A. PROJECT TITLE	Modelling the social-ecological outcomes of community-based interventions
"SHORT" TITLE	Modelling restorative economies
B. THEME / PROGRAMME	Degradation and recovery / EBM in action

C. RESEARCH SUPERVISORS

Role	Name	Institution / company	Email
	Eva Siwicka	University of Auckland	e.siwicka@auckland.ac.nz
	Simon Thrush (1.1 Co-Lead)	University of Auckland	
	Kura Paul-Burke (T1/1.1 lead/co-lead)	University of Waikato/MUSA Environmental	
	Nick Lewis (BE Theme Leader)	University of Auckland	
	Sandra Cortés Acosta (2.2 researcher)	EnviroStrat	
	Karen Fisher (EBM Theme Leader, 4.2)	University of Auckland	
	Eric Jorgensen	Ocean Bay Farms (and 4.2)	

D. INTRODUCTION

Increasingly resource managers around the world are focussing not only on preventing degradation but on advancing the recovery of already degraded natural environments, while also working towards fair and just social outcomes of environmental restoration (e.g. fair sharing of costs and benefits). Similarly, marine conservation managers are faced with recovery and restoration rather than preservation of pristine habitats and local coastal communities often wish for the restoration of a valued species or habitats. Recovery of ecological communities and ecosystems is thus central to the development of policies, plans and actions across all scales of marine governance and stewardship. Researchers, managers, and restoration practitioners have, over time, realised that, even when the focus is on an individual species, predictions of long-term success require understanding of recovery dynamics and management interventions focussed beyond the single species. This brings us to a re-focusing on *Management for Recovery*. This realisation and the multiple drivers of degradation place the science and management required firmly into the realm of ecosystem-based management.

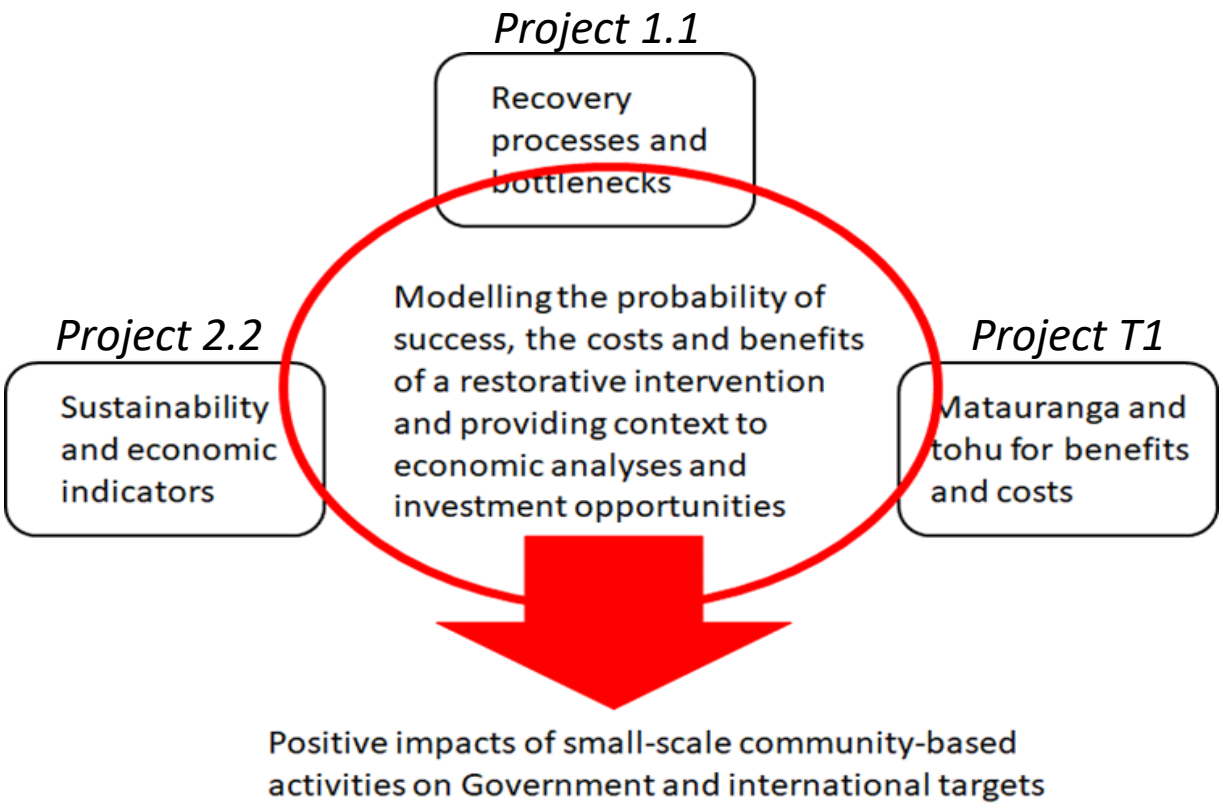
Aotearoa-New Zealand is behind many nations in the restoration of coastal marine ecosystems. A key component of successful recovery initiatives internationally has been building from the ground up in communities because people become invested in the outcome. In A-NZ, community- and iwi-led support for coastal restoration initiatives is very high, however gaining traction and support from regional and central government has been difficult because the benefits (social, ecological and economic) have been hard to quantify. In order to bridge this gap, it is important to understand the characteristics of a social-ecological system that will lead to successful outcomes and develop indicators of success to build investment confidence. Currently lacking is a social-ecological modelling framework that links three critical components that determine the "benefits" of recovery-focused actions; ecological recovery processes (hysteresis, scale, bottlenecks), social processes (institutional bottlenecks, process lock-in and power), and sustainability (economic indicators and Mātauranga Māori tohu).

