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## **Neoliberal Knowledge Production in Aotearoa New Zealand: Confronting Kauri Dieback and Myrtle Rust**

**Katja-Soana Ehler**

katja.ehler579@gmail.com

Te Herenga Waka|Victoria University of Wellington  
Aotearoa|New Zealand

**Courtney Addison**

courtney.addison@vuw.ac.nz

Te Herenga Waka|Victoria University of Wellington  
Aotearoa|New Zealand

**Andrea Grant**

andrea.grant@scionresearch.com

SCION Research

Aotearoa|New Zealand

**Susanna Finlay-Smits**

susanna.finlay-smits@agresearch.co.nz

AgResearch

Aotearoa|New Zealand

**ABSTRACT.** The detection of kauri dieback and myrtle rust pathogens in Aotearoa|New Zealand prompted the government to fund research and engagement into what has been constructed both as a biosecurity risk and a threat to species of profound cultural significance. Researchers, iwi, public sector staff and community members are now working across projects and locations to build an understanding of these two plant pathogens and to develop protections for the trees they target. This paper combines interview material from two projects within Ngā Rakau Taketake's Postcolonial Biosecurity Possibilities remit to investigate the factors that enable and constrain plant pathogen research and practice. Actors in this space discuss the difficulty of working around gaps in basic research, a fragmented and competitive research sector, and expectations of a technological fix for a complex pathogen and its varied ecological relations. We argue that these accounts illustrate the ongoing effects of Aotearoa's neoliberal turn, which continues to shape knowledge production and, in turn, what it is to be a researcher in Aotearoa. While the effects of these reforms have been well documented in relation to higher education and other spheres, their impact on the sciences has received less scrutiny. Foregrounding the views of those involved in kauri dieback and myrtle rust highlights the everyday manifestations and material environmental consequences of a pervasively neoliberalised research landscape.

Keywords: neoliberalism; techno-solutionism; kauri dieback; myrtle rust; knowledge production; relational values; Aotearoa New Zealand

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## **Introduction**

When Kauri dieback (KD) and myrtle rust (MR) were detected in Aotearoa [New Zealand (hereafter referred to as Aotearoa)], their potential impact on native tree species caused concern to ripple through Māori and conservation communities. These growing community concerns across Aotearoa have niggled at the governing system of biosecurity. Aotearoa's economy, dependent on primary industries, relies heavily on biosecurity and Biosecurity New Zealand (BNZ), the national biosecurity response agency, acts as a key governing interface designed to protect traded commodities' access to markets (Stone, 2021). However, it also guards the boundaries of Aotearoa against new pest and disease introductions. In the current context, biosecurity research has become a governing tool and also built a knowledge base for protecting indigenous species and biodiversity (Toome-Heller et al., 2020). KD and MR were both detected without the institutional backing often given to a high-priority biosecurity threat, which is typically of national economic significance and initiates a national response plan. A cohort of biosecurity researchers, particularly those of Māori descent, raised the alarm about the pathogens causing these diseases (Black et al., 2019; Lambert et al., 2019). However, even when MR was detected in Australia in 2010 and KD identified in the Waitakere Ranges in 2006 (despite symptoms of dieback first being identified by scientists in Aotea, Great Barrier Island, in 1974), government efforts to prepare for and respond to these diseases were slow.

It wasn't until 2008 that KD was declared an unwanted organism by the Ministry for Primary Industries (MPI). MR was detected in 2017, and an eradication programme was rolled out. However, the programme ended before the pathogen was eradicated, and there was no formal ongoing surveillance to map its impact and enable a long-term management response. Once MR was detected, researchers within Crown Research Institutes (CRIs) rallied together to collaborate on an initial investment administered through the MPI. Early responses to KD research, led by MPI, have since been criticised for not adequately working with Māori communities, who have valuable knowledge and expertise to contribute, and other conservation communities, who were given little knowledge or tools to take action against the pathogen's impacts. The Bioheritage National Science Challenge directors championed stronger investment in protecting taonga (treasured) species

and research to support awareness of impacts and to develop tools and capacity to respond to these plant pathogens. They also called for stronger investment to support mātauranga (Māori knowledge) or Māori-led solutions to help indigenous communities respond to these biological threats.

Historically, both KD and MR research efforts have been riddled with uncertainties. This can be credited to the ecological complexities of plant pathogens and the novelty of plant pathogen management in Aotearoa|New Zealand, which generate uncertainty and doubt in research communities. For example, the impacts that KD and MR will have on their host species are yet to be clearly defined. Effective management strategies are also still being explored, and there is disagreement as to whether KD is an introduced pathogen or whether it is native to Aotearoa. In this paper, we ask how plant pathogen researchers in Aotearoa navigate the uncertainties of their research space and find in their responses a window onto much broader issues with Aotearoa science.

While the research projects behind this paper set out to examine how questions of value and care manifest for KD and MR researchers, here we explore a different but related issue: the difficulties of producing knowledge about KD and MR in an institutional and political-economic setting heavily contoured by neoliberal norms and policies. While researchers spoke at length about their value and care practices, they also spoke, in detail and with passion, about the challenges and obstacles they faced in their work. We contend that many of these challenges are symptomatic of the neoliberal reforms that have shaped Aotearoa's science sector (along with many others), and that KD and MR represent sites from which we can explore the consequences of these reforms.

### **Neoliberalism and New Zealand Science**

As various critics have observed, the term neoliberalism is widely used but often underspecified and has its greatest analytic power when used in locally attentive ways (Flew, 2014; Hoffman et al., 2006; Mudge, 2008). Here, we treat neoliberalism as a set of assumptions and actions that promote a structured encroachment of market logics and processes into social and political domains. In this figuration, the market is positioned as the best arbiter of value and the government as a facilitator of the market. This position is underwritten by ideals of efficiency and competition, and justifies wide-ranging deregulation, privatisation and commercialisation. Furthermore, through the workings of these assumptions, we also see the formation of the neoliberal subject, who appears in different guises (the worker, the patient, the migrant, the parent), but for whom both morality and success require the embodiment of self-interested, self-responsible individuality (Rose, 1996a, 1996b).

