Applying a values-based decision process to facilitate comanagement of threatened species in Aotearoa New Zealand

Thalassa McMurdo Hamilton 1,2,∗ Stefano Canessa 1,3, Katie Clark, 4 Pani Gleeson, 5 Fiona Mackenzie, 6 Troy Makan, 7 Gena Moses-Te Kani, 6 Shona Oliver, 5 Kevin A. Parker 9, and John G. Ewen 1

1 Institute of Zoology, Zoological Society of London, Regents Park, London, NW1 4RY, U.K.
2 Centre for Biodiversity and Environment Research, Department of Genetics, Evolution and Environment, University College London, Gower Street, London, WC1E 6BT, U.K.
3 Wildlife Health Ghent, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, Merelbeke, 9820, Belgium
4 Te Uri O Hau, Hunt Street, Whangarei, 0110, New Zealand
5 Ngāti Whatua o Kaipara / Ngā Maunga Whakahii o Kaipara, Pouwhakahaere Te Tari Taiao, Commercial Road, Helensville, 0800, New Zealand
6 Ngāti Manuhiri Settlement Trust, Pou Kaitiaki, Leigh Road, Rodney, 0985, New Zealand
7 Department of Conservation - Te Papa Atawhai, Sala Street, Rotorua, 3010, New Zealand
8 Ngāti Kuia, Hōkai Nuku (Ngāti Manuhiri & Ngāti Whātua), Pou Tātaki, Rutherford Street, Nelson, 7040, New Zealand
9 Parker Conservation, Warkworth, 0941, New Zealand

Abstract: Ko koe ki tēna, ko ahau ki tēna ki kiwai o te kete (you at that, and I at this handle of the basket). This Māori (New Zealanders of indigenous descent) saying conveys the principle of cooperation—we achieve more through working together, rather than separately. Despite decades of calls to rectify cultural imbalance in conservation, threatened species management still relies overwhelmingly on ideas from Western science and on top-down implementation. Values-based approaches to decision making can be used to integrate indigenous peoples’ values into species conservation in a more meaningful way. We used such a values-based method, structured decision making, to develop comanagement of pekapeka (Mystacina tuberculata) (short-tailed bat) and tara iti (Sternula nereis davisae) (Fairy Tern) between Māori and Pākehā (New Zealanders of European descent). We implemented this framework in a series of workshops in which facilitated discussions were used to gather expert knowledge to predict outcomes and make management recommendations. For both species, stakeholders clearly stated their values as fundamental objectives from the start, which allowed alternative strategies to be devised that naturally addressed their diverse values, including mātauranga Māori (Māori knowledge and perspectives). On this shared basis, all partners willingly engaged in the process, and decisions were largely agreed to by all. Most expectations of conflicts between values of Western science and Māori culture were unfounded. Where required, positive compromises were made by jointly developing alternative strategies. The values-based process successfully taha wairua taha tangata (brought both worlds together to achieve the objective) through codeveloped recovery strategies. This approach challenges the traditional model of scientists first preparing management plans focused on biological objectives, then consulting indigenous groups for approval. We recommend values-based approaches, such as structured decision making, as powerful methods for development of comanagement conservation plans between different peoples.

Keywords: conservation planning, endangered species, inclusivity, indigenous values, mātauranga Māori, species recovery, structured decision making

∗email thalassa.mcmurdohamilton@ioz.ac.uk
†Deceased

Article impact statement: Values-based approaches like structured decision making successfully enable participation and inclusive conservation practice.

Paper submitted April 30, 2020; revised manuscript accepted October 4, 2020.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

Conservation Biology, Volume 35, No. 4, 1162–1173
© The Authors. Conservation Biology published by Wiley Periodicals LLC on behalf of Society for Conservation Biology
DOI: 10.1111/cobi.13651
Resumen: Ko koe ki tēnā, ko abau ki tēnai kūwai o te kete (tú en ésa y yo en esta asa de la cesta). Este dicho Māori (neozelandeses con ascendencia indígena) expresa el principio de la cooperación - logramos más trabajando juntos que por separado. A pesar de las décadas de peticiones para rectificar el desbalance ambiental que existe en la conservación, el manejo de especies amenazadas todavía depende abrumadoramente de ideas tomadas de la ciencia occidental y en la implementación de arriba-abajo. Los enfoques para la toma de decisiones basados en valores pueden usarse para integrar de manera más significativa los valores de los pueblos indígenas dentro de la conservación de especies. Usamos un método basado en valores, la toma estructurada de decisiones, para desarrollar una estrategia de comanego del pekapeka (Mystacina tuberculata) (murciélago de cola corta) y el tara iti (Sternula nereis davisae) (charrancito australiano) entre los Māori y los Pākehā (neozelandeses de ascendencia europea). Implementamos este marco de trabajo en una serie de talleres en los cuales se usaron discusiones facilitadas para recabar el conocimiento de los expertos para pronosticar los resultados y realizar recomendaciones de manejo. Para ambas especies, los actores sociales mencionaron claramente a sus valores como objetivos fundamentales desde el inicio, lo que permitió el diseño de estrategias alternativas que consideraran naturalmente estos diferentes valores, incluyendo el mātauranga Māori (conocimiento y perspectivas Māori). Sobre esta base compartida, todos los colaboradores participaron voluntariamente en el proceso y la mayoría estuvo de acuerdo con las decisiones. La mayoría de los conflictos esperados entre la ciencia occidental y la cultura Māori no tuvieron fundamentos. En donde fueron requeridos, se realizaron concesiones positivas mediante el desarrollo conjunto de estrategias alternativas. El proceso basado en valores logró exitosamente taba warua taba tangata (junto a ambos mundos para conseguir el objetivo) por medio de estrategias de recuperación desarrolladas en conjunto. Esta estrategia desafía el modelo tradicional de los científicos preparando primero los planes de manejo enfocados en objetivos biológicos para después consultar a los grupos indígenas para que los aprueben. Recomendamos estos enfoques basados en valores, como la toma estructurada de decisiones, como métodos poderosos para el desarrollo de planes de conservación que incluyan el comanego entre diferentes pueblos y personas.