This 2-year Post-doc will be taken up by Dr Eva Siwicka (UoA) who is well placed to undertake this research having recently completed her PhD on modelling ecosystem services and multifunctionality that was funded by Sustainable Seas (Phase 1). Dr Siwcka has also completed a MSc in Ecosystem Services at the University of Edinburgh. Her PhD research involved her in developing techniques to look at the composition of functional trait groups under stress using social network analysis and developing a model of ecosystem functionality that connects changes in species composition to the simultaneous delivery of multiple ecosystem functions that underpin Natures Contributions to People. Her career trajectory means that Dr Siwicka is ideally positioned to link the following aspects of the three underpinning research projects in her 'connections' focused Social-Ecological Post-Doctoral Fellowship. She has the experience and willingness to

work in an interdisciplinary context, which will sit firmly at the interface of research conducted in T1, 1.1 and 2.2 (although see section H for other project linkages). Specifically, it will link:

Research in 1.1 Ecological responses to cumulative effects on disturbance-recovery dynamics, cumulative effects and hysteresis - has been identifying the ecological and environmental conditions that are most likely generate bottlenecks in passive recovery. Dr Siwicka will use this as a foundation to identify the social-ecological benefits of active restoration and where these benefits are most likely to accrue.
Research in T1 Awhi Mai Awhi Atu that weaves together Mātauranga, Kaitiaki and ecology to determine the "benefits" of restorative actions (including the outcomes expected/required) and the development of relevant infrastructure to rural Māori economies. Building on T1's identification of cultural benefits and opportunities. Dr Siwicka will be able to link fundamental ecological knowledge to cultural benefits and opportunities.
Project 2.2 Restorative marine economies' research on restorative economies and review of current practice in A-NZ provides measures that will allow a range of potential investors to assess the viability of restorative economy projects. This will allow Dr Siwicka to draw on the ways that investors consider benefits and costs of restoration.

These three active projects (1.1, 2.2, T1) all seek to support EBM with different forms of knowledge to engage different stakeholders. Dr Siwicka's synthesis project will work to develop heuristic tools to connect these elements of the Challenge and support opportunities to engage in restorative actions. This will add value to Sustainable Seas' projects by expanding ecological projects to cultural context and values; and blue economy to underpin it with ecology.



E. AIMS

The project aims to integrate and add value to our current research projects (1.1, 2.2 & T2) (see also section H) by developing an accessible model that can be used in heuristic co-development processes and scenario planning to better support knowledge flows between ecology, economy and Mātauranga Māori. This integration will be designed to communicate with decision makers in a way that will lead to policy and active recovery actions. The model developed will be ecologically and culturally relevant, managing for recovery solutions that are scalable and that have identified the capacity to promote new economic activity, and ultimately create increased returns on our investment and economic development partnerships with iwi.

Specifically, the 2-year Post-doc aims to:

- Build on research in 1.1, T1 and international science that has developed a framework that highlights where passive restoration may be insufficient and use this to highlight opportunities for restorative economies (2.2)
- Provide a map (Social Network Analysis) linking institutions, stakeholders and ecosystems that supports people navigating knowledge-bases, institutions and bureaucracies to facilitate restorative actions.
- Employ the concepts of Ecosystem Services, Natures Contributions to People and T1's cultural and well-being benefits to people of recovery to build a social-ecological model that supports decision making about where, when and how to restore and advance blue economies, particularly for rural kaitiaki Māori

Work with Sustainable Seas partners (researchers and co-developers) and others with an interest in restoration (e.g., iwi, UoA, Hauraki Gulf forum, TNC, DOC and the aquaculture industry) to identify critical economic indicators (spinning off green growth initiatives) to transition into local scale positive "managing for recovery" actions and policies and plans.

