Genetic Technologies

and

OUR ENVIRONMENT

National Conversations on Genetic Technologies for Environmental Purposes

Using Deliberative Processes To Gather Perspectives From Across Aotearoa

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Statement of Authorship

This report is a compilation of separate reports prepared by each of two research streams that investigated people's perceptions of the use of genetic technologies for environmental management and conservation purposes. The research had two engagement streams:

- General Public engagement undertaken by researchers from the University of Otago and the University of Auckland;
- Māori engagement undertaken by researchers from Te Tira Whakamātaki (TTW), the Māori Biodiversity Network.

Each research stream addressed similar research goals and used phased research methodologies that had commonalities and differences that adapted the research techniques to suit their respective communities. After each research phase, the collected data was analysed and emergent understandings were used to iteratively inform each stream's approach to the next research phase.

Each research stream prepared separate research reports that are combined in this document using the following structure:

- Part A — Research rationale and literature review common to both streams
- Part B — Research methodology, findings and insights from the General Public Engagement stream
- Part C — Research methodology, findings and insights from the Māori Engagement stream
- Part D — References and appendices common to both streams

Executive Summary

Background

This report outlines research findings into New Zealanders' perceptions of genetic technologies for environmental and / or conservation purposes. The work was funded by the Biological National Science Challenge, based on the awareness that *'before we adopt any new technology we must ensure it is suitable for our lands, our native species and our people'*.

To better understand what 'suitable' means to the public of Aotearoa New Zealand, we have engaged people in dialogic and deliberative processes to enable them to deliberate and design in groups what environmental futures might look like for specific genetic technologies in specific contexts.

This research was conducted in two streams, one focussing on engagement with the general public and the other focussing on engagement with Māori to elicit specific aspirations and concerns about gene technology in a way that they self-determine. The public engagement was undertaken by social scientists at the University of Auckland and the University of Otago.

Māori engagement was undertaken by researchers at Te Tira Whakamātaki (TTW). Māori participation in modern biosecurity follows a pattern similar to other Indigenous efforts at asserting Indigenous environmental approaches. These efforts are constrained by colonial histories and ongoing systemic marginalisation, with rare moments to pursue self-determination but occasional opportunities to engage and inform wider strategies.

Methods

Engagement with the general public included three phases: Explore, Refine, Deliberate. A total of 376 participants engaged in 38 engagement events (workshops), 43 deliberative focus groups who deliberated on a total of 69 scenarios.

In the first phase, a wide range of New Zealanders were engaged in discussions about their visions for environmental futures and to consider the use of genetic technologies.

In the second phase a broad range of stakeholders were engaged to understand the technical feasibility of genetic interventions, determine a set of environmental scenarios where genetic technologies are seen to have a potential role, and to explore the range of concerns these scenarios might raise.

In the third phase, the public were again engaged, this time in small group deliberations addressing four specific environmental scenarios: myrtle rust, wilding pines, rats and varroa mite, using RNAi (myrtle rust; varroa mite), gene editing (wilding pines) and gene drive (rats). Each group was asked to reach a consensus decision on the tools they wanted to see in New Zealand's environmental management toolbox, and what cautions or guidelines they wanted considered around the use of management tools.

TTW used two methods to gauge Māori attitudes to, and beliefs on, genetic technologies. They undertook a national survey and received 537 responses, with 26% who self-identified as Māori and 74% as Pākehā. They assessed people's

- support for using genetic tools in pest control and environmental protection;
- comfort with various genetic technology tools;
- trusted information sources.

TTW complemented the survey with group discussions to explore the attitudes, motivations, and cultural nuances underpinning comfort and discomfort to genetic tools in biosecurity. Participants included Māori researchers and academics, community members and kaumatua active in biosecurity. Five scenarios were presented that were specific and of relevance to their communities. These were: De-extinction: Bringing back the Huia; Genome Editing: Mānuka and Pōhutakawa Resistance to Myrtle Rust; Sterile Insect Technique: Fruit Fly Invasion; Transgenics: Kūmara Resistance to Insects and Gene Drive using CRISPR: Possum Infertility.

Key Findings

General Public Stream Phase 1

- ➔ Environmental visions are a key framework in which hopes and desires help to determine a sense of problems and opportunities. For many New Zealanders, the potential role of genetic technology is largely imagined through predator control, including the aspirational Predator Free 2050 project. People have a wide range of perspectives, reflecting hopes and concerns for technology, environment, society, economy, cultural values and beyond.
- ➔ Who should sit around the decision making table? Trust in science remains high, while trust in industry is lower.
- ➔ While the questions around genetic technologies for the environment are not top-of-mind for many New Zealanders, there is a desire for more information and, importantly, for more conversation. This needs to be accomplished in ways that hear and acknowledge multiple views and visions as legitimate, even if people feel a sense that, because they don't know enough about genetic technologies, they lack epistemic legitimacy to speak.
- ➔ Fundamentally, New Zealanders saw the possible introduction of gene technology into the environmental management architecture to be less about the technologies themselves, and more about the social, economic and environmental factors.

General Public Stream Phase 2

- ➔ Science and innovation is often presented to the public in relation to radical and/or futuristic ideas. For quality public engagement, it is necessary to present feasible science, connected to actual problems and genuinely targeted and reachable solutions.
- ➔ The variety and specificity of the technology is often quite distinct from the way gene technology is imagined in the public sphere. Specifically, gene silencing (RNAi) is a front runner in terms of potentially applicable technology.

General Public Stream Phase 3

- People can deliberate with a deep and nuanced consideration when supported with appropriate and contextualised information about environmental scenarios and potential technologies.
- Decisions about the inclusion of genetic technologies in the environmental management toolbox are accompanied by a wide range of cautions, not only for ecological impacts, but also for social, cultural and economic impacts. People wish to see high levels of regulation and oversight of these technologies, both New Zealand wide and internationally, if they were to be used.
- While trust in science is generally high, people wish to see more research done, particularly in contained environments. Trust in industry tends to be much lower, with suspicion levelled in particular at the idea of profit making from genetic technologies, while costs to industry and to exports were also of concern.
- Not everyone accepts environmental problems as presented, and even if they do this does not imply an acceptance of new technologies as solutions. If problems are seen as urgent this raises the acceptance of the possible use of genetic technologies, but not universally.
- Potential support for the introduction of a technology is not determined by the technology itself. Non-technical factors, from commercial interests to whether the intended target is flora or fauna hold more sway over such positions.
- The link to commercial interests is viewed as a concern when it is perceived as potentially biassing, but viewed as a positive when potentially holding industry to account.

General Public Stream Deliberations on the Specific Environmental Issues

This research used a deliberative process with public groups to hear their views on whether and how genetic technologies should be used for four specific environmental scenarios, and what cautions they would want to see in place.

Summary of Public Deliberation on RNAi for Myrtle Rust

- Almost half of the public groups decisively supported the inclusion of RNAi as a genetic technology in the environmental toolbox for myrtle rust, largely as a replacement for fungicides. However, all groups recommended a cautious approach with regulatory control, careful implementation and more and continued research needed to monitor and address ecological and off-target impacts and issues of ownership.

Summary of Public Deliberations on Gene Editing for Wilding Pines

➔ Some groups expressed strong support for the inclusion of the technology in the environmental management toolbox, or for more research into its possible use. But this was tempered by concerns about the potential ecological impacts of genetic engineered pines and a questioning of the problem definition itself (are wilding pines a problem or an opportunity).

Summary of Public Deliberations on RNAi for Varroa Mite

➔ In contrast to the other scenarios, the broader commercial and economic context and human health were considered alongside the ecological impacts in group's decision-making of the varroa mite scenario. While RNAi technology was seen to offer benefits over current tools for myrtle rust and perceived to carry fewer risks, this was not seen to the same extent with varroa mite, with groups largely offering only tentative and conditional support for the implementation of gene technology to manage this biosecurity issue. However, RNAi technologies were considered preferable to genetic modification.

Summary of Public Deliberations on Gene Drive for Rats

➔ While groups agreed that rats were a significant pest in New Zealand and supported a predator free vision, they overwhelmingly called for a very cautious approach to any consideration of gene drive for rat eradication or control. Much of the precautionary approach was driven by the high level of unknowns surrounding the technology. A sense that the current tool box was insufficient or ineffective at meeting predator free visions and the perceived animal welfare advantages that gene technology might offer were set against the considerable environmental, technological, regulatory, governance and legal and ethical challenges of the technology.

Special Interest Group

➔ Two special interest groups were approached to deliberate on the scenarios. The group drawing on GE Free and organics communities across the country expressed deep concern and suspicion about the implementation of gene technologies. This was based on significant concerns over the control and management of the technology. However, there was some variability within these interest groups over the application of gene technologies in specific situations, in particular if genetic technologies reduce the use of toxins in the environment. The group drawn from students in an undergraduate at university course saw considerable potential for the application of gene technologies for environmental purposes and the need for more and continued research to into these technologies, however, they also sought a very cautious approach with regulatory control, careful implementation and research needed to monitor and address ecological and off-target impacts.

The analysis of conversations and the 10 insights provided in the report's synthesis chapter, provides a rich understanding of people's nuanced and careful decision-making, considerations and cautions. These may assist decision-makers to more deeply understand what **safe** and **responsible** innovation may mean to New Zealanders, as they contemplate the potential of genetic technologies in the natural environment.

Māori Stream Survey and Scenario Insights

Reflecting on the survey's key insights emerged:

- Discomfort was primarily driven by the unknowns of genetic tools and technologies
- whakapapa and its implication forms the backbone of any discussion about genetic technologies
- Education, training and information sharing could influence people's comfort levels.

The group scenario discussions revealed consistent perspectives where participants emphasised the importance of thinking about whakapapa (in various forms), fully understanding broader ecological impacts, and strictly following tikanga processes set forth by community for any genetic technology proposal (regardless of which tool). Even for those who showed cautious openness to the use of genetic technologies under specific, well-regulated conditions, significant concerns remain about the unknown consequences and ethical implications, including on whakapapa.

While TTW's results offer valuable insights, they should not be generalised to all Māori across Aotearoa but rather should serve as a starting point for further discussions and community consultations.

Acknowledgements

By its nature, a project like this requires contributions from many people – individuals, groups and institutions. The research team wishes to thank everyone who has given generously of their time, thought and energy.

Many people participated in events. The time, attention, and honesty they gave was truly essential to this work. The team recognises that participants showed sensitivity and respect to each other, which were particularly important given the sometimes contested nature of gene technologies.

Special thanks to Michelle in Queenstown, Robin in Milton and Fiona and Philippa in Dunedin - who went above and beyond in helping to organise workshops, and encouraged members to come along.

We also thank the wide variety of people who shared their knowledge and perspectives including scientists working at universities, in Crown Research Institutes and in other organisations. In addition, social scientists, bioethicists and legal thinkers, who assisted with broadening the research's methodology to include lines of tension that were important to draw out in deliberations. Te Tira Whakamātaki acknowledge and thank Matua Hemi.

Special interest groups gave generously of their time and their years of experience caring deeply about these issues. Their voices, speaking from their deep respect for nature, were very important for this research.

Jovana Balanovic prepared a comprehensive review of relevant literature which was a great help for project conceptualisation and design.

Thanks goes to Debbie Larkins who helped to design the games and to Grant Dumbell who designed the scenario landscape on the report cover and formatted this report.

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Cover Image: Scenario landscape developed for the Public Engagement stream Phase 3 deliberative workshops.

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Introduction

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- General Public Engagement
- Māori Engagement

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1.0 Rationale

1.1 Purpose of the Research

This research has investigated people's perceptions of genetic technologies for environmental and / or conservation purposes by undertaking conversations across Aotearoa / New Zealand. The research has sought to:

- listen to, gather and explore New Zealanders' perceptions and concerns about the possible role that genetic technologies could play in addressing environmental and conservation issues;
- This included gathering perceptions on:
  - current and future management tools including genetic technologies for specific environmental and conservation issues;
  - cautions / guidelines that should be put in place if new genetic technologies were to be considered or used;
- Examine the effect and effectiveness of deliberative processes in supporting decision-making of contested and complex socio-environmental issues.

As Māori cultural identity, beliefs, values, practices and well-being are inextricably linked to te taiao (the natural environment) the research also explicitly sought to engage with iwi/ hapū and whānau

- to elicit their specific concerns and aspirations about gene technology in a way that they self-determine.

The research has been funded by the Biological National Science Challenge, as part of the Molecular Technologies 'Tiaki Protect' Science Challenge. This Challenge states:

> *"Technological innovation is racing ahead around the globe, but what does this mean for Aotearoa? Before we adopt any new technology we must ensure it is suitable for our lands, our native species and our people. This four-part research programme delves into different molecular technologies and what they might look like in a New Zealand context."*
>
> *(Biological National Science Challenge, 2023)*

To acknowledge the Biological Heritage National Science Challenge's recognition that technology must align with wider environmental, social and cultural perspectives, this research has started from the position that there are multiple views and voices about the use of genetic technologies for biodiversity, biosecurity and conservation. Some are supportive, some are opposed, some have questions and concerns.

With complex issues, such as genetic technologies, conversations provide opportunities to involve, listen to, and understand a diverse range of perspectives. The dialogue that is central to the conversation enables people to engage in inclusive and informed discussions about current and future technologies. Underpinning these conversations about controversial technologies is a recognition that innovation is not just technology, but rather it is "a comprehensive vision of what the world might look like" that is "driven by people's needs, ambitions and dreams" (Klerkx, et al, 2012).

The Biological Heritage National Science Challenge has previously funded research into public perceptions of genetic technology research, as part of a research programme that sought to both deepen and broaden understanding of what is important to New Zealanders when considering options for pest control (see Chapter 2 for further discussion). That research programme included an examination of public opinion about the exploration of three novel pest control methods; gene drive (GD), trojan female technique (TFT) and pest specific toxin (PST). It undertook a comprehensive survey of around 8,000 people and supplemented this with focus groups (see MacDonald et al., 2020; Kirk et al., 2020; MacDonald et al., 2021a, 2021b, 2022; Dixson, et al, 2022). Dixson et al. (2023) also looked at perceptions around trust in science and scientists. The Biological Heritage National Science Challenge has also funded kaupapa Måori research to explore cultural perspectives of RNAi technology (Palmer et al., 2021; Palmer et al., 2022).

This current research is a further step forwards in understanding people's perceptions of genetic technologies. To do this, it has engaged people in deliberative and dialogic processes to enable them to co-design environmental futures while engaging in conversations with others about specific genetic technologies in specific contexts. Using 'scenarios' to frame discussions, it has sought to examine whether people feel there is a place, or not, for genetic technologies in Aotearoa / New Zealand in specific environmental contexts, and if they see a place for gene technologies then, under what conditions. Recognising the contested nature of the topic, the research sought to be impartial around both the potential harms and/or benefits of implementing genetic technologies for environmental and conservation purposes in Aotearoa New Zealand.

By using deliberative processes, the research has utilised what Sheila Jasanoff (2003, 2007) calls "social technologies" to inform and also counteract "the predictive technologies of hubris" that largely dominate science innovation. Jasanoff calls these social technologies the "technologies of humility" that, "give combined attention to substance and process, and stress deliberation as well as analysis". The technologies of humility, founded on the processes of deliberation and dialogue, provide opportunities to engage people as active participants, "imaginative, affected by history, place and social connectedness and a source of knowledge, insight and memory." Through deliberative and dialogic processes and the reciprocal learning that occurs, Jasanoff writes that we can "design avenues through which societies can collectively reflect on the ambiguity of their experiences", while assessing "the strengths and weaknesses of alternative explanations."

1.2 Research Scope

The research focuses exclusively on people's perceptions of the use of genetic technologies for conservation and environmental issues. Topics beyond conservation, such as its use for industrial agriculture or human health were not considered for discussion. However, at times the scenarios used in the research overlapped into agricultural / farming / food contexts (e.g. varroa mite and wilding pines).

The research methodologies also preference qualitative methodologies, as these provide an appropriate and effective approach for gathering and examining the nuances in people's conversations. Where appropriate we do include quantitative measures, but these focus more around the effect and effectiveness of the engagement and deliberative processes used in the research. In the scenarios we do seek to give some indication of decisive support or opposition for the technologies under discussion in each scenario.

The research sought to capture a broad range of perspectives. In most cases people have volunteered but in some instances the voice of special interest groups were approached, particularly from the community in New Zealand that is and has been historically opposed to the release of genetic technology research outside contained indoor laboratory environments. In addition we have sought the voice of future 'scientists'. As both groups have been specifically recruited for their particular views, they are deemed to be special interest groups, and any analysis, while included, is not collated with the wider public sessions.

As the research was particularly interested in capturing people's concerns about the application of genetic technologies, the methodologies were designed to enable people to reveal their concerns and how these might be considered in the governance and regulation of new technologies. However, an exploration or critique of the current state of the scientific literature or grey literature on the science of genetic technologies is beyond the scope of this research. The focus instead has been on listening to and gathering the nuances in people's perceptions through deliberative processes, about the application of gene technologies for conservation or environmental purposes. The focus has been on enabling people to work with others to co-develop future possibilities considering the wider socio-cultural-environmental-economic contexts.

During the time of the research, New Zealand's new coalition Government released its Harnessing Biotechnology policy document. This research was established before this policy document was released and had no prior knowledge of it, however, the proposed policy and the subsequent media, political and interest group conversations around gene technology did filter into people's conversations during the research. While the report does not seek to respond directly to the specifics in the policy, the research's findings may offer insights for policy and decision makers to enable the public's perceptions to be heard and included in decision-making.

1.3 Research Streams and Teams

The multi-disciplinary research team draws from a wide breadth of expertise in kaupapa Māori research, theoretical and applied social research including deliberative processes, qualitative and quantitative research methodologies and programme evaluation. The research team is well-versed in trans- and inter- disciplinary research.

To ensure the methodologies, processes and outcomes contributed to Tiriti-led science-policy and governance and were responsive to New Zealand's multicultural society, the research team operated as two distinct but complementary engagement streams as follows:

- General Public Engagement Stream
- Māori Engagement Stream

Both engagement streams shared overall goals, but they differed in the communities they each engaged and how they engaged their communities to ensure appropriate methodologies for their respective contexts. This led to some insights specific to the communities each engaged with, and some insights common to both. To reflect this approach the report presents the engagement stream’s methods and findings separately.

1.3.1 General Public Engagement

Social scientists from the University of Auckland and the University of Otago (and subsequently Australian National University) undertook conversations with a range of groups and individuals across both the North and South Islands of Aotearoa New Zealand, using public dialogue processes, semi-structured individual and small group interviews, and deliberative democracy processes (see Chapter 3 Methodology for a detailed description). These qualitative approaches have been used to paint a rich picture of a range of New Zealanders’ perspectives about genetic technologies for environmental / conservation purposes and their vision for the technologies they wish to see in the future to manage environmental issues.

1.3.2 Māori Engagement

Māori participation in modern biosecurity follows a pattern similar to other Indigenous efforts at asserting Indigenous environmental approaches. These efforts are constrained by colonial histories and ongoing systemic marginalisation, with rare moments to pursue self-determination but occasional opportunities to engage and inform wider strategies.

Many Māori communities are well aware of the urgency of the biosecurity challenges in Aotearoa today. This "situational awareness" and Māori commitment to biodiversity as a cultural as well as an economic foundation to their lives, underpins the formation of Te Tira Whakamātaki, and their involvement in this particular project.

Te Tira Whakamātaki (TTW) is a Māori environmental not-for-profit and was included in this project to engage with Māori across Aotearoa on their perspectives of genetic technology for environmental protection. TTW's aim was to examine the cultural, social, and emotional factors that made Māori participants either comfortable or uncomfortable with the use of genetic technology. Their goal is to use this information to spread awareness amongst Māori communities of potential biosecurity tools; inform them of the factors driving attitudes to gene tech; and be a reliable source of information for decision makers to consider when approaching Māori communities with genetic technology proposals.

Te Tira Whakamātaki (TTW) undertook their work from the lens of several values and principles which serve as guides on the purpose of the work (the why) and how the work is carried out. These values and their associated principles are:

- TOHUNGATANGA | EXPERTISE
  - Acknowledging and elevating Māori experts, kaitiaki, knowledge, and lore to environmental spaces.
- MANAAKITANGA | RECIPROCITY OF CARE
  - Upholding the mana of everything and everyone with kindness, generosity, respect, decolonization, and equitable practices.
- WHANAUNGATANGA | RELATIONSHIPS & CONNECTIONS
  - Fostering reciprocal relationships built on the intention of strengthening connections, especially between people and te taiao.
- RANGATIRATANGA | LEADERSHIP & SOVEREIGNTY
  - Asserting Māori rights, sovereignty, and law in everything we do.
- WAIRUATANGA | UNIQUENESS & BELONGING
  - Living and interacting with te taiao on our own terms (self-determination).
- KAITIAKITANGA | STEWARDSHIP
  - Acting on our responsibility and right to care for and protect te taiao

These values were embedded in the connections, relationships, methods, questions, and analysis TTW made in their work to ensure its relevance for iwi and hapū.

1.3.3 The Researchers

The research team is a multidisciplinary research team, with a breadth of expertise in kaupapa Māori research, theoretical and applied social research including deliberative processes, qualitative and quantitative research methodologies and programme evaluation. The team has extensive experience in transdisciplinary and interdisciplinary research. For more information about the team members visit the project's research website: https://www.talkingecogenetech.nz/about

The researchers also supplemented their own expertise with engagement and collaborations with a diverse range of scholars including scientists who are currently working in gene technology, iwi/hapū and whanau, stakeholders and applied practitioners with experience or interest in gene technologies.

1.4 Audiences for this Report

While the research report has been undertaken for the Biological Heritage National Science Challenge as an extension to their previous social research exploring public perceptions of pest control technologies (see Chapter 2), we acknowledge that the research will have pertinence and interest to a range of audiences. The main audiences are listed below.

1.4.1 Research Institutions

There is a recognition from scientists that community attitudes remain key factors in whether genetic technologies can and should be used in New Zealand. The Royal Society of New Zealand Te Apārangi, which has considered the potential of gene drives for pest control, stated that "Relational trust and communication between the public, government and scientists is required for new genetic technologies to be accepted" (Royal Society Te Apārangi, 'Gene Editing Scenarios in Pest Control, August 2019, p. 17). Similarly scientific papers also increasingly recognise the need for public acceptance and the challenges of achieving this, as Dearden et al. (2018) state, "One key issue is how to open a dialogue with the public that isn't immediately polarised into the pro vs anti-GM debate. … An informed and thinking public contributing to and shaping the debate is essential for the success of our national goals to reduce or eliminate pests." (Dearden, et al, 2018, p. 237).

1.4.2 Policymakers

In New Zealand, a cautionary approach to genetically modified organisms was enshrined in law in the 1996 Hazardous Substances and New Organisms Act (the HSNO Act). The purpose of this Act was to “protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms”, a purpose that is expected to take in account a range of matters including the sustainability and intrinsic value of native flora and fauna, and of valued introduced species, as well as the rights and values of tangata whenua (Parliamentary Counsel Office, 1996).

In 2001, the Royal Commission report on Genetic Modification made the case that a cautious approach was necessary to protect New Zealanders. For this approach they found that the regulatory framework in place was sufficient, in particular that the existing Environmental Risk Management Authority (ERMA) would be well placed to provide oversight and enforcement of the regulatory framework. These responsibilities were transferred to the Environmental Protection Authority (EPA) in 2011.

In 2023, the Coalition Government released a policy document called “Harnessing Biotechnology”. This states: “It is time for New Zealand to responsibly and safely open up access to the benefits of gene technology”. While this current research was established before this policy announcement, and not in response to it, the changing political landscape did enter into people’s conversation and therefore the research’s findings may offer valuable insights for policymakers and decision-makers reviewing New Zealand’s regulation and legislation governing genetic technologies.

1.4.3 Māori

As Māori cultural identity, beliefs, values, practices and well-being are inextricably linked to te taiao (the natural environment), the research will be of specific interest to iwi/ hapū and whānau. Furthermore as the research explicitly engages with iwi/ hapū and whānau through the Māori engagement stream led by Te Tira Whakamatiki, the report findings will provide insights on how Māori concerns and aspirations about gene technology can contribute to Tiriti-led science-policy and governance in ways that Māori self-determine.

1.4.4 Interest Groups

Interest groups, environmental groups and industry bodies hold a diverse and often divergent range of perspectives about novel technologies and particularly gene technologies. While they typically hold firm and sometimes fixed positions, they recognise the complex relationship between science, technology, society and governance and seek inclusive decision-making. The findings may offer these group's insights to the public's current perceptions around genetic technologies.

1.4.5 The Public

This research has been about engaging and empowering participants and communities to be part of conversations that seek to inform Aotearoa New Zealand's environmental futures. By engaging with the public while technologies are being developed and while regulatory frameworks are being considered / re-considered, the public can discuss, plan, raise concerns and even co-design the technologies and their regulations. We argue the most effective time to engage people in the questions that surround genetic technologies for the environment is before decisions are made about the use of those genetic technologies, with the ability to re-open discussions as problems as tensions emerge. Concerns for the environment have accelerated, particularly in the areas of predator control, biosecurity / biodiversity and climate change. While trust in science and in policymakers can be fragile it may be strengthened by grappling with people's visions of environmental futures. As Jasanoff et al. (2015, p. 7) states, "The challenge for democracy and governance is to confront the unscripted future presented by technological advances and to guide it in ways that synchronise with democratically articulated visions of the good."

2.0 Literature Review

2.1 Introduction

This current research adds to a small body of research that has sought to capture, record and publish New Zealanders' perspectives of gene technology. In this chapter we present an overview of published material from both the academic and 'grey literature' that has examined people's perceptions on the use of genetic biotechnologies for conservation and environmental management purposes.

The review had the following key objectives:

1. To summarise existing social science research that has explored public perceptions of the potential development and use of genetic / biotechnologies for conservation and environmental management purposes i.e. for biodiversity and biosecurity purposes, in New Zealand between 1991 and 2023 (see sections 2.2 to 2.9 and Appendices 10.3 and 10.4)
2. To provide insights from the literature that might offer guidance to the approach and methodology used in the public engagement stream (see section 2.10)
3. To gather a broad collection of perspectives from the Social Science Literature addressing Maori perspectives use of genetic / biotechnologies for conservation and environmental management purposes (see section 2.11 and Appendix 10.5).

As such, the review sought to present an 'overall picture' of research to date in New Zealand that has sought to engage the public and Māori communities in dialogue about gene technologies or has gathered public perceptions about gene technologies for conservation or environmental purposes.

Supplementary appendices in this report (Appendix 10.3, 10.4 and 10.5) provide additional summaries of information presented in this chapter. Appendix 10.3 presents a summary of deliberation factors when considering the development and application of biotechnologies for environmental management purposes. Appendix 10.4 presents a descriptive summary of all included social science literature that was reviewed and includes research sources, key research objectives, methods and measurements, and high-level insights relevant to this research's objectives. Appendix 10.5 presents a collection of Māori / te ao Māori and / or mātauranga Māori perspectives from the literature.

2.2 Public Perceptions of Gene Technologies in Social Science Literature

A review of the social science literature was undertaken to identify and examine both academic research and research from the grey literature undertaken in New Zealand between 1991 and 2023 which has examined the use of genetic / biotechnologies for conservation and environmental management purposes.

2.2.1 In Scope

The primary focus was on genetic technologies for conservation or environmental management purposes. However, a preliminary overview of the research revealed that the terminology around genetic technologies is often used interchangeably with terms such as 'genetic engineering' 'genetic modification' 'synthetic biology' and similar (F. J. Coyle et al., 2003; Hunt et al., 2003; Macer et al., 1991). Terms associated with genetic technologies also fall under the broader scope of 'biotechnologies' which are defined as "any technique that uses living organisms or processes to make or modify products, the environment or organisms" (Sheppard & Urquhart, 1991). The Parliamentary Commissioner for the Environment noted the conflation of terminologies in the 2000 report *Caught in the Headlights*.

> *"…participants and interviewees made little distinction between biocontrol issues and genetic engineering issues. Given that all the biocontrol methods currently being researched, except one (hormonal intervention), would use genetic engineering, this rolling together of the issues was not surprising"*
>
> *(Office of the Parliamentary Commissioner for the Environment, 2000).*

As such the review included participants' perceptions/feelings toward biotechnologies for conservation/environmental purposes more broadly. Therefore, the term genetic/biotechnology is used throughout this review.

2.2.2 Out of Scope

The review did not include research into public perceptions of the use of genetic technologies for topics beyond conservation, such as its use for industrial agriculture or human health. However, as some of the studies were broad in scope exploring public perceptions for genetic /biotechnologies in general i.e. for a variety of purposes including environmental purposes, key insights from its use in other applications were at times gathered for comparative purposes. However, this should not be seen as a comprehensive representation of social science research for such applications.

Furthermore, given a key objective was to ascertain an 'overall picture' of New Zealand research i.e. undertaken in New Zealand or about New Zealand, the international literature was not included in this review, although occasional references for comparison have been used to illustrate a finding's importance, impact, or potential.

The focus of the review therefore was on completed and published research that was available online at the time of the review. An historically complete collation of works would require inclusion of studies before 1991 and those not readily available online.

2.3 Methodology of Review

2.3.1 Document Sourcing

Documents were sourced via online public access portals, and relevant academic databases. The review broadly focused on gathering research that could build an overall picture of New Zealanders' acceptance/non-acceptance, views and feelings about the development and potential use of genetic/ biotechnologies for the purpose of conservation (biodiversity) or other environmental purposes (e.g. biosecurity), with specific focus on any mention of 'genetic technologies.'

Key word searches included 'Aotearoa,' 'New Zealand,' 'Gene/Genetic' 'Technology / Tool / Method' and 'Public,' 'Environment' with related word searches including 'Biotechnology,' Conservation',' Gene Drive', and 'Pest Management' alongside relevant general social scientific measures of interest such as 'Perceptions,' 'Views', 'Feelings', 'Acceptance,' 'Support' and 'Social Acceptance'.

2.3.2 Description of Documents

A total of 35 documents were included in the review, including nine official reports and 26 academic articles/chapters. Of the 35 documents, 14 were New Zealand social science studies, while the remaining documents provide broader contextual information such as literature reviews, media analyses, government summary documents etc.

In sustaining the review's primary focus i.e. to gain an understanding of the 'overall picture' of New Zealanders' perceptions and feelings towards genetic / bio technologies for environmental purposes, each research document was assessed for its:

- Relevance to the topic
- Methodological approach (e.g., surveys, interviews, focus groups)
- Key findings and overall insights
- Research methods strengths and limitations

Appendix 10.4 provides a summary of all the reviewed documents.

2.4 Breadth of Social Research

Modern biotechnology publications that notably emerged in the 1970s with studies increasing in the 1980's and particularly in the 1990s initially largely focussed on research for the food industry looking for solutions and/or enhancements for commercial and consumable products (Macer et al., 1991). As research progressed in the 1990s, it expanded to include the indirect impacts of such technologies on the environment such as pest-resistant crops or the removal of DDT from soil, and subsequently their direct application for conservation and environment management purposes e.g. reducing pest numbers (see Edwards, 2017; Macer et al., 1991; Office of the Parliamentary Commissioner for the Environment., 2000; Sheppard & Urquhart, 1991).

Biotechnologies and later genetic technologies, are proposed by researchers for pest management to 'efficiently' and 'effectively' address on-going pest problems e.g. moving from pest or disease suppression and management to eradication, while also reducing costs and unwanted effects of existing methods i.e. trapping, shooting, aerial poisoning with 1080 (see Dearden et al., 2018; Duckworth et al., 2006; Kannemeyer, 2017; MacDonald et al., 2020; Wilkinson & Fitzgerald, 2006). Authors argue this is particularly appealing in the wake of growing and on-going anti-toxin sentiments, where the use of poisons are increasingly seen as an undesirable option by many (Kannemeyer, 2017; Office of the Parliamentary Commissioner for the Environment, 2000).

However, the decision to research and/or implement genetic/biotechnologies is seen as complex, requiring a careful balancing of factors that span far beyond their perceived technical advantages. Important questions are therefore raised about fundamental social values and ethical concerns at both individual and collective levels, that would emerge with any introduction of these tools (Dearden et al., 2018; MacDonald et al., 2020, 2021a, 2021b, 2022; Macdonald, Varey & Barker, 2011; Macer et al., 1991; Office of the Parliamentary Commissioner for the Environment, 2000).

Recognising the complexity surrounding the application of genetic technologies, numerous studies / reports have been commissioned by various New Zealand Government entities to explore public perceptions about the potential use of genetic/biotechnologies in New Zealand. These include the Foundation for Research, Science, and Technology 5-year Dialogue Fund, (Macdonald, Varey & Barker, 2011), alongside reports from the Ministry of Agriculture and Fisheries (Sheppard & Urquhart, 1991), Ministry of Environment (Macer et al., 1991), The Office of the Parliamentary Commissioner for the Environment (2000), Ministry of Research, Science and Technology (Wynne, 2003), and Department of Conservation (MacDonald et al., 2020).

Complementary research has also been undertaken by the Royal Society of New Zealand (Goldson et al., 2015; MacDonald et al., 2022; https://www.royalsociety.org.nz/major-issues-and-projects/gene-editing-in-aotearoa/) and a number of Crown Research Institutes e.g. Landcare Research and AgResearch, see Gamble et al., (2010), Wilkinson & Fitzgerald, (1997, 2006), and partnering universities (Lincoln University, Macer et al., 1991), as well as the University of Otago (MacDonald et al., 2021b) and Victoria University of Wellington (MacDonald et al., 2020). These have sought to identify people's feelings and perceptions about New Zealand's technological trajectory. The intention to include the public in conversation about biotechnologies was explicit in the research programme "The Fate of Biotechnology. Why do the public reject novel biotechnologies?" (cited in; Coyle et al., 2003; Hunt et al., 2003), which directly sought to create a two-way dialogue with the public prior to the development and use of biotechnology tools with the intent that decision-making would need to be balanced and socially sanctioned.

The Biological Heritage National Science Challenge has conducted social science research to both deepen and broaden understanding of what is important to New Zealanders when considering options for pest control (see https://bioheritage.nz/collaborations/predators-and-pests/ for an overview of the research). These studies include an examination of public opinion on the exploration of three novel pest control methods i.e. gene drives (GD), trojan female technique (TFT) and pest specific toxin (PST) (see MacDonald et al., (2020), followed by Kirk et al., (2020); MacDonald et al. (2021a, 2021b, 2022) and Dixson et al. (2022), and the most recent paper by Dixson et al. (2023) looking at perceptions around trust in science and scientists). The Biological Heritage National Science Challenge is also exploring a broader range of social research – moving from 'collecting perspectives' to 'engagement' through informed, deliberative processes including kaupapa Måori research (Palmer & Mercier, 2021, Palmer et al., 2021).

2.4.1 Topics of Inquiry

Most studies have focussed on identifying factors of importance and concern for a range of stakeholders from various occupations, demographic backgrounds, and interest groups when considering the potential applications of genetic/bio technologies, including intentionally manipulated genetic techniques or the use of existing biological organisms, for environmental management purposes.

Specific environmental applications include the use of the myxomatosis disease to control rabbits (Sheppard & Urquhart, 1991); the use of biological and genetic approaches for possum control including hormones and fertility interference (Office of the Parliamentary Commissioner for the Environment., 2000); soil remediation of residual DDT to reduce pesticide/insecticide use (Coyle & Fairweather, 2005a, 2005b); altering existing organisms to promote resilience to external threats (e.g. in kauri) (J. Gamble, 2009); and reduction of wider environmental externalities (e.g., bacteria in sheep stomachs to lessen methane production; Coyle & Fairweather, 2005a, 2005b).

2.4.2 Approaches and Methods

The majority of social research seeks to understand participants' views on the use of genetic/biotechnologies 'in general' for a 'general purpose', or for a specific application to address a specific problem that was in the public discourse and of concern at the time of the study (see Cook et al., 2004; Cook & Fairweather, 2005; Macer et al., 1991; Office of the Parliamentary Commissioner for the Environment., 2000; Sheppard & Urquhart, 1991). This is also supported by Kannemeyer (2017) in her systematic review of 28 articles exploring public perceptions of pest control methods in New Zealand (including 'biotechnology' and 'genetic technology'). Furthermore, a majority of the studies have compared different technologies (e.g., Eppink et al., 2021; Kirk et al., 2020;

MacDonald et al., 2020, 2022; Macer et al., 1991; Office of the Parliamentary Commissioner for the Environment., 2000; Sheppard & Urquhart, 1991) to ascertain the relative importance of varying factors e.g. the problem; the pest/disease; the technology; delivery mechanism; and an array of perceived risks and benefits to explore how these were considered and weighted in public deliberation.

As previously mentioned, the terminology from both the researchers and participants' perspectives has typically not been clearly delineated and is frequently used interchangeably – with 'Genetic Modification' or Manipulation (GM)' interchangeably used with 'Genetic Engineering' (GE) 'Biotechnology', 'Genetic technology, 'Synthetic Biology' or 'Biological Control' and later 'Gene Drive' (F. J. Coyle et al., 2003; Hunt et al., 2003; Kannemeyer, 2017; Macer et al., 1991; Sheppard & Urquhart, 1991). While this makes it difficult to discern the trajectory of views on a 'specific genetic or biological' technology, the studies still assist with determining what tools have in common when being considered by public/s. As such, while the findings are generally reported in isolation (e.g., X number of people were supportive of gene drive for Y purpose in Z study) as per the data available, it is advisable that they be contextualised within a broader set of solutions and trade-offs, including what priorities and factors were likely salient at the time.

Qualitative methodologies were most commonly employed in studies with focus groups, interviews, and other qualitative methods (e.g., Delphi, concept mapping; n=15) the most common, followed by quantitative surveys using a variety of delivery modes (e.g. mail, telephone, online; n = 9). There has been an emphasis on nationwide surveys, with fewer studies undertaking regional and localised analysis (Kannemeyer, 2017).

Only two studies deviated from this, by using experimental design (n=1) or choice-modelling approaches (n=1). No research employed ethnography, journey mapping, content analysis, media analysis, phenomenology or case study methodology. Only one study examined changes in views over time undertaking a 2-year study which sought to assess changes in perceptions over a 1-year period immediately following the lifting of the moratorium in New Zealand (Cook & Fairweather, 2005; Coyle & Fairweather, 2005a; Coyle et al., 2003). No research appears to have examined 'behavioural' responses' i.e., whether people would, or have ever used genetic/biotechnology, which may be particularly pertinent for specific stakeholders such as farmers and environmental / conservation groups and organisations (Wynne, 2003).

2.5 Public Perceptions of Genetic / Biotechnologies

Overall, ‘general acceptance and unacceptance’ for the use of genetic / biotechnologies for environmental purposes’, whether ‘biological control’ or ‘genetically edited organisms’ being released in the wild for example for fertility reduction, has stayed relatively stable over time, ranging between 30 and 50 percent, with more variation occurring for specific applications.

In Sheppard & Urquhart’s (1991) study investigating attitudes towards pests and pest control methods, 50.8% of participants reported being generally opposed to the introduction of a biocontrol for the control of pests. Similarly, Macer et al., (1991) found 49% of their participants reported having concerns about biological pest control. This is supported by subsequent survey data collected by Cook and colleagues in 2003 and 2004 (Cook & Fairweather, 2005) where they found 51.6% and then 43.6% of their participants reporting concern over the use of biotechnologies. A similar pattern emerged when analysing acceptance as opposed to concern, with 45.6% reporting support for biotechnologies. However, 51.9% felt it was unethical while 42% felt the technology was unnatural. MacDonald et al., (2020) assessed people’s acceptance of three novel pest control technologies and found 32% support for Gene Drive (GD), 43% for Trojan Female Technique (TFT) and 52% for the pest specific toxin (PST). Support for gene drive rose to 52.8% in a subsequent study with a different sample group (MacDonald et al., (2021b). The most recent study (Dixson et al., 2023) found that around one third (27%) of participants demonstrated comfort with the potential use of gene drive for pest control purposes, while 33% were concerned (although participants said they might still consider its use with strict controls or as a last resort) – with 30% remaining undecided and 10% unequivocally opposing its use.

While the level of acceptance for genetic / biotechnologies has in general not exceeded 50% (with a few exceptions), there seems to be some suggestion of greater acceptance of these technologies for conservation and environmental purposes – particularly those that alter reproductive processes (rather than causing death). Examples include Cook et al. (2004) and Cook & Fairweather (2005) who found an increase in acceptance from 2003 to 2004 for (i) a virus that induces infertility in possums (53.5% to 57.5%); (ii) pest control purposes; (iii) cloning kakapo for conservation/survival purposes (34.5% in 2003 to 41.9% in 2004). Similar increases were not observed for agricultural or medical applications and most notably, were not present for aerially distributed pest control measures, suggesting that the shift was domain and delivery specific.

However, findings show that attitudes are often polarised between those who were strongly accepting or unaccepting of genetic/biotechnology (Cook et al., 2004; Cook & Fairweather, 2005; MacDonald et al., 2020; Sheppard & Urquhart, 1991). As such, interpretation of results may have been skewed by how ‘acceptance’ was framed (e.g. as ‘support for use under any circumstances’ vs. ‘level of concern’ vs. ‘preferred pest control options’ vs ‘ranked pest control options’). Furthermore, biassed sampling of extremes (e.g. in Cook et al., 2004; Cook & Fairweather, 2005), can mean that an overall ‘50% acceptance’ figure, which is often above levels of support for current methods such as 1080 and other toxins, (e.g. Wilkinson & Fitzgerald, 2006, where it is at 30%), may result from a skewed distribution where the average may not be a true representation of distribution modality or centrality. Indeed, Cook et al. (2004; 2005) acknowledge an overrepresentation of those who were ‘strongly invested’ in the biotechnology, as well as those highly educated and of higher socio-economic status in their study of public acceptance for a suite of biotechnological applications.

Often, acceptance was measured as ‘conditional’ – according to various applications and circumstances. This highlights the prevalent and important finding that acceptance, support, and perceptions varied according to the specific uses, specific problems, for specific groups (in a particular socio-political context) and as such patterns of acceptance varied depending on which factor was more heavily weighted at the time. Such a finding has persisted across the 32 years of research, from Sheppard & Urquhart, noting it in 1991 and similarly MacDonald et al., noting it in their 2020 study.

In general, public acceptance is greatest for medical purposes and least acceptable for agricultural/commercial purposes with environmental / conservation sitting in the middle (Cook et al., 2004; Coyle et al., 2003; Cronin, 2008; Gamble, 2009; Hunt et al., 2003; Macer et al., 1991; Office of the Parliamentary Commissioner for the Environment., 2000). Figure 2.1, drawn from Cook et al., (2004), presents an overview of public acceptance according to the type of applications.

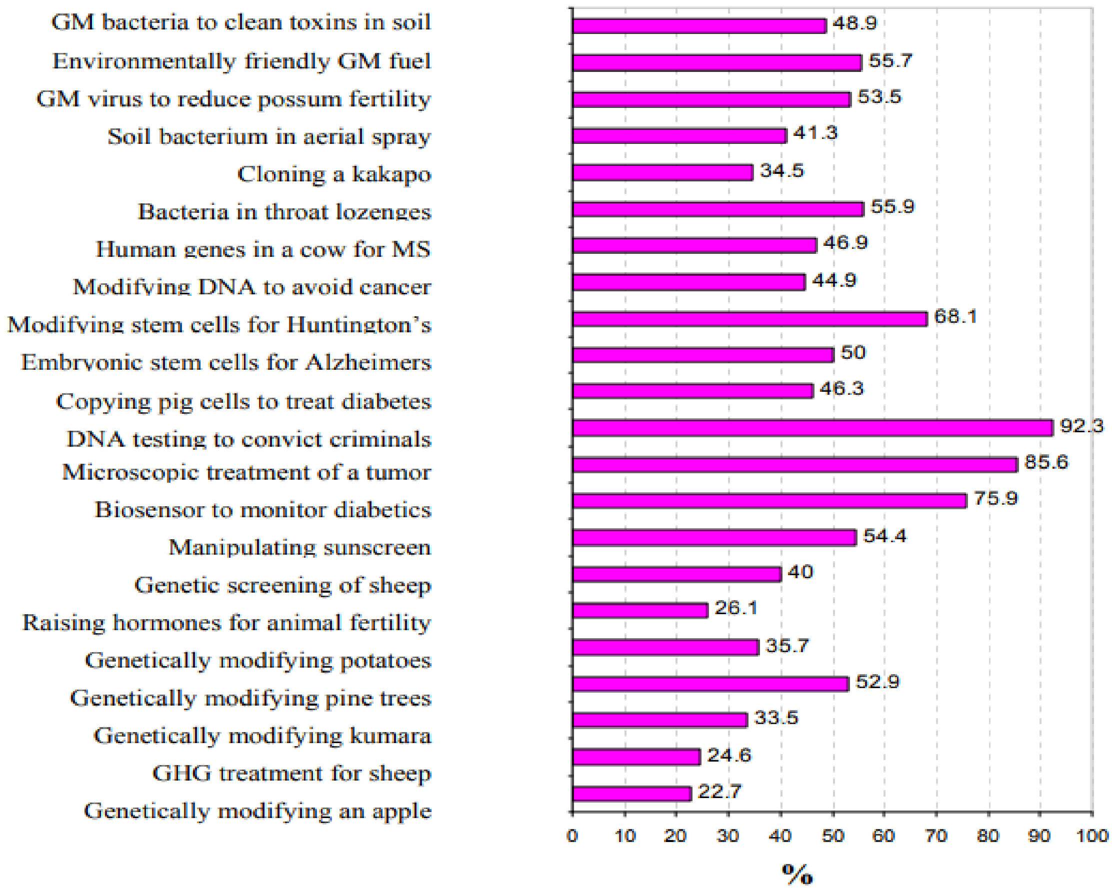

Figure 2.1: Public acceptance of biotechnology applications (Cook et al. 2004)

Overall, 'individual' based technologies appear to be preferred (e.g., DNA testing of criminals) than commercially motivated applications of genetic /biotechnological applications (e.g., genetically modifying an apple), with environmental applications falling between. Notably, environmental applications were not ubiquitously accepted and/or rejected but varied according to what seemed to be the 'deviation from the natural order of things' (e.g., GM virus to reduce possum fertility received almost 20% more acceptance than cloning of a kakapo at 34.5%). Applications which are perceived as being more aligned with 'public good and not for commercial purposes' (Cook et al., 2004; Cronin, 2008; Macdonald, Varey & Barker, 2011; Office of the Parliamentary Commissioner for the Environment., 2000)' as well as those which are perceived as being 'more natural,' are generally preferred over those that are seen as having the potential to result in unequal benefit/risk and/or deviate strongly from what would 'naturally occur in nature' (Coyle & Fairweather, 2005a, 2005b; Gamble, 2009; Office of the Parliamentary Commissioner for the Environment., 2000; Wilkinson & Fitzgerald, 1997, 2006).

Acceptance varies according to the perceived gravity of the environmental problem and/or according to the specific pests/diseases involved. Overall, findings suggest that the more severe and 'personal' the problem is perceived to be, the more accepting people might be of the idea of a genetic / biotechnology being used to solve it. For example, Sheppard & Urquhart, (1991) found that when participants were questioned about their general acceptance for the use of a biotechnology for pest control purposes, 50.8% expressed opposition; but, this shifted to 56.6% support for genetic/bio technologies for managing wasps, with 54.8% in favour of their use for possum control and 66% for rabbit control respectively (rabbit control perhaps being the most acceptable given its heightened attention in the media at the time).

Contrary to earlier research, MacDonald et al. (2020, 2022) found perceived environmental considerations, delivery methods (arguably because of the perceived 'specificity' to only target the stated species) and possible outcomes emerged as the most pertinent factors in people's consideration over and above the technology itself. The importance of the delivery method created the largest shifts in acceptance from 'openness' towards 'concern', a trend noted also by other authors (Edwards, 2017; Eppink et al., 2021; J. C. Gamble et al., 2010). Wilkinson & Fitzgerald, (2006) found that participants' general openness towards genetic/biotechnologies for possum control was significantly reduced when contextualised within the 'reality' of both its development, delivery, and maintenance, what they termed the 'package' of biological pest control.

MacDonald et al. (2021b) found considerably more acceptance of research into gene drives for pest control purposes (77%) than for the use of gene drives in general (52.8%). However, earlier research shows that while participants may be accepting of technologies and applications 'in principle' they have significantly less acceptance of the processes needed to bring these technologies into use, e.g. concerns about field testing (Edwards, 2017; Esvelt & Gemmell, 2017). Future research may benefit from exploring in public dialogue the factors that may need to be overcome in the research and development phase of genetic/biotechnologies for particular applications.

2.6 Factors that Shape Perceptions of Genetic / Biotechnologies

Drawing largely from the qualitative evidence, the following key factors emerged (which have been thematically grouped into four categories although these categories are not really discrete with considerable overlap occurring). The factors are listed in the following subsections:

2.6.1 Technical / Environmental Factors

This factor pertains to discussions regarding how the potential technology would 'operate' as well as its direct and indirect effects on the target pest/host and the wider environment. General questions raised were: What are the unintended/unforeseen consequences of this technology? Will it affect anything other than the target species? (specificity). Can the modified organism change over time? (mutation). If it goes wrong, can we stop it? (controllability). What is the delivery method? (using GMO's or not? Pervasive or not? Does it involve aerially spraying?). Would it lead to a move away from toxins (environmentally positive impact)? What if the technology becomes a problem in and of itself? (environmentally negative impact). What do we know and how do we know it? (unknowns / desire for more research).

