori practitioners, researchers, hapū/iwi kaitiaki, regional council and stakeholders working together to co-create innovative responses and solutions for understanding degradation and assisting recovery in a stressed Ōhiwa Harbour system. Consistent with the principle of manaakitanga this project provides a unique, multi-disciplinary pathway to building the capabilities of Māori and non-Māori to engage and connect with mātauranga Māori, western science, localised kaitiakitanga and research. In so doing, better understand the relevance of science, research and technology in everyday life (solution-oriented, observations, ecology, biology, wild food sustainability, blue economy) and to address current and future issues, such as the role of localised mātauranga Māori and western science in creating a future which provides human services and promotes the protection and restoration of biodiversity (Berkett et al 2015).

Employing collaborative, pragmatic problem posing/solving workshops with practical hands-on field work opportunities for hapū/iwi, researchers and regional council staff, *Awhi Mai Awhi Atu* critically addresses ways in which mātauranga Māori can provide access to a range of new tools and techniques to help improve understandings of degradation, assist recovery and inform marine management strategies, for the long term. Using mātauranga Māori to assist understandings of ecosystem stability, recoverability and resilience across consecutive generations, including cultural managerial approaches, is an important tool for contemporary marine management in Aotearoa New Zealand (MfE & Stats NZ 2019). This project is distinctive, it seeks new ways to access and implement localised mātauranga Māori with western science and research, by developing a body of knowledge that will assist better understandings and explanations of a dynamic and uncertain seascape. This project is initiated, developed and led by Māori, grounded in tikanga and localised mātauranga Māori for the direct benefit of Māori, our wider communities and Aotearoa New Zealand. This project provides a platform to promote and energise Māori voices, aspirations, ideas, practices and knowledge, to actively assist the sustainable future of marine ecosystems for present and future generations.

Vision Mātauranga Deliverables

Partnerships:

VM P1. The project has been co-developed through a range of long-lived existing relationships with hapū/iwi and local Government agencies. Existing relationships include: Te Rūnanga o Ngāti Awa, Te Upokorehe Resource Management Team, Te Whakatōhea Māori Trust Board, Waimana Kaakū, Bay of Plenty Regional Council, Ōpōtiki and Whakatāne District Councils.

VM P2. The project will be co-implemented with hapū, iwi members (iwi resource management officers and teams, local kaitiaki, kaumātua advisory group – te rōpū kairangahau) involved at all levels and all stages of the research. Co-implementation further includes the provision of reciprocal two-way skill, capacity and capability co-development and co-production prior to the uptake of all design, actions, and reporting with research partners at each identified stage of the research design.

Distinctive Contribution:

VM D1. The project will result in distinctive and innovative outputs specifically tailored to Māori interests including wānanga, hui-ā-iwi, kōmiti marae, kaitiaki taiao, workshpos, fieldwork activities, tamariki moana (marine youth).

VM D2. The project outputs are aligned with the identified issues and priorities of hapū/iwi partners.

Meaningful Outcomes:

VM M1. The project has a clear and robust pathway for the development of Māori researchers for example: 1x Māori marine PhD; 1x Māori Environmental/Social Science PhD; 1x iwi research assistant; annual marae based wānanga; 2-way kaitiaki field work capacity and capability development to better identify and reflect Māori aspirations by prioritising Māori issues and needs within the research design including investigating ways to use mātauranga Māori with western science to assist our harbour, our tikanga, taonga species and ultimately, ourselves.

VM M2. The project provides for the appropriate dissemination of knowledge and outputs to Māori, including hui-ā-iwi, marae hui, rūnanga annual reports and Māori centred publications, conference and wānanga presentations.

