Enabling a broad knowledge base for marine management decisions

Increasing the information base for marine management decision-making will improve the quality of those decisions. Marine management decisions deal with complex biological and human political systems and are made in the context of competing demands for space and resources.

The necessary information to make good decisions is often thought to be lacking, but this thinking is partially due to an over-reliance on quantitative data collected by standard methods. While mātauranga Māori is increasingly sought and citizen science is welcomed, narrative analysis and local knowledge are rarely used in decisions. Enabling a broader knowledge base is essential for fit-for-purpose, robust, and place-based outcomes.

About this document

This guidance document:

- explains what sources of information can be used to broaden the knowledge base
- considers the barriers to using broader knowledge
- recommends new processes and skills to involve a full range of knowledge as evidence in marine decision-making processes.

The advice is based on Sustainable Seas National Science Challenge research.

© Look Up Look Down Photography, Unsplash

What knowledge types are there?

Knowledge types that support marine management decisions can be thought of as quantitative or qualitative.

Quantitative or numeric data

Quantitative data is deliberately collected by standard methods or created by numeric models. Production of these types of data are costly and frequently place-specific, for example state of the environment attribute monitoring.

Qualitative information

Mātauranga Māori, local, and disciplinary knowledge are three broad types of knowledge that help people and communities understand the natural world and their place in it. While much of this knowledge is qualitative, it can still be used as evidence, analysed robustly, or form part of scenario decision models.

- Mātauranga Māori includes place-based knowledge generated using techniques consistent with the scientific method but explained according to a Māori world view (Hikuroa 2017). Mātauranga Māori may be in the form of narratives, carvings, or song and generally provides the longest time record.
- Local knowledge is place-based but over shorter time frames than mātauranga Māori. Local knowledge may be narrative, but may increasingly be backed up by visual, time-stamped images.
- Disciplinary knowledge is frequently obtained as expert opinion derived from general theoretical concepts or from observations of cause and effect in other locations and placed in a local context. Disciplinary knowledge can be expressed as principles, narratives, and guidelines.

Broader knowledge can help with system interactions

Including multiple knowledge sources helps decision-makers understand the variety of interactions between people and marine ecosystems, resulting in more fit-for-purpose, robust and place-based outcomes.

Aotearoa New Zealand's law and policy guidance gives central and local government staff wide scope to investigate and use all available relevant data. Using a restricted range of numeric data can lead to decisions with unexpected outcomes and people being left out of the process.

Information is available, but underutilised

There's an emerging trend of seeking multiple types of knowledge in marine management processes. Guidance under New Zealand law and policy allows central and local government staff wide scope to investigate and use multiple knowledge sources in statutory and non-statutory processes such as ki uta ki tai catchment plans and regional coastal plans.

The Resource Management Act 1991 (RMA) and New Zealand Coastal Policy Statement 2010 direct councils to work within Te Tiriti o Waitangi partnership and demonstrate social, environmental, and economic outcomes, and the RMA and Local Government Act set out robust processes to engage and track community input.

In many places, an abundance of information is available, but is underutilised. People making decisions on consents and regional plans are supportive of finding ways to bring in a greater range of knowledge as the basis of consent and plan decisions, but this has been challenging due to:

- a perception that quantitative data best meets the definition of 'best available' under legislation and so will be considered more robust in Environment Court or council hearings
- a lack of understanding about how different worldviews connect to these different knowledge types and about what groups are being left out in consent, permit, and plan decisions
- inexperience with where to source other types of knowledge, the methods to analyse it, and how to give effect to it in decisions.

Recommendations

Scientists, planners, and policy advisors have a role to play in ensuring both quantitative and qualitative information is analysed. They should make themselves familiar with what can be achieved, who to go to, and methods used by other agencies and researchers.

The following recommendations are designed to help enable a wider range of knowledge to be used in marine management decisions.

1. **Acknowledge high quality advice as advice which has been informed by a range of relevant research and local knowledge, and that enables te ao Māori.**

2. **Include qualitative as well as quantitative information from a diverse range of sources in decision-making and advice.** Use science staff to inform debates around cumulative effects and environmental risk assessments using ecological principles – this method can be used in the absence of detailed data. See Appendix 1 on analytical techniques used for non-numerical data. (*Enabling effective marine spatial planning for ecological and economic wellbeing*[1], *Addressing cumulative effects in marine management decisions*[2], and *Addressing risk and uncertainty in decision-making*[3].)

