Positioning Research to Improve Tree-Biosecurity Relations

Alison Greenaway
greenawaya@landcareresearch.co.nz
Manaaki Whenua|Landcare Research
Aotearoa|New Zealand
Sara MacBride-Stewart
Macbride-StewartS@cardiff.ac.uk
Prifysgol Caerdydd|Cardiff University
Cymru|Wales
Andrea Grant
andrea.grant@scionresearch.com
SCION Research
Aotearoa|New Zealand
Susanna Finlay-Smits
Susanna.Finlay-Smits@agresearch.co.nz
AgResearch
Aotearoa|New Zealand
Maria Ayala
maria.ayala@pg.canterbury.ac.nz
University of Canterbury,
Te Whare Wānanga o Waitaha
Aotearoa|New Zealand
Will Allen
willallennz@gmail.com
Learning for Sustainability
Aotearoa|New Zealand
Liz O'Brien
liz.obrien@forestresearch.gov.uk
Forest Research
United Kingdom
Michael Martin
michael.martin@auckland.ac.nz
School of Environment,
Waipapa Taumata Rau|University of Auckland
Aotearoa|New Zealand

ABSTRACT. Management of biosecurity threats to forests and indigenous trees needs to address the legacy of colonising practices that have prohibited diverse knowledges from being included. This work is urgent and challenging in the context of mobile tree

pathogens, investment in climate mitigation through tree planting and greater legal recognition of Indigenous rights and those of trees. While a transition towards shared, collective responsibility for trees and treescapes is compelling, its conceptualisation in practice remains underdeveloped. This is particularly the case when considering tree-biosecurity relations. This paper shows the positioning work a team of social scientists undertook to enable polyvocal imagining of biosecurity possibilities, which trees so urgently need. Situated in Aotearoa|New Zealand and Cymru|Wales, this team of social scientists engaged with colonising forces (of which social science is also a part) to position research for biosecurity and with trees. Presented here are their reflections informed by literature and document reviews as well as research team discussions. Released somewhat from the constraints of displaced ways of knowing human dimensions of trees by means of connecting with Indigenous (especially Māori) scholarship, the research project became more capable of connecting other relations too, between people and nature, knowledge and action, science and society, research and management. The relational approach developed widens the potential for tree-human relations and supports the creation of biosecurity knowledge, systems and practices, not through one but multiple worldviews.

Introduction

At the turn of the millennium, the Food and Agriculture Organisation of the United Nations (FAO, 2007) began to work with an understanding of biosecurity as a strategic and integrated approach to minimise risks to human, animal and plant life, along with risks to the wider environment. Despite a further 15 years of effort, biosecurity capabilities required for working with multiple intersecting values and diverse science practices are still underdeveloped (Barker & Francis, 2021). Indigenous approaches to tree care present wider possibilities for biosecurity practices and discourses. There is now an appreciation of the co-benefits for human health, particularly when trees themselves are well and healthy (Harcourt et al., 2021; Hill et al., 2020). However, the influence of Indigenous knowledges remains constrained. A narrow set of relations with trees prevail, giving more attention to forms of life than ways of life (Marzano et al., 2017; Tsouvalis, 2019). The methodological choices researchers make are part of the problem, often embedding distorted social relations with trees (Dyke, 2018). Here this challenge is addressed. The authors present the choices they made about the terms, concepts and methods they would engage with as a group of biosecurity researchers.

Critically positioning research is an important step in the process of planning for research impact (Maclean, 2022; Muhammad et al., 2015). It has the potential

to reconnect tree-human relations both in place and conceptually. The positioning work addressed in this paper was undertaken at a time when relational approaches were gaining attention through the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) policy-making setting (Díaz, 2015). While human dimensions of forest health had been formally acknowledged, work with relational values through IPBES was still limited (Pereira et al., 2020a, 2020b). Social research into biosecurity had typically only been funded for one-way behaviour change, policy socialisation and communication strategies to convince or alter audiences rather than listen to their feedback (Ministry of Agriculture and Forestry, 2007, 2009). Behavioural change focuses responsibilities on individual actions and typically avoids the kind of cultural legacies and responsibilities (Diprose et al., 2022) being addressed through the Mobilising for Action programme of research outlined in this special issue.[1]

Being non-Māori researchers with a justice orientation, the authors recognised the need for reflexive, participatory and critical approaches to examine cultural assumptions shaping current biosecurity practices (this focus on practices is partially informed by Shove, 2010). Engaging the identity of 'non-Indigenous' reflexively and productively, their work opened dialogue about possible tree-biosecurity relations (a need signalled by Head & Atchison, 2009; Healy, 2006). For some, this meant a rejection of researcher objectivity as an epistemology (Haraway, 2017). For others, it reaffirmed their epistemological stance as action researchers (Kemmis, 2019). Networked across several related programmes, the authors acknowledged that (while hard to capture in reporting practices) work such as this develops individually through the mix of initiatives, topics and places in which they are involved.

Uniquely situated across Aotearoa|New Zealand and Cymru|Wales, this group of social scientists were invited[2] to connect with Indigenous Māori scholarship and biophysical research for iconic trees in Aotearoa|New Zealand. They assessed, through literature and document reviews and – most significantly – group reflection, the values and practices underpinning biosecurity and how these shape relations between people and trees. The group used the process of writing this paper[3] to explore conceptually and in practice (partly informed by Kemmis, 2009) the paradox that research can, at the same time, both create potential solutions for tree health and generate the relationships and conditions that prevent tree health. A methodology for a 3-year project was then developed to identify practices caring for and with trees in both Aotearoa|New Zealand and Cymru|Wales (see 'Healing Fragmentation of Forest Biosecurity Networks: A Conceptual and Reflexive Mapping Analysis of Postcolonial Relations that Matter in Aotearoa and Wales' in this issue of *Knowledge Cultures* by MacBride-Stewart et al. for initial findings of this research). Additionally, a reflection tool and process were designed to support groups involved with biosecurity as they reflect on and reframe social relations for biosecurity. This paper solely outlines the knowledge space the authors have

positioned their work in; additional papers elaborate on the resulting methodology, findings and contributions of the 3-year project.

Exploring the Relationality with Biosecurity Is Important for Trees

Exploring relationality is a practice bound with responsibilities to others and our own practices. This paper provides a situated illustration of this understanding. Tynan (2021) explores what the current turn towards relational thinking means for Indigenous knowledges when, as she states, Indigenous knowledge *is already* a relation. Exploring the rationality of biosecurity helps to move beyond a portrayal of biosecurity as actions taken to protect one place or as belonging to one type of knowledge or practice (Malpas, 2012). Informing an understanding of biosecurity as relational, Tynan (2021) emphasises three considerations. First, it is important not to tie down relationality as a concept because it belongs with what is learnt in the processes of forming relationships. Second, relationality matters in Indigenous thinking when what is at stake 'is a present and future out of balance,' in part because everything is in relation and therefore cannot be separated from the kind of singular threats to tree health that traditional biosecurity is trying to address.

As with most explorations of values, taking a relational approach to biosecurity is messy (Kenter et al., 2019; Saxena et al., 2018). Caution is required in efforts to cohesively represent biosecurity's complex interdependencies and values (Healy, 2011; West et al., 2020). Relational values connect people and places (Chan et al., 2016), and their representation impacts these connections. Through the exploration of human-nature relational values, research is also being positioned with respect to te ao Māori (Māori worldviews) (Bataille et al., 2021). In what follows, the authors situate their inquiry to usefully connect with pluralistic 'knowings and doings' of biosecurity for biodiversity. Contributions of research to biosecurity through value-making and colonising practices are addressed. The paper concludes by pointing to opportunities for science-society relationships to contribute to decolonising biosecurity.

Positioning Research in Relationship with Trees Requires Reflection, Reframing, Relating and Re-Presenting

As Smith et al. (2016) and Maclean et al. (2021) show, reframing research methods, findings and impacts is central to decolonising methodologies. So, the decolonisation of biosecurity for trees requires social sciences to contribute more than detached descriptive acts; a methodology is required that enlivens biosecurity concepts, relationships and practices. Helping those involved with biosecurity to reflect on and reframe their situated relations with trees and pathogens is one of the significant contributions of social science and this paper.

As a group of non-Māori researchers (non-Indigenous to Aotearoa|New Zealand), the authors have attempted to work deeply with the concept of positionality. This academic concept (the topic of much Feminist-, Pacific- and Majority World-inspired scholarship addressing knowledge and power) helps researchers to identify or reposition themselves in power dynamics towards more

just, emancipatory ways of being (Fasavalu et al., 2019; Maclean et al., 2022; Merriam et al., 2001; Muhammad et al., 2015). From this positionality, questions about the limited values guiding biosecurity and care for and with trees were able to be articulated (informed by de la Bellacasa, 2012; Haraway, 2017). Concerns, invitations and relational frames offered through Indigenous leadership were also able to be centred (Greenaway et al., 2021).

