

NEW ZEALAND'S
BIOLOGICAL
HERITAGE

Ngā Koiora
Tuku Iho

National
SCIENCE
Challenges

Predator Free New Zealand: Social, Cultural, and Ethical Challenges

BioHeritage Challenge Bioethics Panel
2019

Cover photo: Maud Island in the Marlborough Sounds, target of ongoing pest invasions (Photo: James Russell)

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Foreword

Predator Free New Zealand (PFNZ) has the aspirational goal to remove entirely the populations of some introduced predatory mammals found in Aotearoa New Zealand. With these eradications from the mainland and islands, PFNZ aims to enhance the recovery and resilience of native biodiversity and ecosystems, both of which contribute to the well-being of the peoples of Aotearoa New Zealand.

The term 'Predator Free New Zealand' is attributed to Les Kelly, who returned to New Zealand in 2007 after working in Australia for 25 years. Noting the conspicuous decline of native birds since his departure, he asked what the cause was, and when told 'introduced mammalian predators' reportedly responded, 'why don't we just get rid of them entirely?' This message eventually reached Sir Paul Callaghan, a notable New Zealand physicist, who in his ultimate speech at Karori (now Zealandia) Wildlife Sanctuary in February 2012, proposed a 'Predator Free' New Zealand as the nation's 'moonshot'. In 2013, the philanthropist Gareth Morgan established the PFNZ Trust, an NGO tasked with networking community predator control groups across Aotearoa New Zealand. In February 2015, the philanthropic NEXT foundation funded the R&D start-up Zero Invasive Predators (ZIP). In May 2015, the first peer-reviewed appraisal of PFNZ was published by James Russell and Manaaki Whenua – Landcare Research colleagues.¹ In July 2016, the Government launched Predator Free 2050 (PF2050) and created the company Predator Free 2050 Ltd to attract philanthropic investment and fund landscape scale predator eradication. In January 2017, the National Science Challenge for Biological Heritage launched its 'High-tech solutions to invasive mammal pests' project, within which the bioethics panel writing this report sits independently. In July 2017, the New Zealand Department of Conservation created a PF2050 unit and in November 2018 launched a discussion guide initiating work towards a strategic plan.

As it currently exists, PFNZ is both a social movement and a government-sponsored initiative. It encompasses a range of predator management activities including those that have long been going on in Aotearoa New Zealand and those that are new to Aotearoa New Zealand. As a social movement, it is realised in various forms. For example, the introduced mammalian predator species considered 'in scope' can differ. The species considered in scope are commonly the three introduced rat species (*Rattus exulans*, *Rattus norvegicus* and *Rattus rattus*), the stoat (*Mustela erminea*), and the brushtail possum (*Trichosurus vulpecula*).² At this point it is unclear whether, or how, non-wild members of these species will be managed, such as those kept for companionship or economic reasons. Mice are typically considered out of scope as they are not a major predator of New Zealand animals. Cats are also excluded from the PFNZ goal and strategic plans because they are a valued companion animal species and subject to their own management plan (the National Cat Management Strategy).

As a social movement, those involved in PFNZ may seek to achieve different results from their contributions. Thresholds of what counts as 'predator-free'—such as complete removal versus control to zero detectability or zero impacts—can vary among interested groups, along with more specific goals. The Government company Predator Free 2050 Ltd has adopted four interim 2025 goals and an ultimate deadline of 2050, which will determine its priorities and actions in the immediate future.³ We adopt this common ('PF2050') understanding of the scope of PFNZ for the purposes of this report, while noting that the wider scope of PFNZ remains a matter of debate. Our aim in doing so is to be clear about the subject matter of our panel's discussion, not to endorse this as the single best way to understand PFNZ's scope.

Many parties are developing novel tools and technologies that could contribute to the vision of PFNZ by supporting cost-effective, landscape-scale predator control, or eradication and surveillance of small mammal pests. However, it is unclear whether New Zealanders at large share the vision of PFNZ as a whole. PFNZ presents opportunities for reasonable ethical disagreement on many levels, from the goals and objectives of PFNZ, to which tools and technologies ought to be designed and how they should be implemented. A candid and thorough exploration of these potential disagreements is vital.

For this reason a bioethics panel was established to map out the landscape of social, ethical and cultural considerations surrounding PFNZ. The panel was co-convened by Emily Parke (School of Humanities) and James Russell (School of Biological Sciences), from the University of Auckland, as part of a larger project called 'High tech solutions to invasive mammal pest control' funded by the Biological Heritage National Science Challenge. The panel brings together 12 academic, industry and community experts (listed below) to discuss and map out the landscape of social, cultural and ethical issues regarding PFNZ. Panel membership is diverse in terms of gender and culture, and includes representatives with experience in Māori tribal governance, philosophy, law, psychology, marketing, ecology, genetics, hunting, animal welfare, and environmental stewardship. The panel met on 15-16 June and 2-3 November 2017 at the University of Auckland, and committed to prepare a public report to aid discussion of key social, ethical, and cultural considerations that arise in relation to the aims of

¹ Russell et al. (2015).

² These are the in-scope species of Cabinet paper CAB-16-MIN-0335.

³ As mandated by Cabinet paper CAB-16-MIN-0335

PFNZ, and the protection and enhancement of biodiversity more generally. In preparing the report, the panel also considered lessons from other ambitious projects of a national scale, including vaccination programmes, compulsory seatbelts, and nuclear-free and smoke-free Aotearoa.

The goals of PFNZ can be considered independently of any particular technologies (such as 1080 or gene editing) to achieve them. The key focus of the panel was to discuss the goals themselves, and advance dialogue where a broader discussion of social, ethical, and cultural issues is called for. While Section 5 of this report focuses on predator management and eradication technologies, our primary aim is to examine the general issues rather than the debates surrounding any particular technology.⁴

Given the diversity of the panel, this report draws on knowledge from different disciplines and worldviews. It represents no single panel member's views, and discusses issues where a diversity of viewpoints may be held. These include issues where not everyone on the panel had the same view, and therefore two (or more) sides of an issue are discussed. We intend this report as a starting point for ongoing discussion of ethical, social, and cultural issues surrounding PFNZ—which we think is critical—but not as a fully comprehensive survey of all such issues, and certainly not as the final word on these issues.

The panel

Members:

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Professor Lisa Ellis, University of Otago
Mr Mook Hohneck, Ngāti Manuhiri
Associate Professor Catherine Iorns, Victoria University of Wellington
Emeritus Professor John Knight, University of Otago
Dr Kate Littin, Ministry of Primary Industries
Dr Edy MacDonald, Department of Conservation
Professor James Maclaurin, University of Otago
Mr Cam Speedy, Wildlife Management Associates
Associate Professor Tammy Steeves, University of Canterbury
Dr Krushil Watene, Massey University
Dr Priscilla Wehi, Manaaki Whenua – Landcare Research

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Dr Emily Parke, University of Auckland
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⁴Recent discussion of particular predator management technologies in New Zealand include Parliamentary Commissioner of the Environment (2011) on 1080 and Dearden et al. (2017) on genetic editing.

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1. Our starting point: Responsibilities to Biodiversity

Making Aotearoa New Zealand predator free is as much a social challenge as it is a biological challenge. Predator Free New Zealand (PFNZ) seeks to remove the biodiversity, economic, population health, and aesthetic impacts of three introduced mammalian predator groups. Furthermore, with these planned eradications from the mainland and islands by 2050, PFNZ aims to enable the recovery and resilience of native biodiversity and ecosystems, both of which contribute to the well-being of the peoples of Aotearoa New Zealand. Alongside the aim of native biodiversity and ecosystem enhancement, PFNZ is also motivated by the cost-effectiveness of pest eradication versus ongoing suppression, the latter of which must be undertaken in perpetuity.

To succeed, PFNZ will require a high level of social consensus over a long period. The perspectives of both Treaty partners should contribute to, and underlie, social consensus about the objectives of PFNZ, and the development and use of new pest eradication tools and technologies. Our responsibilities concerning biodiversity arise from interpersonal, intercultural, international and intergenerational relationships. We begin by detailing what makes Aotearoa New Zealand's biological heritage unique (1.1), the responsibilities agreed to in Te Tiriti o Waitangi (1.2), and our broader international obligations (1.3).

1.1 Aotearoa New Zealand's Biological Heritage

As a group of islands, Aotearoa New Zealand's physical boundaries are well defined. Aotearoa New Zealand split off from the supercontinent Gondwana around 80 million years ago to become its own land mass, and many forms of life unique to Aotearoa New Zealand have evolved since then. These forms of biodiversity are 'endemic' to Aotearoa New Zealand. In addition, there are other forms of life shared with other close landmasses, such as Australia or some of the Pacific islands, which arrived here before human settlement. Both forms of biodiversity are 'native' to Aotearoa New Zealand.

Aotearoa New Zealand was one of the last places on Earth to be settled by people, with first human settlement around the year 1300 when the Polynesian ancestors of Māori people arrived, and subsequent colonisation by settlers of European and other origins from around the year 1800. Because of these circumstances, it is possible to accurately determine which species are native and which have been introduced by humans. Prior to human arrival, the only terrestrial mammalian species living in Aotearoa New Zealand were bats. Mammalian species introduced by humans include the rats, stoats, and possums that PFNZ targets.

In Aotearoa New Zealand, researchers are well positioned to assess the impacts of introduced predators on native biodiversity, and to evaluate efforts to reduce those impacts. For example, the combined impact of human activities and invasive mammalian predator introductions has led to the extinction of more than 40% of the country's terrestrial bird species.⁵ Of the bird species that remain today, roughly one third are in serious trouble, with a further half in some trouble.⁶ Similarly, one third of reptiles are in decline.⁷

Concerns about the loss of Aotearoa New Zealand's biodiversity have been expressed for some time. Whakataukī (ancestral sayings) are powerful reminders of the impact of species losses felt by tribal communities.⁸ For instance, a number of whakataukī remember the size and power of the moa and lament the finality of extinction, which serves as a cautionary reminder to safeguard our biodiversity and prepare for the future. Concerns about the impacts of introduced species were also raised by Māori in the 19th century, and can be identified in the public record. Te Wehi, lamenting the loss of native forest birds, publicly voiced in 1874 his concerns about cats, rats, and honey-bees:

I nāianeī kua kore te manu, kua mate kua ngaro te kaka me te kakariki. Ka matau ahau ka toru nga nanakia o te ngahere nana i huna i ngaro ai nga manu. Te tuatahi, ko ngeru raua ko kiore-hawaiki; na ratou i kai nga kua o ngā manu ki roto ki o ratou kohanga me o ratou rua. Ko te tokotoru o nga nanakia he pi-ngaro.