3. **Engage with iwi/hapū and locals using participatory processes, to understand what knowledge there is and where it's held.** Using participatory processes to bring people together and participatory models during the engagement will bring out the 'who and where' mātauranga and local knowledge is held (Le Heron et al 2019, Sustainable Seas 2020). This can also be used for building trust and reciprocity with tangata whenua and affected local people, and gaining their agreement around how knowledge will be used. (*Marine governance – sustaining ocean outcomes for future generations*[4] and *Empowering Māori knowledge in marine decision-making*[5].)

4. **Use effective methods of gathering and analysing knowledge from various sources.** Methods investigated by the Challenge that allow multiple perspectives and knowledge from experts and stakeholders when the outcome is uncertain include likelihood consequence tables, Bayesian network models and agent-based models.

   Methods used by council staff when formulating regional plans or defending decisions at Environment Court proceedings include one-to-one interviews with mana whenua with mātauranga Māori expertise about current and future impacts on values, and evaluating future scenarios using assessment methods across social, economic cultural and environmental indicators. At least one council has successfully relied on principle-based expert ecological opinion to defend its decision in the Environment Court. Due to a perceived risk of this being a novel method compared to interpretation of numerically modelled data, an external ecological expert was chosen whose previous evidence had been favorably referred to by the Environment Court and therefore had standing. (*Addressing risk and uncertainty in decision-making*[3] and *Addressing cumulative effects in marine management decisions*[2].)

5. **Document processes and results for seeking out and using different types of knowledge.** Determine whether running scenarios of different management actions will be helpful. If so, do this in workshops with extended participation. These workshops should include a brief introduction to world views. (*Addressing risk and uncertainty in decision-making*[3], and *Quick guide: Navigating risk and uncertainty in marine management* (Sustainable Seas 2023).)

6. **Bring legal advisors alongside from early stages, to ensure relevant legal considerations are met when developing content that will go in front of decision-makers.** The result is legally defensible and substantive decisions, drawing on a wide range of knowledge.

   Planners will benefit from in-house legal advice on the opportunities in legislation, national guidance, and other government policy to consider a wide range of sources and types of knowledge. This includes documenting results of participatory processes and setting up knowledge collection as part of RMA section 32 evaluation of social, cultural, economic and environmental effects of proposed options in regional plans and government regulation (Ministry for the Environment 2017).

7. **Resource in-house capability to seek out and use a broad range of knowledge, and value strengths to connect and span boundaries.**

   Teams must be able to seek out multiple ways of investigating a policy issue or plan and ensure the final product uses the knowledge brought in and thoroughly documents the process.

8. **Investigate processes that enable the diversity of knowledge collected, to be bought forward and given weight in decisions.** Require a full range of impact assessments using social, economic, cultural and environmental indicators (Wedderburn and Coffin 2016, Clark et al 2022, Le Heron et al 2021).

   A broad knowledge base is enabled by the choice of methods to evaluate what information is collected. There are examples of joint tangata whenua and regional council governance arrangements to guide the set up and development of regional coastal plans. In the Canterbury Papatipu Rūnanga, council and Rūnanga staff have joint responsibility for assessing and drafting proposed wording for decision-makers. (*Addressing risk and uncertainty in decision-making*[3], *Marine governance – sustaining ocean outcomes for future generations*[4] and *Ingredients to catalyse participation in marine decision-making* (Sustainable Seas 2020).)

What did we do?

We held workshops and gathered individual input from Challenge researchers, regional council and government scientists, council consent and planning staff, and government policy staff. We sought information about trends and changes they were seeing in the forms of knowledge used as the evidence base for policy and consent decisions. We also sought information on the ways that staff could bring in a wider range of knowledge, including support for practice change inside their organisations.

To build confidence in choosing expert opinion about ecosystem responses over costly and potentially narrow numerical models, council staff were keen to test Challenge guidance on a process that relies on published ecological principles (*Addressing risk and uncertainty in decision-making*[3] and *Addressing cumulative effects in marine management decisions*[2]).