To achieve better environmental outcomes and increase Māori contributions to biosecurity, Te Tira Whakamātaki (TTW, the Māori Biosecurity Network) was created in 2016 by Māori biosecurity experts (Black et al., 2019). TTW is raising the profile of Māori communities within biosecurity responses, from active engagement in the early stages of ground surveillance and research design to later phases of data-sharing, hapū-led informed decisions and the ability to influence policy-making. The Biological Heritage National Science Challenge (from here on the Challenge), through a close relationship with TTW, created the Ngā Rakau Taketake programme – saving iconic trees. A waka hourua approach was adopted for co-producing knowledge through the Mobilising for Action programme of the Challenge.[4] The waka hourua approach presents a double-hulled sailing vessel as a guiding metaphor and relational framework for thinking about and planning for the relations of science and mātauranga (this approach is detailed in Harcourt et al., 2021; Rata et al., 2012; and adapted in Maxwell et al., 2020). A direct impact of this relational organising frame[5] is the opportunity for large research programmes to design approaches more transparently for navigating the power asymmetries shaping their contexts.

Core to much of the research being undertaken through the te ao Māori side of the waka hourua was a whakapapa relational approach. A complex and refined system of relations between humans and non-humans, Māori and non-Māori, knowledge and action, the physical and the metaphysical is presented and enlivened through whakapapa scholarship (Roberts, 2013; Salmond et al., 2014; Walters & Ruwhiu, 2021; Wolfgramm et al., 2020). As Forster (2019) indicates, whakapapa (the making of genealogical accounts) is a powerful tool that helps explain new phenomena. Non-Māori social researchers involved with the Mobilising for Action programme were encouraged by Challenge leadership to explore the relational values mixed up with kauri dieback (*Phytophthora agathidicida*) and myrtle rust (*Austropuccinia psidii*).

While there were threads of relationships across these social researchers, this was the first time this grouping worked together. They came together because of professional and organisational relations with previous science for biodiversity and biosecurity initiatives. They had old and new threads of connection to Aotearoa|New Zealand, the UK and Europe, as well as to each other. The authors were also associated with different universities and scientific research institutions in Aotearoa|New Zealand, based in Tāmaki Makaurau (Auckland), Ōtautahi (Christchurch), Caerdydd/Cardiff (Cymru|Wales) and Surrey (England). They brought experiences working at the interfaces of research and policy-making for

biosecurity and biodiversity. There were established kauri and pōhutukawa trees where one author resides; another was raising kauri seedlings. For others, kauri had only been briefly glimpsed. Myrtles were, for some, a fond memory from the past or a connection to places now quite distant.

The authors drew on their interdisciplinary social science perspectives, including multi-stakeholder engagement, participatory action research, geography, sociology, anthropology, organisational change, forest health and cultural values. A few of the authors were aiming for transdisciplinarity: to be guided by participants and each other as much as by their own theories of choice. Some were seeking to become allies to Māori collaborators (Margaret, 2010), engaging with te ao Māori and supporting mātauranga initiatives shaping biosecurity and biodiversity systems.

The research team met monthly (online) to review literature, learn about each other's ways of working, learn about Nga Rākau Taketake, identify opportunities for connecting with science-society networks, write together and explore how to situate the research in these contexts as they were learning more about them. Over the first ten months that they met, read and analysed, policies and programmes were developed shaping the wellbeing of trees in the short and long term, both in Cymru|Wales and Aotearoa|New Zealand. For example, collaborative social science–science spaces have opened in Cymru|Wales due to the co-location of the university and government, as well as the Wellbeing for Future Generations Act (Wales) and its related legislation, the Environment (Wales) Act. In Cymru|Wales, the first Ministers for Climate Change were appointed, and a National Forest for Wales strategy was launched. Similar initiatives were happening in Aotearoa|New Zealand. Our attention also turned to a review of the Research Science and Innovation system, opening opportunities for Tiriti-led science investment (Ministry of Business Innovation and Employment, 2022). A review of the Biosecurity Act (1993) was also initiated. Recognising they were part of wider transformation processes, the authors chose to be reflective about their research contributions and what impacts might be possible in this context.

The section below outlines the approaches the authors took to position a 3-year research project (2021–2023) aimed at mobilising care for trees. First, they engaged with the relational frame of the waka hourua; then, they identified the legacies of colonialism shaping biosecurity in Aotearoa and Cymru|Wales. From this deliberation, a methodology was created which enables further deliberation of team visions, processes and perspectives such that more generative approaches to tree care might be enabled through biosecurity.

A Knowledge Space and Practice to Regenerate Tree-Biosecurity Relations
From a milieu of context, concepts and practices, a collaborative, polyvocal knowledge-action practice is emerging for more careful tree-biosecurity relations, depicted in Figure 1. From this setting, the authors (depicted in an online meeting on a laptop) identified that a more elaborate lexicon for biosecurity is required to help make the social relations of trees more visible. There are indications that

expressions of care for and with trees, treescapes and attention to micro-moments (of authority and negotiation) within everyday practices provide opportunities for reworking tree-biosecurity relations (top right corner of Fig. 1.). Narratives of nature valued as a resource, to pathogens as invaders, to the fragmented nature of biosecurity (also illustrated in Fig. 2) provide entry points for social science contributions for biosecurity. Biosecurity narratives in Aotearoa|New Zealand and Cymru|Wales, while very different, were connected through some similar pathogens, science techniques and tree planting narratives, as well as net zero carbon and local economic development (including tourism) rationales (the flora images and text boxes in the middle of Fig. 1). Finally, the processes shown on the bottom and bottom right of the figure present capabilities for knowingly doing biosecurity that is attentive to its colonial legacies. These capabilities are discussed below and are synthesised in Table 1.

Figure 1

Regenerating tree-biosecurity relations
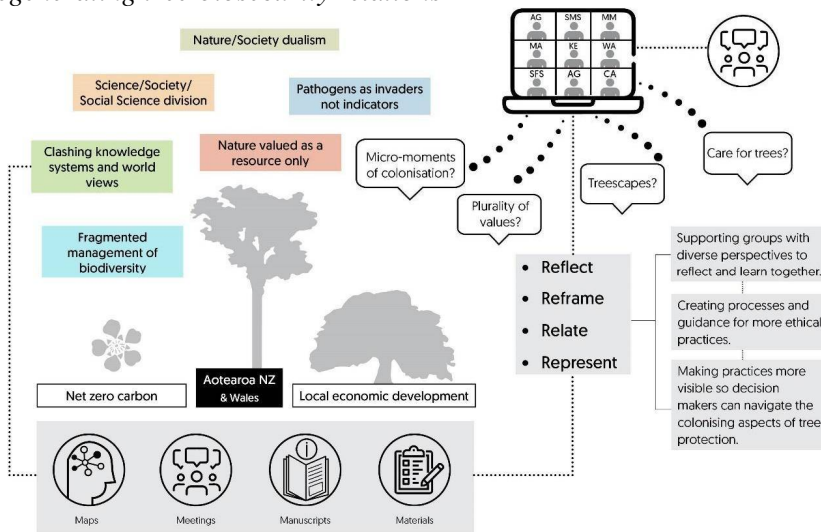
Note. Diagram showing a knowledge space and practice for regenerating tree-biosecurity relations. Copyright 2023 by the authors.

Deliberation about power asymmetries, systemic trauma and the colonising practices of science policy was mixed with discussions about how research methods enact these politics (see Agnew et al., 2008; Braun et al., 2010; Greenaway et al., 2021). While methods themselves can address biases, the choice and prioritising of methods and broader methodological developments are influenced by scientific cultures and systems of validation and legitimation. A collective (if somewhat fragile) understanding is forming across the Challenge of methodologies as knowledge-action capabilities. Some of the authors found that talking about methods liberated and deepened their knowledge production, growing more effective attention to ethics and impacts (Barnes et al., 2007).

240

This ontological-epistemological (knowingly doing) work of social science provided opportunities for robust contributions to public conversations and culture shifts, caring not only about but for and with trees (and cognisant of the legacies and ongoing trauma of colonisation). One year into a 3-year research project, the work of this research group offers practices of reflection, reframing, relating and re-presenting relationships to help build the capability trees require to co-constitute biosecurity for wellbeing. Further research (2022–2023) will show how these capabilities are developing, and what is enabled and constrained through them.

Table 1

Capabilities regenerating tree-biosecurity relations

		Capabilities regenerating tree-biosecurity relations: for researchers and their collaborators knowingly doing biosecurity attentive to its colonial legacies.
Reflect	*Creation of relational frames and attention to relationality*	The researchers worked with analogies and models that emphasise relationships between elements and not just the elements themselves. Relationships are not just human to human; it was critical to consider inter-relationships between the human and non-human plus non-humans with non-humans.
Reframe	*World-making through talk about methods*	They created ways of working by talking through methods before committing to them. Discussions about the genealogy of research methods as they were adopted enabled the group to assess appropriateness, constraints and opportunities. The aim was to make these more visible to all involved; while it sometimes created confusion, it helped overall.
Relate	*Working with the ethics and politics of relationships*	The group has been working in their various organisations and through research networks to mandate consideration of the knowledge politics shaping biodiversity.
Re-present	*Strengthening reflexive, participatory and critical thinking practices*	All the above practices include an element of critical reflection that acknowledges the privileges and limitations that affect how people understand trees and their pathogens and how this shapes their actions for trees. Recognition of this helps to find more productive ways of connecting across perspectives and organisations.
	Transforming everyday practices	Change will happen in diverse ways; attention to micro-moments and everyday practices helped make change processes more visible; relations are being enacted and re-created every day.