Palabras Clave: especie en peligro, inclusión, mātauranga Māori, planeación de la conservación, recuperación, toma estructurada de decisiones, valores indígenas

Introduction

Historically, conservation actions have been overwhelmingly inspired by biological insights and implemented top-down. Despite over 2 decades of calls for more equal and inclusive conservation, where agencies work with communities and indigenous groups (United Nations 1992; Wright et al. 1995; Tallis & Lubchenco 2014; Lyver et al. 2018), inclusivity remains the exception (Mascia et al. 2003; Gregory 2016). Many indigenous groups feel marginalized by, or will not engage in, processes that do not recognize and account for their values significantly (Gregory 2016; Whecler et al. 2020). Changing ingrained practices requires deep engagement between partners and interdisciplinary facilitation methods (Brown 2003; Bennett et al. 2017), but practical examples of how to achieve such a change remain scarce.

Most Western conservationists are trained as biologists and so focus on understanding and mitigating population declines (Fox et al. 2006). Therefore, biology dominates the drive for evidence-based conservation, based on use of systematically collected data to choose management (Sutherland et al. 2004). Evidence-based conservation is a much-needed improvement of current practice, but it
Facilitating Comanagement

Figure 1. The decision-making cycle (adapted from Gregory et al. [2012a]) (counter clockwise arrow; steps may be reiterated if required; bubbles, interpretation of integration of indigenous values relative to Māori as an example, transferable to any indigenous group as that group culture demands). Illustration by J. Wold.

Conservation Biology
Volume 35, No. 4, 2021

does not need to clash with inclusivity. Exclusive focus on biological evidence fails to acknowledge the complexity of decision making, particularly the diverse values involved (Evans et al. 2017; Toomey et al. 2017), making assumptions about what those values are or explicitly excluding them (Gregory et al. 2012a). Furthermore, evidence-based conservation itself is not objective because it is embedded in Western science beliefs about how to correctly interact with the environment (Giles et al. 2016; Salomon et al. 2018).

Because conservation is never value neutral, evidence can only play a support role, albeit a crucial one (Brown 2003; Gregory et al. 2012b; Peterson et al. 2013; Evans et al. 2017). Conservationists must first understand that the objectives of recovery plans reflect values, including, but not limited to, ecological values of nature. Then, they can gather the right information about all objectives, including scientific evidence, to generate long-term solutions that are widely accepted (Gregory et al. 2012a). The centrality of objectives is recognized by many decision-making approaches (Schwartz et al. 2018). Among those, structured decision making (SDM) is a framework that originates from decision theory and risk analysis (Gregory et al. 2012a). Structured decision making is an iterative process with 6 steps: set the decision context; clearly define objectives; develop possible management alternatives; predict performances of alternatives against the objectives; find the best decision across objectives; and monitor to track outcomes (Fig. 1) (Gregory et al. 2012b). Because SDM acknowledges that values (objectives) are the main driver of decisions (Keeney 1996), it is ideal for diverse stakeholder groups. Planners have used SDM in many environmental decisions, from controlling invasive willow in Australia (Moore & Runge 2012) to improving resilience of tidal marshes to climate change (Thorne et al. 2015).

Structured decision making offers opportunities to legitimately integrate indigenous values into conservation decisions. It emphasizes transparency and inclusion of multiple partners, allowing for shared solutions and their implementation (Bennett et al. 2019). Crucially, values are meaningfully described and integrated into each step of a decision (Fig. 1). Structured decision making has been used in this way to conserve boreal woodland caribou (Rangifer tarandus caribou) in western Canada (Hayek et al. 2016), to control non-native fish below Glen Canyon Dam in Arizona (U.S.A.), (Runge et al. 2011) and to devise water-use plans in British Columbia (Canada) (Gregory et al. 2008). In these examples, SDM successfully increased process transparency, participation, and
shared solutions. However, published examples beyond the United States and Canada are scarce (but see Arvai & Post [2012]).

Structured decision making could be particularly useful in a country like Aotearoa New Zealand, where there is a strong desire to rectify a history of cultural bias in environmental management (Wright et al. 1995; Department of Conservation 2000). Te Tiritiri o Waitangi (The Treaty of Waitangi, 1840) is an agreement between representatives of Māori (the indigenous people of Aotearoa New Zealand) and the British Crown. Its second article and its subsequent interpretation in the Conservation Act (New Zealand Government 1975) and Resource Management Act (New Zealand Government 1991) mandate that decision making considers both mātauranga Māori (Māori knowledge, perspective, and culture) and Pākehā (New Zealander of European descent) values. This has led to some positive steps. For example, iwi (tribe) management plans support valid influence of iwi on planning processes (Thompson-Fawcett et al. 2017), yet consideration of mātauranga Māori remains largely unfulfilled and invisible in conservation practice (McAllister et al. 2019; Wehi et al. 2019; Rayne et al. 2020). For example, in our experience, partners, such as iwi, are commonly asked to endorse proposals only after they have been developed.

We examined how SDM provides a way forward from current problematic practice to provide a tool for developing comanagement of threatened species’ recovery plans, integrating mātauranga Māori and promoting ako (teaching and learning through knowledge exchange) through open and transparent definition and assessment of management objectives, alternatives, and trade-offs. We use the term comanagement to mean meaningful “partnerships between Māori and Crown agencies in the management of biodiversity, consistent with the principles of the Treaty of Waitangi,” as defined by the Aotearoa New Zealand government’s Department of Conservation (DOC) (Department of Conservation 2000). We applied SDM to taonga (culturally valuable) species’ recovery programs.