This was seen by council practitioners as an effective method of using knowledge from various sources and experts.

What did we find?

We found that staff are most familiar with quantitative data collected by standard methods, which has become the business-as-usual approach to developing environmental limits and decision-making in Aotearoa New Zealand. With limited budgets for marine management, focusing on traditional data collection de-prioritises effort to gather, record, and present other types of knowledge, such as published principles, narratives and observations based on the long connection of tangata whenua to their places.

As well as the perception that numerical data and modelling should be preferred, there are further barriers to seeking and analysing other types of knowledge. These include short time frames to produce policy advice, plans, permits or consents, and missing skill sets to investigate, analyse, and document the processes and the results of diverse types of knowledge.

Mātauranga Māori, local knowledge, and disciplinary knowledge used to test scenarios and impacts are generally not put in front of decision-makers. As a result, coastal plans may have generic objectives and plans that simply echo what's already in the New Zealand Coastal Policy Statement. Proposed plans that provide little guidance are unhelpful for consents staff in adversarial council and court processes. When fundamental knowledge about the affected place and potential impacts on people and the environment are left out, decisions will not be as robust as they could be.

Appendix 1
Qualitative forms of knowledge: eliciting expert opinion and analytical techniques for non-numeric data

Robust elicitation of expert opinion

There are many ways that expert opinion is sought and structured. Advice to ministers and councillors may be very focused on using delegated experts from different ministries or council areas of interest. However, more generally robustness of expert opinion can be supported in two ways.

Firstly, through the use of recognised principles – these may be from te ao Māori (including kaumatua), Te Tiriti o Waitangi, or (in western ecological science) extracted from theoretically derived peer-reviewed and published documents.

Secondly, the process of eliciting the information may follow a robust process with methods for dealing with uncertainties and differences in knowledge. For example, the structured indirect expert elicitation process (Choy et al 2009) and using the IDEA protocol – 'Investigate', 'Discuss', 'Estimate' and 'Aggregate' (Hemming et al 2018).

Analytical techniques for non-numeric data

The following techniques can help with analysing non-numeric data.

Dealing with narratives

A commonly used method for this is Nvivo and a comprehensive guide is found in Allsop et al (2022). In brief, the method relies on open coding 'reading through an interview and recording...a brief conceptual 'code' that reflects what the participant is discussing', reducing codes to 4-6 common themes, systematically coding the data for those themes and presenting findings in the form of exemplary participant quotations. A summary can be provided using Numerical Content Analysis basically describing the number of times each core theme was found.

Converting non-numeric data to numbers

If information can be converted to numbers (often referred to as semi-quantitative) then the full realm of statistical analysis and modelling becomes available. Due to the long history of this type of conversion there are no general papers that deal with these techniques so we summarise the way information can be converted to numbers in various ways:

- Ranking – the simplest method, for example rank abundance can simply be 'we always see these in large numbers' = 5, 'we often see these in large numbers' = 4, 'we sometimes see these in moderate numbers' = 3, 'we don't often see these' = 2, 'we only found one once' = 1.

  Ranking can also be used to describe the number of likes in a number of categories. For example, most people thought that naturalness was important, a few people thought that being able to collect shellfish was important, and some people thought that knowing there were no invasive species present was important, could be coded as below.

Area	Naturalness	Collecting shellfish	No invasive species
1	5	2	3
2	4	5	3

- Fuzzy coding – coding descriptions in a category so that they run in order. For example, species can be sedentary, move through the sediment, crawl across the sediment surface or able to swim. The category mobility may then take the values 1, 2, 3 or 4 respectively. Similarly, if the category was 'where do people living in an area work' sub-categories may be 0 = 'at home', 1= 'walking distance', 2 = <5km, etc.
- Likelihood – this is where the probability of an answer lying in a certain subcategory is used. For example, a category may be 'where do people in a household work'. Sub-categories may be 'at home', 'walking distance' etc and the number of people in the household exhibiting that subcategory is divided by the number in the household to give a table as below. This can also be used in the mobility example above if there is uncertainty related to the allocations of species to sedentary etc.