Note. Table showing capabilities regenerating tree-biosecurity relations: knowingly doing biosecurity attentive to its colonial legacies. Copyright 2023 by the authors.

Working with Biosecurity as a Value-Laden Social Phenomenon

Social science visioning of biosecurity as a set of interrelated practices and as a contested idea creates opportunities to show how biosecurity emerges in the context of diverse values (Barker & Francis, 2021). The following situates the research in relationships between Aotearoa|New Zealand and the United Kingdom (UK), in a legacy of constrained and contested conceptions of the social relations of trees, and at a time when Māori leadership and knowledge are reshaping biosecurity operations and science. From this setting, the authors could observe how different values (about and for trees) were shaping the focus and function of biosecurity. The authors also acknowledged that science was at this time being challenged, redesigned and relitigated by new plant pathogens and through complex relations with other ecologies (e.g., freshwater and marine) and other biosecurity concerns (e.g., Coronavirus).

Several authors (e.g., Baldwin & Erickson, 2020; Liboiron, 2021; Whyte, 2017) start from the position that environmental degradation and disruption are a form and product of colonialism. Through this understanding, science is implicated in the related marginalisation of Indigenous (and local) knowledge systems (Watene, 2016). Value systems mobilised in the process of characterising threats (including the identification of who or what creates risk) and in biosecurity mechanisms used for protection (including who or what knowledge is mobilised) largely prioritise measurable, generalisable and universal values and predictable actions over others (Borell et al., 2019; Maclean et al. 2022; Smith et al., 2016). While theorists like Haraway (2018) make the point that value systems are often not *knowingly* mobilised in science practices, theorists who look at the dynamics of societal relationships with science and technology assert that social and environmental values underpin beliefs about how to mobilise human behaviours and which behaviours can or should be mobilised over others (Ihemezie et al., 2021; Jones et al., 2016). Indigenous knowledges are often dismissed as value-laden, yet western sciences are equally value-laden – as are attempts to distinguish one knowledge system from the other. Indigenous knowledges are also ripe with the spiritual, ethical and ecological values tree-biosecurity relations require (de Sousa Santos, 2007; Hikuroa et al., 2011; Lambert et al., 2018). A false dichotomy is often perpetuated, assuming Indigenous knowledge is value-laden and specific, and scientific knowledge is neutral, objective, generalisable and actionable.

Scholars working on decolonisation and identifying colonial legacies urge us to think (and work) differently with these complex knowledge-value-action relationships. For biosecurity, this means paying attention to the multiple values that inform knowledge about trees and pathogens and finding ways to work with potentially conflicting biosecurity goals (Harding, 2009). Focusing on the processes and relationships of knowledge that shape understandings of trees involves noticing what values are enacted in the relations between science, policy and practice and where and when colonising processes exclude or make 'others.' Dialogic approaches invite examination of who benefits, e.g., the science,

ecological system, non-Indigenous and/or Indigenous communities, governments or citizens (Funtowicz & Ravetz, 1993; Healy, 2006). Positioned from these perspectives, the following provides a process for navigating tree values and scientific knowledges, offering an agenda for enacting a more polyvocal biosecurity, i.e., open to multiple voices and values, and cognisant of the politics that shape relationships between them.

Moral and Ethical Challenges of Doing Research for Biosecurity and with Trees

There is evidence of an expanding coda of biosecurity threats resulting from the official and unofficial transport of non-native invasive species of plants and animals along the routes of colonisers and travellers, and the emergence of novel pathogens resulting from global processes of climate change (IPCC, 2022; Pörtner, 2021; Tsing et al., 2020). Much scholarship (generated through interconnected social science, science and Indigenous research pathways) reveals colonial and capitalist thinking (represented in discourses that practise dominion over nature and other humans), shaping acceptance that this global movement of goods, people and resources, and the use of nature to support societal progress across the globe, are inevitable (Foster et al., 2011; Hagan & Grove, 1999). Furthermore, Dove (2006) argues that the social sciences are not only an observer of colonising approaches. Social science methods and ideologies, when used naively to articulate Indigenous perspectives, can reproduce the values of the coloniser rather than the colonised. To contribute to new thinking for biosecurity, these moral and ethical challenges also need to be addressed. These concerns are explained in more depth below.

Conventionally, biosecurity has developed as a means of maintaining value and reducing risk to nation-state productivity and natural assets; through this legacy, biosecurity is tied to processes of colonisation – extraction, trade and globalisation – that have fuelled capitalism and a growth-oriented economy. Biosecurity practices are also part of the social contract many nation-states have established to protect human livelihoods and biodiversity, and these practices can reinforce colonialism and protectionism (Blair, 2017). Somewhere between mainstreaming protectionist biosecurity practices and the extraction of natural resources, there is a fine balance. Cooper et al. (2016) suggests this exists when Indigenous perspectives are mobilised as part of a historically situated social contract that protects nature through frameworks of aggregated rights and responsibilities. Using the related concept of indigeneity, the goal is to realise the potential for biosecurity to be informed by an array of human-non-human conceptualisations, including those that seek to protect trees.

Interest in indigeneity and Indigenous systems of knowledge and management (Dove, 2006, p. 193) emerged initially in questions about forest' assets' and concerns over the loss of 'localised systems of resource use under totalising systems of modernity' for Indigenous communities. There was a recognised need for polyvocality and disagreement (Dove, 2006), prompted by science and

Indigenous management initiatives in the global politics of biodiversity decline, in general, and the significance of protecting plants with cultural or spiritual value, in particular. Advocates for the assignment of cultural management roles and responsibilities to Indigenous communities argued that these should be commensurate with other existing land rights and arrangements (Lambert et al., 2018).

The growing field of science–society relations has since reported extensively on the capacity for such arrangements to reflect environmental 'disinterest' by communities where aesthetic or cultural value is separated from utilitarian ('asset') values (Cooper et al., 2016). Yet, despite growing recognition of the need to integrate these diverse understandings, few approaches have gone further to show how the integration of diverse values can generate 'other forms of knowledge' or 'other forms of worlding' (Saxena et al., 2018, p. 46; Yusoff, 2013). The following reflects on and reframes tree-biosecurity relations drawing attention to polyvocality, or, at least, multiple perspectives.

Science–Society Relations and Suppression of Indigenous–Tree Relations
In Aotearoa|New Zealand, stories of biosecurity often narrate back to the arrival of Captain Cook and his crew. Of note are explorers' efforts to take taonga (treasured) species back to Europe while also making way for the subsequent arrival of British settlers, the confiscation of Māori land and the delegitimising of mātauranga through violence and legislation (Moewaka Barnes & McCreanor, 2019).[6] This practice of colonial extraction, including collecting tree specimens, was repeated across many British colonies.[7]

Over the last 250 years, plant specimens have continued to circulate to and from Aotearoa|New Zealand, through their own agency and human interventions, including some shared scientific endeavours. At the same time, particular commodities have grown in significance, and relationships have strengthened between empire and colony, improving knowledge of exotic species, their productivity and biosecurity (Dibden et al., 2011; Fagan, 2005). Relations between Aotearoa|New Zealand and the United Kingdom are revised and re-invigorated as multi-directional, but still embedded in the extraction of knowledge; economics; and cultures (Maye et al., 2012; Potter, 2013). In Aotearoa|New Zealand and Cymru|Wales, these appear as threats, invasions, risks and incursions. Resulting in commitments to internationally agreed identification, surveillance and risk monitoring systems – tied into free trade agreements, while also recognising threats to markets and national sovereignty.

In one view, these practices of collection were about scientific curiosity and exploration. Many species were novel, and the collection of them supported scientific expertise and ecological knowledge. Many collections remain housed in museums across the United Kingdom (Kew, Natural History Museum), in various forms (art paintings, botanical wax sculptures, pressed plants, seed collections, including in the National Museum Wales) but also as living trees in arboretums

(e.g., Tregrehan Garden Cornwall; Botanic Gardens Bristol). There are also numerous biographies written about plant collectors of the British Colonial Empire that emphasise the significance of their scientific exploration and curiosity. These narratives have, in turn, been assessed by scholars in literature and humanities who have largely supported the view that the representations of these scientific endeavours reflect colonialist discourses of power and knowledge (Craciun & Terrall, 2019; Harding, 2009; Krige, 2019). The same scholarly analysis has also revealed alternative discourses and representations, not least because a significant proportion of these collectors were women (both married or single) who made these journeys in the context of otherwise Edwardian, etc., confinement for women (Shteir, 1996[8]). For Māori and many Indigenous scholars, such narratives about colonisation through scientific practices of collection and renaming of plants and trees cannot be de-brutalised. Such tensions sit alongside the role of the Millennium Seed Bank at Kew as a recognised global resource for conservation and protection against the global threats that trees face.