Methods

Case Studies in Recovery Planning for Taonga Species

The peka peka (Mystacina tuberculata) (short-tailed bat) is endemic to Aotearoa New Zealand and comprises 3 subspecies (northern, central, and southern) (Lloyd 2003). Translocations have been suggested as a potential recovery strategy but have been unsuccessful to date. A first attempt failed when all translocated peka peka left the release site within minutes. A second attempt was aborted after translocated bats developed an unidentified infectious disease (Gartrell 2007). No further translocations have been attempted. In 2014, DOC chose to use SDM to plan a translocation of the northern peka peka subspecies from their only remnant population on Te Ha tu turu o Toi (Little Barrier Island) in the rohe (territory) of the iwi Ngāti Manuhiri.

The tara iti (Sterna nereis davisi) (New Zealand Fairy Tern) is Aotearoa New Zealand’s rarest indigenous breeding bird, breeding at only a few beaches across the rohe of iwi Te Uri o Hau, Ngāti Whātau o Kaipara, and Ngāti Manuhiri in the Auckland and Northland regions. Despite intensive management with close community involvement, in 2020, fewer than 12 tara iti breeding pairs remain. In 2017, an internal review reported a communication breakdown between DOC and the wider community involved in tara iti recovery, including iwi partners. Although many partners’ thoughts were recorded, all field management recommendations in the report came from the 4 scientist authors and focused on a single biological value (tara iti population recovery). Recognizing these problems, and after the successful peka peka process, DOC suggested using SDM to restart tara iti recovery planning and implementation.

Preparing for Structured Decision Making

We applied the same SDM process for both examples unless otherwise stated. To select participants, we consulted DOC on known stakeholders engaged with or affected by peka peka and tara iti conservation, including DOC managers, scientists, and field staff, iwi who were kaitiaki (guardians) to the peka peka and tara iti populations involved, community volunteer groups, trusts, landowners, and researchers, and asked them all to send a representative to workshops (n = 16 people for peka peka; n = 37 people for tara iti). Participants committed to working together to seek a feasible solution (Gregory et al. 2012a). Meetings were held in nonacademic spaces, such as marae (Māori meeting houses or complexes), iwi offices, and a sports complex (except for 2 rounds of expert elicitation run at a local DOC office). Ground rules were in place to ensure all voices were heard. Our first step was to develop a shared description of the decision context, identifying scale, scope, and roles in the process.

Elicitation of Values and Alternatives

To identify fundamental objectives, we started by asking participants individually about their values in the decision context (Appendix S1). Anonymous responses were collected by the facilitators, then summarized and shared with the group. Participants then worked in small subgroups to refine and structure their objectives, isolating those objectives that were fundamentally important (Gregory et al. 2012a). Subgroups edited these into concise statements describing the objective and desired direction of change and developed ideas of how the
Table 1. Fundamental objectives and their performance measures as defined by the stakeholders involved in pekapeka translocation planning from Te Hauturu-o-Toi and tara iti recovery planning and data sources and analyses used to predict consequences for each objective.

| Objective                                           | Performance measure                                                                                                                                                                                                                                                                                                                                 | Data source and analysis                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pekapeka translocation planning                     | increase persistence of the translocated subspecies probability of extinction in 50 years                                                                                                                                                                                                                                                                               | Probabilities derived from an age-structured population model (Dennis 2019) based on expert elicited vital rate parameter estimates. Elicitation followed a modified Delphi approach as recommended by Hemming et al. (2018). Costs were obtained from experts with prior experience with different components of bat monitoring and translocation. |
|                                                     | reduce impact on the source bat population probability of extinction in 50 years                                                                                                                                                                                                                                                                                     | Assessment of alternatives with regard to mātauranga Māori was carried out by iwi (Māori tribe) experts representing Ngāti Manuhiri.                                                                                                                                                                            |
|                                                     | minimize cost of translocation total cost of translocation (NZ$)                                                                                                                                                                                                                                                                                                     | Costs were obtained from experts with prior experience costing tara iti and species management.                                                                                                                                                                                                                 |
|                                                     | enhance mātauranga Māori (Māori knowledge and perspectives) subjective scale (from bad to much better)                                                                                                                                                                                                                                                                 | Estimates derived from expert-elicited data. Elicitation followed a modified Delphi approach as before and with wider ecosystem experts.                                                                                                                                                                     |
|                                                     | increase advocacy for species number of visitors to site per year                                                                                                                                                                                                                                                                                                   | Participant knowledge and internet searches of visitor numbers to proposed sites in the 12 months before the workshop.                                                                                                                                                                                             |
| Tara iti recovery planning                          | increase viability of wild tara iti population probability of extinction in 50 years (extinction defined as number of adult females is \( \leq 2 \)) population size of tara Iti in wild                                                                                                                                                                                                 | Probabilities and population sizes derived from an age-structured population model developed by T.M.H. using expert-elicited vital-rate parameter estimates. Elicitation followed a modified Delphi approach as recommended by Hemming et al. (2018). |
|                                                     | integrate mātauranga Māori How well incorporated, and therefore how acceptable (not acceptable, acceptable if certain actions removed [partly acceptable], acceptable)                                                                                                                                                                                                 | Assessment of alternatives with regard to mātauranga Māori as interpreted by iwi experts representing Te Uri o Hau, Ngāti Whātau o Kaipara, and Ngāti Manuhiri.                                                                                                                                                    |
|                                                     | increase wider ecosystem benefits from tara iti management number of breeding pairs of local key bird species                                                                                                                                                                                                                                                       | Estimates derived from expert-elicited data. Elicitation followed a modified Delphi approach as before and with wider ecosystem experts.                                                                                                                                                                     |
|                                                     | reduce cost of management NZ$ per annum                                                                                                                                                                                                                                                                                                                               | Costs were obtained from an expert group with prior experience costing tara iti and species management.                                                                                                                                                                                                          |
|                                                     | increase awareness/respect of tara iti among New Zealanders media stories count                                                                                                                                                                                                                                                                                      | Expert group concluded that strategies (and thus consequences) would be common across all alternatives, so this objective was not pursued.                                                                                                                                                                         |

Objectives might be measured using natural, constructed, or proxy metrics (Gregory et al. 2012a). Subgroups provided feedback on their candidate objectives and performance measures to the entire group; similar objectives were combined to generate a final agreed list.

