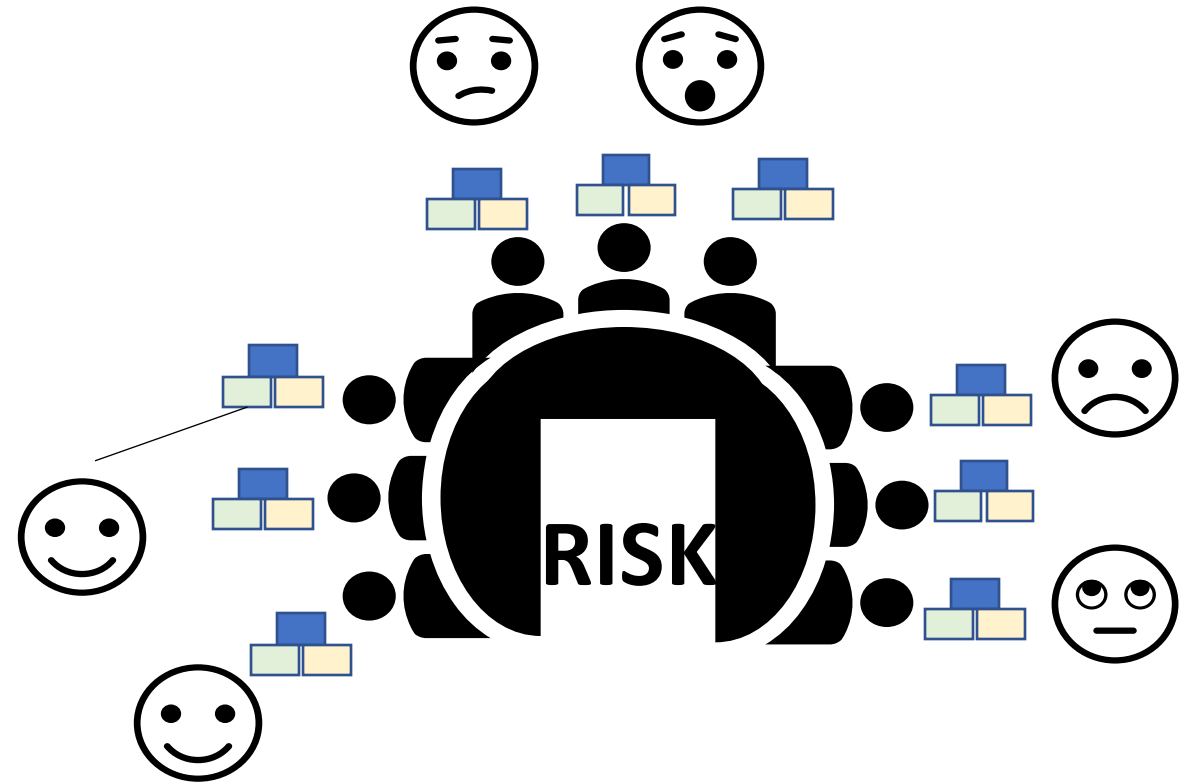
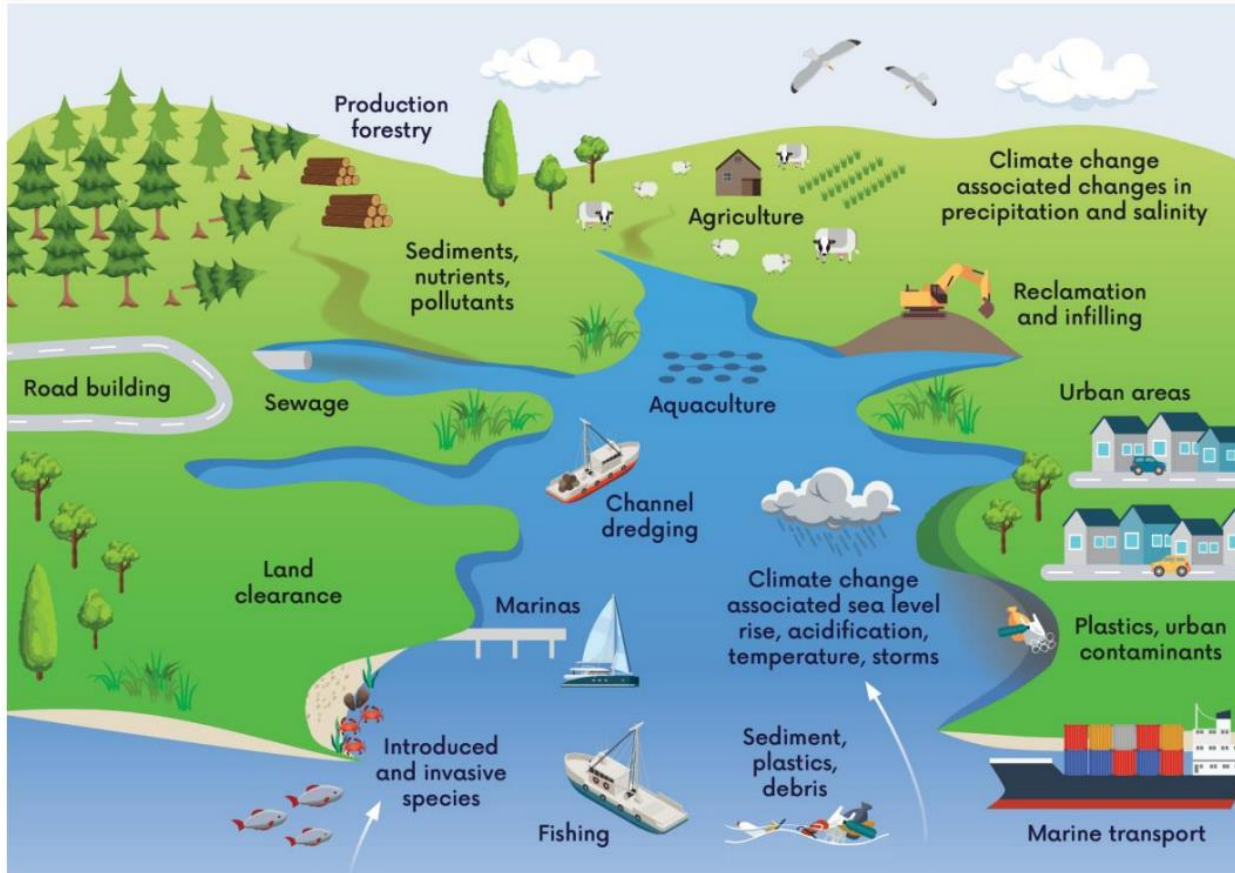