Household	At home	Walking distance	<5km	etc
1	2/5	1/5	2/5	
2				

Visualisation techniques

Once information has been coded into numbers, there are numerous techniques that can be used to visualise relationships between variables (categories and subcategories), objects (species, households etc) or with other factors (eg location, time, backgrounds). Again, these techniques have long histories of use.

- Networks and graph theory: Graph theory is the study of graphs that represent pairwise relations between objects. Graphs are made up of vertices (also called nodes or points) connected by edges (also called links or lines). There are multiple packages that can take pairwise relationships and convert them into a network graph. These graphs can be analysed to determine where there are particularly dense links, where certain nodes may form bridges between different parts of the network and to compare between different networks (see Siwicka et al 2021 and Gladstone-Gallaher et al 2023). Social network analysis (SNA) is a specific method for investigating social structures and characterizes nodes as individual actors, people, or things within the network) with the edges being the relationships or interactions that connect them (figure 1).
- Ordination and clustering: Ordination is a multivariate technique that takes pairwise similarities between many variables and objects and creates a visualisation of how similar the objects are. This was used in Challenge research to show similarity in macrofauna communities at sites around the country (figure 2). Clustering creates groups that exhibit a certain degree of similarity. For both, the relationships are generally derived from a distance measure calculated from a table of numbers (quantitative, semi-quantitative or a mix). There are a numerous distance measures, ordination techniques and clustering methods, generally with specific distance measures being associated with certain ordination techniques.
- Canonical ordination is a technique used to understand how the similarities between objects are associated with other factors (eg temperature, pollution, urban density). It is the multivariate equivalent of regression analysis.
- Participatory modelling is designed to integrate social values in environmental decision-making processes. There are a range of methods assessed in Davies et al (2015), from mediated modelling, through scoring and participatory mapping (representing spatial relationships among real-world structures or objects) to Bayesian network and games models.