This introduces another perspective on the relations of biosecurity that Indigenous academics emphasise: the traumatic and exploitative relations imposed through the colonisation of Aotearoa|New Zealand. This has seen both Māori and the natural environment suffer disastrous declines in both health and wellbeing. Such loss of cultural and spiritual resources for health and wellbeing has resulted in a disconnection from knowledge sources imposed by colonial ways of life that Māori were disciplined into through criminality and punishment (Consedine & Consedine, 2012).

Moewaka Barnes & McCreanor (2019) note that this 'lived experience of injustice, brutality, deprivation and marginalisation has been transmitted across multiple generations, aggravated by land loss, economic disempowerment, poverty, disease and racism' (p. 23). Indeed, as Reid et al. (2017) stress, the trauma of colonisation cannot simply be relegated to the past, perceived as 'a set of traumatising historic events,' but rather it must be understood that colonisation 'creates a traumatising environment, one in which Indigenous peoples are not only exposed to historic traumas but suffer additional traumas created by the colonising atmosphere of the settler nation-state (p. 16).

As such, the process of collecting and naming plant and tree specimens is not a neutral practice. Returning to Tynan's (2021) assertions about relationality, science occurs within such a colonising atmosphere that Aotearoa|New Zealand's environmental management practices have arisen, underpinned by an approach that Moewaka Barnes & McCreanor (2019) refer to as 'whenua (land) as the determinant of wealth' rather than the te ao Māori perspective of 'whenua as the determinant of health' (p. 24). Te reo me ngā tikanga (Māori language and language conventions) are also worldmaking practices ascribing significance and meaning, relationships to people and places, as well as responsibilities and accountabilities. When Indigenous knowledges are excluded through taxonomy practices and Latin binomial conventions,[9] several opportunities for protecting

those species can also be lost. Along with physical and material violence, it is with these relations of cultural and environmental violence that biosecurity must also contend.

As mentioned previously, the cultural violence of colonisation is not only limited to the extraction of resources but also its protection (Blair, 2017). The National Parks Act 1980 placed all of New Zealand's national parks within a utilitarian framework aimed to preserve the lands' for their intrinsic worth and for the benefit, use and enjoyment of the public' (Part 1, section 4, p. 12). Similar legislation creating the National Parks in Cymru|Wales had been implemented in the 1950s. The National Parks framework was colonial in its goals, focusing as it did on creating protected landscapes of significance as an outcome of economic development, particularly tourism. It did so without consideration of relational (including spiritual and kinship) values, nor commitments to co-management with Māori, let alone recognition of te Tiriti o Waitangi. Similarly, while Kew was an early leader in seed banking practices, its colonial legacy is recognised.

Opposition to these colonising practices has not been passive, as evident through the Wai 262 claim,[10] the Te Awa Tupuna (Whanganui River Claim settlement[11]), and countless enactments of environmental protection and restoration (Hikuroa et al., 2018; Moewaka Barnes et al., 2021; Panelli & Tipa, 2007; Ruru et al., 2017). Yet despite these efforts, colonial power structures that privilege Pākehā (New Zealanders of English-speaking European descent) voices and western science perspectives persist, leading to Māori researchers being underrepresented (McAllister et al., 2020) and their contributions to science (McKinley, 2005) and mātauranga (Hikuroa, 2017) too often being undervalued (Ruru & Nikora, 2021). This echoes Tynan's (2021) assertion that relationality matters when considering responses to such a crisis. Responsibility for confronting this injustice cannot fall solely on Māori.

Having exposed how biosecurity in Aotearoa|New Zealand is constrained by its colonial legacies (privileging Pākehā voices and colonising science perspectives), it is now possible to show that these legacies make less visible relational approaches to tree care. This relationality realises multiple truths, and this is even more so when relationality is *for*, rather than *about,* biosecurity.

Discussion: Reflecting on, Reframing, Relating with and Re-Presenting Trees and Biosecurity

Because biosecurity is a value-laden phenomenon, there is a need in both academic and operational settings to work with relational values in new and even unexpected ways. This is because science knowledge-action systems[12] hold both personal and professional values, and the two may not align, causing tensions. In Aotearoa|New Zealand, Māori-led organisations have, until the last decade, largely been excluded from state-led biosecurity responses, as such tensions have been reduced by excluding values that may not be aligned (Lambert et al., 2018; Ministry of Agriculture and Forestry, 2009, p. 3). Despite these exclusions and over 200 years

of oppression and attempts to disconnect Māori from the land, iwi (extended kinship group) and hapū (kinship group) have, in some places, maintained active care for trees.

In the group discussions informing this paper, it was noted, in both the Welsh and the Aotearoa|New Zealand contexts, that the idea that relational values might contribute to biosecurity was not new to many Indigenous knowledge-action systems or those involved in the social-ecological sciences (Dyke, 2018). Additionally, Pasifika scholarship has long invited readers to develop a deeper understanding of connections – of the spaces between (as discussed in Fasavalu, 2019, p. 13). There is still much work to be done to realise the potential of working with relational values in ways that can enliven the social relations of trees.

The inclusion of a relational-value framing within IPBES initiatives came with the hope (as argued by Chan et al., 2016) of more inclusive and responsive connections of biodiversity to wellbeing (e.g., connection to others, place attachment). Thus, seeing humans as part of, impacting on and impacted by nature (Pascual et al., 2017). It was noted in discussions across the group of authors that recent investments in trees for net zero (carbon emissions) did not promote co-benefits, such as those associated with learning and artistic inspiration, symbolic meanings and cultural identity connections and wellbeing (Gawith et al., 2020; MacBride-Stewart et al., 2016, 2019; Tadaki et al., 2017).

More than identifying relational values, regenerating tree-biosecurity relations
One of the many points of departure and return in the research team's discussions was the way that priority has typically been given to understanding environmental values as intrinsic or instrumental. These values are often represented through policy as substitutable by means of production but also as indicators of societal development. In this use of values, the worldwide biodiversity loss due to changes in land-use (mono-cultures, urban expansion, deforestation), exploitation (fishing, hunting), climate change, pollution, invasive species, etc., leaves a paradox that has also become the norm. In this perspective, better science (including social science) only alienates Indigenous perspectives more, but that science and, particularly, social science is necessary to understand how Indigenous perspectives are being affected by this decline (Healy, 2011).

An IPBES report (2022) called for a transformation in how humanity relates to nature, 'decoupling the idea of a good and meaningful life from ever-increasing material consumption.' This argument supports the view that values in the science–society relationship are not benign; different kinds of values (beyond utilitarian and extractive) need to be promoted. For example, kauri trees have cultural values as well as economic and ecological values. Cultural values have often not correlated well with ecological values, as evident in the distinct differences between Boswijk's (2005) natural history of the kauri and Feary's (2012) cosmological and cultural history of kauri, but also in discussions held in UK and NZ. In both accounts, there are overlaps in values where kauri represent 'rootedness in place

and mobility' (Feary, 2012, pp. 2–5) and evidence of early presence and expansion across Aotearoa|New Zealand (Boswijk, 2005). However, this elevation of an approach to always represent both cultural and ecological values risks shifting earlier colonial interpretations towards an updated form of 'green' or 'ecoprimivitism' (Davidov, 2012; Saxena et al., 2018). The researchers were alerted to the need to find better ways to understand how cultural and ecological values integrate and potentially regenerate.

There is also a multiplicity of relations shaping science
The process through which the team learnt about the colonial bias and legacy in Cymru| Wales' biosecurity system may have helped to avoid simple reductionism related to either place and/or culture and to recognise what Liboiron (2021) has termed 'finding allies in unexpected places' (p. 129). Efforts to avoid privileging one perspective over another connect broader Indigenous worldviews and approaches to the increasing inclusion of multiple cultural and ecological values found in contemporary sustainable and stewardship-oriented approaches (Raymond et al., 2016). Describing the ways in which many colonial schools become disloyal to colonialism, Liboiron (2021) asserts that the 'anticolonial' sciences function in pluralistic ways that are sometimes arrayed with, adjacent to or even explicitly against dominant knowledge-action systems. Considerable evidence of the colonial approach being subverted was found when the authors reflected on literature showing how both peoples and trees have disrupted expectations for efficient co-ordinated biosecurity (see 'Healing Fragmentation of Forest Biosecurity Networks: A Conceptual and Reflexive Mapping Analysis of Postcolonial Relations that Matter in Aotearoa and Wales' in this journal edition of *Knowledge Cultures* by MacBride-Stewart et al.).

