

Paula Blackett, Erena Le Heron, Shaun Awatere, Richard Le Heron, June Logie, Jade Hyslop, Joanne Ellis, Fabrice Stephenson and Judi Hewitt

# Navigating Choppy Waters

why are we always arguing about risk and uncertainty in marine multi-use environments and what can we do about it?

---

## Abstract

Arguments about risk and uncertainty are prevalent in marine decision making. Different, often invisible, starting positions of those involved – regarding world views, academic disciplines and positionality – are often responsible. Broadly agreed collective outcomes depend on uncovering these influences. In this article we prioritise navigating multiplicity and plurality rather than constraining them. An iterative cycle of reflection and an openness to make changes are central. However, such a cycle must consider how risk assessment tools open or close possible futures, how evidence is best presented to decision makers, and how mātauranga Māori is reshaping risk perceptions and is the decisive intervention in creating improved decision-making spaces.

**Keywords** risk–uncertainty relations, plural and conditional evidence, world views, disciplines, positionality

---

Paula Blackett is an environmental social scientist at NIWA who specialises in decision making when risk, uncertainty and contestation are key attributes. Erena Le Heron is an independent social science researcher and human geographer with Le Heron Leigh Consulting Limited. Shaun Awatere supports Māori in managing collective assets sustainably and is involved in preparing iwi/hapū Māori for climate change planning. Richard Le Heron is a geographer and emeritus professor at Auckland University. June Logie is an independent social researcher, based in Auckland. Jade Hyslop is a kairangahau Māori in the landscape, policy and governance team at Manaaki Whenua Landcare Research. Joanne Ellis is an associate professor at the University of Waikato in marine science. Her research focuses on multiple stressors in coastal environments. Fabrice Stephenson is a quantitative marine ecologist within the School of Natural and Environmental Sciences at Newcastle University. Judi Hewitt is a marine ecologist and a professor of statistics at the University of Auckland.

Planners and policymakers are very familiar with the complexity of decision making in the marine environment arising from often competing and conflicting activities; from a range of owners, rules, governance arrangements, actors and interests. Navigation of risk and uncertainty arguments are often a core component of disputes over what ‘has been happening’, what ‘should happen next’ and ‘why’. This article argues that risk and uncertainty perceptions are products of both changing regulatory regimes of government and the knowledge and assumptions economic and environmental actors bring to their decision making in often volatile settings. Although the socially constructed and plural nature of risk and uncertainty is not a new concept (Jasanoff, 1999; Stirling, 2010), we offer a unique Aotearoa New Zealand perspective on the multiplicity and plurality of risk and uncertainty in the marine environment and offer a way to approach these choppy waters.

## An evolving landscape of risk and uncertainty

Aotearoa might be seen as land/coast/seascape domains actively created by

ongoing natural resource extraction and use by a multiplicity of small and big investors seeking, for the most part, to make a profit. The emphasis, nature and direction of this evolution has been broadly allowed and facilitated by governments laying down both explicit and implicit rules about economic priorities and investor conduct. For our purposes, we identify radical shifts in regulatory regimes since the mid-20th century in Aotearoa: an era dominated by ‘think big’ national development investments to complete the ‘industrialisation’ of Aotearoa; a period beginning in the late 1980s of neoliberal economic reform and introduction of new public management that mirrored developments elsewhere in the world; and, most recently, a return to highly centralised resource use scrutiny with fast-track consenting legislation (Pawson and Biological Economies Team, 2018; Lewis et al., 2024; Scobie and Sturman, 2024).

Beck’s *Risk Society* (Beck, 1992) first recognised the deep societal implications of neoliberal regimes with the sudden and pervasive need to be ‘risk and uncertainty aware’. This was a world where decision making was being devolved to individuals, entities and institutions. Jasanoff (1999) went further, maintaining that ‘risk is impossible to ignore for anyone professionally concerned with the making and evaluation of environmental policy’. This was a sharply different context from the heavy-handed centralist era that existed previously.

Significantly, two Acts, the Resource Management Act 1991 and the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012, introduced a new order of resource governance and management in Aotearoa. A key feature of the legislation was the attempt to de-politicise consenting processes relating to investment proposals. It was accompanied by increasing application of broad science knowledge to assist decision making. A parallel development of great importance in this era was the Treaty of Waitangi settlement process beginning in the 1990s, which gradually funded iwi and hapū aspirations, giving them increasing investment and decision-making presence in the field of economic and environmental relations (Bargh, 2012; Makey and Awatere, 2018;

Many uncertainty typologies for policymakers have been developed since ... including by those ... who describe the types of uncertainty as inexactness, unreliability and ignorance.