2.6.2 Social Factors

This factor pertains to discussions regarding how the development and use of this potential technology would impact publics on personal and collective levels (though notably these discussions heavily overlapped with the ethical and political themes discussed subsequently). General questions raised within this theme were: Who will benefit from the use of this technology (public distribution of benefits)? Is the risk evenly distributed or will some take more than others (public distribution of risks)? Who will be accountable if it goes wrong (accountability)? How will people be included in the conversation/informed and by who (transparency/public participation)?

2.6.3 Ethical Factors

This factor pertains to broader, moral, and metaphysical discussions, about what is fundamentally 'right or wrong' and what the development and use of these potential technologies would mean for core social values and the trajectory of the New Zealand character. General questions/concerns pertaining to this theme included; fears that scientists/authorities are going too far with technological advancements (playing God), that the interference with nature is 'too far', 'wrong,' and 'will throw everything out of balance' (unnatural/wrong); fears regarding whether acceptance of one application will lead to unwarranted precedent setting and development goes out of control (slippery slopes), particularly if used for commercial purposes (not public good). Equally, participants were concerned about the ethics not just for people but the animals themselves – whether that be that the technology could improve (animal welfare positive) or reduce (animal welfare negative) their well-being.

2.6.4 Political Factors

This factor pertains to discussions regarding how the development and use of potential genetic / biotechnologies would influence and be influenced by the leaders in policy, regulation and overall decision making, and particularly those in Government who are seen as being responsible for maximising public good. General questions raised within this theme were: How would such technologies be regulated (need for regulation)? How would we manage the potential international risk that goes along with a potentially unstoppable genetic organism (e.g., a gene drive possum spreading the infertility gene to Australia where they are a protected species (international image negative)? On the flipside, how could being a leader in this innovative space benefit the New Zealand image and economy (international image positive)? How can the public really trust the information and assurance given to them, with fears about the potential for misuse (distrust/misuse/carelessness) and how would we manage the intellectual property of developing such a technology (e.g., would 'live animals and plants' become patented) (intellectual property)?

2.6.5 Summary of Factors that Shape People's Perceptions

Overall, the qualitative studies provided important exploratory context for unearthing and elaborating on the often unconscious, or at least rarely articulated, thought processes that occur in people's minds when considering the use of genetic / biotechnologies for environmental management purposes. The diversity of stakeholders included in these studies ensured that a wide range of considerations were included along with their rationale.

Quantitative research has provided further detail in terms of the prevalence and relative weightings of concerns – particularly in the trade-off decision making that is generally required for decisions of this complexity. Drawing from across both qualitative and quantitative studies (which held NZ research data, n = 14) Appendix 10.3 highlights the relevant prevalence of the top concerns as depicted in the research as well as example quotes drawn from the qualitative works. The analysis combines both qualitative and quantitative research as study results were often presented in a single narrative (i.e., findings from both quantitative and qualitative approaches were presented thematically e.g., Macer et al., 1991; Office of the Parliamentary Commissioner for the Environment., 2000) and the terms given to the concerns were not consistently used (e.g., unintended vs unforeseen consequences). As such, each instance of the relevant terms was counted once and grouped according to their occurrence in a paper to give an indication of importance.

As demonstrated in Appendix 10.3, the most prevalent factors pertain to levels of discomfort with 'risk' as often articulated by concerns around the 'unintended or unforeseen consequences' of the technologies as well as the inability to 'control its impacts;' followed by the potential positive and negative environmental impacts (a factor across applications). While these factors sit largely in the 'technical' domain, discussions from focus groups reveal that these factors were rarely discrete but rather had many threads of overlap with factors sitting in the social domain. For example, the specificity and controllability of the technology also relates to the desire for personal autonomy and ability to 'choose' whether one is influenced by these technologies as exemplified by the conditional acceptance by some participants so long as the technology was 'Not in my body (NIMB)' or 'Not in My Back-Yard (NIMBY; Hunt et al., 2003).' Another example, the 'need for more research / information', can be seen as being linked to the importance of public consultation, an overarching theme. In addition 'more information' could be content about social and political considerations as well as technical data. Such examples demonstrate that factors that, at face value, appear to be mostly technical concerns (and therefore could be addressed by technical information and answers) have their roots in social, ethical, and political debates and concerns.

MacDonald et al. (2021a) found that, of all the beliefs that predicted support for PST, trojan female and gene drive (using the Theory of Planned Behaviour), the five greatest influences pertained to normative and social issues (i.e. is it good/bad – risky/safe). Beliefs about the technical aspects of the technologies (e.g. its ability to 'protect NZ native wildlife by reducing the number of rats') or the problem (e.g. the 'importance of reducing the number of rats in NZ') did not emerge as influential considerations in their model of acceptance.

This interrelationship between factors highlights that considerations do not occur in isolation but are 'weighed' against each other – suggestive of a dynamic, dialectical process taking place in each case. It is with this understanding, that the Biological Heritage National Science Challenge's 2020 body of research (https://bioheritage.nz/research/public-perceptions-of-new-pest-control-methods/) examined how a selection of factors were 'weighed' when it came to decision-making between three different novel pest control options, for controlling either wasps, stoats, or rats. Interestingly, their results found that the delivery method emerged as being a more powerful predictor of support than the technology itself – with a particular aversion towards aerial or 'indiscriminate distribution' of a particular type of pest control method (Eppink et al., 2021; MacDonald et al., 2020).

Such findings highlight the importance of the factor of 'specificity', 'controllability' and arguably 'animal welfare' factors. Another example of weighted decision-making occurs in studies showing differing views depending on whether the genetic/biotechnology induces 'infertility' or 'death.' For example, Wilkinson & Fitzgerald (2006) found that, compared to poisoning and trapping, fertility control (via interference with fertilisation or breeding hormones) was seen as superior in specificity, efficacy, and humaneness. In contrast the more recent study by Eppink et al., (2021) found the opposite (using a choice modelling method) where 'death' was a preferred outcome over infertility. As both hold plausible explanations, these inconsistent findings emphasise the need for further examination of precisely how and when these factors are prioritised. Little research to date has explored how such factors are weighted when considering specific applications and so generalisations cannot be made about relative importance.

2.7 Demographics: Scientists vs the Lay Public

In general demographics offered little insights to people's perceptions. In a sample of over 8000 New Zealanders, MacDonald et al. (2020) found demographic variables offered no additional explanatory power for determining people's acceptance and views of novel pest control technologies when worldviews (a composition of values, beliefs, attitudes and behaviours) were accounted for in their model.

However, one study found that there may actually be shared values and more similarity of concerns between the 'lay-public' and 'scientific community', particularly in their prioritisation of ethical and social concerns, than is often assumed – an overlap which is perhaps at times missed due to a 'loss in translation' between the different types of language used by both parties (Cronin, 2010; J. Gamble & Kassardjian, 2008). For example, while scientists/experts appeared to place a stronger weighting on ethical issues relating to misuse, inequality of benefits and animal welfare, as compared to non-scientists who emphasised the importance ethical concerns such as the perceived 'naturalness' of the method and discomfort with 'playing God' (Gamble & Kassardjian, 2008), it would be interesting to explore to what extent these differences are pertaining to differences in parlance rather than values e.g. experts may refer to risks of 'setting precedents' where lay public may refer to fears of 'slippery slopes', (Gamble, 2001;

Office of the Parliamentary Commissioner for the Environment., 2000). Indeed, a few studies showed convergence between experts and lay publics in that both highlighted the importance of the right rationale or intentions for the development and use of genetic/biotechnologies, and leadership over the process of safeguarding of technical aspects (Office of the Parliamentary Commissioner for the Environment., 2000).

These cohorts also appeared to have greater acceptance of genetic / biotechnologies for medical purposes although farmers were generally the least accepting of the use of genetic/biotechnologies for human-health applications (Office of the Parliamentary Commissioner for the Environment, 2000). Interestingly, not only does this research suggest that there may be greater overlap between experts and lay publics (regarding values and concerns), but it also suggests that the often focussed on 'gap' between scientific experts and lay public may be less than the gap between publics and industry/business – a conversation that has received little attention in the social research to date. Indeed, compared to immediate personal and national impacts, industry participants (e.g., farmers, business owners) were often more concerned about how New Zealand would be perceived (and therefore affecting overseas market access) and were more concerned about public perceptions and technical issues (e.g., Office of the Parliamentary Commissioner for the Environment., 2000) than other groups.

2.8 Key Themes in People's Conversations

2.8.1 Technical Aspects vs Social Aspects

Overall, studies show that social aspects of gene technologies are at least as important and at times take precedence over technical aspects. For example, Cook et al. (2004) found that 90.1% of their respondents believed that 'the use of biotechnology needs to be transparent', whereas only 51.8% of the respondents believed that 'biotechnology can fix environmental problems that have been caused by humans', revealing the social and value-laden basis of many people's perceptions. More recently, when focus group participants were asked what a panel designated to make decisions about novel technologies for conservation purposes should be considering in their decision-making process – social aspects were seen as the most important considerations (MacDonald et al., 2022). This resonates with the much earlier statement by the Office of the Parliamentary Commissioner for the Environment (2000) where it was acknowledged discussions about gene technologies were more than technical discussions, and instead demand a complete (re)examination of broad values and existential beliefs and identities that sit at the very foundation of the way society is structured and governed.

2.8.2 Personal and Social Values

Conversations about bio/genetic technologies are underpinned by personal and social values that traverse across what would be considered technically 'safe' or 'effective' (Cook et al., 2004; Cook & Fairweather, 2005; MacDonald et al., 2020). This is consistent with the wider risk literature where it is commonly accepted that values are integral to how people form opinions and make decisions, particularly in complex, multifaceted decisions where the outcomes cannot be fully known (and yet urgent decisions still need to be made (Wilkinson & Fitzgerald, 1997)). The value-based and often emotionally driven response to the idea of novel genetic / biotechnologies for environmental management purposes is most evident in the recent National Science Challenge novel technologies work (Dixson et al., 2022, 2023; Eppink et al., 2021; MacDonald et al., 2020, 2021a, 2021b) which explicitly explored and tested the impact that values have on people's decision making and found it to be more influential than objective scientific knowledge on shaping their views.

The values based nature of people's perceptions, approaches to engagement that are largely predicated on the knowledge-deficit model are therefore too limiting for genetic technology discussions. This is because this model assumes that 'more information or education' leads to more support for these technologies (Wilkinson & Fitzgerald, 1997).

Several studies have highlighted the limited impact of knowledge on support of biotechnologies (Cook et al., 2004; MacDonald et al., 2020; Macdonald, Varey & Barker, 2011) even for stakeholders and experts in the conservation space (Kirk et al., 2020). While information was sought in almost every study, the 'type' of information sought, as well as information about 'who it would be delivered by' clearly demonstrates a set of values that cannot be answered by a technical approach alone. MacDonald et al's (2020) research showed that technical information resulted in increased polarisation and a slight shift towards negative opinions about the technology. This pattern that has also been noted with climate change (Hornsey et al., 2016), GMO food (Gaskell et al., 2000), nano-technology (Lee et al., 2015), and synthetic biology (Akin et al., 2017, as cited in MacDonald et al., 2020).

2.9 Social Science Methodologies

2.9.1 Qualitative Methodologies

Consistent with the wider social science literature (Freeman, 2006; Fossey et al., 2002; Kitzinger, 1995; Liamputtong & Ezzy, 2005; Smithson, 2000; Sofaer, 1999), qualitative studies including focus groups, interviews, and workshops elicit a range of topics that publics consider when deliberating over the potential development and use of genetic/biotechnologies for environmental purposes, as well as understanding the explanations behind them and how they differ across cohorts.

However, it appears that the breadth and depth of themes that emerge may differ according to the specific intention of the research and how the conversations are structured. Cronin (2008) review of public conversations on genetic technologies in New Zealand, noted that situations where the intention was to engage in a 'two-way dialogue' and was focussed on 'finding shared values and visions' while 'acknowledging difference' was perceived as being more constructive for coming to a collective decision than where the intention was to communicate one's view in a 'turn-taking' format.

Cronin (2008; 2010) observed that, when scientists were brought in as 'authorities', they were less likely to empathise with the lay public. However, when scientists or science managers were requested to participate as private individuals rather than as representing organisational roles they appeared less conflicted and so a more inclusive and shared perspective emerged in the discussions. This insight highlights the potential impact of 'role representation' when participants are asked to contribute to a conversation that may lead perhaps to an imbalance where lay publics represent their own views, whereas scientists/experts may feel the pressure to, or be explicitly requested to, prioritise the perspective of their profession over their personal views (e.g. see Gamble, 2001). Offering scientists and other individuals scenarios where they are not confined to limited role identities may allow them to draw from a wider array of values and viewpoints, potentially resulting in broader, more inclusive, narratives within and between participants.

Research suggests that homogenous groups may be likely to give more unencumbered and open views as people discuss ideas with like-minded others with freedom and rapport (McLafferty, 2004). In contrast, mixed groups may lead to more 'thinking in action' or dialectical processes (Coyle et al., 2003; Hunt et al., 2003) whereby discussion could be had in novel ways (Femdal & Solbjør, 2018). However, studies have shown that too much heterogeneity in single focus groups, particularly on topics that may elicit strong emotion and opposition, can foster conflict and power imbalances as some participants dominate the narrative over others. Alternatively, they may result in conformity of views as fewer people are willing to voice disagreement (Bloor et al., 2001; Reid & Reid, 2005;).

Overall, it appears advisable to consider how the intention of the research, and therefore that the type of conservation desired by the researcher, should guide the makeup of focus groups in an effort to balance diversity and dialogue with inclusivity and power dynamics. Indeed, one of the key learnings in Winstanley et al's (2005) report *From Dialogue to Engagement* was that participants often enjoy the stimulation of different points of view in certain contexts.

2.9.2 Quantitative Methodologies

Quantitative approaches, mostly surveys, have been employed to assess prevalence of views across the New Zealand population, usually those that have been identified from qualitative approaches, with occasional testing of hypotheses via relationship testing or experimental designs. Many have few if any references, theoretical backing or significance testing (e.g., Office of the Parliamentary Commissioner for the Environment., 2000; Sheppard & Urquhart, 1991). The AERU *The Fate of Biotechnology: Why do some of the public reject novel scientific technologies?* programme of research is an exception, starting with a series of focus groups, followed by two surveys to follow changes over time (see Cook et al., 2004; Cook & Fairweather, 2005; Coyle et al., 2003; Hunt et al., 2003). Similarly, the previously mentioned Biological Heritage National Science Challenge research (Dixson et al., 2022, 2023; Kirk et al., 2020; MacDonald et al., 2020, 2021a, 2021b, 2022) employed a series of theoretical bases which were tested using survey results, including the production of a segmentation model for four key worldviews.

2.9.3 Summary of Methodologies

Given the complexity of genetic/biotechnology conversations, qualitative approaches such as workshops, focus groups and interviews which have the intention of fostering a co-design process using deliberative dialogue that has a clear purpose, as opposed to 'consultation' where the purpose of the research is unknown/unclear, is likely to be a more effective method for eliciting considered views that reveal participants' initial perceptions and also associated values and beliefs. However, efforts to integrate qualitative and quantitative methodologies are valid as together these methodologies provide a cohesive understanding of what people are feeling/thinking, how prevalent these thoughts and feelings are across the country, and what this ‘means’.

2.10 Insights to Guide Public Engagement for Current Research

Several patterns were identified across the studies reviewed that highlighted key aspects that warrant consideration when engaging the public on the topic of genetic/biotechnologies for environmental purposes in New Zealand. These are presented below, in no particular order, as aspects that either have or will warrant particular attention in the research and application space of public deliberation.

2.10.1 Genetic Technologies are More than a Technical or Scientific Issue

Discussions about genetic/biotechnologies for environmental purposes need to be far more than purely technical or ‘scientific’ (Office of the Parliamentary Commissioner for the Environment, 2000). People’s priorities are heavily influenced by values when trade-offs need to be made, particularly when uncertainty and risk are high. This is consistent with the wider international literature which has shown that, particularly in situations where there are many unknowns, people often rely on more heuristic, emotional processing that has roots in an individual’s values and beliefs. These serve as guides for decision-making in the absence of complete information, time, or both (MacDonald 2020; Quartz, 2009 Frankish et al., 2009.; Wilson, 2008). This is most explicitly discussed by microeconomist Daniel Kahneman who elaborates on how, in many instances, people rely on the ‘quick short-cut’ routes to decision making through a ‘gut feeling’ derived from long held, and often unconscious values especially in times where the slow, rational deliberative process is not feasible or desirable. Similarly, Cook & Fairweather (2005) found that the majority of participants were self-aware that the main driver for their opinions of biotechnologies was how they felt (73.4%) as compared to those who saw their opinions primarily being sourced from an understanding of the risks and benefits (61.9%).

Within regard to what the key values might be in the New Zealand genetic / biotechnology space, the literature suggests overall that there is a need for consideration well beyond technical aspects (see Appendix 10.3) and that social, ethical and political values are of equal importance in this decision making process, as is the need for ‘trust’ in the authorities running the research, developing the technology, and regulating its use (Cook et al., 2004; Cook & Fairweather, 2005; Dixson et al., 2022, 2023). Such factors might be particularly pertinent in the wake of COVID-19 where trust in science and organisations in New Zealand was one of the highest in the world (Fetzer et al., 2020 as cited in Dixson et al., 2023).

2.10.2 Conversations Should Focus on Both the Problem and the Solution

Another key aspect that emerged from the literature is that conversations need to be about the ‘problem’ as well as the solution (which in turn supports earlier engagement). Highlighting this often-missed point, Wilkinson & Fitzgerald (1997) found that some of their participants, particularly those with environmental interests, disagreed with the problem scope and definition, in that some did not think pests were the issue but rather poor land use and management. Likewise, over 30% of MacDonald’s et al. (2020) sample did not see a distinction between native and non-native animals and therefore questioned their status as ‘pests’; a critique corroborated by the qualitative sentiments in MacDonald et al. (2022) and Dixson et al. (2022). Such findings highlight that sometimes disagreement regarding the acceptance of specific tools may actually lie deeper in the problem definition itself and therefore may influence subsequent perceptions of any proposed solutions.

2.10.3 Conversations Need to Include Multiple Perspectives

Cronin (2010) noted that public engagement on genetic technologies often involve conversations positioned into a ‘science and society’ binary. While this relationship is important for a healthy democratic society, research also indicates that other voices need to be included when discussing genetic/biotechnologies - particularly regulators, legislators and others who are able to influence decision-making at a higher, strategic level. Indeed, one of the main concerns held by participants across studies is how genetic/biotechnologies will be regulated. This stems from people’s concerns over the ‘slippery slope’ of technology implementation that has potential to lead to misuse and/or development into areas that are not socially acceptable.

Another voice that research indicates is important to include is that of industry/businesses - which are often perceived in a negative light by broader publics who are concerned about the commercialisation of genetic tools (Gamble, 2009; Gamble & Kassardjian, 2008). Establishing clear lines for effective conversations between industry, science, publics, policymakers and other stakeholders is critical for informed decision-making.

2.10.4 Processes Can Influence Participant Engagement

Research indicates that participants may be reluctant to engage if they feel their contributions will not ‘make a difference’ or, even if their views are considered, the process might be carried out in a biassed or pre-determined way (Dearden et al., 2018). Similarly, research suggests that engagement is hampered if participants feel that they are being swayed or manipulated (Macdonald, Varey & Barker, 2011; Office of the Parliamentary Commissioner for the Environment, 2000; Wilkinson & Fitzgerald, 1997). By contrast, if participants feel the engagement is genuine and that their voices are ‘heard’, they can accept aspects they may disagree with because they feel a sense of control in the overall process (MacDonald et al., 2021b).

Numerous studies highlighted the importance of early or ‘upstream’ engagement where the decision to develop or use any technologies has not been decided (Dixson et al., 2022, 2023; Kirk et al., 2020; MacDonald et al., 2020, 2021b, 2022; Macdonald, Varey & Barker, 2011). Conducting engagement processes for one context shouldn’t be taken as widespread approval. Studies show people may be hesitant to support an idea if they perceive their one-off opinions on a specific tool in a specific context is to be treated as outright acceptance for the use of that tool in different contexts and for different purposes in the future. Indeed, Kirk et al. (2020) highlight that social acceptance and support is an ongoing conversation and questions should be included as to how participants wish to be re-engaged and at what frequency. Care should be taken to establish who should be in control of making decisions, particularly when contention and perceived risks appear to be high.

More ‘upstream engagement’ (i.e. early in development stages) is likely to help to avoid polarisation and contestation and, over time, lead to greater trust-building (Esvelt & Gemmell, 2017; Kirk et al., 2020; MacDonald et al., 2020; Winstanley et al., 2005). Indeed, Esvelt & Gemmell (2017) in their technical examination of genetic technologies for conservation purposes, acknowledge that there is an overly high ‘cost of impatience’ to proceed without social acceptance. They call for proposals and research to be open from the earliest stages, with active dialogue between scientists and the community.

2.10.5 Terminology Matters

It is also important to gain a clear understanding of terminology used throughout the engagement process. This includes understanding the technical meaning and connotations of terms used by both researchers and participants. Kannemeyer’s (2017) summary of the different genetic / biotechnology techniques used in biodiversity shows how understandable it is for the public to struggle with meaningfully differentiating between different methods. As such it is important that terms are well defined and discussed in appropriate contexts.

2.10.6 Socio-political Contexts Can Shape People's Perceptions

Studies show that socio-political contexts at play during the time of any research can influence people's perceptions of the genetic/biotechnologies, as do their personal experiences. For example, as argued in Wilkinson & Fitzgerald (2006) the context of the calicivirus breakout in Australia, as well as negative sentiment towards pest control toxin 1080, may have exacerbated issues of controllability, humaneness and distrust in science. A similar observation was made by Gamble et al. in a 2010 qualitative exploration of stakeholder perceptions of three novel biological pest control methods, that the perspectives that emerged were often contextualised within people's perceptions or experiences of "Agent Orange' and 'Painted Apple Moth'. Likewise, a discourse analysis by Weaver & Motion (2002) on the broader discussions of genetic engineering in New Zealand highlighted that some participants may have had reservations regarding genetic/biotechnologies due to previous experiences with the biotechnological industry where information had been framed, altered, or omitted, while maintaining an image of 'dispassionate objectivity'. Cook & Fairweather (2005) found a general increase in support for some genetic/biotechnologies was likely due to fading recollections of the lifting of the GM moratorium in 2003. MacDonald et al. (2022), noted that people's perceptions were often contextualised within the 1080 debate.

These findings highlight that personal experience and social, cultural, political, and technical factors coalesce to shape people's views about genetic/biotechnology in New Zealand. Conversations, therefore, do not occur in isolation but are shaped by people's experiences with broader social issues that influence the 'conversation beyond the conversation' including aspects such as broader views on science and technology and their relationship to industry (Office of the Parliamentary Commissioner for the Environment., 2000).

Further still, Coyle et al. (2003) noted that participants often viewed conversations about biotechnology as encompassing a broader conversation about innovation in New Zealand, balancing innovation with the maintenance of a "clean, green' image (Coyle & Fairweather, 2005a). This was particularly evident in the multi-year Dialogue Fund programme, where the impact of biotechnologies was aligned with national identity with participants feeling that identities were manipulated to meet certain ends, for example. innovation primarily being seen as enabling economic growth (Macdonald, Varey & Barker, 2011). Similarly Kirk et al. (2020) found that stakeholders in the conservation space and farmers shared concerns that the introduction of genetic technologies could influence New Zealand's GMO-Free status, with flow on effects for primary production and tourism. This was balanced by a general sentiment that 'it could go well'.

2.10.7 Summary of Insights

Overall, the studies highlight that genetic/biotechnologies touch the very foundations of people's values and beliefs and, therefore, are framed within broader perceptions about spirituality, morality and fundamental beliefs about 'nature' (Coyle et al., 2003). Furthermore, because genetic/biotechnologies may be viewed as 'altering nature,' they can impact deeply embedded, complex core beliefs and values (Coyle & Fairweather, 2005b). As such, studies across the three decades of this review strongly indicate ongoing and two-way deliberative processes are likely to be the most productive and effective way publics can be listened to and included in decision-making processes.

2.11 Māori Perceptions about Gene Technologies

The social science literature was also examined to find literature which contains Māori / te ao Māori and / or mātauranga Māori perspectives regarding the potential development and use of genetic / biotechnology for environmental management purposes. Key elements of each article were extracted including: the reference; objectives of the research; methods used; overall outline of each article's contents. While the literature search focussed on Māori perceptions of genetic / biotechnology for environmental management purposes i.e. for conservation and biosecurity, the research was often situated within broader articles about genetics, science and society and biotechnology.

These articles were collated into a table, which is contained in Appendix 10.5. The table should be seen as a collection of articles only and not viewed as a review or analysis of the literature.

PART B

Public Engagement Stream

This research has two separate but complementary research streams including:

- General Public Engagement
- Māori Engagement

Part B contains three chapters relevant to the Public Engagement Stream including:

- Public Engagement Methodology
    - Introduction
    - Public Engagement Stream
- Public Engagement Findings
    - Introduction
    - General Public Engagement Participation
    - Phase 1: Explore
    - Phase 2: Refine
    - Phase 3: Deliberate
- Public Engagement Insights
    - Introduction
    - Insights about Complex Socio-Environmental Science
    - Insights for Contested Science Issues
    - Insights for Problem Driven Science
    - Insights for Complex Socio-Environmental Innovation Governance
    - Insights for Innovation
    - Insights for Environmental Futures
    - Insights for Genetic Technologies
    - Insights for Science Communication / Science Engagement
    - Insights for Science / Social Science Education
    - Insights for Deliberative Processes / Insights for Practice
    - Summary

3.0 Public Engagement Methodology

3.1 Introduction

The public engagement research stream followed a methodological process that had three core phases:

- Phase 1: Explore
- Phase 2: Refine
- Phase 3: Deliberate.

The research in this stream aimed to gain an understanding of the thoughts and feelings of the New Zealand public about the use of genetic technologies for environmental and conservation purposes via carefully selected target groups. These groups were selected to sample from a broad range of New Zealanders.

This engagement stream received ethics approval from the University of Otago Human Ethics Committee (non-health). It was written for Phase 1, then amended to cover Phase 3.

The ethics approval permitted several types of data to be captured. This included rich conversations people had about genetic technologies, anonymous democratic information (age, gender, ethnicity) and participants' perceptions on their experience of the deliberative process in Phase 1 and 3.

Several issues required particular ethical care. Firstly Phase 1 and 3 sessions were audio-recorded. Secondly, there was a likelihood that people would hold markedly different views about genetic technologies and these differences could create tension. To address these issues, the participant information sheet informed participants they could withdraw from a session at any time. In addition, the participant information sheet explained that any information captured from the recordings and presented in the report would be anonymised, so that no individual could be identified in the research findings. Furthermore in Phase 1, a quiet area was also provided where participants could step away and spend time relaxing, or doing a jigsaw puzzle if they felt a need.

Participants under the age of 16 were not included in the research.

3.2 Phase 1: Explore

In this phase selected groups of the New Zealand public were engaged in a discussion about their environmental visions for New Zealand conservation and their general perceptions about the use of genetic technologies for environmental purposes. The discussion sought to capture people's thoughts, feelings and values about New Zealand conservation, their concerns and perceptions around tools that are currently used, and tools or technologies such as gene technologies that might be considered for future use.

The discussion was not aligned to any specific tool or technology (e.g. gene editing, RNAi, 1080) or to any specific environmental issue. The intention was to listen to a wide range of perspectives and not to steer people towards a specific, 'correct' or pre-determined set of outcomes, so people could engage in the discussions in ways they felt were most appropriate.

In contrast, to many previous studies this research has sought to gather a rich set of qualitative data rather than to focus on 'numbers' of people who do or do not support the use of genetic technologies. The aim was therefore to listen to people's:

- Visions for the environment,
- Concerns about the environment and tools for managing the environment including genetic tools,
- Environmental 'scenarios' / contexts of interest or concern to them.

Insights from the conversations would then be used to inform the development of the scenarios that would be used in the Phase 3 deliberations. In addition the research sought to examine the process of engagement and in particular:

- The impact and effectiveness of the process of deliberation,
- What people felt they would need to contribute to any future discussion,
- How comfortable people were engaging in conversations about contested and complex science innovations.

Phase 1 workshops were held with a broad range of targeted groups from Northland to Rakiura / Stewart Island as shown in Table 3.1 below.

Table 3.1: Location of Workshops in Phase 1: Explore

Workshop Group	North Island	South Island
Pilot Group		Mixed Participants
Rural Community	Northland	Milton
Tertiary Environment	University of Auckland	University of Otago
Seniors	Warkworth / Kaukapakapa / Orewa	Dunedin
Environmental Groups	North Auckland	Queenstown
Island Community		Rakiura community

As gene technologies may impinge on people's religious beliefs, religious groups in the North and South Islands were approached to participate. Unfortunately no religious group chose to participate. However, as people hold religious beliefs irrespective of whether they belong to a named religious group, these perspectives did emerge in conversations in other settings.

3.2.1 Demographics

In Phase 1, demographic information was gathered from workshop participants to assess the range of people from different ages, genders, and ethnicity being captured by the research. The results from this analysis are presented below.

Age

Workshop attendees were asked to classify their age into one of four age bands:

- 16 - 30
- 31 - 45
- 46 - 60
- 61+

The percentage of workshop attendees in each age band is shown in Figure 3.1.

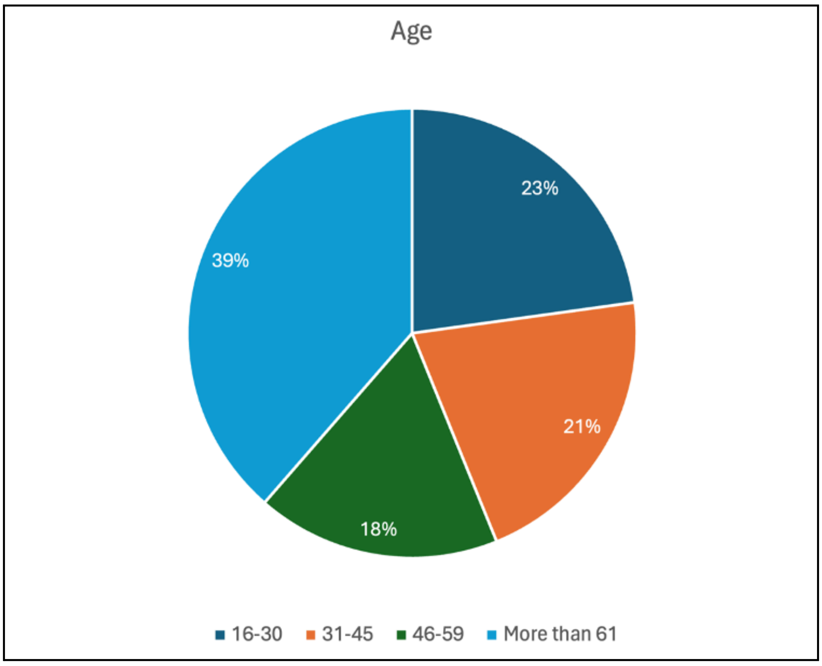

Figure 3.1: Percentage of participants in each age band for all Phase 1 workshops combined.

Figure 3.1 shows that while all age bands were well represented, older people were most likely to attend the workshops and were overrepresented compared to the 22% of the New Zealand population composed of this age group (see Regional Economic Profile | New Zealand | Age composition). The other three age bands were approximately representative of the underlying population of New Zealand.

Gender

Workshop attendees were asked to classify their gender into one of four categories:

- Male
- Female
- Other (Gender diverse)
- Prefer not to say

The percentage of workshop attendees in each gender category is shown in Figure 3.2.

Workshop participants classified their gender approximately 50:50 male:female. Participants who classified themselves as “Other / Gender diverse” or “Prefer not to say” included 3.5% of all participants and although the 1.7% of participants that classified themselves as “Other / Gender diverse” is an underrepresentation of the approximately

4.5% of the New Zealand population who identify as LGBT, it is important to record that the research did capture this demographic.

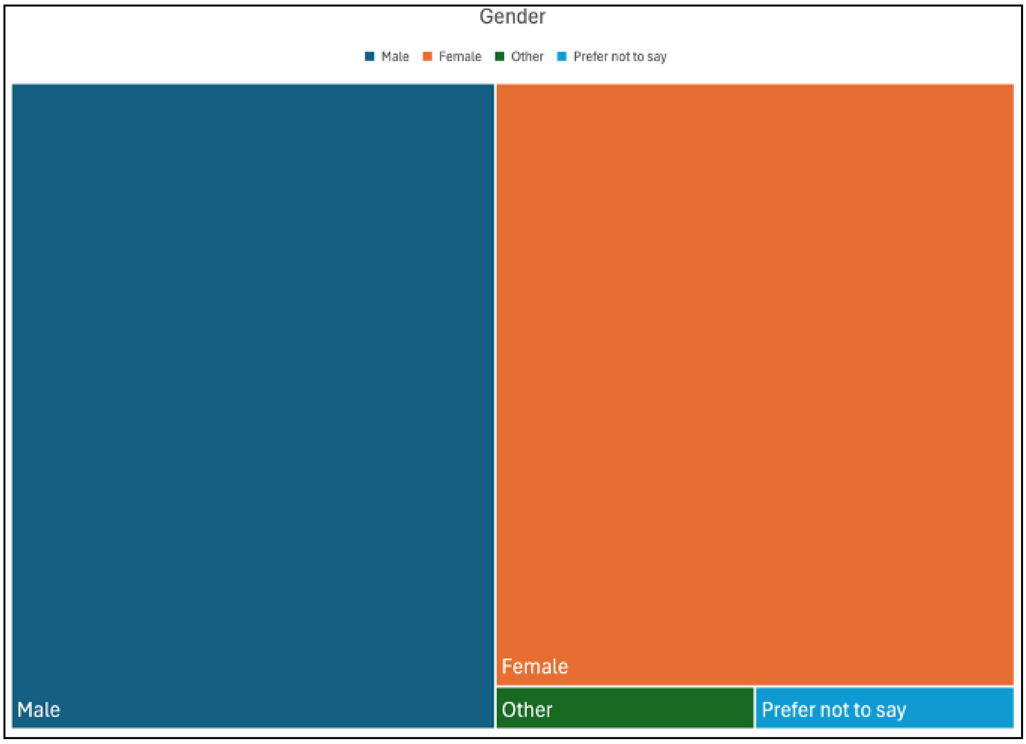

Figure 3.2: Phase 1 workshop participants' gender composition

Ethnicity

Workshop attendees in the public events were asked to classify their ethnicity into a number of categories and in doing so they were free to select more than one category. The ethnicity categories were:

- Pakeha
- Māori
- Pacifika
- Australian
- British
- Asian
- Latin American

The percentage of workshop attendees who identified with each ethnic category is shown in Figure 3.3.

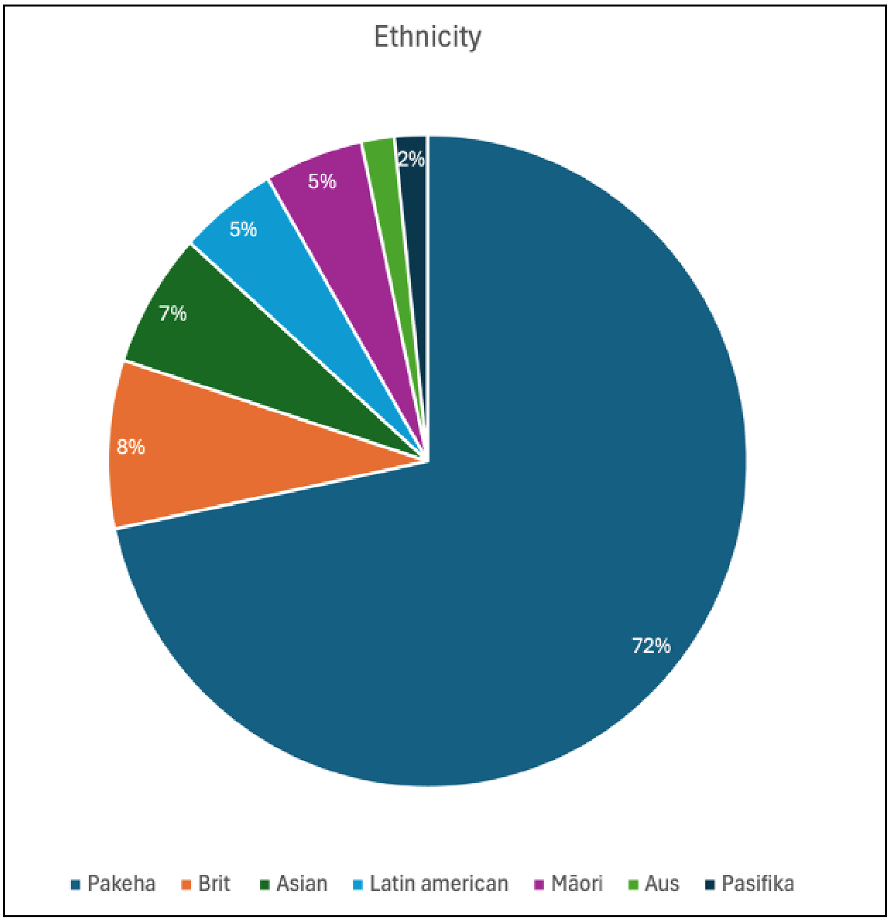

Figure 3.3: Percentage of participants in each ethnic group for all Phase 1 workshops combined. Participants could select more than one ethnicity.

Participants who identified as Pakeha New Zealanders made up almost three quarters of public event participants, which is approximately representative of the overall population of New Zealand. However, when the additional 10% of participants who identified as British and Australian were added, the 82% of participants with European ethnicity was an overrepresentation of the 68% of the New Zealand population in this ethnic category.

Workshop participants included 5% who identified as Māori and 2% who identified as Pasifika making both these groups underrepresented in the Public Engagement stream compared to the underlying population where approximately 18% are Māori and 9% are Pasifika, a pan ethnic grouping of Pacific people. However, as explained in chapter 1 the Māori Engagement stream of the research led by Te Tira Whakamātaki specifically engaged with iwi/hapū/whanau to listen to and gather their thoughts and concerns about the use of gene technologies for conservation purposes. A further 7% of participants identified as Asian which is also an underrepresentation compared to the approximately 17% of New Zealanders who identify with this pan-ethnic category.

3.2.2 Workshop Format

Due to the technical and potentially contentious nature of gene technologies, it was recognised that people may be hesitant about participating in conversations about genetic technologies. People may believe they do not know enough about the technicalities of genetic technologies or ecological issues. This may lead to a feeling of inadequacy, or epistemic deficit with regards to the science of genetics, genetic technologies, and/or ecology. This in turn may lead participants to believe they are not legitimate knowledge holders. Feelings of not knowing enough could therefore lead people to feel ill-qualified or ill-equipped to speak on any of the topics at the workshop.

Furthermore, as genetic technology is a topic that can polarise, people may feel anxious about engaging, hold very fixed views on the topic, or fear that those around them might disagree with their views. The research approach therefore aimed to reduce the impact of these issues by engaging people in purposeful games before participating in a facilitated discussion.

Purposeful Games

At the beginning of each workshop participants were invited to play a set of project-designed purposeful games. The games were based on heritage games that participants would likely already be familiar with such as Snakes and Ladders and Jenga. These games were modified to focus on genetic technologies, the environment, or social aspects of relevance to the conversation, such as the governance of social innovations. A full description of each game can be found in Appendix 10.1.

The games also sought to introduce participants to challenging environmental, social, ethical, economic and cultural concepts, including biodiversity and environmental impacts (Ecological Collapse - Jenga), science innovation (Snakes and Helixes) and innovation governance (Who sits around the table - Darts and Bingo). Participants played the games in small groups at the beginning of the workshop to gain knowledge and confidence by learning some technical terms and concepts associated with gene technologies use for environmental purposes. In addition, the games sought to build social relationships between participants, and create a sense of enjoyment and fun before engaging in the facilitated fishbowl conversation.

Table 3.2 below provides an overview of the six games used in Phase 1 and how each game supported the understanding of different concepts.

Table 3.2: The concepts introduced in Phase 1 by each Purposeful Game

Game	Knowledge-confidence Building			Players		Time-out
	Ecology	Gene Technology	Social / Ethical	Competitive	Team-work	
Ecological Collapse	✓		✓		✓	
Snakes and Helixes		✓	✓	✓ (with chance)		
Target Game: Gene Editing		✓				
Stakeholders. Who sits around the table?			✓	✓		
Word / Concept Pictionary	✓	✓	✓	✓	✓	
Puzzles						✓

The Facilitated Discussion: A Fishbowl Conversation

In the second half of each workshop a facilitated fishbowl discussion was held and all participants were invited to join the conversation. A ‘fishbowl conversation’ sees participants seated in two concentric circles. The central circle is imagined as ‘the fish’, and contains four to five chairs for participants. This is where the conversation takes place. The outer circle of chairs is for the remaining participants.

Participants are invited to join the conversation in three ways:

- by coming into the centre circle at any time to share their views on a range of discussion when a position becomes available;
- by actively listening to the conversation from the outer circle,
- by noting their thoughts on post-it pads provided on each seat.

The fishbowl format means people are not forced to speak their views in front of the whole group, but only when they wish to engage. The process values both conversing and active listening. It does not force or require people to speak. The intention of the fishbowl discussion is for the conversation to develop naturally, requiring minimal intervention by a facilitator, and allowing participants to guide its direction in a natural and participant-led way.

One of the research team acted as the facilitator and opened the discussion seeking participants' general visions and aspirations for Aotearoa New Zealand's natural environment. In this way the conversation was framed around what people hoped for, and leaving it then open for people to discuss the role they could see for genetic technologies, or other technologies, in achieving their visions. Conversations were audio recorded.

3.2.3 Exit Surveys

Evaluation surveys were collected from participants at the end of each workshop to gather people's experiences of the sessions. Participants were not required to answer all questions in the survey.

Participants were asked to score a range of statements using a Likert Scale where they could indicate their level of agreement (from 1 'strongly disagree' to 5 'strongly agree'). Statements ranged from how comfortable they felt during and after the games, whether they felt they had the opportunity to participate in the conversation, how valuable they found the event, and whether their confidence to engage in discussions had increased.

To further explore participants' experiences, participants were asked to describe what they found most valuable in the workshop.

3.2.4 Content Analysis

Leximancer™ (Smith & Humphreys, 2006; Sotiriadou et al., 2014) is a text-analysis software that allows for representation of themes and concepts emergent in a corpus of text using a machine learning technique. The software identifies the key concepts of a text and how they relate to each other, and clusters them into themes.

Leximancer has been widely used to map a variety of texts from news media articles to discussion text (Fraser-Baxter & Medvecky, 2018; Logan et al., 2016). For this analysis, the phrase length was set at two sentences to track concepts and words that are found to travel together through text. Using an inbuilt global thesaurus, the software carries out relational analysis to provide insights into how closely the themes and concepts are related to each other in the corpus of text. Words are assigned weightings as a reflection of the contribution to the text block measured. Through this process, both implicit and explicit presence of concepts are captured.

Leximancer produces two-dimensional maps, displaying the relationship between the categorisation of themes (central idea) of a collection of concepts and displaying the position of concepts throughout the text (Matthes & Kohring, 2008). This visual representation of concepts is regarded as Leximancer's strength as it displays relationships between concepts (Angus et al., 2013).

The software was used to analyse and identify keywords, themes, and concepts that characterise and represent the discussions held by the public during the facilitated fishbowl discussions in Phase 1. The result of this analysis is then mapped, representing the connectivity between themes and concepts (see Section 4.3.4). Relational analysis from Leximancer also ranked the themes and concepts based on their relative occurrences (the more they were discussed, the higher the ranking), providing insights into the concepts dominant in the discussion. Concepts that were considered irrelevant were removed (e.g. 'things'). Concepts considered analogous were merged (e.g. 'tech' and 'technology').

3.2.5 Phase 1: Final Remarks

The workshop gathered the thoughts and feelings of a demographically diverse set of workshop participants about both their visions for New Zealand conservation and the role that genetic technologies may or may not play in that vision. This provided an understanding of people's aspirations for New Zealand conservation and their broad perspectives and cautions around the use of genetic technologies for environmental and conservation purposes.

Framing the fishbowl conversations around people's visions for the natural environment, avoided participants feeling daunted or bogged down by the technical details of the genetic technologies themselves. Moreover, by using games to address the epistemic issues often associated with engaging in potentially contentious issues, an open and friendly atmosphere was created in the workshops, that supported participants to share their own perspectives while being open to listening to others' perspectives.

As each Phase was used to inform the subsequent phase, three emergent ideas were revealed from the Phase 1 methodology. These were:

- Genetic technologies as a potential 'tool' in an 'environmental management toolbox'.
- A sense of the range of perspectives people held;.
- A growing understanding of the range of environmental scenarios in which people were interested

3.3 Phase 2: Refine

The literature indicated that for findings to be relevant and impactful, it was important for people to have realistic, feasible, detailed and accurate scenarios to deliberate. These scenarios would discuss an environmental problem and the current and new genetic control tools that are or could be used to manage (eradicate or control) the environmental issue. The scenarios would be presented to groups in Phase 3 to enable groups to deliberate on them and to see if they could reach consensus on the tools they would consider for the management of the issue.

To assist with developing scenarios for use in Phase 3 deliberations, a variety of knowledge holders were approached and interviewed. These people and groups included scientists engaged in genetic technology research, ecologists, scholars in bioethics and law, scientists with an interest in genetic technology but not specifically involved in genetic technology research, social scientists, government agencies, industry groups and interest groups concerned about or opposed to genetic technologies being used in New Zealand (See Table 3.3).

Engagement with participants in Phase 2 largely occurred in semi-structured interviews. Conversations varied, depending on the expertise and interests of the participants. The discussions aimed to examine three key questions:

1. What is the current state of genetic research in New Zealand?
2. What tools are currently feasible - i.e. they are in late stages of development?
3. What genetic technologies are unlikely to be developed, either for technical, environmental or social reasons?

Participants also provided a range of information including scientific papers, media articles, government reports and interest group documents. This information provided wider understanding about social, ethical, cultural, technical, scientific, environmental, political and regulatory dimensions of genetic technology in New Zealand.

Table 3.3: Phase 2 Participant Knowledge / Interest Contribution

Interview	Information			Interest		
	Genetics	Ecology / Environment	Bioethics / Law	Caution	Research	Policy / Practice
Genomics	✓				✓	
University Scientists engaged in Gene Tech research	✓	✓			✓	
PSGR Scientist	✓			✓	✓	
CRI Scientists engaged in Gene Tech research	✓	✓			✓	
CRI Gene Technology Specialist Group	✓	✓			✓	✓
Predator Free Groups/ Personnel		✓			✓	✓
GE Free Groups		✓		✓		✓
Bioethics			✓		✓	
Boston Science Museum Social Research Team					✓	✓
Industry Groups						✓

3.3.1 Scenario Selection

From the conversations in Phase 1 and 2, four scenarios were selected (Table 3.4). The scenarios that emerged varied across several dimensions:

- Type of organism (flora vs fauna),
- Genetic technique (gene editing vs RNA interference),
- Issue - conservation, conservation but with links to economic production
- Development stage (almost fully developed vs futuristic technology).

The conversations undertaken in Phase 2 enabled the information for each scenario to be developed and these were presented in the same format to ensure consistency across all scenarios. This included:

- Description of the environmental problem
- The problems impact;
- Current environmental management tools,
- New genetic techniques being explored and how they would be applied;
- Current regulatory frameworks governing the technologies use.

Table 3.4: The four scenarios that were chosen for Phase 3 deliberations

Scenario	Organism Type	Genetic Technique	Innovation Issue	Readiness
Wilding Pines	Flora	Genetic Engineering	Conservation, with forestry links	Very Close
Myrtle Rust	Flora	RNAi	Conservation	Close
Varroa Mite	Fauna	RNAi / Genetic modification	Conservation, with food industry links	Close
Rats	Fauna	Genetic Engineering (gene drive)	Conservation	Distant

The scenario information cards used in Phase 3 are presented in Appendix 10.2.

3.3.2 Phase 2: Final Remarks

Phase 2 conversations engaged with a range of knowledge holders including stakeholders from inside and outside the science and technology sectors including key stakeholder interest groups, to support the development and refinement of the scenarios that were to be used in the Phase 3 Deliberation Workshops. The information which was gathered supported not only the technical understanding of genetic technology, but also a range of social, cultural, political, regulatory, ethical, environmental and regulatory dimensions. While participants held a variety of perspectives, knowledges and positions (in some cases) on genetic technologies, all were supportive of a wider public conversation about the use of genetic technologies in New Zealand conservation.