The possibility of intergenerational and multispecies justice
So the research became focused on highlighting relationships and the effects of knowing the world relationally and recognising that this does not rest solely with Indigenous knowledge or values (Cooper et al., 2016; Kawharu, 2000; Watene, 2016; West et al., 2020). It is noted that valuing nature for humans, or humans valuing nature, is just one of a multi-dimensional array of science–society conceptions through which colonialism, capitalism, biosecurity and biodiversity decline are linked. Certainly, it is impossible to talk of Indigenous perspectives without them having been touched by these forms of contact, production and exchange, locally and globally. However, while the possibility of intergenerational and multispecies justice is key to an understanding of the coevolution of Indigenous science, society and environmental values (Celermajer et al., 2020; Stewart-Harawira, 2005; Winter, 2020), often what is missing is the specificity of context in which those relations and Indigenous perspectives are shaped.

Rather than thinking about colonial relations as a history of a place, the research project has been positioned to re-present science as reinforcing colonial relations

relevant to kauri and *Myrtaceae* well beyond Aotearoa|New Zealand. Indeed, these colonial relations also trace back to the treescapes of Cymru|Wales. The relational research approach that the authors have developed made it more possible to see the mobile relationships of biosecurity (not just pathogens) at work in different contexts.

Capabilities for fostering tree-biosecurity relations
This ability to see things differently and thus to understand and engage with them differently, can be understood as a capability (informed by Nussbaum, 2002). Further capabilities for fostering relational approaches to tree care were adopted, which may be useful beyond this project (to be assessed in 2023). These capabilities (see Table 1) of relating, reflecting, reframing and re-presenting focus on the actions as well as the deliberations supported through the process of critically exploring positionality (see Carling et al., 2014 for further articulation of the need to do more than articulate an insider/outsider perspective).

In a polyvocal biosecurity system understood from the perspective of differently located social scientists, these capabilities all emerged as important, with some at times being more important than others. Polyvocality requires of researchers, their collaborators and their funders, reflexive consideration of the multiple ways in which they might act and what multiple politics and ethics might be enacted through research priorities and practices. But how do we grow and retain these capabilities in a way that shapes tree health and does not alienate or cause violence to communities?

Reviews of earlier drafts of this paper prompted authors to consider how they expressed what this positionality work has achieved. As well as guiding the creation of a 3-year research project, this positionality provided some of the authors with a platform in their organisations to promote and make visible several other decolonising or Tiriti o Waitangi-centred initiatives. For others in the group, it gave them a footing for working more closely with te ao Māori. Whilst Māori reviewers, colleagues and collaborators supported the significance of the relational approach presented here, the authors were also cautioned that anything more than tentative claims is inappropriate in a context where Indigenous scholars still struggle to have their work validated through avenues appropriate to their knowledge systems.

Finally, positionality is ever unfolding; always in the making as relationships develop and are revised. This paper presents hints of the concepts, places and people the authors have woven together as they collectively identified the contributions they could make to their contexts. For this paper, the authors presented their exploration of the literature on decolonising science, biosecurity and relationality. The inclusion of terms such as fragmentation, care and regeneration indicates the additional literatures explored, which are elaborated in related papers detailing the other phases of the research project.

Conclusion

Relationality matters for biosecurity. It can hold biosecurity in place, while, at other moments, it can disrupt it. Attention to the social relations of trees forces a thorough assessment of how research performs in the world, of scientific impact. Consequently, the work outlined in this paper is no longer positioned to address how research should inform tree protection; instead, it can ask how research shapes care for and with trees, and it can foster more possibilities for tree-biosecurity relations. This ongoing inquiry invites polyvocal reflection on how conceptual frameworks (e.g., Nature Futures and Ecosystem Services Frameworks or science–society); metaphors (e.g., the waka hourua, treescapes and systems), practices (e.g., taxonomy and positioning research) and importantly values (e.g., relational, intrinsic and utility) are shaping biosecurity for and with trees in and through Aotearoa|New Zealand to Cymru|Wales. Working with relationality provides a mode of accountability applicable to the decolonisation of biosecurity.

Enactments of co-governance enabled by te Tiriti o Waitangi in Aotearoa|New Zealand have generated the opportunity for this intellectual and grounded enquiry into tree-biosecurity relations. This work is part of a collective enterprise across science–society and is sited across research projects and localities. Because detached linear accounts of research for biosecurity are still privileged, positioning work was needed to impactfully engage with the plurality of ways of knowing trees (and their pathogens) the authors were encountering. Across the globe, there are places where tree-biosecurity relations fragment, limiting the potential for wellbeing. Surviving in this fragmentation are possibilities for more ethical, just relationships with trees and their pathogens. New capabilities across science–society relationships will realise these possibilities.

iD

Maria Ayala, https://orcid.org/0000-0002-3195-8874
Will Allen, https://orcid.org/0000-0002-2569-6484
Susanna Finlay-Smits, https://orcid.org/0000-0002-6331-9284
Andrea Grant, https://orcid.org/0000-0001-5952-1976
Alison Greenaway, https://orcid.org/0000-0003-2288-8621
Sara MacBride-Stewart, https://orcid.org/0000-0002-1562-9536
Liz O'Brien, https://orcid.org/0000-0001-7976-9987

Author contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Notes

1. The work outlined in this paper is part of Ngā Rākau Taketake, a programme funded by the New Zealand Ministry for Business Innovation and Employment to combat kauri dieback (*Phytophthora agathidicida*) and myrtle rust (*Austropuccinia psidii*) as part of the Biological Heritage National Science Challenge. To read more, visit the Ngā Rākau Taketake website (Mobilising for Action, n.d.), in particular, the 'Our Research: Postcolonial Biosecurity Possibilities' page.

2. By leadership of the Biological Heritage National Science Challenge through the research funding process (for background see Norton et al., 2016).

3. By now the reader will have noted this paper is written in third person. This was done for 2 reasons, to minimise portrayal of a homogenous shared experience of the research team. Use of third person gave more room to illustrate the multiple perspectives held by those involved. Secondly it gave the opportunity to more clearly present a number of subjectivities those involved were exploring, as well as the wider set of relationships the group had rather than reify typical research project identities.

4. For further information, see the editorial for this edition by Harvey & McEntee and the 'About Us: Waka Hourua' of the Mobilising for Action page (Mobilising for Action, n.d).

5. The decolonising work of waka hourua framing is still being explored. We include reference to Maxwell et al. (2020) and Harcourt et al. (2021), because they are developing waka taurua framing, adding temporal and outcome-oriented relational elements. Other scholars point to the relational space between kāwanatanga and rangatiratanga, presented in Matike Mai Aotearoa (2016).

6. For example, the Native Schools Act (1867) which introduced the teaching of English and overtime violently prohibited use of Te Reo Māori. The Tohunga Suppression Act (1907) was an Act of the New Zealand Parliament aimed at replacing tohunga as traditional Māori healers with western medicine. For more details see Moon (2008).

7. Early Welsh migrants to New Zealand were largely represented in seafaring, whaling and gold mining, where settler communities had a role in extracting minerals and devastating marine life.

8. For more detail about one of these women, see Del (1996).

9. This tension is also evident in this paper, we used Latin names for kauri and *Myrtaceae* when we first introduced them. Our response was to also include some of their te reo Māori names.

10. The Wai 262 claim was a Waitangi Tribunal claim lodged in 1991. It was called the 'Wai 262' claim because it was the 262nd claim lodged in the Waitangi Tribunal. It was also known as the 'flora and fauna' claim.

The claim was one of the largest and most complex in the Waitangi Tribunal's history. It was the Waitangi Tribunal's first 'whole-of-government' inquiry examining the policy

areas of more than 20 government departments and agencies. For further details, see Te Puni Kokiri (2022).

11. For further information, see Whanganui District Council (2023).

12. Maclean et al. (2022) promote deep situated understanding of research impact relations.

References

Agnew, J. A., Mitchell, K., & Toal, G. (Eds.). (2008). *A companion to political geography*. John Wiley.

Baldwin, A., & Erickson, B. (2020). Introduction: Whiteness, coloniality and the anthropocene. *Environment & Planning D, 38*(1), 3–11. https://doi.org/10.1177/0263775820904485

Barker, K., & Francis, R. A. (Eds.). (2021). *Routledge handbook of biosecurity and invasive species*. Routledge.

Barnes, T., Peck, J., Sheppard, E., & Tickell, A. (2007). Methods matter: Transformations in economic geography. In A. Tickell, E. Sheppard, J. Peck, & T. J. Barnes (Eds.), *Politics and practice in economic geography* (pp. 1–24). Sage.

Bataille, C. Y., Malinen, S. K., Yletyinen, J., Scott, N., & Lyver, P. O. B. (2021). Relational values provide common ground and expose multi-level constraints to cross-cultural wetland management. *People & Nature, 3,* 941–960. https://doi.org/10.1002/pan3.10244

Biosecurity Act. (1993).