---

Pawson and Biological Economies Team, 2018; Lewis et al., 2024; Scobie and Sturman, 2024). The research reported in this article relates to major knowledge developments about risk and uncertainty in 21st-century Aotearoa as seen from the changing perspectives and understanding of the research teams involved.

Alongside political, social and economic change sit a diverse set of often fragmented and siloed literatures which pay attention to the notion of risk and uncertainty, each from a particular academic position and grounded in their specific epistemology and ontological perspective (Taarup-Esbensen, 2019). Many focus on a particular scale (the individual, society, legal entities) or a particular set of activities (decisions, strategic planning, businesses management); some are quantitative while others are qualitative, or a mix of both. In some cases, perception of risk and uncertainty are treated together, while in others they are treated separately (Stirling, 2010; Taarup-Esbensen, 2019).

In an extensive review, Taarup-Esbensen (2019) argues that thinking regarding the perception of risk appears to follow three overlapping traditions, each presenting a slightly different position along a spectrum of thinking. The first, the techno-scientific perspective, is where risk

is informed by scientific knowledge and data, and causality and uncertainty are important. Perception of risk appears to mean how different individuals understand the ‘real’ risk. ‘Real’ risk is defined quantitatively as the probability of experiencing particular negative outcomes (Wilson, Zwickle and Walpole, 2019, p.777). In this tradition, the difference between perception of risks and ‘real’ risk can be closed by effective (science) communication. Most of the science and engineering disciplines sit within this tradition and pay attention to how risk can be quantified, explained and managed through risk assessment practices. It is worth noting that decisions in the marine environment have typically lent heavily on numerical concepts of what risk and uncertainty can be known and described (Clark et al., 2021)

The second, the cognitive perspective, views risk perception as a more subjective phenomenon that is modified by human behaviour, cognitive biases, culture, social norms and values. Grounded in psychology and behaviour sciences, this tradition originated in the 1960s when scholars began exploring the reasons for the gap between ‘real’ risk and individual and public perceptions of risk (Sjöberg, 2000; Wilson, Zwickle and Walpole, 2019). This involves a convergence on the idea of perception of risk ‘as a feeling’ instead of a probability (Wilson, Zwickle and Walpole, 2019), which shifted the emphasis from risk communication to understanding the factors that influence perceptions.

The third tradition, qualitative social science perspectives, sees risk perception in a situated sense-making or meaning-making process that accounts for, and is influenced by, social, cultural, economic and political contexts. Here, more qualitative perspectives on risk can be presented which link risk perception with culture, histories and narratives, power and politics (Beck, 1992; Douglas, 1992; Jasanoff, 1999; Taarup-Esbensen, 2019). Risk and risk perception are understood as complex phenomena that are shaped by society at large. This has enabled the formulation of non-technical, accessible and easily debatable risk and uncertainty dimensions to be sketched out.

In reality, the categories have very porous boundaries and continue to blur

Figure 1: Mātauranga Māori concepts in terms of risk and uncertainty

Whakapapa: provides a place or whenua baseline for assessing responsibility and environmental risk.

Kaitiakitanga: describes the interface between the spiritual and the physical dimensions of natural resource management (NRM). It is a process that regulates human activity with te taiao.

Mauri: the form of value that indigenous risk management responds to.

Mana: fundamental importance of natural resources for well-being of the wider environment, not just for humans. (Hyslop et al.)

Source: Sustainable Seas, 2023

together over time as research and practice evolve. They are nevertheless a helpful initial framing.

The longstanding controversies over uncertainty in the academic literature go back to 1920s debates between Knight and Keynes (Dimand, 2021). Many uncertainty typologies for policymakers have been developed since (Walker et al., 2003), including by those (e.g., Funtowicz and Ravetz, 1990) who describe the types of uncertainty as inexactness, unreliability and ignorance. Walker et al. (2003) present uncertainty as a three-dimensional matrix based on where the uncertainty is located in a decision-making model, the level of uncertainty, and whether the uncertainty is due to imperfect knowledge or inherent variability of the subject matter. Diverse sets of knowledge, values, perceptions, economics, political and social contexts relevant to policymaking are acknowledged and included. Stirling (2010) provides an uncertainty matrix and reveals the tensions between efforts to arrive at probabilities (in the science tradition) and those concerned with possibilities, opportunities and outcomes (a more discursive and open range of interpretations). Stirling's synthesis highlights the interplays of knowledge of any kind that can go into decision making and the power of interests that can modify and direct interpretations that favour particular investment hopes. Hanna, White and Glavovich (2020) offer similar insights suggesting that uncertainty is a contagion spreading outwards from technical assessments into governance, financial, political and socio-cultural domains. Like Stirling, Hanna, White and Glavovich suggest that action and change are more likely to arise from a 'focus on the relations between forms of knowledge and coordinating interactions between the diverse arenas'.