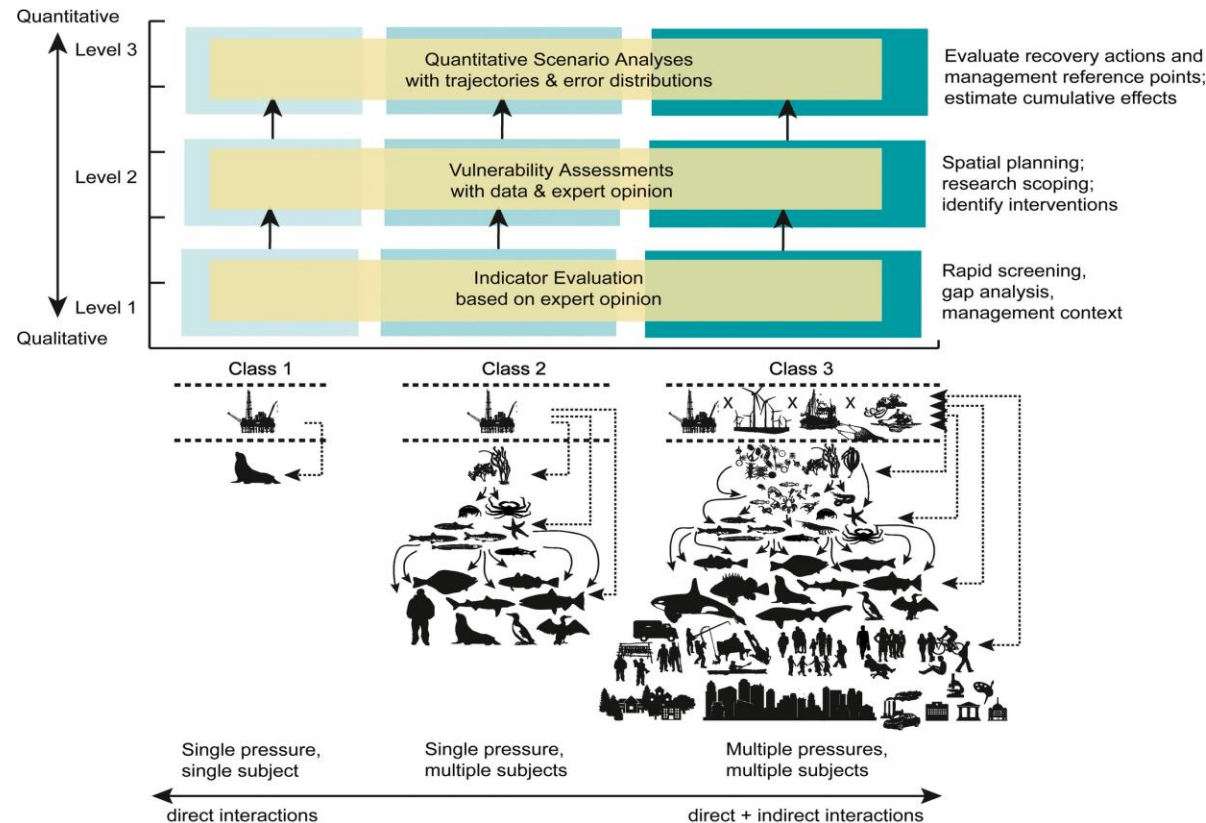
Dealing with risk and uncertainty in contested marine spaces

Judi Hewitt, Joanne Ellis, Rebecca Gladstone-Gallagher, Jasmine Lowe,
Conrad Pilditch, Simon Thrush

Today's management reality



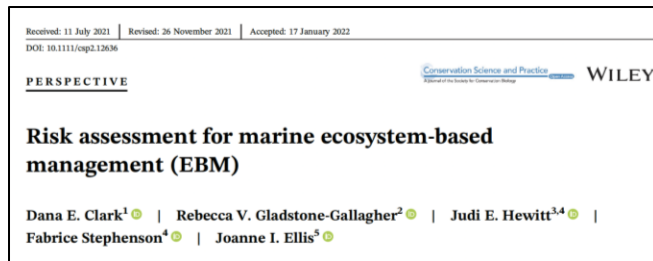
EBM: Multiple stressors and multiple subjects



- Consider cumulative effects
- Recognize ecological complexity
- Consider multiple knowledge types

EBM approach to risk and uncertainty

- Methods and frameworks that can assess risks arising from cumulative effects
- Identified 12 criteria important



See Clark *et al* 2022

Can the risk assessment approach...?

Accommodate different components, values & knowledge types	<p>Multiple values</p> <p>Include multiple values? (ecological, social, cultural, economic)</p>	<p>Multiple ecosystem components</p> <p>Assess risk to multiple ecosystem components?</p>	<p>Multiple knowledge types</p> <p>Incorporate different knowledge types? (numeric, qualitative, Indigenous knowledge)</p>
Integrate complexity	<p>Indirect effects</p> <p>Include indirect effects on the variable of interest?</p>	<p>Feedbacks</p> <p>Incorporate temporal feedbacks between ecosystem components?</p>	<p>Interactions</p> <p>Account for interactions between different stressors or ecosystem components?</p>
Place and time specific	<p>Spatial outputs</p> <p>Produce spatial outputs? (maps)</p>	<p>Temporal outputs</p> <p>Produce temporal outputs? (changes through time)</p>	<p>Locational context</p> <p>Incorporate location-specific contexts?</p>
Evaluate recovery, thresholds & uncertainty	<p>Recovery</p> <p>Separately evaluate recovery? (not combined with impact)</p>	<p>Threshold values</p> <p>Explore threshold responses in outputs?</p>	<p>Uncertainty</p> <p>Estimate uncertainty?</p>