In the present day the birds are but few, and the kākā and the kākāriki have almost disappeared. In my opinion there are three pests of the forest which are destroying the birds. First, the cat and the rat, which eat the young birds in the nests and holes (of the trees). The third pest is the honey-bee.

(Te Wehi, 1874)

⁵ Parliamentary Commissioner for the Environment (2017), p. 21.

⁶ *ibid.*, p. 28.

⁷ Hitchmough et al. (2015), pp. 3-4.

⁸ Wehi et al. (2018), pp. 461-470.

Te Wehi was not alone in his concerns about introduced species. A year earlier, Hapurona Tohikura outlined his own concerns about the disappearance of many native species, and identified introduced species as the cause of the problem.⁹ Similarly, hapū and marae communities have long voiced their concerns regarding the ongoing loss of biodiversity and ecosystem functioning tied to the widespread loss of tribal lands, languages, and knowledge. Treaty of Waitangi claims, not least the WAI 262 claim, detail these ongoing concerns and struggles.¹⁰ Recent Treaty settlements—such as Te Urewera Act 2014 and Te Awa Tupua (Whanganui River Claims Settlement) Act 2017—pioneer developments in environmental law and protection. These developments demonstrate both the extent of these ongoing concerns, and how enabling Māori tribal communities to undertake customary responsibilities can benefit us all.¹¹

So the social movement to protect Aotearoa New Zealand's biodiversity precedes the development of PFNZ. This is further demonstrated in landmark environmental cases, such as the raising of Lake Manapouri¹² and the protection of Coppermine Island,¹³ both in the 1960s, and in our collective attitudes towards nuclear status¹⁴ and mining activities¹⁵ in the 1980s. At the start of the 20th century, land managers began systematically removing introduced large mammals (goats and pigs) from some islands around the coast of Aotearoa New Zealand; by the middle of the 20th century they were doing the same with introduced small mammalian predators (rats).¹⁶ Since then, through dedicated fieldwork underpinned by scientific and technical advances, introduced mammals have been increasingly controlled on larger islands and eradicated from smaller islands. Today, Aotearoa New Zealand is perceived as leading the world in introduced mammalian pest management. As of 2015, some 45% of the 'mainland' (the combined North and South Islands) was under some form of predator monitoring or management, and one third of the offshore islands, totalling 10% of offshore island area, were predator-free.¹⁷

Box 1: Terminology of ecology¹⁸

Native: a species which is naturally found at a location without human intervention.

Introduced: a species transported to a location outside its native range by human agency.

Invasive: an introduced species which has been judged to have overly negative impacts on its recipient ecosystem.

Pest: a species (native or introduced) which has been judged to have overly negative impacts on its recipient ecosystem.

Predator: a species which preys upon (eats) other animal species.

Control: the suppression of pest populations.

Eradication: the complete removal of pests from a defined geographic location (e.g., an island).

Biodiversity: the total biological diversity in a region (not just the number of species, but often measured as such; see discussion in Section 2.2).

The protection of Aotearoa New Zealand's biodiversity and ecosystem functioning has a long-standing basis of shared concern and shared responsibilities. These responsibilities are broad, extending across social, cultural, economic, ecological, and animal welfare issues. However, the grounds for, and nature of, these responsibilities differ because of individuals' different reasons for valuing the natural environment, biodiversity, and, ultimately, a predator-free New Zealand. We take it to be the case, nevertheless, that there are grounds for agreement about both the need for protection and the need for cooperation in the pursuit and realisation of biodiversity protection.

We can therefore identify PFNZ as a recent development in a long-standing cultural drive to protect and restore Aotearoa New Zealand's biodiversity. What is unique about PFNZ is that it requires collective action at a national scale.

⁹ Tohikura (1873).

¹⁰ See Waitangi Tribunal (2011a, pp. 17-24; 2011b, pp. 2-3).

¹¹ Ruru et al. (2017).

¹² Mark et al. (2001).

¹³ Newhook (1969).

¹⁴ Lange (1990); Clements (2015).

¹⁵ Craig et al. (2000, p. 62); Morton et al. (1984).

¹⁶ See the appendix of Clout and Russell (2008) which provides an overview of eradications in the 20th century.

¹⁷ Russell et al. (2015), pp. 521-522.

¹⁸ Some of these definitions are contentious: not all conservation scientists agree, for example, on how to define an invasive species. These are the understandings that we adopt for the purposes of this report.

1.2. Te Tiriti o Waitangi

When modern Aotearoa New Zealand was founded in 1840, a partnership between two cultures and two systems of law and morality was forged. Te Tiriti o Waitangi (Te Tiriti), The Treaty of Waitangi, recognises this to be the case. It affirms and promises to uphold the mana, tino rangatiratanga, and tikanga¹⁹ of Māori, and commits to a relationship of equal partnership between Māori chiefs and the British Crown.²⁰

The intentions of Te Tiriti are significant for a PFNZ for at least two reasons. The first is that Māori systems of law and morality are grounded in philosophies that differ from many mainstream Western views—especially views concerning the place of the natural environment in our lives. Māori political philosophies are grounded in whakapapa, in which our relationships to each other, all living and non-living things, are central. These relationships are fundamental to a well-functioning society, which includes the protection of land and natural resources. This is because for Māori, all human beings, non-human animals, and the natural world have common origins, histories, and futures. Our lives are not merely made possible or enriched by the natural environment; they are bound up with and inseparable from it. Our human lives are only one part of a story that weaves together all things in the natural world. This is why native species, lands, oceans, and rivers are ancestors and kin. It is also why it makes little conceptual sense to *own* natural resources or value them as our property. Our relationships entail responsibilities to protect and conserve them for those who lived before us, those living today, and those who are yet to be born.²¹ On the other hand, property ownership plays a prominent role in Western thinking about our place in the environment: land and natural resources can be owned by individuals, and their value is frequently a measure of how useful they are to society.²²

Of course, these philosophical differences are not always so clear in practice. While many Māori value strong connections to tribal communities, today many others live away from those communities, and some have little desire to maintain connections to tribal lands and marae communities.²³ Similarly, despite the continuing prevalence of thinking grounded in property ownership, many of us value the natural environment because we see ourselves as having a connection or relationship of some sort with it. Many of us value that our natural environments sustain us in one way or another and also value the way that our native birds, rivers, seas, lands, and mountains enrich our lives beyond mere survival. Many of us recognise that our natural environments are important for our collective identities, memories, and hopes for the future.

This second reason why Te Tiriti is significant is because it entails duties and responsibilities to work together in equal partnership on collective concerns, recognising everyone's commonalities despite our differences. Protecting biodiversity and ecosystem functioning is a case in point. Because our natural environment is a common concern, genuine engagement with the widest possible coverage of New Zealanders, including all Māori tribal communities, is critical; as is doing so in ways consistent with their needs, goals, and values. Te Tiriti requires more than merely acknowledging the extent to which Māori tribal communities have their own philosophies, which may also resonate in some way with the personal and collective values of non-Māori. It requires that we all proactively work to ensure that these philosophies, and therefore the diverse perspectives of Māori communities, remain central.²⁴ Māori communities remain limited in their ability to actively participate in decisions that impact on shared lands and natural resources within their tribal areas, and are not always genuine partners in environmental policies. Our shared responsibilities to protect biodiversity and ecosystem functioning—and our strategies for doing so, such as PFNZ—are issues of both social and environmental justice that should centre on fulfilling the intentions of Te Tiriti.

1.3. International Obligations

The United Nations Convention on Biological Diversity (Convention) recognises global obligations to conserve biodiversity, to provide for its sustainable use, and to ensure the fair and equitable sharing of the benefits of that use.²⁵ The Convention is important here for several reasons. First, our economy is heavily reliant on tourism based on our international reputation as an unspoiled natural paradise. Secondly, Aotearoa New Zealand is recognised as a unique biodiversity hotspot. Thirdly, it recognises the relationship of indigenous peoples with biodiversity, and thus underlines the importance of partnership as envisioned in Te Tiriti.

Eradicating pests, such as the target species of PFNZ, would provide huge benefit to endangered native species. However, Aotearoa New Zealand's obligations under the Convention require much more than just reducing threats to biodiversity, as detailed in the Department of

¹⁹ In the context of this report, we use these terms to refer broadly to such things as customary authority, leadership, and law. For more on the broader dimensions of these concepts see Marsden (2003a; 2003b), Mutu and McCully (2003), Kawharu (1997), Matike Mai Aotearoa (2016), and Mead (2003).

²⁰ See, for instance, Kawharu (1989), Waitangi Tribunal (2011a; 2011b), and Mutu (2018).

²¹ Watene (2013; 2016).

²² An influential view here has been the work of 17th-century political philosopher John Locke, who believed that property ownership is an extension of self-ownership. See Locke (2016), pp. 15-16.

²³ See, for instance, Kawharu (2014).

²⁴ Te Momo (2007).

²⁵ United Nations (1992).

Conservation's 'New Zealand Biodiversity Action Plan 2016–2020'.²⁶ While pest eradication is recurrent in the New Zealand Biodiversity Action Plan, initiatives such as PFNZ can be only one of a set of detailed strategies to meet these obligations.

The United Nations Declaration on the Rights of Indigenous Peoples (Declaration) builds on the Convention summarised above, and underlines the importance of treaties and the significance of indigenous peoples for protecting the world's biodiversity.²⁷ The Declaration reinforces that protecting biodiversity is bound up with protecting indigenous peoples' self-determination. The Declaration includes the right to self-government; the right of indigenous peoples to participate in, and consent to, any decisions which affect them; and the right to control (and to have returned) traditionally owned lands and natural resources. The extent to which biodiversity initiatives like PFNZ impact the lives of Māori tribal communities is tied directly to the extent to which these communities can actively undertake customary responsibilities to protect, enhance, and manage environmental resources collectively and sustainably within tribal boundaries.

The Hawai'i Commitments (Commitments), developed by the 2016 IUCN World Conservation Congress, further emphasise the need for policy, laws, and best practice based on equitable and sustainable use of natural resources, as well as highlighting the inextricable linkages between culture and nature.²⁸ The Commitments are clear that biodiversity loss is linked to threats to indigenous cultures and languages, and recognise indigenous peoples as key stewards of the world's biodiversity. The Commitments build on prior global initiatives, such as the United Nations Sustainable Development Goals and the Paris Agreement, that address both social needs and ecosystem protection for managing climate change, particularly in marginalised and local communities. Concepts such as aloha 'āina,²⁹ kaitiakitanga,³⁰ minobimaatisiwin,³¹ sumaq kawsay,³² and related indigenous socio-environmental concepts (embodying the reciprocal dependence of humans and the natural world), exemplify a 'culture of conservation'.