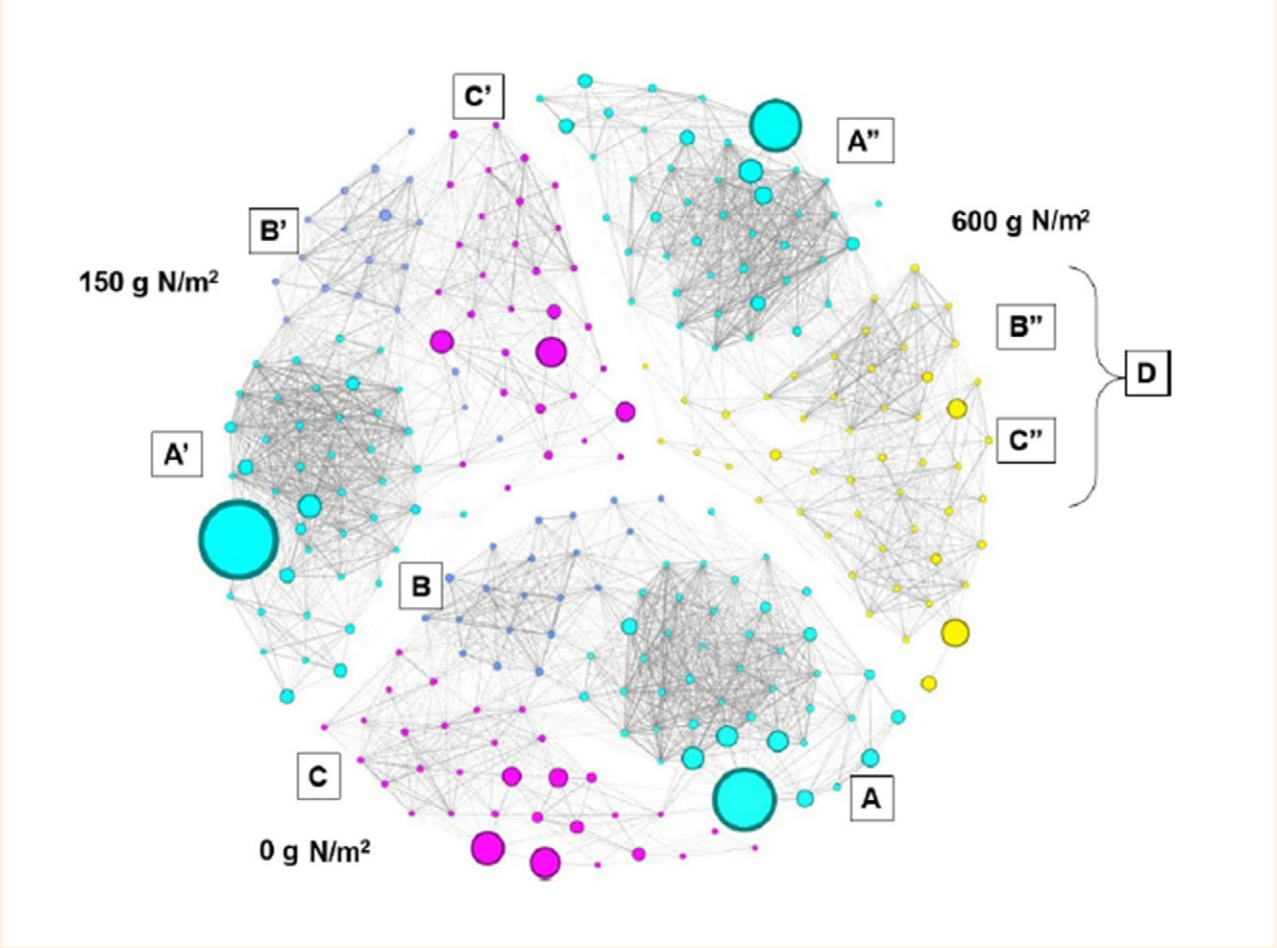

Figure 1 Network analysis of traits. The dominant species are represented as multiple nodes based on the measurement of body length, shell length, or body width. The associations between species are depicted with lines whose thickness indicates the weight based on the number of traits shared between species pairs (Siwicka et al 2021)