Four step process

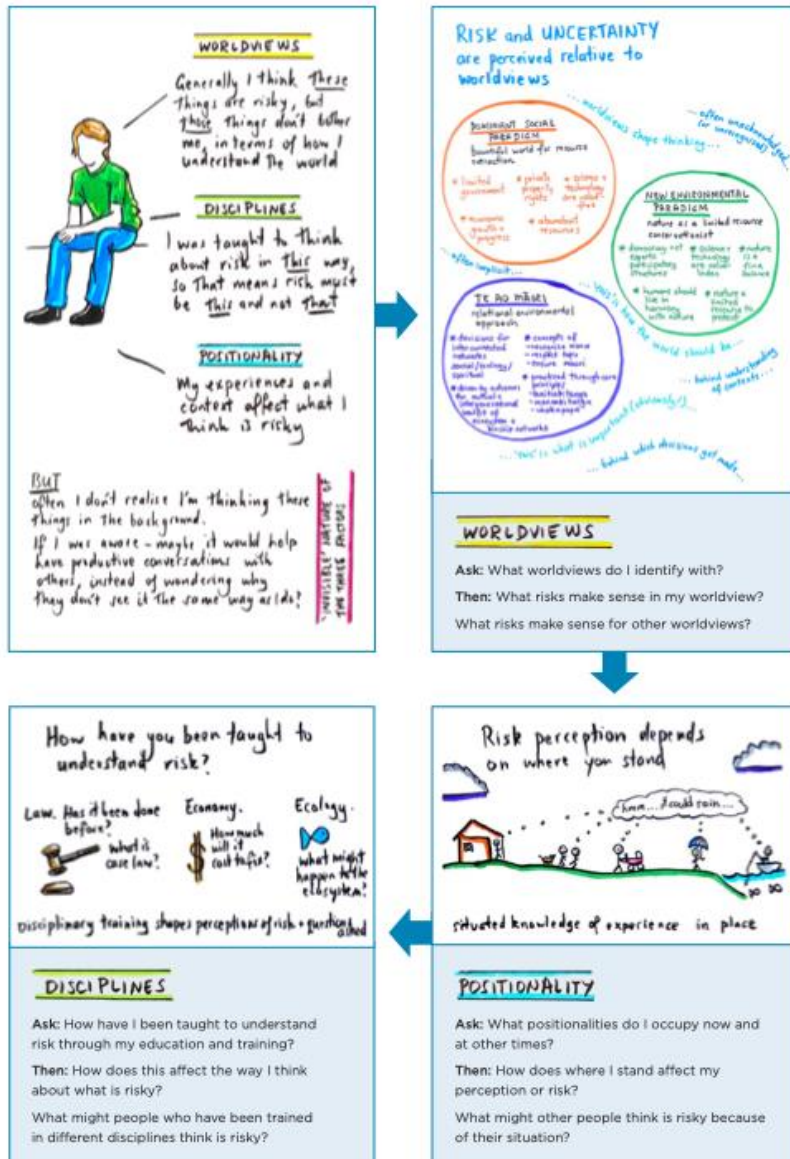
Recommendations

We recommend more standardised best practice risk assessment methods to account for broader values, multiple activities and stressors, and cumulative effects. Specifically, we recommend you follow four important steps.

- » Identify perceptions of risk.
- » Identify the best risk assessment method and tools to support your decision-making processes.
- » Consider uncertainty.
- » Link risk and uncertainty information with management decisions.



Step 1: Identify perceptions of risk



National Science Challenges

1 Perceptions of risk and uncertainty influence marine management decisions

2 Worldviews influence people's perceptions of risk and uncertainty

3 Te Ao Māori understanding of tūraru me te haurokuroku (risk and uncertainty)

4 Tools to help navigate perceptions of risk and uncertainty

5 How to incorporate risk and uncertainty in ecosystem-based management

QUICK GUIDE SERIES: Navigating risk and uncertainty in marine management

SUSTAINABLE SEAS

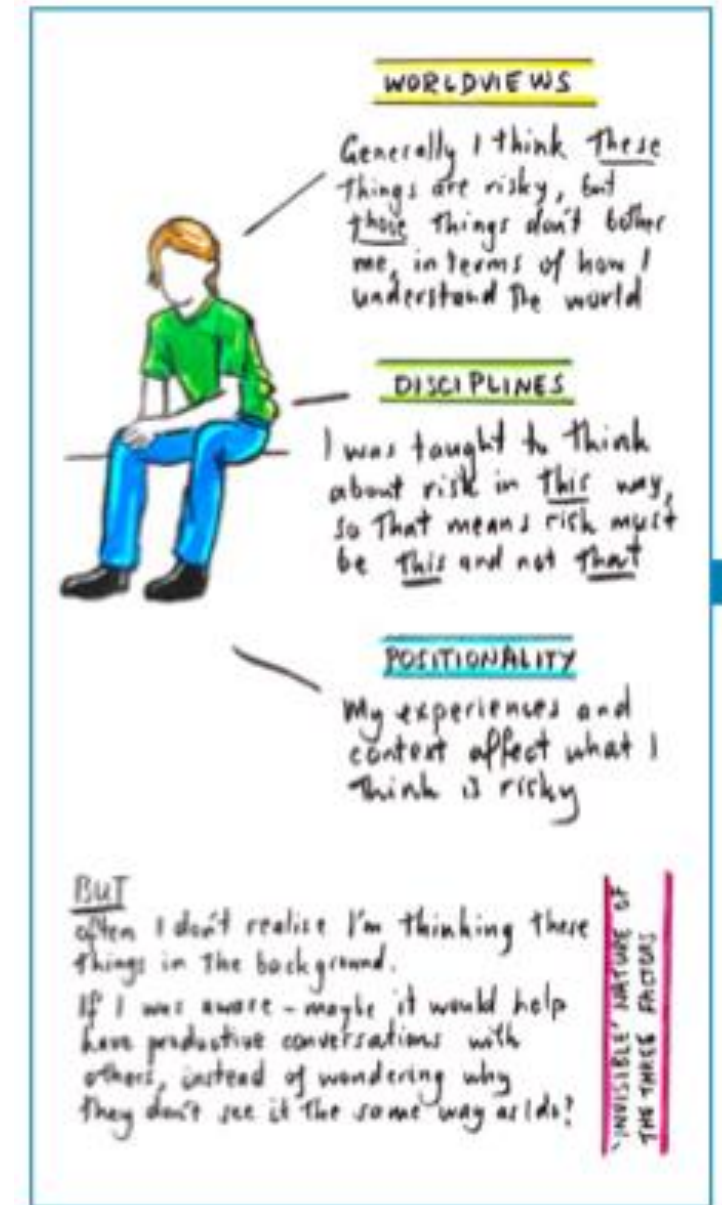
Kōwhiri me te hāroko

➤ People perceive risk and uncertainty in diverse ways and value different things - this generates conflict over desired outcomes

