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# Moana Project: lessons learned from a national scale transdisciplinary research project

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## 1 Introduction

The Moana Project (moanaproject.org) started in 2018 with the ambitious goal of revolutionizing ocean modeling and observations in New Zealand and building a bridge between traditional indigenous knowledge and the scientific process. The overarching objective was to help ensure a sustainable and enduring seafood sector. The project initially included more than 60 researchers representing 16 national and international institutions. At the end of the project in September 2023, however, we had more than 30 institutions collaborating to maximize the benefits derived from project research and operational outcomes.

Numerous challenges were overcome during the project's 5 years, including the COVID-19 pandemic, changes in internal leadership, and a review of New Zealand's science sector. Together with the science challenges presented by the research process, these culminated in a richness of results and practical lessons learned on the development and implementation of large, multidisciplinary, cross-cultural research projects. The objective of this article is to share some of these lessons.

## 2 Lessons learned

### 2.1 While models are useful, the local communities are key

One of the project's objectives was to describe the connectivity of three marine species of particular economic and cultural relevance: green-lipped mussels, abalone, and rock lobster. To this end, we combined ocean models, genetic analysis, shell microchemistry analyses (for mussels), and mātauranga Māori (traditional knowledge). The similarities between connectivity matrices obtained from the models and the results of genetic and microchemistry analyses was remarkable (Quigley et al., 2022; Quigley et al., 2023; Chaput et al., 2023; Wu et al., 2023), and all these methods converged with the mātauranga held by local communities.

Therefore:

- Numerical models provide a cost-effective way to understand biological connectivity, when extensively calibrated (Montaño et al., 2023; Souza et al., 2023) and compared to *in situ* biological analyses for key sites. Models can then be used to give a fair overview of the large-scale picture before committing to more expensive and time-consuming field experiments.
- The richness of information held by local and traditional communities is a key resource to guide initial research questions, progress (e.g. provide local resources and ethical framework), and fieldwork planning (e.g. location of mussel beds), and contribute to maximizing research outcomes (e.g. information is tailored to community needs).

## 2.2 Co-design is essential

The innovative subsurface ocean observing system developed and deployed during the Moana Project - the Mangōpare sensor system (Jakoboski et al., 2023) - was only possible thanks to a broad range of partnerships with the commercial fishing industry, local communities, educational vessels, citizen scientists, and others. This system now provides unprecedented *in situ* observation coverage of New Zealand's coastal water temperature.

- Fit-for-purpose technological excellence is a key foundation for the Mangōpare sensor system. ZebraTech (https://www.zebra-tech.co.nz/) was able to successfully co-design a robust, reliable, automatic, accurate system through working very closely with the commercial fishing industry.
- Early engagement and open, transparent partnership with the fishing industry were essential to realize the observation system using a cost-effective approach.
- Stay engaged! Participating vessels must harvest the benefits from their contribution by receiving the information back in a format that is directly useful for them. Identify engagement opportunities that work for program participants and support those who are willing to enter a culture that might be new to them. Share results with program participants - even if you don't hear from them often, it's likely they will be excited to hear about the benefits of their efforts, which can be a long-term motivator.
- Look outside your borders. The success of the Mangōpare system was an important motivator for the formation of the Fishing Vessel Ocean Observing Network (Van Vranken et al., 2023) that collaborates with scientists across the globe.
- Genuine respect is essential. This means treating all partners as the experts in their fields that they are. Make space for, and encourage communication of, concerns and suggestions, even if they may initially result in differences of perspective and require resources to address. Openness and willingness to take risks with "out-of-the-box" suggestions can lead to benefits for a wider group of users and, at times, may prove critical to overall program success.
- Large-scale partnership programs, such as those involving 250+ vessels in an ocean observing network, require appropriate resources dedicated to communication. In this context, communication is a keystone that leads to research-quality data and should be resourced accordingly. This includes resources to celebrate and acknowledge the contributions of all involved, encouraging participation.

## 2.3 Build long-term relationships

An award of funding often assumes that research project initiation and subsequent progress will be 'instant' or at least reasonably rapid given that research teams have regular research milestones to achieve and frequent reporting to submit - whereas engagement with local and traditional communities is not instantaneous; it is a relationship building exercise. It can be very difficult and time consuming to establish such connections and to receive feedback or input from traditional communities. This can be related to limited capacity - there simply aren't the number of people required with the appropriate resources. This raises the question of whether the timing mismatch is recognized by the scientific community and funding agencies, and if so, what sort of contingencies are made by these groups to allow for the challenge. Having these communities integrated in the research process from conception is a very good start.

It is essential to recognize such relationships as a long-term investment that is built through and permeates multiple individual projects. In addition, building cross-cultural relationships may require stepping into traditional and/or cultural ways of sharing knowledge, which should be valued, resourced, and supported appropriately.