3.4 Phase 3: Deliberate

Phase 3 engaged members of the public in deliberative conversations in small focus groups where they explored the scenarios developed in Phase 2, to see if each group could reach a consensus decision about the tools that should be considered in the environmental management toolbox for the scenario under consideration. Each group was randomly selected to deliberate over two of the four scenarios.

3.4.1 Participant Recruitment

While phase 1 approached targeted communities, phase 3 also sought a broader range of publics and more open deliberation. Participants who had engaged in Phase 1 were approached to engage again, along with any member of the public who wished to engage. Participants who had engaged were encouraged to invite their networks to widen the interests people might bring to the conversation. In addition, public sessions were advertised via media, and community facebook pages. Figure 3.4 illustrates a newspaper article in Dunedin's 'The Star' newspaper, delivered free to all households in the Dunedin area, inviting the public to deliberative events in Dunedin's public library and at the Clubs and Societies building at the University of Otago (See https://www.odt.co.nz/the-star/views-sought-use-gene-technology-eco-issues).

The Star

THURSDAY, MARCH 28, 2024

www.thestar.co.nz

Views sought on use of gene technology on eco issues

STAFF REPORTER

Researchers from the Universities of Otago and Auckland want to learn how New Zealanders feel about the use of genetic technology to solve environmental problems.

Should genetic technologies be used to reduce numbers of rats? Or to control the fungus that causes myrtle rust? If not, why not? If so, who would you trust to oversee the programme? What rules need to be in place?

Dunedin residents are invited to a workshop to discuss their views on the topic, to be held on Tuesday, April 9, from 6pm-7.30pm, in the Dunningham Suite, fourth floor, Dunedin Public Library.

A second workshop for Otago University students and staff will be held from 12.30pm-2pm on Wednesday, April 10, in the Otago Room, OUSA Clubs and Societies Centre.

The team will also be hosting workshops in Queenstown and Milton in early April.

Project lead Dr Fabien Medvecky said in the workshops small groups would discuss an environmental scenario in-depth and decide together what they would like to see in the future.

"We all have a stake in the future of our natural environment. So whether you know lots about genetic technologies, or nothing at all, we'd love to see you there. Every voice counts," Dr Medvecky said.

The team has already completed two phases of this project, which is funded by the Biological Heritage National Science Challenge.

During the first phase, they ran sessions in several locations, including Auckland, Queenstown, Dunedin and Rakiura Stewart Island, to hear people's aspirations for our natural environment as a whole.

The research team then spoke to a variety of interest groups and experts to better understand the current technologies being used, as well as the potential genetic technologies that might be developed.

They used these conversations to develop a set of scenarios about rats, varroa mites, wilding pines and myrtle rust.

"We want to make sure people get an unbiased view of the problem and the possible solutions, so they can make up their own minds about whether genetic technologies are right for Aotearoa New Zealand and if so, how they need to be regulated," Dr Medvecky said.

Figure 3.4: Newspaper article inviting the public to deliberative events in Dunedin.

In addition two special interest groups were approached to participate in Phase 3. These were a group that drew its membership from GE Free and Organics sectors across New Zealand who participated in an online workshop, and a course of undergraduate social science tertiary level students who engaged in the Phase 3 scenario activity in their tutorial and who opted into the research. These groups provided ages and perspectives that were not captured well in the public engagement events (Table 3.5). The data collected from these special events were collated separately from the public engagement events and are presented separately in the research's findings.

Table 3.5: Locations of Phase 3 deliberation workshops

Geographic Location	Group type
NORTH ISLAND	
Pilot (Central Auckland)	Open to public - seniors & postgraduate students
Warkworth	Seniors and conservation groups
Auckland	Open to staff, students and alumni of University of Auckland
Titirangi	Open to the whole community
SOUTH ISLAND	
Otago Lakes region	Environmental contractors and volunteers
South Otago	Voluntary community group, plus partners and friends
Dunedin	Open to whole community
Dunedin	Open to staff, students and alumni of University of Otago
SPECIAL	
University Course	Undergraduate science course
Interest Group Online	GE Free / Organics Network

3.4.2 Demographics

Phase 3 workshop participants were asked to categorise their age and gender on their exit survey forms and this demographic information has been summarised to compare with the demographics of workshop participants in Phase 1.

Age

Although Phase 3 workshop participants were asked to classify their age in different age bands compared to Phase 1, it is clear the Phase 3 workshops were dominated by older New Zealanders as more than half of all participants were aged 55 or older. In contrast, approximately one third of participants were younger New Zealanders aged under 35. Middle aged participants aged between 35 and 55 were underrepresented in Phase 3 as this group only made up a little more than 10% of workshop participants whereas they make up approximately 26% of the overall New Zealand population see Figure 3.5.

However this Phase 3 demographic data does not include information from the two special Phase 3 events. One event with an undergraduate course was unsurprisingly dominated by a younger cohort of participants with 95% of the students from the 18-24 year old age band. Only four of the 10 participants at the online workshop completed an exit survey, and of those three were over 55 and one was from the 45-54 age range.

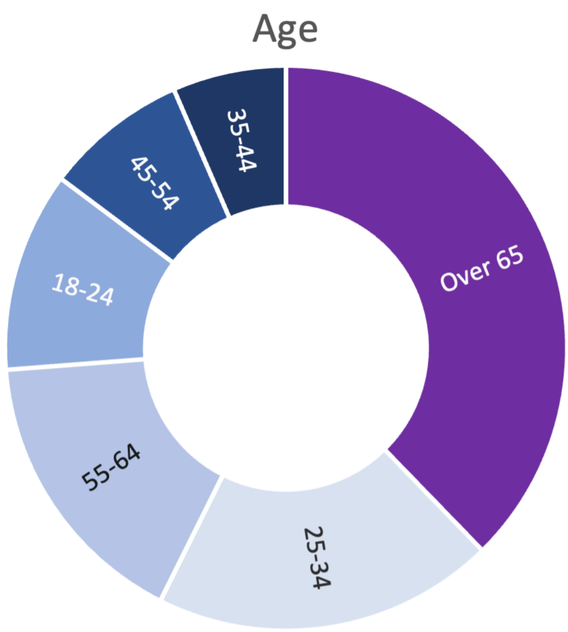

Figure 3.5: Relative age composition of participants in all Phase 3 public workshops.

Gender

As in Phase 1, Phase 3 workshop attendees were also asked to classify their gender. This indicated (Figure 3.6) a much higher frequency of men, approximately 2:1 attended the public engagement Phase 3 workshops compared with women. The non-binary gender demographic was again captured in Phase 3 as it was in Phase 1.

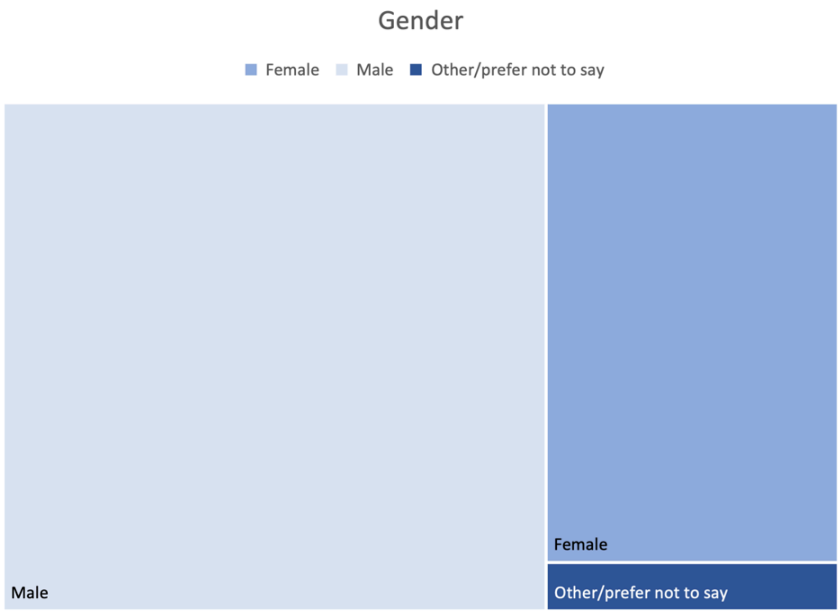

Figure 3.6: Phase 3 workshop participants' gender composition

In the special student workshop 46% of participants were female, 53% male and 1% gender diverse, while in the online event 75% were female and 25% were male. These data are not included in Figure 3.6.

3.4.3 Workshop Design and Format

The workshop was designed to enable each focus group to deliberate over two scenarios. Each group was provided with a variety of resources and materials to support their dialogue and deliberation. These are detailed in Table 3.6 below and a photograph of a deliberation table is presented in Figure 3.7.

Table 3.6: Materials supplied to support deliberative discussions.

Deliberative Discussion Materials
Stylised A1 sized landscape map - with placeholders for Perspective & Scenario cards
Environmental toolbox - Perspective, Scenario and Blank cards inside with pens and post-it notes
Instruction sheet - read out the Perspective cards followed by Scenario cards
Twelve Perspective cards - same gene tech perspectives for each scenario
Two scenarios - out of the possible four with different pairings for each group
Blank cards - white for writing decisions and yellow cards for writing cautions.

To minimise the risk of oversimplifying genetic technologies use for environmental purposes, each group was presented with twelve perspectives on genetic technologies. The perspectives which were drawn from the Phase 1 discussions and Phase 2 interest group discussions ranged widely and covered positive, negative and neutral perspectives and spiritual to pragmatic perspectives. Participants were asked to read these perspectives aloud from the printed cards, and to lay the cards around the landscape so they could be easily referred to during the discussions. The perspectives cards are presented in Table 4.2.

Scenario information cards about the problem and the current and new management tools including the genetic technology were presented for each scenario as eight numbered cards which were intended to be read in order. Each card had a heading to make clear the focus of the information – for example, ‘background’ and ‘current management tools’. The information cards addressing the genetic technologies cards

5-7 were divided into an explanation of how the genetic technology would work, how it would be implemented, and how it was currently regulated. As participants would come with varying levels of prior knowledge the information cards covered only key information to explain the issue clearly to a non-expert audience. The sessions were designed to be completed in 90 minutes. This meant that for groups to deliberate on two scenarios, only key information could be provided. People could ask questions and could also use their phones to source further information.

Figure 3.7: Table set for small group deliberative discussions

To incorporate all wider context of genetic technologies that had been raised by Phase 2 participants, a stylised landscape was placed on the table, and participants placed the perspective cards around this once they had been read. The landscape positioned the problem and the management tools within the wider social, political, cultural, economic and environmental context in which they operate (See Figure 3.7 above).

Participants completed their ethics information including reading the participant information sheet and signing their consent forms at the beginning of the session. In focus groups of up to four people were asked to examine the landscape and take turns to read out and discuss the perspective cards. Next they read the scenario information cards. They then discussed the scenario, working together to reach a consensus decision about what tools they wanted in their ‘environmental management toolbox’ to address the environmental issue at hand.

Decisions and cautions were written on the appropriate cards. After a short break the same process was followed for their second scenario. Each group had one genetic engineering technique and one RNAi technique to address. Researchers did not join these discussions, but remained attentive in case groups had questions about the process or the content.

One ‘special’ workshop was run online with an interest group with members spread across New Zealand.. To run this effectively, after an introduction and time for questions, the groups were divided into two online ‘breakout rooms’. All materials were put into a website so that people could see the scenario landscape and read and discuss the perspectives and scenarios together. Shared ‘whiteboards’ with a tool called Mural were provided so people could collectively write their decision and cautions. Each ‘room’ had a facilitator to support participants with the technology.

The students' special workshops were run in the students’ course tutorial time. This followed the same format as the public events, however as the time was limited to one hour, only one scenario was covered by each group. Students voluntarily opted into the research. Not all groups who did the scenario decided to participate in the research, however 17 groups who did opt in completed the ethics consent forms and exit surveys.

3.4.4 Data Analysis

Completed focus group decision and caution cards were collected and analysed. These were carefully separated into the four environmental scenarios, ensuring that each group’s decisions and cautions remained together and separate from the other groups.

The following data was analysed from Phase 3:

- Focus group decision and caution cards from all ‘public’ engagement workshops
- Focus group decision and caution cards for the two special interest events;
- Participants’ evaluation of the deliberative process (exit survey)
- The three words participants stated they would use to describe genetic technologies (exit survey)

Emergent patterns were coded to identify key themes for the decision and caution cards. This gave an understanding of the nuances around groups' decision-making and key areas of concern for specific issues and technologies.

Furthermore, the analysis explored the level of decisive support or rejection for the inclusion of genetic tools in the environmental toolbox for each scenario. In addition frames groups used in reaching their decisions were identified including features of technologies that shaped group thinking, and rules / regulations / governance they wanted put in place to manage genetic technologies if they were implemented. Five common issues were also analysed to see the relationship between these issues in relation to the level of decisive support. These five issues were: characteristics of various environmental tools and technologies, the state of knowledge, visions of alternative futures, the effect current technologies had on shaping people's views of new technologies and regulation, rules and governance.

In addition to identifying emergent patterns from the decision and caution cards as a whole, caution cards were coded for types of environmental, social, regulatory, ethical and economical impacts identified by participants The caution cards were also coded for comments relating to a tool's feasibility, viability, and desirability.

3.4.5 Exit Surveys

To assess people's experiences of the deliberative workshops, an exit survey was conducted. This assessed:

- the workshop's impact on people's thinking about genetic technologies.
- the impact of deliberative processes on pre-existing positions.
- The impact of the workshop on people's understanding.
- Whether people felt listened to in their focus groups.
- Whether groups reached consensus.
- Three words participants would use to describe gene technology.

Participants could also share general comments about the workshops. This information was collected and analysed and the results are presented in Chapter 4.

3.4.6 Phase 3: Final Remarks

These deliberative workshops provided an opportunity for people to engage in dialogue and deliberate about the use of genetic technologies for specific environmental scenarios. Groups had the opportunity to decide not only what tools they would want to see in New Zealand's environmental toolbox, but also to detail the reasoning behind those decisions. In addition, they were able to discuss and record the things that concerned them and how these might be addressed. This provided a rich and important dataset to enable a detailed examination of people's perceptions about the use of gene technologies for environmental purposes. It also provided critical understanding about the value of deliberative process in supporting people's engagement with complex and contested science.

4.0 Public Engagement Findings

4.1 Introduction

This chapter presents the research findings. It draws primarily from qualitative data from the fishbowl conversations in Phase 1, the interviews and small group meetings in Phase 2 and the deliberative focus groups in Phase 3. This has provided a rich set of data that has sought to gather and understand people's perspectives about the use of genetic technologies for environmental purposes. The qualitative data is supplemented with quantitative data where appropriate. We begin by detailing the number of people who have engaged with the research and then move to presenting the findings from each of the Phases. This chapter provides the underlying evidence for the insights which are presented in the final synthesis chapter.

4.2 General Public Engagement Participation

4.2.1 Participation Across All Phases

The public engagement stream team engaged with a total of 376 participants across 38 separate engagement events (workshops). Phase 1 engaged with 135 participants in a total of 10 workshops including four in the North Island and six in the South Island. These workshops included between four and 30 participants each and participants played a total of 41 purposeful games.

The Phase 2 interviews engaged with a total of 57 participants in 18 different engagement events. Seventeen participants were interviewed in 14 one on one or one on two interviews and a further 40 participants were interviewed in four group interviews that included between five and 15 participants each.

Phase 3 engaged with 184 participants in a total of 10 engagement events (workshops). Four events were conducted in each of the North and South Islands and a further two special engagements were conducted with a university undergraduate social science course and an online engagement with participants from an interest group drawn largely from GE Free and organic networks from across New Zealand. The total of 184 Phase 3 participants were subdivided into 43 deliberative focus groups generally with a minimum of three participants in each and these focus groups deliberated on a total of 69 scenarios. Generally each focus group deliberated on two scenarios each, however due to time constraints the 17 focus groups formed from the university course students each deliberated on only one scenario.

4.2.2 Stratification

Of the hundreds of participants that the research engaged with, each gave between one and three hours of their time to their research participation. Therefore, total participant engagement totalled at least 750 hours and included deep interrogation of participants' views of the use of genetic technology for environmental and conservation purposes.

While it was not realistic for the research to attempt to sample the New Zealand population using a strictly representative sampling regime, the participation and engagement sampling was nevertheless designed to draw from the New Zealand population using broad stratification using a range of different criteria. These included:

- Geography
    - North Island
    - South Island
    - Stewart Island
- Community
    - Urban (Auckland and Dunedin)
    - Periurban (Warkworth, Titirangi)
    - Provincial city / town (Queenstown, Milton)
    - Rural (Northland, Rakiura / Stewart Island
- Demography
    - Pre-career (University students)
    - Mid-career (Conservation, Science, Farming)
    - Post-career (Retired)

- Gene Technology Engagement
    - Scientific knowledge
    - Professional knowledge
    - Technical knowledge
    - Lay knowledge
    - Social science knowledge
    - Ethical / legal knowledge
    - Industry knowledge
- Gene Technology positions
    - A wide range of community perspectives (see Table 4.2)
    - People who held strong positions on gene technology
    - People who held no position on gene technology

Accordingly, it is concluded that the research drew input from a wide range of New Zealanders with different backgrounds. The research data demonstrates New Zealanders hold a wide range of views about, and knowledge of genetic technologies and their potential application for environmental and conservation management. The findings for each phase of the public engagement stream are presented below.

4.3 Phase 1: Explore

4.3.1 Participants' Experiences of Phase 1 Workshops

Evaluation surveys were collected from participants at the end of each workshop to gather people's experiences of the sessions. Participants were not required to answer all questions in the survey and some chose to only answer some of the questions.

Participants were asked to score a range of statements using a Likert Scale where they could indicate their level of agreement from 1 'strongly disagree' to 5 'strongly agree'. Statements ranged from how comfortable participants felt during and after the games, whether they felt they had the opportunity to participate in the fishbowl conversation, how valuable they found the event, and whether their confidence to engage in discussions had increased. (See Figure 4.1).

The Phase 1 evaluation surveys demonstrated that for four of the six questions approximately 50% or more of the participants 'strongly agreed' with the statements:

- The games we played made me feel more comfortable to participate in the rest of the event

- Overall, the 'fishbowl' conversation was facilitated effectively
- I felt that I had every opportunity to meaningfully participate in the 'fishbowl' conversation
- Overall, I found this event valuable

For these four statements the percentage of participants that 'agreed' or 'strongly agreed' was approximately 80% or better, and for the statement, 'Overall, I found this event valuable', approximately 95% of participants 'agreed' or 'strongly agreed'.

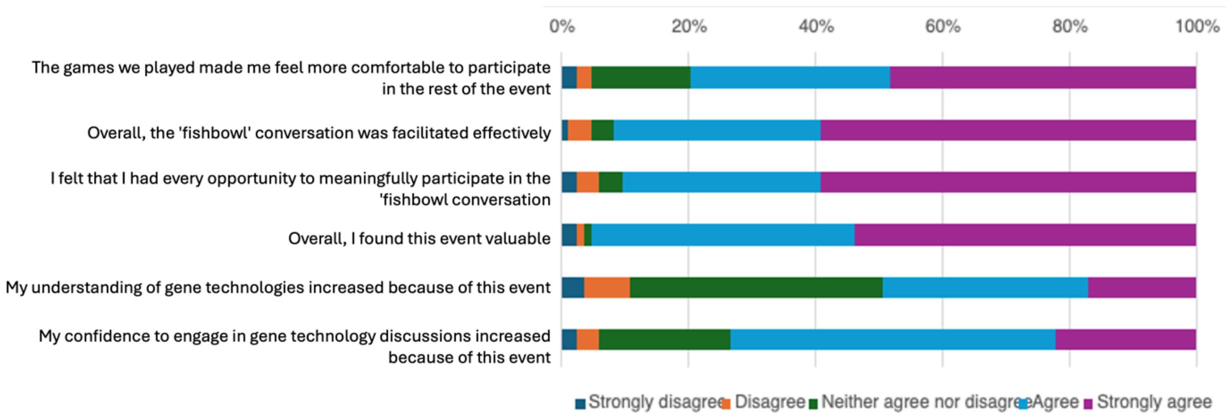

Figure 4.1: Percentage of participants who agreed or disagreed with statements about the Phase 1 workshop.

Approximately 75% of participants either 'agreed' or 'strongly agreed' with the statement, 'My confidence to engage in gene technology discussions increased because of this event', whereas a further 20% of participants 'neither agreed nor disagreed' with the statement. The statement 'My understanding of gene technologies increased because of this event' was scored as 'strongly agree' by only 15% of participants, however, this increased to 50% when 'agree' or 'strongly agree' were combined. Around 10% of participants scored it as 'disagree' or 'strongly disagree'.

These Phase 1 evaluation survey results demonstrate that participants felt safe and supported to be able to engage in the workshops where their interaction with gene technology information was supported and facilitated by the researchers and as a result, more than three quarters of participants left feeling more confident to engage in discussions about genetic technologies. However, only about half of the participants felt they gained greater understanding of gene technologies indicating that while the Phase 1 workshops were very successful as fora for discussion about genetic technologies and led to many participants gaining greater confidence with this subject area, a smaller proportion of participants gained educational outcomes from the workshops. About half of all participants felt they did gain knowledge despite this not being a primary function of the workshops.

Participants were also asked to provide feedback on their experience of the workshop. Responses overwhelmingly indicated people valued the opportunity to contribute to the discussions and listen to others' perspectives. Below are some responses that illustrate people's feedback:

> *Fishbowl conversation was excellent, Hearing opinions from a variety of people and diverse backgrounds.*

> *Knowing that different people have so many different perspectives and how this is very important in relation to ethical concerns. I also got more insight into the nature of science and the values around it.*

Participants who held very strong positions, particularly those who opposed the use of genetic technologies, found value in hearing others who shared their views, as the following examples indicate.

> *No outcome. We do not want GE tech to control pests as there are other already approved tools.*

> *Quite illuminating seeing the lack of trust of science and politics and how [dysfunctional] both systems are.*

Participants were also asked to provide feedback to better understand what was effective with the workshop and what could be improved. Of the people who responded to this question, the most common response was to suggest more time or longer sessions, and more information, context, background as an introduction. The following quotes illustrate the desire for more information.

> *Some basic information, perhaps a quick outline of what gene-tech is before the discussion as some may not have enough context to effectively participate.*

> *It would be good to have the science perspective as there were a lot of what ifs that I'm still concerned about. Awesome introduction to social aspects!*

4.3.2 Participants' Perceptions of the Games

Participants were also invited to share their experiences of the games in an exit poll. Respondents reflected on the role of the purposeful games to explore connections between ideas, or as an enjoyable way to learn different perspectives for example:

> *Jenga game was very effective method to show the impact one thing has on others.*
>
> *Discussions and learning and follow up Q and A during games led to significant growth in understanding.*
>
> *It was cool to see different perspectives. Games were also very fun.*

4.3.3 Participants' Choice of Decision-makers

The *'Who Sits Around The Table'* game, combined Bingo and Darts to explore genetic technology governance by gathering data from Phase 1 participants on who they believed would be necessary members of a governance body to make decisions and oversee genetic technologies in New Zealand. Participants were asked to circle four of eight pre-selected groups they believed should 'sit around the decision making table' and could also name any stakeholders not listed. The eight groups were:

- Scientists
- Māori
- Environmental groups
- EPA
- Policy-makers
- Rural communities
- Urban communities
- Industry

The data gathered from this game was analysed to provide a measure of which groups / individuals / sectors / stakeholders, people believed should sit around a governance table see Figure 4.3.

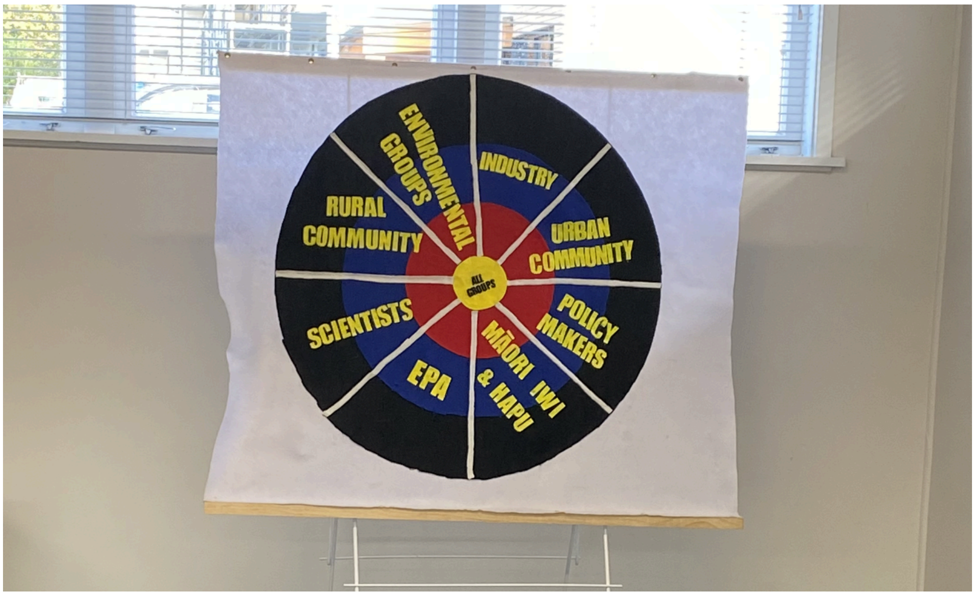

Figure 4.2: Stakeholder Game: Who Sits Around the Table?

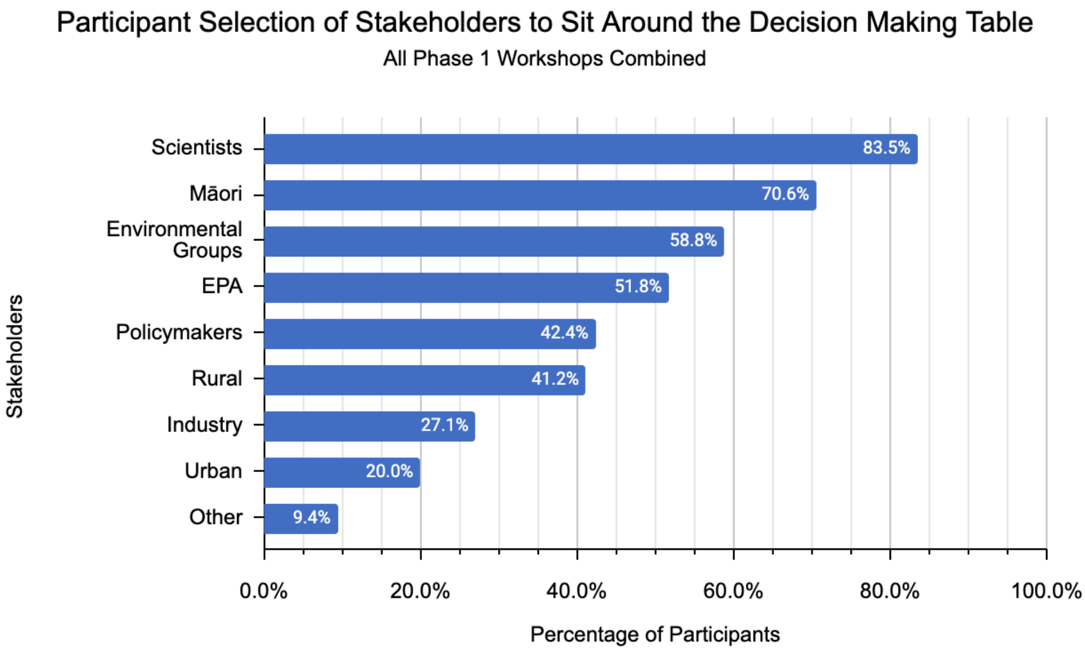

Figure 4.3: Preferred stakeholders from the 'Who Sits Around the Table' game.

Participants who played the game indicated very clearly they wanted scientists to be present at the decision-making table. Not uncommonly reference was made to 'independent scientists', although the term "independent" was not defined. There was also wide acceptance in the public engagement sessions that, because gene technology impacted on Māori values, iwi, hapū and whanau should also be at the decision-making table. Notably, industry groups being at the decision making table was only supported by just over a quarter of participants, likely because of the view that any vested interests that exist with this group may affect their ability to deliver objective governance decisions.

4.3.4 The Fishbowl Facilitated Conversation: Leximancer Analysis

A total of six hours of transcripts, or 57,877 words were analysed from Phase 1 events across both the North and South Islands and on Rakiura Stewart Island. The automated Leximancer software analysis identified keywords, themes, and concepts that characterised participants' views and perspectives as they emerged during the facilitated fishbowl discussions on gene technologies and the New Zealand environment. A relational analysis was then carried out in Leximancer to provide a cross sectional insight into how closely the themes and concepts were related to one another for each data set. The results of this analysis were mapped to give a visual insight into the connectivity between themes and concepts. Figure 4.4 and Figure 4.5 both represent the same data set with varying degrees of detail, where 0% abstraction shows every concept as a theme to 100% abstraction where all concepts are clustered under only one overarching theme.

The bubbles represent the themes, with each colour corresponding to a different theme. Solid dots within the circle denote the concepts associated with each theme and the main ones are themselves labelled in black. Connectivity between each concept is indicated by lines, with shorter lines denoting a stronger conjunctural relationship between the concepts in the dataset. Figure 4.4 presents a 'zoomed-out' perspective showing only the dominant themes (75% abstraction) while Figure 4.5 presents a more fine-grained perspective (25% abstraction).

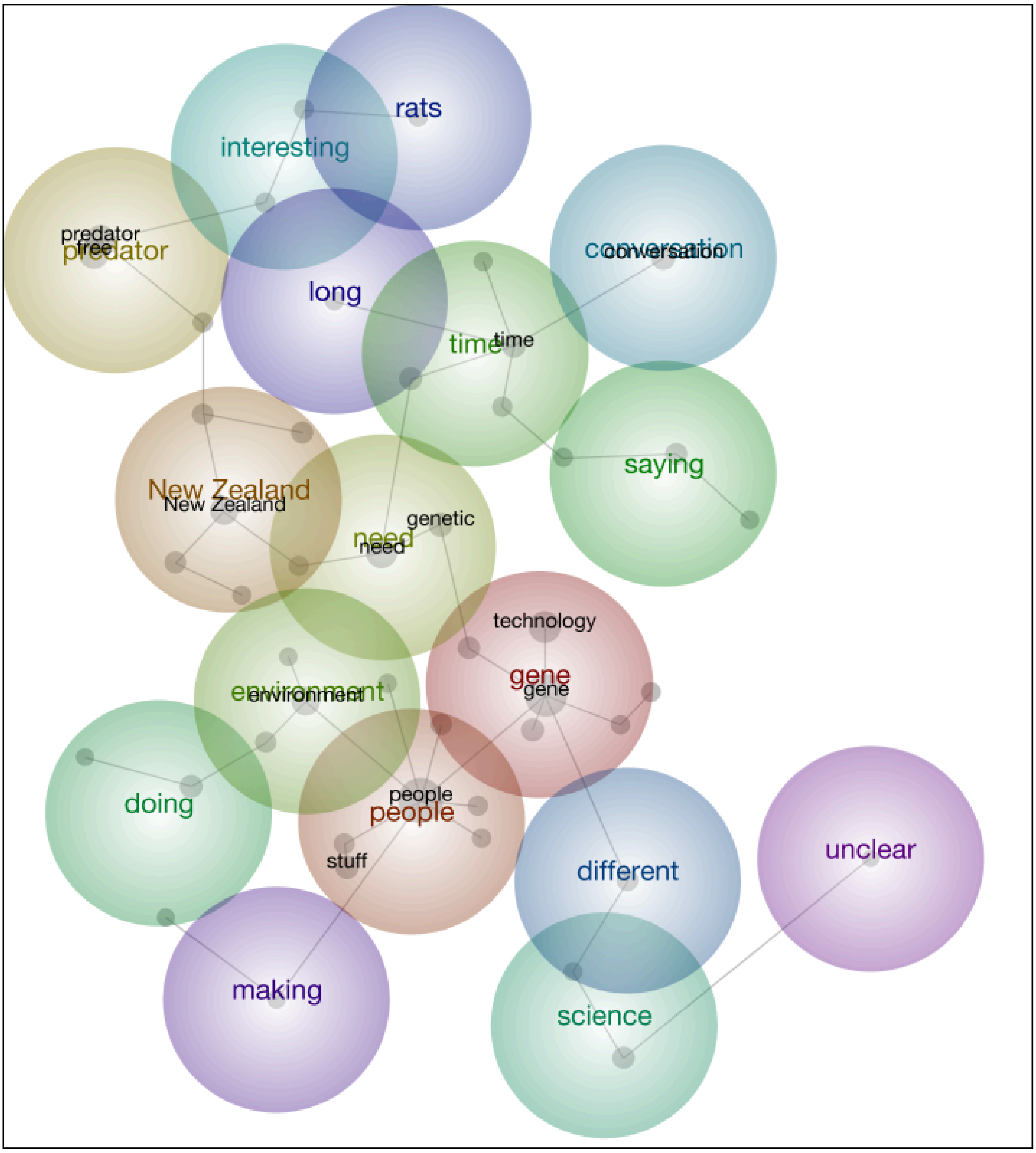

Figure 4.4: Leximancer analysis of the dominant themes (75% abstraction)

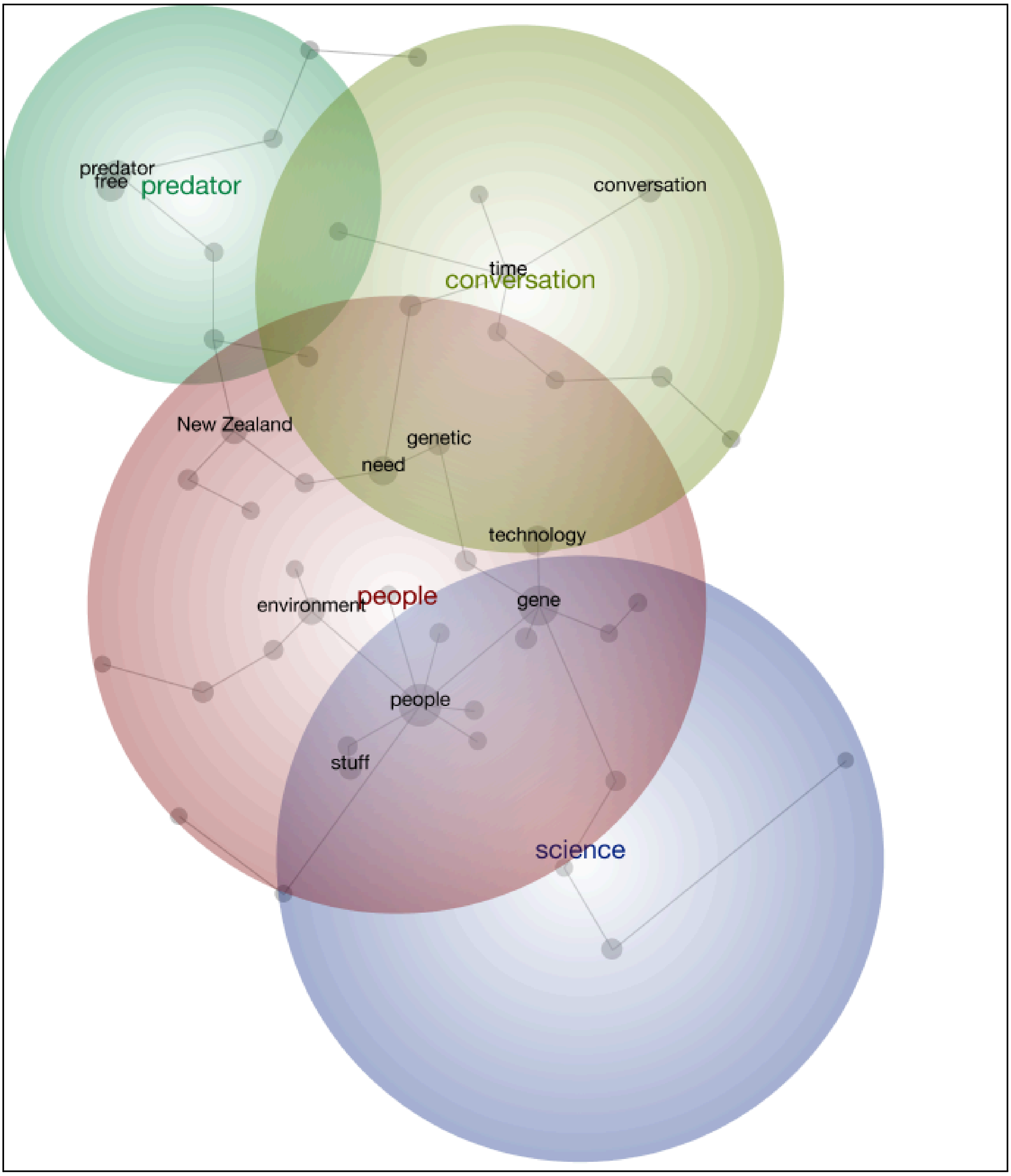

Figure 4.5: Fine-grained perspective of Leximancer analysis (25% abstraction)

Using a mid way point of 50%, eight themes were identified. These were:

- people
- New Zealand
- conversation
- predator
- science
- interesting
- scientists
- sure

What this makes explicit is the centrality of people in conversations. The use of gene technology for environmental purposes according to general public participants is first and foremost about people: what people think about it, how it does or might affect them, and their capacity to interact with both the technology and the decisions around the technology. Further, the prominence of conversation as a theme highlights how significant this is for most involved. This is illustrated in the following quotes taken from the transcripts of the fishbowl conversations.

> *How do you get **people** to come on board or not and on what might they come on board with.*
>
> *Voting once every four years, or every three years doesn't give you enough information of what **people** actually think. Discussions do*
>
> *And I think if **people** had a slightly better understanding of what this thing is, and a little bit more familiarity with that as a concept of like, this is the DNA and this is how, it gets transcribed, it makes proteins.*
>
> *That allows farmers and **people** who have a direct economic stake in these changes to make those decisions and get support.*
>
> *Getting **people** involved in the first step of the ladder*
>
> *So it can't be fully objective, because there is always a **people** element*

The prominence of 'New Zealand' was to be expected given the context of the conversation. The discussion highlighted the various ways in which New Zealanders perceive their country and its future direction in regards to genetic technologies. On one hand, there was recognition that gene technologies may not be an obvious fit for the

100% Pure NZ image and its current ‘position’ internationally as GE Free. On the other hand, there was a recognition that New Zealand needed to engage with possibilities for different pathways in the future. These perspectives are illustrated in the following quotes taken from the transcripts of the fishbowl conversations.

> *So how do you sell that? How's **New Zealand** going to look If we don't try?*
>
> *And we can't just keep turning the place into a conservation park. The whole of **New Zealand**.*
>
> *Ultimately weighed up against the economic benefits for **New Zealand** because if it affects our GE state which it would of course, what does that do for our exports and our markets?*
>
> *I think **New Zealand** will be a great example of what it can be done as a community and as a group and as a country united.*
>
> *Personally, I'd say, when we look at gene technologies, and how they're progressing in this country, I'm both extremely hopeful and extremely concerned. I'd say, one thing that I'd really like to see is if we are getting to a point soon, where we are legalizing the use of and allowing more genetic technologies to be used in **New Zealand**.*
>
> *And so we can see all the effects we've had, unlike other continents, where there's been millennia of humans, mucking with things, burning things and exterminating things whereas in **New Zealand**, we can absolutely see every impact we have, here, we know exactly what we've lost and what we can lose and what things look like before we were here. We're pretty unique, and we can see all that kind of stuff, and we know what we can lose.*

New Zealand’s predator free aspirations by 2050 has clearly resonated widely with people with predator-free being commonly raised in the discussions. Indeed, when asked about people’s personal visions for New Zealand conservation, both predators and predator control dominate the public imagination with a focus on mammalian predators, and particularly rats. However, support for predator free New Zealand was not connected to any agreement over methods used to achieve this, the regulations required, where risk lies, and trust in various actors. Indeed as seen in the quotes below, taken from discussion transcripts, people raised many issues about both the feasibility and the viability of achieving predator free New Zealand.

Nonetheless, people's alignment with 'predator free' was significant, given so much of the gene technology ready (or near ready) in New Zealand is for everything but mammalian predator control. From varroa mites to wilding pines to myrtle rust, the technology for these environmental issues is far closer than technologies such as gene drive for rats, stoats or possums. Yet gene drive and similar technologies have typically become the go-to reference point for discussion about genetic technology.

> *But I'm certainly happy for [place name] [to be] predator free and as many practical places that we can do, to [be] predator free the better.*
>
> *I mean, I believe we are leading the world in that aspect in predator control.*
>
> *But what we've got isn't enough for sure. It's the tools we have at the moment - 1080 and trapping isn't enough to achieve predator free.*
>
> *So, if you were going to … try this gene technology out on a country like New Zealand, then predator free is probably as good a slogan as, as you could find because people know that it means rats and possums and stoats and they're eating all the birds.*
>
> *So if we release a cohort of rats that only produces males. How many rats? How long does it take for that genetic mutation to effect a reduction in the predator guild sufficient to have an effect on the bird populations or lizard populations?*
>
> *And there's also a skew and that is the removal of a predator is one piece of the puzzle. Because in some instances, with some species, there's more than one pressure point, coming from more than one direction.*
>
> *So it might be that we look at targeting stoats in New Zealand with gene technology. But in Europe, stoats are an important part of the ecological system.*

Interestingly, and relatedly, the data saw a near complete absence of discussion on flora. Again, this highlights the dominance of the predator control rhetoric in the New Zealand vision of environmental management.

The discussion was also closely related to people's conceptions of science, and this formed primarily into two areas:

- science as the provider of knowledge and
- science's relationship to ethics, governance and policy as the following quotes illustrate:

  So a lot of science that has been done at the moment has actually been done by businesses who pay for a result.

  And that's when you rely on science, isn't it. Because none of us here have the brainpower to.

  It needs to be bipartisan, based on science

  So science needs to be part of the fundamental ground floor elevator shaft of that conversation. Because if you have a government funding agency, a government is only going to relinquish money, if it's informed by something, and that something's going to be science or social, a social driver at some level, or some major economic trade partner, that's going to result in a big impact on GDP or something like that.

  So that being said, I think the role of science is really necessary. Because through science, we understand descriptively the phenomena, climate change and global warming, and then we act on it, it is the human mind that acts on it.

  So, the science for me needs to be very rigorous and evidence based, before we do anything. So, if there's something constructive, that's great, but I'm also very aware of the law of unintended consequences, that occurs in much of life because that can occur with gene technology as well.

As this analysis is composed of group discussions, some terms common for rhetorical purposes appear, notably interesting and sure. The term interesting is commonly used in everyday discourse to recognise a statement without taking a clear position or as a way to bring something into a conversation (a TV show is described as 'interesting' when one wants to talk about it without praising or dismissing it). While this serves a rhetorical purpose, it does not provide much content per se. Likewise with the term sure which is used as a way of acknowledging another claim or to link to another's statement. (eg “sure, but what I mean is”). Looking deeper into our data revealed that this was how both interesting and sure were predominantly used, hence no further meaning can nor should be attributed to them despite their prominent use in the dialogue.

4.3.5 Phase 1 Findings for Scenario Design

Two key findings emerged from Phase 1 that informed the design for the Phase 3 scenarios. These were the toolbox metaphor and participant perspectives that captured the range of views and opinions expressed by Phase 1 participants.

The Toolbox Metaphor

A useful framing metaphor was commonly raised by participants in several workshops. This was the metaphor of the toolbox. The toolbox was used both literally and figuratively for the phase 3 scenarios. A toolbox housed the perspective cards and information cards for each scenario and where participants were asked to place their completed decision and caution cards and this was present on each focus group table. It also formed the key question participants were asked to reflect upon in Phase 3 - ‘What tools do you want in your environmental management toolbox to manage this invasive species?’

Table 4.1: Development of the metaphorical environmental toolbox

Phase 1 Participants ‘Environmental Toolbox' Quotes	Effect on ‘Toolbox’ Design
And [things] we definitely could add to our toolbox in fighting against environmental change to very dangerous stuff that we should not touch ever. And it's up to us and everyone else to be, with the help of science and policymakers and other groups, to come to an informed decision on where we draw the line.	Tools in the toolbox need to be decided and regulated by a process of collective decision-making.
I don't think that will be the only thing that we should be using. It can be… a part of it can be in the toolbox with the other things, because there will be no one thing that will fix the problem.	Multiple tools are necessary
When you bring a new tool into the toolbox, it's… that's a fresh opportunity, opportunity to brand it, market it right and give it a new reputation that doesn't isn't already tarnished.	New tools provide new opportunities
Well, we're going to, you know, we're going to basically improve the toolbox. So we can have a real go at that. It's within the realms of possibility that there'll be enough people that will say, Okay, let's give it a go.	Toolbox as a way to present genetic technologies for public consideration
I'm saying it's one tool in a big box. And I think a carefully selected programme could have massively beneficial impacts. But like every tinker is not without risk.	New tools can supplement old tools, with judgements of risk

The toolbox metaphor emerged from the fishbowl conversations and was seen as a way to operationalise the decision people would have to make in Phase 3 when considering the genetic technologies for particular scenarios. Table 4.1 illustrates how this metaphor was articulated by people in the Phase 1 fishbowl discussions.

Participants' Perspectives

Insights from the academic literature on genetic technologies in environmental contexts shows that people hold multiple perspectives and that their perspectives are likely to go well beyond the technical aspects of the technologies encompassing social, political, economic, ethical, ecological, spiritual and cultural values (see, section 2.6). Our analysis of transcripts from the fishbowl facilitated discussions in Phase 1 and the knowledge-holder and interest group interviews in Phase 2 reinforce these findings from the literature. As people talked, they expressed a range of attitudes and emotions which drew from a range of dimensions. Some were supportive of the potential use of genetic technologies, some were opposed and most raised issues of consideration, caution or concern.

Our analysis recorded key perspectives that emerged in Phase 1 fishbowl discussions. We did not seek to give weightings to the perspectives, but rather to identify the range of perspectives which arose. These perspectives were presented to participants in Phase 3. This inclusion of perspectives from Phase 1 in Phase 3 scenarios maintained the iterative approach to our methodology where Phase 1 discussions informed the development of Phase 3. Statements found in our transcripts were sometimes distilled to present these as clear and concise expressions of one or more speakers' perspectives to represent key elements of that perspective, or were slightly abridged versions of the exact quotes to make the perspective quickly accessible to people. Each was presented on cards of equal size that participants could read aloud and discuss during their deliberations. This also allowed participants to connect their own attitudes to the perspectives of others. Further, it helped them to understand and respect the views of others and gave a voice to the landscape map on their tables (see Figure 3.7).

Table 4.2: Perspectives from Phase 1 and 2 used in Phase 3 scenarios. Note: Yellow shaded cells indicate the perspectives gathered from 'GE Free' / organic interest groups in Phase 2 and not from the Phase 1 dialogue workshops.

Scenario Card Title	Scenario Perspective
"We need more tools"	*Just think about how much bush we've got, how many places we just can't get to. And think about how much time and money it takes to put traps out, and bait out, and monitor it all. We don't have enough - we need more tools in our conservation toolbox.*
"Animals don't have to suffer and we can stop using poisons"	*What we've got at the moment for pest control are traps or toxins. Neither is great for the animals. Maybe a genetic technology would stop reproduction, so they're not born, they don't have to suffer, and we don't have to be putting poisons into our environment.*
"Genetic technologies offer incredible possibilities"	*Innovation is what drives humanity. What we should be looking at are the incredible possibilities genetic technologies offer and how we can best and most safely use them. We can figure out how to manage any bad side effects of genetic technologies.*
"Our laws are freezing scientific progress"	*Our best scientists go overseas where they're allowed to do this work properly. Our laws are really putting a freeze on scientific progress.*
"What will the regulations be?"	*The big question is who will make sure this goes well. Like with any tech, I want to know what the regulations are going to be and how they'll be enforced.*
"Technology risks"	*I worry about the harm genetic technologies will do to the animals and plants directly and indirectly being targeted. It is not clear what the risk is to them across their entire life-cycle.*
"Once the genie is out of the bottle…"	*You're saying there's no risk in editing genes. But what if something goes wrong? Will we be able to undo it? We're just people, we don't know everything. We can't predict the future. Once the genie is out of the bottle we can't put it back in.*
"Stop playing God"	*Nature knows how to look after itself best. We keep wanting to tinker with the natural world, but we need to stop playing God. These are decisions that are beyond our capacities.*
"We'll lose so much if we don't take a leap of faith"	*We can't know everything. And we could just let that paralyse us. But if we don't have courage, if we don't take the leap of faith, what are the consequences? We'll lose so much.*
"We're all interconnected"	*Te Ao Māori is our starting point of the world. Land, water, people, animals, practices – we're all interconnected. We all depend on each other. We have our responsibilities too. That's how it is.*
"Gene technologies do not align with our community goals"	*We always get these technologies pushed on us. They never align with our community or local goals - things like food sovereignty and security or a thriving bird population along our rivers and coasts.*
"Let's not jeopardise our GE Free reputation"	*Why do people buy New Zealand food? Why do they like to visit here? Because we're clean and green, and part of that is our GE Free reputation. Let's not jeopardise that.*

These perspectives represent a broad range of frames in which people see genetic technologies. Some perspectives connect to overall world views, such as the Te Ao Māori view of the interconnectedness and spiritual being of all things in nature. Others focus on ethical issues, such as the possibility that genetic technologies could lessen the use of toxins in pest control, and therefore possibly reduce animal suffering. Some were economic, looking at the value to New Zealand exports of a GE free status. Some perspectives were pragmatic, looking, for example, at the time and money that might be saved in conservation efforts or the benefits to scientists being able to do research in New Zealand.