NOTE: Engagement (Section O below) includes: meetings with co-development hapū/iwi partner representatives of te rōpū kairangahau will be held a minimum 2 times a year at 6 monthly intervals. It is our experience and anticipated however, that ad hoc meetings may also occur dependent on unforeseen issues that may arise). Meetings are further supported with monthly group email discussions and/or review of relevant fieldwork/documents/papers/reports/plans/topical events. After these meetings the representatives return to their respective rūnanga, hui-ā- marae/iwi and/or kaitiaki resource management team to discuss. The researchers are usually required and/or invited to attend marae hui to discuss recent findings and how the wider whānau of each hapū/iwi wish to proceed with the next stage/steps. Researchers also meet with regional council a minimum 3 times a year coupled with consistent monthly email conversations. The co-management OHIF forum meetings are usually held every 6 months in March and September. The researchers submit a short report as an agenda item and present at every OHIF meeting, seeking endorsement of current activities/findings and approval to proceed to the next stage (NB: the next stage includes a logistical plan co-developed by hapū/iwi via the previous marae/hui-ā-iwi, which is then approved by te rōpū kairangahau prior to presenting to the OHIF). The principles of successful co-development through face-to-face availability/engagement are underpinned by a lived experience of tikanga Māori which are described below.

O. ENGAGEMENT REQUIRED WITH IWI AND STAKEHOLDERS

This project has been co-developed with hapū/iwi of Ōhiwa harbour. It is supported by the Bay of Plenty Regional Council and the seven partners of the co-management Ōhiwa Harbour Implementation Forum. This project has arisen from the issues, challenges, actions and aspirations of Māori and is grounded in **Whanaungatanga** - the principle of working in meaningful, genuine collaboration to influence how mātauranga Māori and western science principles and practices are translated operationally in ways that recognise cultural values, knowledge systems and opportunities. The principles of whanaungatanga include; **Kotahitanga** – the concept of mahi tahi or working together to achieve a common goal. **Manaakitanga** – highlights the responsibility to act, at-all-times, in a respectful manner that uplifts and enhances the mana or prestige of others. **Kaitiakitanga** – refers specifically to the obligation to care for the environment and taonga (culturally important) species and spaces. **Rangatiratanga** – promotes strategic coordination and affirmation when agencies contribute to collective decision-making (Waitangi Tribunal 2011). Co-development with hapū/iwi and stakeholders is foremost throughout the life of the project and beyond, as is consistent with tikanga Māori (Mead, 2003, Te Awekotuku 1999) a whanaungatanga approach to research (Paul-Burke et al, 2018) and the principles of kaitiakitanga (Jackson et al, 2018).

P. PROJECT COMMUNICATIONS

Project T1 has a number of positive and successful media/public communication partners established over the last 8 years. These include: Bay of Plenty Regional Council OHIF communications team; local newspaper/reporters for Whakatāne Beacon, Ōpotiki news, Te Whare Wānanga o Aotearoa website/media releases; Ngāti Awa te toki facebook page, Te Rūnanga o Ngāti Awa Annual Plan, Ngāti Awa Customary Fisheries Authority Annual Report; Ōhiwa Harbour community newsletters; signage and branding at all boat ramps of the harbour. More recent relationships include LEARNZ in conjunction with Sustainable Seas; University of Waikato research profiling/communications. Other project communications include scientific and indigenous conference presentations, publications, public symposium/seminars, Māori centric wānanga/hui-ā-iwi and recurring annual presentations to the MBIE VMCF Matangireia project; Whare Wānanga post-graduate lecture series and Department of Conservation marine ecosystems annual hui. We are currently exploring Māori Television via Te Karere and Te Ao with Moana as potential national Māori centric communication outlets.

Q. RISK & MITIGATION

Other hapū/iwi members wanting to insert themselves as a co-development partner. Mitigation measures include the following:

- Te Rōpū Kairangahau (named by Te Upokorehe kaumātua) has been developed to identify the long-standing participating hapū/iwi co-development partners; the local community researcher; and the project leaders, as the core research decision-making collective, who have co-designed and developed this project over many years.
- It was agreed that the members of Te Rōpū Kairangahau reserve the right to approve or decline new membership as a collective, if the issue arises.

Risk: intellectual and cultural property rights where hapū/iwi may wish to keep certain information closed to the public. Mitigation includes:

- Open conversation and shared agreement of what information is considered closed knowledge and what may be used publicly.