Black, A., Mark-Shadbolt, M., Garner, G., Green, J., Malcolm, T., Marsh, A., Ropata, H., Waipara, N., & Wood, W. (2019). How an indigenous community responded to the incursion and spread of myrtle rust (*Austropuccinia psidii*) that threatens culturally significant plant species: A case study from New Zealand. *Pacific Conservation Biology, 25*(4), 348–354. https://doi.org/10.1071/PC18052

Blair, J. J. A. (2017). Settler indigeneity and the eradication of the non-native: Self-determination and biosecurity in the Falkland Islands (Malvinas). *Journal of the Royal Anthropological Institute, 23*(3), 580–602. https://doi.org/10.1111/1467-9655.12653

Borell, B., Waru Rewiri, K. T., Barnes, H. M., & McCreanor, T. (2019). Beyond the veil: Kaupapa Māori gaze on the non-Māori subject. *Journal of Sociology, 56*(2), 197–212. https://doi.org/10.1177/1440783319893503

Boswijk, G. (2005). A history of kauri. In *Australia and New Zealand forest histories* (pp. 19–26). Araucarian Forests, Australian Forest History Society. https://www.foresthistory.org.au/wp-content/uploads/2022/01/anzfh2entire.pdf#page=15

Braun, B., Whatmore, S. J., & Stengers, I. (Eds.). (2010). *Political matter: Technoscience, democracy and public life*. University of Minnesota Press.

Carling, J., Erdal, M. B., & Ezzati, R. (2014). Beyond the insider–outsider divide in migration research. *Migration Studies, 2*(1), 36–54. https://doi.org/10.1093/migration/mnt022

Celermajer, D., Chatterjee, S., Cochrane, A., Fishel, S., Neimanis, A., O'Brien, A., Reid, S., Srinivasan, S., Schlosberg, D., & Waldow, A. (2020). Justice through a multispecies lens. *Contemporary Political Theory, 19*(3), 475–512. doi:10.1057/s41296-020-00386-5

Chan, K. M. A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G.W., Martin-Lopez, B., Muraca,

B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggert, J., & Turner, N. (2016). Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences, 113*(6), 1462–1465. https://doi.org/10.1073/pnas.1525002113

Consedine, R., & Consedine, J. (2012). *Healing our history: The challenge of the Treaty of Waitangi* (rev. ed.). Penguin.

Cooper, N., Brady, E., Steen, H., & Bryce, R. (2016). Aesthetic and spiritual values of ecosystems: Recognising the ontological and axiological plurality of cultural ecosystem 'services.' *Ecosystem Services, 21*, 218–229. https://doi.org/10.1016/j.ecoser.2016.07.014

Craciun, A., & Terrall, M. (2019). *Curious encounters: Voyaging, collecting and making knowledge in the long eighteenth century*. University of Toronto Press.

Davidov, V. (2012). From colonial primitivism to ecoprimitivism: Constructing the indigenous 'savage' in South America. *Arcadia*, *46*(2), 467–487. https://doi.org/10.1515/arcadia-2011-0030

de la Bellacasa, M. P. (2012). 'Nothing comes without its world': Thinking with care. *Sociological Review, 60*(2), 197–216. https://doi.org/10.1111/j.1467-954X.2012.02070.x

Dell, R. K. (1996). *Blackwell, Ellen Wright*. Te ara: Encyclopedia of New Zealand. https://teara.govt.nz/en/biographies/3b37/blackwell-ellen-wright

de Sousa Santos, B. (Ed.). (2007). *Another knowledge is possible: Beyond northern epistemologies*. Verso.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., ... & Zlatanova, D. (2015). The IPBES conceptual framework: Connecting nature and people. *Current Opinion in Environmental Sustainability, 14*, 1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Dibden, J., Higgins, V., & Cocklin, C. (2011). Harmonising the governance of farming risks: Agricultural biosecurity and biotechnology in Australia. *Australian Geographer, 42*(2), 105–122. https://doi.org/10.1080/00049182.2011.569983

Diprose, G., Kannemeyer, R., Edwards, P., & Greenaway, A. (2022). Participatory biosecurity practices: Myrtle rust, an unwanted pathogen in Aotearoa New Zealand. *New Zealand Geographer, 78*(3), 175–185. https://doi.org/10.1111/nzg.12347

Dove, M. R. (2006). Indigenous people and environmental politics. *Annual Review of Anthropology, 35*(1), 191–208. https://doi.org/10.1146/annurev.anthro.35.081705.123235

Dyke, A., Geoghegan, H., & de Bruin, A. (2018). Towards a more-than-human approach to tree health. In J. Urquhart, M. Marzano, & C. Potter, C. (Eds), *The human dimensions of forest and tree health* (pp. 445–470). Palgrave Macmillan. https://doi.org/10.1007/978-3-319-76956-1_17

Fagan, R. (2005). Globalisation, the WTO and the Australia–Philippines 'banana war.' In N. Fold, B. Pritchard (Eds.), *Cross-continental agro-food chains: Structures, actors and dynamics in the global food system* (pp. 207–222). Routledge. https://doi.org/10.4324/9780203448175

Fasavalu, T. I., & Reynolds, M. (2019). Relational positionality and a learning disposition: Shifting the conversation. *International Education Journal: Comparative Perspectives, 18*(2), 11–25. https://openjournals.library.sydney.edu.au/IEJ/article/view/14035

Feary, S., (2012). From kauri to kumara: Forests and people of the Pacific Islands. In B. J. Stubbs (Ed.), *Australia's ever-changing Forests VI: Proceedings of the eighth national conference on Australian forest history* (pp. 202–207). https://www.foresthistory.org.au/2010_conference_papers/Feary%20Paper.pdf

FAO. (2007). Biosecurity principles and components: Part 1. In *FAO biosecurity toolkit: Food and agriculture organisation of the United Nations* (pp. 1–20). United Nations Nutrition Division. https://www.fao.org/3/a1140e/a1140e.pdf

Forster, M. (2019). He tātai whenua: Environmental genealogies. *Genealogy, 3*(3), 42. https://doi.org/10.3390/genealogy3030042

Foster, J. B., Clark, B., & York, R. (2011). The environment of consumption [L'écologie de la consommation]. *Écologie & Politique, 3*(3), 107–130. https://doi.org/10.3917/ecopo.043.0107

Funtowicz, S. O., & Ravetz, J. R. (1993). Science for the post-normal age. *Futures*, *25*(7), 739–755. https://doi.org/10.1016/0016-3287(93)90022-L

Gawith, D., Greenaway, A., Samarasinghe, O., Bayne, K., Velarde, S., & Kravchenko, A. (2020). Socio-ecological mapping generates public understanding of wilding conifer incursion. *Biological Invasions*, *22*(10), 3031–3049. https://doi.org/10.1007/s10530-020-02309-2

Greenaway A, Hohaia H, Le Heron E, Le Heron R, Grant A, Diprose G, Kirk N, Allen W (2021) Methodological sensitivities for co-producing knowledge through enduring trustful partnerships. *Sustainability Science, 17,* 443–447. https://doi.org/10.1007/s11625-021-01058-y

Hagan, J. M., & Grove, S. L. (1999). Coarse woody debris: Humans and nature competing for trees. *Journal of Forestry, 97*(1), 6–11. https://doi.org/10.1093/JOF/97.1.6

Haraway, D. J. (2017). Symbiogenesis, sympoiesis and art-science activisms for staying with the trouble. In A. L. Tsing, N. Bubandt, E, Gan, & H. A. Swanson (Eds.), *Arts of living on a damaged planet: Ghosts and monsters of the anthropocene* (pp. 25–50). University of Minnesota Press.

Haraway, D. (2018). Staying with the trouble for multispecies environmental justice. *Dialogues in Human Geography, 8*(1), 102–105. https://doi.org/10.1177/2043820617739208

Harcourt, N., Awatere, S., Hyslop, J., Taura, Y., Wilcox, M., Taylor, L., Rau, J., & Timoti, P. (2021). Kia manawaroa kia puawai: Enduring Māori livelihoods. *Sustainability Science, 17*, 391–402. https://doi.org/10.1007/s11625-021-01051-5

Harding, S. (2009). Postcolonial and feminist philosophies of science and technology: Convergences and dissonances. *Postcolonial Studies, 12*(4), 401–421. https://doi.org/10.1080/13688790903350658

Head, L., & Atchison, J. (2009). Cultural ecology: Emerging human-plant geographies. *Progress in Human Geography, 33*(2), 236–245. https://doi.org/10.1177/0309132508094075

Healy, S. (2006). Toward a vocabulary for speaking of the engagement of things into discourse. *Journal of Environmental Policy & Planning*, *7*(3), 239–256, https://doi.org/10.1080/15239080500339745

Healy, S. (2011). Post-normal science in postnormal times. *Futures*, *43*(2), 202–208. https://doi.org/10.1016/j.futures.2010.10.009

Hikuroa, D., Slade, A., & Gravley, D. J. (2011). Implementing Māori indigenous knowledge (mātauranga) in a scientific paradigm: Restoring the mauri to te kete poutama. *MAI Review, 3*(1). https://www.review.mai.ac.nz/mrindex/MR/article/download/433/433-3375-1-PB.pdf