Some of the perspectives were concerned with the question of how to make decisions when there are so many unknowns. These explored in various ways what responsible innovation looks like, including the opportunity cost of doing nothing. For example, while one perspective frames the unknowns as a risk that lies beyond our capacities to predict or control, another frames these same unknowns as risks we simply have to take in order to save species.

Finally, some perspectives emphasise the role of regulation. These perspectives also question who should have the right to make decisions, including for local communities. Some were confident that any negative side effects could be controlled, others worried about the specifics of the regulations and how they would be enforced. By providing a range of perspectives researchers did not bias Phase 3 conversations, but rather gave people a wide set of perspectives with which people view gene technologies.

4.4 Phase 2: Refine

The Phase 2 interviews, which engaged with 57 participants from both inside and outside the science and technology sectors in 18 different engagement events, provided a range of understandings about the broader ethical, social, ecological and practical issues that surround genetic techniques. These informed the development of the scenarios which were central to the Phase 3 workshops and included the following advice:

- A preference for scenarios that would be realistic and feasible.
- An accurate understanding of the information that was essential for the scenario information cards (this was tested in the Phase 3 pilot with participants from a broad range of ages and backgrounds, and subsequently adjusted based on the pilot group feedback).
- Perspectives from GE Free / Organic groups which were included in the perspective cards.
- Understanding of containment and important geographical features of landscapes that informed how the stylised landscape was created.

- Industry perspectives that informed how the stylised landscape was created.
- Discussions about animal ethics that informed perspective cards.
- Importance of including rural stakeholders (which informed event organisation).
- Broad ethical considerations (which informed the stylised landscape design).

While some environmental issues such as rats, wilding pines and myrtle rust emerged in the conversations in Phase 1, it was not until Phase 2 that these were explored in more depth. In addition, varroa mite emerged as an important issue. Through conversations with Phase 2 participants these were developed and refined into scenarios which could be used in the Phase 3 deliberation workshops.

The scenario information cards (see Appendix 10.2) provided information on the issue / environmental problem, the issue's impact, current management tools, the potential genetic technology and how it would likely be applied, as well as the regulatory systems currently in place. In other words, Phase 2 discussions were a starting point to refine the question and information. Each set of information cards for the four scenarios therefore offered a similar quantity of information and uniform design, to ensure consistency across the scenarios.

Participation in a workshop with the Boston Science Museum social science team at a conference at the University of Rhode Island, allowed innovative scenario designs to be explored. The research drew on the general learnings from the Boston Science team, while also enriching the scenarios used in Phase 3 with the information and advice gathered from the other phase 2 participants and from Phase 1 fishbowl conversations. The approach used in Phase 3 was therefore informed by international experience, adapted to ensure it was relevant to an Aotearoa New Zealand context, and enriched by the evidence drawn out of Phase 1 and 2.

4.5 Phase 3: Deliberate

Ten deliberation workshop events were undertaken (Table 3.5), four deliberative workshops in the North Island, four deliberative workshops in the South Island and two special interest group sessions - one nationwide online workshop and the other in a university undergraduate course. In total there were 43 deliberative focus groups at these events with 69 scenarios that were deliberated by the focus groups. Each focus group deliberated for 90-120 minutes discussing two scenarios preselected from the four scenarios that were developed (Table 3.4 and Appendix 10.2).

Each focus group was asked to deliberate on one gene editing scenario and one RNAi scenario. The varroa mite scenario however was an exception in that the scenario presented two methodologies for RNAi's delivery, one scenario was deemed to be genetic engineering as it created intergenerational changes. Due to student availability, the student special interest focus group only deliberated on one scenario.

The analysis sought to answer two key questions:

- How might the context of the problem shape people's perspective of the technology?
- How might the type of technology shape the perspectives?

To answer these questions the decision and caution cards completed by each group as part of their toolbox were analysed.

The analysis of the decision cards examined:

- the frameworks groups used on which to base their decisions,
- perceptions of current and new technologies,
- perceptions of the problem definition.

The analysis of the caution cards identified:

- Impacts,
- Guidelines for implementation and regulation.

While groups were not required to reach decisive decisions in terms of a yes or no for the genetic technologies in each scenario, some groups did. Therefore the analysis identified the level of decisive support or opposition for each scenario. A decisive decision is a clearly written indication of support or rejection. Many groups chose to simply give their reasoning and while these typically suggested a level of support, quantitative measures are assigned only to decisions that decisively supported or rejected the genetic technologies under consideration in each scenario.

4.5.1 Participants' Experiences of Phase 3 Deliberations

The literature review had indicated that events where participants could engage in deliberations around gene technology was needed in New Zealand. This research was directly responding to this need. Therefore a central question of the research was to explore the effect and effectiveness of deliberative processes in supporting decision-making around the contested and complex socio-environmental issues of gene technology. The methodology had been specifically designed to encourage engagement, to allow people to engage with complex issues and to enable robust conversations in safe spaces. The exit survey gave people the opportunity to reveal their opinions about the success of the workshops in enabling them to deliberate seeking both quantitative and qualitative feedback.

Qualitative Feedback: Experience of Sessions

The exit survey for Phase 3 explored participants' experiences of the workshops and the deliberations. Participants' comments indicated that they appreciated talking with and listening to people with diverse backgrounds and perspectives. This meant a range of viewpoints were brought into conversations, including at times from people who had more technical or ecological knowledge of the various issues at hand. As one participant said, “The diversity of the group was helpful”. Another commented on the impact of having someone with research experience as part of her focus group, as the participant explained, “Very interesting to talk to academics with experience with these technologies in experimental and regulatory contexts! I enjoyed this 😊"

Participants had more varied views about what was the right quantity of information needed for each scenario. For some, there was too much information, “There was a lot of information to take in”, while others indicated they would have liked more as the following example shows: “More subject info needed to form opinions for and against.” Another reflected on the challenge of providing enough information for issues that remain uncertain, as they stated, “It was difficult to come to a consensus/form an opinion without knowing what the risks of the gene editing might be. But I guess nobody really knows ...”

One person from the online special session with participants largely from the GE Free and Organics sector, commented about the accuracy of the information in the scenario information cards as follows:

> *There was a "bias" in both of the pre-question discussion information. It's assumed there is no currently available "cure"! There are already best practice management and strategies (methodology) used by specialist industry contractors that deal with the economic eradication of rats or mitigation of parasites in livestock.*

This view was not felt by all participants with another commenting in their exit survey:

> *There were a number of closed minds…I don't believe the information was biased, but there was certainly a biased group.*

The technology was an initial barrier in the online session particularly in getting participants connected to the resources and this took up some of the session time. In addition some people connected via their phones, so this made viewing the resources more challenging. Nonetheless people appreciated the opportunity to engage,

> *Some tech problems gobbled up a bit of time.*

> *Probably easier in person, but we managed. Nice to have a chance to discuss my views.*

Quantitative Feedback: Consensus Agreement Reached in Groups

Participants were asked to indicate for each scenario, if their group reached consensus. Analysis of the exit surveys for the public workshops showed consensus was reached in 95.8% of scenarios. The 4.2% of cases where consensus was not reached occurred in regional settings - wilding pines in Milton; myrtle rust and rats in Warkworth. In all deliberations of varroa mite groups reached consensus (see Figure 4.6)

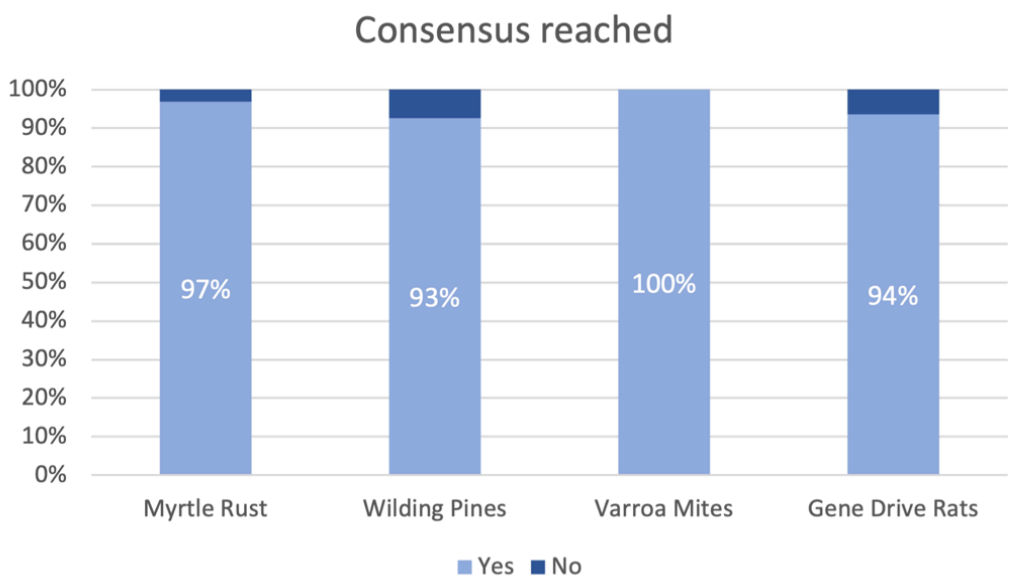

Figure 4.6: Percentage of public workshop focus groups who reached consensus

Quantitative Feedback: Effectiveness of the Deliberative Workshops

Four YES / NO questions were asked to explore people's perceptions of the effectiveness of the deliberations. The four questions were:

- Did the discussions today expand your understanding of gene technologies?
- Did you have a position on the use of gene technology before today?
- Did the discussions today cause you to re-evaluate your position?
- Do you feel your contributions to the group discussion were listened to by other members of your group?

Public event participants' responses are presented in Figure 4.7 below.

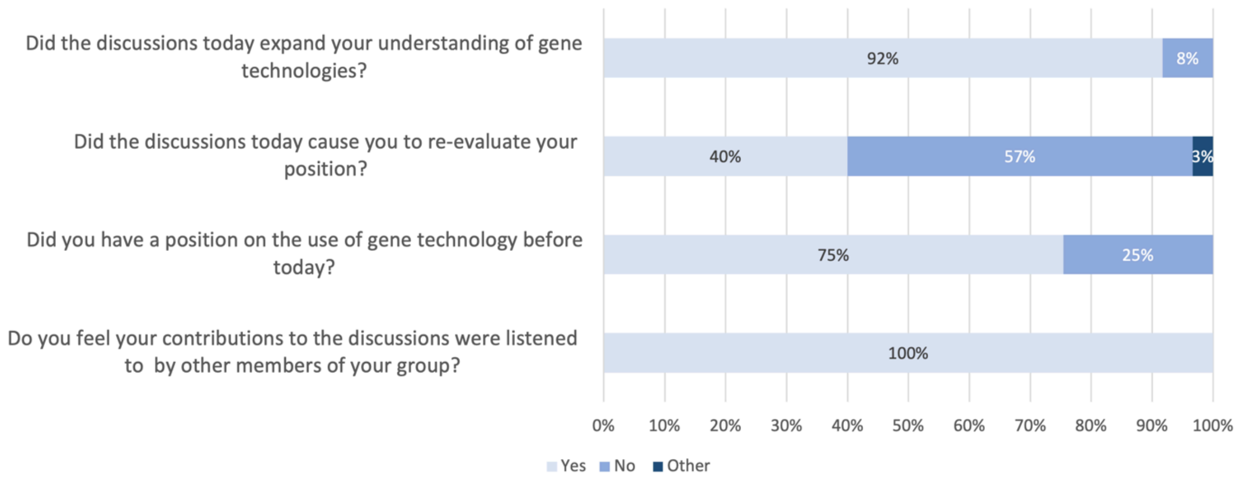

Figure 4.7: Participants' assessment of their deliberation workshop experience.

Three quarters of the research participants who participated in the deliberations, reported they had a position on the use of gene technology before they attended the deliberative workshops and 100% of participants reported that they felt their contributions to the discussion were listened to by other members of their deliberative focus group. Of attendees 92% felt that the deliberative discussions expanded their knowledge of gene technologies, and 40% reported that the deliberative discussions caused them to re-evaluate their position.

Key points to emerge from the deliberative workshop exit survey include:

- Although three quarters of participants held a position on the use of genetic technology before the workshop they all felt others listened to their contributions, 75% of whom can be assumed to have arrived with a predetermined position.
- As a result of these discussions, 92% of participants felt the discussions expanded their knowledge of gene technologies, again 75% of whom can be assumed to have arrived with a predetermined position.
- It is likely that for over half of the participants that did arrive with a predetermined position on the use of gene technologies the discussions during the workshop caused them to re-evaluate their position.

Therefore the exit survey demonstrates that although a substantial majority of participants held a pre-determined view of gene technology before the workshop the deliberative discussions undertaken by the participants were:

- Respectful (100% felt listened to)
- Informative (92% expanded their understanding)
- Educational and thought-provoking (40% re-evaluated their position)

The following quote placed on an exit interview illustrates how challenging conversations could still be 'good' and 'interesting' even in those with deeply held perspectives.

> *Interesting process, good discussions. Still very cautious about all types of GE. Vested interests dominate in GE which is part of my caution. GE is not as safe or predictable as proponents say. Good regulation is essential to protect our environment.*

In the special undergraduate student event, all students reported reaching consensus and that they had felt listened to by their groups. Almost half (42%) came to the session with a position on gene technology, however 42% reported that they had re-evaluated their position and 87.5% said the engagement had increased their understanding. In the online session, only four people completed an exit form, of which 75% of participants (3 of the 4) reported that they had come to the session with a position on gene technology, however 100% of those who completed the survey reported that they had not re-evaluated their position as a result of the deliberation, although two participants reported that they had increased their understanding of gene technology.

It therefore can be argued that the deliberative workshops were a safe and effective platform and mechanism for deliberative dialogue around gene technologies for environmental purposes. The methodology provided an avenue for robust and engaging discussions where people learnt, deliberated and engaged around a contested topic in an open and respectful manner. This provides robustness to the decisions and cautions that the groups reached and which are provided below.

4.5.2 Scenario Analysis from the Phase 3 Deliberative Workshops

Myrtle Rust

Thirteen focus groups from the public events deliberated on the scenario of myrtle rust and double stranded RNAi technology. Of the four environmental scenarios, myrtle rust received the highest level of decisive support for the use of genetic technology as an environmental management tool - with 46% of groups indicating decisive support. Not one of 13 groups indicated that they were decisively opposed to the technology. Nearly all participants who considered the myrtle rust scenario (97%) reached consensus agreement.

Genetic vs Current Management Tool

Participants ranked ecological / environmental benefits of the RNAi (gene silencing) technology as the most important deciding factor when considering the myrtle rust scenario. They perceived RNAi technology applied to myrtle rust carried less environmental risk than the current tool of fungicide treatment.

> *We think it is worth the risk. Seems to be low risk as it is targeted gene silencing. We do not think this is playing God GE Free reputation not that valuable if myrtle rust is so widespread.*
>
> *Support the use of siRNA to target M rust because what is being currently used is not effective.*
>
> *New tools required! Fungicide not working. Harm caused is not justifiable. Fungicide - not a reliable enough strategy to invest in. Requirement for more tools.*
>
> *Do not foresee the management tool of gene silencing encroaching into environments where it is unwanted, unlike fungicides.*

Needs to be seriously considered as an alternative to pesticides.If RNAi is a "promising tool" it needs to get out of the labs now and be trialled in controlled areas to determine effectiveness. If this doesn't happen the impact to current trees/plants could be devastating, change the landscape. Seek trials of both types of RNAi. Easier to deal with possible harm caused by this genetic control than the fungicide! Then depending on trials, seek widespread implementation.

The perceived ecological benefits of RNAi over fungicides were most noticeable in groups that were decisively supportive of RNAi technology. Groups which saw fungicides and RNAi technology with a similar risk profile, still indicated support for the genetic technology of this scenario, but less decisively. The ecological benefit was also supported by perceptions of RNAi's efficacy, particularly when compared to fungicide treatment.

Support the use of siRNA to target M Rust because what is being currently used is not effective.

Inadequacy of current management.

Features of the Technology

Participants also engaged with the technology itself, commenting on specific features of RNAi technology that made it more acceptable, less risky or more 'natural' compared with fungicides or genetic engineering.

More natural, non-intrusive and we think it is no worse than using fungicides. Also No risk to other fauna or flora.

Socially, gene silencing seems very promising. Reason being there is no need for genetic modification.

RNAi is not used for genetic modification as it doesn't change the genetic makeup so shouldn't be considered as a genetic modification technology. … [it] 'needs to be seriously considered as an alternative to pesticides.

Can be modified if it becomes resistant.

Indeed two groups that were decisively supportive perceived the technology offered advantages for wider public acceptability and suggested this may be useful for science communication efforts.

> *need to carefully market it to the public – explain low risks – needs to be digestible for the public. Be cautious about calling it RNA.*

> *public education i.e. RNAi vs GM.*

In the one group where consensus was not reached, it appears that disagreement around the naturalness of RNAi led to their inability to reach consensus.

> *RNAi technology preferred option, it is a sped up version of what happens anyway … Other opinion is that nature creates its own resistance but slower admittedly … have to be prepared to lose plants in the process.*

In this case participants who preferred to let nature find its own solution, accepted that this may take time and were prepared to accept the ecological consequences from infected trees/plants dying.

Regulation

While support for myrtle rust was highest across all the four scenarios this support was not unconditional even among the 46% of groups where support was decisive. Groups openly sought regulations to control the technology, specific guidelines to manage its use, and bodies to oversee its implementation or the implementation of genetic technologies in general.

> *Guidelines - Adhering to established International standards; A regulating body is needed; EPA leads on it; Need to create NZ specific guidelines; Environmental Select Committee to review its process.*

> *EPA should be in control.*

> *Concerned around the implementation of gene silencing across plant species. Revision might be necessary of current governmental regulation around genetic technology.*

Some groups expressed specific concern over the ownership of the technology and so government regulation was seen as a way of ensuring the technology stayed out of the control of commercial interests.

> *Who owns it? Who controls it*

> *Would like to know who owns/regulates the technologies and who pays? Don't want to beholden to private interests.*

Groups that were decisively supportive of RNAi technology did perceive current regulations to be restrictive and they questioned the effect this was having on science research, for example

> *We should go through a regulatory process. We should review GMO Regs to allow EPA to approve/allow technologies based on risk vs blatant y/n.*

> *Laws that impact on scientific progress. What is the flow on effect if we do nothing or don't take a chance.*

However, only one group felt the current regulatory environment was sufficient

> *As it is 'promising' and there are currently many regulations in place - worth investing in.*

Caution cards that groups completed during their decision-making deliberation, showed why they felt regulatory controls were needed. Although perceived ecological benefits of the technology influenced group's support for gene technology, possible ecological harms or environmental 'unknowns' drove a cautious approach to implementation.

> *Genetic Options - siRNA ensure it only effects target and does not have unintended ecological effects.*

> *Impacts on other plants, animals and humans? Do we have enough information?*

> *How is it applied and used? Spray - air spread and contamination, public concern, unable to have control, weather dependent.*

> *Non-target impacts.*

> *Sounds like a relatively benign technology BUT I would be very cautious about its use.What might other effects be? Off-target effects on other species? Silencing other parts of the myrtle rust genome? If it backfired it could be catastrophic - spread M. rust further and faster.*

> *RNAI- If it is sprayed, will it endure in this environment to affect other things? Get into waterways? Stay in soil for years. How is it applied? do only new trees have it. Can it be applied to old trees. How will it affect the*

surrounding environment? as it is wind blown it cannot be tested in the environment.

Even more difficult to control from a biosecurity perspective if it is spread through wind/field gear. High off-target effect.

<u>*Implementation*</u>

In their cautions, groups offered very specific advice on how RNAi technology should be implemented. For most groups implementation should be cautious, carried out in controlled and restricted environments and two groups specifically called for engagement with Māori before implementation.

Potential stepwise rollout to worst affected regions with consultation with iwi - observe closely for off-target impacts.

It should be prioritised in the nursery space. At risk areas should be prioritised or at least seen as prospects. Licensed applicators during monitoring.

Regional use of gene tech initially (East Cape for example).

Trial in containment first. Mana whenua need to be consulted, need to make decisions about this.

Te Ao Maori perspective must be considered.

CONTROLS ESSENTIAL. Small trials only.

Limited roll out under close observation? Leverage off international studies, e.g. Australia.

Despite the technology being close to ‘field readiness’, compared with gene drive for rats, participants saw the need for more and continual research, either before implementation to fill knowledge gaps, or during implementation to monitor effects.

Needs to have controlled field trials/tests/peer review.

Well researched and tested before being implemented.

Explore RNAi further. If possible, learn from/utilise research from abroad.

Effects must be constantly evaluated.

Needs monitoring in regard to environmental effects/ impact.

More Information Needed

In addition, groups' concerns were driven by a sense that there was insufficient information known about both the technology and myrtle rust. Groups not uncommonly asked questions in their caution cards and these were likely triggered by their engagement in the activity, which stimulated a deeper interest in the technology and the issue of myrtle rust.

> *Given overseas experience how might myrtle rust spread in different areas of NZ?*
>
> *What's happened in South America with myrtle rust?*
>
> *How targeted is the spray? Might it interfere with native fungi? Invertebrates? Collateral damage to other 'good' fungi?*
>
> *How is it applied? do only new trees have it. Can it be applied to old trees?*
>
> *Are there any myrtle species showing resistance to myrtle rust overseas? Are there any environmental, geographical, ecosystem factors that help or hinder myrtle rust?*

However, questions also speak to deeper issues about whether there is sufficient information, and questioning whether science is looking for other options. These 'cautions' speak to wider issues of responsible innovation.

> *Timeframe concerns? Are there other tools available that we haven't considered?*
>
> *Do we have enough information?*

Summary of Public Deliberation on Myrtle Rust

In summary, while almost half of the public groups decisively supported the inclusion of RNAi as a genetic technology in the environmental toolbox for myrtle rust, largely as a replacement for fungicides, all groups recommended a cautious approach with regulatory control, careful implementation and more and continued research needed to monitor and address ecological and off-target impacts and issues of ownership.

Special Interest Group Deliberations on Myrtle Rust

A special interest group, which drew members from organics and GE Free communities engaged in an online meeting with one group deliberating on the myrtle rust scenario. While participants in the group engaged in discussion, the decision was not a consensus decision but rather a range of perspectives from individual group members. Of the four scenarios, myrtle rust was the only scenario that received a variation in views beyond outright rejection as the following quotes illustrate.

> *RNAi no thanks*
>
> *Possible introduction of bio-controls from its natural habitat. Great care needs to be taken with this.*
>
> *Need to be v. careful when introducing natural bio controls*

Rejection of RNAi for myrtle rust was driven by past evidence of introduced bio-controls, along with concerns that decisions were being made for the wrong reasons e.g cost. However, another participant indicated they were open to discussing possibilities for the technology and even its use beyond myrtle rust.

> *Previous solutions have been disastrous e.g. stoats to control rabbits*
>
> *Need to reassess our values with fixing these problems and not just use the cheapest option*
>
> *Control of exotic hosts like monkey apple*

Two groups from the undergraduate social science course discussed the myrtle rust scenario. Both groups gave decisive support for the use of RNAi for myrtle rust management either as a supplement to current treatments or as a replacement.

> *We think that both tools (RNAi and the current management of synthetic fungicides) should be used to manage the issue of myrtle rust in NZ.*
>
> *We agree with the use of RNAi technology*

Students also readily engaged with the technology and the features that they perceived made it more desirable.

> *This is a beneficial implementation as it reduces the environmental impact by tackling the issue at the root cause. Rather than being an 'ambulance*

> *at the bottom of the hill' solution, this is one that stops the production of Myrtle Rust at the beginning of the life span of the affected organisms.*

> *it isn't necessarily changing the organism, just reducing the likelihood of the existence of adverse effects.*

However, support did not come unconditionally. Students sought controlled release in containment sites (e.g. offshore island), strict regulation, oversight and monitoring.

> *Regularly monitored to prove it doesn't affect bird population, rivers and coast, and the bees. To give assurance to people with negative perspectives.*

> *Regulated by professionals within the field (not a DIY project) – can only be bought for public places.*

As with all the scenarios, students acknowledged that the technology required community acceptance and engagement and they recommended this as part of the innovation's research and development.

> *It would be important to ensure that the community that is affected is educated and collaborated with, so that they understand the impacts of the innovation and what is actually being done.*

Wilding Pines

Eleven focus groups from the public events deliberated on the scenario of wilding pines and genetic editing. Of these groups, 45% decisively supported the use of genetic editing as an environmental management tool for wilding pines. One of 11 groups openly indicated that they opposed the use of the technology. While nearly all groups reached consensus, wilding pines had the lowest level of consensus agreement of the four scenarios with 93% reaching consensus.

The Problem Definition

For supportive groups the problem and most notably the scale of it and the potential efficacy of gene technology were the deciding factors that shaped their support for use of a genetic technology to manage wilding pines, as the following examples illustrate:

> *Scale of the problem means we [need?] all the tools including gene technology available.*

> *We were all of the opinion that GM organisms should be used to tackle this immense problem. Current tools are ineffective.*
>
> *GMOs SHOULD be considered to manage the issue. It appears as the most effective method of management.*

However, in contrast to the other scenarios, more groups questioned the problem definition, believing there was potential for economic opportunities in wilding pines, with wood chipping, carbon farming and the ETS offered as potential avenues for using pines. In addition one South Island group was emphatic that the focus on wilding pines overlooked the important issue of rabbits.

> *Use them commercially for wood chips to run factories that have gone away from coal. Leave wilding pines for sequestration of carbon - The cost of extraction or use of the wilding pine for wood chips etc would be very expensive so perhaps the use of genetic modification would/could be seen as very cost effective…*
>
> *Can we trade wilding pines into the E.T.S? Can we use them to create a financial incentive to keep them?*
>
> *A wilding pine is a judgement call - just a pine tree in the wrong place. Who makes this judgement call?*
>
> *Ensure [word highlighted] adequate resources available to control current problem, deliver on current wilding conifer strategy.*
>
> *DON'T FORGET ABOUT RABBITS!!*

Groups who were less decisive on the use of gene technologies typically favoured current management tools, while also still leaving the door open for genetic technology use and research, or they considered its use as a supplement rather than replacement for current tools. However, even groups who were decisively supportive of the use of the gene editing technology for wilding pines, still recommended the concomitant use of current management tools.

> *Continue with current management - drilling, spraying, cutting down, controlled burns.*

> *Question why decision is made on cost/economic grounds or for protection. Is it cheaper than expanding manual control?*
>
> *Application of herbicide. Carefully and selectively applied.*
>
> *Proceed with conventional control strategies (e.g. chem) until novel technologies render them redundant or use them in combination with new technologies if it is worthwhile doing so.*
>
> *Maintain interest and focus on other tools as well. Consider stop planting (Radiata - conifer plantation forests)- and look at other plantations.*

This desire to continue using current tools or to see opportunities in the wilding pines, may have stemmed from an understanding that while the genetic technology may address future pines, it could do little for the existing issue, as illustrated by the following comment

> *Current problem is how do you sterilise the already planted/growing wildings/plantations?*

This was very different to myrtle rust where participants were very concerned about the potential environmental impacts of the current management tools - fungicides, and so this concern shaped their preference for RNAi technology.

Decision-making Frame: The Technology

While groups were often not convinced about the problem definition of wilding pines as a pest species, concern about the impacts associated with the technology also influenced people's decision-making. Group concerns around impacts focussed primarily on ecological impacts and these were numerous compared with myrtle rust. Concerns about ecological impacts focussed on plantation forests, exotic conifer species and native trees as well as potential effects to overseas ecosystems.

> *How genetically similar is a wilding pine to a NZ native? Is there potential for an impact? Is there a different genetic modification for each species (larches, firs etc)?*
>
> *What impact is there on 'native' conifers and/or other introduced species eg Douglas Fir? Would want/need to know that can't spread/propagate or extend beyond our control: Species, borders, locations.*

Potential impact on native conifers.

Should be tested on other "like" species or a range of species to lessen possible ecological impact. Check all related species for impact and G Technology.

Prevent modified pines from leaving NZ/entering countries with indigenous populations of pines (or conifers that could interbreed with our wilding conifers). We can't cause an environmental crisis elsewhere whilst trying to solve our own.

Being able to manage/control the spread of the genetic technology to non selected plants. Ensure the safe control of the gene technology to only targeted/selected trees.

Could controlling reproduction affect native conifers down the line?

Ensure the specificity of the gene product to only affect the intended target.

However, there are so many uncertainties in the space that it is too risky to jump in without proper risk analysis and certainty that negative effects are mitigated. unseen negative consequences.

Ensure any genetic intervention targets the undesired species - not stock.

While the fact that the genetic technology for this scenario involved gene editing likely influenced the high level of cautions and the preference for supplementation, only one group explicitly identified the technology itself as the risk, while another questioned the validity for undertaking the New Zealand research on female sterility.

Technology seems risky. Blanket deployment problematic.

What's wrong with the Japanese technology? Can we use that?

Implementation

Groups were also quite detailed or specific as to how the technology could be implemented to manage potential risks and this was often combined with a need for more research to understand impacts before any widespread deployment.

Technology, when properly developed, might make sense for irreversible areas if properly controlled. If specifically targets wilding pine species, might be safe for certain areas? Who controls this?

Implementation of an application process, with approval of the research required prior to use; monitoring of the research then the implemented technique/tool - restrictions implemented when needed; a case-by-case analysis.

If research proves acceptable/ effective should be tested on a remote island or isolated area to reduce impact on non target trees of similar species.

Only sterile plants should be allowed in plantation forests(as neighbours bear the costs).

Investigate new genetic technologies (e.g. gene drives) to mitigate spread of wilding conifers in NZ. If they are feasible and don't have any major ecological concerns associated, trial their use in a controlled setting and implement when in-situ accordingly.

Instigate trials in a contained area for GM organisms eg off-shore island.

Tools to consider: Genetically modified pines to be used in any new plantations; Selective herbicide application [for existing trees]; Manual removal of trees in highly populated areas.

Genetically modified pines to be used in any new plantations

- Selective herbicide application

- Manual removal of trees in highly populated areas

Regulation

The high level of concerns led to many comments about how the technology should be overseen and regulated.

What guidelines? an independent body needs to be maintained e.g. EPA Systems in place: EPA - independent NZ controlled body.

> *GMOs won't go outside of their domain - a responsibility of those conducting the research to ensure the specificity of the outcome/GMO product.*
>
> *An organisation or board responsible for ensuring the GMOs are in-line; research up to date, continuously monitored.*
>
> *Legislate to only plant sterile males.*
>
> *Appropriate systems and regs to manage the technology.*

Supportive groups, while still recognising a need for regulatory oversight often called for the need for research to extend beyond the current time-frames of six years to ensure that the sterility of modified wilding pines could be ascertained in New Zealand. These calls were in part driven by what was perceived as restrictive regulatory rules which decisively supportive groups in particular felt inhibited the research.

> *More research over extended time period in controlled environment. With an open mind to other avenues of control eg Japanese - male sterility.*
>
> *Regulations to allow research to progress. Extend EPA timeframes/restrictions (6yr Thing) to enable research to extend lifecycle - Maintain [HSNO] tool to contain before release.*
>
> *Change the HSNA Regs so that research can continue beyond 6 year stage for pollen and seed production research.*
>
> *Can we not extend the EPA time frames to allow research to allow us to test/research lifecycles ie cone development?*
>
> *Need current NZ regs amended to allow research to be concluded to prove viability and safety of gene technology.*
>
> *EPA should extend trial time-frame to see if trees produce fertile cones.*

Commercial Interests

Discussions around wilding pines occasionally bought in economic frames. A few groups expressed concern about the economic viability of the technology, and questioned the impact of the technology on commercial users.

> *Forestry industry might not be happy / not good if costs of GE trees are higher. Who is supplying the trees?*

What are we giving away if all saplings must be produced in a lab?

How much control/input do we want to hand away i.e. to labs in the U.S. [or] Japan?

Assuming farmed pines are genetically modified to reproduce, what are we giving away if all saplings must be produced in a lab?

Public Acceptability

Groups who were decisively supportive of the genetic technology also believed that the technology may face public opposition and that a social licence to operate was required.

Ethics: Proportion of the population may oppose GE on ethical grounds and not want any modifications to the environment despite WP being invasive non-native species

Perception of the public.

Need to think about the communication to maintain support - social licence for the tools - 'Public perspective" - Especially over the time frames i.e. will take decades.

These groups often believed in deficit models of science communication, in that the public needed to be educated about genetic technologies to gain their acceptance.

Education and communication to the general public to let people understand the efficacy of the implemented GMO.

Common public should be educated.

Summary of Public Deliberations on Wilding Pines

In summary, while some groups expressed strong support for the inclusion of the wilding pine genetic editing technology in the environmental management toolbox, or for more research into its possible use, this was tempered by concerns about the potential ecological impacts of genetic engineered pines and a questioning of the problem definition itself (are wilding pines a problem or an opportunity).

Special Interest Group Deliberations on Wilding Pines

A special interest group, which drew members from the organic and GE Free communities engaged in an online meeting with one group deliberating on the wilding pines scenario. The group rejected the genetic engineered solution to wilding pines, expressing that current management tools could manage the issue.

> *No gene tech*
>
> *Manual and mechanical control??*
>
> *No control??*

Rejection of gene technology was driven by concern that GMO’s were unproven, that the feasibility of the technology was unconvincing, and a concern about the effect gene technology would have on natural processes.

> *GMO is unproven*
>
> *GMO research has been shown to not meet the requirements*
>
> *Fundamental philosophy that we shouldn't be tinkering with nature and life*

Six groups from the undergraduate social science course discussed the wilding pine scenario. Five groups gave decisive support for the use of gene technology for wilding pine management either as a supplement to current treatments or as a replacement. No group rejected the genetic technology. However, as with the myrtle rust scenario this support came with conditions to ensure careful monitoring and oversight and address public concerns.

> *We all think that it is a good idea to make the most of GE when it comes to plant life only. We believe that there should be continued research into the long-term effects of the GE of wilding pines.*
>
> *We are in support of the use of gene editing for wilding pines, Continual monitoring will be required to assure the response of any adverse effects of GE.*
>
> *For Genetic Modification of wilding pines, with caution.*
>
> *Genetic editing of the wilding pines is okay. ..but it is important to have regulation - We must consider some guidelines as gene editing can go wrong with many risks and to ease public concerns.*

New Zealand needs as many tools as it can get its hands on when it comes to conservation and ecological preservation, Gene editing is a potential valuable tool to help us in these endeavours, with a few caveats.

One group suggested a knockout gene to manage risks.

Further research – ensure the science is proved to be correct and reliable. Like a “knock out” gene should it have the capacity to harm other plant species aside from that of the conifer including native species.

Students felt current tools were insufficient.

Current control management is not enough, and gene editing is the future. These [current] methods may harm other plants or animals in the area which is not good for the NZ environment.

It will also reduce fire hazards and reduce unnecessary wilding pine growth. It is better not to burn the wilding pines as this will contribute to climate change.

However they acknowledged that genetic technologies carried risks and called for careful monitoring, regulation, and management particularly to address community concerns.

Continual monitoring will be required to assure the response of any adverse effects of GE.

However they must be regulated and monitored, having a test run first.

We must consider some guidelines as gene editing can go wrong with many risks and to ease public concerns. We also need to let the public be aware of what is going on

This includes conducting a trial perhaps on an isolated location such as an uninhabited island reserve to see the effects of the gene editing on a population

Given the necessity of containing the wilding pine seedlings, we have deemed it necessary to strictly adhere if not more so to the already proposed HSNO guidelines.

Two groups however called for current regulations to be modified to extend the six year timeframe when trial trees are destroyed in containment sites

> *We think that the time period that researchers are allowed to hold onto the plants that they test on should be extended beyond the 6-year period in order to allow for a better understanding of whether the plants are sterile or not.*
>
> *However, we also believe it prudent to extend the containment period of the conifer beyond 6 years to enable further research on the conifer seedlings.*

Varroa Mite

Eleven focus groups from the public events deliberated on the scenario of varroa mite and RNAi genetic technology. Of these groups, 27% decisively supported the use of RNAi as an environmental management tool for varroa mite, a much lower level of support compared with myrtle rust (46%) and wilding pines (45%). Two of 11 groups openly indicated that they were opposed to the use of the technology. All groups reported reaching consensus (100%), which was the only scenario to reach this level of agreement.

Decision-making Frames

Only a few groups offered decisive support for double strand RNAi's use for treating varroa mite, for example

> *Genetic modification in successfully introducing such techniques as double stranded RNA should be in the toolbox*

But despite their decisive support groups typically still sought further research

> *Very thorough research, various trials. Understand the ecosystem. We are all for the use of genetic technologies to mitigate varroa mites.*

This contrasts with the decisive support that almost half the groups gave RNAi's use in the myrtle rust scenario. Support for RNAi's use for varroa mite for most groups was far more tentative.

> *Soft yes- make sure negative impacts are well understood/mitigated*
>
> *RNAi has potential as a tool*

> *Would be open to looking at the use of all tools available providing due diligence on every aspect of the tool was performed*

However, the varroa mite scenario also introduced in the group's information cards a variation for spreading RNAi to the mites using the bee's own gut bacteria, but as this would have intergenerational effects it would be considered genetic modification (GM). Interestingly, when groups considered the GM variation, they were far more decisive in their support for the non-GM approach to the RNAi technology which was put in sugar water in the hives and which nurse bees fed to developing bee larvae which the varroa mite then fed on. This is illustrated in the following examples:

> *RNAi has potential as a tool … [gut bacteria application] not keen on because it crosses generations.*

> *Agree RNA used in sugar water an acceptable varroa control tool to be further researched,*

> *Sugar water feeding - gene silencing ok. Research should continue on use of gut bacteria before it's rolled out - using national and international guidelines/best practice --- oversight ---- food standards Aus and NZ*

> *DsRNA would be a preferred solution because it is contained with bees- [gut bacteria] once out there is no going back. Our GE Free reputation for our agricultural product will be lost.*

Two groups decisively opposed RNAi for varroa mite, Their decision-making was based on the unknowns of the technology with one group even perceiving the technology as "dangerous" and the other suggesting that the technology might be unnecessary given their view of the mite's limited impact (6% of hives affected in 2022) and belief that commercial interests may be driving its development. Indeed both groups raised issues around commercial stakeholders, including concerns about commercial stakeholders' control over gene technologies.

> *Which tools? Stick with current tools. Wait and see what research says - can gene silencing actually control varroa? EPA. Professional beekeepers association? How to keep small-time apiarists in line/toeing the line?*

> *Genetic tech [is] quite harsh/drastic because [varroa mite] affects only small numbers of mite population (6%). Seems dangerous. Mainly a*

commercial issue. Only affects their financial bottom-lines by small amounts.

A few groups suggested that science needed to explore alternatives to both miticides and genetic technologies as the following examples illustrate,

Other research: Introduction / impact of asian honey bee (natural defence) - use Asian Honey bees? alt tech for honey- as good/better than european bees.

Like to see cross breeding with the Asian Bee because it has natural immunity

This is similar to wilding pines where alternative solutions were also proposed. When technology is seen to carry higher levels of unknowns or risks, it appears some groups look for alternative treatment options for scientists to explore.

Economic / Commercial Aspects Central to Decision-making

While commercial interests were raised by groups for all scenarios, since honey was an export industry, varroa mite received the highest number of comments that were linked to industry and commercial interests. These comments focussed on reputational effects to New Zealand of gene technologies being used, ethical/legal aspects, commercial risks and economic aspects relating to industry dynamics and small bee keeper access to the technology

Support local /small beekeepers (Make sure it is not cost prohibitive) to avoid large companies squashing small w/access to dsRNA

Damaging the reputation of the honey industry

RNA once out there is no going back. Our GE Free reputation for our agricultural product will be lost.

Damaging the reputation of the honey industry. Honey and sales built on quality/environmental standards - may affect perception of this eg Manuka and high UMF (?) grade.

Even though it's a little misleading, our clean green image is an effective marketing tool that's worth protecting.

Understanding commercial risk and labelling it GE

Controls and public information on who / how much funding tech has

Cost for beekeepers/bee industry (if constant treatment)

Benefit large companies over small beekeepers - make sure local is supported.

Worried about market response i.e. will our exports be rejected. Need to be tested with market to make sure they don't reject it

Impacts: Ecological

Ecological and human health were the main impacts raised by groups. In regards to ecological impacts, groups were concerned about the technologies potential effect on the environment, “the bee and its natural behaviours”, native bee species and the complexity of “all living systems”. As such ecological impacts were far more wide ranging than for myrtle rust, as the following quotes illustrate,

Impacts on wider environments

Test the cross breeding with Asian bee before release in NZ

DsRNA has a no-going back result. What other mites are in our environment that are part of the ecosystem that may be impacted?

Need to ensure gene silencing doesn't actually affect the bee, and its natural behaviours.

Ensure transmissibility is inconsequential or impossible. If RNAi can perpetuate, there is a possibility that it may negatively impact other organisms. One may be able to demonstrate that it cannot damage wax-moths but the nuanced biology/genome of other organisms could, hypothetically, render them vulnerable to it. So, one caution would be that it could appear in other organisms (e.g. indigenous mite species).

Does this mite affect native bees?

What is impact on other non-bee and non-mite species. Don't know.

Unknown impact on other species

Due to the high level of perceived unknowns groups called for more, and longer periods of research to ensure the ecological impacts were understood and this was sought for both forms of RNAi mentioned in the scenario

> *Research needs to continue on use of gut bacteria -- to check impacts on bees, humans and other species*
>
> *More research into effects of consuming [double stranded] RNA by non-target species.*
>
> *Don't know how long research is going on for. Is it 12 months or 12 years?*
>
> *Explore the impact of gut bacteria RNA understanding impact, e.g. native bees.*
>
> *Risk of gut bacteria RNA needs to be fully explored*
>
> *Continue to investigate the use of gene, or quasi-gene, editing technologies to mitigate the impact of varroa mite. I think it is critical to explore these relationships in controlled settings though, to avoid adverse environmental consequences. Existing control strategies sound fairly crude and ineffective anyway.*

Impacts: Human Health

In the four scenarios presented in Phase 3 only varroa mite triggered concerns about impacts on human consumption / health which related to the scenario's links to food and nutrition through honey production. Groups were concerned about RNAi entering the human food chain, impacting organic honey production, or affecting honey quality.

> *We eat honey. What is the residue effect? How provide mRNA honey not in honey being eaten.*
>
> *Risk to organic honey*
>
> *Impact on honey quality - nutrition.*

However, one group believed that people's concerns about contamination of the food chain may be primarily driven more by the 'RNA', as food was already contaminated by management controls such as miticides and herbicides.

> *People being concerned about RNAi entering their food - may not be aware that there is already small amounts of miticides and herbicides in their honey and just are concerned because RNA is involved.*

Implementation and Regulation

The concerns around impacts necessitated many cautions around how any genetic technology might be implemented and regulated,

> *DsRNA [first] contain it, then to Chatham Islands*

> *Use judiciously so that it's not over-used - loses effectiveness*

> *Utilise National and International guidelines/best practice (MPI)*

> *What systems/guidelines?*

Summary of the Public Deliberations on Varroa Mite

In summary, in contrast to the other scenarios the broader commercial and economic context and human health were considered alongside the ecological impacts in group's decision-making of the varroa mite scenario. While RNAi technology was seen to offer benefits over current tools in the myrtle rust scenario (i.e. fungicides) and perceived to carry fewer risks, this was not seen to the same extent with varroa mite, with groups largely offering only tentative and conditional support for the implementation of gene technology to manage this biosecurity issue. However non-GE dsRNAi technologies were considered preferable to genetically modified RNAi.

Special Interest Group Deliberations on Varroa Mite

A special interest group, which drew members from the organic and GE Free communities, deliberated on the varroa mite scenario. Their decision showed some variability among the participants as the following examples show.

> *How does it get rid of the Varroa mite? Should not be released into any organism. Clean up our environment.*

> *Sense of saving something may make RNA in Varroa less problematic than GE.*

Those who rejected the genetic technology identified uncertainties, risks and technology feasibility as influencing their decision.

Is it retractable?

Neonicotinoids affected by the pesticides. Pfizer RNA is in the DNA. Just different suffering to animals.

Reverse Transcriptase (RT) also known as RNA Dependent DNA polymerase, is a DNA polymerase enzyme that transcribes single-stranded RNA into DNA. What it does to the mite is not so important. May not seem as transferable.

When beehive gets weak the Varroa Mite might get hold of the beehive.

If a bee ingests the RNA how will it affect the bee?

Management issue. Lots of uncertainties.

Opened another can of worms

There was concern about commercial interests;

It's an industry selling its product.

Mistrust of current controls and the science;

Scion field trial language - what does it mean by the term field?

Possibilities of alternative treatments and strategic approaches;

Work with Asian bees

Strategy and management first and second tools.

And an overall belief that current regulations were "fit for purpose".

Legislation is fit for purpose.

Among the social science students who participated in the other special interest group, six student focus groups considered varroa mite. One group rejected the use of RNAi gene technology for managing varroa mite while providing an alternative treatment option, two groups gave decisive support and three groups provided tentative or partial support. All groups sought stringent controls. The genetically modified gut bacteria option was not supported.

We are happy with using double-stranded RNA as it is considered not to be genetic modification. We think that it is a really promising tool. We *want to be cautious about how this technology is used. If the technology ended up using the bee gut bacteria, we would advise not to proceed if there is any intergenerational effects of the technology.*

We should keep using miticides until RNAi is shown effective for honeybees. RNA can be used to target honeybees to reduce the amount of miticide residue in honey, Don't advance RNAi to become a gene modification technology

Investigate further and develop the possible genetic technology management tool (RNAi), but on the condition that the tools are tightly regulated.

Include both pesticides and RNA gene tech inside the toolbox. Transition the use of pesticides to gene technology over a period of time.

We need to take a different approach. Funding will be allocated to researchers and scientists to develop a poison that doesn't affect honeybees but is deadly to the varroa mites.

Decisions supporting the use of RNAi were largely driven by the perceived ineffectiveness and environmental harm caused by current treatments, and acceptance of the problem definition as the following examples illustrate,

Pesticide use is often harmful to not only the organism being eradicated but also for other species, …as animals may naturally develop a resistance to the miticide - causing an increase in development costs as well as possible human exposure to more harmful chemicals.

the varroa mites present significant damage and challenges to the environment, which need to be mitigated…We don't believe that the current technology is effective in reducing the varroa mite population

Students were, however, concerned about potential risks including environmental harm and so recommended a cautious approach to implementation and a considered approach to public engagement and robust research

Gradual transition from traditional pesticides to RNA technology to gauge public response and environmental impact. Raise awareness to the public of the benefits and risks of new technology.

> *Genetic technology may be a worthwhile alternative to chemicals, but will need to be approached with caution as this technology can alter the ecosystem drastically, and wreak havoc on nature.*

> *…the technology should be incorporated slowly and by way of using mathematical modelling to gauge what the outcomes may be and understand the complex problem. Thus we have to be cautious with our usage of the technology.*

Rats

Twelve focus groups from the public events deliberated on the scenario of rats and genetic engineering using gene drive. Of these groups, 25% decisively supported the use of gene drive as an environmental management tool for varroa mite, which was the lowest level of support across all four scenarios. Interestingly no groups were decisively opposed to the use of the technology, although two groups were unsure. Of the 12 groups, 94% reported reaching consensus.

Decision-making Frames: Problem Definition

The rat scenario was the only scenario which was focussed on a mammalian species. Participants were in wide agreement that rats were responsible for significant damage to New Zealand's natural environment. This is unsurprising given that rats were perceived as a major biodiversity threat in phase 1 of the research, and why a rat scenario was included as one of the scenarios in the Phase 3 deliberations.

The agreement that rats needed to be eradicated / controlled was a major driver in group decision-making. Most groups clearly aligned with New Zealand's predator free goals and sometimes explicitly with Predator Free 2050 and they in general felt more tools would be needed to achieve this goal. Some even suggested predator free goals needed to extend beyond the current three pest focus (rats, stoats, possums) to include mustelids and mice. Some groups expressed a sense of urgency and a perception that current tools were insufficient and ineffective and to achieve predator eradication.