- This will be raised at the next Te Rōpū Kairangahau meeting; hui-a-iwi, and any other hui/meetings as deemed appropriate, and as an ongoing conversation if required

R. CONSENTS & APPROVAL
required to undertake
research

- Resource Consent RM18-0295-AP consent to occupy coastal space, use of structures in the coastal and marine area of Ōhiwa Harbour for the purpose of mussel restoration in designated areas of the harbour is granted. The consent shall expire on 31st May 2024. A copy of the resource consent is attached.
- Letter stating support to conduct the research project *Awhi Mai Awhi Atu: Enacting a kaitiakitanga based approach to EBM* endorsed by the seven elected partners of the co-management Ōhiwa Harbour Implementation Forum (OHIF), 19th September 2019. A copy of the letter is attached.
- Ethical approval will be required for the 2x Māori marine science PhD candidates (RA1 part 1 & 2) and will be undertaken as per their PhD ethical approval process with Waikato University.

S. REFERENCES

- Aswani, S., & Lauer, M. (2006). Incorporating fishermen's local knowledge and behavior into geographical information systems (GIS) for designing marine protected areas in Oceania. *Human Organization* 65 (1): 81-102.
- Ban, S. S., R. L. Pressey, and N. A. J. Graham. 2015. Assessing the Effectiveness of Local Management of Coral Reefs Using Expert Opinion and Spatial Bayesian Modeling. *PLoS ONE* 10: e0135465.
- Bay of Plenty Regional Council. [BOPRC], (2008). The Ōhiwa Harbour Strategy 2008. Whakatāne, New Zealand: Author.
- Bay of Plenty Regional Council. [BOPRC] (2013). State of the Ohiwa Harbour and catchment. Environmental Publication, 7, 1-76.
- Bay of Plenty Regional Council. [BOPRC] (2014a). Ōhiwa Harbour. Community Newsletter, 11, 1-4. March 2014.
- Bay of Plenty Regional Council. [BOPRC] (2014) Ōhiwa Harbour Strategy Refreshed 2014. Whakatāne, New Zealand: Author.
- Berkett N, Wade O, Cornelisen C, Newton M, Bell K, 2015. Guiding coastal and marine resource management: The Coastal Special Interest Group Research Strategy. Prepared for C-SIG.
- Bulmer, R. H., F. Stephenson, and J. E. Hewitt. 2019. Exploring the impact of multiple stressors on estuarine ecosystems using a Bayesian Network model. Prepared by NIWA for the Parliamentary Commissioner for the Environment. Report number 2019246HN.
- Butman, C. A., Freécheette, M., Geyer, W. R., & Starczak., V. R. (1994). Flume experiments on food supply to the blue mussel *Mytilus edulis* L. as a function of boundary-layerflow. *Limn. Oceanogr* 38(7): 755-1768.
- Cancino, L., & Neves, R. (1999). Hydrodynamic and sediment suspension modelling in estuarine systems Part 1: Description of the numerical models. *Journal of Marine Systems* 22: 105–116.
- Elsäßer, B., Fariñas-Franco, J. M., Wilson, C. D., Kregting, L., & Roberts, D. (2013). Identifying optimal sites for natural recovery and restoration of impacted biogenic habitats in a special area of conservation using hydrodynamic and habitat suitability modelling. *Journal of Sea Research* 77: 11-21.
- Handley, S. 2017. Advice for mussel restoration trials in Pelorus Sound/Te Hoiere, Marlborough. Report prepared for Marlborough District Council, June 2017. NIWA client report No: 2017215NE.
- Jackson, A.M., Mita, N., Hakopa, H. (2017). Hui-te-ana-nui: Understanding kaitiakitanga in our marine environment. *Ko ngā moana whakauka: Sustainable Seas National Science Challenge, 2017: Ministry of Business Innovation and Employment.*
- Jeffs, A., & zu Ermgassen, P. 2019. Shellfish reef restoration: Beyond oyster reefs. In: *Restoration Guidelines for Shellfish Reefs* (eds. J. Fitzsimons, S. Branigan, R.D. Brumbaugh, T. McDonald and P.S.E. zu Ermgassen), pp. 2-6. The Nature Conservancy, Arlington VA, USA.
- Lamare, M., Channon, T., Cornelisen, C., & Clarke, M. (2009). Archival electronic tagging of a predatory sea star: Testing a new technique to study movement at the individual level. *Journal of Experimental Marine Biology and Ecology*, 373, 1-10.
- Lamb, E. G., K. L. Mengersen, K. J. Stewart, U. Attanayake, and S. D. Siciliano. 2014. Spatially explicit structural equation modelling. *Ecology* 95:2434-2442.
- Lewis, N. S., Fox, E. W., & DeWitt, T. H. (2019). Estimating the distribution of harvested estuarine bivalves with natural-history-based habitat suitability models. *Estuarine, Coastal and Shelf Science* 219: 453-472.
- Lohrer, A., F. Stephenson, E. Douglas, and M. Townsend. 2019. Mapping the estuarine ecosystem service of pollutant removal using empirically validated boosted regression tree models. *Ecological Applications*, in review.