The Aichi Targets in the Strategic Plan for Biodiversity 2011–2020 signal the preferred pathway to meet the vision of the Convention, with the goal that "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people".³³ To be consistent with these perspectives, best practice must incorporate cultural resource use parameters and acknowledge the importance of indigenous ecological knowledge and cultural values.³⁴ Within the Aotearoa New Zealand context this means fully engaging in partnership models as part of PFNZ to incorporate relevant cultural information and develop clear pathways to enhance resilience planning. Through their alignment to United Nations principles and Sustainable Development Goals, such models can promote both human wellbeing and the protection of natural resources. This will lift the standard for meeting global targets and shift potential solutions to those that focus on the retention of biological and cultural diversity and support community wellbeing.

²⁶ DOC (2016).

²⁷ UNPFII (2007); Anaya (2004); Waitangi Tribunal (2011a, 2011b).

²⁸ IUCN (2016).

²⁹ IUCN (2016).

³⁰ Kawharu (2000).

³¹ McGregor (2009).

³² Merino (2016).

³³ United Nations (2010).

³⁴ See further discussion in Sobrevila (2008).

2. Kaitiakitanga and Conservation Philosophy

A responsibility to do something, whatever that something may be, stems from an underlying belief that something is, in some way, valuable. In Māori philosophy, our relationships are valuable, and there is an associated responsibility to protect and enhance those relationships.³⁵ In mainstream Western philosophical discussions of conservation, justifications for action often rest on the claim that *biodiversity* is valuable, and that there is an associated responsibility to conserve it. This responsibility can conflict with responsibilities to other things considered valuable, such as the well-being of introduced species who are impeding conservation efforts. This section includes a brief discussion of these ideas of value (2.1.); the value of biodiversity itself and its relationship with other things considered valuable (2.2.); and the entities that are commonly thought to be morally responsible and those that require moral consideration (2.3.).

2.1. Valuing the Natural Environment

Whakapapa charts our relationships with each other and all parts of the natural world in descent (linear) and kinship (lateral) layers. People, landscapes, seascapes, waterways, natural resources and other creatures have their own mana and mauri, and they are tupuna (ancestors) and whānau (kin). Framing relationships in terms of kinship gives rise to a system of responsibilities to protect these relationships and to enhance their quality. The quality of these relationships determines such things as, for instance, whether and in what ways shared needs can be met, what goals we can and ought to pursue, and how shared values ought to be applied. These relationships can be enhanced by pursuing the qualities in each of these relational dimensions (for instance, in terms of needs, goals, and values).³⁶

The concepts underpinning manaakitanga (to enhance and care for others) and kaitiakitanga (practices of trusteeship) capture the intentions and applications of these responsibilities. Manaakitanga is centrally about practices that nurture and enhance the value of these relationships over time. Relatedly, kaitiakitanga encompasses the suite of Māori concepts relevant for environmental responsibilities in the widest possible sense. Together, these concepts and practices centre customary responsibilities to protect, enhance, and collectively and sustainably manage socio-environmental relationships across tribal landscapes. The relationships determine not only access to resources and the correct practices relating to their use, but also the tribal communities that hold reciprocal responsibilities to protect and enhance all flora and fauna, natural resources, and people as extended whānau.³⁷

Widespread loss of land, language, and community has had a profound effect on these relationships and responsibilities. Today, nurturing and enhancing these relationships involves a range of marae-based cultural reconnection and education programmes, hapū and iwi research programmes, customary sustainability activities (such as traditional harvesting practices and restrictions), and restoration projects, as well as various approaches to managing introduced species.

Concepts and activities that centre on relationships appeal to the value of natural entities in themselves, the value that these entities can have for others (including, but not limited to, people), as well as the value of the particular kinds of relationships that exist among them. Such views can gain wide support by appealing to the many ways in which value can be determined.

We find similar views in mainstream Western environmental ethics, which divide justifications for value into two groups: those that claim *intrinsic value* of the natural entity to be conserved (value in and of itself) and those that claim *extrinsic value* of the entity (for example, value because they enjoy it or because it is useful to them). The recognition of intrinsic values may encourage people to protect nature for its own sake, not only where it directly and clearly benefits humans. So-called 'deep ecology' is typical of this kind of approach to environmental ethics that centres on the intrinsic value of natural ecosystems.³⁸ While such views are common among committed environmentalists, they are less common in the wider population. Moreover, such views have proved difficult to distil into practical conservation policy. The idea that all of nature is intrinsically valuable cannot easily be used as a justification to disinterested third parties for decision making, in light of limited resources and political will, about the prioritisation of strategies, sites or taxa. However, in its favour, an intrinsic value approach may engender a greater responsibility in humans, individually and collectively, and encourage more humility in relation to our place in the wider ecosystem.

In societies where conservation priorities are set according to democratic principles, it is much more common for conservation to be justified in light of extrinsic values such as economic gain, mental or physical health, or aesthetic appeal. According to such approaches to environmental ethics, environmental policy should be set so as to maintain, restore, or enhance ecosystem services. Such a broad characterisation is set out in the Millennium Ecosystem Assessment, which divides these environmental goods to include provisioning (for example, food production),

³⁵ Whyte (2013).

³⁶ We take such a view to be implied in Māori thought. See, for instance, Kawharu (2000), Marsden and Henare (1992), Mutu and McCully (2003), and Sadler (2007). See also Whyte (2013).

³⁷ Kawharu (2010).

³⁸ For more in-depth discussion see Naess (2001) and Devass and Sessions (2001).

regulating (for example, control of climate), supporting (for example, nutrient cycles), and cultural benefits.³⁹ In the context of PFNZ, additional considerations include public health benefits from eradicating diseases, such as tuberculosis and leptospirosis. While intrinsic and extrinsic value approaches may seem to stand in stark contrast to one another, it should be noted that they can often justify similar biodiversity policy.

2.2. The Value of Biodiversity

Aotearoa New Zealand's recognition of its responsibilities concerning biodiversity ties to the ratification of the UN Convention on Biological Diversity (see Section 1.3). The Convention justifies these responsibilities on the grounds that biodiversity is both intrinsically and extrinsically valuable as a source of ecosystem services.⁴⁰ As stated earlier, biodiversity refers broadly to the range of different forms of life in a given ecosystem, but this reflects multiple specific features of the biosphere. Important aspects of biodiversity include genetic, morphological, phylogenetic, and ecological diversity of life forms themselves, but it also includes *biocultural* diversity—the mutually supportive relationship of life forms, human language, and culture. In this way, biodiversity refers to a broad assortment of things that are biologically important: to population or species survival, and to human populations because of their various effects on ecosystems services or their cultural value.

These different aspects of biodiversity are *incommensurable*: There is no single unit of measurement that accurately represents biodiversity in general in the way that, for example, degrees Celsius measures temperature. Hence, biodiversity can mean different things to different people or groups. Different people or groups can then be at odds about how to maintain it—for example, in maintaining indigenous or community cultures through the desire to harvest animals, either native or introduced, or removing one species to protect others. There are, however, a variety of characteristics that are recognised as good indicators of, or surrogates for, the biodiversity of ecosystems. These include the number of species or higher taxonomic categories (such as families or orders) present, the phylogenetic diversity of the organisms present, and physical aspects of the environment that influence the number of ecological opportunities available.⁴¹ The complex nature of biodiversity measurement makes environmental policymaking more difficult, as regions and biota that score high on some measures of biodiversity may not score high on others.

Moreover, biological measures of biodiversity often do not reflect the fact that species vary a great deal in the nature and extent of their contributions to ecosystem services or cultural interests. 'Keystone' species (such as the kererū—the only bird dispersing large fruit in Aotearoa New Zealand), for example, have disproportionately large effects on the functioning of ecosystems in which they occur, whereas 'charismatic' species (such as the kiwi—a national emblem in Aotearoa New Zealand) have disproportionately large effects on the recreational and cultural benefits humans receive from ecosystems. So, while biodiversity is undoubtedly important, and many aspects of it are well understood, there is not a simple relationship between measures of increased biodiversity and increased ecosystem services or cultural benefit.

Moreover, not all sectors of Aotearoa New Zealand receive similar benefit from biodiversity, or indeed from introduced species. Not all New Zealanders wish to remove introduced species, even when those species have negative effects on the environment. For example, pig hunting is an important cultural and economic activity in many rural communities, despite the damage that pigs cause in forested areas. Watercress and other introduced plant species have been incorporated into food dishes that are now commonplace on many marae, and as such may be regarded as desirable. Of most relevance for PFNZ, the kiore, or Pacific rat, is not universally regarded as a pest. Within some Māori tribal communities, the kiore remains valued as a species brought to Aotearoa New Zealand by the Polynesian ancestors of Māori, and as an ecological indicator (its abundance can be thought of as a proxy for underlying ecosystem health). In the context of PFNZ recognising these nuances is paramount.

2.3. Moral Agents and Moral Patients

The Māori concepts underpinning manaakitanga and kaitiakitanga determine the application, scope, and nature of relational responsibilities. Kaitiakitanga is about socio-environmental resource management in terms of trusteeship. In one sense, this acknowledges the relationships in which we stand with other people (ancestors and future generations) and all parts of the natural environment. Manaakitanga and kaitiakitanga are about serving others as our extended whānau because of our interdependence. We look to the nature of those relationships and interdependence for guidance about what is required of us all.

In Western views of environmental ethics regarding our relationships and interdependence, *moral agents* are distinguished from *moral patients*. The idea is that while human beings are clearly the moral agents making the decisions affecting our environment, many think that we should be interpreted as making those decisions on behalf of a much broader group of *moral patients*. This group is commonly thought

³⁹ Report of the Conceptual Framework Working Group of the Millennium Ecosystem Assessment (2003), p. 3.

⁴⁰ United Nations (1992), p. 1.

⁴¹ See further discussion in Maclaurin and Sterelny (2008).

to include many, but not all, animal species. Most standard views in animal ethics are *individual-based*: they say that we should extend moral consideration or rights to non-human animals in virtue of features they have as individuals, such as their ability to feel pleasure and pain, or simply because they are 'subjects of a life'.⁴² This idea underpins the thinking of animal welfare advocates who argue that extrinsic value approaches to environmental ethics should not be purely human-centred. Instead, the benefits for human and non-human animal populations should be weighed against the suffering of non-human animals that might result from conservation practices, such as the use of toxins.