Aotearoa was an early adopter of neoliberal reforms and embraced these more vigorously than many other countries (Larner, 1997). These reforms concretised in diverse forms: through reliance on private third parties who tender and are contracted to provide health services (Lovell et al., 2014); the ascendance of

performance metrics in tertiary education (Narayan, 2020); successive migration policies that fashion and permit entry to the desirable (high income) migrant (Simon-Kumar, 2015); the rise of the academic precariat (Stringer et al., 2018); the mass corporatisation and then privatisation of state services such as railroads and airlines, the electricity grid, banks and primary industries such as forestry and fisheries (Kelsey, 1997). The research sector was not exempt from these changes. The 1990s saw the government's Department of Scientific and Industrial Research (established 1926), along with the research components of the Meteorological Service and the Ministry for Agriculture and Forestry, disestablished and reformed as Crown Research Institutes (CRIs). CRIs were modelled on private enterprise and were expected to fund their research through contestable funding allocated meritocratically, according to priorities set by the government. In keeping with the neoliberal telos, this was supposedly a more efficient way of organising research (Kelsey, 1997; Priestley, 2010). Aotearoa's particular brand of neoliberalism thus also embodies the contradictions at the heart of neoliberal thought, which does, after all, require state intervention, maintenance and often rescue to support the very processes from which it seeks to retreat (Miller et al., 2022).<sup>1</sup>

In general, the impacts of neoliberal reform on research policy (Miller et al., 2022) and practice have received less attention than sectors such as education and health. Science and Technology Studies (STS) scholars, however, have mapped the workings of neoliberalism in relation to the entrepreneurial university (Kleinman, 2003), the bioeconomy (Goven & Pavone, 2015; Miller et al., 2022) and the knowledge economy more generally (Tyfield, 2010). These accounts point to the enclosure of knowledge through mechanisms such as intellectual property law (Lave, 2012), the commodification of an ever-widening range of objects, such as biomatter (Cooper, 2011) and processes of assetisation, in which various financial and legal tools construct revenue-generating scientific assets as an even greater source of profits than commodities (Birch, 2017).

Whilst these processes unfold in locally particular ways<sup>2</sup>, they share a 'techno-solutionist bent' (Floegel & Costello, 2021) and a relentless orientation towards the sciences as a vehicle of value creation. In Aotearoa, as elsewhere, researchers are subject to intensifying forms of metricisation and audit culture, and incentivised to generate publications and other research outputs through schemes such as the Performance-Based Research Fund, which attaches research funding to scholarly performance indicators (Shore, 2010). However, sociologist Joanna Kidman (2020, p. 247) also draws attention to how neoliberal ideologies interact with Aotearoa's colonial legacies. She points to universities' performative embrace of inclusionary rhetoric and how swiftly that is transfigured into assimilative efforts that uphold colonial forms of knowledge production *and* market logics. Here, we bring insights from this literature to bear on interviews with KD and MR research practitioners; analysing their remarks from this perspective highlights how neoliberal reforms and ideals shape knowledge production work and act as a subjectifying force, shaping what it is to be a researcher in contemporary Aotearoa.

## A Brief History of Kauri Dieback and Myrtle Rust in Aotearoa

### *Detection of KD and MR in Aotearoa and institutional responses*

Kauri dieback and myrtle rust are both plant pathogens that affect native species, kauri and *Myrtaceae* (which includes taonga species such as pōhutukawa, rātā and mānuka) and have been targeted through joint investment over several programmes of research. Kauri showing symptoms of KD in several parts of Northland between 2005–2010 spurred research funding to support management operations via the Ministry for Primary Industry’s Kauri Dieback Programme to operationalise knowledge about kauri dieback (Froud, 2020). Fewer preparations were made for the arrival of MR, which was spreading around the world from its origins in South America and was detected in Australia in 2010. Urgent research support of \$3.8M was allocated when MR was detected in Aotearoa in 2017, followed by a joint investment of \$13 million in 2018 to support a range of research areas, including social, cultural (mātauranga) and natural science in response to a wider concern about impacts of the two pathogens on native tree species.

### **Phytophthora agathadicida causing kauri dieback**

Kauri dieback is caused by *Phytophthora agathadicida* (Pa), a soil-borne ‘water mould’ of the *Phytophthora* genus that impacts kauri trees at the root (Winkworth, 2020). Pa is easily disseminated as it has both sexual and asexual reproduction stages, which produce oospores and zoospores, respectively. Oospores are robust and allow Pa to be disseminated without the loss of pathogen efficacy (Froud, 2020). Being well protected, oospores are able to lie dormant in the soil for several years, awaiting optimal conditions (Bradshaw et al., 2020). Zoospores, alternatively, are ephemeral, motile and waterborne. Their flagellated tails allow zoospores to ‘swim’ in wet soils toward kauri tree roots, which is the site of infection. Once the pathogen enters through the roots of a kauri tree, it slowly cuts off the supply of nutrients to the canopy, where photosynthesis takes place, by killing fine roots and blocking vascular tissues (Guo et al., 2020). Visible signs of the pathogen’s presence include bleeding at the trunk and loss of canopy. A severely affected kauri will lose its scale-like bark, revealing a colourful pattern of cumbria characteristic of kauri trunks. When Pa was first detected in Aotea (Gadgil, 1974), it was initially misdiagnosed as *Phytophthora heveae*, then *Pythophthora taxon agathadicida* (Pta), and much later confirmed as Pa in 2008 (Beever et al., 2009). The difficulties in identifying Pa point to the complexities of this pathogen.