Each author brings a slightly different lens to the problem, which supports Stirling's (2010) conclusion that policymakers need to be cognisant of the multiplicity and plurality of perceptions of risk and uncertainty to avoid an 'inadequate response to imperfect knowledge'. We argue that it isn't just a plurality of knowledge that's important, but a plurality of methods across different disciplines, to provide a broad lens through which to approach risk and uncertainty in real-world decision making.

#### *Another way? Te ao Māori perspectives on risk and uncertainty*

We are fortunate in Aotearoa to contribute to the international risk and uncertainty conversation in unique ways. To appreciate the uniqueness, some definitional aspects need to be introduced (see Figure 1). Whakaaro Māori does not separate uncertainty from risk, focusing less on mitigating 'undesirable' outcomes and more on enhancing mana, restoring mauri and managing the (marine) environment in a more holistic way that is cognisant of the relationship between people and places (Hyslop et al., 2023).

A connection between people and places, and an inherent view of the world as a complex, integrated and interdependent whole, are fundamental attributes of Māori thinking about risk and uncertainty.

Given the discussion so far, multiple perceptions of risk and uncertainty need to be uncovered, explored and navigated to make the process of achieving agreed collective decisions more possible. Our starting point is to acknowledge that people think about risk differently and are often at loggerheads over 'what is at risk and for whom' and 'how uncertain are we'. Experts, stakeholders, iwi/hapū and the wider public all hold positions on, and

perceptions of, risk and uncertainty that decision makers must navigate, guided by legislation, policies and plans, to make decisions. Many of the differences in how risk and uncertainty are perceived may not be immediately clear and may emerge as contestation over other issues. For example, disagreement over numerical model parameters, or the relative merits of different models, may be more about the impact a decision is perceived to have on an interest or desired outcome than the elements of the model itself. The debate over the suitability of the model to be used to inform a decision may be a staging ground to manage or avoid the perceived risk an action has on something of value.

#### *The research journey*

This article proceeds in a somewhat unorthodox manner to outline how we gradually, and iteratively, obtained risk and uncertainty insights, and how we made a switch to policy-bridging efforts around our findings. The strength of our approach has been the authors' (Māori researchers, social scientists and ecologists/modellers) ability to draw on ten years of research in the mission-led Sustainable Seas National Science Challenge projects (Sustainable Seas, 2024a, 2024b). This has generated a holistic lens through which to view perceptions of risk and uncertainty. Our journey has continually applied interdisciplinary mixed-method approaches using local and international literature reviews, interviews, workshops, case studies, and analysis of secondary documents (reports, policy and plans, media webpages, evidence statements from consent processes under the Resource Management Act).

Phase 1 of Sustainable Seas (2016–19) sought to establish national and place-based overviews of marine resource use concerns, with special attention to the proliferation of participatory processes at the local level and their role in advancing ecosystem-based management in the marine setting. A key outcome was recognition of the importance of diversity in participation itself and comparable aspects of diversity expressions of desired outcomes. Good process allows constructive conversations to develop and mutual understandings to be agreed on, and a focus on community/collective definition

of ends and means can result (Le Heron, Le Heron, Logie et al., 2019b). Because diversity is place-based and grounded, no single recipe for success exists, nor should it. In essence, each participatory process that was researched had to be worked through enactive agency (Le Heron, Le Heron, Blackett et al., 2019) accounting for embracing diversity. We carried the message of diverse narratives forward in our later research. In Phase 1 we had minimal understandings of risks and uncertainties, but we were very attentive to providing evidence that ecosystem-based management as a concept needed to be unpacked and grounded in its development.

In Phase 2 (2019–24) three research groups were tasked with collaborating to move forward the theoretical, conceptual, empirical and policy-bridging frontiers of risk and uncertainty research in Aotearoa and internationally. We also sought to expand existing ecological risk assessment tools in ways that allowed them to consider a variety of knowledge sets. A wrestle with the multiple disciplinary positions of how perceptions of risk and uncertainty could or should be understood shifted us towards a more pragmatic, grounded approach where we sought to observe and interrogate how perceptions played out in decision making in socio-ecological systems influenced by politics, culture, regulations, economics and unequal power.