In practice, and with either view, it is difficult to weigh the interests of each morally relevant consideration. For example, often we need to prioritise particular relationships over others. What's more, in getting something done we often have to think about the process involved and how it impacts on these relationships. For instance, if an animal that was poisoned would instead have died of starvation or in the jaws of a predator, it might be the case that the poisoning would not actually increase the sum total of suffering over the animal's lifetime. Nonetheless, animal welfare arguments are usually taken to justify a preference for conservation methods that avoid directly human-induced suffering. Causing unnecessary suffering would undermine the mana of the animals themselves, the relationships in which we stand with the animal, and subsequently our mana as kaitiaki. Improper trapping that results in maimed animals would be considered neither tika nor ethical (from a relational or an animal welfare perspective) nor efficient. A quick and (relatively) painless death would (in many cases) be considered both ethical and efficient.⁴³

Animal welfare advocates are not the only people who acknowledge non-human moral patients. Views amongst conservationists tend to be more holistic, in the sense that they focus not on our duties towards individual living beings, but larger collectives such as populations, species, communities, ecosystems, or the biosphere as a whole. These collectives can themselves be treated as moral patients, often due to a sense that they can possess a kind of well-being or 'health' in and of themselves.⁴⁴ Viewing an ecosystem as a moral patient means viewing its well-being as something worth moral consideration, regardless of whether humans can derive some benefit from the services it provides (though its capacity to provide these services may be taken as indicative of its well-being). However, there has been considerable debate about whether ecosystem health is tied too closely to benefits for human populations, or to other policy objectives, to count as a genuine scientific property.⁴⁵ Other sceptics doubt that ecosystem health can generate the same sort of moral obligations as the wellbeing of humans and other animals, which are capable of experiencing well-being.⁴⁶

We may find that we consider both individuals and collectives to be moral patients, but there will be cases where our desire or obligation to preserve ecosystems will come into conflict with our desire or obligation to uphold commitment to (individualist) animal ethics. There is a significant literature trying to reconcile environmental ethics with animal ethics.⁴⁷ Some people think that we should take environmental ethics as primary, with animal ethics as secondary—that is, decision makers should take both ecosystems and individual animals under consideration, but, when tensions arise, ecosystem health should take priority over the lives of individual animals that might be threatening it.⁴⁸ Others have proposed more complicated sets of duties which are meant to include both ecosystems and individual animals at once.⁴⁹ While these sorts of views might sound appealing, they are not always clearly action-guiding for conservation, if the conservationists in question want to uphold commitments to both environmental and animal ethics.⁵⁰ The extent to which one set of commitments may be compromised by the other depends heavily on the context.

Broadly speaking, environmental ethics calls on us to protect Aotearoa New Zealand's biological heritage. The New Zealand Animal Welfare Act (1999) allows for this within certain 'humane treatment' restrictions. Despite this, pursuing an environmentally ethical course of action can be inconsistent with at least some views in animal ethics. However, concern for the welfare of individual animals, in an animal ethics framework, can arguably be thought of as consistent with a (even higher priority) concern for native collectives in the context of controlling or eradicating invasive mammals—depending on the control or eradication method and technology in question. For example, using genetic approaches to prevent animals from being born (with the goal of eliminating populations) arguably raises fewer concerns, from an animal ethics perspective, than using toxins to kill already living animals. However, the cultural considerations of such practices warrant consideration. What's more, the welfare costs of pursuing PFNZ must still be assessed against accepted standards for any lethal control.⁵¹

⁴² For some classic works in animal ethics along these lines see Singer (1995) and Regan (1987).

⁴³ The extent to which this is the case depends on the animal ethics view in question; for a recent survey, see Dubois and Fraser (2013). See Regan (1987, 2012) for a standout exception, and Hutchins (2008) and Mathews (2012) for further dissenting views.

⁴⁴ Callcott (1989).

⁴⁵ For example, see Lackey (2002) and Carolan (2006).

⁴⁶ See, for example, Jamieson (1995).

⁴⁷ For some starting points, Callcott (1980) and Sagoff (1984) discuss this reconciliation and argue that it is impossible; Jamieson (1998) and Paquet and Darimont (2010) hold that there is no conflict.

⁴⁸ For example, see Katz (1983).

⁴⁹ For example, Varner (2003) argues that reconciliation, at least in practice, is possible.

⁵⁰ Parke and Russell (2018).

⁵¹ See Fisher (2017) for a preliminary assessment of PFNZ against such standards.

3. Human Dimensions

Conservation policy-setting is about balancing the interests of different groups of humans, rather than the interests of humans versus nature. Despite arguments for the intrinsic value of species, it is ultimately humans who make the decisions, who are responsible for the original introductions of non-native species, and who debate conservation strategies and policies. What PFNZ even means to different people, or how they might be motivated, will be critical elements of how it proceeds. The human dimensions of PFNZ thus overarch the entire project—this is what motivates our claim at the outset of Section 1, that the challenge is as much social as it is biological. This section considers specifically those human dimensions, such as how we might know if there is social licence to undertake a particular course of action, utilise a particular control tool, or advance PFNZ as a whole (3.1.), and what types of behavioural changes may be required of New Zealanders for PFNZ to be successful (3.2.).

3.1. Social License

Social license is the idea that an important and potentially risky activity can be justified on the grounds that, if polled, the community or society at large would sanction the activity. In this sense, there are two ways that social license could be interpreted. The first is when the activity in question is already underway, and continuation of the activity will either gain or cost popular support for the entity undertaking it—the activity could be said to either have or lack social license, respectively. The second interpretation is a more fundamental sense of social license, where a large amount of public support is needed for the activity to even commence. The longstanding and widespread acceptance of Aotearoa New Zealand's anti-nuclear stance can plausibly be interpreted as the country refusing social license, in this more fundamental sense, for the transport, deployment, or storage of nuclear weapons on our shores. Achieving the goals of PFNZ would require significant expenditure and effort over a very long period of time spanned by many different governments. So, at the outset it seems reasonable to think of PFNZ as a project requiring social license in both senses of the term.

However, PFNZ differs in key ways that set it apart from other cases in Aotearoa New Zealand where social license has been crucial. First, both the goals of PFNZ *and* the means of achieving those goals will require social license. In the case of our anti-nuclear stance, the means to achieve this goal are only refusing to allow nuclear weapons into New Zealand territory—it is the ongoing *maintenance of an absence*. On the other hand, PFNZ will call for the use of specific and novel pest-control tools, new government policy, and potentially the redirection of funding to achieve its goals. Those means will themselves require acceptance. As an example of the importance of social license for both goals and means, one need only consider the current widespread use of 1080 (a vertebrate toxin used at large scale to control invasive mammals) for bird conservation.⁵² Although 1080 can lead to the inadvertent killing of non-target species,⁵³ opposing its use for bird conservation (notwithstanding its primary use for control of bovine tuberculosis) severely limits the ability to protect birds at landscape scales.⁵⁴

A second way that PFNZ differs from other cases is that the actions of individual citizens or communities whose values are challenged by PFNZ could potentially set back PFNZ greatly. It is not reasonable to think that an individual could undermine our country's anti-nuclear stance, but depending on the technologies used, individuals could undermine the goals of PFNZ: for example, by reintroducing target species to areas where they have been eradicated or refusing to eradicate those species on privately-owned land. Communities might wish to challenge eradication of target species from specific sites or lands. From these considerations it should be apparent that PFNZ requires a level of public acceptance that is greater than most prior undertakings Aotearoa New Zealand has committed itself to.

While there was considerable positive publicity at the Government announcement of support for PFNZ, it is difficult to estimate how New Zealanders will react when the extent and potential costs of the project become more widely realised. While there were diplomatic repercussions, our anti-nuclear stance directly cost the country relatively little. PFNZ would likely cost more (in terms of both money and opportunity costs), but its potential benefits could be far-reaching. There is no widespread agreement about the conditions for achieving genuine social license.⁵⁵ But in this case, there would have to be widespread acceptance that the costs, borne by all New Zealanders, would be balanced out by widespread and long-lasting benefits accruing to people in all regions and in all walks of life.

3.2. Behavioural Change

Some New Zealanders already have a strong relationship with nature and recognise that pests are a threat to our biodiversity and they are already doing something about it. If supported, the success of PFNZ will rely, at least in part, on New Zealanders changing their behaviour,

⁵² See Battle for our Birds: <https://www.doc.govt.nz/our-work/battle-for-our-birds/>.

⁵³ Veltman and Westbrooke (2011).

⁵⁴ Parliamentary Commissioner for the Environment (2011).

⁵⁵ See Parsons and Moffat (2014) for lessons from the mining industry.

or being able to act in ways that align with PFNZ. This can involve direct behavioural changes (for example, changing how they compost) or indirect ones (for example, supporting the use of controversial new technologies). If PFNZ is to engage the nation, the simple linear assumption, that knowing about biodiversity problems elicits care for biodiversity and ultimately translates into conservation action, needs to be discarded. It has repeatedly been shown that knowledge and caring for an issue rarely translate into behaviour change, and in some cases there can be a boomerang effect (the more we know, the less we act).⁵⁶ Resonating with Māori views, recognising that New Zealanders have a diverse relationship with nature and may take action to protect it for a range of reasons (economic, social, cultural, recreational or health-related), and not just for pure biodiversity gains, is essential. A focus on these wider relationships and co-benefits of predator control will help build a broad and diverse coalition of New Zealanders.

Until we know whether there is broad support for PFNZ, the list of potential behaviours (direct or indirect) that New Zealanders may need to change over the course of the next decades remain unknown. As a strategic approach develops for PFNZ, identifying the full spectrum of relevant behaviours will be essential. Once these behaviours are identified, implementing a behaviour change programme for each of them might be necessary, as the barriers and benefits for each behaviour will vary. Furthermore, for some of the more extreme or complex behaviours a step-wise approach might be required. This model, based on over 30 years of research from public health, recognises that behaviour change is best implemented via small incremental changes rather than one giant leap.⁵⁷ Finally, to avoid overwhelming New Zealanders with multiple behaviours they need to change, prioritising the behaviours will be essential. This process quantifies behaviours based on the trade-off between the conservation impact and the likelihood of adoption. Thus, it can identify behaviours that are 'low hanging fruits'. By focusing on these initially, public support for PFNZ can be fostered through hands-on experience of pest control, and can prepare New Zealanders for further behavioural change.

The enormous challenge PFNZ faces here should not be underestimated: a great many New Zealanders may need to change their behaviour. However, existing behaviour science research and best practice provides lessons to identify the essential elements of early engagement with New Zealanders and co-development of a way forward.



Juvenile bellbird (*Anthornis melanura*) on Auckland Island, target of the Pest Free Auckland Island campaign (Photo: James Russell)

⁵⁶ See Schulz (2011) and Hart and Nisbet (2012).

⁵⁷ Michie et al. (2011).