Kauri is an iconic species (Lambert et al., 2018). It has a long history of removal for land clearing (Steward & Beveridge, 2010) and was harvested extensively for timber until the 1920s when some measures to control kauri exploitation were introduced (Halkett, 1983; Sando, 1936). Māori have spiritual and kinship ties to kauri and the responsibility to guard and protect the species as a key evolutionary ancestor linked to Māori cosmology and origins stories

(Lawrence et al., 2019; McEntee et al., 2023). A response was initiated by MPI, tangata whenua (Indigenous people in relationship with specific geographic areas), Department of Conservation (DOC) and Local Authorities within the natural range of kauri (Hill et al., 2021). The pathogen was found in the Waitakere Ranges and other places in Northland between 2005 and 2010, where kauri trees were showing similar signs of decline as those that had been found earlier in Aotea (Beever et al., 2009).

A six-year research programme led by Scion, Healthy Trees Healthy Futures (2013–2019), was funded to address the threat of *Phytophthora* species to agriculture, horticulture and natural and urban forest estates in Aotearoa (Healthy Trees Healthy Future|Enabling technologies to combat *Phytophthora* diseases [wordpress.com]). In addition, the aforementioned Kauri Dieback Programme took place between 2009–2020. However, despite continued efforts, there has been a lack of progress towards solutions to control KD or its spread. The Ngā Rākau Taketake (NRT) programme, administered under the BioHeritage National Science Challenge (BHNSC), received funding to support a collaborative research development process. The NRT programme was given \$8 million in funding for KD that included investment in science and mātauranga (Māori knowledge) research to both develop knowledge and mobilise action across diverse stakeholders and in partnerships with tangata whenua.

Coordination of effort and resources in the management of KD has improved since the first two decades of its detection and identification in Aotearoa. Initial work focused on its distribution, establishing containment and hygiene measures, providing educational and awareness tools, and understanding how to manage the disease (Hill et al., 2021). This has contributed to a growing awareness of how far the pathogen has spread and (some competing) scientific theories on how long it has been in Aotearoa (Winkworth et al., 2021) and whether other factors are contributing to kauri decline, including encroaching development on kauri forests and climatic changes (Waller et al., 2022). Nevertheless, the loss of kauri remains a significant concern for both Māori and non-Māori people in Aotearoa.

### ***Austropuccinia psidii* causing myrtle rust**

Myrtle rust is a disease made visible by yellow pustules on the surface of young leaves and stems. Caused by *Austropuccinia psidii* (Ap), the disease was first detected in Aotearoa in 2017. The arrival of MR was anticipated, as it was spreading rapidly through the east coast of Australia since its initial detection there in 2010 (Ramsfield et al., 2010). MR is an airborne pathogen that can be transported by wind (Teulon et al., 2015). The pathogen is devastating because it affects the whole family of plants known as *Myrtaceae*, including species that are indigenous as well as exotic to Aotearoa, with a range of cultural, amenity and economic values (Teulon et al., 2015; Toome-Heller et al., 2020). There are over 500 known species of *Myrtaceae* globally (Narouei-Khandan et al., 2019), and, in Aotearoa, there are 27 known indigenous *Myrtaceae* (McCarthy et al., 2021).

Several exotic *Myrtaceae* are now part of the landscape as production species, garden plants and food sources. Efforts to prepare for the disease's arrival had begun as part of the Better Border Biosecurity programme (Teulon et al., 2015), and, in 2017, a research programme was funded to look at the resistance and susceptibility of myrtle species grown from seed and tested in Australia (Smith et al., 2019, as cited in Beresford et al., 2019). Māori networks had also activated and catalysed the formation of the National Māori Biosecurity Network, Te Tira Whakamataki (Black et al., 2019). In spite of this progress in better preparing for MR, little was known about how it might impact Aotearoa's myrtle species, as both local species and conditions differ.

Myrtle rust was first detected in Aotearoa on Raoul Island, part of the Kermadec Islands (1000 km northeast of the Aotearoa mainland), in March 2017 and found in Te Tai Tokerau Northland in May 2017. The government responded with an eradication programme implemented by MPI's Biosecurity New Zealand and initiated surveillance undertaken by contract organisation AssureQuality to determine the extent of the outbreak. By May 2017, the pathogen was found in Taranaki, Waikato and the Bay of Plenty, and, by June 2018, it was found across many other sites, including Wellington and Tasman. Biosecurity New Zealand decided to move to long-term management, and, in August 2018, government surveillance ended (Beresford et al., 2019; Toome-Heller et al., 2020). By December 2018, MPI had allocated \$3.7 million to urgent research over two years to 2020, and a communications campaign was initiated to increase awareness of MR.

In late 2018 following a meeting of the Strategic Science Advisory Group (SSAG), made up of key advisers from Crown Research Institutes, the Department of Conservation and the Ministry for Primary Industries, it was decided that there would be greater benefit from combining KD and MR investments to build tools and capacity to respond to both these pathogens. Ngā Rākau Taketake was a result of that decision and was provided with a total of \$13 million (combining \$5 million for MR and \$8 million for KD) to run a multidisciplinary programme addressing both pathogens. A five-year, \$13 million Ministry of Business, Innovation and Employment (MBIE) programme, Beyond Myrtle Rust, was also funded in September 2018 to understand the behaviour, ecology and impacts of the disease in Aotearoa. The story of KD and MR to date has thus seen a convergence of these two plant pathogens in the face of vexing scientific difficulties associated with each. They have attracted concerted political focus, which has shifted over time from eradication to management and has prompted changing organisational and funding arrangements to attempt to generate the knowledge and practices necessary to control these two plant pathogens.

One of the projects initiated under the NRT Mobilising for Action theme, 'Postcolonial Biosecurity Possibilities,' worked with the existing NRT programme activities and beyond to explore researchers' unfolding relationships in working toward tree protection and restoration. Key to the NRT was working with a waka

hourua model that positions western science and mātauranga Māori sat side by side, contributing to knowledge development that could be enacted by both Māori and non-Māori. Our interviews recruited participants from across the research landscape of KD and MR knowledge production activities. Our exploration of the experiences of researchers and practitioners connected through the concerns about KD and MR provides insights into how neoliberalism impacts these actors' abilities to protect trees of social, cultural and ecological importance.