> *Needs to become a viable option because current tools are unlikely to achieve our PF2050 goal. Caution should be exercised but may be the game-changing technology that we need.*

> *Support the use of cas9 technology. Current control processes not effective and labour intensive.*
>
> *Introduced rats are bad for NZ environment and need to go. Need better tools than what we have now.*
>
> *The same process needs to be implemented in relation to other pests such as weasels stoats cats*
>
> *Investigate mustelid and mouse application at same time.*
>
> *Potential for making a big improvement to pest control.*

However, acceptance of the problem definition of rats negatively impacting New Zealand's biodiversity, and agreement that removal of rats may require an expansion to the tools in the toolbox, did not mean groups gave unconditional support for genetic technologies. Indeed groups were very cautious about the use of gene drive and indicated much higher levels of concern about this technology compared with the technologies introduced in the other scenarios, including the genetic editing technology of wilding pines. The following examples illustrate the acceptance of the problem definition but the cautionary approach recommended by groups for gene drive.

> *More caution and regulation needed compared to RNA but will be key in our goal for PF2050.*
>
> *Need another / more tools to cope with the pests ... but only implement with utmost caution.*
>
> *Kevin Esvelt, one of the developers of gene drive technology, is now urging caution with it*
>
> *Communities/public/iwi need to be communicated with clearly and from the start. Caution should be exercised but may be the game-changing technology that we need.*

Decision-making Frames: Ethical Concerns of Current Management Tools

In addition to the overwhelming acceptance of the problem definition, another driver that shaped people's support for gene technology in their decision-making was ethical considerations surrounding current technologies. Gene technology (although not necessarily gene drive) was seen as a more ethical choice for pest control as it was perceived to address animal welfare issues particularly in relation to the use of 1080 and other poisons. The reduction in pest suffering associated with poisons was seen as a good in its own right and as the last quote illustrates also seen as being important for public acceptance of pest control / eradication.

> *PROS - Not having to use poisons which cause suffering.*
>
> *Support the use of cas9 technology. Greatly reduces animal suffering if gene drive were implemented.*
>
> *Species specific as opposed to methods such as 1080.*
>
> *If methods can be publicly accepted, animal welfare concerns will ease regarding toxin use and trapping. Risk is lower compared to other countries due to no native land mammals and geographic isolation*

Decision-making Frames: Considerable Level of Unknowns

The genetic technology proposed in this scenario i.e. gene drive, was in the earliest research development stage (at least for mammalian control) compared to the technologies used in the other three scenarios. The technology's early development stage created many concerns around technology unknowns.

> *At this moment, stay with the status quo. The technology is in its early stages; too many unknowns. We like the idea but risks too high. Potential for making a big improvement to pest control. Current methods ok, but costly and ineffective.*
>
> *Not proven? What problems have been solved*
>
> *We don't know possible negative impacts - tech not understood well (pop dynamics).*
>
> *Te Ao perspective currently unknown - also iwi to iwi dependent*

However, interestingly the high levels of unknowns did not necessarily lead groups to decisively oppose gene technology as a treatment method, but rather to either favour current methods, seek more research, suggest scientists investigate alternative gene technologies and not gene drive, and demand very strict control of the technology. For instance several groups recommended strict containment sites as the technology was being developed. However, some groups expressed concern about the likelihood of containment sites being able to actually contain the technology. The unknowns also led one group to question their own legitimacy in making a decision about this technology.

> *Allowed to work on it - Develop in controlled env/lab*
>
> *Could be trialled on remote island not visited by humans.*
>
> *More research, more trials - in containment. Don't know enough.*
>
> *GE - possibility of difficult to reverse harms caused unlike other tools available (super rats) . More scientific trials required (possibility of island trials) - from lab to real life*
>
> *How to keep contained? What if animals get out into their native ecosystems? So many unknowns!. Need more international evidence or studies to show way forward. Lots and lots of unknown with potential genetic mods.*
>
> *Biosecurity needs reinforcement. Integrated pest management preferred. Whole ecosystem needs focus, not piecemeal.*
>
> *New technologies need to be tested thoroughly and proven before release perhaps in a remote site.*
>
> *Are we the right people to make the decision?*

Therefore in grappling with the many unknowns, participants balanced the technology's early developmental stage with the impact of rats on New Zealand's biodiversity and biosecurity and the need/urgency they felt for more tools in the environmental management toolbox to eradicate or control rats.

Supplement to Other Existing Technologies

Given its early stage in development, groups who decisively or cautiously supported gene drive saw it as a supplement only to current technology.

> *Need another/ More tools to cope with the pests. Need to look more thoroughly at past issues- solutions. Take gene tech a step closer to reality but only implement with utmost caution. Trapping / Poison + Gene modification*
>
> *Rats have a short lifespan (+_ 2 years) so using genetic technology could result in a quick turn around (more efficient) - especially used with other tools*

> *Even if it takes decades to be ready to roll out, and be effective, it will supplement other tools.*
>
> *Begin cautious consideration of gene editing implementation within conservation toolbox (longterm) whilst continuing a mixed use approach with poisoning and trapping dependent on contextual priorities.*
>
> *Continue poisoning until CRISPR-Cas9 tech is capable of main use*

Decision-making Frames: The Technology

Of all the four scenarios tested, gene drive received the highest level of discussion by participants about the technology itself, with groups particularly exploring the innovation's feasibility and viability.

> *Believe there is a chance of successfully eradicating rats through gene drive.*
>
> *Risk that new gene tech will be temporary. Pests will evolve past the technology*
>
> *Time taken to implement gene drive*
>
> *Gene tech can be temporary and will not adapt as fast as pests*
>
> *Huge investment - tons of $ - May not find tech.*
>
> *Funding – is this economically viable?*

Therefore while some groups believed the technology was feasible a number questioned whether gene drive was possible and even if it was worth the investment.

Impacts: Environmental

The high concern around the unknowns of gene drive as a technology extended into the group's caution cards, with a very high proportion of cautions focussing on the potential for environmental impacts. These particularly focussed on impacts on other animal species in both New Zealand and internationally. In addition, while animal welfare was seen as a reason to support genetic technology, it was also seen as a reason to question the use of gene drive.

> *New tools need to understand [the] full impact on the environment. Decision: Genetic technology short of unclear gene modification.*

What is [the] limiting factor / mitigation to prevent it spreading to other countries?

Gene modified rats could accidentally be introduced into other countries where they'd damage a population.

Fully understand impacts on equilibrium.

Unintended consequence of species eradication.

Rats can jump onto ships and go anywhere - could affect other ecosystems elsewhere in the world - need caution.

Do we know impact on land/ecosystems weighted vs poison unknown impact on rats - how do they look

Animal ethic consideration needs to be included.

Gene transfer- impacting on other species (? transfer gene) - potential jump to other mammals (bats/cat/dog/humans!)

Any animal preying on the rat is not affected by the gene technology (including bacteria and fungi). Rigorous testing to find out if gene technology affects the environment eg. it allows another animal to reproduce at plague numbers.

Impact on animal behaviour and how this might have undesirable environmental outcomes.

Furthermore, despite the high level of agreement that rats were a significant pest in New Zealand, rats were not necessarily treated as one single pest category by all participants. Particular mention was made of kiore both from a cultural perspective and from an ecological perspective if for instance kiore were not targeted for cultural reasons.

Would have to test in a controlled environment to ensure hybridisation wouldn't occur between European spp and the kiore (cultural significance)

What about kiore? Māori need to be in the centre of decision making.

Explosion in other non target species like koire rats. Potential of hybridisation with other rats.

Unsure - so many risks to mitigate - Invest in research of -Tech itself - potential implications - Consider Te Ao Māori - especially Kiore

Impacts: Economic

Groups also commented on the potential impact of gene drive on New Zealand's economy and reputation. These comments focussed on New Zealand's "clean green image", trade and tourism and increasing cost from associated with biosecurity.

Could impact trade and tourism. Costs of import/export may increase due to increased biosecurity.

Affecting NZ's "clean green" by partaking in genetic modification. Opposition both nationally/internationally. Possibility of it spreading into unintended places.

Will this affect NZ GE Free reputation?

Regulation / Governance / Legal Issues

Gene drive received the most cautions of any scenario relating to regulation and governance. Regulatory cautions were linked to comments about the high level of unknowns surrounding the technology as a result of its early stage development. In addition some groups commented that engagement in gene drive would necessitate engagement with international regulatory protocols. In addition it would necessitate changes to biosecurity regimes. Concern was raised about ownership and control and regulation.

Regulations are required.

Regulated by Hazardous Substances and New Organisms Act

Standards are so specific so should be NZ-led.

- *ethics committee needed*
- *International input needed as risk will be increased in other countries.*

Protective mechanisms must be put in place first

Regulation - not wild west - don't mess too much w/DNA

Biosecurity

> *Increased biosecurity needed at borders to prevent spread to other countries.*
>
> *Heightened biosecurity because of the risk of these males spreading globally which could be detrimental to other ecosystems*

International Agreements

> *GLOBAL AGREEMENT POSSIBLE PROBLEM.*
>
> *Cartagena Protocol - NZ is a signatory. A number of governments have said no at this stage to gene drives. Would need discussion and agreement at international level.*

Governance, Ownership and Responsibility

> *What happens if something goes wrong with the gene editing. Would a change in Govt alter the process of development and implementation.*
>
> *The technology could be weaponised having said that new technologies are developed all the time. This discussion is about us using it.*
>
> *What about liability if something goes wrong? Who pays? Would insurers insure against it?*
>
> *Who owns this technology? If it is privately owned is the cost as big as trapping?*

Summary of Public Deliberations on Rats

In summary, while groups agreed that rats were a significant pest in New Zealand and supported a predator free vision they overwhelmingly called for a very cautionary approach to any consideration of gene drive for rat eradication or control. Much of the precautionary approach was driven by the large level of unknowns surrounding the technology. The perceived advantage that gene technology (not always gene drive) offered, driven by a sense that the current tool box was insufficient or ineffective at meeting predator free visions, and the perceived animal welfare advantages that gene technology might offer, were set against the considerable environmental, technological, regulatory, governance, legal and ethical challenges of the technology and its implementation.

Special Interests Group Deliberation on Rats

The special interest group, which drew members from the organic and GE Free communities deliberated on the rat scenario. Their decision showed no variability among the participants and strong rejection of gene drive as a possible genetic tool for eradicating rats.

Unlike the public deliberations which strongly supported the problem definition, some in this focus group questioned the need to eradicate rats, along with the “unnaturalness” and feasibility of the technology, impacts from eliminating only some species in the predator guild and the large level of unknowns, and they also provided counter-arguments to resolve challenges of current technologies. The arguments provided were very specific and participants drew evidence from selected studies to support claims.

> *Not all agree we should get rid of rats. Getting nature in balance is really hard. Balance is important.*
>
> *Risk of Downs and other chromosomal issues.*
>
> *Explosion in mice population. Learned behaviours of rats make it challenging.*
>
> *12% failure rate.*
>
> *1080 could go in bait stations*
>
> *What are the by-effects - Will other species inherit genetic change. Taonga Species. Chain effects. Transgenic changes on a large scale. Too many questions that remain unanswered.*
>
> *[Rat Eradication] should be managed by professionals not community groups. Strategy and management.*
>
> *Can you go back? Containable or retractable?*
>
> *Introduce a new technology to solve a big problem - What are the consequences?*

Three student focus groups in the social science undergraduate course deliberated on rats. All three decisively supported the technology but with high levels of caution. This was almost exclusively driven by concerns about the effectiveness and safety and animal welfare issues of current technologies.

> *We all decided that we were for gene editing. We reached this decision because we felt that trapping methods are not as effective and require a lot of maintenance as poison methods have potential risk and are very controversial.*

> *Yes we are in favour of the use of gene technology to control invasive rat populations in NZ. Make sure it doesn't jump species… Support the scientists so that they can successfully implement this gene technology - encourages scientists to stay in New Zealand!*

> *We have decided to choose the genetic technology that uses Crisper-Cas-9 to induce a male-only inheritance. This technique mitigates the negative outcomes of 1080 and poisoning/ trapping*

They recommended careful implementation and transparent engagement with the public to ensure the technology moved carefully and in step with public views.

> *Run extensive trials on uninhabited islands to ensure any failed attempts do not cause issues for the rest of the country.*

> *Work with the community: that's because people are worried about it not aligning with their goals, concerned about regulations, impact on the wider view of New Zealand.*

> *Be transparent with how we go about gene editing in rats.*

4.5.3 Insights from Scenario Analysis

While the analysis of the groups' decisions and caution cards provides a depth of understanding about each scenario including the environmental problem and current and new management tools for that problem, a holistic investigation of all the scenarios in comparison with each other, provides an overall picture of New Zealanders' perspectives about gene technologies for environmental purposes. Bringing together all the responses for all four technological scenarios enables points of convergence and contention to become more apparent.

Patterns in Groups' Decisions

A cross-scenario analysis assessed how often five factors which drove groups' decision-making occurred in relation to each scenario and expressed as a percentage of the total responses for each technology. As this research was largely qualitative in nature, the specificity of the numbers are not what matters here, rather, it is the prominence (or lack thereof) of specific aspects that matter. The five issues identified and considered were:

- characteristics or specifics of each environmental tool and technology
- knowledge of genetic technology and/or need for further research.
- visions for alternative approaches
- supplementary use new and current technologies
- the need and place of regulation and governance

To contextualise this, each scenario was also assessed on net-support, i.e. the percentage of group responses that stated decisive and clear support for the technology minus the percentage of responses that decisively rejected the technology. This is presented in Figure 4.8 below.

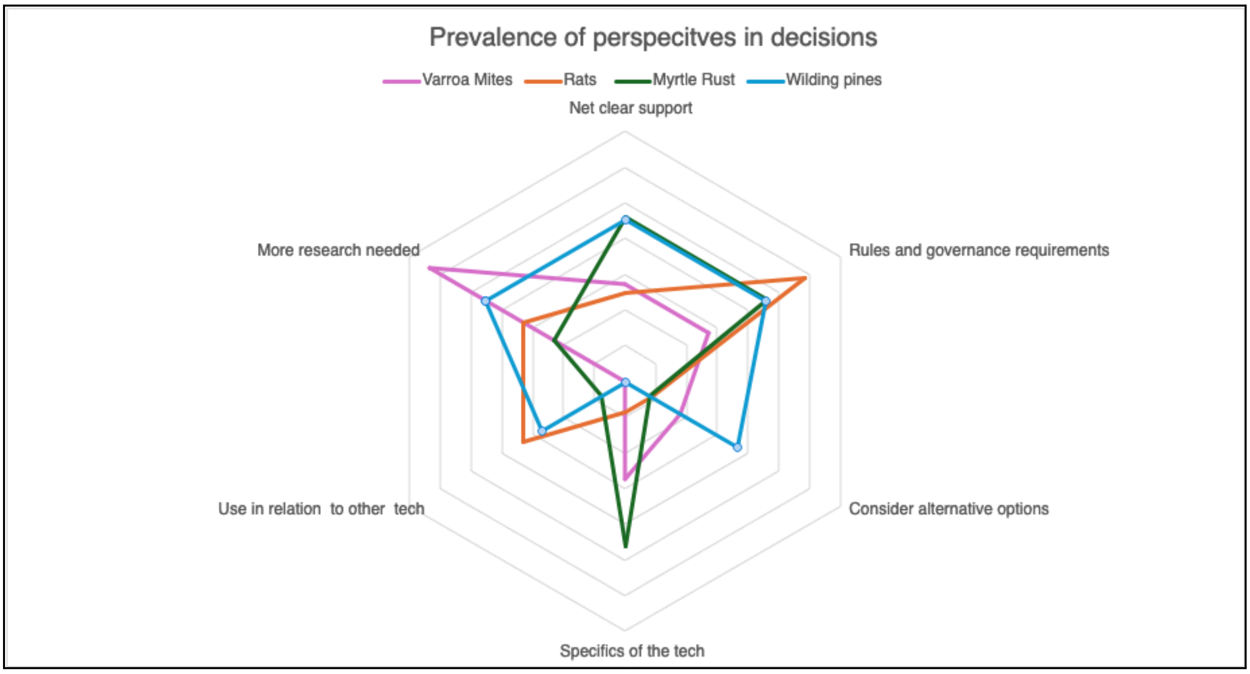

Figure 4.8: Prevalence of key perspectives for each scenario across Phase 3 workshops exclusive of the two special interest groups

When it came to what shaped people's decisions, four key dynamics became evident:

1. The technology itself (whether gene editing/modification or RNAi / gene silencing) is not the driver of group decision-making.
    - While it had been anticipated that RNAi or gene silencing (myrtle rust and varroa mite) would be the more socially acceptable technology and genetic modification / engineering less so (wilding pines and rats), the testing of these different types of technologies across the four scenarios, revealed that the technology itself is less important than the context. Socially complicating aspects, such as negative perceptions around the safety of existing tools (myrtle rust); commercial entanglements (varroa mite); impacts- ecological and human health (varroa mite), acted to support (for myrtle rust) and undermine (for varroa mite), the acceptability of RNAi / gene silencing for myrtle rust but not for varroa mite.

2. Applications of gene technologies to flora are more supported than applications of gene technologies to fauna
    - A clear difference emerged between applications of gene technology for fauna and flora. Overall, there was noticeably more support for applications of gene technologies to plants than to animals, irrespective of which technology it was. While use of gene drive in rats caused high levels of concern and little 'decisive' support for its use, although not high levels of rejection, the use of gene technologies in sentient animals - be they rats (gene drive) or bees (RNAi) was preferred less than genetic technologies use in wilding pines (gene editing) and myrtle rust (RNAi). Again the technology type was not the primary driver of the decision. It could however be interesting to explore this issue further to see the response towards RNAi use in wasps rather than honey bees which carried added concerns around human health.

3. The closer the technology is to implementation, the more the details of the technology were discussed
    - While the technology itself wasn't the deciding factor in terms of acceptability, the details of the technology—how it worked particularly in relation to the current tools (myrtle rust) and to a lesser extent varroa mite were of interest. As RNAi / gene silencing is a technology closest to deployment, it would be interesting to understand further why this is the

case. One could speculate that the interest stems from the nearness to deployment (people want to really understand a technology that might be close to release); but it could also be because RNAi / gene silencing hasn't been as readily discussed as gene drive.

4. The further away and more uncertain the technology, the more regulation mattered
    - Temporally far-off technologies such as mammalian gene drive demanded greater regulatory oversight. Overall, it was noted that, compared to other applications, discussions on the use of gene technologies in distant future contexts, where there is still great uncertainty over the technology, the technology's feasibility and viability are questioned, and the implications of using it led New Zealanders to seek for considerable controls, regulation and governance.

Patterns in Groups' Cautions

As with the analysis of decisions, a cross-scenario analysis considered how often each of eight topics identified as core to the cautions —5 impacts and 3 innovation concerns (feasibility, viability, desirability)—occurred in relation to each scenario (again expressed as a percentage of total response for each technology). These were:

- Innovation Feasibility (questions or concerns of technical feasibility),
- Innovation Viability (questions of economical or business viability),
- Innovation Desirability (questions of social desirability and/or acceptance)
- Impacts
    - Ecological
    - Health / social
    - Regulatory
    - Economic
    - Cultural

Again, a net-support for each scenario was used to contextualise this, as shown in Figure 4.9

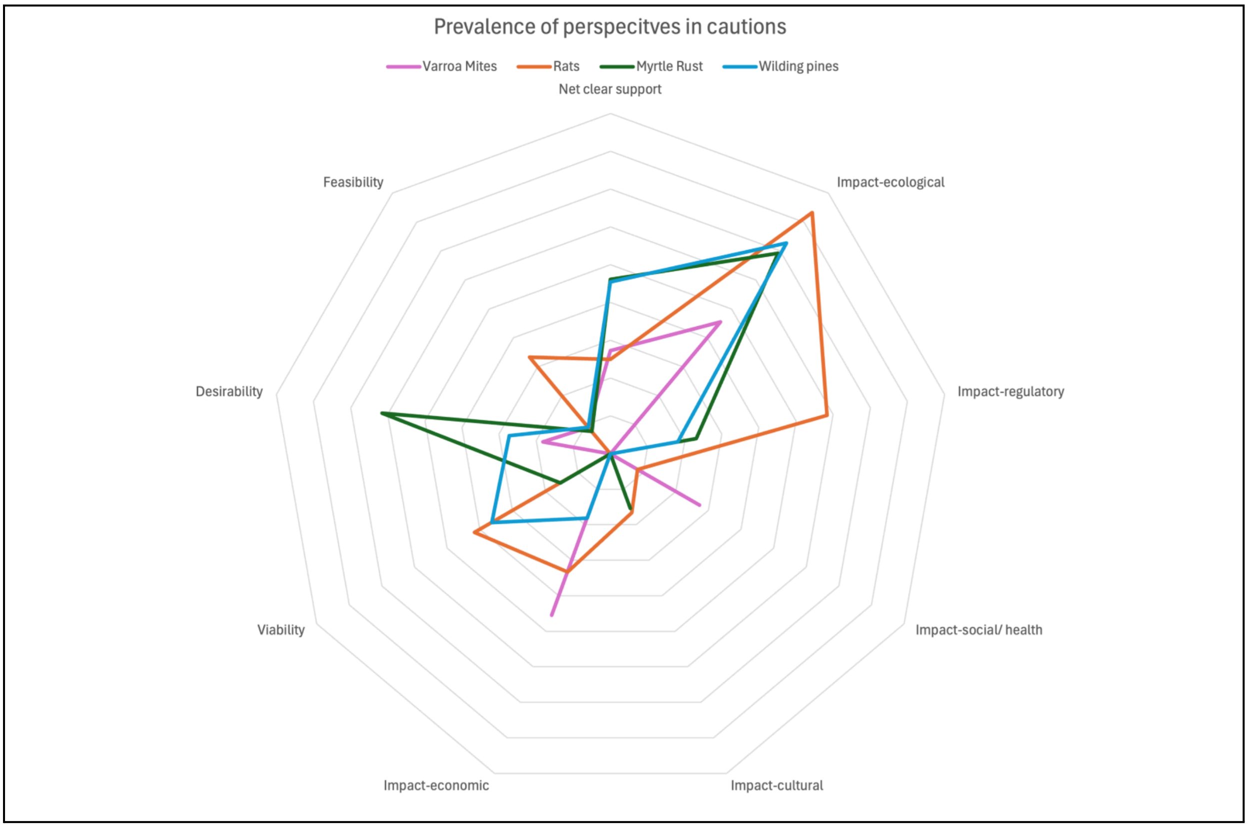

Figure 4.9: Prevalence of cautions for each scenario across Phase 3 workshops exclusive of the two special interest groups

As for what shaped people's caution, four aspects become evident:

1. The closer the technology is to implementation, the more likely social acceptance and desirability became an issue
    - While many gene technologies are still some years away if government regulations change, once their technical feasibility and regulatory viability have been established, concerns turn to public acceptance and social desirability. This creates cautions over public acceptability but also takes in concerns over proper and sufficient public education / understanding which is seen as an essential step in ensuring desirability.
2. The further away and more uncertain the technology, the more overall cautions emerged
    - There were many more cautions across the board for technologies that were still somewhat aspirational e.g. gene drive. While such technologies naturally raised more questions around technical feasibility than other technologies, they also raised more concerns overall, and specifically around their potential ecological and regulatory impacts.

3. Gene technology that interacts with food raises questions of health and safety
   - Perhaps unsurprisingly, the application of gene technologies that directly interact with food consumption and products raised concerns around their health implications. In fact, no other technology raises such concerns.
4. Technology's relationship to business cuts two ways depending on whether it is perceived to directly benefit industry or directly benefit society
   - The relationship between gene technology and commercial interests can be seen as either a benefit or a challenge depending on who gains the benefits. Applications of gene technology by commercial industries that are seen to drive commercial profit maximization (varroa mite) raise concerns about compliance, fairness and influence. Conversely, applications of gene technology by commercial industries that are seen to maximize social well-being are perceived as a benefit (for example by using gene technology to ensure industry absorbs what had previously been a negative externality).

Workshop Exit Survey Word Clouds

The exit surveys asked people to provide three words they would use to describe the use of gene technologies for environmental purposes. This voluntary question received 154 words from participants in the public events, 211 from the special university student event and 12 words from the special interest group online event. These are presented as word clouds below (Figures 4.10, 4.11, 4.12). While word clouds can be a little unsophisticated, they nonetheless provide a simple and clear visual summary of participants' perceptions of gene technology following their engagement in the Phase 3 deliberative workshops.

Figure 4.10 below reveals the 154 responses from participants who chose to complete this question at the public engagement events. This visually shows that communities across New Zealand want a very cautious approach to any use of gene technologies for environmental purposes. Many recognise the possibilities of gene technologies and some are excited and positive about its potential as an effective tool, particularly when compared to current technologies. However, the high level of unknowns and the complexities of ecosystems means people view these technologies as carrying risks that participants feel require continued research and a careful and cautious approach to any implementation to ensure ethical innovation.

Figure 4.10: Word cloud of participants' perceptions of gene technologies following their deliberations in Phase 3 workshops (n = 154 responses)

Students enrolled in the undergraduate social science course who chose to engage in this research and who provided 211 words are also concerned about the risks associated with gene technology and call for a cautious approach. However, unlike the public engagement participants they view genetic technology as an innovative tool that offers considerable benefits for ethical biosecurity management. They appear to be more comfortable with using technological innovations for managing environmental issues, but also recognise the controversial, complex, complicated and challenging aspects of gene technology and they call for regulations to oversee implementation.

The small number of participants in the special interest online group who completed an exit survey provided 12 responses. This group drew from GE Free and organics communities across the country. Their word cloud shows deep concern and suspicion about the implementation of gene technologies. This is based on significant concerns over the control and management of the technology. However, one person's response from the four participants who did respond, suggests they see potential in what gene technologies may offer when compared to poisons, coupled with concern about the level of unknowns. This does indicate some variability within these interest groups over the application of gene technologies in specific situations (albeit from a small sample).

Figure 4.11: Word cloud of students' perceptions of gene technologies following their deliberations in a university course Phase 3 workshop (n = 211 responses)

Figure 4.12: Word cloud of participants' perceptions of gene technologies following their deliberations in an online special interest group Phase 3 workshop drawing from the GE Free and Organics sector (n = 12 responses)

5.0 Public Engagement Insights

5.1 Introduction

This research asked the public to consider whether specific, problem-centred genetic technologies should be included in New Zealand's environmental toolbox Over the past 18 months a diverse range of people have engaged in rich conversations providing their visions, aspirations and feelings for Aotearoa New Zealand natural environment and about the role genetic technologies might play in this.

This chapter draws out key insights from the findings that have been presented in chapter 4. These are intentionally presented as insights as a way of synthesising the myriad of ideas, feelings, thoughts and perspectives New Zealanders shared during the three phases of this research. These insights seek to inform science research, science governance, science policy, science engagement and communication, and science education. As such they have relevance to diverse audiences that include policymakers, genetic researchers, environmental scientists, social scientists, science communication specialists, interest groups and more. They may also be of interest and use for members of the New Zealand public, many of whom have engaged in this research and who care deeply about New Zealand's natural environment.

5.2 Insights about Complex Socio-Environmental Science

Complex issues go beyond their inherent 'complicatedness', and are entwined with human values, desires, emotions, habits and visions (Klerkx et al, 2012). The use of genetic technologies for conservation or environmental purposes is a complex socio-environmental issue. Participants' engagement in all phases of this research has clearly demonstrated that genetic technologies cannot be viewed or assessed based only on their technological or scientific aspects. This research clearly demonstrates that people view genetic technologies within much wider visions about the world they would like to live in. People's responses are entwined with environmental, social, ethical, cultural, economical, and political dimensions that emerge from people's deeply held and personal views and values. Decisions about whether to accept genetic technologies are, therefore, not simple yes and no answers but are deeply considered and very nuanced; they have lots of "ands' and many many 'buts' and sometimes even appear contradictory. People may, and in this research many did, see the potential of gene technologies, BUT they also see the inherent risks and unknowns of the technology and this means people attach high levels of caution to these technologies that require considerable levels of oversight, regulation and control.

The nuanced understanding brought on by this complexity is seen in the way people assessed the scenarios in this research. People do not simply decide RNAi is ok and gene drive is not, as shown by the fact that myrtle rust and varroa mite, which both had RNAi as possible genetic management tools, received markedly different responses. People's decision-making was influenced by their values and their perceptions of the impacts of current management tools, and in the case of varroa mite by perceived impacts on human health, not simply by the technology. This research has shown how this complexity in decision-making plays out across different scenarios. People are not for or against gene technologies as a whole. Instead they consider technologies within the wider contexts in which they will operate, and they then evaluate these within their own individualised set of values, understandings, beliefs and even morals, as was the case with rats where morals around animal welfare of current technologies influenced people's decision-making.

Capturing the nuances in people's decision-making of complex socio-environmental issues requires methodologies that allow time to engage with people's values and which position technologies within the complex landscapes and contexts in which they operate. By designing methodologies in ways that attend to complexity, people can feel supported to bring a wide range of perspectives to the conversation, building meaning in their experience. Importantly, appropriate methodology enables collecting data that provides rich insights into people's decision-making about the issues that matter most to them. It captures people's visions for a protected natural environment, their feelings and concerns about research and certainty vs unknown futures, about regulation and governance, and about power (vested interests). In other words, acknowledging and embracing complexity allows people to express views and attitudes that go well beyond yes or no answers, and enable a more detailed and nuanced picture of their perspectives and concerns that are context dependent.

5.3 Insights for Contested Science Issues

Genetic technologies are contested issues. Genetic modification discussions in New Zealand have historically been very polarised. In this research 75% of people reported coming with pre-held positions on gene technologies, although they did not need to be explicit in declaring their position. However, this research shows that through dialogue and conversation people will re-evaluate these positions with around 40-45% of those who participated indicating that their engagement led to them re-evaluating (though this does not mean changing) their position. Dialogic and deliberative processes which give people time to express their views and listen to others' provide people space to consider, to evaluate, to learn and to reach decisions. In all but one phase 3 event (the special online event), participants reported feeling listened to by their groups. This is particularly heartening, as many events contained participants who had never met before.

In general, the public engagement stream events fostered robust discussions where a diverse range of perspectives were canvassed. However, the research found that many public events, particularly in cities, did not attract the breadth of opinions that might be expected from an issue as potentially polarising as gene technology. To capture the full breadth of opinions it was necessary to specifically approach groups, particularly groups opposed to the use of genetic technologies outside contained lab environments, and other voices from, for example, the organics sector. The public meetings particularly in cities did not often capture these voices, perhaps because people were wary of engaging with research they felt might be positioned. In addition, it was important to capture the rural sector voice, and particularly voices in isolated communities.

Where trust is low, the potential for contestation is much higher. For this research, aspects of trust related to trust in science (and which science you trust), scientists (and which scientists you trust), and science institutions; trust in government and government agencies; trust in science funders (notably MBIE as a major funder of science); trust in authority particularly trust in regulation and regulators; and trust in policymakers and politicians.

When trust is low it is challenging to hold conversations about contested issues. In 38 events undertaken in this research only one resulted in people becoming agitated by the conversation about genetic technologies. This occurred in a Phase 1 remote rural community event in Northland. The community felt the conversation and the research was attempting to threaten their GE Free status and their desire for locally determined decision-making. Trust levels were also impacted by a legacy from vaccine mandates. Nonetheless, the Northland discussion did provide valuable insights and community opinions that were captured in some of the perspectives that framed the landscape in Phase 3. Including these voices in the 12 perspectives that were presented in the Phase 3 scenarios allowed others to hear a full range of voices; voices they had never considered, voices they aligned with, and voices that they disagreed with. Most importantly people could see themselves in one or more of the voices and they often openly declared this as the group read out the perspectives. It is important that research, science and policy steps out into 'hard to reach' communities to provide avenues for all voices to be heard and for others to consider them.

In general, people across New Zealand found their participation worthwhile and they enjoyed engaging in conversation, being able to speak and be heard and developing their own learning and understanding about genetic technologies and New Zealand conservation. Although attracting participants to meetings was challenging, New Zealanders who did attend were very interested to engage in a conversation about gene technology and in almost all cases commented the time was right for this conversation.

5.4 Insights for Problem Driven Science

Scientists, and indeed researchers in general are often motivated by problems they feel need solutions. However, this research shows that the public may not agree that what researchers might define as problems are, in fact, problems. And, even where they do agree on the problem as defined by researchers, this may not lead them towards an acceptance of technological solutions such as gene technology.

The wilding pines scenario provided the greatest scepticism around the problem definition. Not all saw wilding pines as a problem, some saw them as an opportunity – the timber being seen as a resource for fuel, for carbon capture, or for claiming in emissions trading. These same groups suggested that a different problem had more urgency: 'DON'T FORGET ABOUT RABBITS'. Acceptance or rejection of the problem definition becomes a significant contributor in people's decision-making about gene technology. In myrtle rust the problem as defined was completely accepted and the current tools were also seen as problematic, and this became significant in people's decision-making.

For the most part, people did accept the problems as presented to them, but this did not mean they accepted genetic technologies as a solution. This ranged from putting forward alternative solutions, supporting the use of existing tools over genetic tools, or supporting further research on genetic tools but not their current use.

When genetic technologies were accepted for inclusion in the environmental management toolbox, this was often, though not always, motivated by a sense of the urgency of the problem. Even then, this should not be seen as a carte blanche to roll out genetic technologies. Caution was still called for. If genetic technologies are supported, and even when they are decisively supported, this support is conditional.

Concern about the effectiveness or impact of current solutions to the problem motivated strong support for genetic solutions. In the case of myrtle rust in particular, people’s dislike of fungicides was an important driver for their decisions to include genetic technologies in the toolbox. This lay alongside the sense that RNAi was comparatively targeted, contained, non-heritable, and ‘natural’. Thus, one problem (current solutions) trumped the other. However, interestingly these perceived benefits of RNAi for myrtle rust were not seen as benefits that outweigh risks in the varroa mite scenario.

In summary, researchers should not assume that what they perceive as problems will be seen as such by the public more generally. And what they see as solutions may not be seen by publics as solutions either.

5.5 Insights for Complex Socio-Environmental Innovation Governance

Any introduction of genetic technologies into Aotearoa New Zealand will need to come with significant and well-formed governance infrastructure. A high level of public trust in science needs to underpin science innovation governance. Overall, there was frequent and significant call for science and scientists to play an active role not just in the development of the technology, but to also be involved in its ongoing governance and in public engagement.

But trust in science is complex. On one level, there is trust in the concept of science as a method for gaining knowledge. Then there is trust in scientific institutions, from universities to CRIs to industry-led research and beyond. And lastly, there is trust in specific scientists.

In the case of complex socio-environmental innovations such as the ones under consideration here, these three forms of trust do not always come together. There was near universal trust in the concept of science, but when it came to both institutions and specific scientists, who was trusted became more nuanced.

Of particular note are concerns over the influence of commercial interests on both science and the governance of technologies. This was most explicitly reflected in the phase 1 process that asked participants to name who should sit around the table to make decisions on the use and implementation of gene technologies for environmental purposes. While scientists received the highest ranking for being the sector group participants preferred to be present at the decision-making table (83.5%), industry was towards the bottom of the list (27.1%).

5.6 Insights for Innovation

When people are presented with technologies in context, it is not only feasibility concerns that are important to them. Certainly, people mentioned the issues of making the technology work, and work in targeted, well understood ways. But many groups were more concerned with whether the technologies would be economically viable, including in comparison to existing technologies, and whether they would be socially desirable, including through regulation and oversight.

In other words, the insight here is for people working in innovation not to stop at feasibility concerns, but to recognise that for the public, having a technology that works as intended is only part of the puzzle. For enhancing innovation that really works for society, awareness of viability concerns and desirability concerns need to be central.

This reflects international moves in innovation governance towards upstream engagement, ensuring the public is taken along the journey early on, so as to ensure that any innovation brought to market is not only technically feasible, but also economically viable within the existing business model and aligned with social norms, ensuring its desirability.

To ensure this alignment between the technical, the economic and the social, the dominant international framework has become ‘Responsible Innovation’ (sometimes called Responsible Research and Innovation). Most commonly, the process for achieving Responsible Innovation has required meeting the four AREA principles: Anticipate (consider what might come of the innovation, both good and bad); Reflect (consider the assumptions and motivations that go into the innovating process); Engage (engage stakeholders and the public upstream to see how the innovator’s visions align with the former's visions); Act (revise and / or refine the trajectory of the innovation based on the previous steps). The process undertaken in this project provides one way to enact the first three principles.

There are three key insights worth noting here. Firstly, scientists who this project spoke with who were working and researching in the gene technology area proved to be very much aligned with the Responsible Innovation perspective, though they often lacked the required know-how for implementation, both theoretically and practically. They expressed interest in and value for this project as a way to better understand what the public thought, cared and were concerned about, and wanted from their science for Aotearoa New Zealand's future.

Secondly, the public discussions were incredibly nuanced, balancing both the need for caution with the need to consider alternatives such as gene technologies. They suggested a myriad areas where innovator visions and public visions are not currently finding alignment. Crucially though, the project saw that there was an appetite and capacity from the public to meaningfully engage and help shape what safe and responsible innovation might look like.

Lastly, these public discussions were able to engage at different levels depending on whether the technologies were near at hand (where more focus was put on the specific of the technologies and their implementation, including what might be required for the public to accept the technologies), or further into the future (where more focus was on the inherent uncertainty of technologies and the greater need for caution and governance systems to keep the technologies on track). This suggests that the questions for responsible innovation will be different depending on how futuristic the technologies in question are.

5.7 Insights for Environmental Futures

Environmental aspirations and visions were a fruitful conversation starter for the initial Phase 1 conversations. However, across the four different environmental scenarios the implications of these visions played out differently. When thinking about gene drive for rats, the removal of rats (under a Predator Free lens) was a conservation driver for decisions, and given further support by an animal ethics argument. For RNAi technologies for myrtle rust, the environmental driver was the reduced need for chemical treatments like fungicides. For varroa mite and wilding pines, environmental visions were used as drivers of decisions, but much more seldom.

These hopes for positive environmental futures – with healthy trees, and fewer predators – were tempered with cautions. In particular, participants wanted to ensure that genetic technologies do not become the preserve of commercial interests and/or industry. To some extent it mattered who would bear the costs and benefits. Technologies that seemed likely to benefit the New Zealand natural environment for the common good, with costs borne by industry were perceived more favourably than technologies that might benefit industry with costs of externalities socialised. Where a technology could lead an industry to absorb the costs of what had previously been a negative externality (e.g. wilding pines), this was seen as a potential advantage.

5.8 Insights for Genetic Technologies

While they do not hold across all groups, there are some linkages between the characteristics of each genetic technology and the environmental problem that make it more or less likely for people to signal that they would be comfortable to include genetic technologies in the environmental management toolbox. As discussed in chapter 4 findings, people were more likely to support the inclusion of genetic technologies that would apply to plants rather than animals. Applications to food, or that could impact the food system, raised specific concerns for people.

How close to readiness/potential deployment the technologies are, mattered to participants. For technologies that were close, like RNAi for myrtle rust, people had a lot of questions about how they worked, but also whether they would be desirable, or they provided advice on how they could be made publicly desirable. For technologies that were further away, people had a lot of concerns about how they would be regulated.

Regardless of the type of organism or distance to readiness, containment was a key concern. This was often emphasised as a vital part of research so that trials were controlled, ensured for example by running trials on off-shore islands. Participants were also interested in ensuring impacts would be contained by the target species, and requiring a high level of confidence that the technologies would not impact non-target species. Containment was also mentioned regarding urgency, for example beginning use in the areas worst affected (e.g. wilding pines). Containment also came into discussions of how the technology should be applied, with applications that had more risk of non-target effects like aerial spraying being a matter of enhanced concern.

A sense that genetic technologies might be more contained than current tools was also a factor mentioned in their favour, especially when compared to chemical treatments which can be broad spectrum and last as residues in water, soil, and honey. For some scenarios, particularly myrtle rust, the uncontainable nature of chemical treatments was an argument in favour of genetic technologies.

Containment in one generation was important to people too, which lent RNAi technologies more support from some quarters than gene editing and gene drive. Technologies that would have intergenerational effects were seen as much more risky, having a ‘no going back result’.

Containment was a vital consideration for many people because of concerns that genetic technologies could have off-target impacts. These were seen as potentially impacting other species and, thus, disrupting ecological systems in unpredictable, uncontrollable ways. Further, off-target effects were seen as potentially changing the target species in unintended ways. This was expressed as a concern that instead of rescuing the environmental problem, genetic technology might make the target species stronger or more damaging to the environment.

Finally, containment issues were brought into consideration when thinking about Aotearoa New Zealand’s responsibility to the rest of the world. The possibility of genetically modified species entering other ecosystems where they were needed was recognised as needing consideration and regulation. This was framed, at times, as a precautionary principle of not causing harm to others while we attempted to solve our own ecological problems.

Beyond concerns about containment, people expressed important ethical concerns over genetic technologies, especially when the technology was presented in relation to current technologies. These were most obvious in the case of rats, recognising the need for extra consideration given to the needs of sentient animals. However, these considerations didn’t mean the ruling out of genetic technologies; rather they added another dimension to the weighing up of options. For many, current predator control tools like trapping and chemical poisons were seen as leading to animal suffering, a problem that was not raised in relation to varroa mite or to the flora scenarios.

Ethical considerations were further addressed by the caution expressed by some that there should be an ethics committee to oversee these technologies. Further, ethics were mentioned as an important element for public acceptability of the technologies. Time to readiness, containment, and ethics are shown to be important factors that impact how people assess the safety and responsibility of using genetic technologies for environmental issues.

5.9 Insights for Science Communication / Science Engagement

Genetic technologies are complicated. Underlying genetic technologies is the microscopic scale of amino acids in DNA up to the population scale of species. The technologies based on these scientific understandings are complicated further because of the various ways that have been developed to try to tinker with genetics at different scales and through different channels. These range from modifications of DNA, which would be heritable, to interventions in the expression of RNA as proteins, which would not. These are important distinctions but are not necessarily easy to understand or explain. Nor does explaining them necessarily impact people's feelings or beliefs about genetic technologies.

Many members of the New Zealand public have a sense that they, and people around them, do not fully understand genetics or genetic technologies. This may well be due in part to the absence of genetic tools being used in the country, and with the resulting lack of discourse about them in the public domain.

In Phase 1 of this research, it emerged that there was a desire among participants for more information about genetic technologies. This was expressed in exit surveys, asking for a 'general introduction on genetic engineering. What it is and the level of development NZ has', or for 'a bit more info regarding the different forms of genetic tech before starting the conversation'. But exactly how to go about providing such information in a way that is both clear and objective without introducing some form of bias is incredibly hard. Two main insights were evident in relation to science communication: language and content.

To begin with, language matters. There are specific terms that lead participants to understand and interpret the information in specific ways. And not everyone interprets the same information in the same way. Secondly, how the issue is framed, presented, and related to other topics and issues invites not only certain perspectives and discussions, but also, to some extent, invites (or dis-invites) certain participants.

In terms of content, there are important considerations over both the quantity and the type of information provided. Providing too much information risks overwhelming participants with volume and can introduce unnecessary confusion; providing too little may mislead or seem unprofessional. There are also questions to ask over the type of information that is appropriate, from the format to the specificity.

A key insight this project found was that information was best received, understood and made sense of when it was specific and contextualised. In particular, the use of information cards during the deliberation phase, along with the contextualising landscape and perspectives, provided a well-balanced basis for discussions.

A second set of key insights came from the tension between the requests for more information from participants and the long-argued-for recognition in science studies that assuming a public ‘deficit of scientific knowledge’ is problematic. For one thing, such assumptions of deficit can lead to failures to recognise the richness of public knowledge across domains and the richness of the publics’ broader values. Moreover, the ‘deficit’ model has been used in the past alongside fallacious assumptions that when people learn more about technologies, they are more likely to support their use. Indeed, research shows that when people know more, they often feel more strongly opposed to technologies.

For some people, this sense that they did not know enough about the complicated science was linked to a feeling that they were not legitimate opinion holders on the topic. Using games as part of the workshop process helped to support people’s feelings of legitimacy by broadening the conversations away from the technical side of technologies, and into the connected questions of trust in decision makers, ecological complexity, unknowns and unintended consequences, and the ethically and socially inflected journey of science. Games and facilitated discussions based on environmental values were important tools to support people’s sense that they had the epistemic legitimacy to speak.

There can be a difficult balancing act between providing enough to support confidence in deliberation but not so much that it was hard for participants to absorb. Even with this complicated science, almost all participants were able to use the information provided to develop rich and nuanced decisions and cautions. That one group wrote that ‘after much consideration the group decided that its ignorance of these issues prevented informed input' shows that it was possible in our methodology to refuse decision making on the basis of feeling epistemically illegitimate, and supports the presumption that other groups did feel epistemically legitimate.

It was important that the information was about realistic and feasible technologies. This was achieved by refining understandings of technologies with the help of genetic scientists. They also had to be appropriately contextualised, in terms of environmental issues, the socio political and ecological landscape, and in relation to varied perspectives. Embedding all these contexts helped to ensure that the technical information was experienced as only a part of wider conversations about visions for acceptable places for genetic technologies.

Putting all the above together, the insight, then, is that appropriate quantities of high-quality information remain important, but not straightforwardly so. For participants to feel legitimate to speak, a lack of information and feelings of epistemic deficit can be defused by contextualising technologies appropriately in the broader social, political, and ecological landscape, as well as framing the conversation in terms of the values and visions that animate decision making. This relates to noted concerns around epistemic anxiety and epistemic shame, the former is defined as "a doubt on whether it is safe for us to form (or maintain) the corresponding belief" (Vazard, 2018, p. 147) and the latter to the feeling of inferiority stemming from the acknowledgement of one's inadequacy, whether real or not.

While both shame and anxiety are often negatively perceived, there is increasing recognition that some level of these (in the context of epistemic endeavours) are healthy. In relation to epistemic anxiety, it has been noted that "this emotion supports our ability to adapt our cognitive activities to practical factors relevant to the task, by helping us to quickly identify high-stakes questions and invest greater cognitive efforts in their resolution" (Vazard, 2018, p. 141).

The insight for communication and engagement, then, is to provide enough information for the public to feel permitted to participate, without overloading them, to have supplementary information available if/as needed, and to allow their concern over how much they know to also drive the search for further knowledge.

5.10 Insights for Science / Social Science Education

The research's findings provide valuable insights for science education that call for future scientists to engage with social complexity during tertiary studies. Scientists operate in a complex world. Funtowicz and Ravetz (1994) stated that in complex societal issues "typically we find facts are uncertain, values in dispute, stakes high and decisions urgent" (p. 1882), and their conception of science for such complex problems was one that involved politics and values as much as science (see also Ravetz, 2006). To engage effectively in this complexity requires a mindset and skills beyond technical and scientific expertise.

The technology transfer model that favours a top-down approach to science innovation carried out in isolation from communities is problematic in this environment of complexity. In general, participants had high levels of trust in science, and people wanted scientists to play a key role in science governance of gene technologies. They also wanted scientists and their research to be more visible, to engage with the public and to be transparent. There was also a sense in Phase 1 discussions that since the Royal Commission into Genetic Modification in 2001, scientists working in gene technology had been largely invisible. There was a very strong call by participants for scientists to engage with the public. While participants discussed management of risks through containment or regulation as being central for any introduction of genetic technologies in New Zealand, they valued science research being conducted in New Zealand, and cautiously called for a loosening of current restrictions to enable science research to be fully conducted in New Zealand, particularly in the wilding pines scenario.

In addition to their strong disciplinary knowledge (clearly needed for genetic research), the research shows that scientists need transdisciplinary mindsets and skills that value collaboration, reflexivity, respect and participatory and co-design methods of engagement with people beyond the science and technology sector. Public acceptance and contested science went hand in hand, and participants overwhelmingly felt there is a need for scientists to work with communities and to take them along on the innovation journey. This approach embraces a responsible approach to innovation beyond the idea of 'gaining' social licence, to one of building ongoing, trusting and inclusive relationships with diverse communities.

In addition, the research provides insights to the social sciences. Communities were often very unsure of what social science did and how it operated. A number believed social science in this research sought to provide scientists with a social licence to operate so they could simply do their genetic technology research. They came to the Phase 1 workshops expecting to be educated about gene technologies, seeing themselves as audiences for scientists waiting to be granted a social licence. They were surprised to find their voice and knowledge were valued. Using innovative methodologies such as playing serious games was particularly useful, as it raised people's sense of epistemic worth as valid and valued knowledge holders in their own right. It also had an additional and unintended benefit of people seeing the role of social science through the games that touched on wider social and cultural aspects of innovation.

5.11 Insights for Deliberative Processes / Insights for Practice

How can a workshop enable communities' voice in decision-making? While there are many models and processes for dialogue and discussion, these are not necessarily useful for or directly relevant to decision-making. It is not only important to recognise that the public hold a range of views and perspectives; one also needs a set of perspectives that speak directly and intentionally to decision-making.

What the methods of this project showed was how effectively a clearly policy focused discussion led to a useful deliberation - and in turn, perspectives that engaged with desires for policy making. The process of asking participants in phase 3 to answer what tools they wanted in the environmental management toolbox pushed them to engage with various tensions decision-makers regularly face, having to trade off financial viability with environmental decline with social acceptance and more. Key to this was the specificity of the process. Two main points need to be highlighted.

Firstly, making the focus of the deliberation about which tools the participants wanted and under what conditions placed participants in the shoes of decision-makers. This was key to naturally guiding the discussion towards the kinds of perspectives that help shape decision-making.