4. Governance and Oversight

Ethically justifying the end goal of PFNZ is one thing—it must be convincingly established that the complete absence of target predator species from Aotearoa New Zealand is, in some significant way, better than the current state where they are abundant, as well as everything in between. But it is another matter entirely to justify the ways we go about achieving that goal. If the means of achieving the goal are not viable, then the goal itself will be unattainable. This section addresses the issues that arise when considering potential specific routes to achieving PFNZ. These issues fall into coalition-building and the role of policy, whether community or governmental (4.1), and the legitimacy of the democratic process (4.2).

4.1. Coalitions and Policy

In section 3.1 (Social License) it was noted that PFNZ raises some societal challenges. Meeting them may require greater than usual engagement among stakeholders, beyond conventional consultation, to the construction of a durable coalition capable of sustained effort. Engagement between all levels of government, iwi leaders and tribal groups, representatives of civic groups, landowners, and ordinary New Zealanders, with genuine uptake of local perspectives including mana whenua, should go a long way towards building the durable coalition that can support this long-run project. Successful outcomes in PFNZ can then build on community-led pest eradication initiatives, learn from successful existing partnerships and models in its design, and further enhance these partnerships and initiatives in its implementation. Pest eradication tools, technologies, and initiatives should be framed and communicated realistically, including accurately assessing and communicating the range of (cultural, social, political and economic) costs and benefits involved.

Conventional consultation processes and stakeholder inclusion schemes often fall short due to perceptions that they are just formalities. Many stakeholder inclusion schemes are also structured so as to make it difficult for ordinary citizens to participate (for example, the meetings are held during working hours, require whole days of unpaid work, or are poorly advertised). Better models of genuine engagement among Treaty partners and stakeholders require more effort, but are worthwhile because they can ground genuine social license.

Ensuring PFNZ be genuinely responsive to ordinary people's views on pest management policy is this essential. Perhaps most New Zealanders would endorse PFNZ's general goal of eradicating some invasive mammalian predators in the interests of conservation and ecosystem services. However, there may be significant diversity of opinion on every other aspect of the policy. Getting an early public impression of PFNZ right, by presenting genuine options and engaging with public opinion, could make the difference between the long-run success or failure of the effort.

Coalition-building and its relationship with successful policy implementation is well understood both in Aotearoa New Zealand and internationally. The key lesson to be remembered for PFNZ is that to sustain a major policy that provides a long-run public good, you need both political leadership and civic organization, and both of these need institutions that continually replenish public understanding of, and commitment to, the policy.⁵⁸

4.2. Democracy and Legitimacy

A democratic government ought to serve the interests of its people, for both ethical and practical reasons. Legitimate democratic policy is public, responsive, transparent, and accountable. To be successful it also needs to be supported by local communities including Māori tribal communities, and these groups will be more likely to support those policies that have the above qualities.⁵⁹ However, there are some well-understood barriers to acting in the people's interests, especially for cases of environmental policy like PFNZ. For instance, pest eradication on the scale contemplated here is a public good (that is, someone has to pay for it but no one can be excluded from using it, leading to temptations on everyone's part to free-ride). The public goods problem in this case is particularly acute because of the need for simultaneous action to achieve at least regional eradication: dissenting landowners might be able to undo the work of everyone else (at least under existing technology).

Democratic accountability is easier to achieve in cases where the problems facing society are right in front of us, easy to see and to understand.⁶⁰ Even though the risks of insufficient pest management are harder to see and to understand than, say, the problem of making repairs after an earthquake, we can still have a democratically accountable PFNZ. The real costs of failure to manage invasive pests can be communicated,⁶¹

⁵⁸ Rahman (2017) and Skocpol (2003).

⁵⁹ Skocpol and Fiorina (1999); Bächtiger (2018).

⁶⁰ Ellis (2016).

⁶¹ See, for example, Nimmo-Bell (2009) on financial investment in mitigation of pest impacts through control operations.

along with more difficult issues of technological and biological uncertainty. The costs of the status quo are relatively invisible, while the path to improvement is uncertain and long. These characteristics of the PFNZ issue could interfere with a democratically accountable policy unless it is evident that PFNZ is an important public good. PFNZ needs to be framed realistically, its costs and benefits measured accurately, and the coalition representing the broadest public good needs to be made aware of its common interests.

Moving towards policy in the general interest requires public understanding, organization, and leadership. The most enduring general interest policies have institutions in place that continually renew public understanding and commitment via both public and private sector organization. For example, social welfare policies that serve organised interests like retired people tend to be more resilient to exogenous shocks than those that serve relatively disorganized groups.⁶² Short-run top-down policies can help build momentum, but they need broad public engagement if they are to serve the general public over the long run. Civic initiatives led by the state without substantial grassroots participation tend to fizzle out (think of the effort by the United States government in the 1970s to convert to metric measurement); even grassroots movements are fragile without organised civil society behind them (think of the influential but short-lived Occupy Wall Street movement). Social movements can arise in response to perceived exclusion and lack of engagement from policymakers, as has arguably also been the case in the stand-off between the 'yellow vest' protesters and Emmanuel Macron's government in France in 2018 and 2019. But these kinds of social movements tend to express rejection of top-down policy rather than a positive vision of some general good.⁶³ Where we would hope that interaction between policymakers and civil society would lead to resilient policy in the common interest, this interaction must be the right kind: ongoing, respectful, and substantially two-way rather than top-down.⁶⁴ There is now widespread scholarly consensus about the superiority and resilience of engaged, participatory, collaborative policymaking compared with command-and-control, top-down styles.⁶⁵



Oban township on Rakiura/Stewart Island, target of the Predator Free Rakiura campaign (Photo: James Russell)

⁶² Olson (1965); Skocpol and Fiorinia (1999).

⁶³ The polarization and stasis of the "yellow vest" protest in France has some interesting similarities to the divided community that arose in the early years of 1080 use for predator control in New Zealand: in both cases, a sense of exclusion from and distrust of official discourse has given rise to polarisation and blocked potential avenues of consensus. On the New Zealand case, see Green and Rohan (2012).

⁶⁴ Fung and Warren (2011).

⁶⁵ Bächtiger et al. (2018).

5. Technology

Aotearoa New Zealand continues to be perceived as a world leader in mammal eradication on islands. Indeed our pride and ability in this has likely contributed to our desire to continue to push the envelope further in invasive mammal eradication to the entirety of the mainland. While the technology exists today to entirely eradicate the target species of PFNZ from areas of tens of thousands of hectares, and to manage reinvasion, these technologies have potential financial and geographical limits of scale. This section addresses social issues that arise from the technology that might be used in pursuing a PFNZ. These include the issues that arise from reaching the limits of current technology (5.1) and how novel tools might be regulated should they become available (5.2). However, we once again reiterate that the context-specific issues of different methods which might achieve a PFNZ (e.g., 1080 or gene editing)⁶⁶ are not the focus of this discussion.

5.1 Technological limitations

So far, eradication of invasive mammals has been achieved only on offshore islands where 100% of the individuals of the target species can be removed, and where reinvasion is so low that, due to the ocean being a formidable barrier, it can be managed through biosecurity.⁶⁷ More recently, such an approach has been replicated in predator-proof fenced reserves on the mainland, where the fences, also a New Zealand invention, provide an equally formidable barrier.⁶⁸ However, these eradication tools (toxins and fences, among others), although efficient, may not be sufficiently cheap to be used entirely, nor simultaneously, across Aotearoa New Zealand⁶⁹, at least not without risk of reinvasion from an untreated area back to a treated area. Thus, in the first instance, technology is limiting only in cost. However, even if it were possible to simultaneously deploy the entire suite of tools across the country, some tools are necessarily restricted in use, either by regulations or public acceptability (or both); for example, some tools are regulated not to be used close to or over waterways, nor are they socially acceptable in densely inhabited areas such as cities. Thus, there is also a social limit to the use of some current technologies.

Current technology for most mainland pest management in Aotearoa New Zealand has been developed with sustained long-term control in mind. While high levels of control, sometimes up to 99%, are achieved, there are still usually some survivors. Trapping also has its limits as an eradication tool, as humans must be able to access the traps to check them, traps are not always set properly, some require daily checking, target species develop wariness of them, and animal welfare issues limit the trap types approved for use.

Existing technologies are also governed by a range of legislation and regulation that limits how close to target species eradication these tools can get. For example, one of the most effective tools for mammal eradication is currently the anticoagulant brodifacoum, but potential resistance and residue issues with it mean that its use on the mainland is currently restricted on public conservation lands. If eradication is the focus, significant changes are probably required in both the suite of current tools and the regulatory environment that governs them. Where toxin and animal welfare issues are a legitimate concern, this will encounter social acceptability challenges.

The toxin and trap technologies currently used in Aotearoa New Zealand will arguably be sufficient to make incremental steps towards the goals of PFNZ, to get us close to a 'Predator *Impact* Free New Zealand', and even to achieve predator eradication in some areas and for some species. However, using only the current suite of tools may be prohibitively expensive, with continual and increasing use, and may be insufficient to achieve complete eradication unless we can develop more effective barriers to movement. Traditional pest control technologies may need to either work in tandem with, or be replaced by, new technologies for eliminating the last survivors.⁷⁰ These may in turn require new and potentially more difficult social acceptance. However, this social acceptance will depend at least significantly—though not inevitably—on the specifics of these new technologies, and will likely differ among groups. Some groups, for example, may prefer the use of novel technologies over the introduction of more effective toxins; others may take the opposite approach.⁷¹

5.2. Novel Tools

If new pest management tools are likely to be necessary, then the regulatory environment for their approval and use must be considered. Approvals of some novel tools are governed by the Hazardous Substances and New Organisms Act 1996 (HSNO Act). Decisions on applications must consider a variety of different matters. An application to import or release a new organism or new toxin must be declined if it fails to meet certain minimum standards against causing damage; these standards include the likelihood of significantly displacing a native species

⁶⁶ See RSNZ (2017).

⁶⁷ See summary in Clout and Russell (2008).

⁶⁸ For a detailed overview see Burns et al. (2012).

⁶⁹ Jones and McGlinchy (2016).

⁷⁰ Campbell et al. (2015) provide a horizon scan of some such technologies for rats.

⁷¹ See Hudson et al. (2019).

within its natural habitat, of causing significant deterioration of natural habitats, or of significantly impacting New Zealand's inherent genetic diversity. If it meets those standards, a number of other matters must be considered, including:

- the ability of the organism to establish an undesirable self-sustaining population;
- the ease with which it could be eradicated if this were to happen;
- any adverse effects to human health or the environment (particularly ecosystems and their constituent parts);
- alternative methods of achieving the research objective that have fewer adverse effects; and
- the impact of any effects of transfer of genetic elements to other organisms.