## Methods

This paper combines data collected from two different projects within the Mobilising for Action theme of Ngā Rākau Taketake: one, a Master's research project on KD led by Ehler and the other, an action research project spanning KD and MR. Both projects comprised social science explorations of how key actors experienced and characterised the KD and MR research landscape, and both followed a constructivist, semi-structured interview methodology.

The Master's project was concerned with understanding the relational values held by KD knowledge producers. Relational values are a subset of environmental values that emerge from the relationships between people and the natural environment (Chan et al., 2016). This thesis, therefore, looked at the relationships between knowledge producers and their subjects of study: kauri trees. The thesis found that there were institutional forces in the KD research system, which hindered participants' ability to realise their values. Between July and September 2021, the Master's project collected six semi-structured interviews with scientists working in the KD research and operational space. Four interviewees worked for universities, and two worked at a botanic garden that is owned and managed by the city council. Participants were invited via email to be part of the study, and the interviews were a mix of online and in-person, depending on location, participant preference and COVID-19 restrictions. Interviews ranged in length, with the shortest being ~40 minutes and the longest ~90 minutes. The interviews were recorded with participants' consent and later transcribed. The data collection was approved by the Victoria University of Wellington Human Ethics Committee (#29543). Participants had the opportunity to review their contributions and the findings in the final report.

The second project explored the question of what postcolonial biosecurity possibilities emerge by mapping shared and relational values around kauri and *Myrtaceae*. Between March and June 2021, twelve interviews were conducted with participants involved in KD and MR research both within and outside of NRT. This participants group included research managers, community advocates, operational staff, kairangahau (Māori researchers) and science researchers. The interviews addressed participants' care practices and the lessons they had taken from KD for responding to diseases that impact other native plants. Interviews were conducted by three members of the research team, online or face-to-face, and ran from 20 to 60 minutes. Participants were invited initially via email and, for those that were



interested in taking part, supplied with an information sheet that was followed by a phone call to discuss the research and obtain informed consent; for in-person interviews, consent was granted and recorded verbally. Data collection was approved by Manaaki Whenua Landcare Research ethics in human research protocol (2021/24 NK). An online questionnaire on care practices was also distributed among ten community members (some of whom were also researchers). Interviews were recorded and transcribed, then analysed in NVivo12 (along with questionnaire responses) by Ehler while working as a research assistant on the project. Members of the research team reviewed and discussed the coding conducted, adding insights to the development of the code frame and thematic analysis.

The decision to combine datasets from these two projects had multiple motivations. Being part of the same broader NRT research undertaking, the projects shared a common topical interest in KD and MR. Furthermore, both were initially interested in the values key actors brought to this space. Despite working with interview guides designed to elicit different conversations, there was also significant resonance between the project's findings, which Ehler was able to detect during the coding process and discuss with the wider Postcolonial Biosecurity Possibilities team. The framing of this paper, which focuses on the neoliberal shaping of the plant pathogens impacting native species in Aotearoa, emerged from a recognition, in the findings, that when talking about values and care, participants were often talking about the difficulty of realising these in practice.

## **Results**

### ***'A tree is not a tree': Knowing plant pathogens***

As an island nation, Aotearoa's abundance of endemic flora and fauna species had evolved in isolation for 65 million years (Lambert et al., 2018). In the 19th century, European settlers migrated to Aotearoa, introducing foreign species, pests and diseases, which competed with the existing native ecosystems. Together with damaging changes in land use and brutal deforestation, these introduced species have competed with the existing native ecosystems, causing the population of indigenous species to fall drastically. The diminishing population size in Aotearoa's flora has increased plants' vulnerability to plant pathogens. Studies have found that kauri are more likely to be impacted by KD when they are near walking and cycling tracks (Froud, 2020). Similarly, at the edges of forests or in sites prone to human disturbance appear to be more vulnerable.

Research on KD and MR is characterised by a swathe of unknowns about the natural history, behaviour and impacts of the pathogens. In part, these unknowns reflect the novelty of plant pathogen management in Aotearoa. Participants shared honest, eye-opening and, at times, very moving accounts of their experiences with KD and MR research to shed light on the challenges that are embedded within this

novel field of research. One participant drew comparisons between pest control and pathogen management to explain the challenges of the latter:

We've done possum control, and weed control, and rat control, and stuff like that for a long time. They're areas where there [are] sort of reasonably good toolkits available. People know how to do those things. They're somewhat formulaic ... but I think one of the things about this plant pathogen stuff is that it's an area that we didn't historically – prior to kauri dieback, we weren't active in that space at all. We've really had to learn and grow an entire team in that space from nothing. [Operational C#02]

This lack of any historical plant pathogen response means that a lot of the tools and management strategies for KD and MR are being developed for the first time. Another participant acknowledged that the gaps in basic knowledge about Aotearoa's native species were limiting how effectively KD, and its ecosystem impacts, could be addressed.