F. PROPOSED RESEARCH

The project has 3 main research components:

1. Development of a social ecological network map that links the need to restore coastal ecosystems, the potential constraining ecological and environmental factors, the cultural and societal benefits of restorative actions, the economic and investment opportunities and governance accelerators and brakes.

2. Evolution of a Bayes Net (BN) model developed in the SS Phase I Valuable Seas Ecosystem Services project (see below). This model focuses on nature-people links and allows a holistic and transparent analysis of the relationships between species, their functional traits, multiple ecosystem functions and nature's contributions to people (NCPs). Our evolution will involve generalising the species and traits elements in a recovery framework while further developing the cultural, social and ecological components by incorporating information provided from Projects 1.1, 2.2 and T1.

3. Run workshops and provide resources to the co-development networks of 1.1, 2.2, T1 and other relevant projects based on 1 & 2 above that seek to create an ecology, cultural and blue economy blueprint of how we can, via EBM, transition our economic activity to deliver social and environmental benefits. This elements of synthesis will link current policy and plans to ecologically and culturally feasible recovery plans that attract investors/businesses.

The project will integrate knowledge generated by core Challenge projects into social network analyses and BN modelling frameworks that will determine the probability of success of passive vs active management for ecological recovery actions. With a focus on modelling the social-ecological system it will identify the conditions necessary for success and identify where ecological, social and governance bottlenecks exist, while

linking with Project 2.2 to determine where investor demands and confidence constraints occur. It is anticipated that the 'currency' of ecosystem services/natures contributions to peoples (NCPs) will be a significant component of the model, with kaitiakitanga and tohu being others. This modelling will also follow how small-scale community-based activities positively impact on Government and international responsibility/targets for biodiversity and sustainability (links to Project 4.2).

Component 1: Will use a framework, developed by 1.1 and T1, to map the potential for active and passive restoration based on legacy effects, scale, and potential for hysteresis – all factors likely to promote active restoration over passive. The project will start with a focus on mussel restoration. This will involve expert elicitation and will link the ecological realities to the management and policy frameworks and the potential for kaitiaki Māori to affect change. Input from 2.2 on restorative economy drivers and investment strategies will also be included. After this initial development phase within the Challenge's research projects, we will expand to engage with other institutions who are mandated under current policy to manage marine biodiversity and maintain good ecological status. Social network analysis (SNA) or Sankey diagrams will highlight the important connections and constraints.

Component 2: Our growing understanding of ecosystem services/ NCPs will allow us to assess the potential for *managing for recovery* to improve cultural and well-being benefits to people of restorative actions. The multifunctionality BN model developed by Dr Siwcka (Siwicka and Thrush 2020) provides a strong foundation to link seafloor ecological change to natures benefits to people. Using this model will require a simplification of the current ecological model and an extension into the social and cultural space, facilitated by expert elicitation involving iwi, managers and restorative community groups. For cultural elements we will focus on the sense of responsibility and connectedness to nature. For cross-cultural human well-being we will draw on previous research in Phase I of the Challenge, research in T1 and T2 and international research. The ecosystem services targeted in this social-ecological model will be identified in the Component I social network analysis (SNA) processes, we anticipate they will include a range of production, regulation and cultural services – but in particular we will ensure we capture the services that underpin the Blue Economy projects underway in 2.2.

Component 3: Shifting the economic framing is a global challenge, but we can take steps in this direction via workshops and engagement processes using the networks and resources of the Challenge. A key element of the project is to enhance the role of ecology in blue economy research. This is a critical transition to shift our economic analysis into a space that supports ecological sustainability. The *management for recovery* framework and the expansion of the Siwicka and Thrush BN model provide a unique opportunity to create *the fundamental underpinning of nature (ecology) to economic opportunity. This adds substantive value to the work* being undertaken in 2.2 as this project will allow for a seamless interrogation of networks to highlight the interconnected social-ecological system in an A-NZ context and support the necessary understanding that facilitates action while revealing potential unintended consequences. Working through the co-development networks of 1.1, 2.2 and T1 we will explore the appetite for restoration actions by various sectors of our society and how to create investment opportunities and that allow businesses and government agencies to report on sustainability, ecological health and biodiversity goals. In these workshops we will focus on specific themes or groups of theses that best work for the co-development partners of the underpinning challenge projects. These could include:

- Premium brand status for aquaculture in international markets
- New species and spin-off shellfish hatcheries particularly in rural communities to support kaitiaki Māori restoration efforts
- Improved coastal defence
- Māori economic and social development, including creation of highly skilled jobs
- Increased fish stocks benefiting recreational fishers
- Reduced waste costs via shell recycling for restoration sites
- Tourism, recreation and employment opportunities in regional areas

This is a particularly important section of the work as the economic opportunities of restoration and restorative tourism are poorly understood in A-NZ, but they are developed internationally and are driving

substantive investment in restoration by governments – but not yet in A-NZ. For example, US studies show that 1 km^2 of restored shellfish bed could create 60 new jobs and inject $40M into the economy from enhanced ecosystem services, recreation, and tourism. In Half Moon Reef, Texas (partnering with TNC) the restoration of 54 acres of shellfish created 12 new jobs, approximately $US0.5M in annual labour income, with $US1.3M in total value added to the economy from enhanced recreational fishing alone. Biodiversity increased by 40%. TNC have documented many direct and spill-over benefits to recreational and commercial fishers, First Nations, coastal property owners, government/resource managers, research and education and tourism. NOAA's office of habitat conservation has demonstrated a reduction of $9–20M in maintenance costs for Skagit County (Washington) from a $7.7M investment in habitat restoration. Socio-economic analysis in the US revealed that habitat restoration projects created, on average, 17 jobs per $US1M spent. In Australia, Chris Gilles (TNC) notes, "Repair of Australia's marine habitats such as shellfish reefs, seagrasses and saltmarshes … is a modest cost (AU $350M) in comparison to upgrading grey infrastructure projects such as roads or rail. The return on investment can be reached in five years, based on improvements to fisheries alone."

G. LINKS TO PHASE I RESEARCH

4.2.1 Tipping Points
1.2.2 Navigating marine social-ecological systems
2.1.3 Measuring ecosystem services and assessing impacts
IF 1.3.1 Participatory process for marine ecosystem restoration
1.1.1 Testing participatory processes for marine management
2.1.1 Development of valuation frameworks and principles
2..1.2 Mauri Moana, Mauri Tangata, Mauri Ora: How do New Zealanders value marine ecosystems?

H. LINKS TO & INTERDEPENDENCIES WITH PHASE II RESEARCH PROJECTS

As detailed above there is dependency on information and outputs collected by 1.1, T1 and information collected by 2.2
There are also links to:
4.2 through its social-ecological modelling of the effects of mismatches of scale of management and the ecology and its focus on governance and practice pathways
2.3 through research on the Maori economy
2.4 through the ability of managing for recovery to create educational and restorative tourism opportunities as well as underpinning eco-tourism

I. VISION MĀTAURANGA (VM)

Embedding mātauranga Māori approaches into research on taonga species and ecosystem services will create new knowledge and the development of models applicable to other sectors.
Iwi partners have advised us of their ambition to align economic development opportunities with their cultural values to resolve resource management issues. Iwi understand the significance of what we have lost in our marine ecosystems and wish to unlock the innovation potential and deepen their understanding of the science needed to address this. Combining mātauranga Māori and ecological science is the kaupapa of building a more just and equal partnership with Māori.
Our Vision Mātauranga alignment:

i) collective engagement in solutions-focused research
ii) integrating mātauranga Māori knowledge and aspirations to grow the Blue Economy to create diversification benefits in iwi-led tourism and aquaculture
iii) linking innovative kaitiakitanga to Māori tikanga to create the potential for skilled jobs and obtain higher value for produce given the premium paid by consumers (both here and abroad) on the basis of an evidence-based sustainability.

J. ENGAGEMENT REQUIRED WITH IWI AND STAKEHOLDERS

Engagement for this project will be through contacts made by, and co-development partners of projects 1.1, T1, T2 and 2.2, and will cover management institutions, hapū and businesses.

K. PROJECT COMMUNICATIONS

The outputs of this postdoc, network analysis and a Bayes Net focussed social-ecological model are highly visual and easily understood and communicated. It is envisaged that a webinar and a workshop would be effective means of communication, although presentation at a high level to government organisations and politicians would allow the Challenge to place this in the arena where understandings need to be developed.

L. RISK & MITIGATION

This project is low risk provided the right Post-doc can be found. The foundations of the model development are already there from Phase I research and the required data for model development is being collected by core Challenge projects. The mentoring team will provide the connections to relevant co-development partners of the Challenge and, along with their broader networks, will support the project.

The main risk is that we will need to carefully manage the project to ensure that it remains focused and does not become too thinly spread.

M. REFERENCES

Siwicka, E and S.F Thrush (2020) Advancing Approaches for Understanding the Nature-People Link. *Ecological Complexity,* **44** 100877 https://doi.org/10.1016/j.ecocom.2020.100877