Step 1: Identify perceptions of risk

Guides to identify:

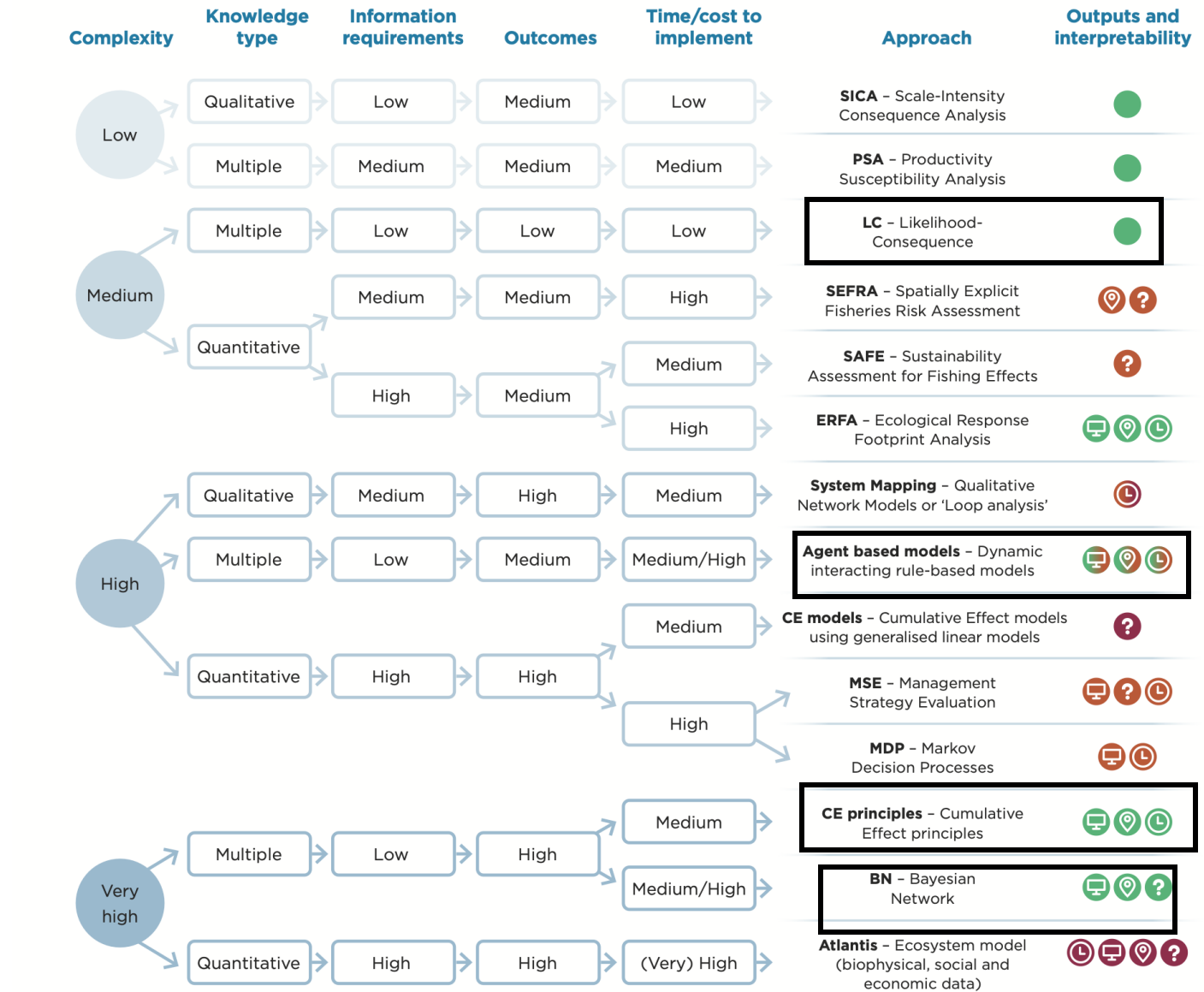
- How are indigenous peoples' values and roles considered?
- What is considered evidence?
- What balance of rights are supported?
- What RA methods are appropriate?



See GD: Addressing *Risk and Uncertainty in decision making*

Step 2: Identify the best method

- Don't let the method constrain the process
- Make sure you can use all available relevant information
- Hierarchy - depending on outcome complexity and risk level



See: Addressing Risk and Uncertainty in decision making



		Likelihood →				
		Rare	Unlikely	Possible	Likely	Almost certain
Consequence ↓	Trivial					
	Minor					
	Moderate					
	Major					
	Severe					

BOX 1: Likelihood-Consequence (LC)

Method description

Produces a matrix of likelihood and consequence for each activity

Key applications in New Zealand

Used to assess risks associated with:

- Species invasions
- Fishing
- Cruise ships
- Oil spills
- Wastewater overflows
- Land-based coastal stressors

Key advantages

- Easy to setup and run
- Multiple knowledge types
- Highly flexible
- Can categorise data quality
- Easy to communicate
- Can produce multiple output types

Key references: Campbell and Hewitt, 2013; Heath 2014; Campbell and Gallagher, 2007; Johnston 2019; Bermingham 2015; Johnston 2017; Robertson and Stevens, 2012; Stevens and Robertson, 2017; MacDiarmid et al. 2012

BOX 5: Bayesian Networks (BN)

Method description

Probabilistic model that graphically presents a set of variables and their interdependencies