Our exploration of data from document analysis, interviews and participant observation across three case studies: mangrove management (Le Heron et al., 2022); Okura housing development proposal at the northern boundary of Auckland City; and a Chatham Rock Phosphate seabed mining proposal on the Chatham Rise (see Sustainable Seas, 2023). And a revisitation of a thought exercise from a Phase 1 conference workshop (marine wind farm location exercise (Blackett et al., 2020; Le Heron, Le Heron, Logie et al., 2019a)) showed that no single disciplinary tradition fully explained the interaction between actors. Each set of methods and practices were attentive to some factors or scales, and missed others. In short, we noted that plurality and multiplicity of thinking were key to explaining what occurred in each decision-making process. By combining different

**Table 1: Invisible forces on perceptions of risk and uncertainty**

<p><i>Positionality</i> is a common concept in the social sciences (Warf, 2010) which refers loosely to the place people stand. It includes how individuals and groups engage directly in their environment and everyday world, their personal situation, their lived experiences and what their interests and desired outcomes are. Cognitive biases, social and cultural norms, interests and values are all relevant (Sustainable Seas, 2023, 2024b, 2024a).</p>
<p><i>Disciplines</i> schools of thought and training with collective rules and norms regarding how perceptions of risk and uncertainty could or should be known and described: e.g., technological perspective (Taarup-Esbensen, 2019). Each discipline typically has a preference for a certain type of tool, or for certain knowledge or outcomes that should be included, which may be different from another.</p>
<p><i>World views</i> affect how we (as individuals or as groups) think the world works, should work and might be made to work. In the Aotearoa context, three dominant world views are especially discernible:</p> <ul style="list-style-type: none"> <li>• the dominant social paradigm, which mandates doing things for oneself and values highly profit making, and views the world's resources and human ingenuity as limitless (Dunlap and Liere, 1984; Dunlap et al., 2000; Thomson, 2013);</li> <li>• the new environmental/ecological paradigm, which gives priority to preserving ecological processes in harmony with people, and views the world's resources as limited (ibid.);</li> <li>• te ao Māori world view, which grounds principles and actions in place relating to people and ecology for collective short- and long-term benefits (Harmsworth, Awatere and Pauling, 2013; Harmsworth, Awatere and Robb, 2016)</li> </ul>

Source: modified from Sustainable Seas, 2023

disciplinary traditions, we suggest that perceptions of risk and uncertainty appear influenced by three frequently invisible factors: disciplinary training, world views and positionality. Explorations of these hidden influences are cited in Table 1.

In the final year of Phase 2 we distilled our research and refined knowledge processes into digestible, useful and useable knowledge for those involved with policymaking at ministerial and CEO level, and a wider base of policy institutions ranging across regional councils, local authorities, economic development agencies, iwi organisations and major consultancies – in essence, taking the notions of working with the plurality of perceptions of risk and uncertainty into policy relevant insights that advance practice and begin to unpack and expose why we have arguments about risk.

#### **What have we learnt from our research journey?**

Our position on perceptions of risk and uncertainty has evolved over the last ten years to a similar place to other authors who have stepped back from their disciplines and sought to explore the messiness of real-world decision making (Stirling, 2006). We argue that working with plurality is essential, to avoid locking in a certain set of business-

as-usual outcomes that benefit a certain set of groups in society. In practice, regulations and requirements make this plurality more challenging.