To elicit alternative management strategies, the groups brainstormed possible actions with an influence diagram to show key relationships between threats and management (Gregory et al. 2012a). Participants then worked in small subgroups to combine individual actions into complex strategies. Subgroups described their chosen strategies to the entire group, which discussed them and developed a set of comprehensive strategies. Facilitators further consulted stakeholders about strategies afterward.

**Prediction of Consequences and Evaluation of Trade-Offs**

To predict the consequences of alternative strategies, expert working groups for each objective self-identified. Facilitators and expert groups used multiple data sources and analyses to estimate consequences (Table 1). To estimate biological consequences, we used empirical data and formal expert elicitation to parameterize demographic models. For economic and social objectives, expert groups shared knowledge, conducted research, and finalized outcomes through deliberation. For detailed methods, see Appendix S1.

For the mātauranga Māori objective, Ngāti Manuhiri representatives led a kōrero (conversation) with facilitators during the initial pekapeka workshop, whereas nominated representatives from Te Uri o Hau, Ngāti Whātau...
Table 2. Indicative consequence with expected outcomes of a subset of proposed strategies for 3 of final 10 Pekapeka translocation strategies.

| Strategy | Objective | persistence of subspecies | persistence of source | cost | advocacy | aggregate score (SMART excluding mātauranga Māori) | mātauranga Māori |
|----------|-----------|---------------------------|-----------------------|------|----------|-----------------------------------------------|-----------------|
|          |           | $P(\text{ext}) t = 50$ years \(^a\) | $P(\text{ext}) t = 50$ years \(^a\) | Total NZ$ | n of annual visitors | scale (see text) |
| 1. Hen Island (Hauturu-o-Toi to Taranga): capture pregnant females and pup in captivity at source, release females at source, move juveniles to destination, and hold for a period plus supplementary feed to anchor them | 0.000 \(^b\) | 0.006 \(^b\) | 124,540.00 | 811 | 0.57 \(^b\) | good |
| 2. Codfish Island to Secretary Island (southern subspecies’). Capture pre and postflight juveniles, move and release at destination as in 1 | 0.000 \(^b\) | 0.007 | 103,620.00 | 235 | 0.55 | much better \(^c\) |
| 3. Hauturu-o-Toi to Hunua Ranges: capture preflight juveniles and move and release as destination as in 1 | 0.007 | 0.007 | 96,540.00 \(^b\) | 70,775 \(^b\) | 0.22 | bad |

\(^a\) Probability of population extinction after 50 years.  
\(^b\) Best outcome for each objective, respectively, and for the aggregate score weighted by objective preferences (based on simple multiattribute rating technique).  
\(^c\) Strategy ultimately supported by the group.

The predicted outcomes for each strategy against all objectives were then summarized in a consequence table for evaluation. There are multiple tools to assist trade-off choices (Gregory et al. 2012a). The pekapeka group decided to use simple multiattribute rating technique (Keeney & Raiffa 1993; Appendix S1) to identify the strategy that provided the best outcomes across objectives. All participants expressed their preferences as 0–100 weights on individual objectives. Quantitative predictions for each action (Table 2) were normalized and weighted by the elicited preferences of objectives to obtain an aggregate score across all objectives for each representative and an aggregate group score based on the average of the group weights (the group agreed this would only be used to help the discussion). Because Ngāti Manuhiri preferred to express their assessment of mātauranga Māori verbally rather than numerically, their qualitative judgments for different strategies could not be included in the aggregate scores; instead, they were placed alongside the numerical analysis, and the group then discussed results. The tara iti group chose a simpler approach, simplifying the consequence table with hard constraints that the group agreed on. Alternatives that did not meet certain criteria or fell below certain thresholds were eliminated, leaving a few alternatives to be selected.

Results

Decision Context

The pekapeka group agreed that 4 decisions were needed regarding pekapeka translocation: which subspecies to translocate, where to source individuals, where to release individuals, and what methods to employ. Decisions made during the SDM process would form the basis of a permit application to DOC. The working group tasked with developing the decisions included the key stakeholders normally approached during permit evaluation and consultation by DOC and as such provides a collective view to submit for approval. This process
would allow the DOC director to make decisions based on advice provided by a wider group of stakeholders.

The tara iti group agreed a decision was needed about which management strategy to employ for tara iti within the current range of the remnant population. Like the pekapeka example, the SDM process included the key stakeholders normally approached by DOC for management strategy consultation and approvals (detailed in Methods above). In this way, the group viewed the process as empowering and efficient, allowing DOC (the decision maker) to fully endorse the recovery plans recommended by the group and all stakeholders to coordinate action as quickly as possible.

Objectives and Values

The pekapeka group identified 5 fundamental objectives (Table 1). They recognized the importance of establishing a new population while avoiding harm to the source population. They also recognized 5 nonbiological fundamental objectives: minimize management costs, increase advocacy for the species, and enhance mātāuranga Māori values. Mātāuranga Māori, as viewed by Ngāti Manuhiri, was shared with Pākehā participants through kōrero, to ensure understanding across the group. Through this process of ako, the group learned that Ngāti Manuhiri values of mātāuranga Māori are centered around mauri, a life principle that reflects vital essence of life or well-being. Mauri is influenced by at least 4 major factors, whakapapa (genealogy), tapu (the sacred or prohibited), noa (the ordinary or unrestricted, opposite of tapu), and kaitiakitanga (guardianship). This kōrero clarified links between these values and conservation management actions. For example, whakapapa is about connections and location: translocations that move animals within the rohe of an iwi would be viewed as better than those that move them outside. Moves outside of the rohe could also be good if they enhanced known ties between hapū (subtribes) and iwi. Alternatively, they could be good as a form of utu (paying it forward) by creating ties between hapū or iwi (i.e., toro mai, toro attū [reciprocity where good actions encourage an appropriate response for balance]). Similarly, whakapapa influenced the view of alternative methods of moving individual animals. For example, keeping family units together may be viewed as better than splitting parents from young or males from females. Tapu and noa were presented as rules of good behavior, and the group learned to see them as advice for health and safety, normally with binary (i.e., yes or no) answers. For example, some translocation options may be tapu if entry to destination sites is forbidden.