Key applications in New Zealand

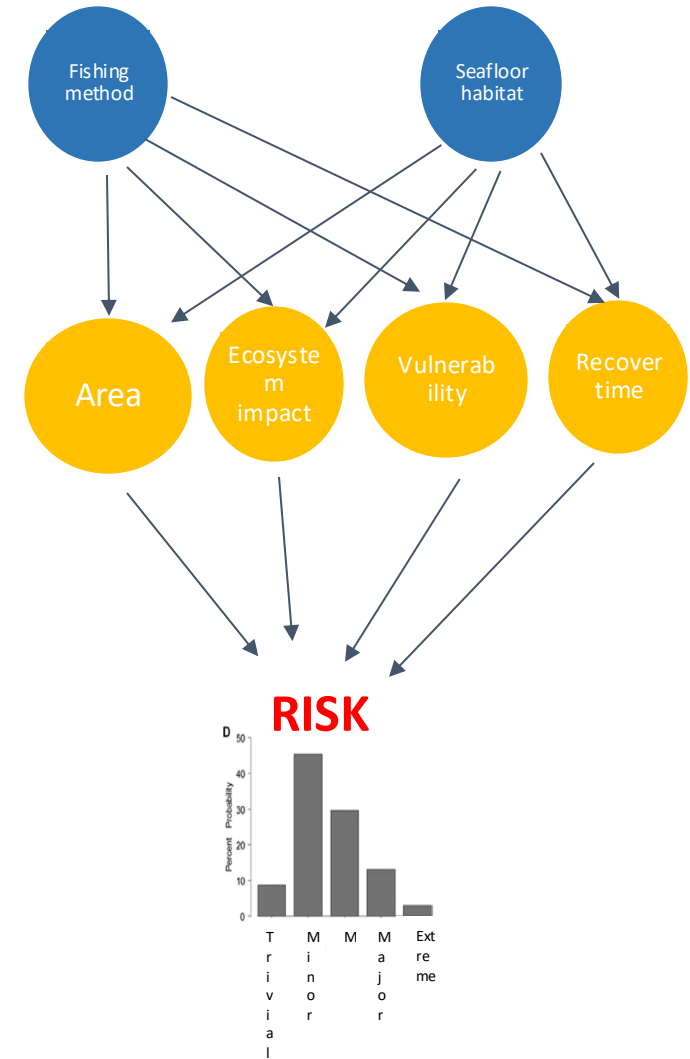
Used to assess risks associated with:

- Benthic impacts of fish farms
- Effects of multiple stressors on estuary functioning
- Effects of multiple stressors on fish populations

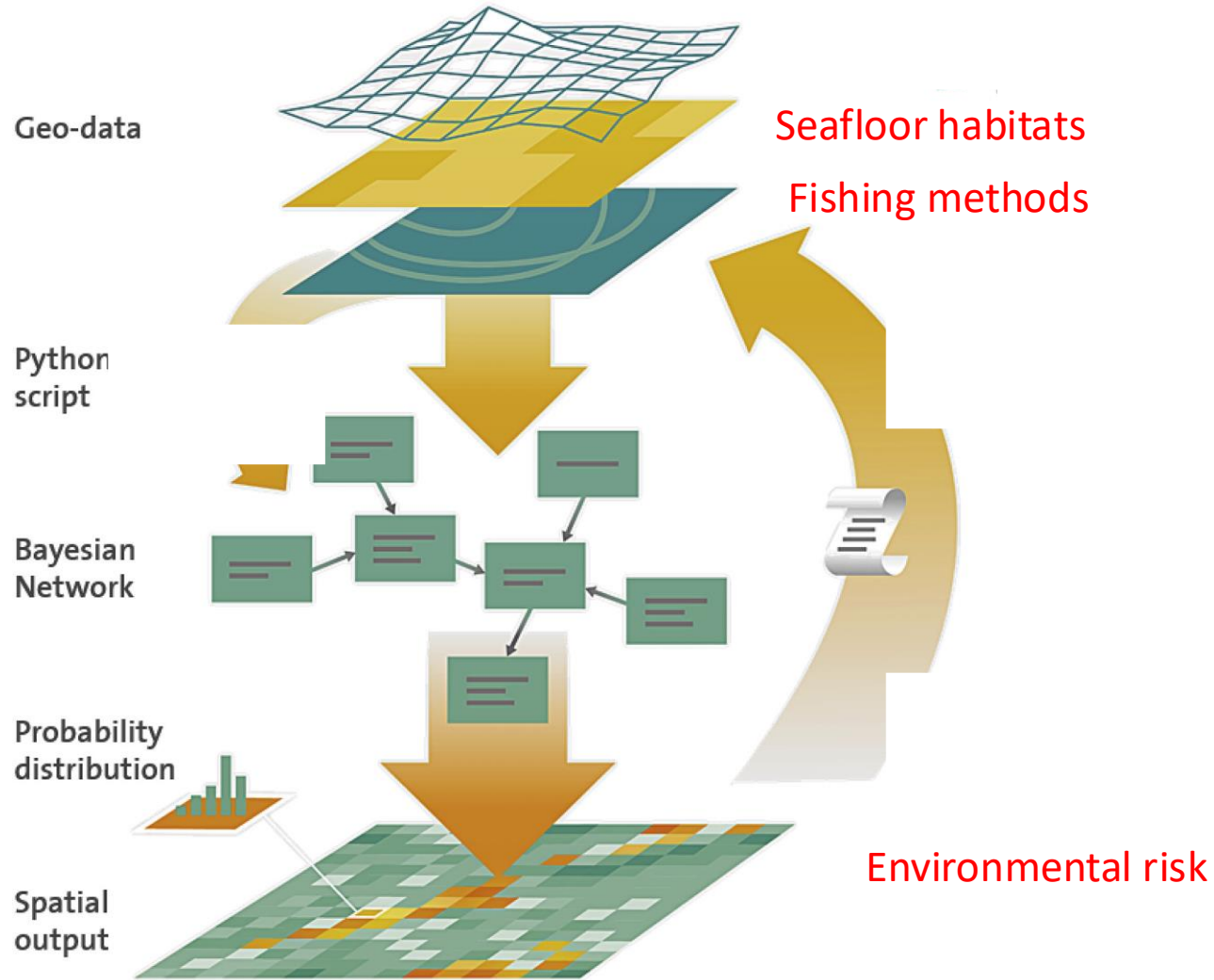
Key advantages

- Highly flexible
- Multiple knowledge types
- Quantifies uncertainty
- Easy to communicate
- Can produce multiple outputs
- Spatial predictions possible