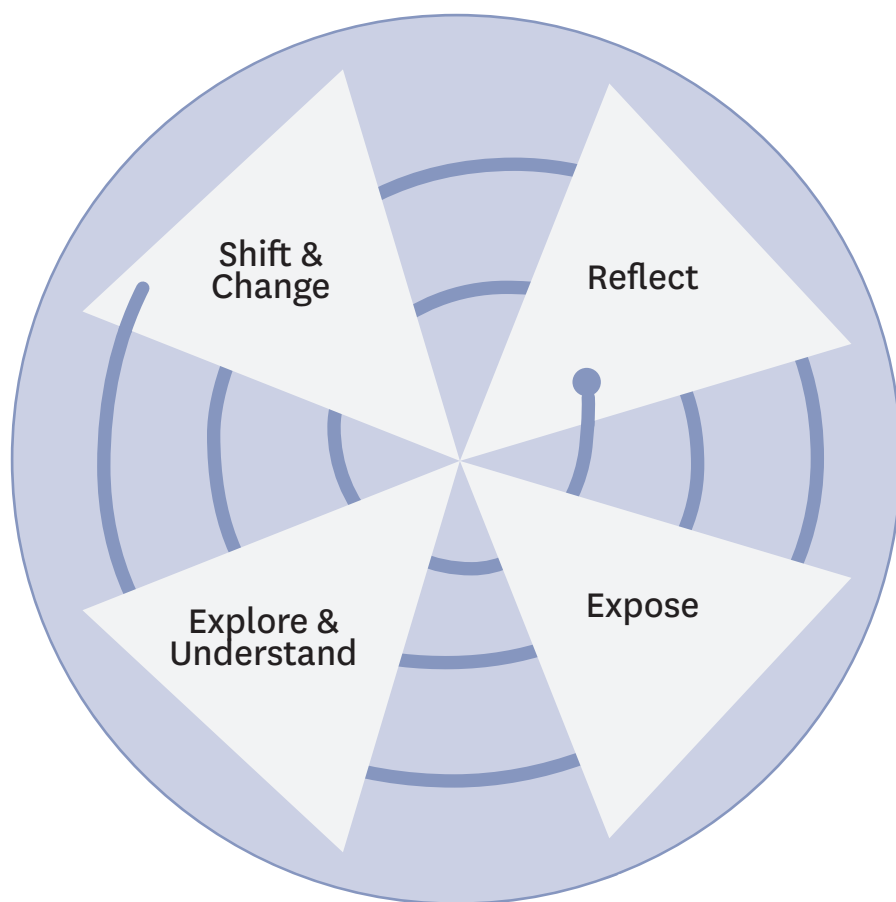
#### ***The choice of risk assessment tools matters as different practices can create different futures***

Contemporary reviews of risk assessment stress the strengths and weaknesses of different risk assessment tools across a variety of disciplines and domains, each stressing the need to move towards more complex assessments (Clark et al., 2021; Simpson et al., 2021; Logan et al., 2022).

The findings of the ecologist team in our research project give much specificity and clarity to what making risk assessment For ecologists, risk assessment needs to shift from simple assessments generally focussed on one activity (risk from what stressor) influencing one species or habitat (risk to what value) to methods that can account for (Clark et al. 2022; Sustainable Seas et al. 2023), ecological, cultural and social (including economic) complexities, management actions, indirect effects, and feedbacks. In particular:

- Cumulative effects, while widely acknowledged, are largely missing from risk assessment tools. A range of components, outcomes and stressors

Figure 2: Iterative steps involved in understanding and working with the multiplicity of perceptions of risk and uncertainty



influence both the ecological response of multiple interacting ecosystem components (e.g., biodiversity loss, contamination, changes to ecosystem function, alteration of food quantity/quality, and changes to trophic levels) and the social, cultural and economic values.

- Multiple knowledge types (e.g., expert opinion, mātauranga Māori or local knowledge, as well as quantitative data) enable quantitative data gaps to be filled, widen the evidence base and ensure that ecosystem-based management objectives align with the values of multiple sectors of society. The definition of what constitutes evidence can remain broad and not be reduced to purely quantitative information.
- Accommodating and communicating spatial and temporal variability requires attention which places demands on communicating the risks posed to locations of interest (e.g., maps).
- A step of focusing explicitly and separately on recovery, rather than

combining it with impact, gives attention to ecological feedback. Hysteresis and recovery lags can hinder recovery, even when stressors are reduced, and the object of the risk assessment may be recovery of the mauri rather than minimising future degradation.

Scenarios exploring the relative success of different actions give some level of confidence about the effects of different actions on desired outcomes. This is particularly useful for a risk assessment operating under ecosystem-based management. Finally, Bayesian networks and agent-based models offer new possibilities, as does a new method specifically developed by Sustainable Seas focused on assessing risks of specific management actions based on ecological principles (Gladstone-Gallagher et al., 2024).

Essentially, most risk assessment methods and processes currently in use in Aotearoa in the marine environment do not meet criteria required to support

cumulative impacts, the needs and aspirations of Māori or EBM, nor do most operate well in a world of cumulative impacts from multiple activities and sparse numeric data.

### *Significance of te ao Māori perspectives of risk and uncertainty*

We argue that te ao Māori concepts have much to offer in terms of reconceptualising risk and uncertainty. Because te ao Māori is grounded in people, places, care, reciprocal rights and responsibility, the basis for reconceptualising risk and uncertainty is enhanced. The connectivity and interrelations of te ao Māori go beyond the typical confines of Eurocentric conceptions. Policies and plans drawn from holistic understandings, cognisant of reciprocal rights and responsibilities, are less likely to veer to choices that privilege one group over another (in both space and time) and will be more cognisant of unintended consequences. In short, te ao Māori offers viable solutions that can reshape perceptions of risk and uncertainty away from reductionist practices that are negatively framed, towards ecosystem-based management (Hyslop et al., 2023; Sustainable Seas, 2023).

