



# Management for estuary values and aspirations: an extension of the Estuaries Bayesian Network Model

**This document summarises a project involving three estuaries where an existing Bayesian Network (BN) model was adapted using expert and community-based knowledge of key ecosystem dynamics and associated values.**

**Model scenarios were developed for the three case study estuaries, and results presented at workshops with local communities to help address management concerns and support participatory processes, to inform marine management decision making.**

**This summary introduces BN models and explains what the project did and found. You can read a full report on the project on the [Sustainable Seas website](#) and [Tohorā](#) (an AI-powered research tool).**

## **A better understanding of ecosystem health and community values is needed to improve marine management**

Estuarine and coastal environments in New Zealand face multiple stressors that are driving declines in ecosystem health. In 2022, the Minister for the Environment (MfE) highlighted the desire to better understand ecosystem health, and the associated values and aspirations, for coastal environments such as estuaries, so they could be better managed.

Key findings from research from the Sustainable Seas National Science Challenge include the need to focus on ecological responses of estuarine environments to the direct and indirect effects of stressors, and the importance of participatory processes in terms of engagement, involvement in modelling, and transparency in decision-making. Research from Sustainable Seas also highlighted the need to understand community uses and aspirations in-place and the trade-offs that should be considered in management decisions.

Bayesian Network (BN) models are probabilistic-based models that are useful tools for ecosystem-based marine management and decision-making. These models can integrate different knowledge types for example, empirical data as well as mātauranga Māori, and social, cultural, and economic values. Importantly, BNs can be developed through participatory processes by stakeholders.

In 2019, the Parliamentary Commission for the Environment (PCE) commissioned the development of a Bayesian Network (BN) model building off research that had been undertaken during the Sustainable Seas Challenge. The BN model was developed to explore the effect of four stressors (nutrients, metals, suspended sediment, and sedimentation) on ecosystem functions and health of an estuary.



Here, we report on the expansion of the existing BN through participatory processes to include additional stressors and values of interest to local communities.

## What did we do? How did we do it?

To aid marine management decision-making, the Ministry for the Environment wanted to use and test the guidance and methods developed by Sustainable Seas in real estuaries considering the values and aspirations of their associated communities.

Three estuaries were chosen as case studies to explore marine ecosystem networks alongside the values and aspirations of local communities: Kakanui (Otago), Whangateau (Northland) and Ahuriri (Hawkes Bay). The case study estuaries were chosen based on sufficient data availability to inform models, and community interest and engagement. In addition, estuaries of different sizes and geomorphology were chosen.

For each estuary, a series of meetings was held with interested stakeholders to identify the values of various groups and people and their aspirations for the estuary. This work included identifying the key estuarine stressors the local stakeholders and tangata whenua wanted alleviated.

The existing estuarine BN model (originally developed for the PCE) was modified based on values identified for each estuary. Key concerns identified by the local communities included climate change and extreme weather events (marine heatwaves), long residence times leading to poor water quantity and quality (eg macroalgal blooms), as well as impacts on birds, inanga and biodiversity. Based on this, two new stressors (marine heatwaves and water residence time) and elements of interest, specific to the values identified by the locals (eg bird abundance and diversity, inanga abundance), were added to the existing model. Management scenarios were generated based on values identified for each estuary and used to demonstrate how BNs could:

- stimulate further discussion about the values and aspirations of the community
- inform management actions and the risks associated with different scenarios.

## Finding — scenario testing is useful for exploring ecosystem responses to change

The BN models enabled the local communities of each estuary to visualise the interactions between multiple ecosystem elements, social drivers, and management activities. Through scenario testing, the models were able to show how an estuarine system is likely to respond to increasing stress or management interventions (eg whether shellfish abundance is likely to increase or decrease in response to heatwaves).

## Finding — participatory models are powerful tools for aligning community values with marine management

The participatory development of the BN models for the three case studies:

- enabled the values and aspirations of local communities to be incorporated into the decision-making process
- provided examples of how tools can be used to align management decisions with different community values.

The case studies also mirrored other research that has shown that participatory involvement in developing the model can enable engagement by local communities, stakeholders, and managers, which helps to increase understanding of the relationships and trade-offs associated with different management interventions. The use of BN models and other participatory approaches:

- provides a means of increasing communication and collaboration between different groups
- enables a common understanding of complex environmental problems
- acknowledges the values of different groups.

Overall, the case studies highlighted the ability of local communities to grasp the underlying concepts of ecosystem health and networks and use participatory tools to inform proposed management actions.

## Next steps — tools to empower marine management decision-making

The process described above is an example of the value of engagement and collaboration between local communities, stakeholders, and management agencies in marine management decision-making, and how tools such as BNs can support this process. Continued input from local communities will improve the outputs provided by decision support tools. For example, eliciting knowledge from community groups and scientists to inform how bird and inanga components interact with the wider ecosystem and how they may be impacted by management actions.

Resources are available to support local communities and marine managers with the tools, guidance, and roadmaps to ecosystem-based management. These resources aim to empower decision-making and consider the values and aspirations of different groups. Find resources on the [Sustainable Seas website](#) and [Tohorā](#) (an AI-powered research tool).