I mean, just look at how ill-equipped we are as a nation to deal with all of this. You'd think if we couldn't determine even where kauri was when we started to get worked up about kauri dieback as a pathogen, that we had to build that up from ground zero for one of the most conspicuous trees that is rather geographically confined, then what the hell prospect do we have for most others? [Researcher C#06]

Continuing, this person argued that there are challenges in addressing not only KD but also other pathogen issues because so little is known about the native host plants themselves. 'We know so little,' they added, 'we have invested so little in knowing about just the most basic ecology of nearly all our trees.' From this account, a lack of knowledge about KD and MR is secondary to a more profound ignorance about the native trees of Aotearoa, for which even basic information about distribution is missing. Another participant added concern due to the likelihood of future invasions of plant diseases impacting native species:

It's kauri dieback, and it's myrtle rust, and there's more diseases floating round on the global sphere [that are] going to make their way sooner or later to us. So, what we need is to model how do we do pathogen invasion for our native flora in New Zealand. How do we combat that? [Researcher T#06]

In this way, KD and MR have the potential to establish better plant pathogen responses for future plant diseases, but they also highlight the scale of the research challenge in the here and now. Another researcher articulated how difficult it was to work from this total lack of a research base: 'From my scientific perspective, the biggest barrier preventing me from understanding how to care for trees is a lack of

baseline data, specifically in native forests' [Researcher C#, Questionnaire]. Geographer Rebecca Lave (2012) suggests that basic science research often falls victim to 'the tyranny of relevance' that characterises so many neoliberalised science sectors. Logics of 'relevance' demote research by directing funding to work with obvious commercial value. Here we find a pronounced deficit of basic information about species of profound cultural significance that is only being addressed now that those species have become a biosecurity risk.

If a lack of information about native trees represents one barrier, the pathogens themselves are another. Researchers explained that there were aspects of both Pa and Ap that made their research challenging. 'Some of the biological attributes are just that much more challenging than some of those other species' [Operational C#02], another participant explained. These pathogens are complex, difficult to visualise and somewhat paradoxical in that they disseminate rapidly yet kill slowly. Together, these attributes make Pa and Ap difficult to understand and consequently manage. The invisibility of the pathogens can create doubt among researchers and practitioners regarding the distribution and dispersal. As one person described,

If you do some surveillance and you find the plant pathogen, well, you know it's there ... [but] if you don't detect it, it doesn't mean it's not there. It could be that you just haven't looked hard enough yet. [Researcher C#01]

For this reason, it is often only when an infected tree starts to show visible symptoms of the disease that it becomes certain that the pathogen is present. This is complicated by the fact that both pathogens are relatively slow acting. In the case of Pa, there can be a delay of several decades from the tree being infected before it starts to show symptoms of the disease (Froud, 2020). Ap is a similarly 'slow killer,' in that it can take several years before it starts to notably impact a tree's growth. As one person explained,

It [myrtle rust] is disheartening, and because it's so slow ... you can go out, and you can look at them [infected plants], and they look okay. If you look up closely, you can see that they're not quite as green and lush as they might usually be. It's not quite right, but, in general, the tree can look okay. [Researcher L#10]

The protracted action of the pathogen makes it difficult to 'visualise' since even infected trees appear healthy in the early stages of their infection. The same person went on to say,

I think that what a lot of people don't realise is how much of a slow killer this disease [myrtle rust] can be, in particular, for species that aren't highly susceptible, and that's where we don't have a very good understanding of what's going to happen. [Researcher L#10]

Because it takes some time for KD and MR to cause discernible symptoms in affected trees, it is difficult for researchers to gauge the true distribution and, subsequently, the impact of these pathogens. These factors also create a high barrier to entry for understanding and working with KD and MR. One person explained that in their role as a strategic advisor, the nature of these pathogens has complicated their ability to make informed and strategic decisions.

I'm used to being able to come into a situation and suck up the sort of more specialist technical knowledge that some other people in the team will have and ... pull out that key strategic direction, and it's becoming increasingly difficult with some of these more complex things like pathogens to really come in lightly ... without having that depth of immersion.... I feel really conscious that if I come in, in that kind of light touch sort of way, I'm likely to put my foot in it because of how complex it is. [Researcher L#10]

They continued on to describe this pathogen research as being 'all consuming' in the sense that they felt the need to commit a lot of time and work in order to develop a well-rounded understanding of these tree diseases. 'You're either all in, or you're not in at all,' they stated.

These complexities are further compounded by broader knowledge gaps that make it hard to predict what these diseases might ultimately mean for Aotearoa:

There are a lot of ecological questions that haven't been answered, and that means that we can't answer things like, 'What's this going to look like in 50 years' time if we just let it run? Are there going to be any kauri left?' Some of those really big scary questions. I think there are still big unknowns. [Researcher L#11]

These sentiments were shared by another participant who pointed out that

We have no idea the impacts of *Phytophthora agathidicida*.... What would that mean for the future of that species? What would that mean for the future of the landscape? [Researcher T#02].

As with most diseases, gaps in understanding of how Pa and Ap function make it difficult to come up with effective management strategies. However, they also make it difficult to gauge the potential scale of the problem – a problem, notably, that is not just ecological but also social, cultural and political.

A further layer of complexity emerged when some researchers acknowledged that Pa and Ap were not straightforwardly problematic pathogens. Although these pathogens are not native to Aotearoa and are destroying trees within the ecosystem, some interviews also framed them as legitimate actors in those ecosystems themselves. One participant mused whether Ap performed a useful ecosystems function:

All of these microbes have a role, and there's not a silver bullet – it's not going to fix it. But it's part of what makes a healthy ecosystem; it's part of what makes plants resilient. [Researcher L#10]

Rather than framing pathogens as invasive or intrusive, here, the participant acknowledges that they can be considered as belonging to an ecosystem. For example, in South America, where Ap originated, the plants that have co-evolved alongside MR are not notably impacted by it. This same participant shared similar sentiments for Pa, stating that, although it causes a devastating tree disease, it is nonetheless part of the wider ecosystem and part of the bigger context in which kauri live:

They [plant pathogens] serve a function. It's that part of realising that a tree is not a tree. It's a community of organisms that all live together. And that's no different from *Phytophthora*. In their natural environment where everything's in balance, *Phytophthora* don't continuously cause huge disease issues.... In a normal ecosystem, it's all in a level of balance.