### *How can policymakers approach plurality in a pragmatic and respectful way?*

We argue that plurality and multiplicity can be navigated to uncover new possibilities, opportunities and imagined alternative futures, but that to do so, plurality and multiplicity must first be exposed and understood (Figure 2). As each decision-making journey will be set in a specific context with different pressures, there is no clear recipe that can be taken off the shelf (Le Heron et al., 2024). To enable progress, we offer key signposts, and readers are directed to Sustainable Seas (2023, 2024a, 2024b) for additional tools and material.

The interactive cycle starts with reflection and moves clockwise round the figure. Thoroughly exposing issue sets a template for constructive enquiry. Issues may be: sensitive, such as the right distribution of power; pragmatic – who is at the decision table; ethically laden – who experiences risk and harm; concerns about giving space for differing views to be voiced, listened to and genuinely acted upon; or

completely out of left-field. Exploring and understanding can be approached in many ways, but the intent is to develop possible steps to transitioning or transformation with those involved. We have found that the technique of phrasing and using key questions gives unexpected scope to reset the agenda of discussion.

- *Reflect:* What is my position? What do I think and how might this affect the way I enter into a conversation or discussion where risk and uncertainty are relevant. What toolbox might I apply and what are the limitations of the methods I am familiar with? Importantly, practitioners and decision makers are influenced by their own world views, training and positionality, and this of course influences the solutions they may consider and recommend. Actively challenging our own preconceptions is helpful because it may expose strengths and weaknesses in our assumptions, processes, policies and practices.
- *Expose:* What are the positions of other people and groups? How do they understand the world in a way that's different from me? What is the breadth of perspectives present, and how might touchstones be identified and given attention?
- *Explore and understand:* What do the differences mean regarding how risk and uncertainty are considered, understood and framed in this discussion, in this place? What does this mean for the outcomes we seek and the things we disagree on? The more planners and policymakers are able to identify the reasons and accompanying narratives behind risk and uncertainty assertions, the more likely they are to be able to steer towards negotiated understandings. This may not resolve conflicts, but it can potentially create room for focused conversations around concrete differences, in the spirit of the advice and steerage of Stirling (2010), Jasanoff (1999) and Hanna, White and Glavovich (2020).
- *Shift and change:* From our collective positions, what new possibilities emerge, and how can these be put into persuasive storylines and enacted? We suggest that by taking a considered,

... it is likely that the true nature of the disagreement remains unseen, meaning some potentially mutually agreeable solutions or policies may also remain unseen.

---

reflexive approach, policymakers and practitioners could achieve a deeper understanding of the plurality of perceptions of risk and uncertainty and begin to shift arguments about risk and uncertainty to a space where new possibilities exist. In doing so, we can begin to shift the focus from arguments about risk to the process of making visible more agreeable actions in the marine environment.

#### Conclusion

In this article we argue that multiple perceptions of risk and uncertainty need to be uncovered, explored and navigated to make the process of achieving broadly agreed collective decisions more possible. If they are not exposed, it is likely that the true nature of the disagreement remains unseen, meaning some potentially mutually agreeable solutions or policies may also remain unseen. By placing risk and uncertainty into a relation, we create new ways to bridge knowledge and policy, including imagining alternative futures. Importantly, such possible new futures could avoid the typical dichotomy between environmental and economic goals, and the decades-old tussle over which should take precedence. In essence, we argue that

the way forward in tackling perceptions of risk and uncertainty lies in navigating the multiplicity of views rather than constraining them.

We suggest that progress can be made by engaging in an iterative cycle of reflection, exploration and revising positions, while paying close attention to three other considerations. First, the tools that are used to assess risk open up or shut down possible futures due to the limitations and strengths of the tools themselves. Second, the manner of presenting evidence to decision makers is a difficult but strategically important step in effectively engaging with risk and uncertainty. We affirm the insights of the literature reviewed that stress that making it complex by delineating the plurality of evidence gives decision makers the chance to weigh the merits and demerits of any case, so arriving at conditional but pragmatic answers. This is a route to bypassing adversarial decision making and a lapse into seeking consensus.