Hikuroa, D. (2017). Mātauranga Māori: The ūkaipō of knowledge in New Zealand. *Journal of the Royal Society of New Zealand, 47*(1), 5–10. https://doi.org/10.1080/03036758.2016.1252407

Hikuroa, D. Clark, J., Olse, A., & Camp, E. (2018). Severed at the head: Towards revitalising the mauri of Te Awa o te Atua, New Zealand *Journal of Marine and Freshwater Research*, *52*(4), 643–656, https://doi.org/10.1080/00288330.2018.1532913

Hill, R., Adem, Ç., Alangui, W. V., Molnár, Z., Aumeeruddy-Thomas, Y., Bridgewater, P., ... & Xue, D. (2020). Working with indigenous, local and scientific knowledge in assessments of nature and nature's linkages with people. *Current Opinion in Environmental Sustainability: Indigenous Conceptualisations of Sustainability, 43*, 8–20. https://doi.org/10.1016/j.cosust.2019.12.006

Ihemezie, E. J., Nawrath, M., Strauß, L., Stringer, L. C., & Dallimer, M. (2021). The influence of human values on attitudes and behaviours towards forest conservation. *Journal of Environmental Management, 292*, 112857. https://doi.org/10.1016/j.jenvman.2021.112857

IPBES. (2022). *Summary for policymakers of the methodological assessment report on the diverse values and valuation of nature of the intergovernmental science-policy platform on biodiversity and ecosystem services*. IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.6522392

IPCC. (2022). *Climate change 2022: Impacts, adaptation and vulnerability: Contribution of working group II to the sixth assessment report of the Intergovernmental Panel on Climate Change.* Cambridge University Press.

Jones, N. A., Shaw, S., Ross, H., Witt, K., & Pinner, B. (2016). The study of human values in understanding and managing social-ecological systems. *Ecology & Society, 21*(1), 15. http://dx.doi.org/10.5751/ES-07977-210115

Kawharu, M. (2000). Kaitiakitanga: A Māori anthropological perspective of the Māori socio-environmental ethic of resource management. *Journal of the Polynesian Society,109*(4), 349–370.

Kemmis, S. (2009). Action research as a practice-based practice. *Educational Action Research, 17*(3), 463–474. https://doi.org/10.1080/09650790903093284

Kenter, J. O., Raymond, C. M., Van Riper, C. J., Azzopardi, E., Brear, M. R., Calcagni, F., ... & Thankappan, S. (2019). Loving the mess: Navigating diversity and conflict in social values for sustainability. *Sustainability Science*, *14*, 1439–1461. https://doi.org/10.1007/s11625-019-00726-4

Krige, J. (Ed.). (2019). *How knowledge moves: Writing the transnational history of science and technology*. University of Chicago Press.

Lambert, S., Waipara, N., Black, A., Mark-Shadbolt, M., & Wood, W. (2018). Indigenous biosecurity: Māori responses to kauri dieback and myrtle rust in Aotearoa New Zealand. In J. Urquhart, M. Marzano & C. Potter (Eds.), *The human dimensions of forest and tree health* (pp. 109–137). Springer. https://doi.org/10.1007/978-3-319-76956-1

Liboiron, M. (2021). *Pollution is colonialism*. Duke University Press.

MacBride-Stewart, S. (2019). Atmospheres, landscapes and nature: Off-road runners' experiences of wellbeing. *Health, 23*(2), 139–157. https://doi.org/10.1177/1363459318785675

MacBride-Stewart, S., Gong, Y., & Antell, J. (2016). Exploring the interconnections between gender, health and nature. *Public Health, 141*, 279–286. https://doi.org/10.1016/j.puhe.2016.09.020

Maclean, K., Robinson, C., Bock, E., & Rist, P. (2022). Reconciling risk and responsibility on Indigenous country: Bridging the boundaries to guide knowledge sharing for cross-cultural biosecurity risk management in northern Australia. *Journal of Cultural Geography, 39*(1), 32–54. https://doi.org/10.1080/08873631.2021.1911078

Maclean, K., Woodward, E., Jarvis, D., Turpin, G., Rowland, D., & Rist, P. (2022). Decolonising knowledge co-production: Examining the role of positionality and partnerships to support Indigenous-led bush product enterprises in northern Australia. *Sustainability Science, 17*, 1–18. https://doi.org/10.1007/s11625-021-00973-4

Malpas, J. (2012). Putting space in place: Philosophical topography and relational geography. *Environment and Planning D: Society and Space*, *30*(2), 226–242. https://doi.org/10.1068/d20810

Margaret, J. (2010). *Working as allies.* Winston Churchill Memorial Trust.

Marzano, M., Allen, W., Haight, R. G., Holmes, T. P., Keskitalo, E. C. H., Langer, E. R. L., Shadbolt, M., Urquhart, J., & Dandy, N. (2017). The role of the social sciences and economics in understanding and informing tree biosecurity policy and planning: A global summary and synthesis. *Biological Invasions, 19*(11), 3317–3332. https://doi.org/10.1007/s10530-017-1503-4

Matike Mai Aotearoa. (2016). *He whakaaro here whakaumu mō Aotearoa: The report of Matike Mai Aotearoa: The independent working group on constitutional transformation.* https://nwo.org.nz/wp-content/uploads/2018/06/MatikeMaiAotearoa25Jan16.pdf

Maxwell, K., Awatere, S., Ratana, K., Davies, K., & Taiapa, C. J. (2020). He waka eke noa/we are all in the same boat: A framework for co-governance from Aotearoa New Zealand. *Marine Policy, 121*, 104213. https://doi.org/10.1016/j.marpol.2020.104213

Maye, D., Dibden, J., Higgins, V., & Potter, C. (2012). Governing biosecurity in a neoliberal world: comparative perspectives from Australia and the United Kingdom. *Environment & Planning A*, *44*(1), 150–168. https://doi.org/10.1068/a4426

McAllister, T. G., Naepi, S., Wilson, E., Hikuroa, D., & Walker, L. A. J. (2020). Under-represented and overlooked: Māori and Pasifika scientists in Aotearoa New Zealand's universities and crown-research institutes. *Journal of the Royal Society of New Zealand*, 52(1), 38–53. https://doi.org/10.1080/03036758.2020.1796103

McKinley, E. (2005). Brown bodies, white coats: Postcolonialism, Māori women and science. *Discourse: Studies in the Cultural Politics of Education, 26*(4), 481–496. https://doi.org/10.1080/01596300500319761

Merriam, S. B., Johnson-Bailey, J., Lee, M. Y., Kee, Y., Ntseane, G., & Muhamad, M. (2001). Power and positionality: Negotiating insider/outsider status within and across cultures. *International Journal of Lifelong Education, 20*(5), 405–416.

Ministry of Agriculture and Forestry. (2007). *A biosecurity science strategy for New Zealand: Mahere rautaki putaiao whakamaru*. MAF Biosecurity New Zealand.

Ministry of Agriculture and Forestry. (2009, March). Biosecurity and Māori. *Biosecurity*, *90*. MAF Biosecurity New Zealand.

Ministry of Business Innovation and Employment. (2022). *Te ara paerangi: Future pathways white paper*. MBIE.

Mobilising for Action. (n.d.). *Mobilising for action*. https://www.mobilisingforaction.nz/

Moewaka Barnes, H., Harmsworth, G., Tipa, G., Henwood, W., & McCreanor, T. J. (2021). Indigenous-led environmental research in Aotearoa New Zealand: Beyond a transdisciplinary model for best practice, empowerment and action. *AlterNative: An International Journal of Indigenous People, 17*(2). https://doi.og/10.11771801211019397.

Moewaka Barnes, H., & McCreanor, T. (2019). Colonisation, hauora and whenua in Aotearoa. *Journal of the Royal Society of New Zealand, 49*(sup1), 19–33. https://doi.org/10.1080/03036758.2019.1668439

Moon, P. (2008). *The tohunga journal: Hohepa Kereopa, Rua Kenana and Maungapohatu*, David Ling.

Muhammad, M., Wallerstein, N., Sussman, A. L., Avila, M., Belone, L., & Duran, B. (2015). Reflections on researcher identity and power: The impact of positionality on community-based participatory research (CBPR) processes and outcomes. *Critical Sociology, 41*(7–8), 1045–1063. https://doi.org/10.1177/0896920513516025

Native Schools Act. (1867).

National Parks Act. (1980).