The tara iti group recognized mātāuranga Māori as a fundamental objective of tara iti recovery planning, alongside 4 other environmental, economic, and social objectives (Table 1). Iwi representatives outlined corner-
translocate the northern subspecies from Te Hauturu-o-Toi. However, risk aversion by iwi and other representatives meant the group did not select this alternative. Instead, they selected the action with the second highest aggregate score (alternative 2, Table 2), which was the preferred choice in terms of mātauranga Māori and focused on a more abundant subspecies. Translocation would still benefit this subspecies but incur less disease-related risk, while further developing translocation techniques that would eventually benefit the northern subspecies. This shift from the initial focus means the SDM process must be repeated with additional iwi who are kaitiaki for the suggested subspecies.

The tara iti group agreed to use acceptability as a hard constraint on mātauranga Māori to simplify the decision. For example, when it became apparent that removing infertile males was biologically favorable yet was deemed unacceptable by iwi, the entire group agreed to add a modified strategy that left infertile males in place (all other actions were unchanged) in the consequence table (alternative 2, Table 3). Partners acknowledged that Western science and mātauranga Māori had not always worked well together previously but would if the group continued in this way. Critically, iwi partners were able to have input in the decision-making process at each step (Fig. 1), leading to shared understanding of objectives, codevelopment of alternatives, and simple resolution of trade-offs. This process is ongoing but has initiated a lot of positive kōrero and through this, ako. All partners have demonstrated a willingness to work together in a mana-enhancing way (enhancing authority, prestige, and influence) that addresses cultural imbalance.

### Discussion

In our case studies, SDM helped the planning process move away from traditional unilateral methods, overcome barriers to inclusivity, and explicitly include diverse value systems, such as mātauranga Māori, in decision making for conservation of threatened species. This makes for fairer, inclusive decisions, which realizes the legal mandate set out in the Treaty of Waitangi and the Conservation Act (New Zealand Government 1975). We thoroughly recommend SDM for providing the space and support for meaningful kōrero and ako, vital components of good relationships and inclusive decision making.

Simply collaborating with indigenous people or recognizing indigenous values does not mean their values are automatically incorporated in decisions as effectively as others (Jackson 2006; Wheeler et al. 2020; Zafra-Calvo et al. 2020). In resource management, progressive steps are being taken to recognize mātauranga Māori, such as iwi management plans as starting points for

---

**Table 3. Indicative consequence with expected outcomes of a subset of proposed strategies for 3 of 7 final tara iti recovery strategies.**

| Alternative | Persistence of tara iti in wild | Population size of tara iti in wild | Cost | Change in northern NZ dotterel breeding population | Mātauranga Māori |
|-------------|---------------------------------|-------------------------------------|------|---------------------------------------------|-----------------|
|             | $P(\text{ext}) \ t = 50$ years | Mean n (females) $\ t = 50$ years | Annual NZ$ spent (millions) | % change in number of breeding pairs | scale (see text) |
| 1. Field 1 + captive 2: | 0.12 | 20 | 0.78 | +15 | partially acceptable |
| low-intensity field management, low-intensity harvest, captive rear and release within current range, infertile males brought into captivity | | | | | |
| 2. Field 2 + captive 3 + keeping infertile males: | 0.04 | 31 | 1.29 | +36 | acceptable |
| high-intensity field management, high-intensity harvest, captive rear and release inside and outside current range, infertile males remain available as foster parents | | | | | |
| 3. Field 2 + OZFT*: | 0.02 | 31 | 0.47 | +27 | not acceptable |
| high-intensity field management, single and infertile clutches supplemented with Australian Fairy Tern eggs | | | | | |

---

*a Probability of population extinction after 50 years.

b Mean number of adult females in population after 50 years.

c Best outcome for each objective, respectively.

d Australian Fairy Tern.
engagement (Thompson-Fawcett et al. 2017) and the legal personhood granted to the Whanganui River, reflecting its relation to Māori (Ko au te Awa, ko te Awa ko au, [I am the river, and the river is me]) (Whanganui River Maori Trust Board 2014). Yet, these still address indigenous values separately from scientific or Pākehā ones. We found SDM helpful because it required a clear, initial expression of values as objectives. In both case studies, the articulation and discussion of iwi values allowed us to codevelop a set of alternatives that already considered scientific, social, and cultural values. This contrasts with the traditional model of scientists preparing alternatives to be judged a posteriori. Ignoring fundamental values at the outset risks developing a set of alternatives, and ultimately decisions, that may be insensitive to social or cultural values. In this sense, during kōrero, the pekapeka group realized that it was critically important not only which plan was developed, but also how it was developed. Ngāti Manuhiri viewed the SDM methods as enhancing mana and enabling people to enact their responsibilities as kaitiaki. All partners involved expressed hope that future steps would continue the mana-enhancing process.

A major challenge in our case studies was to express spiritual or cultural feelings to allow comparison with science-based metrics. Facilitators and groups listened to iwi and codeveloped qualitative, verbal expressions to judge how well alternative strategies incorporated mātārauranga Māori (Tables 2 & 3). Similarly, Ngāi Tahu and Aotearoa New Zealand’s Ministry for the Environment developed a cultural health index to evaluate river health that encompasses both physical and spiritual values in land and water to be integrated into decision making with water managers (Tipa & Teirney 2006). Taking time to develop performance measures with partners is critical to inclusivity because it allows cultural values to be described appropriately and treated in the same way as common values, such as species persistence or cost (Gregory et al. 2012a).