- Lundquist, C. J., Olman, J. W., & Lewis, M. J. (2009). Predicting suitability of cockle *Austrovenus stutchburyi* restoration sites using hydrodynamic models of larval dispersal. *New Zealand Journal of Marine and Freshwater Research* 43: 735–748.
- Mackenzie, H. 2013. State of the Ohiwa harbour and catchment (Environmental Publication 2013/07). Whakatāne, New Zealand: Bay of Plenty Regional Council.
- Mantyka-Pringle, C. S., T. D. Jardine, L. Bradford, L. Bharadwaj, A. P. Kythreotis, J. Fresque-Baxter, E. Kelly, G. Somers, L. E. Doig, P. D. Jones, and K.-E. Lindenschmidt. 2017. Bridging science and traditional knowledge to assess cumulative impacts of stressors on ecosystem health. *Environment International* 102:125-137.
- McLeod, I., Parsons, D., Morrison, M., Le Port, A., & Taylor, R. (2011). Factors affecting the recovery of soft-sediment mussel reefs in the Firth of Thames, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 63(1), 78-83.
- McLeod, I., Parsons, D., Morrison, M., Van Dijken, S., & Taylor, R. (2013). Mussel reefs on soft sediments: a severely reduced but important habitat for macroinvertebrates and fishes in New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 48(1), 48-59. doi:10.1080/00288330.2013.83483
- McQuaid, C. D., & Phillips, T. E. (2000). Limited wind-driven dispersal of intertidal mussel larvae: in situ evidence from the plankton and the spread of the invasive species *Mytilus galloprovincialis* in South Africa. *Mar Ecol Prog Ser* 201: 211–220.
- Mead, H. M. (2003). *Tikanga Māori: Living by Māori values*. Wellington, New Zealand: Huia Publishers.
- Menge, B. A., & Sanford, E. (2013). Ecological role of sea stars from populations to meta-ecosystems. In J. M. Lawrence (Ed.), *Starfish: Biology and ecology of the Asteroidea* (pp. 67-80). Baltimore, MD: The John Hopkins University Press.
- Ministry for the Environment. (2017). *Statement of Intent 2017-2021*. Wellington, New Zealand: Author.
- Morrison, M. (1996). Ōhiwa harbour green lipped mussel (*Perna canaliculus*) population assessment: Results of the 1996 survey and a collation of the historical time series from 1978-1996 (Unpublished draft technical report for the Ministry of Fisheries). Wellington, New Zealand: NIWA.
- Paine, R. T. 1971. A short-term experimental investigation of resource partitioning in a New Zealand rocky intertidal habitat. *Ecology* 52:1096-1106.
- Paine, R. T. 1974. Intertidal community structure. Experimental studies on the relationship between a dominant competitor and its principal predator. *Oecologia* 15:93-120.
- Paine, R. T., J. C. Castillo, and J. Cancino. 1985. Perturbation and recovery patterns of starfish-dominated intertidal assemblages in Chile, New Zealand, and Washington State. *The American Naturalist* 125:679-691.
- Paul-Burke, K. 2007. Baseline survey of Kuku, *Perna canaliculus*, Green lipped mussels in Ōhiwa Harbour. Client report for Environment Ngāti Awa, Te Rūnanga o Ngāti Awa, Whakatāne, NZ.
- Paul-Burke, K. & Burke, J. 2014. *Perna canaliculus*, Green Lipped Mussel Populations Ōhiwa Harbour. Client report for Bay of Plenty Regional Council, Ōhiwa Harbour Strategic Consultation Group, January 2014. Whakatāne, NZ.
- Paul-Burke, K. & Burke, J. 2015. Report on the findings of sub-tidal monitoring in Tauranga Moana Mātaitai reserve: Client report for Tauranga Moana Iwi Customary Fisheries Trust, Port of Tauranga, Te Whare Wānanga o Awanuiāngi, Tauranga, NZ.
- Paul-Burke, K. & Burke, J. (2016). Report on the findings of sub-tidal sampling surveys of *Perna canaliculus* Green Lipped Mussel populations in Ōhiwa harbour 2016. Report prepared for the Ōhiwa Harbour Strategic Coordination Group and Te Ūpokorehe Resource Management Team. Whakatane, New Zealand: Bay of Plenty Regional Council.
- Paul-Burke, K. (2017). Māori marine management In. P. Kayes (Ed.). *Te Taiao Rangahau ki Te Whare Wānanga o Awanuiārangi – Environmental Research at Te Whare Wānanga o Awanuiārangi*. (Chapter 2). Te Whare Wānanga o Awanuiārangi, Whakatāne, New Zealand.