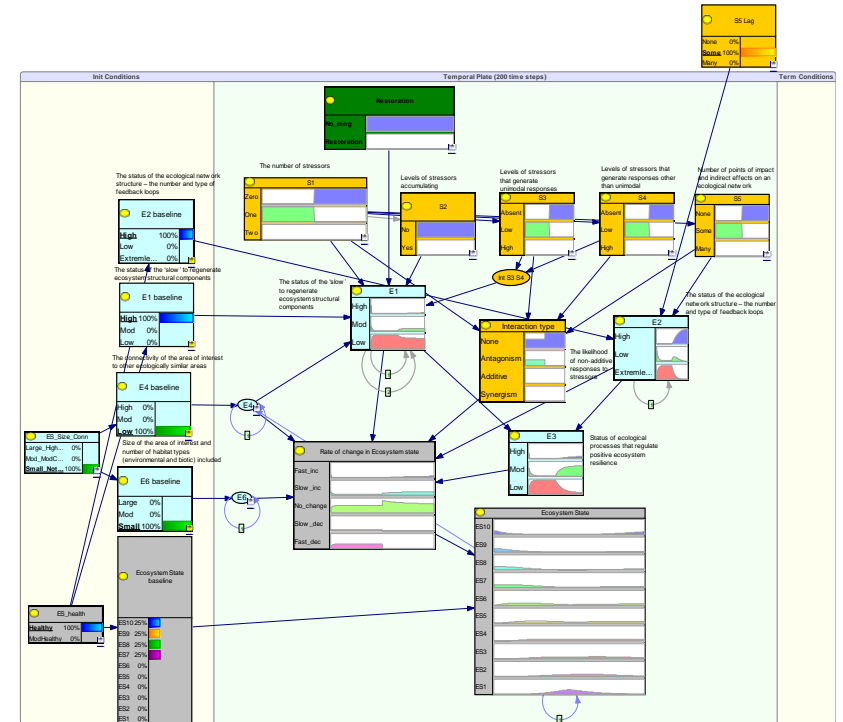
Key references: Marcot et al. 2019, Bulmer et al. 2019, Kaikkonen et al. 2020



Spatial BNs



Temporal BNs

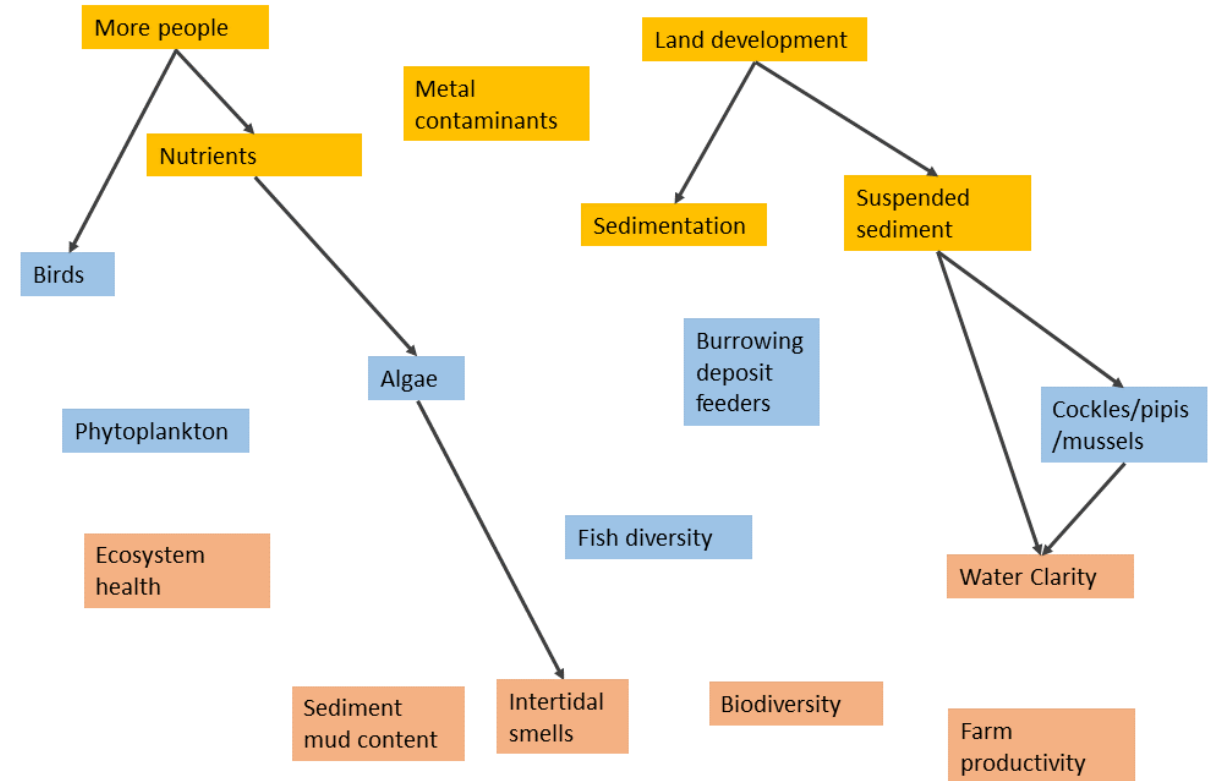


Step 2: Obtaining the basic maps

- **Unstructured conceptual mapping**
- **Structured systems mapping**

Allows

- Different knowledge types
- Diverse components- what's important locally
- Diverse outcomes- what are the aspirations?