In both case studies, we assessed alternatives against all objectives in parallel. This helped eliminate the implicit sense of ranking that would result if, for example, actions were first selected based on biological analyses and then submitted for approval from indigenous groups. Instead, our decision making clearly presented the impacts of each alternative on all stakeholder values (Tables 2 & 3). Scientific evidence predicting biological consequences of management was presented alongside, not before, consequence assessments for the other objectives. Done this way, evidence-based conservation is much more inclusive.

Codevelopment and parallel assessment of alternatives yielded another considerable benefit. Before engaging in SDM, some biological experts presumed that opening the comanagement process might require considerable compromises, such as accepting suboptimal biological outcomes to accommodate mātāuraunga Māori. In the pekapeka case, such conflict did not materialize because the assessment based on mātāraunga Māori largely overlapped the aggregate scores based on more traditional Western science-dominated values. For example, sustainability, valued by both conservation science and mātāraunga Māori perspectives, was captured in biological viability models and kaitiaki principles of sustainable use. For tara iti, some compromise was necessary, and was facilitated by codevelopment of alternatives. Again, the process provided a secure platform for all stakeholders to grow in understanding and seek shared vision despite different backgrounds. Considering both value systems like this improves long-term planning and highlights the nuances of their complementarity. This was captured well in the statement taha wairua taha tangata (bringing both worlds together to achieve the objective) (Table 4). It echoes the sentiment of the Mi’kmaq people of Eastern Canada when they found the “two-eyed seeing” (i.e., “learning to use both these eyes together, for the benefit of all”) approach to decision making to be beneficial (Giles et al. 2016).

Through its focus on values, SDM also encourages recognition of context-specific differences, rather than a one-size-fits-all approach. Mātāraunga Māori is a dynamic belief system, with diverse values among and within hapū and iwi (Whaanga et al. 2017). We already found slightly different interpretations and emphasis of elements of mātāraunga Māori between the pekapeka and tara iti cases. We encourage managers not to make broad assumptions about how mātāraunga Māori, or any indigenous belief system, is expressed or judged within a given decision.

Structured decision making provides a space for kōrero and ako. This openness improves alignment and inclusivity (Gregory 2016) and improves thinking about threatened species by enabling distillation of the best information available. Comanagement meant partners could ask and answer each other’s questions, as opposed to simply presenting information. This could be a nonexpert Pākehā asking for clarity on the mātāraunga Māori objective from iwi experts or a nonexpert DOC representative asking a population ecologist to explain extinction probability. In the tara iti case, discussions helped break down long-standing relationship barriers. For example, expressing concerns about negative impacts of tara iti egg management on whakapapa resolved confusion around language used between DOC and other partners. Such relationship building and shared language use are known critical components of successful resource management (Thompson-Fawcett et al. 2017; Boiral et al. 2020).

The relevance and utility to conservationists of the benefits brought about from values-focused decision frameworks cannot be understated. More conservationists across many realms are adopting these tenets and
Table 4. Descriptions and interpretations (right column) of the mātauranga Māori (Māori knowledge and perspective) view for tara iti (left column) defined by Te Uri o Hau, Ngāti Whātua o Kaipara, and Ngāti Manuhiria participants at the first Tara iti recovery planning workshop.

| Te Ao Māori          | Holistic Māori world view                                                                 |
|----------------------|------------------------------------------------------------------------------------------|
| Mauri                | The binding force or essence that holds together the physical and spiritual components of a being or thing. The mauri of tara iti is diminished and needs to be rebalanced. |
| Whakapapa            | The spiritual connections, lineage, genealogy, and direction. It is the connection between humans and the natural world, ecosystems, all flora and fauna, etc. We are part of the system, not separate. Everything has whakapapa, our world is built on it. Everything comes from somewhere. It is holistic and integrated and applied to many aspects of life. |
| Kotahitanga          | The oneness, unity of relationships. For tara iti, it means support and connection with community, schools, and conservation groups (planned activities). It is collaborating to achieve objectives. |
| Kaitiakitanga        | A combination of kaitiaki and tikanga and the processes and practices of protecting and looking after the natural environment, the taonga. It involves a set of obligations and responsibilities to those who come before you and those who come after. Kaitiaki are the guardians and the caregivers—everyone has the role of kaitiaki. |
| Maramataka           | To restore systems and knowledge of agricultural productivity, marine and forest gathering, resource management, health, healing, and daily practices that provide sustenance for well-being. |
| Rāhui                | A form of tapu (sacredness), the practice of protecting or applying restrictions to an area to let resources recover. |
| Ako                  | A 2-way learning relationship, transmission of knowledge. Combining science and education with mātauranga Māori (knowledge of both tangible and intangible). Emerging ideas are shared, both are learning and teaching for the benefit of tara iti. |
| Taha wairua taha tangata | Bringing both worlds together to achieve the objective, the survival of the tara iti. |
| Urutau               | The earth is shifting, things are changing, and we must change with it (i.e., climate change). Evolving the practice--create new karakia (prayer) for tara iti with the new unity, upgrades and changes within our time. Acknowledge our relationship with the tara iti. |

Finding them to be fair and effective and to deliver robust outcomes for conservation (Bennett et al. 2019; Collier-Robinson et al. 2019; Rayne et al. 2020; Wheeler & Root-Bernstein 2020). Despite this, challenges remain. Well-meaning managers may be confused about what stakeholder values are or how they could be integrated (Jackson 2006) or may be afraid of upsetting partners and so avoid action or become overcautious (Meek et al. 2015). At worst, managers may consider others’ values irrelevant or unnecessary hurdles to species recovery or ignore them completely (Fox et al. 2006; Chapman et al. 2020).