The Authority can then either approve the application, if it considers that the positive effects of the organism outweigh the adverse ones, or decline it if the opposite is true. In coming to such a conclusion, the decision-maker must utilise the Hazardous Substances and New Organisms (Methodology) Order 1998 (the Methodology). The Methodology reflects the relevant considerations set out in the HSNO Act, though it notably does not include the requirement to take into account Te Tiriti. The Methodology sets out the process for how the Authority must evaluate the risks, costs and benefits of the organism in an application and determine how to make a decision on an application. Notably, clause 25(1) requires that in the evaluation of risks, "the Authority must begin with a consideration of the scientific evidence relating to the application", with values and other matters, such as the relationship of Māori culture and traditions with their ancestral lands and taonga, secondary to science. The Methodology also provides for how the Authority ought to deal with uncertainty in the evidence regarding the potential risks of an organism in an application, however it largely refers to scientific or technical uncertainty, rather than uncertainty arising from, for instance, values and other matters.

Many of the factors that the Authority must take into account in making a decision might significantly favour the release of gene-drive modified animals. For instance, section 36 requires an application to be declined if it is likely to significantly displace a native species within its natural habitat, or to significantly impact New Zealand's inherent genetic diversity. However, the sole purpose of releasing gene-drive modified animals would be to protect native species and genetic diversity, and thus not trigger the section 36 threshold to decline it.

One major critique that has been made of the way the HSNO Act currently operates is in regard to the primacy given to Western scientific thought and economic rationality above other social, cultural and ethical considerations. For example, risk is conceptualised within the HSNO Act framework as dominantly corresponding with rational (Western) scientific concerns and definitions.⁷² Furthermore, tikanga Māori concerns have been given underwhelming effect under the HSNO Act, despite the nominal importance of Te Tiriti in the scheme of the legislation.⁷³ The above issues speak to the broader fact that it is unclear how decision-makers under the HSNO Act should balance competing interests and views that have to be taken into account.

By failing to take into account the social, cultural and ethical dimensions of risk when assessing new tools and technologies, the decision-making process and the institutions responsible for making those decisions might lose their legitimacy in the eyes of the Aotearoa New Zealand population and the world.⁷⁴ Additionally, they are far more likely to fail to avoid dramatic negative outcomes relating to the social, cultural and ethical aspects of new technology, as these will not have been considered as important as the concepts of Western science and economic gain. As such, the HSNO Act could be modified to better balance the importance granted to these different elements of risk, and to provide better guidance on how to weigh these different, competing aspects against each other.

Precaution, or the precautionary principle, as incorporated in the HSNO Act, relates to the management of adverse side effects, rather than requiring caution prior to the actions which result in the realisation of such adverse effects.⁷⁵ This is significantly weaker than the way the principle is phrased in the Rio Declaration on Environment and Development and other international formulations (see Section 1.3).⁷⁶ As with the failure to ensure adequate weight is provided to non-Western scientific and economic concerns, this diluted approach could result in a higher likelihood of uncertain risk-taking.

Although the HSNO Act provides for criminal and civil sanctions for breach of its own provisions, there is no liability regime in place for the potential damaging effects of a release that goes wrong in unexpected or catastrophic ways.⁷⁷ Although the Royal Commission on Genetic Modification believed that the common law tort system would suffice to deal with any possible harm caused by the release of a GMO,⁷⁸ many rigorous legal analyses disagree.⁷⁹ As such, consideration should be given to whether a dedicated liability regime ought to be put in place to deal with this eventuality should it arise.

⁷² Havemann (2003), pp. 28 and 38.

⁷³ See, for instance, Oldham (2017).

⁷⁴ Hayward (2005), p. 146.

⁷⁵ *ibid.*

⁷⁶ UNESCO (1992), Principle 15.

⁷⁷ Hazardous Substances and New Organisms Act, parts 7 and 7A.

⁷⁸ See Thomas Eichelbaum et al. (2001).

⁷⁹ Including those conducted by the Law Commission and the law firm Chen Palmer. See NZLC (2002) as cited in Hayward (2005), p. 160; and Terry et al. (2001), p. 35, as cited in Havemann (2005), p. 13.

6. Outcomes

While PFNZ targets the eradication of selected mammal species, its fundamental justification, and ultimately the measure of its success, is sustainably restoring native species and ecosystems. Should PFNZ be successful, there will be a large increase in the numbers of many native species across Aotearoa New Zealand, not seen since mammalian predators first arrived in Aotearoa. This restoration of species, in turn, is justified in terms of the benefits it will bring, including the culturally important relationships to which they are central. Planning before and throughout the process is critical to ensuring that the outcomes are achieved, maximised, and equitably distributed. This section addresses the outcomes anticipated from a PFNZ. These include how we might imagine and ultimately declare success (6.1) and what might follow PFNZ should it succeed or fail (6.2).

6.1 Measuring success

PFNZ is intended to serve broader goals of biodiversity conservation, ecosystem services, and more generally human and non-human well-being. In addition to measuring progress towards predator eradication directly, we should also estimate the progress (or lack thereof) contributed by PFNZ toward these broader goals. However, what the relevant units of value measurement are, or should be, is not obvious. Whereas pest presence or absence is easily confirmed, this will not tell us what direct and indirect consequences their absence will have for valued outcomes, such as native species flourishing, tourism revenues, or agricultural sustainability, among others.

A further reason to seek to estimate the broader values of eradication outcomes is that it will enable us to make democratically legitimate decisions that serve the people of Aotearoa New Zealand. Managing our biological heritage responsibly entails understanding the costs and benefits associated with the status quo mainland suppression and island eradication models,⁸⁰ as well as the costs and benefits of alternatives. Equally important is the effective communication of these values to the public.

There are several different approaches to estimating the value of environmental outcomes, each with advantages and disadvantages in specific contexts. These involve natural capital assessment—or ecosystem services assessment—approaches, which are important internationally. Many of these approaches produce dollar value estimates, though other currencies are also used. A different kind of approach is threshold/dashboard approaches, which focus more on answering the question of whether we are on a sustainable path or not. For example, the New Zealand Sustainability Dashboard project is working to adapt a European farm biodiversity tool to Aotearoa New Zealand conditions, so that farmers can get evidence-based feedback about the effectiveness of management practices such as mowing techniques.⁸¹ On a more global scale, the Planetary Boundaries project maps current states of environmental conditions, such as ozone depletion or land-use change against estimated safe levels.⁸² Finally, for implementing collective goals (such as reducing global emissions), there are comparative tools like the Climate Action Tracker; these make different sets of policies comparable to each other and to the desired end state.⁸³ Unfortunately, we do not yet have a reliable UN-led international best practice standard in biodiversity value measurement.

For some New Zealanders, the appeal of PFNZ may be that it concerns protecting entities perceived as intrinsically valuable (native biota) against those that threaten them (introduced predators). This perceived intrinsic value may override justification for PFNZ in terms of extrinsic factors, such as economic gain or personal well-being. Others may consider a given extrinsic benefit incommensurably more important than another (such as aesthetic appeal over economic gain), and see PFNZ as an obviously beneficial (or harmful) movement. There is no single answer, in part due to the theoretical problem of aggregating very different kinds of costs and benefits. Nonetheless, PFNZ challenges us to reconcile our various values and perspectives. It demands that we agree, or at least agree to reach a working compromise, on our responsibilities concerning biodiversity.

6.2 Beyond PFNZ

Working toward a PFNZ is not the only action required to restore all native species and ecosystems, and achieving a PFNZ itself may create other unanticipated ecological, cultural, and social issues. It is also important to recognise that failure to achieve PFNZ targets would not necessarily mean failure to achieve significant biodiversity outcomes. Thinking beyond PFNZ reinforces the importance of trying to clearly define objectives in partnership between Treaty partners and relevant stakeholders, making it more likely that we will anticipate and resolve conflicts likely to cause inaction or other poor management choices in the future. Imagining ‘pre-mortem’ scenarios of what could prevent achieving biodiversity objectives, regardless of whether the PFNZ targets are met, can be useful.

⁸⁰ Parkes et al. (2017).

⁸¹ See http://www.nzdashboard.org.nz/uploads/2/3/7/3/23730248/biodiversity_tool_background.pdf.

⁸² Steffen et al. (2015).

⁸³ See <https://climateactiontracker.org/> and Figueres (2017).

Although PFNZ has increased awareness and levels of support for predator control, if the PFNZ goal of complete eradication is not met, there is potential for disillusionment and lost opportunity from resources that could have been invested elsewhere. Failure to meet expectations of a PFNZ could be perceived as a failure of Aotearoa New Zealand conservation as a whole. There is already a well-developed network of ecosanctuaries around the country, and these are successful in terms of local ecological restoration, primarily through predator control or eradication followed by reintroductions of native species.⁸⁴ However, the long-term viability of these sanctuaries is always uncertain because their maintenance depends on perpetual investment. A worst case scenario may be that failure to meet PFNZ targets results in loss of investment in the sanctuary movement, and associated reversal of local native biodiversity gains achieved in recent decades. Conversely, a successful PFNZ programme could potentially result in significant scaling up of sanctuaries and greater sustainability of those programmes, even if eradication is not achieved.

If the PFNZ targets are met, removal of predation and competition from rats, stoats, and possums will not only impact native species, but could also affect other introduced species. For example, mice might increase through competitor release, especially in mast seeding years in beech forests. Mice, particularly in the absence of other introduced mammals, are increasingly recognised to have a wide range of impacts on Aotearoa New Zealand ecosystems, as well as negative social and economic impacts. The removal of PFNZ's target species may also make cats a more prominent limiting factor for some native wildlife, which may generate renewed enthusiasm for control and therefore further controversy around companion animal management. Other unintended ecological effects may also take place, both positive and negative. There will always be an element of uncertainty in the outcomes of a major intervention such as species eradication. However, what is most important, as it is today for island eradications, is whether any new negative impacts outweigh the previous negative impacts which have been remediated.

Pursuing PFNZ would also require reconsidering how we go about biosecurity. Aotearoa New Zealand already has a strong pre-border biosecurity system for both agricultural and biodiversity pests. Incursions by vertebrate pests are only occasional, but do still occur. The target mammals of PFNZ are unlikely to be accidentally introduced today (although rats do still occur on a non-negligible proportion of ships entering Aotearoa New Zealand's ports),⁸⁵ but intentional introduction could still occur. Nonetheless, Aotearoa New Zealand is already well practiced in responding to incursions of these mammal species on its islands. Because the current pre-border biosecurity system is already 'fit for purpose', it may be that few changes are actually required in pre-border biosecurity, although stronger actions such as turning ships away at the border may become more frequent than they already are. Some level of post-border biosecurity for human movements within the country may still also be required, as eradication might not occur simultaneously across the country, and even after, some rats, such as the laboratory and pet rat (both strains of Norway rat) and kiore may remain in parts of the country.