Third, we are increasingly convinced that understanding how mātauranga Māori is reshaping our understanding of risk is the decisive intervention that will create the space that counts most. We point to the Sustainable Seas waka taurua framing (Maxwell et al., 2020) values, and practices, alongside international initiatives such as Ecosystem-Based Management ('EBM'). This framing interweaves te ao Māori and te ao Pākehā in Aotearoa New Zealand and could flow directly into future environmental legislation and decision making. This encompassing and collectively directed approach has great potential to mitigate short-termism and open up thinking, especially for intergenerational outcomes.

#### Acknowledgements

The authors would like to acknowledge the participants and research partners who gave their time to participate in interviews and workshops. In particular, we would like to acknowledge Ilze Ziedins, Maria Armoudian, Richard Bulmer, Dana Clark, Rebecca Gladstone-Gallagher, Ani Kainamu and Vera Rullens from the Sustainable Seas Communicating Risk and Uncertainty Research Project. Funding was provided by the Sustainable Seas National Science Challenge.

## Navigating Choppy Waters: why are we always arguing about risk and uncertainty in marine multi-use environments and what can we do about it?

### References

- Bargh, M. (2012) 'Impacts on post settlement', in J. Hayward and N. Wheen (eds), *Treaty of Waitangi Settlement*, Wellington: Bridget Williams Books
- Beck, U. (1992) *Risk Society: towards a new modernity*, London: Sage
- Blackett, P. et al. (2020) 'Enacting participatory processes learnings: an experiment with interdisciplinary engagement', in E. Probyn, K. Johnston and N. Lee (eds), *Sustaining Seas: oceanic space and the politics of sustainable seas*, London: Rowman and Littlefield
- Clark, D.E., R.V. Gladstone-Gallagher, J.E. Hewitt, F. Stephenson and J.I. Ellis (2022) 'Risk assessment for marine ecosystem-based management (EBM)', *Conservation Science and Practice*, 4, e12636
- Clark, D.E., R. Gladstone-Gallagher, F. Stephenson and J. Ellis (2021) *A Review of Risk Assessment Frameworks for Use in Marine Ecosystem-based Management (EBM) in Aotearoa New Zealand*, Sustainable Seas National Science Challenge
- Dimand, R.W. (2021) 'Keynes, Knight, and fundamental uncertainty: a double centenary 1921–2021', *Review of Political Economy*, 33, pp.570–84
- Douglas, M. (1992) *Risk and Blame: essays in cultural theory*, London: Routledge
- Dunlap, R.E. and K.D. Van Liere (1984) 'Commitment to the dominant social paradigm and concern for environmental quality', *Social Science Quarterly*, 65, pp.1013–28
- Dunlap, R.E., K.D. Van Liere, A.G. Mertig and R.E. Jones (2000) 'New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale', *Journal of Social Issues*, 56, pp.425–42
- Funtowicz, S.O. and J.R. Ravetz (1990) *Uncertainty and Quality in Science for Policy*, Dordrecht: Springer
- Gladstone-Gallagher, R.V., J.E. Hewitt, J.M.L. Low, C.A. Pilditch, F. Stephenson, S.F. Thrush and J.I. Ellis (2024) 'Coupling marine ecosystem state with environmental management and conservation: a risk-based approach', *Biological Conservation*, 292, 110516
- Hanna, C., I. White and B. Glavovic (2020) 'The uncertainty contagion: revealing the interrelated, cascading uncertainties of managed retreat', *Sustainability*, 12
- Harmsworth, G., S. Awatere and C. Pauling (2013) 'Using matauranga Māori to inform freshwater management', policy brief 7, Lincoln: Landcare Research Manaaki Whenua
- Harmsworth, G., S. Awatere and M. Robb (2016) 'Indigenous Māori values and perspectives to inform freshwater management in Aotearoa-New Zealand', *Ecology and Society*, 21 (4)
- Hyslop, J., N. Harcourt, S. Awatere, D. Hikuroa, P. Blackett and R.L. Heron (2023) 'Kia aiō ngā ngaru, kia hora te marino: smoothing the waters in natural resource management to mitigate risk and uncertainty', *AlterNative*, 19 (2)
- Jasanoff, S. (1999) 'The songlines of risk', *Environmental Values*, 8, pp.135–52