There is still a need for “transformative change” (Wheeler et al. 2020), and although more researchers are recognizing and eliciting values, there is still a scarcity of examples demonstrating their integration in decision making outside North America (Dam Lam et al. 2019; Zafra-Calvo et al. 2020). We encourage managers to recognize the complexity of decision making in conservation and embrace value pluralism by using relevant expertise because it generates a much deeper understanding of a system and promotes shared, well-supported decisions (Bennett et al. 2019). Our results highlight that inclusivity need not compromise use of the best available scientific evidence. However, relationships with indigenous groups require time to be built (or mended), to share information and accommodate different ways of working together. Financially supporting indigenous representatives and allowing time to participate is essential (Cisternas et al. 2019; Wheeler et al. 2020) and was echoed by iwi representatives. Both would improve capacity for communities to engage meaningfully in decision-making processes (Thompson-Fawcett et al. 2017). Finally, comanagement is an ongoing process and in some cases will require continual dialogue and participation from all partners to maintain relationships and efficacy (Gorris 2019).

Conservation continually seeks to become fairer and better, giving indigenous communities more defined, prominent roles in decision making (Turner et al. 2008; Augustine & Dearden 2014). It also increasingly recognizes that to improve decision making, meaningful, values-led approaches are needed (Gregory 2016; Mukherjee et al. 2019). Achieving this requires an interdisciplinary approach to clearly express values and identify the best way of achieving them. We are finding that SDM provides such a framework. Although there is still far to go in reaching widespread successful comanagement in Aotearoa New Zealand and elsewhere, there are reasons to be optimistic. The result will be better outcomes both for species and all interested partners.

Acknowledgments

The pekapeka work was supported by the Zoological Society of London and DOC. The tara iti work was...
supported by The Te Arai and Mangawhai Shorebirds Trust. We thank everyone who attended the peka peka and tara iti workshops and contributed their time, values, and expertise. We acknowledge the insight and contributions of K.C., who passed away in 2019, and we dedicate this paper to her. T.M.H. is supported by a Natural Environment Research Council PhD Studentship (grant award number NE/L002485/1). S.C. was supported by the Research Foundation Flanders (FWO16/PDO/019).

Supporting Information

Additional information is available online in the Supporting Information section at the end of the online article. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Literature Cited

Arvai J, Post K. 2012. Risk management in a developing country context: improving decisions about point-of-use water treatment among the rural poor in Africa. Risk Analysis 32:67–80.
Augustine S, Dearden P. 2014. Changing paradigms in marine and coastal conservation: a case study of clam gardens in the Southern Gulf Islands, Canada. Canadian Geographer 58:305–314.
Bennett NJ, et al. 2017. Conservation social science: understanding and integrating human dimensions to improve conservation. Biological Conservation 205:93–108.
Bennett NJ, Di Franco A, Calo A, Nethery E, Niccolini F, Milazzo M, Guidetti P. 2019. Local support for conservation is associated with perceptions of good governance, social impacts, and ecological effectiveness. Conservation Letters 12:12640.
Boiral O, Heras-Saizarbitoria I, Brotherton MC. 2020. Improving environmental management through indigenous peoples’ involvement. Environmental Science and Policy 103:10–20.
Brown K. 2003. Three challenges for a real people-centred conservation. Global Ecology and Biogeography 12:89–92.
Chapman M, Satterfield T, Chan KMA. 2020. How value conflicts infected the science of riparian restoration for endangered salmon habitat in America’s Pacific Northwest: lessons for the application of conservation science to policy. Biological Conservation 244:108508.
Cisternas J, Wehi PM, Haupokia N, Hughes F, Hughes M, Germano JM, Longnecker N, Bishop PJ. 2019. Get together, work together, write together: a novel framework for conservation of New Zealand frogs. New Zealand Journal of Ecology 43:1–10.
Collier-Robinson L, Rayne A, Rupene M, Thoms C, Steeves T. 2019. Embedding indigenous principles in genomic research of culturally significant species: a conservation genomics case study. New Zealand Journal of Ecology 43:3589.
Dam Lam R, Gasparatos A, Chakraborty S, Rivera H, Stanley T. 2019. Multiple values and knowledge integration in indigenous coastal and marine social-ecological systems research: a systematic review. Ecosystem Services 37:100910.
Dennis G. 2019. Minimising non-target impacts of anticoagulant rodenticide use for a highly susceptible species, the New Zealand lesser short-tailed bat (Mystacina tuberculata). PhD dissertation. Massey University, New Zealand.
Department of Conservation. 2000. The New Zealand biodiversity strategy. Wellington, New Zealand. Available from https://www.doc.govt.nz/globalassets/documents/conservation/new-zealand-biodiversity-strategy-2000.pdf (accessed April 2020).
Evans MC, Davila F, Toomey A, Wyborn C. 2017. Embrace complexity to improve conservation decision making. Nature Ecology and Evolution 1:1588.
Fox HE, Christian C, Nordby JC, Pergams ORW, Peterson GD, Pyke CR. 2006. Perceived barriers to integrating social science and conservation. Conservation Biology 20:1817–1820.
Gartrell BD. 2007. Dermatitis of the pinnae in lessor short-tailed bats Mystacina tuberculata translocated to Kapiti Island. Kakoko 14:25–31.
Giles A, Fanning L, Denny S, Paul T. 2016. Improving the American eel fishery through the incorporation of indigenous knowledge into policy level decision making in Canada. Human Ecology 44:167–183.
Gorris P. 2019. Mind the gap between aspiration and practice in co-managing marine protected areas: a case study from Negros Occidental, Philippines. Marine Policy 105:12–19.
Gregory R. 2016. The troubling logic of inclusivity in environmental consultations. Science Technology and Human Values 42:144–165.
Gregory R, Failing L, Harstone M. 2008. Meaningful resource consultations with First Peoples: notes from British Columbia. Environment 50:34–45.
Gregory R, Failing L, Harstone M, Long G, McDaniels T, Ohlson D. 2012a. Structured decision making: a practical guide to environmental management choices. Wiley-Blackwell.
Gregory R, Long G, Colligan M, Geiger JG, Laser M. 2012b. When experts disagree (and better science won’t help much): using structured deliberations to support endangered species recovery planning. Journal of Environmental Management 105:30–43.
Hayek T, Stanley Price MR, Ewen JG, Lloyd N, Saxena A, Moehrensclager A. 2016. An exploration of conservation breeding and translocation tools to improve the conservation status of boreal caribou populations in Western Canada. Centre for Conservation Research, Calgary Zoological Society, Calgary, Alberta, Canada.
Hemming V, Burgman MA, Hanca AM, McBride MF, Wintle BC. 2018. A practical guide to structured expert elicitation using the IDEA protocol. Methods in Ecology and Evolution, 9(1):169–180.
Jackson S. 2006. Compartamentalising culture: the articulation and consideration of indigenous values in water resource management. Australian Geographer 37:19–31.
Keeney RL. 1996. Value-focused thinking: identifying decision opportunities and creating alternatives. European Journal of Operational Research 92:537–549.
Keeney RL, Raiffa H. 1993. Decisions with multiple objectives: preferences and value trade-offs. Cambridge University Press.
Lloyd BD. 2003. Intraspecific phylogeny of the New Zealand short-tailed bat Mystacina tuberculata inferred from multiple mitochondrial gene sequences. Systematic Biology 52:140–147.
Lyver POB, et al. 2018. Building biocultural approaches into Aotearoa–New Zealand’s conservation future. Journal of the Royal Society of New Zealand 49:394–411.
Mascia MB, Brosius JP, Dobson TA, Forbes BC, Horowitz L, McKean MA, Turner NJ. 2003. Conservation and the social sciences. Conservation Biology 17:649–650.
McAllister TG, Beggs JR, Ogilvie S, Kirikiri R, Black A, Wehi PM. 2019. Kua takoto te mânuka: mautaranga māori in New Zealand ecology. New Zealand Journal of Ecology 43:359.
Meek MH, et al. 2015. Fear of failure in conservation: the problem and potential solutions to aid conservation of extremely small populations. Biological Conservation 184:209–217.
Moore JL, Runge MC. 2012. Combining structured decision making and value-of-information analyses to identify robust management strategies. Conservation Biology 26:810–820.
Mukherjee N, Sutherland WJ, Rose DC, Everard M, Geneletti D. 2019. Response to expanding the role of social science in conservation through an engagement with philosophy, methodology, and methods. Methods in Ecology and Evolution 10:303–307.