Secondly, the process required each group to come to a consensus. What this did was push participants to engage beyond their comfort zone, but in a collaborative manner. The time limit was crucial in setting boundaries, and the possibility to have cautions alongside decisions allowed for nuance and more than yes/no answers.

Key insights here are that structuring the discussion in the right kinds of ways is essential to enable conversations that are useful and relevant to decision-making. The right kinds of ways include, at the very least, an outcome directed question that places the participants in the shoes of decision makers, and a process that invites robust but collaborative decision making, even if this is uncomfortable at times for participants.

Deliberative processes are an appropriate way to approach genetic technologies for environmental or conservation use, because both genetic technologies and the natural environment are sites that cluster meaning for human values. People might have strong views on genetic technologies, motivated by collections of attitudes about technology, science, whakapapa, tikanga, unknowns, social good, ethics, and beyond. They might be in support of research into the use of genetic technologies, in opposition to, or a more nuanced in-between. In addition, the natural environment is connected intimately with how people choose to live their lives, and is central to how they imagine the future.

People need to be given the opportunity when considering genetic technologies to engage in discussions that enable the technologies to be framed in terms of broader conversations about values and visions, with conversations then narrowing down to the role of the technologies within those visions.

5.12 Summary

The purpose of this research was to explore New Zealanders' perceptions and concerns about the possible role that genetic technologies could play in addressing environmental and conservation issues. To do so, we have engaged in lengthy dialogue and deliberations with hundreds of people across Aotearoa / New Zealand.

To respond to the call for more dialogic and deliberative approaches to explore New Zealanders perspectives about gene technologies use for environmental / conservation purposes, this research developed a comprehensive methodology using a three phase process, referred to here as the **ERD** process:

- **E**xplore
- **R**efine
- **D**eliberate

This research shows that in most cases carefully designed dialogic and deliberative processes can enable people to reflect on, listen to, share, develop, evaluate, re-evaluate and, in general, reach consensus decisions about contested and complex socio-environmental issues. Importantly these processes provide ways forward for grappling with the inherent complexities in socio-environmental issues, such as genetic technologies.

This methodological process has shown that New Zealanders can engage in deep conversations about socio-complex scientific issues that are also very technically challenging. The process supported people to overcome any sense of epistemic anxiety or inadequacy they had about engaging in complex conversations, particularly when they saw that these conversations are fundamentally about the type of world they want to live in.

The research has found that people want to have conversations about environmental futures, and appreciate the opportunity to share their perspectives and engage with those of others. These conversations have provided a rich understanding of people's nuanced and careful decision-making, considerations and cautions, particularly around four specific environmental scenarios: varroa mite, wilding pines, myrtle rust, and rats.

These conversations should assist decision-makers to more deeply understand what **safe** and **responsible** innovation may mean to New Zealanders, as they contemplate 'harnessing' the potential of genetic technologies in the natural environment.

PART C

Māori Engagement Stream

This research has two separate but complementary research streams including:

- General Public Engagement
- Māori Engagement

Part C contains three chapters relevant to the Māori Engagement Stream including:

- Māori Engagement Methodology
    - Introduction
    - National Survey
    - Māori Group Discussions: Genetic Technology Scenarios
- Māori Engagement Findings
    - Genetic Technologies for Environmental Protection
    - Survey Findings: Support or Opposition to the Use of Genetic Technology
    - Results from Group Discussions
- Māori Engagement Insights
    - Introduction
    - The Unknowns of Genetic Tools and Technologies
    - Regulations: Tikanga, Te Ao Māori, and Māori Involvement
    - Whakapapa and Its Implications for Genetic Technology
    - Urgency and the Use of Genetic Technology
    - The Importance of Education, Training and Information Sharing
    - Conclusion

6.0 Māori Engagement Methodology

6.1 Introduction

Two methods were used to gauge Māori attitudes to, and beliefs on, genetic technologies. A national survey was first undertaken and the full report is published at https://www.ttw.nz/_files/ugd/522737_d8fcd65237154166b28a4607db470a8d.pdf with a brief overview of results given below. To add to these important insights, a series of group discussions were held in Ōtautahi to coincide with a Predator Free symposium (October 2023) where attitudes, motivations, and cultural nuances underpinning comfort and discomfort to genetic tools in biosecurity were explored. Participants included Māori researchers and academics, community members and kaumatua active in biosecurity, and the results from these discussions are presented in section 7.3.

6.2 National Survey

TTW's survey assessed Māori and Pākehā comfort, influences, and trust with genetic technology for pest control and environmental protection. This survey was also designed to gather data on general biosecurity and pest control attitudes, influences, and decision making, as well as Predator Free 2050 (PF2050).

The survey was published using SurveyMonkey and was open from July 9th – August 27th, 2023. The link was distributed through TTW networks and a paid advertisement on Facebook to recruit respondents. It was also distributed through TTW's newsletter and shared on Twitter. Lastly, it was sent to the TTW biodiversity network, and they were asked to spread the link (i.e., snowball method). Anyone who lived in Aotearoa New Zealand was eligible to participate.

The survey received 537 responses and 26% of the sample self-identified as Māori, with the remaining 74% as Pākehā. The respondents were spread relatively evenly across

Aotearoa and the majority self-identified as a woman (74%; compared to 21% men). The average age of Māori respondents was 46 (ranging from 21 to 74), and the majority of Māori respondents were actively practising kaitiakitanga at place (74%). An incentive draw for one of three $250 gift cards to New World was used to help boost participation.

To better analyse attitudes and deciding factors, Māori and Pākehā answers were separated and compared to one another. Results from Māori respondents are presented in this report along with data comparing Māori with Pākehā respondents. An overview of key survey findings is presented below and interspersed with key findings from the results from our group discussions where appropriate. Interested readers are directed to the full survey report which is supplementary to this report and provides additional context to the themes described in this report.

6.3 Māori Group Discussions: Genetic Technology Scenarios

The opportunity to discuss with senior Māori researchers and kaumatua was a unique opening within the Indigenous biosecurity space to explore the diverse views that had been surveyed earlier. The discussions were structured around five scenarios that were created to reflect developing genetic technologies relevant to pest management, with scenarios composed as if they were being read as a news article or social media post.

Each scenario was displayed on a screen and read aloud. Participants' comments were recorded beginning with first reactions and then delving into the ideas that opened up in discussions with explanations of the tools and prompts, asking again whether participants were comfortable with the potential tool, and why, or uncomfortable and the reasons for any discomfort. Scenarios were intentionally designed to include pests, taonga and other native species, and the human food chain.

The group discussion scenarios were designed to be short, sharp, and accessible. It was assumed that participants would have varying levels of knowledge about the tools used in each scenario, with many having limited knowledge. To mimic what participants might encounter in real life, each scenario was presented (in a couple of sentences in length) and participants were asked for initial reactions. Some of the technicalities were then explained behind each tool and participants were again asked for reactions to see if their comfort had changed by knowing more about the tool in question. Scenario timelines and type of species (pest or native) were changed to see how this influenced comfort levels. Selected results from this design are presented below.

7.0 Māori Engagement Findings

7.1 Genetic Technologies for Environmental Protection

To match the design of the scenarios and ensure the factors driving the comfort or discomfort with each scenario was understood, each group discussion scenario was analysed separately. When put together, however, there are several common patterns that appear to be driving attitudes and thinking at a higher level. Therefore, the results for each scenario are presented separately to outline how the changing circumstances in each scenario did or did not change participants' comfort. General themes across all scenarios are introduced throughout and summarised at the end of the results section.

While there is confidence that the findings stretch across multiple contexts and communities, it is acknowledged that results are representative of those who responded to the survey and the group discussions, and so advise against blanket generalisation of these results to all Māori across the country. These results can guide initial conversations and understandings and provide direction for community consultations. However, additional consultation with Māori communities is a necessary step for any proposal using genetic technology.

7.2 Survey Findings: Support or Opposition to Genetic Technology

To gain a broad understanding of perspectives on genetic technologies, the following open-ended question was posed to respondents in the national survey:

> **What is your opinion on using genetic technologies as a way to control pests and protect the environment? In your answer, please explain the reasons why you do or do not support the use of genetic technologies.**

A total of 458 responses were received to this question. Māori and Pākehā responses were analysed separately. Findings show that Māori were relatively split between being supportive of the use of genetic tools in pest management and environmental protection and being against it. There were also many respondents who chose not to volunteer a perspective for or against because they were too unfamiliar with genetic tools or wanted additional research on them, a finding that is supported throughout the Māori engagement stream of this project. In the quantitative analysis 44% of Māori respondents indicated that they supported the use of genetic tools in pest management and to protect the environment. In contrast, 25% of Māori respondents did not support the use of genetic technologies and 27% said that they weren't sure if they supported the use of technologies. When combining this with the percentage of respondents who did not support the use of genetic technology, the percentages are nearly split down the middle (50/50), with Māori respondents less likely to support their use (a combined 56% either against or unsure).

Questions also aimed to explore participants' comfort with various genetic technology tools, who is most trusted to give information on genetic tools, as well as the factors that most influence people's decisions to protect the natural environment. Analysis suggests the following play a role in overall attitudes and behaviours towards genetic technology.

A list of potential ways to trap pests was created, some of which were genetic technology tools, and respondents were asked to give their comfort rating for each. The scale used for this question was:

1. Should never be used under any circumstances
2. Should only be used as a last resort
3. I'm uncomfortable with this method but will accept it with appropriate controls
4. I am comfortable with this method if appropriate controls are in place
5. I have no concerns at all about this method
6. I don't know

To enable comparisons to be made, the graph below shows results when you combine a 4 and 5 (reflecting more comfort) and compare it to a 1, 2, and a 3 (reflecting a general lack of comfort). This type of analysis twas then used to compare comfort levels between Māori and Pākehā respondents. In general, Māori respondents were less comfortable with many of the genetic technology techniques that were listed (e.g., pheromone technique, trojan female technique, gene drive technique, genetic editing). Those that had the largest differences in comfort were genetic editing that result in most offspring being male (54% of Māori were uncomfortable compared to 43% of Pākehā respondents), and selective breeding that results in infertile males (45% of Māori were uncomfortable compared to 29% of Pākehā respondents). It should be noted that both groups were quite comfortable with trapping and hunting methods of pest management, and both were more comfortable with poison bait laid by hand as compared with aerial distribution. In general, both groups were also less comfortable with genetic technologies to control pests as compared to methods that do not use genetics (e.g., hunting, trapping, poison, pheromone technique).

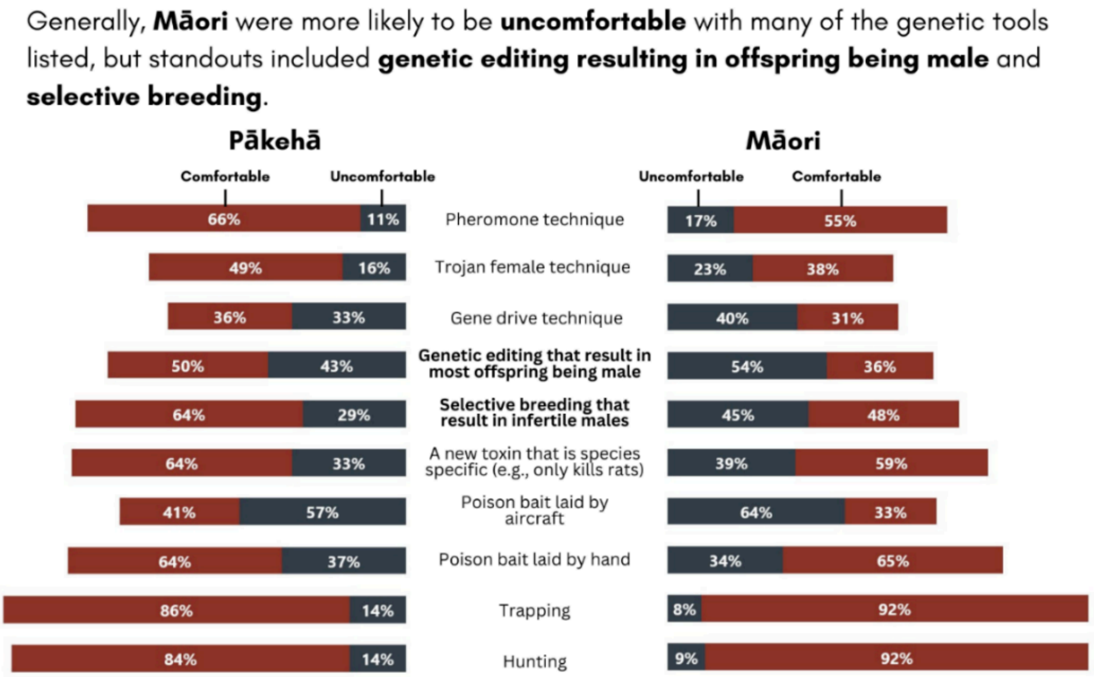

Figure 7.1: Comparison of Māori and Pākehā comfort with different pest management methods

Breaking down these results further, a clearer picture emerges around comfort levels and knowledge of genetic technologies. For both groups, it was common for respondents to answer 'I don't know' for questions about genetic tools (e.g., 39% of Pākehā indicated they 'didn't know' for the trojan female technique). This suggests a general lack of knowledge about these genetic tools. This could be driving some of the discomfort but may speak to the need for additional education about what the genetic tools are, what they do, and how they are applicable in Aotearoa. Additionally, the percentages below also show the contrast in the number of respondents who have no concerns with a method vs. those who are comfortable if there are appropriate controls.

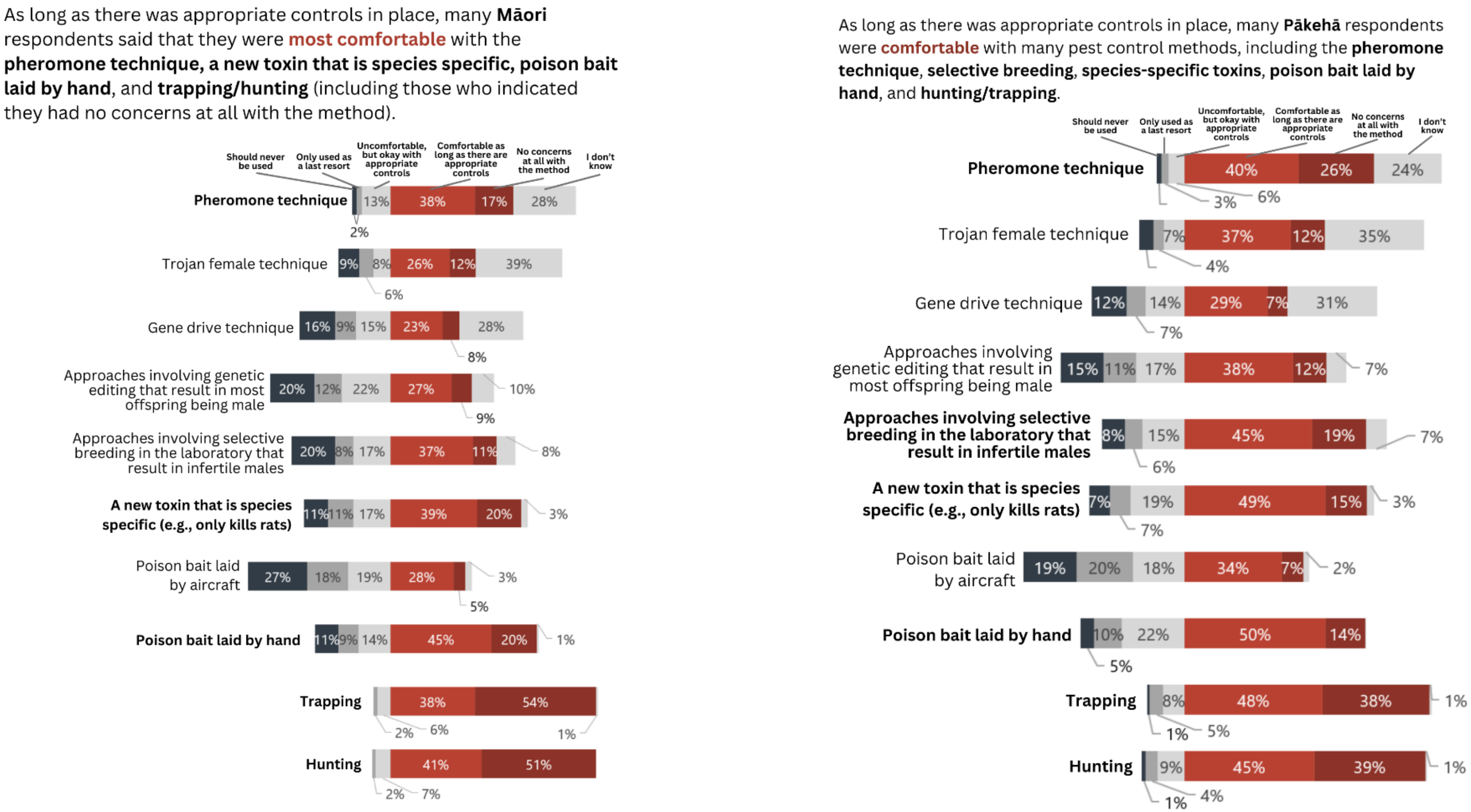

Figure 7.2: Comparison between Māori and Pākehā preferences for hierarchical levels of control ranging from 'No concerns' to 'Should never be used' to be applied to different pest management methods.

To determine what the best type of communication of such tools would be for the public, respondents were asked to indicate how much they trusted various sources to provide information about a new genetic technology tool. They indicated this on a scale from 1 (strongly distrust) to 7 (strongly trust). The graph below reflects the percentage of respondents who selected a 5 (somewhat trust), 6 (trust), or 7 (strongly trust). Percentages between groups were quite similar, with scientists being the group that both groups trusted the most to give them information on genetic technologies (82% for Pākehā respondents; 73% of Māori respondents). However, for Māori respondents this was closely followed by Iwi leaders or authorities (70%), while only 46% of Pākehā respondents trusted this source, a difference of 24%). Both groups trusted religious leaders the least, followed relatively closely by news media and elected officials.

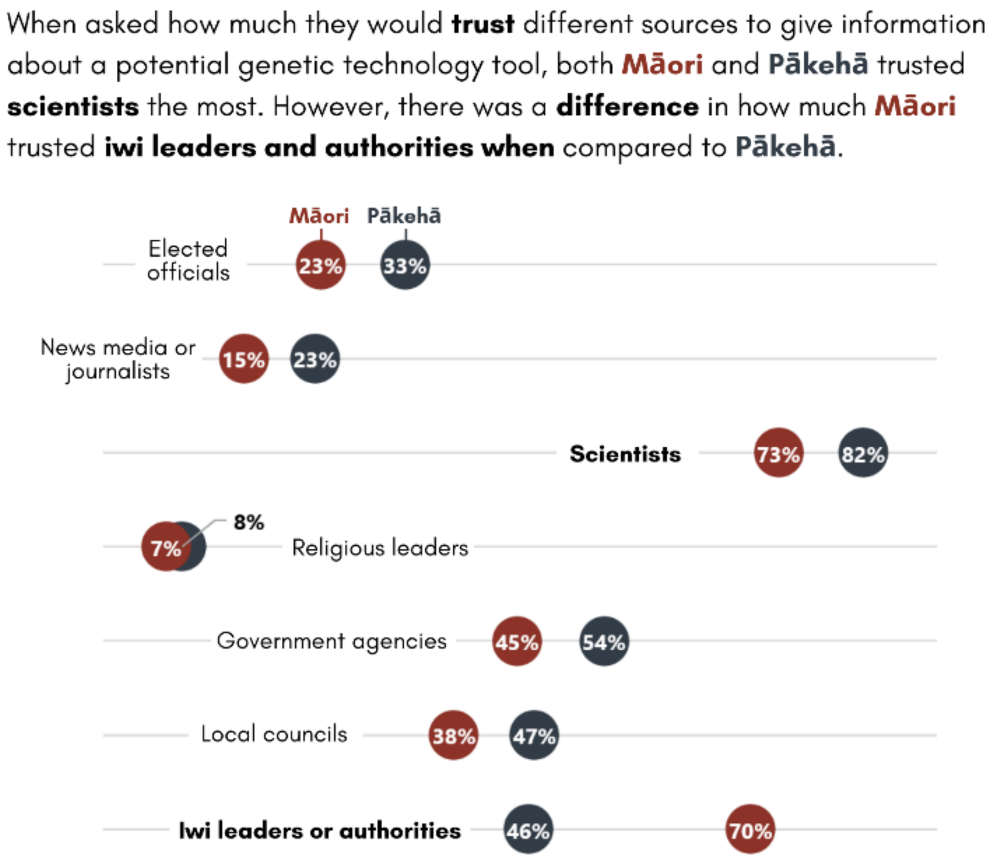

Figure 7.3: Comparison between Māori and Pākehā trust of different sources of information about genetic technology tools.

7.3 Results from Group Discussions

To assist understanding of how the design of each scenario affected participants' responses to it, and to illustrate how comfort levels varied across circumstances and contexts, each scenario is presented with the following information.

- the tool utilised
- the scenario text
- the key elements of the scenario
- scenario findings

7.3.1 Scenario 1: De-extinction

Bringing back the Huia

Full scenario text

> After discovering the remains of a Huia, scientists reveal that it is possible to bring it back from extinction. Using DNA from those remains, they propose modifying a kōkako so that its offspring are genetically identical to the Huia.

Key elements of this scenario

- native species (taonga)
- animal
- would not happen 'naturally'
- non-reversible once you reach population levels.

Scenario findings

For many participants, this scenario brought discomfort. Participants brought up the fact that the huia went extinct in the early 20th Century and reasoned that today's ecosystems are different to what they were back then; many argued the environment is in a worse state. They questioned how the huia would realistically survive in ecosystems full of invasive species (e.g., possums, stoats, and rats). When presented with an opportunity to bring back a long-extinct taonga species, participants' first thought was often of protecting it and seeing it within a wider ecosystem (i.e., as a part of a bigger system rather than a single bird). When taken together, this reaction is evidence of the responsibility participants felt as rangatira and kaitiaki living on this land. This is because their immediate concern with this technique would be the wider effect it would have on the ecosystem and the well-being of the huia, not that it would be great to have a taonga species back in the environment. Participants described this by saying:

> *"With regards to extinct species, they went extinct because we changed te taiao. And from a kaitiaki perspective, I'd be really uncomfortable in bringing any species back when we haven't fixed the issues that we have with the taiao. Even if we took the kōkako out of this equation and we were looking at more of a surrogacy-type gene modification where they laid huia eggs and raised them, I'd still be uncomfortable because we're bringing that species back into taiao that can't support it."*
>
> ***Group Discussion Participant***

> *"There's something that is stopping me from feeling comfortable with it, and I think one of those things is the fact that the way that land is so completely different to when they were here, that they potentially wouldn't have developed the right evolutionary things to sustain themselves or to stick around for any period of time."*
>
> ***Group Discussion Participant***

> *"It was around a hundred years ago, and its home has had a hundred years of changes through it so where do we put it back, some museum or some zoo, what are we bringing it back to?"*
>
> ***Group Discussion Participant***

This sentiment was backed by survey results, where Māori and Pākehā rated four common considerations for pest management from the most to least important. A noticeable difference between the two groups was that Māori had the wellbeing of native taiao ecosystems as the most important factor to consider (on average), whereas Pākehā respondents rated that third. For Pākehā respondents, the involvement of hau kāinga (people of the marae) was the most important (it was rated as second most important for Māori respondents). Additionally, the second most important factor for Pākehā was income for hau kāinga, whereas Māori respondents rated that as the least important factor when planning pest control activities. Taken together with results from the group discussions, this is further evidence that Māori respondents' attitudes are based in the well-being of the environment and their responsibilities tied to that.

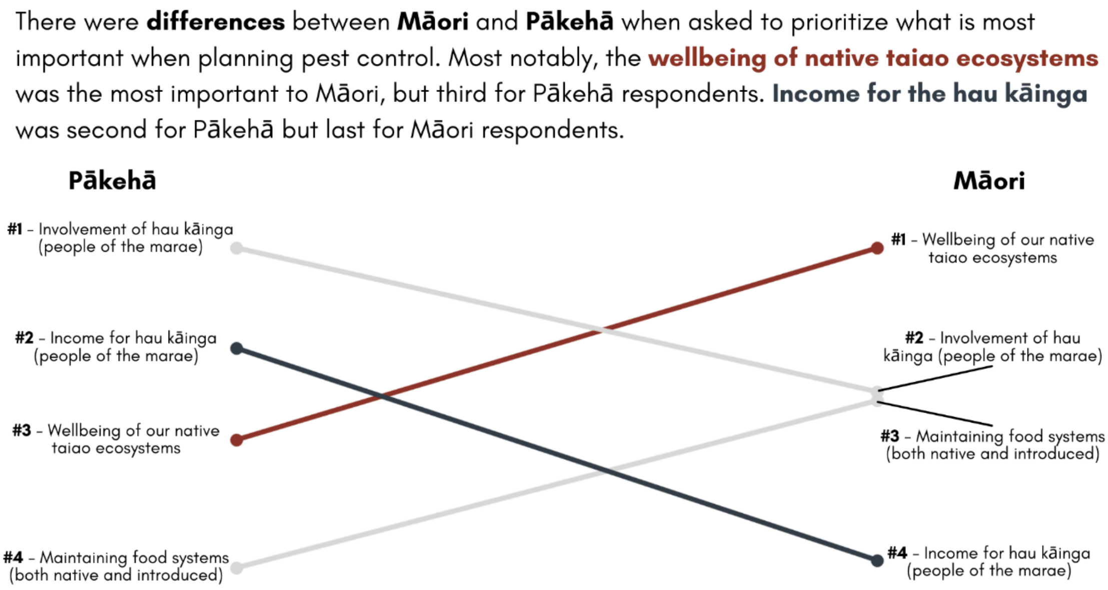

Figure 7.4 Comparison between Māori and Pākehā prioritisation of key considerations when planning pest control.

Another factor driving discomfort in group discussions was the perceived amount of resources needed to successfully bring back the huia. This was often contrasted with current environmental efforts, which are stretched for capacity and generally lacking the resources they need to be successful. As to the responsibility participants' felt, they questioned the use of resources to bring back an extinct species when many species around today are endangered and that there are many other, perhaps better, places to allocate resources (e.g., pest control):

> *"I'm not comfortable with it because you can't even look after what we already got."*
>
> ***Group Discussion Participant***

> *"Just for me, it's just a little bit before the horse in terms of priorities. I would want to get rid of pest numbers first before we start introducing an extinct species back into the ecosystem."*
>
> ***Group Discussion Participant***

> *"It's a wasted effort for something that won't be sustainable when we have an obligation to deal with what we already have and not focus on these things that are gone. We've got kākāpō and stuff that need the attention… it's not on the cards for us."*
>
> ***Group Discussion Participant***

To test these two themes, TTW facilitators would often change the scenario in the middle of the discussion by introducing the hypothetical extinction of a species around today. Specifically, participants were asked to gauge their comfort if this tool was used to bring back the kea who, in the scenario, was wiped out by the avian bird flu overnight. In these scenarios, some individuals felt more comfortable because they knew the kea could survive in the current environment and because they are important for other species and people around them. Noting that other alternatives would need to be explored first (e.g., storing embryos until wānanga on its extinction could happen), that strict regulations would have to be in place, and tikanga processes would need to be followed, some noted their comfort with this change by saying:

> *"I guess once you bring it into the context of something that we've all seen, that makes it, I guess, a little easier to think about in the modern context. I think, because I love kea, I'd be quite supportive to see them return because I'll miss them when they're gone, right?"*
>
> ***Group Discussion Participant***
>
> *"Yes, it's a good answer for me. It's a knowing whether we should, but having the technology to be able to preserve as we go through a process to the edifying, should we? Sure. My comfort level is definitely different to introducing a species that has died out in the past for whatever reasons."*
>
> ***Group Discussion Participant***
>
> *"I would agree. I mean, its environment is still here and let's see… I don't really have an issue with it, I'm very comfortable doing that. I'd argue that's a really good use of that technology."*
>
> ***Group Discussion Participant***

Some participants also spoke about how their comfort around this change in scenario was still framed around their responsibilities as protectors of the environment and that they were only comfortable with using this technology as a last possible resort:

> *"I think for me, this is that it's more about things that we as humans and Aotearoa have had an impact and had an involvement in their extinction. I think there's an element of responsibility that goes with that. I guess I'm kind of looking at it from that timeframe."*
>
> ***Group Discussion Participant***
>
> *"You'd need to make sure that you had appropriate tikanga around that. And you'd need to make sure that these manu [birds] are released into an environment in which they can thrive. Otherwise, what's the point? But I think for more modern extinctions, which are very much human driven, I would feel more comfortable with that, but only as a last resort."*
>
> ***Group Discussion Participant***
>
> *"I think only as a last resort. There must be other things that can be done to protect the bird 'flu rather than genetically modifying."*
>
> ***Group Discussion Participant***

This was backed when the scenario returned to the huia, as participants stated that a condition of their comfort was strict regulation of the technology, underpinned and intimately guided by the uncompromising inclusion of tikanga and te ao Māori. This is something that is common across all scenarios, and will be discussed in detail in the overall reflections, but reflects the idea that tikanga processes already exist that could theoretically deal with scenarios like this one. If all options had been exhausted, and 'natural' solutions were chosen before genetic ones, then some individuals expressed support for the idea as long as tikanga had been followed. Once again, participants explained they would only be comfortable if it was proven that bringing the huia back would have great benefit for the forests and broader ecosystems:

"Yeah, I think you have to put a process. In te reo Māori, it's called tikanga. tikanga is the right way of doing things. So, I take all those kōrero that are just being said, and we need to decide why we're doing it, what's the purpose, and if we are going to do it, then we must make sure that we practise that kaitiakitanga to the T, so that we know all the angles, spiritually, physically, and environmentally, culturally, all of those things. So really, it needs to be led by te ao Māori...to protect all of those processes. And if we come to the agreement that we don't want to do it, then we don't do it."

Group Discussion Participant

"I have no problem with exploring this so long as our tikanga is followed to the letter and making sure that tapu and noa are part of the process of developing the process for this to happen."

Group Discussion Participant

"For me, the 'why' would be that the ngahere needs huia. It has nothing to do with people, it's all about the ngahere and the ecosystem. So, if there was an identified gap, if we looked at the taiao and all the whakapapa intergenerationally, if we can pick up that maybe something else where our chain reaction was set off because the huia disappeared and we could identify the potentiality that if we brought that huia back, then that chain would be broken and rehabilitated and so forth. So, it would all be all about the ngahere and not people centric."

Group Discussion Participant

7.3.2 Scenario 2: Genome Editing

Mānuka and Pōhutakawa Resistance to Myrtle Rust

Full scenario text

In an effort to save trees in Aotearoa, scientists have discovered that it is possible to make species such as the Mānuka and Pohutukawa resistant to myrtle rust by editing the genetic information of those species.

Key elements of this scenario

- native species (taonga),
- plant,
- could happen ‘naturally’,
- non-reversible.

Scenario findings

As with the first scenario, participants were often uncomfortable with the content of this second scenario. Many stated that they were uncomfortable because they did not fully understand what the consequences of changing the genetic information of Mānuka and Pōhutakawa would be for the trees themselves and for the broader ecosystem. Specifically, some were concerned that by using this tool, it could potentially change the make-up of the Mānuka and Pōhutakawa species. In parallel to the de-extinction scenario, participants almost always preferred natural solutions to deal with myrtle rust over genetic modification:

> *“But probably not direct gene editing because especially with plants, it's really difficult if you edit one gene, quite often something else gets changed. If it was gene drive to a natural stable mutation, then I'd feel comfortable with that.”*
>
> ***Group Discussion Participant***

> *“From a practitioner perspective, I think it would have a huge amount of application. But again, I'd want to know what that does to the health of the plant. Because it's putting all of its energy into fighting off. Because the bioactives that produces that fight off myrtle rust aren't specific to myrtle rust. It's also what allows it to detoxify E. coli contaminated soil. And from a stormwater, wastewater perspective, it would have huge applications to do something like that. But yeah, what's the overall impact on the forest for that would be my question?”*
>
> ***Group Discussion Participant***

> *“Yeah, I tautoko all those kōrero. For sure. Natural is the best no matter what. Natural immunisation is the best. It's better than genetically tampered with modified immunisation. So, anything to do with editing and splicing genes is a no-go zone for me. We need to do it naturally.”*
>
> ***Group Discussion Participant***

Further, many survey and group discussion participants spoke of how there are existing mātauranga and biodiversity methods that could and should be used long before any genetic tools are considered. This is an indication that, while genetic technologies could be a tool to manage incursions, many believed it wasn't an overly necessary or needed path to go down. Instead, they would rather rely on proven methods of resistance for the plants and only in the most urgent of situations would this be considered:

> *"I think it would definitely have to be a last resort type of thing. Yeah, you are messing with the whakapapa. And even though, that bouncing back is like... That will be genetic changes, but there's a difference between selective breeding and letting the ones that are resistant propagate and actually going in there and changing things. That feels quite another step that you'd only be wanting to do that if it was really, really necessary."*
>
> ***Group Discussion Participant***

> *"Yeah. If the research has been done and there's no mātauranga in that space to support an alternative approach, then great. Go this way."*
>
> ***Group Discussion Participant***

> *"But also in this scenario, both those, so the manuka has its own rongoā that it creates to deal with myrtle rust and that rongoā can be applied to pōhutukawa in an external factor. Again, I would want to see gene editing of the pōhutukawa as a last result resort and maybe looking at topical application of... A manuka oil fungicide spray is the first resort for that."*
>
> ***Group Discussion Participant***

> *"I don't hold much knowledge about genetic technologies, I am interested to learn how genetic technologies can be effective without harming or changing our native species that still exist... I believe as a kaitiaki of our taiao and as a harvester and user of our native species there are more natural approaches of eradicating invasive species, if only those who work in environmental spaces through tikanga and kawa like myself had more resources, financial support, and opportunities to create a better approach I believe there are other options."*
>
> ***Māori Survey Respondent***

“We have created the problem through intervention we viewed as best based on limited knowledge. Therefore, I am against the utilisation of genetic knowledge as an answer. We need to use old skills and tools we understand. Not those whose future outcomes we cannot quantify.”

Māori Survey Respondent

To support this and to provide a contrasting point to the first scenario, the only factor that appears to be driving comfort for the use of genetic technologies in this scenario is urgency. That is, if all mātauranga-based solutions had been explored and the plants still faced imminent extinction, then the greater good of saving the species took priority over the discomfort of using genetic technologies. Participants said this would be further amplified if they one day knew all the potential consequences and impacts editing the mānuka and pohutakawa would have. Unsurprisingly, urgency was a key factor across all scenarios that often overrode the hesitancy people felt to use genetic technologies. If it meant the survival of a taonga species, then individuals were more likely to accept its use (with the conditions its application followed tikanga and the tool was heavily regulated). For example:

“Yeah, I'm totally comfortable with this, but agree with [name], seeing as how he said it, that mātauranga Māori should be a first port of call. Yeah. Especially if it's working.”

Group Discussion Participant

“But I think that's obviously the biggest consideration is, ‘Are we absolutely sure that what we are doing isn't going to have follow on effects down the line in 10, 20, 1500 years, 200 years?’ If we are confident, then sure.”

Group Discussion Participant

“But I think for this particular question, I'm more than comfortable if we are able to support the return of te waonui a tāne through a method such as this. But I think, simultaneously, the kōrero has to be had, why haven't we approached mātauranga Māori first to try, at least to try, given that we can see that mātauranga Māori has had insane impacts to areas of science.”

Group Discussion Participant

> *"I'm comfortable with it mainly because we've lost two three species, our native myrtles from home, so not going be prepared to sit by in random chance that they're going to get some natural resistance through them…so yeah, time. There's a real sense of urgency to this…a lot more comfortable with this one than the last one."*

Group Discussion Participant

This was supported by survey results, where supporters of genetic tools saw it as the best chance to protect taonga species. It's important to note that these respondents were not completely comfortable with the tools but, similar to group discussions, saw it as the best way to manage pests and protect the environment if all other options had been exhausted. In other words, they saw it as a tool for the greater good that could protect key species and could lead to the outcomes they desired:

> *"Yes, if it is the best option of protecting taonga species. Taonga species have whakapapa to Aotearoa and tangata whenua have whakapapa to taonga species…a continuing loss of taonga poses serious threats to the identities of tangata whenua/iwi/hapū as much of our identity is derived and learnt from te taiao and many species. Further loss will have implications on our knowledge systems."*

Māori Survey Respondent

> *"I'm on the fence here a bit - but I guess where it is the only alternative to ensure survival of a native species or is important to our biodiversity, I would be in favour."*

Māori Survey Respondent

> *"If we could eradicate rats, stoats, and possums this way without risk to other species I would be totally in favour. I want my tamariki to hear the dawn chorus and have heard it increase as a result of pest control in our area."*

Māori Survey Respondent

7.3.3 Scenario 3: Sterile Insect Technique

Fruit Fly Invasion

Full scenario text

Fruit flies have been deemed a threat to Aotearoa and researchers discover that any incursions can be countered by releasing swarms of infertile male flies near the incursion. Scientists make them infertile by using radiation that damages their chromosomes and prevents them from being able to successfully reproduce. As they mate with the fertile female flies, both swarms would die relatively quickly because there are no offspring.

Key elements of this scenario

- invasive species
- not actually a genetic tool (uses radiation)
- wouldn't happen 'naturally'
- swarm presence is reversible, but release is not.

Scenario findings

This scenario was intentionally created to test comfort with a tool that seems like it is a genetic technology but technically is not. It was also the first to use an invasive species, which shifted comfort levels amongst participants to use the technology. The fact that fruit flies are not native to Aotearoa and its damaging effects are generally known, meant that participants were more likely than not to be comfortable with using the technology in this scenario:

"I'm pretty comfortable with this one. I don't really have a problem with this one. Because for me, I guess there's a few elements to it. One is around them being fruit flies and there's something that's not, as far as I know, they're not native to New Zealand."

Group Discussion Participant

"I have no issues at all, for many reasons. One is you're dealing with an exotic species that's invasive and it's going to have massive impacts to Aotearoa in many probably different and unforeseen ways."

Group Discussion Participant

In contrast to the other scenarios, participants were often more comfortable with this scenario because they believed that it had lower risk and was more targeted than the previous technologies (i.e., it had less risk to affect other species and ecosystems). This was one of the main points of contention in the previous two scenarios and knowing that the fruit flies would die out quickly and that native ecosystems would be untouched helped to ease concerns. In other words, low levels of risk, the ability to precisely target species, and the short time frame made this scenario more comfortable for participants:

> *"I'm the same. The only impact on the utilisation of this is on the pest species that you're wanting to target. You can't really get more selective than that."*
>
> ***Group Discussion Participant***

> *"I'm pretty comfortable with sterile insects because of the way that they're created. You're not going out and irradiating a whole bunch in nature, and therefore you'll accidentally get some unintended species as part of that. That that's done in a very controlled fashion."*
>
> ***Group Discussion Participant***

> *"Well, these are much more targeted. It's a lot easier to be targeted. You can be a lot more certain that what you are doing is only affecting the organism that you're targeting."*
>
> ***Group Discussion Participant***

Comfort was also driven by previous and new knowledge of the tool. To clarify, participants were sometimes already familiar with the sterile insect technique and, for those who were not, the way the scenario was written helped to demonstrate the consequences and a clear purpose of using it (i.e., the swarms of invasive flies would die out). Combined, this meant that this scenario contained the least amount of 'uncertainty'. Most knew that the tool had worked in other parts of the world and had minimal, if any, impact on species around it. Therefore, it was seen as a useful shield for future fruit fly excursions:

> *“Yes, absolutely. And I think that the method, the approach, the kind of disruption of the reproductive cycles in this kind of method is when I know that's something that's been used quite a lot already, and I haven't seen any major unintended consequences from it, 'cos it's quite especially specific.”*
>
> ***Group Discussion Participant***

> *“I'm personally comfortable with this one because it has a really clear purpose. Fruit flies are a pest, and they affect a whole bunch of things in a negative way. I'm not aware of any positive impacts that they have… so for me, this one's clearly different to the other two scenarios.”*
>
> ***Group Discussion Participant***

> *“I personally prefer this scenario because for me, this one in theory on the face of it, is less likely to have impacts on other species, whereas toxins aren't... Well, yes, they can be selective to some degree, but for me it's all about the impact on other species…this feels targeted.”*
>
> ***Group Discussion Participant***

Further, some participants commented on how this seemed like a humane, practical tool that would be useful across the country. It was also seen as a good alternative to toxins and sprays:

> *“I prefer these methods, gene drives, those things over the current approach of poison the crap out of it. Yeah, I'm good with these things.”*
>
> ***Group Discussion Participant***

> *“Yeah. It's humane and deals to a problem without too much input with people… it feels a bit more organic is making them go infertile, then you've wiped out a population within a generation. Great.”*
>
> ***Group Discussion Participant***

It should be noted, however, that not all participants felt comfortable with this tool. This underscores an overall theme, that there was never 100% agreement on the scenarios. In this case, some participants were uncomfortable with the thought that radiation was being used to potentially change the 'make-up' of the animal to make it infertile. They questioned the ethics of doing so and used that as a basis to express their discomfort:

> *"I think there is, and I have seen this in some research with Indigenous communities where they say, 'Who has the right to interfere in this animal's life and life drive, which includes to reproduce?'"*
>
> ***Group Discussion Participant***
>
> *"Yeah, that's probably, I think where my discomfort in, it's like we're making ourselves like God, we're wiping out a species. Yeah, that's probably my only discomfort about it."*
>
> ***Group Discussion Participant***
>
> *"We don't have the right to do that to any living beings. It's like... They're part of our ecosystem. And if we're going to do that to something that's in our ecosystem, that's not right. It's not right."*
>
> ***Group Discussion Participant***

By far, this was the scenario that people were most comfortable with supporting the use of the tool. It is likely that factors such as high levels of knowledge, understanding of the consequences of using it, it being highly targeted, and, interestingly, the fact that it was not a genetic tool all contributed toward that comfort.

7.3.4 Scenario 4: Transgenics

Kūmara Resistance to Insects

Full scenario text

> To make the Kūmara more resistant to insects that might attack it and destroy crops, scientists propose taking genes from a common bacteria known to repel insects and add it to the genome (genetic information) of the Kūmara.

Key elements of this scenario

- food
- taonga
- would not happen ‘naturally’
- non-reversible (though crop can be destroyed)

Scenario findings

While the third scenario might have been the most comfortable for participants, this scenario was certainly the least comfortable for participants. No one participant supported the use of this tool on the kūmara. The kūmara was intentionally used to see if changing from plants and animals to food would make a difference in how comfortable participants were with genetic technologies. In nearly every case, people were strongly opposed to the use of genetic technologies to make the kūmara more resistant. This was because it is in the food chain and it is a significant taonga across the country, meaning people were resistant to the idea of changing it. Furthermore, the scenario was written in such a way that there was no urgency to the situation, which further cemented discomfort. This formed the ‘perfect storm’ of resistance as participants explained:

> *“For me the words, ‘might attack it’ - so it's sort of like it's a hypothetical and also kūmara is sort of emblematic to Māori. Kūmara or the seed of kūmara came down from Maui during the creation stories. And I mean I don't know how I'd feel about it, but I'm pretty sure that others wouldn't be comfortable with the changing the whakapapa about the kūmara specifically.”*
>
> ***Group Discussion Participant***

> *“I was just explaining for me it's a big no because the word might, the insects might attack it, but more importantly that kūmara is central to Māori is a pre colonisation the pātaka which housed kūmara was the most important taonga in the marae…I just couldn't foresee a situation whereby I would accept the situation.”*
>
> ***Group Discussion Participant***

> *“This is the food crop that our tūpuna survived on when they came here, and it's a taonga that's special. But it's also that you are changing who that plant is. You're changing who the kūmara is by doing this, and you*

don't know the effects of that in the real world. And plants can adapt to changes in the environment if you select the ones that do better in that environment each year. And they can adapt, you can do other things to protect the crops rather than changing who they are.”

Group Discussion Participant

For most participants, discomfort was also driven by not knowing the consequences of adding bacteria to the kūmara, a common theme across all scenarios. Specifically, they were not sure what effect it would have on human or ecological health and often just preferred to stay completely clear of any food genetic modification:

“For me, yep, the whakapapa thing I have an issue with that. I hate, it's a food chain thing. Yeah, really uncomfortable about that…I mean, this is such an unnatural way to go about something.”

Group Discussion Participant

“For me, number one is just fundamentally wrong. It's mucking with evolution if you like. I have a strong reaction to this one too, but not quite to the same extreme as that first one [huia scenario]. I just think that's just really wrong. This one, yeah, for me, the biggest reason really, if I had to name it, it's because it's in the food chain.”

Group Discussion Participant

“Again, it would depend on how this bacteria was presented in people, whether it had effects or no effects, and how long it had been looked into. Was it just a couple of years? Do we know the long-term effects? Lots of questions, more questions than I have answers.”

Group Discussion Participant

“No, not at all. Whoa. Now that's mucking around with the source of life. The genetic material is the source of life and you're mucking around with the source of life within our tapu food crops. And I mean, our tūpuna used to deal with things like... I can't remember the name of the caterpillar by

burning manuka around the marae. There's so many other things that can be done other than mucking around with the genetic life of kūmara when you cannot research the full effect of doing that in a controlled environment. No."

Group Discussion Participant

When compared to the other scenarios, people were quick to offer unprompted alternative, natural, solutions to boosting kūmara resistance instead of using genetic technology. In one case, a participant even preferred to use chemicals that they knew caused harm over using genetic technology to protect the kūmara. This evidence suggests the mātauranga and techniques for protecting kūmara are well known and validated, and people have been successfully implementing it for many generations. Therefore, the need for genetic technologies is so low on the priority list that it appears to seem useless. When combined with the fact that people do not want to mess with their food, participants were much more likely to offer a multitude of mātauranga and naturally based solutions for this scenario:

"In a situation like that, we already have those really nasty for the environment with our scorched earth levels of effectiveness, we can go back to those older chemistries and mitigate the off-target environmental impacts of them rather than the genetic editing of the kūmara."

Group Discussion Participant

"Again, there's also, there's a whole lot of other solutions that you could look at to achieve this, that that looking at biopesticide options where you are genetically modifying soil bacteria to put out things that will help repel it as opposed to messing with the kūmara itself."

Group Discussion Participant

"Pretty much anything to do with messing with our kūmara genetically, I'm totally dead against it. Our tūpuna had amazing ways of dealing with it. They utilised the bugs that worked in harmony and ate certain parts of the rotten parts that made it thrive. We need to get back to those types of tikanga of how they grew it back then, bring it back to now and block the borders so that we don't get any of these pests coming in."

Group Discussion Participant

> *"Because there are those practitioners of māra kai that know how to grow their kūmara and protect it, we know how to do that. But if we're talking from a commercial economic or want to export, that to me challenges our why would we for economic gain, there's no tikanga in there for me, there's no Māori in that reasoning. It's not like we've only got one kūmara left in all of Aotearoa, that's not the scenario. We want to make sure that we can sustain this export endemic species, it's not even unique, it's from around the world. So again, it comes back to my why and I wouldn't be comfortable with scientists missing with such tikanga, when we have practitioners that have natural ways of being able to manage the diseases that are prevalent in these commercial productions."*
>
> ***Group Discussion Participant***

7.3.5 Scenario 5: Gene Drive using CRISPR

Possum Infertility

Full scenario text

To work towards Predator Free 2050, scientists have researched a way to promote genes in possums that make them less and less fertile. This gene is already naturally occurring in possums, but only usually present in a very small part of the population. If introduced, it would mean that the population of possums would decline across Aotearoa over time.

Key elements of this scenario

- invasive species
- nothing 'added' to the animal
- could happen 'naturally'
- non-reversible.