From this perspective, disease is not just a result of a pathogen's action but rather of a broader loss of equilibrium in the wider ecosystem. By extension, understanding these plant pathogens is a matter not only of understanding the pathogens themselves but of understanding and addressing the pathogens *as* relations. Through reflections such as these, researchers reframe the problem of KD and MR, decentering Pa and Ap and reintroducing a broader set of no-less-complex questions about how the native ecosystems of Aotearoa have become vulnerable to these pathogens in the first place. This perspective also challenges the eradication logic that underlies the country's typical biosecurity operations – and one interviewee levelled this challenge directly.

We've been primed to think success in biosecurity looks like eradication.... [That] really plays out quite poorly when you're thinking about pathogens because it's not eradication. [Operational C#02]

For these researchers, eradication is not necessarily the ultimate goal of managing these diseases. Rather, the focus may need to be shifted towards restoring balance to the ecosystem through disease management comprised of long-term practices that 'minimise the spread of the pathogen' [Operational C#02] and keep infectious agents at a low level.

Indeed, the complexities associated with understanding the basic characteristics of Pa and Ap become complexities in managing and mitigating these pathogens. In interviews, participants reflected on the fact that there was no single or easy answer to either KD or MR. 'I don't think there'll ever be a silver bullet in my heart of hearts' [Researcher Community L#09-2], one person stated. Instead, interviewees

maintained that effective management of these plant diseases would consist of a ‘toolbox’ of different solutions, which could collectively help to address these diseases. A myrtle rust researcher suggested as much, noting that possible MR solutions would probably be context-specific:

Myrtle rust is a very difficult pathogen to deal with ... and we have a lot of different tools. We might have some things which are applicable for one kind of environmental situation, but that might not be suitable for something else. [Researcher L#10]

From this perspective, good MR management had to respond not only to the pathogen itself, but also to the context of the affected trees. As such, this participant felt strongly that there was room for a multitude of management practices and that holding out for ‘one cure’ was a fruitless endeavour, particularly regarding Ap, which could impact a wide range of host plants. ‘It’s not going to be a one-stop shop,’ they added, ‘people [have] to understand it’s often a range or a suite of different things, and it also has to be tailored to the particular plant species’ [Researcher L#10]. Another participant reflected on how appealing but unrealistic the idea of a single, effective solution could be; speaking about the wash stations installed at bush entrances to mitigate the spread of Pa through soil particles on recreational equipment like hiking shoes and bikes, they said:

It’s like we’re holding out for something that is 100% going to kill everything that passes through those washdown stations. Yet when you draw a parallel to COVID, we all know that you have to wash hands and you’ve got to use hand sanitiser and stuff, but we all recognise that’s not the only part of the solution. And, so, I find that ... it’s almost as though we’re not game to start doing things that help the cause if they’re not absolute when it comes to kauri dieback. [Researcher L#11]

Indeed, participants felt that a ‘toolbox’ of management practices was a less appealing proposition in the public eye because the contributions that each of those management strategies makes on their own may be unrecognisable. These interviewees’ comments implicitly recognise the social and political predilection towards solutionism. A hallmark of neoliberal thought, this has been framed variously as the desire for market-based (Lave et al., 2010) and/or technological (Floegel & Costello, 2021) solutions to what might be better thought of as social problems requiring complex, social-political-economic solutions. In advocating for modest, partial and incremental plant pathogen management, these respondents challenge that logic whilst acknowledging the appeal it holds for both political and social audiences.

***‘The quickest way to achieve nothing’: The structure of Aotearoa science***

The ecological complexities of kauri dieback and myrtle rust are well-matched by the field’s socio-political challenges. Researchers lamented that fragmentation of the research sector and conservative norms around data enclosure resulted in work not being done at all or being duplicated by different people and organisations. One researcher described the KD space as ‘quite a fractured community, where people don’t necessarily share ideas or talk even though it’s been really strongly encouraged for that to happen’ [Researcher #T03]. This person directly links sharing practices with institutional fragmentation, highlighting the potential epistemic stakes of organisational order. Indeed, researchers lamented how difficult it was to break out of their institutional silos and learn who was working in allied spaces. As one person observed,

People do their best to work *around* the fragmentation of our science programmes, and our science institutes, and our science funding, but it’s frustrating that we have to do this. That there even are two myrtle rust programmes in this country, to me, is absolutely nuts; it’s bonkers.... I think we’re all doing our best to try and keep connected and talk to each other and understand who’s doing what so that we’re not doubling up in an unproductive fashion. But ultimately, if we are all split, not only across different institutions but across different funding streams, it becomes more difficult. [Operational C#05]

This person went on to point out the irony of the interview itself, in which the interviewer was funded by one agency to learn about MR, while the interviewee was funded by another group entirely to carry out research in the same space.

One person contextualised this with reference to Aotearoa’s history of research sector reform. Citing the creation of CRIs in the 1990s and the subsequent dispersal of researchers across organisations, they explained,

some [researchers] went to Ag Research, some went to Manaaki Whenua, some went to NIWA, but they all used to be in the same division, and some went to Scion, and then they were suddenly not allowed to talk to each other. No, we’re competing.... So, it tore the heart out of collaboration, collegiality, out of even one discipline, let alone working with social scientists or economics or whatever, chemists, physicists, whatever, right? So that was at the heart of why people didn’t talk to each other, actually. [Researcher Community L#09-1]

This interviewee directly attributes the lack of collegiality and collaboration they experience in the research sector to the structural changes instigated by the reforms, sometimes colloquially referred to as ‘the New Zealand experiment.’ Another interviewee spoke about the fallout from this period, reflecting on how the early days of Aotearoa neoliberalisation undermined their previously strong working relationships with iwi:

I began my career in rural Te Tai Tokerau, where mana whenua were employed to work in the ngahere. And the people who did were knowledgeable.... The government reforms of the early 1980s filleted that social compact, and only now are we starting to see that reconstructed.... So, the government is being responsive to it, but I think the government of the 1980s destroyed that compact and did so with a vengeance. [Researcher C#06]

Participants placed a great deal of value on close and mutually beneficial working relationships with tangata whenua, and comments such as this highlight the wider effects that institutional (re)arrangements have on relationships within and beyond the research community. Though ostensibly guided by ideals of greater efficiency, these accounts suggest that research restructuring produced its own inefficiencies, making it harder for researchers to work in dialogue and to sustain the relationships that inform and support their work.