## 2.4 Address Indigenous rights

Acknowledging the presence and rights of Indigenous communities in the areas where research is being conducted and identifying ways to provide appropriate attribution and authorship was a key lesson (Hudson et al., 2023). Moving beyond consultation and getting permission to sample from their territories to collaboration and co-design is central to effective relationship building. The integration of mātauranga Māori into the research program and vice versa also highlighted issues of indigenous cultural intellectual property and Indigenous Data Sovereignty which needed to be explicitly addressed to maintain trust and respect in the collaboration (Hudson et al., 2020; Māngai, 2020). This included consideration of the CARE Principles (Collective Benefit, Authority to Control, Responsibility, Ethics) for Indigenous Data Governance (Jennings et al., 2023). We worked with our iwi (tribal) partner (Whakatōhea) to apply traditional Knowledge and Biocultural Labels to community outputs including the Whakatōhea Moana Plan (Maxwell et al., 2023). Whakatōhea were also involved in the review process for stakeholder briefing papers and presentations to ensure they were comfortable with the information being shared publicly.

## 2.5 Explicitly plan for diversity

An explicit plan for experience level, gender, national origin, cultural, and ethnic diversity in the research team is a keystone for success. Respectfully and openly bringing together different points of view makes for more robust science that delivers long-lasting benefits. In the Moana Project, deliberate collaboration between Māori and non-Māori scientists provided a platform for cross-cultural exchange, e.g. around indigenous data sovereignty in a world of open science data, and the need for scientists to incorporate indigenous perspectives to ensure relevance to local communities.

The project also deliberately brought together different disciplines, increasing research impact. For example, ocean physicists collaborated with biologists, and the project brought environmental agencies together with the commercial fishing industry. This led to a shared understanding of problems and solutions, ultimately advancing adoption of science findings.

## 2.6 Ensure long-term institutional support

In addition to building an effective team of individuals, the inclusion of partner organizations that have the vision and appetite for something as intrinsically risky as science can help avoid issues with de-prioritization, team instability, lack of leadership, and the transition to a post-project reality. The continuation of project outcomes after the funding cycle is often problematic and can result in waste of resources. Establish a strong, long-term personal investment from higher management and maintain constant communication for early detection of priority changes can mitigate this problem. This is particularly important when operational services are derived from the research, and when a wide range of stakeholders have committed time and effort towards long-term benefits beyond the initial funding cycle.

## 2.7 Research to operations

In cases like the Moana Project, research will lead to operational products. An early, well-informed overview of operational costs is essential. These are commonly not known or are under-estimated in research and development projects. Working with operational and government agencies and final users from the start helps ensure a smooth transition and avoids discontinuation of services that ocean stakeholders may depend on.

## 2.8 Deliberately focus on benefits

To ensure publicly funded science provides the benefits the government expects, science projects must engage deeply with stakeholders. On the Moana Project, this was done by embedding end-users of project outputs at three levels: in the project governance group, the technical advisory group, and the stakeholder advisory group.

Stakeholder interactions were explicitly prioritized through the inclusion of a targeted project work stream, Whai Hua, that focused on benefits delivery. The Moana Project co-developed the project's impact mapping framework with 27 stakeholder agencies via a series of investment logic mapping workshops, which saw science end-users directly determining how the project's success should be assessed.

The work stream also resourced communications, ensuring broad public outreach through a well-maintained website which acted as a repository for project outputs and findings, targeted newsletters to stakeholder subcategories to keep collaborators and communities informed about project progress, and provided numerous media releases to engage the New Zealand public around project findings.

# 3 Discussion

In addition to scientific results, there is a richness of lessons that arise from the planning and conducting of large research projects. These practical lessons are rarely documented or communicated in scientific journals. As a consequence, we see best practices often ignored and repetitive misconceptions getting through to proposals and funded research. While a mix of more experienced and junior researchers is the best approach to build successful projects, a well-documented list of lessons can be helpful and provide a starting point for new projects.

Although somewhat field specific, there are general issues that permeate research in geo-and-life-sciences. In our case of a national scale, ocean focused, applied research project, these lessons can be grouped in 4 large classes: (1) early and ethical engagement with local and indigenous communities, (2) institutional support and link to operations, (3) practical lessons from the scientific results, and (4) an explicit and deliberate focus on societal benefits.

We provide this overview in the hope that future projects will be able to avoid some of the bumps we encountered during our journey and that we can optimize the use of our limited resources for the greatest possible benefit to all members of society.

# Author contributions

JS: Conceptualization, Investigation, Project administration, Supervision, Writing – original draft, Writing – review & editing. MF: Conceptualization, Funding acquisition, Project administration, Writing – original draft, Writing – review & editing. JJ:

Conceptualization, Project administration, Writing – original draft, Writing – review & editing. JG: Conceptualization, Project administration, Writing – original draft, Writing – review & editing. MH: Conceptualization, Project administration, Writing – original draft, Writing – review & editing.

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## Conflict of interest

Author JMACDS, JJ and MF was employed by the company MetOcean Solutions Ltd.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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