- Le Heron, E., R. Le Heron, S. Awatere, P. Blackett, J. Logie and J. Hyslop (2024) 'He uiui aromatawai tūrarū: guidance for "risky" and uncertain resource use decision-making in Aotearoa', *New Zealand Geographer*, <https://doi.org/10.1111/nzg.12400>
- Le Heron, E., R. Le Heron, P. Blackett, K. Davies, J. Logie, W. Allen, A. Greenaway and B. Glavovic (2019) 'It's not a recipe ... but there are ingredients: navigating negotiated change through participatory processes in marine spaces', *Planning Quarterly*, June, pp.32–7
- Le Heron, E., R. Le Heron, J. Logie, A. Greenaway, W. Allen, P. Blackett, K. Davies, B. Glavovic and D. Hikuroa (2019a) 'Participatory processes as 21st century social knowledge technology: metaphors and narratives at work', in E. Probyn, K. Johnston and N. Lee (eds), *Sustaining Seas: oceanic space and the politics of care*, London: Rowman and Littlefield
- Le Heron, E., R. Le Heron, J. Logie, A. Greenaway, W. Allen, P. Blackett, K. Davies, B. Glavovic and D. Hikuroa (2019b) 'Diversity, contestation, participation in Aotearoa New Zealand's multi-use/user marine spaces', *Marine Policy*, 106
- Le Heron, R., C.J. Lundquist, J. Logie, P. Blackett, E.L. Heron, S. Awatere and J. Hyslop (2022) 'A socio-ecological appraisal of perceived risks associated with mangrove (mānawa) management in Aotearoa New Zealand', *New Zealand Journal of Marine and Freshwater Research*, 5, pp.447–65
- Lewis, N., R. Le Heron, D. Hikuroa and E. Le Heron (2024) 'Rent as a regional asset: rent platforms and regional development in Kaikōura, Aotearoa New Zealand', *Regional Studies*, 58, pp.151–3
- Logan, T.M., T. Aven, S.D. Guikema and R. Flage (2022) 'Risk science offers an integrated approach to resilience', *Nature Sustainability*, 5, pp.741–8
- Makey, L. and S. Awatere (2018) 'He mahere pāhekoheko mō kaupara moana – integrated ecosystem-based management for Kaipara Harbour, Aotearoa New Zealand', *Society and Natural Resources*, 31, pp.1400–1
- Maxwell, K.H., K. Ratana, K.K. Davies, C. Taiapa and S. Awatere (2020) 'Navigating towards marine co-management with indigenous communities on-board the waka-taurua', *Marine Policy*, 111, 103722
- Pawson, E.E. and the Biological Economies Team (2018) *The New Biological Economy: how New Zealanders are creating value from the land*, Auckland: Auckland University Press
- Scobie, M. and A. Sturman (2024) *The Economic Possibilities of Decolonisation*, Wellington: Bridget Williams Books
- Simpson, N.P. et al. (2021) 'A framework for complex climate change risk assessment', *One Earth*, 4, pp.489–501
- Sjöberg, L. (2000) 'Factors in risk perception', *Risk Analysis*, 20, pp.1–12
- Stirling, A. (2006) 'Analysis, participation and power: justification and closure in participatory multi-criteria analysis', *Land Use Policy*, 23, pp.95–107
- Stirling, A. (2010) 'Keep it complex', *Nature*, 468, pp.1029–31
- Sustainable Seas (2023) *Understanding and Communicating Risk and Uncertainty (Te Tūrarū me te Haurokuroku) in Marine Management: a framework and guidance document*, <https://www.sustainableseaschallenge.co.nz/assets/dms/Guidance/Risk-and-uncertainty/Risk-and-uncertainty-guidance.pdf>
- Sustainable Seas (2024a) 'Communicating risk and uncertainty', <https://www.sustainableseaschallenge.co.nz/our-research/communicating-risk-and-uncertainty>
- Sustainable Seas (2024b) 'Perceptions of risk and uncertainty', <https://www.sustainableseaschallenge.co.nz/our-research/perceptions-of-risk-and-uncertainty/>
- Taarup-Esbensen, J. (2019) 'Making sense of risk: a sociological perspective on the management of risk', *Risk Analysis*, 39, pp.749–60
- Thomson, J. (2013) *New Ecological Paradigm survey 2008: analysis of the NEP results*, Hamilton: Waikato Regional Council
- Walker, W.E., P. Harremoës, J. Rotmans, J.P. van der Sluijs, M.B.A. van Asselt, P. Janssen and M.P. Krayen von Krauss (2003) 'Defining uncertainty: a conceptual basis for uncertainty management in model-based decision support', *Integrated Assessment*, 4, pp.5–17
- Warf, B. (2010) *Encyclopedia of Geography*, Sage Publications
- Wilson, R.S., A. Zwickle and H. Walpole (2019) 'Developing a broadly applicable measure of risk perception', *Risk Analysis*, 39, pp.777–91