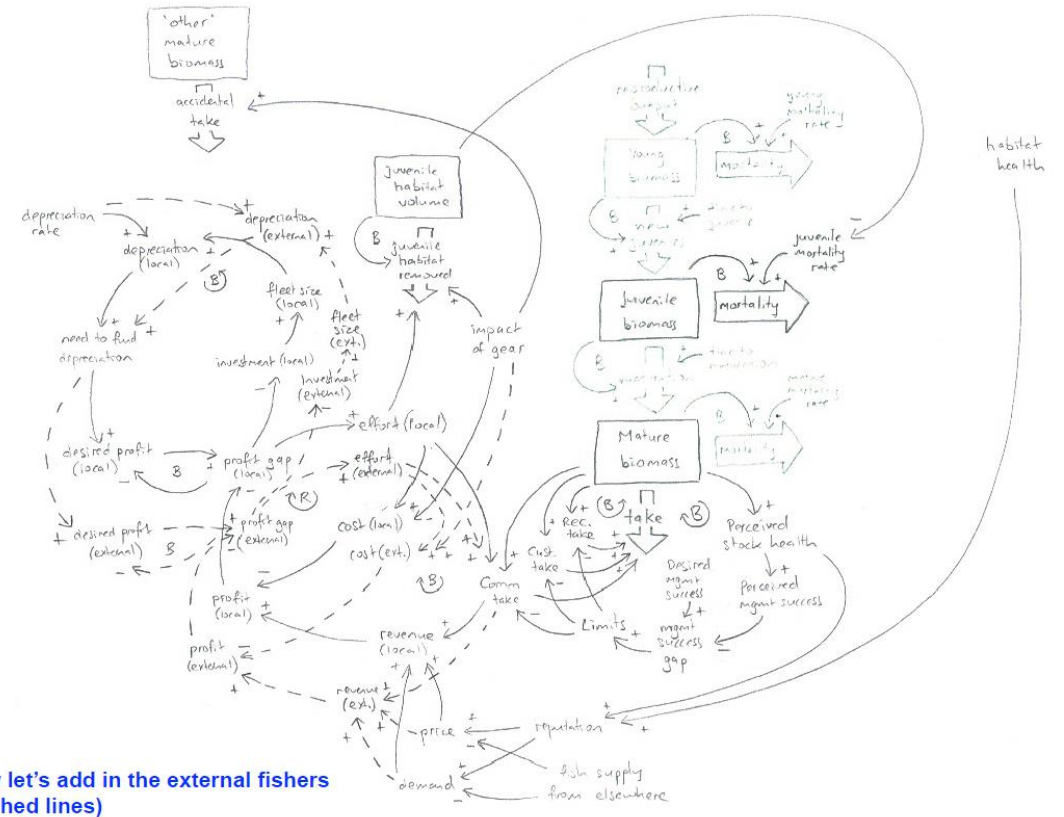


Step 2: Obtaining the basic maps

- Unstructured conceptual mapping
- **Structured systems mapping**

Allows

- Different knowledge types
- Diverse components- what's important locally
- Diverse outcomes- what are the aspirations?