Scenario findings

In contrast to both the huia and kūmara scenarios, individuals were relatively quick to offer their support for a gene drive when possums were involved. Participants were more comfortable with using this method because of the damage possums are doing to the environment and because they are a 'pest'. Several individuals also believed that using genetic technologies to promote possum infertility was a more 'humane' way of dealing with them when compared to poisons and toxins. Overarching themes of the 'greater good' for the forests and birds also drove comfort for this, meaning that participants would be okay with the use of genetic technologies if it meant this serious pest started to disappear from Aotearoa. Participants explained:

> *"Because it's a pest not from here. It's not a native. It's stuffing up our taiao at a remarkable rate chewing through our forests. Where I live in the far north, 20 years ago, we never had a possum ever until they started moving up, and they were thinking of putting a predator proof fence right across Whangarei way back then, and they didn't. I wish they had because we would've had no possums up there and it's just chewing up all our native plants and trees."*
>
> ***Group Discussion Participant***
>
> *"Yeah, this is the lesser of all the evils."*
>
> ***Group Discussion Participant***
>
> *"Possums is the easiest one. Yep. I'm okay with it because…it's a foreign species, beautiful species. None of it is its own fault, but they're not whakapapa and they're not taonga to us…so yeah, I'm okay with that..."*
>
> ***Group Discussion Participant***
>
> *"It's the only way we'd ever get towards Predator Free 2050, is by doing these things. Trapping, poisoning, those things are not going to get us there. We need things like gene drugs and these technologies to reach that goal."*
>
> ***Group Discussion Participant***

However, this initial support sometimes turned for participants when they heard more about how the gene drive would need to work. Participants were told that a large number of genetically modified possums (upwards of 250,000[1]) would need to be released into the wild for the infertility gene to take hold in the entire population and for the tool to start working (i.e., a decline in overall possum numbers). After hearing that

[1] Gene editing for pest control - Predator Free NZ Trust

and thinking about the short-term implications of doing that (i.e., damage to the forest, birds, ecosystem) some individuals were less inclined to be fully comfortable with its use. Instead, these individuals felt more comfortable with recommending controlled trials. This underscores another overall theme, the importance of education and knowing the full extent of what the genetic tool involves. This will be explained in the next section, but participants commented:

> *"I'm going to do a 180. I think I was really keen on it right at the start, and I think now, hearing a bit more, I think I'd want to see a controlled trial first on maybe a particular forest or a particular block of land to see what the unintended consequences are. If it's a, let's say, we're saying it's a 10% success rate on... Well, 90% success rate on reduction of offspring. Let's say if it's one in 10, instead of 10 out of 10 babies, that's great. But if it's not and it's the other way around, then we've just released 250,000 possums to do that nine times, so we end up with what's closer to more like 2 million possums over time. Yeah, I'd want to see a controlled trial on that."*
>
> ***Group Discussion Participant***

> *"Definitely not as keen as I was initially. I mean, it wasn't in my thoughts at all, but hearing, thanks again, [name], for being in this conversation, hearing about a controlled trial and it would be... I totally took that because as well as seeing how this possum plague would actually play out, not only for the area that was the controlled area itself, but seeing how the manu [birds], if they're able to... Oh God, it sounds really shit because wherever you pick, whatever birds are there, you're essentially like... You are sort of sacrifice…so, the risk versus rewards from the start, from just posing this here, to more information about it, has grown a lot."*
>
> ***Group Discussion Participant***

Additionally, some individuals indicated that there was some discomfort in using this technology because of some potential unknown consequences of it. Specifically, they were worried about genetically modified possums escaping to Australia where they are considered a taonga species. This again highlights the thinking of broader ecosystem impact that goes into the consideration of using these tools. For example:

> *"Personally no, but not for myself, but more for the people of Australia if it got in there would be responsible for wiping out their species."*
>
> ***Group Discussion Participant***

> *"All of these things where we are looking at dealing with a pest, to be good indigenous partners we need to make sure that we're not having a tutu [play] with someone else's taonga."*
>
> ***Group Discussion Participant***

> *"One is the chances of it getting to Australia through contamination is a massive risk and is probably the one that's probably going to stop this research dead in its tracks. I think there's some of the things has happened in the past, basically Australia will sue us, sue the New Zealand government if we have basically introduced something into a possum population and then it gets into Australia and particularly if it devastates their native possum population."*
>
> ***Group Discussion Participant***

8.0 Māori Engagement Insights

8.1 Introduction

What are the Results from the Group Discussions and Survey Saying?

While there were unique results for each scenario and the survey, there were also common themes. These, regardless of the specific context, seemed to be driving respondents' attitudes to the use of genetic technology for environmental protection.

8.2 The Unknowns of Genetic Tools and Technologies

By far the most common theme driving discomfort with tools by participants in both group discussions and the survey are the 'unknowns' of genetic tools. Participants were uneasy with their use because they believed that there were far too many unforeseen consequences that could arise with their use and no way of controlling those consequences once it had been used. A general feeling of discomfort was present throughout many of the scenarios (with the exception of the sterile insect technique) with comments such as 'it doesn't feel right' or 'there is a lot we don't know'.

> *"As a scientist, I got excited about the tool and the capability that it has, but then I'm also terrified in what that tool would be used for."*
>
> ***Group Discussion Participant***

> *"For me, there's just something really - I'm going to use the word ethically problematic from a whakapapa point of view…I mean, this is just my reflective, instant gut feel, right? There's something about that that is really uncomfortable. But then also for me, it's the unknowns. Yeah, the things that they haven't thought about."*
>
> ***Group Discussion Participant***

> *"I think sometimes you think, oh, if you're adding something in, there's more unintended consequences. But actually, there are lots of unintended consequences sometimes even just taking out one gene, if it has some downstream cross-effects promoting another gene that you didn't know about. We can't say for sure that's not unintended consequences just because you're removing something rather than adding it in."*
>
> ***Group Discussion Participant***

> *"It just seems to me that the technology is going to take us in directions that it's unpredictable what the results would be in three or four generations time, and what the results will be in the ngahere [forest] and in us. You can't research those effects in laboratories. So major caution required."*
>
> ***Group Discussion Participant***

Māori survey respondents backed this by indicating that their discomfort with technologies came with uncertainties, unforeseen consequences, and that they were hard to control once they were released:

> *"I don't support genetic modification technology of any description in any form especially when the tech is released into the general environment as it could have unforeseen and possible devastating effects on the environment in generations to come. Although it may be amazing technology and on paper and in a lab, it could be great however when exposed to our natural environment and with changes in general over time we could be creating a much bigger problem…"*
>
> ***Māori Survey Respondent***

> *"They should not be used in Aotearoa because they can have unforeseen consequences, can affect the health and integrity of indigenous species and their life cycle and are an affront to the natural order and tikanga Māori."*
>
> ***Māori Survey Respondent***

> *"I don't support the use of genetic technologies because these are very difficult to control."*
>
> ***Māori Survey Respondent***

8.3 Regulations: Tikanga, Te Ao Māori, and Māori Involvement

For some, one way to decrease the uneasiness driven by the unknowns are regulations and strict control. Guidance for that regulation and usage would ideally come from te ao Māori, tikanga, and government regulations for scientists. Participants described that if these processes were in place that it would mean that the chance for unforeseen consequences of a tool would theoretically be lessened, and that they could have more confidence in the tool's effectiveness knowing it had gone through an ethical process checked by social and cultural considerations. Using tikanga would also help to answer the 'why' of the tool or, in participants' words, why or for what purpose the tool is being used. Evidence suggested that having that purpose clear and understood also helped to decrease discomfort:

> *"I would just like to add that I think, I'm assuming with all these scenarios, a major thing is how regulated it is. I think that makes a big difference between things going wrong and getting out of control or having unseen constant sequences and not. So, if the technology and processes are highly regulated, which if they were left containment, they would have to be, and I'll give you, they already are within containment, then that reduces the risk considerably."*
>
> ***Group Discussion Participant***

> *"The why is that you've actually got a conservation purpose and it's highly likely that it will work and not really have any unseen consequences."*
>
> ***Group Discussion Participant***

> *"I think it needs to be explored, because at least it's made very clear, that once it's done you can't really take it back. If there are other options that are more likely to not have unforeseen consequences, then they should be explored. Maybe it's too expensive, maybe they're not climatically suitable or something like that. There are all these sorts of variables, but they should at least be explored before jumping to gene editing or anything like that."*
>
> ***Group Discussion Participant***

"That lacks an ethical robustness by saying there's a whole lot of questions we don't know, but let's just, because we know the science will work, but we just want to see how many over what time, it lacks the ethical robustness. I assume that there was a contained scenario where that has happened and if that hasn't happened, again, it's a little bit of science madness."

Group Discussion Participant

This finding is also backed by survey evidence, where Māori respondents indicated that their support for these technologies would only be there if it could be proven that it was completely safe to use and that strict regulations were in place to prevent any unintended consequences or misuse. For example:

"Genetic technologies offer a promising tool for controlling pests and protecting the environment. With research, mature regulation, and responsible deployment, it has the potential to revolutionise pest management practices and contribute to the preservation of biodiversity and ecosystem health. Genetic tech can provide an alternative to the overuse of pesticides, which can lead to the development of pesticide-resistant pests and pose risks to human health and the environment."

Māori Survey Respondent

"To protect our native Indigenous species and kai I don't oppose genetic technology as long as there are appropriate safety measures with it."

Māori Survey Respondent

"I support it if it is well researched, tested and done in a safe way that will not affect or have unintended consequences for people, their pets, or endemic animals. I believe this is only way to effectively eradicate predators and in turn protect the taiao and its biodiversity."

Māori Survey Respondent

When asked how processes and protocols involving genetic technologies should be undertaken, participants overwhelmingly indicated that tikanga and mātauranga need to be at the centre of all decision-making. To do that, Māori need and assert the right to be consulted during the entire process of genetic tool implementation and that any and all proposals need to be through a process that is rooted in community tikanga. This would also be a process that is more likely to contain much needed discussions on ethics using the mātauranga that has been guiding those discussions for centuries. Survey and group discussion participants described this by saying:

"Someone's going to come to Māori with a proposal. Whereas my preferred way of thinking is that Māori are at the centre of these technologies and kind of leading the way and are a key part of it. And then from there, the ethics and the morals over how those technologies are used. Māori are a much better position to be able to comment and be involved in that."

Group Discussion Participant

"I think having a risk-based approach that is informed by tikanga and mātauranga, but also acknowledges that tikanga is designed to evolve as we get more information and more mātauranga would be the best way to do it."

Group Discussion Participant

"Then the other thing in regard to tikanga iwi, tikanga hapū, tikanga whānau… there will be some things that based on all of us belonging to te ao Māori that we will have common views in in terms of risk and how we want to approach that."

Group Discussion Participant

"No, the fact that I would have to eat [the kūmara] doesn't really change effect or influence my decision. It's more about the whakapapa and the trust in our tūpuna wisdom as scientists, as experts."

Group Discussion Participant

“Tikanga Māori is important as a guide for new technologies.”

Māori Survey Respondent

“I think it is important to start the conversation about their use, and I do support this approach being used if it is found to be effective, and decision making is done in partnership with iwi and communities, especially in large areas of bush (e.g., Te Urewera). I also support this approach if there is engagement done with Aboriginal mobs about using it for possum control.”

Māori Survey Respondent

“I think they are an exciting space to explore that show potential. However, a lot more work needs to be done such as ensuring things are in place for considerations of rangatiratanga, tikanga, and mātauranga throughout the whole process.”

Māori Survey Respondent

In the survey, respondents were asked who should be leading environmental decision making in Aotearoa (implying those who would also be involved in the consultation and uses of genetic technologies). To do this, we provided a list of seven entities and asked respondents to rank them from 1 to 7 (with #1 being the preferred decision-making body). Māori ranked iwi or hapū entities as their top preference to lead environmental decision-making by a good margin, whereas Pākehā rated the Department of Conservation as their first option and the Ministry for the Environment as a close second (noting that these entities were the second and third choices for Māori respondents as well). The remainder of the options fell towards the bottom of the list and there weren’t many differences between groups. Councils and the Ministry for Primary Industries were at the bottom of both groups’ lists.

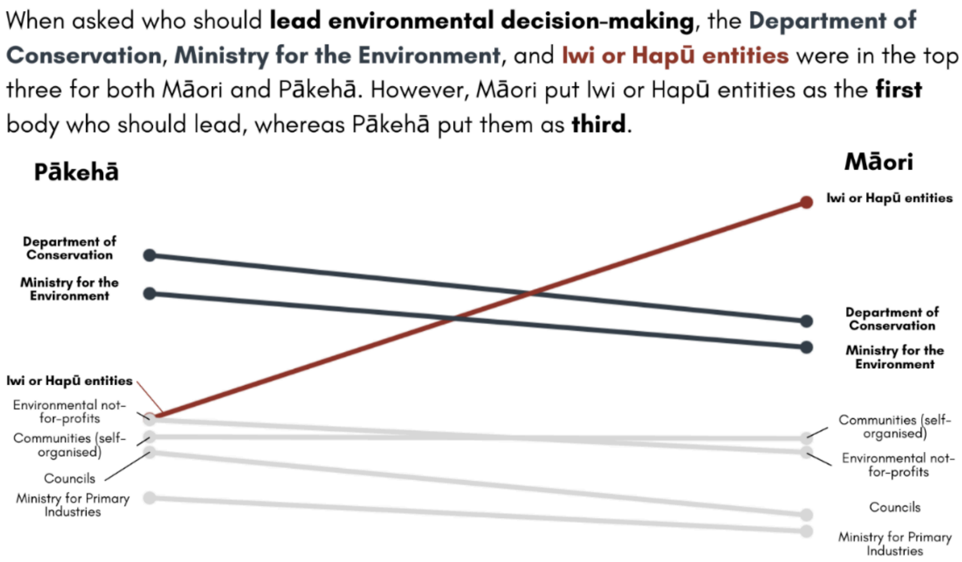

Figure 8.1 Comparison between Māori and Pākehā prioritisation of agencies to lead decision making for pest control.

Part of this process would involve discussing 'why' the tools are needed or necessary and exploring the urgency their use may hold. For participants, this 'why' would unsurprisingly need to be explained using a te ao Māori perspective and match with local tikanga. Without that, the acceptability of using a tool would plummet. It was explained that this process is also about ensuring that everyone is comfortable with the ethics of using the tool. For example:

> *"To us [Māori] it's an ethical problem, and to the scientists, it's a practical problem. They don't necessarily see that as an ethical issue. That's a challenge. And to crack that challenge is to do their job as they see it."*
>
> ***Group Discussion Participant***

> *"Understand that every hapū has a different whakaaro on their whakapapa and their connections. So, what we might deem as a pest, they might not... we would've to do a whole lot more wānanga in a circle. Maybe you can do some hui in the circle before the do-ey. In this case, a little bit more hui before the do-ey is okay."*
>
> ***Group Discussion Participant***

> *“Because we're dealing with ones that don't have those cultural backgrounds, that's why we are here as kaitiaki to make sure that things are done properly.”*
>
> ***Group Discussion Participant***

> *“There's the understanding in a scientific way, but it's totally disconnected from understanding about whakapapa and there's a long way to go before we've got enough Māori with cultural knowledge and doing the science to actually be able to even really have these conversations.”*
>
> ***Group Discussion Participant***

Once again, survey responses backed these sentiments. Specifically, we asked respondents to rate six factors that could possibly influence environmental decision making (on a scale from 1 – no influence at all to 7 – completely influences). Doing so can help explore the motivations behind some of the results we have already outline and perhaps provide avenues for how to effectively communicate with groups about pest management and genetic tools. Below is a graph where we combined the percentage of Māori and Pākehā respondents who selected a 5, 6, or 7 when rating the factor (indicating a medium to high amount of influence for that factor). There were marked differences between Māori and Pākehā in the following factors:

- Whānau/family wellbeing (86% of Māori respondents vs. 61% of Pākehā respondents)
- Treaty of Waitangi (75% of Māori respondents vs. 37% of Pākehā respondents)
- Māori tikanga (81% of Māori respondents vs 36% of Pākehā respondents)
- Iwi tikanga (77% of Māori respondents vs 29% of Pākehā respondents)

Interestingly, the percentage of Māori and Pākehā respondents were similar for the factor ‘broader wellbeing of my society’ (79% and 73% respectively).

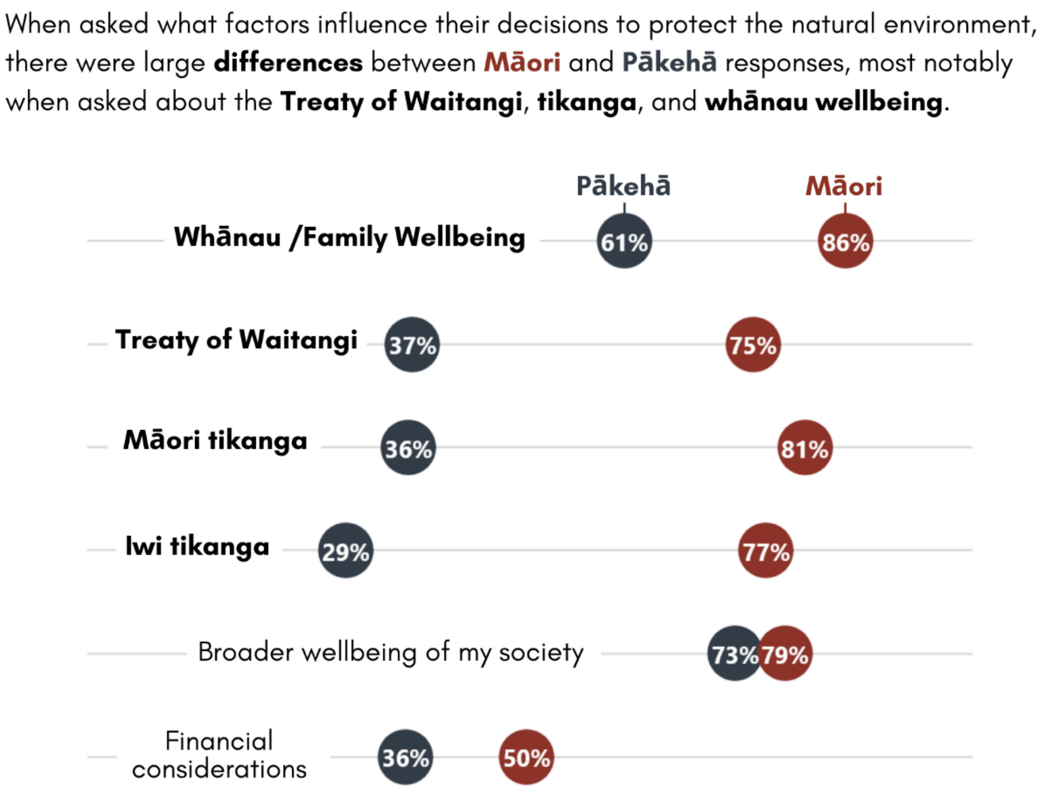

Figure 8.2 Comparison between Māori and Pākehā prioritisation of factors influencing their decisions to protect the natural environment.

8.4 Whakapapa and Its Implications for Genetic Technology

Evidence across methods suggests that one integral part that forms the backbone of any discussion about genetic technologies is whakapapa, the genealogical connections by which Māori frame the universe and understand their relationships within it. This was regularly brought up by participants without prompt and was the heart of much of their thinking about the use of genetic technology for environmental protection. Participants used whakapapa to frame their judgement of genetic technologies by saying:

> *"Yeah, the only surprise I had was that I'm pleasantly surprised that [we] are referring to all of this as whakapapa. Even within our legislation, we talk about taonga this, taonga that, but this is whakapapa. All our creatures, everything, Nga Taiao, it's all whakapapa. And when we refer to these things as whakapapa, we treat them a whole lot differently. Whereas a taonga can be given and taken and lost and forgotten about that."*
>
> ***Group Discussion Participant***

“But it's the whole mixing of whakapapa lines. We're not mixing within a whakapapa. We are mixing outside of two whakapapa that never would have come together without human intervention. And that's the thing that I really... That's where I feel like we are trying to be atua.”

Group Discussion Participant

While whakapapa was brought up frequently in each scenario, it also played a prominent role in the de-extinction scenario. Namely, the thought of bringing back a huia using a kōkakō brought up discussions about what the huia’s whakapapa would be, including whether that would change the whakapapa of the kōkakō. This is another indication that whakapapa would be a primary lens used by Māori when discussing genetic technologies, because everything always goes back to its whakapapa. If the tool is seen as disturbing the whakapapa of the species, our evidence suggests that people will be less comfortable with it (noting this is amplified for native species). The huia whakapapa discussion (i.e., the whakapapa of the ‘new’ species) may not be a thought in scientists’ or decision makers minds but all evidence suggests that it will be major factor to consider for Māori:

“But then whakapapa of those new huia would actually be kōkako!”

Group Discussion Participant

“Try to figure of what the whakapapa is. If you are reciting whakapapa you can only go back to this kōkako.”

Group Discussion Participant

“I'm sort of glad that you can understand it and you're able to explain it to me. And you too are at least you've got Māori people who I think you've got the same sort of understanding of Māori. Māori thinking on the whakapapa and how much we attach to our whakapapa, our genealogy…and I just wondered how I felt that it took a something and made another one. I'm still sort of a bit confused over it, but I thank you for very different thinking and the different impact, because I'm starting to understand the problem, but it's still a problem. It's an ethical problem.”

Group Discussion Participant

> *"Yeah, I think the first up reaction is, 'Ooh, why?' What would be the intention of doing it? Probably similar to yourself, [name], will it just send us down the same old track of creating some sort of taonga for the sake of having a taonga or is it whakapapa-based? Were there other things attached to it? And if we were to do that, then what would be the repercussions, first of all, to the Kōkako whakapapa and then to everything else around that potential huia."*
>
> ***Group Discussion Participant***

> *"Our tūpuna knew all about genetics and knowledge come out from genetics. So from tūpuna to the mokopuna and passed on through genetics. I really try and angle and focus on if that is possible, that the genetics of the huia will bring out a lot of the qualities of the huia as it develops and grows as well from its tūpuna if it was from the actual genetics that they scraped off and put into that kōkako embryo."*
>
> ***Group Discussion Participant***

8.5 Urgency and the Use of Genetic Technology

When looking across the scenarios and the survey, one factor that drove acceptability of tools was how urgent the situation was. If the situation was seen as dire (e.g., a species was facing imminent extinction) and all other possible options had been exhausted, then participants were more likely to accept that the tool could be used (assuming existing mātauranga and natural solutions had already been tried). This speaks to the practical nature of many participants who would rather keep a taonga species using these technologies than lose it forever, even if it meant feeling discomfort in using these tools. To be clear, urgency and comfort do not equate in this situation and tikanga processes would need to be used to make decisions around it and deal with the implications of doing so. As an example, when we changed the urgency in a scenario, as we did with switching the huia for a hypothetical situation where kea are threatened by avian bird flu and would go extinct overnight, it appeared to have made a difference for participants. For example:

“Yeah, that'll be the extreme back-up plan only [use of de-extinction on a kea]. That's how I would see it. We've got to still fight and make sure that we can keep them alive as long as possible if the avian flu's coming through, let's find lots of natural ways rongoā Māori maybe, I don't know, give them some kūmaraho, I don't know. That might help. Put that into them. Start utilising all these other aspects of natural ways of strengthening their immune system against it before. I told you that's the extreme back-up plan if nothing else works.”

Group Discussion Participant

“If we had a month, and I like to think of those D-day movies where it's like, ‘There's an asteroid coming. We've got a month. How are we going to save the planet?’ Well, yeah, the good guys always save the planet. I'm not sure if this is going to happen in this scenario. But I think if all exhausted avenues of science, we've gone down every single avenue and scientists keep coming back to the same thing, different scientists from different countries, from different organisations all came back to the same thing, we've got a month, then, I guess, yeah. If we've explored everything else, including mātauranga.”

Group Discussion Participant

“I probably, I mean absolute last resort, think about it, but we're not there yet. We're not at a point where we would even consider something like that for kea or for any other bird with this low fertility. Yeah, we're just not there at a point where this is necessary, nor do I think we'll get to a point where it's the only resort to... it's the only thing we can do.”

Group Discussion Participant

“You’d need to make sure that you had appropriate tikanga around that. And you'd need to make sure that these manu [huia] are released into an environment in which they can thrive. Otherwise, what's the point? But I think for more modern extinctions [kea], which are very much human driven, I would feel more comfortable with that but only as a last resort.”

Group Discussion Participant

8.6 The Importance of Education, Training and Information Sharing

As mentioned earlier in the report, we designed the group discussions to gather initial reactions to the scenario, explain the tool in more detail, and return to the discussion to see if participants' comfort levels had changed after they knew more about the tool used in the scenario. On several occasions, this designed caused participants to change their mind on how they felt about the tool. This went both ways and depended on the tool (i.e., the explanation either made them feel either more or less comfortable). Examples of change after learning more about the tool included:

> ***Facilitator:*** *"That's been done in the past on a few species. The most famous example was cacao where they took out this gene to allow it to fight off infections better. Knowing that that is the change that would be made and the way that it would be done, does that make you more or less comfortable with it?"*
>
> ***Participant:*** *"Maybe a little more comfortable. Yep."*
>
> ***Facilitator:*** *"And is that just because nothing new is added in or what's the reason for being a little bit more comfortable?"*
>
> ***Participant:*** *"Because the tree's still doing what it would normally do, but you're extending its range in a way. You're not changing anything else about the tree."*

> *"But again, it boils down to knowledge. I knew a bit of knowledge that made me comfortable. They [possums] are a pest, I've seen the damage that they can cause in our natural environment and so this seems like a less invasive way."*
>
> ***Group Discussion Participant***

> *"Yep, that does clarify it a little bit more. So non-native flies, not genetically modified, but mutation formed by radiation. I am okay with that because it's a lesser evil, I guess, and it's a lesser evil. Yeah, the toxins and poisons. I still don't know how it would work so well, but if it's already in use in other countries, then I think I don't know enough about the fruit flies."*
>
> ***Group Discussion Participant***

This speaks to the critical importance of educating the public on all genetic tools that may be considered in Aotearoa. This is because much of the population are not aware of tools, how they work (technically and in the environment), or of their potential consequences. Therefore, mis- and disinformation are common and participants viewed consistent and ongoing education, using language the majority can understand, was an important factor towards the acceptance of genetic tools:

> *"Having something pitched at a 12-year-old level, which can be given to kura. As part of science classes, somebody can learn about it. It's also something that's accessible to whānau as to what actually is genetic modification and how does this mean? There's a huge engagement comms piece that needs to be done throughout Aotearoa on that."*
>
> ***Group Discussion Participant***

> *"I need more information when it comes to any of this stuff. When it comes to my whānau and people that are inside my sphere of influence or colleagues etc., in te ao Māori, I was likened back to other things when it comes to genetic engineering."*
>
> ***Group Discussion Participant***

> *"It needs a lot of information and a lot of research and science and results and things behind it. Yeah, just needs to be really well-prepared and then also have these things in a way that is layman's terms for people like myself who don't know anything about transgenics, for example."*
>
> ***Group Discussion Participant***

> *"Yeah, I think asking for perspectives on genetic technology from Māori only really works when we really understand what's going on and usually we don't. And a lot of the times scientists come in and they just spit jargon and our whānau aren't following because they haven't done 10 years of school, learning all of this nonsense jargon that still goes over my head, even though I did 10 years of learning this jargon. From the other side of it, we need to be a lot better at communicating exactly how things are happening, exactly what's happening and not... here, I've seen scientists approach Māori communities as if they're stupid and dumbing everything down. That's not what I'm talking about here. I'm talking about*

communicating effectively these things that are full of jargon, are full of all of these nonsense words that are all made up and no one knows."

Group Discussion Participant

8.7 Conclusion

The findings from this report provide a well-rounded understanding of Māori perspectives on using genetic technologies for environmental protection. The group discussions in particular revealed consistent perspectives where participants emphasized the importance of thinking about whakapapa (in various forms), fully understanding broader ecological impacts, and strictly following tikanga processes set forth by community for any genetic technology proposal (regardless of which tool). Even for those who showed cautious openness to the use of genetic technologies under specific, well-regulated conditions, significant concerns remain about the unknown consequences and ethical implications, including on whakapapa.

A notable, yet unsurprising, finding is the general lack of knowledge about genetic tools amongst participants. This was evidenced by a high percentage of survey respondents indicating uncertainty in their responses and the necessity to explain technologies in group discussions. This underscores the absolute need for clear and effective education and communication regarding these technologies to better inform and address concerns that are already in place.

While these results offer valuable insights, they should not be generalised to all Māori across Aotearoa. Instead, they should serve as a starting point for further discussions and community consultations. Continued engagement with Māori communities is essential and that process should take a relational approach that integrates te ao Māori, whakapapa, and long-standing tikanga-based processes implemented by community.

PART D

References & Appendices

This research has two separate but complementary research streams including:

- General Public Engagement
- Māori Engagement

Part D contains two chapters relevant to both research streams including:

- References
- Appendices
  - Purposeful Games
  - Public Engagement Scenarios
  - Reviewed Social Science Literature on Deliberation
  - Reviewed Social Science Literature Summary
  - Collated Social Science Literature with Māori Perspectives

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10.0 Appendices

10.1 Purposeful Games

10.1.1 Jenga: 'Ecological Collapse'

Ecological Collapse was based on the popular collapsing tower game Jenga, where players progressively remove stacked wooden blocks from a tower making it more unstable until eventually the tower collapses. The idea of a collapsing tower lent itself perfectly to a scenario to support understanding of ecological collapse. A commercial giant sized block tower was used to give the game more impact.

The purpose of the game was to raise awareness of the diverse range of impacts, most of them negative, that native habitats face that, working in concert and over time, can lead to the ecological collapse of the habitat. New Zealand's 'forest habitat' was used as the context for our game. Unlike the actual Jenga game which is competitive, in this game players were encouraged to work collaboratively in teams of up to eight players to AVOID ecological collapse (i.e to avoid the block tower falling down). Players could suggest which blocks might be ideal to remove to avoid ecological collapse. Furthermore, as players removed blocks, they generally did not place the block back on the tower.

To enable deeper understanding of impacts to forest ecosystems, each block was etched with one of five images representing 'impact scenarios' that affect the forest. Our five 'impact scenario' types were: land; climate; people; fauna; flora. When a player removed a block from the tower, they then picked up a card corresponding to the image on the block and read out aloud the scenario that was written on the card. In some cases, the scenario resulted in considerable negative impacts to the forest, and the player faced a penalty that required them to pull out further blocks, as in the following example of a 'People impact scenario" that incurred a penalty:

Visitors introduce a new plant disease into the forest that kills trees and spreads rapidly. PENALTY: REMOVE ANOTHER BLOCK FOR THIS DISEASE SPREAD

Where a scenario resulted in a positive impact to the forest, the player could receive a bonus that allowed them to place the block back anywhere into the stack as in the following example of a 'Fauna impact scenario' that gave a bonus to the player:

The Forest is undisturbed for a long period of time and a thick layer of humus builds up from leaf fall that increases the fertility of the soil. BONUS: PLACE BLOCK BACK IN THE STACK

There were many more penalty cards than bonus cards and the game would end when either ecological collapse occurred with the block stack collapsing OR when all 'scenario impact cards' had been used. At that point. if the tower had not collapsed, the team turned over the large A3 card on which the playing cards sat, and read aloud the message written on the back:

Congratulations your ecosystem has not collapsed, but what is the quality of the ecosystem that remains?

10.1.2 Snakes and Helixes: ‘Scientific Discovery and Research’

To familiarise players with concepts about scientific discovery and research, including genetic technologies and techniques relating to biodiversity conservation, a grid of 100 squares was made on an A0 sized gameboard (841 mm x 1189 mm, or 33.1 x 46.8 inches) based on the heritage board game of snakes and ladders. Using a 12 sided dice to speed up the game, so it could be played in a 30 minute timeframe, up to eight players took turns to journey through the game, taking their ‘chosen wooden scientist figure’, along the grid squares according to the number they rolled on the dice.

The board contained short scenarios relating to technical, social, financial (funding) and ethical aspects of research that could affect a scientist’s research journey. Where the scenario could slow the scientist’s research journey, the player encountered a snake, and slid down or backwards. Where the scenario could accelerate the scientist’s journey the player encountered a helix (ladder) and would go up or forward on the board

A glossary was provided to support players understanding of some of the more complicated scenarios or words such as ‘gene drive’ and ‘trojan female technique’, or EPA (Environmental Protection Authority), to allow players to step into the shoes of a research scientist and recognise they are part of the complex systems of science, funding, ethical processes, biosecurity/environmental agencies, and public opinion.

The game was competitive, so the first person to reach the end won the game, although all remaining players were still encouraged to continue playing to also reach the end. However, recognising that a scientist’s journey often involves elements of chance, particularly when working in more controversial and contested science fields, such as gene technology, an aspect of chance was added into the game

When a player reached 100 (or past 100), they had to STOP and undertake public consultation by rolling the dice again. If the dice landed on 1, 2, 11 or 12, the public supported the player’s research and they could PROCEED and therefore won the game. If the dice landed on 3, 4, 9 or 10, the public rejected the player’s (scientist’s) research and they could no longer play and must withdraw from the game. If the dice landed on 5, 6, 7 or 8, consultation was delayed. The player had to wait on 100 till their turn came around again, when they could engage in further public consultation by rolling the dice.

10.1.3 Target Game: ‘Gene Editing’

To familiarise players with the technique of gene editing and to recognise possible unintended consequences of gene editing, a gene target game was designed and created to assess a player’s skill at editing a gene. The aim was to ‘edit’ a targeted area on a DNA chromosome helix using the CRISPR-CAS tool symbolised by a nerf gun. The chromosome was a wooden frame with six numbered gene targets that would flip around when hit.

The player stood behind a line and rolled a dice. The number on the dice indicated the numbered specific target gene for a scientifically perceived ‘beneficial trait’ on the chromosome the player had to strike with the CRISPR-CAS nerf gun. Each player used the CRISPR nerf gun to aim at the specified target and had six attempts to hit the correct gene. If they hit the correct gene, they had successfully edited the gene. If they missed and hit another gene of the chromosome an unintended consequence had occurred and their turn ended. The game was not competitive but tested individual skill level. Importantly it introduced the concept of non-target effects and unintended consequences.

10.1.4 Stakeholder Game: ‘Who sits around the decision-making Table’.

To engage people in decision-making about who should be included in discussions around gene editing for environmental purposes, a game called ‘who sits around the decision-making table?’ was designed and created for up to six players. While there was an element of competitiveness to see who finished first, all players were encouraged to continue until they finished the game.

The game combined darts and bingo. On a ‘decision-making participants card’, players circled four key groups, from a choice of eight, they thought should be included in decisions about gene technology. The choices were: Scientists; indigenous Māori tribes/sub-tribes; policymakers; EPA (Environmental Protection Authority); Industry / commercial players; Environmental Groups; Rural Communities; Urban Communities. They could write on the card any other participants they believed should be included.

Three Velcro balls were provided to each player to throw at a Velcro dart board with the names of all eight participants in a segmented target. The player aimed for their chosen participants and when a Velcro ball successfully attached to a participant the player had circled, they could mark that participant on their card. Players continued taking turns until they had successfully stuck their Velcro balls to all of their four chosen participants. When this occurred, rather than calling 'bingo' they called out "COMMITTEE APPOINTED".

The dart board also had an ALL GROUPS bullseye, which gave a player a chance to get all their participants in one throw, however if they missed, they lost their turn. This added a high risk, high reward element to the game around choosing participants. All player's cards were collected at the end of the game to provide valuable 'quantitative' data on players choices as to who they felt were priority participants in deliberations around gene technology.

Two further 'games' were also developed, but were not commonly used.

10.1.5 Word Concept: 'Pictionary'.

This game for teams of eight players enabled people to familiarise themselves with gene, science and conservation concepts and words. One player drew pictures to represent a word drawn from a selection of cards and their team had to guess the word or phrase before a one minute time expired for each word. Teams retained the cards for the words / phrases they correctly guessed and the team with the most cards won. Four word / phrase THEMES were used: Action; Person, place or thing; Animals & plants; Social aspects, values & beliefs.

10.1.6 Puzzles

Puzzles were provided to enable participants to take 'time out' from the purposeful games to build a puzzle either individually or in small groups. Two puzzles were created, one showing gene editing and the other showing a scene of natural New Zealand landscape.

10.2 Public Engagement Scenarios

Phase 3 workshop focus group participants generally deliberated on two genetic technology scenarios selected from four scenarios around invasive species developed for this phase of the research. The four scenarios each addressed potential genetic technologies that could be applied to one invasive species, including:

- Wilding Pines
- Myrtle Rust
- Varroa Mite
- Rats

All four scenarios followed the same format and were each composed of seven information cards, to provide scenario specific information to participants, and one question card for the focus group to deliberate on. Each scenario included the following cards:

- Background
- Invasive Species
- Impacts
- Current Management Tools
- Possible Genetic Technology Management Tool
- Implementation of Genetic Tools
- Regulation of Genetic Tools
- Question - What do we decide?

The content of each card for each scenario is in the following sections.

10.2.1 Wilding Pines

Wilding Pines Information Card 1

BACKGROUND

Over two million hectares of New Zealand is affected by wilding pines, including the Tongariro National Park, Marlborough Sounds, the MacKenzie Basin, and Central Otago. One estimate suggests 25% of New Zealand would be covered by wilding pines in 30 years if their spread is not controlled. The current area of New Zealand covered by wilding pines is now greater than the area covered by plantation forests.

Wilding Pines Information Card 2

INVASIVE SPECIES

Wilding pines are various conifers, including pines, larches and fir trees that have spread into wilderness areas, especially conservation land.

Many wilding pines have spread from plantation forests, farm shelterbelts and from areas previously planted for erosion control.

Wilding Pines Information Card 3

IMPACTS

Wilding pines are a problem because they spread quickly and grow faster than native tree species, outcompeting them for light and water. As their canopy can be very dense other plants struggle to grow underneath them.

Wilding pines reduce biodiversity because they are not native habitat, so do not provide the right food to support native birds, lizards and insects. Due to their effects on native biodiversity they negatively impact cultural values.

Wilding pines can be a serious fire hazard. They also reduce the amount of water flowing into rivers by 30 – 40% causing problems for the health of river systems.

Wilding Pines Information Card 4

CURRENT MANAGEMENT TOOLS

Wilding pines are most effectively controlled when they are small and many community-led control initiatives focus on this phase. They get more difficult and extremely costly to control as they grow larger. In steep country there are very limited options to control wilding pines

Depending on their size, how many there are in an area, and how accessible they are, wilding pines may be burnt in controlled situations, felled with herbicide applied to stumps to stop re-growth, drilled with holes so herbicide can be inserted or large areas helicopter sprayed.

Wilding Pines Information Card 5

POSSIBLE GENETIC TECHNOLOGY MANAGEMENT TOOL

Gene technology has already been developed to suppress reproduction of wilding pines by preventing the formation of pollen and therefore the development of fertile seeds in female cones.

In 2015 Japanese researchers developed a male sterility ‘knockout’ gene that switches off male reproduction in conifers. New Zealand researchers have instead focussed on the more challenging research of female sterility in conifers as females produce the seeds.

Wilding Pines Information Card 6

IMPLEMENTATION OF GENETIC TOOLS

The New Zealand researchers have genetically modified wilding pines to suppress female conifer reproduction and they currently have live trees in an indoor containment facility, but not planted outside.

However, NZ’s Environmental Protection Agency (EPA) requires these trees to be destroyed after six years, which is before the trees produce cones, so scientists are unable to confirm if the trees are sterile. New Zealand scientists have now partnered with researchers in the USA to trial this research overseas.

Wilding Pines Information Card 7

REGULATION OF GENETIC TOOLS

Gene edited wilding pines are deemed to be a GMO (Genetically modified organism) in New Zealand so current regulation under the Hazardous Substances and New Organisms Act (HSNO) prevents their release from their containment site. The HSNO Act also prevents any inheritable material leaving the site.

Wilding Pines Question Card 8

QUESTION - What do we decide?

What tools do you want in your environmental management toolbox to manage this invasive species.

10.2.2 Myrtle Rust

Myrtle Rust Information Card 1

BACKGROUND

The myrtle family of plants dominate New Zealand's forests and include native trees and shrubs such as pōhutukawa, miro, mānuka, kānuka, rātā, tawake or swamp maire and ramarama. Well known exotic myrtle plants include feijoa, guava, and eucalyptus gum trees.

Myrtle Rust Information Card 2

INVASIVE SPECIES

Myrtle rust is an invasive wind-blown rust fungi first found in South America and now found around the world. It arrived in New Zealand in 2017 and has been found on myrtle plants throughout the North Island, as far south as Canterbury, on Aotea Great Barrier Island and the Chatham Islands.

Myrtle Rust Information Card 3

IMPACTS

Myrtle rust has been present in Australia since 2010. Since its arrival there it has caused population declines and localised extinctions of some species of myrtles.

In New Zealand, myrtle rust has led to local population declines of ramarama on the North Island's East Cape and of the rare tawake or swamp maire also in the North Island. Myrtle rust has also been found on many other myrtle species including on Te Waha o Rerekohu (the mouth of Rerekohu) at Te Araroa, East Cape, the largest living pōhutukawa tree that is culturally significant and believed to be at least 600 years old.

Myrtle Rust Information Card 4

CURRENT MANAGEMENT TOOLS

Current management of myrtle rust relies on synthetic fungicides being sprayed over infected plants or trees. However fungicide has limited use in non-agricultural settings because of off-target effects such as being toxic to other organisms and runoff into waterways. In addition, myrtle rust can develop resistance to fungicides. Plant breeding for disease resistance is not a recommended option, due to the scale of the disease, the number of species myrtle rust affects, and the long life of many New Zealand and Australian trees.

Myrtle Rust Information Card 5

POSSIBLE GENETIC TECHNOLOGY MANAGEMENT TOOL

RNAi is a bio-control gene technology that scientists describe as a “promising tool” for managing myrtle rust. RNA is found in all living cells. RNAi is short for “RNA interference”. This is a natural process that occurs in cells where small RNA molecules ‘silence’ or decrease the activity of specific genes by preventing them from becoming active. This is why RNAi is commonly called “gene silencing”.

Artificial double stranded RNA or dsRNA is being developed as a gene technology treatment for myrtle rust. It is produced outside the cell and can target very specific genes.

Myrtle Rust Information Card 6

IMPLEMENTATION OF GENETIC TOOLS

In a 2023 Australian study, artificial double stranded RNA (dsRNA) has been shown to both cure and prevent myrtle rust in rose apple, a species of Australian myrtle. Artificial dsRNA is being developed in New Zealand as a spray that when applied to infected plants passes into the fungus that causes myrtle rust. Double stranded RNA makes it less likely for the fungus to become resistant. If it does become resistant the dsRNA can be modified to match any changes.

Myrtle Rust Information Card 7

REGULATION OF GENETIC TOOLS

RNAi does not change the genetic makeup of the organism that it interferes with. Therefore, while it does interrupt genetic processes it is not regarded as genetic engineering or genetic modification.

In New Zealand, RNAi technology is controlled by the governmental Environmental Protection Agency (EPA). The EPA currently does not allow RNAi to be used in trials outside of the laboratory. Trials can only take place in containment areas and any RNAi technology that is developed will then need to go through a comprehensive registration process before it can be used.

Myrtle Rust Question Card 8

QUESTION - What do we decide?

What tools do you want in your environmental management toolbox to manage this invasive species.

10.2.3 Varroa Mite

Varroa Mite Information Card 1

BACKGROUND

Honey bees are an important pollinator for commercial crops including kiwifruit and apples, and for grasses in agricultural fields. Honey bees are also used to collect honey from native forests to produce a range of speciality honeys including valuable manuka honey. New Zealand's 28 species of native bees do not make honey but are important pollinators of native plants.

Varroa Mite Information Card 2

INVASIVE SPECIES

The varroa destructor mite is a parasite that feeds on adult honey bees and their developing young. Varroa mites are visible on bees and on developing larvae and pupae. The young either die or survive in a weakened state. Varroa can also spread viruses to bees, such as the deformed wing virus.

Varroa mites were probably brought to New Zealand around 2000, possibly on a queen bee brought in illegally by mail or in personal luggage.

Varroa Mite Information Card 3

IMPACTS

European honey bees in New Zealand have no natural defences against varroa mites, unlike Asian honey bees that have co-evolved with varroa. Varroa can cause a beehive to collapse in less than three years. They can spread to other hives by bee-to-bee contact, or by humans shifting hives and trading queens.

In 2022, 6% of New Zealand bee hives were lost to varroa despite 99% of beekeepers doing varroa control. Beekeepers spend an estimated $14 million per year on varroa treatments. Controlling varroa mite across New Zealand may cost $400 million to $900 million over the next 35 years.

Varroa Mite Information Card 4

CURRENT MANAGEMENT TOOLS

Current management of varroa is mostly with miticides – chemical treatments designed to kill mites. There are some indications some miticides are becoming less effective and bee keepers may now need to use more to control varroa.

Varroa Mite Information Card 5

POSSIBLE GENETIC TECHNOLOGY MANAGEMENT TOOL

RNAi is a bio-control gene technology that scientists describe as a “promising tool” for managing varroa mite. RNA is found in all living cells. RNAi is short for “RNA interference”. This is a natural process that occurs in cells where small RNA molecules ‘silence’ or decrease the activity of specific genes by preventing them from becoming active. This is why RNAi is commonly called “gene silencing”.

Artificial double stranded RNA or dsRNA is being developed as a gene technology treatment for varroa mite. It is produced outside the cell and can target very specific genes.

Varroa Mite Information Card 6

IMPLEMENTATION OF GENETIC TOOLS

In experimental trials in New Zealand, dsRNA is being delivered in sugar water that larvae take up and pass to the varroa mites which feed on the larvae.

The dsRNA being trialled against varroa mite has not been found in other insects, including bumble bees and wax moths.

Currently honey contains a range of pesticides collected by bees from agricultural fields, as well as virus particles and a variety of RNA. If dsRNA was used for managing varroa mite, then honey would contain traces of that as well.

Varroa Mite Information Card 7

REGULATION OF GENETIC TOOLS

The use of double-stranded RNA is not considered by the Environmental Protection Agency (EPA) to be a genetic modification technology as it doesn’t spread from one generation of bees to the next or have an impact on the DNA in the cell nucleus of bees and mites.

It may be possible to use the gut bacteria of bees to spread the double-stranded RNA to mites but this technique would have intergenerational effects that mean that once released it could not be removed from the environment. This would be considered by the EPA to be genetic modification.

Varroa Mite Question Card 8

QUESTION - What do we decide?

What tools do you want in your environmental management toolbox to manage this invasive species.

10.2.4 Rats

'Rats' Information Card 1

BACKGROUND

Aotearoa New Zealand's biodiversity is unique. Millions of years of geographic isolation have resulted in a vast array of plants and animals found nowhere else in the world. Invasive rats are one of the biggest threats to New Zealand's biodiversity.

New Zealand has made a huge effort to remove invasive predators from islands, and we are a world leader in pest eradication and island conservation and restoration. However, pest-free sanctuaries and islands are less than 2% of New Zealand's land area.

'Rats' Information Card 2

INVASIVE SPECIES

NZ has 3 invasive rat species – Norway rats and Ship (black) rats arrived on European ships and kiore which were brought here as a food source by polynesians and have cultural significance for some iwi.

Rats breed rapidly, having several litters of 11-16 young each year, making their populations difficult to control. The ship rat is the most common and the largest threat to wildlife as it is a good climber and can reach birds nests in trees. Some rats can swim over 2km.

'Rats' Information Card 3

IMPACTS

All three rat species are a major threat to NZ's flora and fauna because they are omnivores and compete with native wildlife for food. Rats eat wētā and other insects, snails, frogs, lizards, tuatara, birds and bats, as well as the flowers, fruits and seeds of plants. Rats also cause threats to human health and agriculture.

The IUCN (International Union for the Conservation of Nature) 'red list' is a global inventory of the conservation status of species. New Zealand has more than 3000 native plants and animals listed as threatened or vulnerable, with about 800 of those listed as facing the risk of extinction.

'Rats' Information Card 4

CURRENT MANAGEMENT TOOLS

Trapping and poisoning are the two main methods to manage rats Trapping is done where trappers can access and traps are baited to attract rats but they need to be cleared and re-baited regularly so trapping is labour intensive.

Poisoning causes internal bleeding in the rat. Poison is placed in bait stations to protect non-target species, but secondary poisoning can occur from non-target species eating poisoned rats. 1080 is a poison that is applied aerially and kills close to 100% of rats. It is used in areas tdifficult to access. Aerial poisoning carries risks to other species, including native birds and hunted species.

'Rats' Information Card 5

POSSIBLE GENETIC TECHNOLOGY MANAGEMENT TOOL

Scientists worldwide are undertaking research to see if there is a genetic tool that could be effective at eradicating invasive rats.

The technique receiving the most attention is gene drive, which is a way to push an altered gene through generations of an organism. For rats, this could be a way to push a sterility or male-only gene through the population to reduce numbers. Gene drives can theoretically transmit a trait to 100% of offspring.

'Rats' Information Card 6

IMPLEMENTATION OF GENETIC TOOLS

The effectiveness of gene drives for rat eradication is still unknown. Research is in the early stages and currently focuses on computer modelling to explore technical questions and check assumptions if a gene drive were to be undertaken. Gene drives have been successfully developed for mosquitoes, flies, worms, and yeast.

International researchers have demonstrated that CRISPR-Cas9 technology could be used to edit the gene(s) required to bias the sex of a rat population to only males. This is likely the main consideration for rat eradication and control.

'Rats' Information Card 7

REGULATION OF GENETIC TOOLS

Gene drive is genetic engineering. Genetically modified rats as a result of a gene drive, would be classed as a new organism and so are currently regulated by the Hazardous Substances and New Organisms Act (HSNO Act). There are many technical, ecological, legal, ethical, cultural and social implications of developing gene drives to eradicate rats, need to be fully considered.

'Rats' Question Card 8

QUESTION - What do we decide?

What tools do you want in your environmental management toolbox to manage this invasive species.

10.3: Reviewed Social Science Literature on Deliberation

Table 10.1 Summary of Deliberation Factors when Considering the Development and Application of Biotechnologies for Environmental Management Purposes.