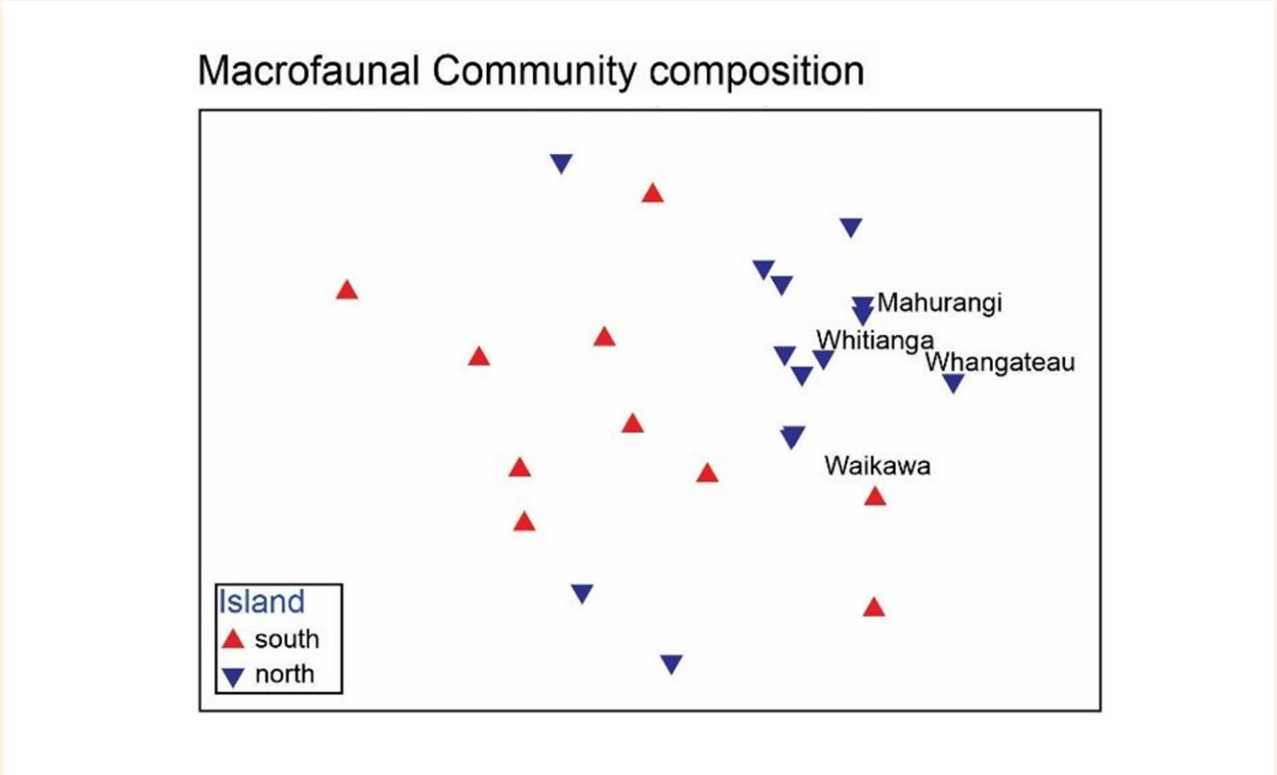

Figure 2 Composition of macrofaunal community

Definitions

In the context of this document, evidence is knowledge that is ordered and presented in a way that different audiences can digest.

Mātauranga is knowledge, wisdom, understanding, skill. Mātauranga Māori spans Māori knowledge, culture, values and world view (Hikuroa 2016).

References

- Clark D, Gladstone-Gallagher R, Hewitt J, Stephenson F, & Ellis J (2022). **Risk assessment for marine Ecosystem-Based Management (EBM)**. Conservation Science and Practice 4(3): 12636
- Hikuroa D (2016). **Mātauranga Māori – the Ūkaipō of knowledge in New Zealand.** Journal of the Royal Society of New Zealand 47(1), 5–10
- Le Heron E (2019). **It's not a recipe... but there are ingredients: Navigating negotiated change through participatory processes in multi-use/r marine spaces.** Planning Quarterly 213, 32 – 37
- Le Heron E, Allen W, Le Heron R, Logie J, Glavovic B, Greenaway A, Hikuroa D, Davies K, & Blackett P (2021). **What does success look like? An indicative rubric to assess and guide the performance of marine participatory processes.** Ecology and Society 26(1): 29
- Ministry for the Environment (2017). **A guide to section 32 of the Resource Management Act: Incorporating changes as a result of the Resource Legislation Amendment Act 2017**
- Sustainable Seas National Science Challenge (2020). Ingredients to catalyse participation in marine decision-making. **sustainableseaschallenge.co.nz/tools-and-resources/ingredients-tool**
- Sustainable Seas National Science Challenge (2023). Quick guide: Navigating risk and uncertainty in marine management. **sustainableseaschallenge.co.nz/tools-and-resources/quick-guides-risk-and-uncertainty**
- Sustainable Seas National Science Challenge (2024). Enabling effective marine spatial planning for ecological and economic wellbeing[1]. **sustainableseaschallenge.co.nz/tools-and-resources/enabling-effective-marine-spatial-planning**
- Sustainable Seas National Science Challenge (2024). Addressing cumulative effects in marine management decisions[2]. **sustainableseaschallenge.co.nz/tools-and-resources/addressing-cumulative-effects-in-marine-management-decisions**
- Sustainable Seas National Science Challenge (2024). Addressing risk and uncertainty in decision-making[3]. **sustainableseaschallenge.co.nz/tools-and-resources/addressing-risk-and-uncertainty-in-decision-making**
- Sustainable Seas National Science Challenge (2024). Marine governance – sustaining ocean outcomes for future generations[4]. **sustainableseaschallenge.co.nz/tools-and-resources/marine-governance-sustaining-ocean-outcomes-for-future-generations**
- Sustainable Seas National Science Challenge (2024). Empowering Māori knowledge in marine decision-making[5]. **sustainableseaschallenge.co.nz/tools-and-resources/empowering-māori-knowledge-in-marine-decision-making**
- Wedderburn E, & Coffin A (2016). **Integrated Assessment of Healthy Rivers Wai Ora: Baseline and Scenarios for Technical Leaders Group**. Waikato Regional Council

Contact information

Judi Hewitt / judi.hewitt@auckland.ac.nz

This document was prepared by Justine Young. We thank Challenge researchers and co-development partners for participating in workshops and reviewing drafts that informed the content.

For more information and support with marine management decisions, please see our other synthesis project summaries and guidance documents in this series.