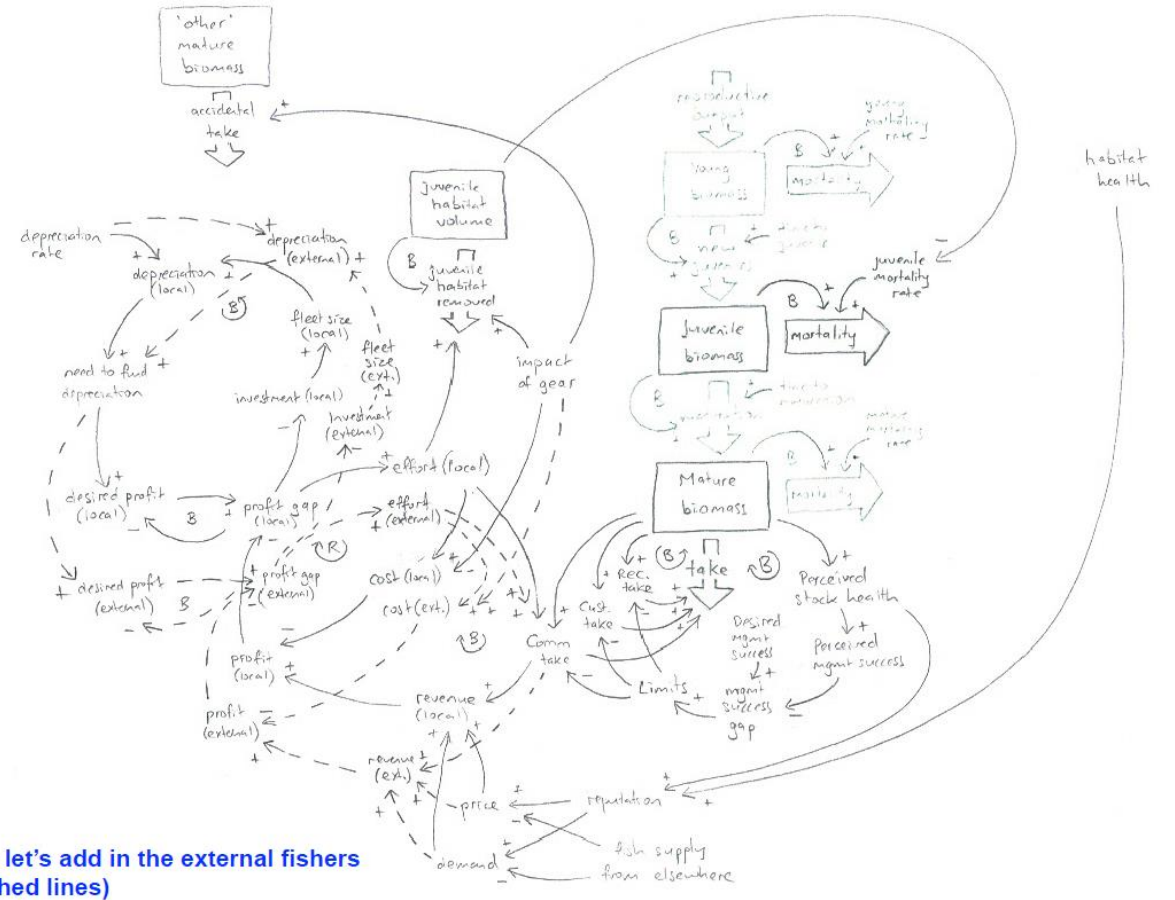


Step 2: Obtaining the basic maps

- Unstructured conceptual mapping
- Structured systems mapping

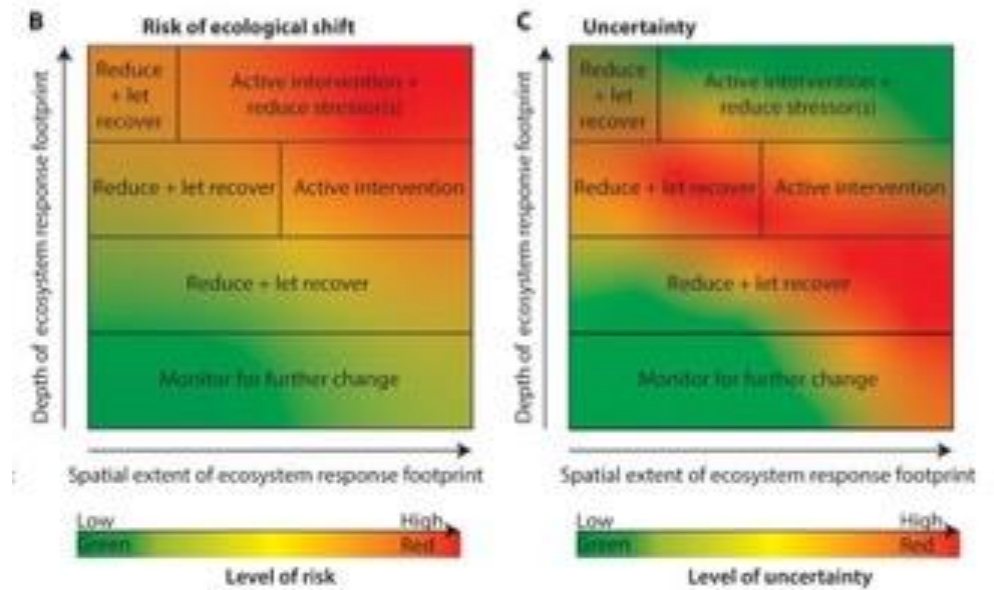
Allows:

- Different knowledge types
- Diverse components- what's important locally
- Diverse outcomes- what are the aspirations?

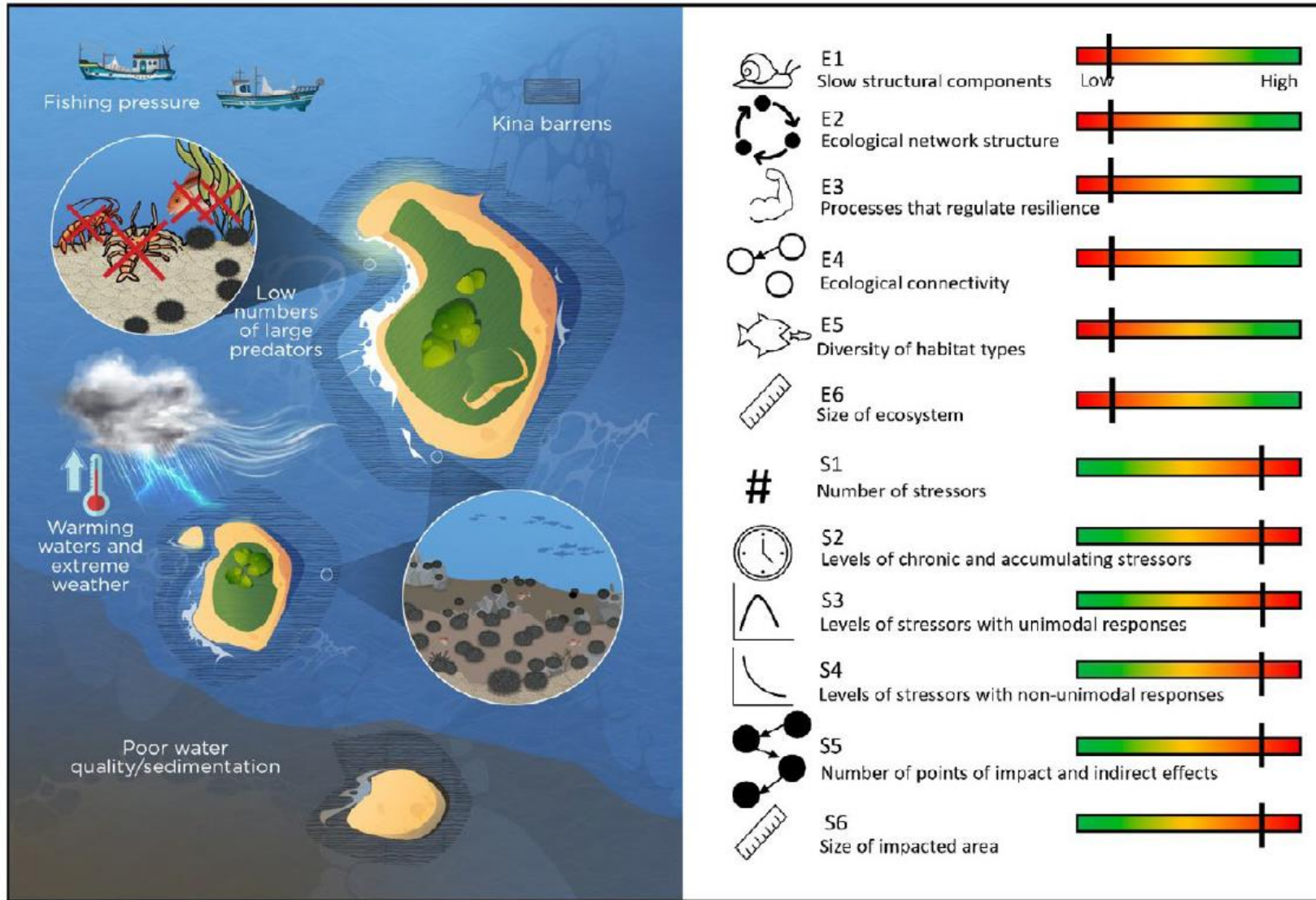


Step 3: Consider uncertainty

- The perfect data does not exist - decisions need to be made
- We're often more uncertain at medium risk areas than at low and high



Step 4: Link to management decisions



See GD: Addressing CE in marine management decisions

Conclusions

- Risk Assessment tools for EBM should be able to incorporate
 - Multiple knowledge systems and values
 - Flow on effects
 - Non-linearity
- Using participatory processes to create underlying maps of desired outcomes and connections reduced conflicts