Nussbaum, M. (2002) Capabilities and social justice, *International Studies Review*, *4*(2), 123–135. https://doi.org/10.1111/1521-9488.00258

Norton, D. A., Young, L. M., Byrom, A. E., Clarkson, B. D., Lyver, P. O. B., McGlone, M. S., & Waipara, N. W. (2016). How do we restore New Zealand's biological heritage by 2050? *Ecological Management & Restoration*, *17*(3), 170–179. https://doi.org/10.1111/emr.12230

Panelli, R., & Tipa, G. (2007). Placing wellbeing: A Māori case study of cultural and environmental specificity. *EcoHealth, 4*(4), 445–460. https://doi.org/10.1007/s10393-007-0133-1

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., ... & Yagi, N. (2017). Valuing nature's contributions to people: The IPBES approach. *Current Opinion in Environmental Sustainability*, *26*, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006

Pereira, L. M., Davies, K. K., den Belder, E., Ferrier, S., Karlsson-Vinkhuyzen, S., Kim, H., ... & Lundquist, C. J. (2020). Developing multiscale and integrative nature–people scenarios using the nature futures framework. *People & Nature, 2(*4), 1172–1195. https://doi.org/10.1002/pan3.10146

Pörtner, H. O., Scholes, R. J., Agard, J., Archer, E., Arneth, A., Bai, X., ... & Ngo, H. T. (2021). *IPBES-IPCC co-sponsored workshop report on biodiversity and climate change.* IPBES and IPCC. https://doi.org/10.5281/zenodo.4782538.

Potter, C. (2013). *A neoliberal biosecurity? The WTO, free trade and the governance of plant health.* Routledge.

Rata, A., Hutchings, J., & Liu, J. H. (2012). The waka hourua research framework: A dynamic approach to research with urban Māori communities. *Australian Community Psychologist, 24*(1), 64–75. https://psychology.org.au/aps/media/acp/rata-et-al-acp-24(1)64-75.pdf

Raymond, C. M., Bieling, C., Fagerholm, N., Martin-Lopez, B., & Plieninger, T. (2016). The farmer as a landscape steward: Comparing local understandings of landscape stewardship, landscape values and land management actions. *Ambio, 45*(2), 173–184. https://doi.org/10.1007/s13280-015-0694-0

Reid, J., Rout, M., Tau, TM, & Smith, C. (2017). *The colonising environment: An aetiology of the trauma of settler colonisation and land alienation on Ngai Tahu whanau*. Ngai Tahu Research Centre, University of Canterbury. https://www.canterbury.ac.nz/media/documents/ngai-tahu-research-centre/The-Colonising-Environment---PDF-final.pdf

Roberts, M. (2013). Ways of seeing: Whakapapa. *Sites: A Journal of Social Anthropology and Cultural Studies, 10*(1), 93–120. https://doi.org/10.11157/sites-vol10iss1id236

Ruru, J., & Nikora, L. W. (2021). *Ngā kete mātauranga. Māori scholars at the research interface.* Otago University Press.

Ruru, J., O'Lyver, P. B., Scott, N., & Edmunds, D. (2017). Reversing the decline in New Zealand's biodiversity: Empowering Māori within reformed conservation law. *Political Quarterly, 13*(2), 65–71. https://doi.org/10.26686/pq.v13i2.4657

Salmond, A., Tadaki, M., & Gregory, T. (2014), Enacting new freshwater geographies. *New Zealand Geographical Society, 70*, 47–55. https://doi.org/10.1111/nzg.12039

Saxena, A. K., Chatti, D., Overstreet, K., & Dove, M. R. (2018). From moral ecology to diverse ontologies: relational values in human ecological research, past and present. *Current Opinion in Environmental Sustainability, 35*, 54–60. https://doi.org/10.1016/j.cosust.2018.10.021

Shove, E. (2010). Beyond the ABC: Climate change policy and theories of social change. *Environment and Planning A, 42*(6), 1273–1285. https://doi.org/10.1068/a42282

Shteir, A. B. (1996). *Cultivating women, cultivating science: Flora's daughters and botany in England, 1760–1860.* Johns Hopkins University Press.

Smith, L. T., Maxwell, T. K., Puke, H., & Temara, P. (2016). Indigenous knowledge, methodology and mayhem: What is the role of methodology in producing Indigenous insights? A discussion from mātauranga Māori. *Knowledge Cultures, 4*(3), 131–156. https://core.ac.uk/download/pdf/132284617.pdf

Stewart-Harawira, M. (2005). Cultural studies, indigenous knowledge and pedagogies of hope. *Policy Futures in Education 3*(2), 153–163. https://doi.org/10.2304/pfie.2005.3.2.4

Tadaki, M., Sinner, J., & Chan, K. M. A. (2017). Making sense of environmental values: A typology of concepts. *Ecology & Society, 22*(1), 7. https://doi.org/10.5751/ES-08999-220107

Te Puni Kokiri. (2022, October 20). *Te pae tawhiti: Wai 262.* Te Puni Kokiri. https://www.tpk.govt.nz/en/a-matou-whakaarotau/te-ao-maori/wai-262-te-pae-tawhiti

Tsing, A. L., Deger, J., Keleman Saxena, A., & Zhou, F. (2020). *Feral atlas: The more-than-human anthropocene.* Stanford University Press.

Tsouvalis, J. (2019) The post-politics of plant biosecurity: The British government's response to ash dieback in 2012. *Transactions of the Institute of British Geographers. 44*, 195–208. https://doi.org/10.1111/tran.12259

Tynan, L. (2021). What is relationality? Indigenous knowledges, practices and responsibilities with kin. *Cultural Geographies*, *28*(4), 597–610. https://doi.org/10.1177/14744740211029287

Walters, T., & Ruwhiu, D. (2021). Navigating by the stars: A critical analysis of Indigenous events as constellations of decolonisation. *Annals of Leisure Research, 24*(1), 132–149. https://di.org/10.1080/11745398.2019.1643749

Watene, K. J. (2016). Valuing nature: Māori philosophy and the capability approach. *Oxford Development Studies, 44*(3), 287–296. https://doi.org/10.1080/13600818.2015.1124077

West, S., Haider, L. J., Stålhammar, S., Woroniecki, S. (2020). A relational turn for sustainability science? Relational thinking, leverage points and transformations. *Ecosystems & People, 16*(1), 304–325. https://doi.org/10.1080/26395916.2020.1814417

Whanganui District Council. (2023). *Te awa tupua: Whanganui river settlement.* Whanganui District Council. https://www.whanganui.govt.nz/About-Whanganui/Our-District/Te-Awa-Tupua-Whanganui-River-Settlement

Whyte, K. J. (2017). Indigenous climate change studies: Indigenising futures, decolonising the anthropocene. *English Language Notes, 55*(1), 153–162. https://doi.org/10.1215/00138282-55.1-2.153

Winter, C. J. (2020). Does time colonise intergenerational environmental justice theory? *Environmental Politics, 29*(2), 278–296. https://doi.org/10.1080/09644016.2019.1569745

Wolfgramm, R., Spiller, C., Henry, E., & Pouwhare, R. (2020). A culturally derived framework of values-driven transformation in Māori economies of wellbeing (ngā hono ōhanga oranga). *AlterNative: An International Journal of Indigenous People, 16*(1), 18–28. https://doi.org/10.1177/1177180119885663

Yusoff, K., (2013). Insensible worlds: Post-relational ethics, indeterminacy and the (k)nots of relating. *Environment & Planning D: Society and Space*, *31*, 208–226. https://doi.org/10.1068/d17411

Glossary

hapū	local sub-tribes that make up larger iwi groupings, at local or district geographic level
iwi	an extended kinship group, tribe, nation, people, nationality, race; often refers to a large group of people descended from a common ancestor and associated with a distinct territory
kairangahau Māori	Māori researchers
kaupapa Māori	Māori approach, Māori topic, Māori customary practice, Māori institution, Māori agenda, Māori principles, Māori ideology; a philosophical doctrine, incorporating the knowledge, skills, attitudes and values of Māori society
kauri	*Agathis australis*
kauri dieback	*Phytophthora agathidicida*
kāwanatanga	government, dominion, rule, authority, governorship, province
mātauranga	Māori knowledge, Māori knowledge system, belief system, wisdom
myrtle rust	*Austropuccinia psidii*
Pākehā	New Zealander of European descent; probably originally applied to English-speaking Europeans living in Aotearoa|New Zealand
rangatiratangaright	to exercise authority, chiefly autonomy, chiefly authority, kingdom, realm, sovereignty, principality, self-determination, self-management
tangata tiriti	the people of te Tiriti o Waitangi who are in relationship with tangata whenua
tangata whenua	the local people, hosts, indigenous people; people born of the whenua, i.e., of the placenta and of the land where the people's ancestors have lived and where their placenta are buried.
taonga	treasure, anything prized; applied to anything considered to be of value, including socially or culturally valuable objects, resources, phenomenon, ideas and techniques
te ao Māori	the Māori way of perceiving and understanding the world, and the values and systems of thought that underpin those perceptions
te reo me ngā tikanga	Māori language and language conventions
Te Tiriti o Waitangi	the Treaty of Waitangi: one of Aotearoa New Zealand's founding documents, establishing rights, responsibilities and relationships between the Crown and tangata whenua; takes its name from the place in the Bay of Islands where it was first signed, on 6 February 1840
waka hourua/ waka taurua	a double-hulled sailing vessel
whakapapa	ancestral lineage, hierarchical assemblage of descendants, inter-connections