New Zealand Government. 1975. Treaty of Waitangi act. New Zealand Government, Wellington.

New Zealand Government. 1991. Resource management act. New Zealand Government, Wellington.

Peterson MN, Peterson MJ, Peterson TR, Leong K. 2013. Why transforming biodiversity conservation conflict is essential and how to begin. Pacific Conservation Biology 19:94–105.

Rayne A, Byrnes G, Collier-Robinson L, Hollows J, McIntosh A, Rasmussen M, Makarini R, Tamati-Elliffe P, Thoms C, Steeves TE. 2020. Centring indigenous knowledge systems to re-imagine conservation translocations. People and Nature 2:1–15.

Runge MC, Bean E, Smith DR, Kokos S. 2011. Non-native fish control below Glen Canyon dam—report from a structured decision-making project. U.S. Geological Survey, Reston, Virginia.

Salomon AK, Lertzman K, Brown K, Wilson K, Secord D, McKechnie I. 2018. Democratizing conservation science and practice. Ecology and Society 23. https://doi.org/10.5751/ES-09980-230144.

Schwartz MW, Cook CN, Pressey RL, Pullin AS, Runge MC, Salafsky N, Sutherland WJ, Williamson MA. 2018. Decision support frameworks and tools for conservation. Conservation Letters 11:1–12.

Sutherland WJ, Pullin AS, Dolman PM, Knight TM. 2004. The need for evidence-based conservation. Trends in Ecology & Evolution 19:305–308.

Tallis H, Letchman J. 2014. Working together: a call for inclusive conservation. Nature News 515:27–28.

Thompson-Fawcett M, Ruru J, Tipa G. 2017. Indigenous resource management plans: transporting non-indigenous people into the indigenous world. Planning Practice and Research 32:259–273.

Thorne KM, et al. 2015. Collaborative decision-analytic framework to maximize resilience of tidal marshes to climate change. Ecology and Society 20. https://doi.org/10.5751/ES-07018-200130.

Tipa G, Teirney L. 2006. A cultural health index for streams and waterways: a tool for nationwide use. Ministry for the Environment, Wellington, New Zealand.

Toomey AH, Knight AT, Barlow J. 2017. Navigating the space between research and implementation in conservation. Conservation Letters 10:619–625.

Turner NJ, Gregory R, Brooks C, Failing L, Satterfield T. 2008. From invisibility to transparency: identifying the implications. Ecology and Society 13. http://www.ecologyandsociety.org/vol13/iss2/art7/.

United Nations (UN). 1992. United Nations conference on environment & development, agenda 21. UN, New York.

Wahi PM, Beggs JR, McAllister TG. 2019. Ka mua, ka muri: the inclusion of mātauranga Māori in New Zealand ecology. New Zealand Journal of Ecology 43:1–8.

Whaanga H, Waiti J, Hudson M, Williams J, Roa T. 2017. How institutions frame mātauranga Māori. Waikato Regional Council, Hamilton, New Zealand.

Whanganui River Maori Trust Board. 2014. Whanganui river settlement. Whanganui River Maori Trust Board, Whanganui, New Zealand.

Wheeler HC, et al. 2020. The need for transformative changes in the use of indigenous knowledge along with science for environmental decision-making in the Arctic. People and Nature 2:544–556.

Wheeler HC, Root-Bernstein M. 2020. Informing decision-making with indigenous and local knowledge and science. Journal of Applied Ecology 57:1634–1643.

Wright SD, Nugent G, Parata HG. 1995. Customary management of indigenous species: a Maori perspective. New Zealand Journal of Ecology 19:83–86.

Zafra-Calvo N, et al. 2020. Plural valuation of nature for equity and sustainability: insights from the Global South. Global Environmental Change 63:102115.