The flow-on effects for native species management could also be complex and controversial. In particular, eradication of rats, stoats and possums would create increased demand for translocations of native species. The existing regulatory process for translocations involves two stages of proposals and extensive consultation that takes up to a year to approve a translocation of a single species to a single site. This process would need to be substantially modified to avoid it placing major limitations on restoration initiatives, but would simultaneously need to ensure translocations programmes are well considered and conform to international guidelines. There might also be uncertainty and conflict regarding the negative impacts of native species on other native species, such as bird impact on lizards and invertebrates. Native species, such as parrots, restored in abundance, might return to being pests on orchards and other cultivation. We may find that human-wildlife conflicts still exist, but are now oriented around the impacts of native biota. Indeed, the realization of PFNZ's goals may highlight social issues that have not yet been resolved and require further discussion. Future increased abundance of bird species in particular will open further potential opportunities for the customary harvest of mahinga kai species such as kererū. New conversations to bring together those who wish to see total protection of species, and those who support sustainable harvest of species, may need to take place.

Awareness of the limitations of PFNZ is also important. Introduced mammalian predators are a major threat to the native species and ecosystems of Aotearoa New Zealand, but they are by no means the only threat, and for some species and ecosystems other threats can be more important. Focusing on the outcomes for biodiversity in New Zealand thus requires situating PFNZ within a wider context. Other invasive species, such as cats and wasps, can be predators, and for some species ongoing habitat loss poses the primary threat.⁸⁶ The benefits of eradicating rats, mustelids, and possums will therefore not be equally spread across all of Aotearoa New Zealand's biodiversity, which makes PFNZ an implicit judgement on the value of some native species over others. Over the long term of PFNZ, new threats to native biodiversity such as climate change may intensify, and other unanticipated threats may emerge, all to be considered in the broader scope of a New Zealand biodiversity strategy.

⁸⁴ See Hunt and Campbell-Hunt (2013) for a good summary.

⁸⁵ 0.2-0.3% of ships entering New Zealand and Australia. See Brown et al. (2015).

⁸⁶ Ruffell and Didham (2017).

Once again, making Aotearoa New Zealand predator free is as much a social challenge as it is a biological challenge. Uncertainty, conflicts, and inadequate planning could hamper progress towards PFNZ, resulting in lost conservation opportunities and maybe even preventable disasters. While PFNZ has great potential to improve biodiversity outcomes, as well as economic, social, and other values that matter for New Zealanders, there are many alternative future scenarios that must be prepared for. Therefore, it is important that PFNZ continues to be incorporated in a broader national biodiversity strategy. For PFNZ, this means an essential step is clearly identifying the fundamental objectives, which will not only include biodiversity and environmental objectives, but also ethical and economic objectives along with the need to better realise the partnership intent of Te Tiriti.



Pacific gecko (*Dactylocnemis pacificus*) on Red Mercury Island, target of predator eradication in 1992 (Photo: James Russell)

8. Bibliography

- Anaya, J. (2004). *Indigenous peoples and international law*. Oxford: Oxford University Press.
- Bächtiger, A., Dryzek, J. S., Mansbridge, J. and Warren, M. E. (Eds.) (2018). *The Oxford handbook of deliberative democracy*. Oxford: Oxford University Press.
- Brown, K., Elliott, G., Innes, J., and Kemp, J. (2015). *Ship rat, stoat and possum control on mainland New Zealand: An overview of techniques, successes and challenges*. Wellington: Department of Conservation.
- Burns, B., Innes, J., and Day, T. (2012). The use and potential of pest-proof fencing for ecosystem restoration and fauna conservation in New Zealand. In M. J. Sommers and M. W. Hayward (Eds.), *Fencing for Conservation* (pp. 65–90). New York: Springer.
- Callicott, J. B. (1980). Animal liberation: A triangular affair. *Environmental Ethics* 2(4): 311–338.
- Callicott, J. B. (1989). *In defense of the land ethic: Essays in environmental philosophy*. Albany, USA: SUNY Press.
- Campbell, K. J., Beek, J., Eason, C. T., Glen, A. S., Godwin, J., Gould, F., Holmes, N. D., Howald, G. R., Madden, F. M., Ponder, J. B., Threadgill, D. W., Wegmann, A. S., and Baxter, G. S. (2015). The next generation of rodent eradications: Innovative technologies and tools to improve species specificity and increase their feasibility on islands. *Biological Conservation* 185: 47–58.
- Carolan, M. S. (2006). Science, expertise, and the democratization of the decision-making process. *Society and Natural Resources* 19(7): 661–668.
- Clements, K. (2015/1988). *Back from the brink: The creation of a nuclear-free New Zealand*. Wellington: Bridget Williams Books.
- Clout, M. N., and Russell, J. C. (2008). The invasion ecology of mammals: a global perspective. *Wildlife Research* 35(3): 180–184.
- Conceptual Framework Working Group of the Millennium Ecosystem Assessment (2003). *Ecosystems and human well-being: a framework for assessment*. Washington DC: Island Press.
- Craig, J., Anderson, S., Clout, M., Creese, B., Mitchell, N., Ogden, J., Roberts, M., and Ussher, G. (2000). Conservation issues in New Zealand. *Annual Review of Ecology and Systematics* 31(1): 61–78.
- Dearden, P. K., Gemmell, N. J., Mercier, O. R., Lester, P. J., Scott, M. J., Newcomb, R. D., Buckley, T. R., Jacobs, J. M. E., Goldson, S. G., and Penman, D. R. (2018). The potential for the use of gene drives for pest control in New Zealand: A perspective. *Journal of the Royal Society of New Zealand* 48(4): 225–244.
- Department of Conservation (DOC) (2016). New Zealand biodiversity action plan 2016–2020. Department of Conservation. <https://www.doc.govt.nz/nature/biodiversity/nz-biodiversity-strategy-and-action-plan/new-zealand-biodiversity-action-plan/>.
- Devall, B., and Sessions, G. (2015). Deep ecology. In L. P. Pojman, P. Pojman and K. Mcshane (Eds.), *Environmental ethics: Readings in theory and application* (pp. 157–161). Boston: Cengage Learning.
- Dubois, S., and Fraser, D. (2013). Rating harms to wildlife: A survey showing convergence between conservation and animal welfare views. *Animal Welfare* 22(1): 49–55.
- Eichelbaum, T., Fleming, J., Randerson, R., and Allan, J. (2001). *Report of the Royal Commission on Genetic Modification*. Wellington: Royal Commission on Genetic Modification.
- Ellis, E. (2016). Democracy as constraint and possibility for environmental action. In T. Gabrielson, C. Hall, J. M. Meyer and D. Schlosberg (Eds.), *The Oxford handbook of environmental political theory* (pp. 505–519). Oxford: Oxford University Press.
- Figueres, C., Schellnhuber, H. J., Whiteman, G., Rockstrom, J., Hobley, A., and Rahmstorf, S. (2017). Three years to safeguard our climate. *Nature* 546(7660): 593–595.
- Fisher, P. (2017). Animal welfare and Predator Free New Zealand. *Welfare Pulse* 22: 10–11.
- Freya, M. (2012). The anguish of wildlife ethics. *New Formations* 76(76): 114–131.
- Fung, A. and Warren, M. E. (2011). The participedia project: An introduction. *International Public Management Journal* 14:3, 341–362.
- Green, W. and Rohan, M. (2012). Opposition to aerial 1080 poisoning for control of invasive mammals in New Zealand: risk perceptions and agency responses. *Journal of the Royal Society of New Zealand* 42(3), 185–213.
- Hart, P. S., and Nisbet, E. C. (2012). Boomerang effects in science communication: How motivated reasoning and identity cues amplify opinion polarization about climate mitigation policies. *Communication Research* 39(6): 701–723.
- Havemann, P. (2003). Genetic modification, ecological good governance and the law: New Zealand in the age of risk. *James Cook University Law Review* 10: 7–50.

- Hayward, A. (2005). The Hazardous Substances and New Organisms Act, precaution, and the regulation of GMOs in New Zealand. *New Zealand Journal of Environmental Law* 9: 123–162.
- Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., van Winkel, D., and Rolfe, J. (2015). Conservation status of New Zealand reptiles, 2015. New Zealand Threat Classification Series 17. Wellington: Department of Conservation.
- Hudson, M., Mead, A. T. P., Chagne, D., Roskruge, N., Morrison, S., Wilcox, P. L., and Allan, A. C. (2019). Indigenous perspectives and gene editing in Aotearoa New Zealand. *Frontiers in Bioengineering and Biotechnology* 7: 70.
- Hunt, D., and Campbell-Hunt, C. (2013). *Ecosanctuaries: Communities building a future for New Zealand's threatened ecologies*. Dunedin: Otago University Press.
- Hutchins, M. (2008). Animal rights and conservation. *Conservation Biology* 22(4): 815–816.
- International Union for Conservation of Nature (IUCN). (2016). The Hawai'i commitments. Gland, Switzerland: International Union for Conservation of Nature. <https://portals.iucn.org/congress/hawaii-commitments>
- Jamieson, D. (1998). Animal liberation is an environmental ethic. *Environmental Values* 7(1): 41–57.
- Jones, C. J., and McGlinchy A. (2016). Costs of control of vertebrate predators by New Zealand regional and national agencies: July 2010–June 2015 (Report No. LC2658). Auckland: Manaaki Whenua – Landcare Research.
- Katz, E. (1983). Is there a place for animals in the moral consideration of nature? *Ethics and Animals* 4(3): 74–87.
- Kawharu, I. H. (1989). Mana and the Crown: a marae at Orakei. In I. H. Kawharu (Ed.), *Waitangi: Māori and Pakeha perspectives of the Treaty of Waitangi* (pp. 211–233). Auckland: Oxford University Press.
- Kawharu, I. H. (1997). *Māori land tenure: Studies of a changing institution*. Oxford: Clarendon Press.
- Kawharu, M. (2000). Kaitiakitanga: A Māori anthropological perspective of the Māori socioenvironmental ethic of resource management. *Journal of the Polynesian Society* 110(4): 349–370.
- Kawharu, M. (2010). Environment as marae locale. In R. Selby, P. Moore & M. Mulholland (Eds.), *Māori and the environment: Kaitiaki* (pp. 221–239). Wellington: Huia Books.
- Kawharu, M. (Ed.). (2014). *Maranga Mai! Te Reo and marae in crisis?* Auckland: Auckland University Press.
- Lackey, R. T. (2002). Appropriate use of ecosystem health and normative science in ecological policy. In D. J. Rapport, W. J. Lasley, D. E. Rolston, N. O. Nielsen, C. O. Qualset and A. B. Damania (Eds.), *Managing for healthy ecosystems* (pp. 175–186). Boca Raton: Lewis Publishers.
- Lange, D. (1990). *Nuclear free: The New Zealand way*. Auckland: Penguin Books.
- Linklater, W., and Steer, J. (2018). Predator Free 2050: A flawed conservation policy displaces higher priorities and better, evidence-based alternatives. *Conservation Letters* 11(6): e12593.
- Locke, J. (2016). *Second treatise of government and a letter concerning toleration*. Oxford: Oxford University Press.
- Maclaurin, J. and Sterelny, K. (2008). *What is biodiversity?* Chicago: University of Chicago Press.
- Mark, A. F., Turner, K. S., and West, C. J. (2001). Integrating nature conservation with hydro-electric development: conflict resolution with Lakes Manapouri and Te Anau, Fiordland National Park, New Zealand. *Lake and Reservoir Management* 17(1): 1–25.
- Marsden, M. (2003a). The natural world and natural resources: Māori value systems and perspectives. In C. Royal (Ed.), *The woven universe* (pp. 24–53). Ōtaki: Estate of Rev. Māori Marsden.
- Marsden, Rev. M. (2003b). The achievement of authentic being: God, man and universe, a Māori view. In C. Royal (Ed.), *The woven universe* (pp. 2–23). Ōtaki: Estate of Rev. Māori Marsden
- Marsden, Rev. M., & Henare T. A. (1992). *Kaitiakitanga: A definitive introduction to the holistic worldview of the Māori*. Unpublished paper.
- Mathews, F. (2012). The anguish of wildlife ethics. *New Formations* 76(76): 114–131.
- Matike Mai Aotearoa. (2016). He Whakaaro Here Whakaumu Mō Aotearoa: The Report of Matike Mai Aotearoa – The Independent Working Group on Constitutional Transformation. <http://www.converge.org.nz/pma/MatikeMaiAotearoaReport.pdf>
- McGregor, D. (2009) Honouring our relations: An Anishnaabe perspective. In J. Agyeman, P. Cole, R. Haluza-DeLay and P. O'Riley (Eds.), *Speaking for ourselves: Environmental justice in Canada* (pp. 27–41). Vancouver: UBC Press.
- Mead, H. M. (2003). *Tikanga Māori: Living by Māori values*. Wellington: Huia.
- Merino, R. (2016). An alternative to 'alternative development'? Buen vivir and human development in Andean countries. *Oxford Development Studies* 44(3): 271–286.