The logic of competition that underwrote research sector reform was also framed by several participants as an obstacle to good research practice and outcomes. 'We are all set up as competing organisations,' one respondent said, 'And that is so, so anti to what I've always thought was appropriate for New Zealand because we actually do our work for New Zealand' [Researcher L#08]. This tension between common purpose and competitive funding was also expressed by a university researcher:

You can say, 'ooh, we're going to have this grand collective team,' but if you're still putting people in competition for each other, for not enough resources to do what we need to do anyway, like, of course, people are going to get titchy. [Researcher T#03]

From these perspectives, pitting people with a common goal against one another produces inefficiencies and perhaps even resentment. Indeed, one researcher described competitive funding models as 'the quickest way to achieve nothing' [Researcher T#01].

One way researchers saw these inefficiencies manifest was through data-sharing practices – or a lack thereof. One interviewee explained that researchers 'put a lot of effort into collecting data and want to have a go at analysing those data and publishing them and getting due credit for them. Sometimes that takes a long time, and those data aren't available for others. That's not necessarily a bad thing.' They continued later,

I think there's always a sense of ownership, particularly among researchers, a sense of protection of one's own data.... A lot of effort and money goes into collecting data, and I think people are reluctant to just hand it over to others to do great things with when they're hoping that they're going to great things with it. It just seems a little bit more extreme in this case with the plant pathogens, in particular, with management



agencies such as DOC and MPI where they're really – I guess they're not after research publications.... It's a little bewildering why there would be that sense of the need to protect data and not share widely. Maybe I'm being a bit unfair because I think they are coming to the table. I think we are starting to get a sense that we'll be able to share data among groups. But it's taken a long time. [Researcher C#01]

The conservative or proprietary approaches to data that this interviewee describes arise from both institutional constraints and cultural norms that construct data foremost as property. As STS scholars have demonstrated, commodification and assetisation are now part and parcel of contemporary scientific life, fortified through intellectual property mechanisms and incentivised by research institutions increasingly driven by commercial interests (Birch, 2017; Cooper, 2011). These proprietary norms are also intimately tied to the precarity produced by a competitive research environment, as one respondent communicated:

I mean, even among DOC and MPI and the Crown Research Institutes and researchers, there's so much uncertainty about our futures, not only as our working groups but us as individuals, and where we're going to get our next grant. And having those data and being able to do something significant with it is really important for justifying getting that next grant. [Researcher C#01]

Here, workforce pressures are exacerbated by a structural environment that ties job security to funding and funding to privileged access to data. A different participant drew out the personal toll these uncertainties could take.

There's this ironic situation, I guess, where it's very competitive, right? A lot of people want to do this kind of work because it's rewarding, and it has meaning to them.... But once they get into it, they find it can take an enormous personal toll on their lives because of the competition [Operational C#05]

Here, this participant points to a common theme from our interviews: strain and burnout amongst individual researchers, which *en masse* risk becoming a problem of retention and workforce longevity. We thus begin to see linkages between institutional research structures and the social relationships that those support or curtail, which 'trickle down' to shape individual experiences of being a researcher in this context. This is emblematic of what Kidman (2020, p. 249) describes as the 'affective regime that has come to dominate the neoliberal workplace,' in which precarity, surveillance and managerialism all interact to shape researchers' experiences of their vocation.

Importantly, some people spoke about their own efforts to counter proprietary norms around data access and ownership. One individual spoke about their ambitions to open up data to a wider range of users:

I think my main aim or aspiration is to ... make science available to guide decisions so that all decisions with regard to managing plant pathogens in our forests are evidence-based. And, so, my work and my contribution, I'm hoping, is trying to facilitate that process by which people have access to data, can share data and have tools to understand those data, to make better decisions for management of our forests. [Researcher C#01]

This person explicitly connects broader data access to better environmental outcomes and, in doing so, indicates one point of purchase from which dominant institutional norms might be challenged. Another person spoke about the data management system they were building, which itself became a platform for fostering relationships alongside data sharing. They explained,

The approach is really to, at the very foundation, make the surveillance system work for Māori. And, therefore, it starts out at the very foundation being hapu-centric and a system that respects data sovereignty and cultural authority and allows other agencies, researchers, universities, Crown agencies, such as DOC and MPI, to come into this system to access data, contribute data and to facilitate connection between Western scientists and managers and mana whenua on the land. So, yeah, developing that collaboration by having a [pathogen] surveillance and data management system that keeps everyone happy, so to speak, and then providing a basic data analysis tool ... and it brings in Western science data collection and risk models, but it also aims to bring in mātauranga, the knowledge system, into it as well. [Researcher C#01]

Reflections such as this demonstrate how practical research tools shape data practices, which in turn open up new opportunities for collaboration and, more widely, doing science differently. In other words, for these researchers, the work of doing KD and MR research is not just the work of learning about two pathogens but also the work of navigating and potentially changing the research culture in which that work takes place.

Another participant spoke about the social labour they performed to counteract the lack of connection between researchers in the MR space. They told a story of a conservation worker in a remote part of the country who had recently observed MR in a species that had not previously been affected in the wild. This person's employer wasn't resourced to work on MR, so they were monitoring the disease without any formal institutional support, and the interviewee, having gleaned this information, was now trying to figure out who they could notify in the hopes of generating a more effective response. The participant added,

They probably already know because everyone talks to each other, but they might not, so I'll tell a few people, and the word will get around, but how silly? How silly that it has to happen like this? And that there's not one – I mean, I tell you what I really think, too, there should be one

authority for managing and communicating funds and discoveries around plant disease in this country. It's crazy. [Operational C#05]

In this story, people's relationships are employed to offset the detachments that arise from a resource-limited, institutionally fractured research sector. While organisational order and norms can stifle data and knowledge sharing, people's own social resources and motivations are, in some instances, brought into play to circumvent such barriers.