- Paul-Burke, K., Burke, J., Te Ūpokorehe Resource Management Team, Bluett, C., & Senior, T. 2018: Using Māori knowledge to assist understandings and management of shellfish populations in Ōhiwa harbour, Aotearoa New Zealand, *New Zealand Journal of Marine and Freshwater Research*, DOI: 10.1080/00288330.2018.1506487
- Pauly, D. 1995. Postscript: Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology and Evolution*, 10(10), 430.
- Pollack, J. B., Cleveland, A., Palmer, T. A., Reisinger, A. S., & Montagna, P. A. (2012). A Restoration suitability Index Model for the Eastern Oyster (*Crassostrea virginica*) in the Mission-Aransas Estuary, TX, USA. *PloS One* 7: e40839. doi:10.1371/journal.pone.0040839.
- Sarka, H. 2014. Tools of internal communication from a knowledge transfer perspective. *Journal of Competitiveness*. Vol. 6, Issues, 4, pp.50-62, December 2014. DOI: 10.7441/joc.2014.04.04
- Stephenson, F., J. R. Leathwick, S. W. Geange, R. H. Bulmer, J. E. Hewitt, O. F. Anderson, A. A. Rowden, and C. J. Lundquist. 2018. Using Gradient Forests to summarize patterns in species turnover across large spatial scales and inform conservation planning. *Diversity and Distributions* 24:1641-1656.
- Te Awēkotuku, N. (1991). *He tikanga whakaaro: Research ethics in the Māori community*. Wellington, New Zealand: Manatu Māori.
- Waitangi Tribunal. (2011). *Ko Aotearoa tēnei: A report into claims concerning New Zealand law and policy affecting Māori culture and identity (WAI 262)*. Wellington, New Zealand: Legislation Direct.
- Wehi, P. M., Whaanga, H., & Roa, T. (2009). Missing in translation: Maori language and oral tradition in scientific analyses of traditional ecological knowledge (TEK). *Journal of the Royal Society of New Zealand* 39: 201-204.
- Wilcox, M. (2017). *Population dynamics of restored green-lipped mussel (Perna canaliculus) beds in the Hauraki Gulf, New Zealand*. PhD Thesis. University of Auckland, Auckland, New Zealand.
- Wilcox, M. & Jeffs, A. 2019. Impacts of sea star predation on mussel bed restoration. *Restoration Ecology*. Vol. 27, No.1, pp.189-197.