- Michie, S., Van Stralen, M. M. and West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science* 6(1): 42.
- Morton, J., Ogden, J., Hughes, T., and Macdonald, I. (1984). *To save a forest: Whirinaki*. Auckland: David Bateman for The Whirinaki Forest Promotion Trust.
- Mutu, M. (2018). Behind the smoke and mirrors of the Treaty of Waitangi claims settlement process in New Zealand: No prospect for justice and reconciliation for Māori without constitutional transformation. *Journal of Global Ethics* 14(2): 208–221.
- Mutu, M., and McCully, M. (2003). *Te Whanau Moana i Nga Kaupapa me Nga Tikanga: Customs and Protocols [The Customs and Protocols of Te Whanau Moana]*. Auckland: Reed.
- Naess, A. (2015). Ecosophy T: Deep versus shallow ecology. In L. P. Pojman, P. Pojman and K. Mcshane (Eds.), *Environmental ethics: Readings in theory and application* (pp. 150–157). Boston: Cengage Learning.
- New Zealand Law Commission (NZLC) (2002). Liability for loss resulting from the development, supply or use of genetically modified organisms. NZLC Special Report 14. Wellington: New Zealand Law Commission.
- Newhook, F. J. (1969). Coppermine Island and conservation. *Biological Conservation* 1(4): 313–317.
- Nimmo-Bell. (2009). Economic costs of pests to New Zealand (Report No. 2009/31). Auckland: Ministry of Agriculture and Forestry Biosecurity.
- Oldham, O. (2017). If Māori speak in a forum that doesn't have ears, have they spoken at all? A critical analysis of Māori consultation processes in decisions on GMO trials. Unpublished Honours paper written for LAWS 489, Victoria University of Wellington.
- Olson, M. (1965). *The logic of collective action: Public goods and the theory of groups*. Cambridge: Harvard University Press.
- Parliamentary Commissioner of the Environment (PCE) (2017). *Taonga of an island nation: Saving New Zealand's birds*. Wellington: Parliamentary Commissioner of the Environment.
- Parsons, R., and Moffat, K. (2014). Constructing the meaning of social licence. *Social Epistemology* 28(3–4): 340–363.
- Paquet, P. C., and Darimont, C. T. (2010). Wildlife conservation and animal welfare: Two sides of the same coin. *Animal Welfare* 19(2): 177–190.
- Parke, E. C., and Russell, J. C. (2018). Ethical responsibilities in invasion biology. *The Ecological Citizen* 2(1): 17–19.
- Parkes, J. P., Nugent, G., Forsyth, D. M., Byrom, A. E., Pech, R. P., Warburton, B., and Choquenot, D. (2017). Past, present and two potential futures for managing New Zealand's mammalian pests. *New Zealand Journal of Ecology* 41(1): 151–161.
- Parliamentary Commissioner for the Environment (2011). *Evaluating the use of 1080: Predators, poisons and silent forests*. Wellington: Parliamentary Commissioner for the Environment.
- Rahman, K. S. (2017). *Democracy against domination*. Oxford: Oxford University Press.
- Regan, T. (1987). The case for animal rights. In M. W. Fox and L. D. Mickley (Eds.), *Advances in animal welfare science* (pp. 179–189). Dordrecht: Springer.
- Regan, T. (2012). Animal rights and environmental ethics. In D. Bergandi (Eds.), *The structural links between ecology, evolution and ethics* (pp. 117–126). Dordrecht: Springer.
- Royal Society of New Zealand (RSNZ) (2017). The use of gene editing in pest control. Discussion paper. Wellington: Royal Society of New Zealand. <https://royalsociety.org.nz/what-we-do/our-expert-advice/all-expert-advice-papers/gene-editing-for-pest-control/>
- Ruffell, J., and Didham, R. K. (2017). Conserving biodiversity in New Zealand's lowland landscapes: does forest cover or pest control have a greater effect on native birds? *New Zealand Journal of Ecology* 41(1): 23–33.
- Ruru, J., Lyver, P. O'B., Scott, N., and Edmunds, D. (2017). Reversing the decline in New Zealand's biodiversity: Empowering Māori within reformed conservation law. *Policy Quarterly* 13(2): 65–71.
- Russell, J. C., Innes, J. G., Brown, P. H., and Byrom, A. E. (2015). Predator-free New Zealand: conservation country. *BioScience* 65(5): 520–525.
- Sadler, H. (2007). Mātauranga Māori (Māori epistemology). *International Journal of the Humanities* 4(10): 33–45.
- Sagoff, M. (1984). Animal liberation and environmental ethics: Bad marriage, quick divorce. *Osgoode Hall Law Journal* 22(2): 297–307.
- Schultz, P. W. (2011). Conservation means behavior. *Conservation Biology* 25(6): 1080–1083.
- Skocpol, T. (2003). *Diminished democracy: from membership to management in American civic life*. Norman: University of Oklahoma Press.
- Skocpol, T. and Fiorina, M. P. (Eds.) (1999). *Civic engagement in American democracy*. Washington, DC: Brookings Institution.
- Singer, P. (1995). *Animal liberation* (2nd ed.). London: Pimlico.

- Sobrevila, C. (2008). *The role of indigenous peoples in biodiversity conservation: The natural but often forgotten partners*. Washington DC: The World Bank.
- Steffen, W., Richardson, K., Rockstrom, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., and Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science* 347(6223): 1259855.
- Terry, S., Simon Terry Associates, and Chen Palmer & Partners (2001). *Who bears the risk? Genetic modification and liability*. Wellington: Chen Palmer & Partners, Simon Terry Associates.
- Te Momo, O. H. (2007). Biotechnology: The language of multiple views in Māori communities. *Biotechnology Journal* 2: 1179-1183
- Te Wehi (1874). Letter to the editor. *Te Waka Māori o Niu Tirenī* 10(19): 239-240.
- Tohikura, H. (1873). Ki a te kaituhi o te Waka Maori (Letter to the editor). *Te Waka Maori o Niu Tirenī* 9(6): 45.
- United Nations (1992). *Convention on biological diversity*. <https://www.cbd.int/convention/text/>
- United Nations (2010). The strategic plan for biodiversity 2011-2020 and the Aichi biodiversity targets. New York: United Nations. <http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf>
- United Nations Educational, Scientific and Cultural Organization (UNESCO) (1992). The Rio Declaration on Environment and Development. UNESCO. http://www.unesco.org/education/pdf/RIO_E.PDF
- United Nations Permanent Forum for Indigenous Issues (UNPFII) (2007). *United Nations Declaration on the Rights of Indigenous Peoples*. <http://www.un.org/esa/socdev/unpfii/en/drip.html>
- Varner, G. (2003). Can animal rights activists be environmentalists? In S. J. Armstrong and R. G. Botzler (Eds.), *The Animal Ethics Reader* (pp. 410-421).
- Veltman, C. J., and Westbrooke, I. M. (2011). Forest bird mortality and baiting practices in New Zealand aerial 1080 operations from 1986 to 2009. *New Zealand Journal of Ecology* 35(1): 21-29.
- Waitangi Tribunal (2011a). Ko Aotearoa Tēnei: a report into claims concerning New Zealand law and policy affecting Māori culture and identity. Te taumata tuatahi. Wai 262. Wellington: Legislation Direct.
- Waitangi Tribunal (2011b). Ko Aotearoa Tēnei: a report into claims concerning New Zealand law and policy affecting Māori culture and identity. Te taumata tuarua. Wai 262. Wellington: Legislation Direct.
- Watene, K. (2013). Indigenous visions for sustainable development law? Continuing the conversation. In K. Bosselmann, D. Grinlinton and P. Taylor (Eds.), *Environmental law for a sustainable society*, NZCEL Monograph Series, Vol. 1 (2nd ed.).
- Watene, K. (2016). Valuing nature: Māori values and the capability approach. *Oxford Development Studies* 44(3): 287-296.
- Wehi, P. M., Cox, M. P., Roa, T., and Whaanga, H. (2018). Human perceptions of megafaunal extinction events revealed by linguistic analysis of indigenous oral traditions. *Human Ecology* 46(4): 461-470.
- Whyte, K. (2013). Justice forward: Tribes, climate adaptation and responsibility. *Climatic Change* 120(3): 517-530.

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