## **Discussion**

To date, the KD and MR research has been characterised by ecological, social and political challenges. We argue here that the disparate issues that interviewees identify - a lack of basic research, institutional fragmentation, a culture of competition and data enclosure, and the allure of techno-solutionism - all reflect the ongoing effects of Aotearoa's extensive neoliberal turn. Beginning in the 1980s, this so-called 'New Zealand experiment' reshaped virtually all aspects of the country's public and private life. However, while a lot of attention has been dedicated to the damage these reforms have done to higher education, less has considered their effects on the research sector and knowledge production. This is even though science and technology are widely considered to be central to the neoliberal turn due to their value-generating potential. Biosecurity itself, entangling governance and knowledge production, arguably no longer sits neatly within an economically oriented neoliberal setting, instead resembling one that connects and realises diversity in valuing and value creation practices (Ayala, 2022; Black et al., 2021). Against this recognition of the limitations of practices associated with neoliberal goals expressed by our participants, we note the current review of the Aotearoa science, research and innovation system, Te Ara Paerangi. The current organising goal (vision) for Te Ara Paerangi, expressed in a white paper that is currently in circulation, is for '[a]n RSI system that supports wellbeing for all current and future New Zealanders, a high-wage low-emissions economy; and a thriving, protected environment through excellent and impactful research.' This statement, which places the economy at the heart, if not the very start, of a renewed vision for Aotearoa science, suggests an ongoing neoliberal inflection in local knowledge production.

Here we have built on scholarship from STS, in particular, to consider the imprint of neoliberal policy on the current plant pathogen landscape in Aotearoa. This is most obvious in the institutional structure of the research sector, where Universities and Research Institutes work together on a common problem and simultaneously work in competition over funding and data. However, it is also evident in how neoliberal norms, values and assumptions shape the way research is undertaken and received. For example, we see in these actors' accounts how disinvestment in kauri and *Myrtaceae* species, which hold deep cultural meaning but are no longer readily commoditised, has left researchers struggling to solve an urgent biosecurity problem with a deficit of basic ecological data. Of course, even

with adequate baseline data about species distribution and so on, a good outcome for KD and MR might not resemble the type of (techno) solution favoured under contemporary value regimes. Here, the resourcing, organisation, norms and expectations that sciences are subjected to all shape how knowledge is or is not produced for a problem of national significance. They also profoundly shape the experiences of those conducting research in this space: people who are often passionate and motivated about addressing plant pathogens but are burnt out by the toll of constant competition and workforce precarity.

There are lessons here for the future of Aotearoa science, which is poised for change through Te Ara Paerangi, but perhaps, noting some of our participants' comments, through changes developing from the ground up as well. (Recall one interviewee's comment that government agencies were increasingly 'coming to the table'). One of the challenges for Te Ara Paerangi will be how to realise new organisational forms for research that can redress some of the fragmentation our respondents described. The review might also consider the place of less obviously commercialisable knowledge production: basic science research, but also social sciences and related humanities fields that offer new ways of engaging with a world at risk and the diverse people who share it. Whether Te Ara Paerangi can challenge a market orientation that has been embedding now for several decades remains to be seen. However, as this account shows, that orientation is taxing the research landscape in myriad ways. One possible entry point to this issue is to critically open up how seemingly benign concepts (efficiency, relevance) are actually constructed and mobilised in exclusionary and harmful ways. This paper has set out some suspected problems in Aotearoa's research landscape, as seen by those working on one particular environmental problem. Future research should take the suggestions made here further: investigating how policy materially shapes what research is done in Aotearoa and how, and empirically exploring knowledge production practices *as they are shaped* by political, economic, social and institutional forces.

## **Conclusion**

Since they were respectively detected in Aotearoa|New Zealand, *Phytophthora agathidicida* and *Austropuccinia psidii* have seen multiple efforts to reorganise research and policy in ways that might facilitate their elimination and, more recently, management. The accounts presented here map a host of challenges faced by researchers, policymakers and advocates in the plant pathogen space. Kauri dieback and myrtle rust themselves pose a formidable scientific challenge, with a lack of baseline ecological data compounding the difficulties of knowing a complex pathogen and its impacts. However, interviewees also highlight social and institutional factors that compound those challenges relating to the legacy of neoliberal institutional designs over research investment and management. This data offers an important insight into the lived and material effects of neoliberalism in Aotearoa's research sector, highlighting how socio-political factors interact with

pathogens to produce a particularly vexatious research problem. It bears noting also that KD and MR are not only research problems – they are also social issues, bearing on species of great cultural significance and highlighting fault lines in the contemporary political order of the country.



Susanna Finlay-Smiths, <https://orcid.org/0000-0002-6331-9284>

Andrea Grant, <https://orcid.org/0000-0001-5952-1976>

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### **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. This is illustrated in Dew & Davis's (2014) analysis of Pharmac, Aotearoa's pharmaceutical procurement agency, which they describe as 'a case of neoliberal governments putting in place institutional barriers to neoliberal agendas' (p. 150). The organisation was created to reconcile competing tensions between expectations of public healthcare provision, and the need to constrain costs, which, the authors argue, has largely resolved through a decision-making process organised around objective funding criteria and occurring at a remove from government.

2. For example, Elizabeth Popp Berman (2014) suggests that economisation might more accurately capture these dynamics in the USA. In her case, government is not necessarily small, but remains dedicated foremost to economic growth. Economisation turns attention to how technological innovation and knowledge production become enrolled into the pursuit of economic growth, and how private interests are brought into the sciences, through industry partnerships, private research funding, and intellectual property.

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