	Factor	Frequency	Example Qualitative Data
Technical	Unforeseen/ Unintended Consequences	24	*"So really it's not only the things you can deal with but it's the* unforeseen *things that can be a bit scary as well"* (Hunt et al., 2003). "*If we use a GE plant to protect the forest, we might unleash something with more far-reaching consequences than just the possums"* (Office of the Parliamentary Commissioner for the Environment., 2000).
	Controllability/ Mutation/ Specificity	30	"*I like that there's no health risks, there's no residue left anywhere. It's only affecting fruit flies and it's not affecting food or kids or waterways."* (Gamble et al., 2010)
	Environmental impact (negative)	19	*"…ecology is complex and the systems we are playing with are really complex. If you tweak one thing you can get flow on effects, by reducing the predators itself that will be a flow effect and there's nothing you can really do about that…*"(Kirk et al., 2020).
	Environmental impact (positive)	17	*"I'd be prepared to put up with some risk (e.g., if the parasite did live on and link into something else), with the benefit that it was going to wipe out the possum population* (Office of the Parliamentary Commissioner for the Environment., 2000).*"*
	More information/ research	13	*"We need to be informed and nothing hidden because I think that's when they get the problems*" (Gamble et al., 2010).
Social	Public Distribution of risk/benefits	15	*"[W]ith biotechnology (as with nuclear technology and the use of pesticides and herbicides) the risks are not carried by the individual who makes the decisions, nor only by those who stand to gain from the use of technology. Risk is carried by the society, by those who may not benefit at all, and/or by future generations*" (Office of the Parliamentary Commissioner for the Environment., 2000).
	Accountability	6	*"Mechanisms for ensuring that those who initiate decisions with potentially damaging outcomes (because thresholds are possibly near) should be responsible for any consequences… The onus of proof is shifting towards the risk creator*" (Office of the Parliamentary Commissioner for the Environment., 2000)"
	Transparency/ public participation	15	*"No matter what, if you go back to looking after people again, no matter what their social, or economic culture beliefs are, again if you've listened to what those are too, you are taking care of hopefully everybody's needs too and respecting"* (Gamble et al., 2010)*"*

	Factor	Frequency	Example Qualitative Data
Ethical	Animal welfare (positive)	12	*"The death of the animal that we are targeting is of natural reasons, so they don't die by unnatural causes, and because we don't have fertile males then the population is going to decrease it's a nice way to get rid of species*" (MacDonald et al., 2022).
	Animal welfare (negative)	12	*"There's a certain degree of suffering that I'm not prepared to put a possum through, even though it is a possum and I believe all possums should be got rid of"* (Wilkinson & Fitzgerald, 2006).
	Slippery Slope (precedent setting)	6	*"When you allow GE for possum control, that says to the New Zealand public "look at this wonderful too for controlling possums" they think perhaps it's not so bad if we have it in our food, or crops grown in the environment"* (Office of the Parliamentary Commissioner for the Environment., 2000).
	Playing God	12	"*Yeah, you're playing God, you're changing our natural environment"* (Coyle et al., 2003).
	Unnatural/wrong	17	*"One is 'natural', and the others are genetically modified"* (Wilkinson & Fitzgerald, 2006).
	For public good (not commercial)	9	"*There are vested interests, that's why we see so much research going into chemicals and GE, there may not be any money in other controls for these companies because they don't have patents in that area"* (Office of the Parliamentary Commissioner for the Environment., 2000). "*If it's to feed the starving people of the world then yeah absolutely. If it's to make money then no* " (Gamble & Kassardjian, 2008)"
Political	Distrust / Misuse / Carelessness	14	*"You can bet your bottom dollar there's someone out there somewhere who's got no ethics or has been paid for cloning the super sportsman or super soldier"* (Gamble & Kassardjian, 2008).
	Need for regulation	9	*"It's not science that has lost us control of the crops in our fields. It's the rush for profits by biotech companies chasing new markets, and the sluggish response of governments in regulating them*" (Office of the Parliamentary Commissioner for the Environment., 2000).
	International risk/ National Image (negative)	12	*"How does NZ want to promote itself internationally? We can't promote ourselves as clean and green fi we have biological warfare with our native plants"* (Office of the Parliamentary Commissioner for the Environment., 2000).
	International risk/ National Image (positive)	12	"*As long as it's* controlled *I think it could enhance our clean green image"* (Coyle et al., 2003) *"I think a potential benefit is sharing the techniques. If we can show it works here [New Zealand] we are potentially world leaders"* (Kirk et al., 2020).
	Intellectual Property	4	*"Ownership of nature, patenting life forms is wrong"* (Office of the Parliamentary Commissioner for the Environment., 2000)

10.4: Reviewed Social Science Literature Summary

The following table provides an outline of the social science literature reviewed, focusing on New Zealanders' perceptions regarding the potential development and use of genetic / biotechnology for environmental management purposes. Key elements were extracted including the reference, objectives of the study/paper, the main methods used and key findings. Aspects to bear in mind when reading this table:

- Only literature relating to the perception of genetic / biotechnology for environmental management purposes (i.e. conservation and biosecurity) was reviewed, though this was often subsumed within reports/studies with a wider scope e.g. agricultural applications or other pest control methods.
- Given the considerable length of some of these documents, many over 100 pages, priority was given to findings which were a) relevant to the research question and b) unique to that study.
- Note only key methodological details included (see original papers for more details about exact methods of development, pre-testing, piloting etc).

Table 10.2 Summary of social science literature focussing on New Zealanders' views of genetic / biotechnologies for environmental management purposes.

	Reference	Objectives	Methods	Key Findings
1	Attitudes to pests and pest control methods: Results from a sample survey of the NZ population (Sheppard, 1991)	To understand perceptions of the use of myxomatosis for control of rabbits in NZ	Telephone survey (N = 1,000) 23 trained interviewers - call backs allowed. Spoke to those 'who are at home now'. Bias however for those with listed phone directories. Higher proportion of females (at home), 57.1% as compared to males 42.9%	● 50.8% did not think that the introduction of natural enemies or diseases (*a type of biotechnology*) was a good way of controlling pests in NZ. ● Older and female respondents more likely to think it was not a good approach. ● Main concern was that it would become a problem (66.1%), followed by unknown consequences (13.9%) and need to do research (11.2%). ● There also seemed to be an influence of pest specificity, where people were more favourable towards the use of a 'general disease' when the pest was specified (e.g., movement of 19.5 to 36.8% of those who 'didn't know' about the use of diseases or natural enemies were in favour for its use for wasp control, 35.9% against diseases supported their use for possum control and, 29.4% generally against disease were okay for rabbit control. ● However, the specificity of the method seems to have the mixed effects (Over 30% generally opposed to use of a general disease were okay with myxomatosis while 25.5% in favour of a general disease were against myxomatosis specifically).

	Reference	Objectives	Methods	Key Findings
2	Genetic engineering in New Zealand: science, ethics and public policy (Macer, 1991)	Present a balanced discussion describing the future of GE – (with some focus on application in environmental spaces)	Face to Face survey[2] (N = 2,034 of general public)[3] 3 telephone surveys for specialised groups: farmers (N= 200), scientists (N= 258) and biology teachers (N = 277). Offered multiple biotechnological options to compare and contrast different qualities.	**Face to Face Survey** ● 82% had heard of biological pest control, 21% could explain it. Whereas 74% had heard of GE and 20% could explain it. ● 86% general population thought biological pest control was worthwhile to New Zealand (72% for biotechnology in general). ● 49% had concerns about biological pest control, and 55% for GE generally (this was slightly higher by education and those who felt they could explain it). ● Perceived unacceptance under any conditions for manipulation was 85% for plants, 71% for microbes, 56% for animals and 43% for humans. ● Other than farmers – groups were less comfortable for humans. **Specialised groups:** ● Scientists mostly concerned with research ethics (misuse of knowledge/lack of controls in experiments) – equal levels of concern but saw greater benefits. ● Farmers perceived less risk/more benefit for GMO for food and more aware of biotechnologies - but equally concerned for GE in general, with main concern was for human application. ● Biology teachers – had higher awareness of biotechnologies in general and lower concern overall compared to general public. ● All three saw more benefit to GE than general public.
3	Public perceptions of biological control of rabbits in New Zealand: some ethical and practical issues. (Wilkinson & Fitzgerald, 1997)	Public consultation to assist in the decision making on whether the Rabbit Calicivirus Disease (RCD) should be used as a method of biological control of Rabbits in NZ.	**Focus groups** (N = 11) in 1994 with government, primary sector, forestry, animal welfare, environmental and conservation organisations, and urban public and rural public. **Follow up focus groups** (N =7) to explore changed perceptions in 1996 with farmers, animal welfare organisations, central government policy advisors, scientists, urban women, and urban public. Follow	**Focus Groups and Survey Findings (reported together)** ● **Overall views of pest control methods for rabbits:** Labour intensive methods preferred but seen as expensive; biocontrol (including naturally occurring or gene modified rabbit diseases), were next most acceptable with a GMO being more acceptable than an imported natural virus. RCD more acceptable than unnamed virus. ● **Looking across support and reasons for support/concern, six groups emerged:** supporters (22%), concerned supporters (33%), undecided (13%), ethically concerned (22%), cautious (19%) and rejecters (19%).

[2] Note that the word 'interview' was used synonymously with the word 'survey' in this time. Looking at the results, it is inferred that this study employed face to face survey methods despite often being referred to as interviews.
[3] This report is referring to the results from another study (Couchman). This was not reported on directly as this was not available online and outside of the time scope of the research. Nevertheless, integration into this report – with additional methods – was seen as useful and included.

	Reference	Objectives	Methods	Key Findings
			ups were chosen based on qualitative differences. **Telephone survey** (N= 1,127) geographically stratified random simple domestic numbers.	● Straight forward support for virus would be received for **about one third of the population**, opposition for a third unsupportive, and about a quarter remaining undecided (though elaboration reduced acceptance).
4	Caught in the headlights: New Zealanders' reflections on possums, control options, and genetic engineering (Office of the Parliamentary Commissioner for the Environment, 2000)	Have a strategic conversation about genetic science and research with New Zealanders and its potential use for the control of possums.	**Reference group** (4 full day workshops & ongoing input/guidance). Participants included: veterinary science, animal welfare groups, rural stakeholders, science and research policy experts, activist groups opposed to GE, media and comms, Tangata Whenua, conservation organisations, biotechnology industry experts, regional government agencies and social research sciences. **Public focus groups (4 types):** ● General public ● Special interest groups (science experts, animal welfare stakeholders, PR practitioners, farmers, forestry experts, pest control specialists, biotechnology industry, people opposed GE and conservation /environmental interest groups). ● Provincial group. Followed a double-meeting methodology (ran a single workshop – give participants information - then two weeks later reconvened). No differences before and after	**Qualitative and Quantitative results (reported together)** **Key concerns:** ● **Safety and Specificity:** Biotechnologies might have irreversible and negative impacts on environment, other species and people (Including overseas where possums are native). ● **Unpredictability and unknowns**: People want rigorous and extensive, long-term, testing. Uncertainty of unintended effects. ● **Humaneness**: Farmers concerned because of consumer perceptions overseas. Some people varied according to the degree to which they saw the problem as pressing. ● **Effectiveness**: How well would they actually work? Would it be permanent or temporary? What are the changes and consequences of reinfection? How much better are they than current methods? Can immunity develop? How will this interfere with breeding rates? ● **Ethics:** Questions of 'should' rather than 'can'. What is 'natural' and 'not natural'. Closer to order of things - more natural. Some didn't see a difference between animals and humans. ● **Risk:** While impossible to get to zero risk, people want to explore many aspects including: timeframes of research, what risk means to different groups, risk assessment frameworks, how are they weighed against the benefits? how does it compare to alternatives? ● **Responsibility:** who carries the burden of proof? Who will take on the liability? How do we cater for multiple interests? How to include a range of perceptions? How to foster trust? What role does science play? Industry? Government? Concerned Citizens? Media?

	Reference	Objectives	Methods	Key Findings
			so double-meeting method not repeated. ● Tangata whenua hui: Similar to focus groups but was conducted on a one-on-one basis. Included anti-1080 protestors, and farmers with interaction with possums and control and those economically impacted by possums. ● Included commissioned ethics paper and literature review (method details not provided).	
5	Genetic engineering: The New Zealand Public's Point of View (Gamble, 2001)	To collect, analyse and disseminate information on public perception of transgenic products relevant to needs of NZ policy makers, research planners, appropriate public sector groups and industry.	**Delphi method** - expert workshops/focus groups: Two-way feedback system allowed for open communication between experts - pooling of insights and ideals. **Approach** - initial survey of experts using open ended question, which was tabulated and sent back to participants for further comment. This process of clarification was continued until a consensus or pattern of conflict emerged. The self-completion format allowed for anonymity. **Questions:** Given the broad scope of potential issues, experts were which would be most relevant to their organisation (E.g., environmental organisation and public concern about impact of biotechnologies).	While mostly focussed on GMO of food stuffs, some broader discussions were had about the use of this technology in other areas, including environmental management. **Overall Factors influencing perceptions:** ● **Unforeseen consequences:** perceived unpredictability of effect of use of biotechnologies on the environment. ● **Balanced trade-offs:** creation of plants with desirable/undesirable properties and potential development of tougher pests/diseases or eradication of pest/diseases. ● **Controllability:** Level of control over the process (particularly genetic). ● **Regulation:** Specific groups saw impact on their industry – need to consider Māori/environmental interests - need for regulation use and development. ● **Cultural considerations:** exploitation vs conservation of the environment, commercial gain vs public good. Effect on clean-green image. ● **Slippery Slope:** GMO may affect the advice/precedent given on biodiversity, land management, and protection of indigenous habitats. ● **Engagement:** Experts recommended focus groups with range of consumers.

	Reference	Objectives	Methods	Key Findings
			Presentations: (N=2) for final feedback though no environmental organisations were present.	
6	Sabotage and subterfuge: public relations, democracy, and genetic engineering in New Zealand (Weaver & Motion, 2002).	Provide a discussion on the political influence on how the public has been engaged when it comes to GE (and biotechnologies more generally)	Description and discourse analysis of the public relation patterns following the king-salmon case in New Zealand - providing background context to people's responses to GE and science/research development in general in New Zealand.	**King salmon case study:** ● The ‘Gene Technology Information Trust’ was set up to “provide authoritative gene technology information to enable NZ to make informed choices about the use of the technology” run by a private, foreign owned company. ● Its aim was to be an impartial informant with an interactive website, information packs and brochures, public help line and road show seminars. ● However, a private PR company got most of the funds with sponsorship coming from Monsanto ($27,500), NZ beef and Lamb marketing Beuro ($6525), NZ kiwifruit ($5625), NZ plant breeding research association ($3749) and Agriseeds ($1000). ● Science communication was however seen as biased – with documentation from the company explicitly stating that only positive information should be shared while framing the findings in a ‘rational’, ‘dispassionate’ discourse. **Discussion:** Exemplifies the background context for why some publics may have concerns when it comes to the communication of science, particularly in the biotechnology space. In the case of King Salmon, there was evidence of an intentional construction of a ‘rational’ scientific and ‘dispassionate’ frame - that nevertheless only presented positive findings and understandings of GE, with an unrepresentative and narrow focus on the concerns and benefits for human health - not the environment.
7	Public understandings of biotechnology in New Zealand: factors affecting acceptability rankings of five selected biotechnologies	Explore and examine how and why focus group members ranked the acceptability of five selected biotechnologies	**Focus groups** (N = 11). Interviewing was conducted using Donna Haraway's dialogic approach - which captures not only text and personal views and attitudes, but the interrelationship between research subjects and their interpretations of the world. Recruitment was conducted PTA’s.	**Explicitly mentioned factors influencing rankings of specific novel genetic / biotechnology:** ● **Balanced Trade’ offs:** positive must outweigh the negative impacts (though acknowledge 0% risk is not possible). The benefit must be a societal and equitable one, not just commercial one. ● **Fair decision-making process:** Unbiased and reputable research done by trusted scientists, given to public to decide. ● **Longevity**: Need to avoid the problem-solution-problem scenario (where the solution becomes a new problem; PSP).

	Reference	Objectives	Methods	Key Findings
	(Hunt, Fairweather & Coyle 2003)		**Locales:** 2 workshops formed the general guide, after which the remainder were conducted across the south and north islands. 1) 3 focus groups were conducted with Asian, Pacific and Western Europeans. 2) No specific Māori group was run but cultural interests were integrated into sessions (to avoid overlap with Mere Roberts who focussed exclusively on Māori and biotechnology). **Interview Approach**: presented with a series of exemplars of recent developments biotechnologies (including environmental) pertaining specifically to New Zealand. **Initial question**: how they would like to see New Zealand in 20 years' time? Followed by discussion into specific examples of new biotechnologies. **Note:** For the purposes of this research, results only pertaining to biotechnologies for non-commercial, environmental purposes are reported (i.e., the remediation of soil from DDT and the reduction of methane production in sheep using bacteria)	● **Controllability**: perception that there are too many quick fix options that go wrong down the line. Technology needs to be introduced in a controlled and cautious way. ● **Information:** Many people are aware that they don't have enough information but acknowledge that even if they had it, they would not feel competent to make a decision. **Implicit factors influencing rankings:** ● **Complexity:** The more complex - the less acceptable. ● **Familiarity**: Some perceived that if its already out there, it must've been 'tested' and 'good.' ● **Fear of unforeseen side-effects**: need safeguards against unknown environmental impacts such as mutations. ● **Fear of slippery slopes**: Setting a precedent that once approved for one application, easier for other applications. ● **Distrust**: Despite regulation, perception that people will still break the rules/misuse the technology (particularly biotechnology companies). ● **Playing with God/interfering with nature**: more ineffable discomforts that disrupt the 'natural order of things.' Perceptions of human animal relations and what is suffering emerged. Nature seen as threatening or good. ● **Personal experience**: those that had been affected by the problem, more likely to get support (e.g., Farmers were more supportive of DDT remediation).

	Reference	Objectives	Methods	Key Findings
			and key variables likely influencing their decision making.	
8	Public Understandings of Biotechnology in New Zealand: Nature, Clean Green Image, and Spirituality (Coyle, Maslin, Fairweather & Hunt, 2003)	Explore and examine how and why focus group members viewed a series of five selected biotechnologies relate to New Zealand's Clean, Green image and Spirituality.	**Same as above** (7) with focus on discourse around impact of biotechnologies on New Zealand's Clean, Green image and Spirituality concerns. **Analytic Approach**: Drew from biologist, Donna Haraway's view of 'situated knowledges,' - where scientific knowledge is situated within personal context. Science is not 'view from above'. As such, transcriptions from audio-recordings were integrated with field observation from focus groups and everyday life.	**General finding:** Discussion about genetic / biotechnologies seen as to relate to both New Zealand's future (including environmental) but also to its identity as an 'innovative' country. **Findings relating to genetic / biotechnology's relationship with views of Nature, Clean Green New Zealand And Spiritual Values:** ● **Nature:** multi-faceted, complex construction that is historically/socially bound. Ranging from 'nature is good' and 'what's natural is best' to 'nature is threatening and will punish us if we play God.' ● **Biotechnologies & nature**: Depending on definition of nature, perceptions of genetic / biotechnologies ranged from being perceived as being potentially able to 'enhance' nature (moving away from pesticides or 'killing things') to wrongfully interfering with the 'natural order of things', making irreversible and dangerous changes to the environment (in a way making it less natural). ● **Biotechnologies & NZ Clean Green Image**: Understood as a national icon, but one that existed either in the past or a potential future utopia that participants strived to reach. This utopia could either be maintained/accomplished by steering away from genetic / biotechnologies or by using it to sweep up the remnants of past mistakes (e.g., pesticide contamination/DDT). ● **Biotechnologies & spirituality**: Absence of references to spirituality was revealing, suggesting that New Zealanders feel uncomfortable discussing this issue in public. The few references were mostly from a Christian point of view where specific biblical codes of ethics were cited in relationship to their receptivity towards biotechnologies "e.g., They want to be smarter than Him [God]."

	Reference	Objectives	Methods	Key Findings
9	New Zealand social research on impacts of genetic modification and related biotechnologies: An international strategic review (Wynne, 2003)	Summary of general themes and future trends of social research of biotechnology, noting any research gaps, in general terms and recommendations for future NZ research.	Strategic and comprehensive review of genetic technologies social scientific research in New Zealand (mostly focussed on GMO but with references to broader discussions about biotechnologies and multiple applications, including environmental).	**Overall (generally consistent with international trends - in 2003):** ● Shift towards more qualitative and interactive forms of attitude and dialogue research in the portfolio is well-founded and reflects international trends. ● Emphasis on public attitudes, dialogue, and communication, and on ethical issues. ● Less socioeconomic, regulatory systems/ instruments - particularly how privately/commercial funded research will be integrated into policy/public sphere. ● Less on human-behavioural research (which is particularly needed as the exploration of a case-by-case release of GM's will require an understanding of 'co-existence' with these new technologies). ● Little or none on the implicit social and cultural assumptions embedded in scientific and technical knowledge. ● Little is known on how Intellectual property and knowledge commodification will be conducted and socially received. ● Little is known (though desired buy the public) about how liability and unanticipated consequences will be managed.
10	New Zealand public acceptance of biotechnology (Cook, Fairweather, Satterfield & Hunt, 2004)	Identify and determine the relative importance of factors involved. in perceptions of biotechnologies in New Zealand. **Part of same programme of work as 7 & 8**	**National postal survey** (N = 701) addressed 'to the householder,' with follow up non-response telephone interviews. **Questionnaire:** Began with definition of biotechnologies as well as related terms (GM, GMO, and GE). Range of items (N = 199) included: ● Concern of biotechnology as a social issue (and broader issues facing society). ● Acceptability of 22 biotechnological items (Incl. for environmental & conservation purposes) ● Views of biotechnology. ● NZ identity & Clean, green NZ image	**Overall views of biotechnology:** ● It is a public concern, but often not top priority with 51.6% concerned or very concerned. ● Overall, even split between acceptance and non-acceptance, with acceptable sitting at 45.6% whereas many felt it was unethical or unnatural (51.9% and 42% respectively). **Biotechnology beliefs:** Out of 14 captured, the top 4 beliefs were: ● The use of biotechnologies needs to be transparent (90.1%), ● When we try to play God we make mistakes (64.4%), ● It feels wrong to mix genetic material from plants and animals (53.4%) and; ● Biotechnology can fix the environmental problems that have been caused by humans (51.8%). **Perceived Pro's and Con's:** ● Those positive saw it benefiting public good (not companies/profit) but largely believed that corporations would benefit the most (80.3%). ● Out of all the biotechnologies, the most apprehension was situated around those with GE.

	Reference	Objectives	Methods	Key Findings
			● Views about technology in general ● Beliefs about nature ● Post materialist values ● Spiritual beliefs ● General viewpoints ● Demographics **Analytic approach**: regression analysis to test two models as explanation of a general attitude towards biotechnologies in New Zealand.	● This apprehension was mostly due to fear of a lack of compliance with rules/regulations (83.7%) and the problem-solution-problem scenario (83.7%). ● There was a lot of concern about distributions of wealth (66.6%) **Nature Beliefs:** ● Most prevalent views on nature are that interference leads to unpredictable consequences (77.1%) ● Its dynamic (74.1%), ● We [humans] have a special place in nature (75.3%). ● Many remember when environment was more 'natural' (68.5%), ● We [the environment] can only absorb a limited amount of damage (72.1%). **NZ identity beliefs:** ● More thought agriculture (95%) was a part of NZ identity than the clean green image (55.7%). **Key application differences:** the use of GM in making a bacterium, making a fuel, and developing a virus were more acceptable than the use of a <u>soil bacterium for pest control and the cloning of the kakapo</u>.
11	New Zealanders and Biotechnology: Attitudes, Perceptions and Affective Reactions (Cook & Fairweather, 2005)	Continuation of the research programme surveying the public to assess current responses to biotechnology and to examine possible changes in attitudes over time **(rows 7, 8 and 10)**	**Postal survey** (N = 657) with Questions mostly drawn from previous (**row 10**) research, looking to statistically examine differences in views towards biotechnologies between 2003/4 and 2005. **Questions (155 items) included**: ● Acceptability of 12 examples of biotechnologies as well as a whole ● Perceptions, beliefs affective reactions towards specific applications (including, GM bacteria to clean soil from DDT	**Overall findings:** ● Acceptance for biotechnology as a whole did not increase (falling at 43.6%), with fear of irreversible harmful outcomes (29.2%) as well as it being unnatural 48.9% emerging as key concerns. ● 77.6% saw biotechnologies as creating more problems. ● Should only be considered with extensive public consultation (68.5%) ● Main predictor variables were beliefs about nature and beliefs about technology. **Acceptability for specific environmental biotechnologies**: ● Increased acceptance for virus that induces infertility in possums (53.5% to 57.5%) for pest control purposes. ● Increased acceptance for cloning kakapo (34.5% to 41.9%) for conservation/survival purposes.

	Reference	Objectives	Methods	Key Findings
			as well as virus to reduce possum fertility. ● Elements of worldviews Included: spiritual beliefs, beliefs about nature, attitudes towards tech and post material values. **Sample:** ● Similar to previous, over-representation of extremes. ● Similar characteristics to 2003/4 (mostly observing differences in attitudes).	**Specific removing DDT from soil remediation example:** ● The belief that the use of this technology will result in irreversible harmful outcomes increased from 15.1% to 40.8% ● Major concern that it couldn't be removed from the soil 69% - as well as negative views from overseas consumers (47.2%). **Affective Responses** ● Most participants were self-aware that their reactions to biotechnologies come principally from how they feel about it (73.4%), followed by understanding of risks and benefits (61.9%) and finally ethics or morals (37.7%) ● A similar weighing of extremes emerged with 58.6% finding it interesting, while 52.1% feeling apprehensive and 37.1% feeling uneasy. Indeed, 40.8% found it acceptable whereas 40.7% found it wrong. **Spirituality and Nature** ● No difference between spiritual beliefs about nature and technology ● Nature imbued with spiritual qualities
12	Space, time, and nature: Exploring the public reception of biotechnology in New Zealand (Coyle & Fairweather, 2005a)	Explore the meanings of various "natures", the ways they impact upon how people draw boundary lines between "natural and unnatural / artificial" and how these boundary lines impact acceptability of new biotechnologies.	**(Same study and therefore methods and data as rows 7 & 8)** **Note:** For the purposes of this research, results only pertaining to biotechnologies for non-commercial, environmental purposes are reported (i.e., the remediation of soil from DDT and the reduction of methane production in sheep using bacteria) and key variables likely influencing their decision making.	**Overall Finding:** nature is a contested, manipulatable, and varied concept (i.e., there are different chronotypes) and that participants manipulated nature chronotypes) to justify any judgement they made or action they took, without the need for some form of moral accountability (*when it comes to decisions around biotechnologies)*. **5 chronotypes in relation to biotechnologies (with overlap):** **Wise nature:** nature personification as 'mother earth' (caring, nurturing). ● Participants holding this view placed great trust in the wisdom of nature, a moral frame of reference for the decision-making on biotechnologies. ● Biotechnologies often seen as 'inferior' and a sign of humans 'playing God'. **Traditional nature:** A nature of time-past and reminiscence for what once was. ● Participants holding this view saw 'nature' as having a slower pace of life that not reversible (near static). ● Biotechnologies seen as speeding up nature time which is dangerous. ● Confusion emerged as some wanted progress (to realise the Clean, Green New Zealand image) but also trusted traditional methods. ● Clean Green New Zealand and range image of 100% Pure New Zealand.

	Reference	Objectives	Methods	Key Findings
				Pure nature: Sanctified, revered and ideally untainted with 'timeless' values. ● Participants holding this view saw nature separate from everyday urban experience (Everyday life doesn't feel natural/pure) and there are clear boundaries between natural and artifice. ● Biotechnologies therefore seen as a perversion to the 'pure' way of Nature. **Complex nature:** Nature as a process - dynamic, complex, transient and evolving. ● Participants holding this view of 'nature' saw it as an actor that couldn't (and shouldn't) be directed through human intervention. ● Biotechnologies seen as an extreme of 'humans competing with nature' - which elicited fears of manipulating uncontrollable, unpredictable process that would result into a chaotic world. ● As such, biotechnologies often seen as a 'quick fix' – in our avoidance of sustainable changes (A critique of society as a whole). **Balanced nature:** Similar to complex but with checks and balances to keep things 'in the right place.' ● Participants holding this view of nature often saw biotechnologies as throwing things 'out of balance' characterised by monsters that could mutate and change. ● Laboratory research seen as an 'uncoupled' from the competitive complexity of the external, natural world.
13	Challenging a place myth: New Zealand's clean green image meets the biotechnology revolution (Coyle & Fairweather, 2005b)	Exploring how the potential biotechnologies are viewed in relation to the 'Clean, Green image' aspect of New Zealand identity.	**(Same as rows 7, 8 & 23)** **Note:** For the purposes of this research, results only pertaining to biotechnologies for non-commercial, environmental purposes are reported (i.e., the remediation of soil from DDT and the reduction of methane production in sheep using bacteria) and key variables likely influencing their decision making	**Overall Finding:** with the increasing recognition of environmental degradation, the icon of clean green New Zealand was perceived as temporally polarised –some as seeing it as part of an idyllic past or paradise future (but rarely was it seen as being representative of the present). **Clean, Green Image and Biotechnologies:** ● For some, biotechnologies were seen as a way of realising the distant ideal (either historically or in the future) by finding solutions to problems that current methods are unable to do as well as moving from 'harmful' methods (such as toxins/pesticides etc). ● This was often juxtaposed with the image of New Zealand being a country of 'innovators.'

	Reference	Objectives	Methods	Key Findings
				● For others, biotechnologies were seen as moving further away from this distant ideal, by introducing ‘unnatural’ entities that could be destructive down the line and fundamentally irreversible.
14	From dialogue to engagement? Learning beyond cases Cross Case Study Learning Group (Winstanley et al, 2005)	Aim of the Dialogue Fund Evaluation Team (later called the Cross Case Study Learning Group) was to produce an integrated analysis of all information available from the project teams.	A thematic analysis across projects conducted to assess key learnings about what is considered good dialogue between science and society (including on topics such as biotechnology). **Projects include:** ● Manaaki Whenua: A process for enhancing dialogue on biosecurity issues. ● Science Dialogues: The communicative properties of science and technology dialogue. ● Hands across the water: Developing dialogue between stakeholders in the New Zealand biotechnology debate. ● Finding common ground: Improved wastewater management systems that address Māori cultural and spiritual values.	**Overall findings:** Across the four studies, it was found that effective dialogue/public engagement about science and technology (including about biotechnologies for environmental purposes) includes: ● Set up of opportunities for shifts in individual and organisational understandings. ● Build capacity and willingness for further engagement. ● Consider culturally appropriate approaches. ● Be included early in the design of the scientific project (i.e., upstream) **What does good dialogue look like?** ● Making people feel safe and welcomed ● Setting time/resources aside for relationship building ● Structure that is defined but flexible (and adaptive) ● Opportunities for people to take on different perspectives. ● Connecting activities (e.g., such as food sharing) & informal interactions ● Having clear expectations - and outcomes - of the event ● Good facilitation (respectful listening/turn taking/consideration) ● Accepting differences while coming to shared understandings and perspectives. **Beyond dialogue:** ● Researchers can benefit from the experience. ● Social scientists should not be brought in at the end of the research process on 'how to engage the public' - their knowledge, and those who they represent, is an integral part of the development and decision-making process. ● Providing opportunities for follow up makes it 'real' and sustains engagement: dialogues are rarely successful as one-off events. ● People enjoy difference in the right context.
15	Pest Control: Does the Answer Lie in New Biotechnologies?	Exploring option of biotechnologies for their use for New Zealand	Book chapter mostly focussed on technical feasibility of genetic / biotechnologies in New Zealand conservation, the review also	**Overall Finding:** Most people accept the need for controlling mammalian pests and prefer manual methods (shooting/ trapping) which are seen to be more humane and

	Reference	Objectives	Methods	Key Findings
	(Duckworth et al, 2006)	conservation, situated within wider context of genetic technologies.	discusses social aspects with reference to surveys/focus groups from other research (local and international).	environmentally friendly. People are least accepting of poison, with biotechnologies sitting between manual methods and toxins. **Critical Aspects:** ● People rate themselves as less knowledgeable about biological controls – and so higher acceptance may be partially due to less knowledge and media exposure. ● Biotechnologies are often seen as being able to address animal welfare concerns (but not always). ● People seem more accepting if they feel they have a good level of influence, good access to relevant information and time to learn and discuss issues. ● Suggestion that how technology is introduced to the public and how much control they have over long-term effects (i.e., risk reduction) may be as important as the technological performance itself. **Conclusion**: ethical, social, and political acceptability needs to occur separately for each approach. Dialogue needs to include aspects of effectiveness, specificity, delivery systems.
16	Public Attitudes toward Possum Fertility Control and Genetic Engineering in New Zealand (Wilkinson & Fitzgerald, 2006)	Determine likely public response to the biological control of possums as compared to other, currently used methods.	**Focus groups** (N = unknown) conducted in 1999 with stakeholders with interest in possum controls (formed part of the PCE work). **Sample:** ● Urban public ● Mixed provincial public ● Science and health experts ● People with ethical interests ● Industry practitioners ● Opponents of GE ● Conservation/environmental interest groups ● South Island iwi group	**<u>Focus Groups</u>** **Problem:** possums seen as a NZ problem - and a need to prevent further damage for the sake of biodiversity. **Controls:** ● Most participants didn't like 1080 or international image for using it. ● Interfering with fertilisation by rendering possums sterile was widely acceptable (though contraception was preferred). ● Saw halting hormones more favourable (no GE) - and so still seen as natural. ● Safe synonymised with 'specific' ● 'Humaneness was important (i.e., quick/painless death or lead out a normal life) **Delivery Method:** ● Specificity - need it to only target one species. ● Unease about other organisms delivering fertility control - esp. about longer-term specific and the use of GE organisms. ● Lack of endorsement for the use of GE organisms to spread the control.

	Reference	Objectives	Methods	Key Findings
			National survey (N = 1,002), conducted in March 2001 - asked about perception of the nature and extent of possum problem and their perceptions of the various methods for fertility control of possums and their likely action to support/oppose the introduction of such controls.	<u>**Survey**</u> **Problem:** 96% agreed possums are a problem ● Most had heard of GE but few knew a lot. ● 36% indicated they'd be willing to learn more. **Control** ● Number one acceptable form of control was fertility control (up to 57% very acceptable). ● Current possum control (1080 and trapping) only very acceptable to 30%. ● Anticipate fertility control to sit between 75% and 81% for acceptance, with 76% being comfortable with interfering with fertilisation. **Delivery Method:** ● Participants presented with 2 Delivery methods (each involving GE: one a plant and one bacteria) where one would only be in the lab the other would be released into the environment. ● Although methods more acceptable than trapping and poisoning, still less acceptable than two methods of fertility control. ● <u>Acceptance in principle, but reality of delivery less accepting.</u> ● Tended to be polarised either in the extreme very unacceptable - or very acceptable position, though slanted towards the negative at 31%.
17	The privatization of public talk: A New Zealand case study on the use of dialogue for civic engagement in biotechnology governance (Cronin, 2008)	Discussion on the use of 'dialogue' for civic engagement in the topic of biotechnologies in New Zealand.	**Review and discussion** of: “The Hands across the water project” which trialled three approaches to engagement. **Note:** The ‘hands across water’ project was <u>not covered specifically in this report</u> as its focus was outside the scope (i.e., on Genetic Engineering for commercial / agricultural applications) However, <u>key insights were extracted</u> about public engagement	**Overall Finding:** Approaching the discussion from a dialogue point of view (rather than consultation) resulted in key advances in the overall discussion including: ● Participants were able to **discover ‘common ground,’** where ‘**issue mapping’** was particularly useful for identifying conceptual overlap [between community and science perception of risk and acceptance]. ● **Participants were able to move beyond ‘argument’ based communication** where there is a winner and a loser. New conversations emerged about shared expectations around the social and environmental applications and impacts of genetic technologies that were acceptable to scientists, science managers and community stakeholders. ● All four projects funded under MoRST dialogue Programme **were successful for reducing conflict and identifying common technological preferences** and innovation that could contribute to economic development and improved science and society relations.

	Reference	Objectives	Methods	Key Findings
			with the use of differing dialogue methodologies including: ● Appreciate inquiry (Cooperrider et al. 2003), ● The civil conversation and (Chasin et al. 1996) ● Issues mapping (Cronin and Jackson 2004).	**Specific findings:** ● **Shared interests emerged** in the a) questioning of **commercial drivers** of biotechnologies, b) the role of the **media in fostering conflict** and c) the importance of **civic engagement in technological decision making**. ● Biotechnological governance requires o public dialogue, transparency and democratic engagement. **o A normative or strategic conversation** o Expansion beyond economic interests o Engagement at policy development rather than operationalisation stages.
18	The use of selected community groups to elicit and understand the values underlying attitudes towards biotechnology (Gamble & Kassardjian, 2008)	Examine the social, cultural. and spiritual dimensions of biotechnology through an analysis of five selected community groups	**Focus groups** (N= 10) 2 per category: ● Scientists Horticulture and food research - email to all scientists from all areas of research regardless of knowledge or opinion on biotech ● Religious background of Buddhism ● Mothers with young children ● Business-people (company owners) ● Environmentalists/Conservationi sts **Relevant discussion topics:** ● Applications of biotechnologies (e.g., human vs plant gene source, commercial vs altruistic) ● Lifting of the moratorium on application for release of GM organisms ● Opinions regarding the technologies in general ● Opinions on specific applications (including DNA fingerprinting for conservation purposes)	**Overall Findings:** ● **Buddhists, environmentalists, and mothers:** shared commonalities in their worldviews. They were the least optimistic about biotechnologies and expressed concern with unknown long-term consequences for health and the environment. They wanted strict regulation and were cynical and resentful of physical and moral negative impacts of business considerations on quality of life and preservation of nature. ● **Business-people**: distinct in their attitudes towards progress. More optimistic but still concerned with consequences and wanted assurances to prevent misuse. ● **Scientists:** shared similar concerns with non-scientists, particular around who would benefit from the technology/future generation impacts and ethical issues of animals being used for our benefit (though this may often be missed as the layperson and scientists were often not communicating at the same level even though they had the same concerns, but had different languages. Scientists more comfortable with 'lack of proven safety.' **Perceptions of the GMO debate:** ● Seen as polarised and extreme. ● Participants felt the debate was inaccessible to influence and unavoidable (general feeling of powerlessness. ● Scientists felt powerless as perceived as not being listened to

	Reference	Objectives	Methods	Key Findings
19	Guardians of our future: New Zealand mothers and sustainable biotechnology (Gamble, 2009)	Seek to understand mothers' views on specific 'sustainable technologies (*as identified in Gamble & Kassardjian, 2005*) in more depth and the values underlying them.	**Focus groups (N = 10**) with women with at least one child 10 years or younger. **Topics of discussion included:** ● Bioremediation/bioprospecting ● Developing genetically modified pest-resistant trees. **Prompts included:** what are the key issues? What values they felt informed their views? What the groups felt would be most impacted on? Under what circumstances the application could be sustainable? Which aspect of sustainable development should take precedence in deciding what is an acceptable (e.g., economic, social, environmental, cultural, or ethical).	**Mothers' views on Bioremediation/Bioprospecting:** ● Perceived as most natural and therefore most acceptable. ● Wanted to know how the fungus would be grown/collected (concerns about the impact on kauri and the environmental/food chain. ● <u>Environment of greatest concern to the mothers</u> ● Liked the idea of soil being clean for future generations. ● Distrust of overseas companies (seen as environmentally irresponsible). ● Biodiversity/biosecurity was a top priority (assurances required that it wouldn't affect kauri followed by its function (removal of fungus) and specificity (that it wouldn't affect anything else). ● Third major concern was around ownership (Overseas companies would leave New Zealanders with limited control). **Mothers' views on developing genetically modified pest-resistant trees:** ● Initial discussion about GM pest-resistant trees typically focused on spraying and its negative impacts. ● Prevention seen as better (e.g., border control) and natural alternatives. ● Concerns around unforeseen consequences (e.g., will it develop resistance? Impact on other species? Down the food chain? ● Two main factors of importance for acceptance: 1) that it looked after people (proven safe and was done for good reasons) and 2) didn't negatively impact the environment.
20	Interviews with New Zealand community stakeholders regarding acceptability of current or potential pest eradication technologies (Gamble, Payne & Small, 2010)	Explore community perceptions of current/future pest control technologies (to inform the B3 programme - Better Border Biosecurity)	**Three pest control techniques explored**: ● Aerial spraying using biopesticides ● Aerial spraying of pheromones ● Sterile insect technique. **Semi-structured focus groups and interviews (N= unknown)** with people who had traversed overseas at least once in the last year (people recently experiencing biosecurity.	**Response to techniques** ● **Sterile insect biotechnologies** (most acceptable) seen as having no health concerns and sounded the most natural and did not require spraying. ● **Irradiation** (mostly accepted though Department of Conservation participants had more concerns about safe breeding environment. ● **Sprays** (least accepted) regardless of what was in it (e.g., biopesticide or pheromones ● **Pheromones** (more acceptable than bacteria) **Factors of Consideration:** ● **Context:** many opinions were contextualised within people's experiences with Agent Orange experience. Greatest resentment appears to lie in experience with biosecurity measures imposed with no or tokenistic consultation (E.g., painted apple moth)

	Reference	Objectives	Methods	Key Findings
			Sample: ● General public (focus groups) ● City/regional councils (Interviews) ● Department of Conservation. (Focus groups).	● **Environmental Impact:** How long would it be in the environment? Would it affect anything other than the target species? Can it develop resistance? ● **Safeguards:** Is there sufficient testing? Have alternatives been considered? ● **Trade-off concerns**: Need to consider the cost of using it vs damage done by pest and who benefits (trade-offs need to be re-done for each application). ● **Engagement:** Open and honest communication required.
21	The "Citizen Scientist": Reflections on the Public Role of Scientists in Response to Emerging Biotechnologies in New Zealand (Cronin, 2010)	Exploring the role and positioning of scientists in the engagement dialogue about biotechnology with community groups in New Zealand.	**Review and discussion** of: "The Hands across the water project" with an analytical focus on the 'citizen scientist' and 'scientific citizen'. **Note:** The 'hands across water' project was <u>not covered specifically in this report</u> as its focus was outside the scope (i.e., on Genetic Engineering for commercial / agricultural applications). However, key insights were extracted regarding broader communication of biotechnologies from qualitative discussion with N = 45 science participants.	**NZ scientists' views on the social dimensions of science** ● Scientists often felt responsible for highlighting to the public the hazards of science and technology (particularly in the space of biotechnologies). ● In many cases, scientists agree the public needs to be involved and problems need political as well as technical/scientific solutions. ● Scientists also questioned the commercial outputs of science policies. **Hands across the water - scientists engage in dialogue with citizens on biotechnologies in New Zealand** ● As with any cohort, there was diversity in views among scientists, with varying attitudes towards science and society by scientists. ● When asked about aspects such as their social awareness of their work, any sense of responsibility and engagement, several wanted separation between science from social. ● However, others saw it as connected to ethical and spiritual concerns raised by biotechnologies. ● When it comes to biotechnologies, while many of the scientists surveyed were more comfortable with it (as compared to non-scientists), most opinions had shades of grey, as they saw risks similar to that of the public (unknowns, uncontrollable, irreversibility - need for caution as well as cultural, health, economic and ethical issues).
22	Science and technology development and the depoliticization of the public space: The case of socially and culturally sustainable	Analysis of the MoRST five-year, research study in 2003 designed to create public dialogue regarding sustainable biotechnology in	**Aim:** explore of why such a successful stream of research failed to influence policy and public debate. **Analytical approach:** Findings and critical review of 21 publications (including peer reviewed publications as well as workshops, end-user	**Five emergent Key themes** **Values:** ● Biotechnology decisions are a 'subjective socio-political' risk assessments. ● Understanding values is a 'high priority' (Included Māori values). ● Biotechnologies raise ethical issues with potential to disrupt social, cultural, and moral norms. Arguments that the GM debate was rooted in conflicting economic, environmental, and cultural/spiritual beliefs.

	Reference	Objectives	Methods	Key Findings
	biotechnology in New Zealand (Macdonald, Varey & Barker, 2011)	New Zealand and use the findings to shape public policy.	presentations, academic articles, conference presentations). First author summarised key contributions and was checked by second and third authors. The findings where then thematically analysed. Regular meetings between authors occurred in assessment and debate of themes.	**Identity:** ● Public views about biotechnologies are reflected in multiple identities in NZ culture (identity as the custodians of an environmental paradise in tension with knowledge and innovation economy. ● Scientific experts and cutting-edge technology often contrasted with 'organic products.' **Participation & Engagement (themes combined):** ● NZ prides itself on being fair and transparent in its science (hence the investment in dialogue and inviting citizens to be 'part of the process)' ● Set up of Futurewatch programme represented this whose aim was to "*scan, analyse and disseminate information on emerging biotechnologies to enable constructive engagement*." ● However, later events, such as *Biotechnologies to 2025* moved back to a one-way knowledge-deficit communication model. ● Ethical consideration became subordinate to scientific advances that would ensure NZ is at the forefront of genetic research and development. ● Pre-determined plans for engagement left people cynical/reluctant to participate. **Discourse:** ● The public felt "alienated" during the GE debate, leaving them feeling powerless in the face of the commercial profit imperatives which they regarded as driving decision making about genetic modification. ● Exclusion of public from informed debate left a subsequent sense of ignorance about the biotechnologies and an overreliance on identity of 'growth, profit, and market share.' ● *Catching the Knowledge Wave* conference was used to legitimise pre-determined goals, marginalise views outside of dominant economic discourse, suppress conflict and establish power relations.
23	Conservation demands safe gene drive (Esvelt & Gemmell, 2017)	Exploration of self-propagating gene risks, solutions, and public approaches	Critical evaluation of technical genetic techniques (with a focus on the social responsibility lens).	**Reasons why fear might be wrong:** ● No harm in developing genetic technologies for environmental purposes in laboratory safeguards. ● Understanding of invasiveness problem is not widely shared (if it was, there may be more support). ● Unauthorised release may not result in public backlash if the technology is effective (public might even be happy about it). ● Ecological consequences are uncertain.

	Reference	Objectives	Methods	Key Findings
				● Justified if done for only genuine plagues, (e.g., malaria, which has few countermeasures and realistic path towards international agreement). **Critique:** All of the above require luck. **Open, community-guided eco-engineering research:** ● Proponents of gene technological solutions to conservation problems are correct in starting the public conversation early (now). ● Likely cost of impatience in this space is simply too high. ● Conversation should not be constrained to scientists, regulators, politicians or a single nation.
24	The potential for the use of gene drives for pest control in New Zealand: a perspective (Dearden, 2018)	Explore the potential use of gene drives in New Zealand for conservation purposes, as well as barriers and risks (social included)	Review and analysis of relevant technical and social research. Note: for the purpose of this report, only the social insights/commentary are extracted.	**Problem statement:** Predator Free 2050 was launched in 2016 to address New Zealand's ongoing biodiversity decline this ambitious and challenging aim is only possible with public support and novel 'next generation' pest control tools. **How to engage the public on gene drive for conservation purposes?** ● "The mechanisms to hear social, cultural, ethical and spiritual concerns have not always existed, functioned well or resulted in satisfying outcomes for the public." ● To get social licence to operate, we [New Zealand] need relational trust and communications between the public, government, and scientific communities. Don't want polarisation, but an informed and thinking public. ● People need to feel that the engagement is not in fact a fait accompli. ● Gene drives might be the most effective and specific way (can differentiate between an indigenous and non-indigenous wasp). ● Another approach could be through manaakitanga (raising of status) - how could we genetically 'lift' endemic species to co-exist better with introduced ones? ● However, people are afraid of 'slippery slopes.' ● Need sufficient data to have meaningful debate.
25	Research into genetically modified organisms in New Zealand: An examination of a sociotechnical controversy (Edwards, 2017)	Examination of the variety of interacting factors that are serving to shape this controversy [GMO's], the	**Review of research and analysis of case studies including:** ● Governing GMO Research: The Legislative Context ● Debating GMO Research: The Royal Commission on Genetic Modification ● Doing GMO Research: Progress Amidst the Controversy	**Context:** ● Late 20thC saw a growth in biotechnology development. Largely unregulated at first, which led to Hazardous Substances and New Organisms Act in 1996. ● Biosafety was introduced which "*addresses the technologies and practices that are implemented to prevent the unintentional exposure to humans or accidental release of new organisms into the world*". ● Approval types for GMO development - fully contained (inside), or contained (outside), broader geographical location (recallable) and wide (unrecallable). ● Generally, the public are okay with indoor but not outdoor.

	Reference	Objectives	Methods	Key Findings
		influence it is having on research practices, and the implications for future risk management policy.		● Royal Commission on Genetic Modification (RCGM) imposed a moratorium on the field releasing May 2000. **Survey** ● A survey (N=1000) was distributed to assess the present and future option available to NZ regarding GM technologies and the legal and institutional changes that would be required. ● Maintaining the "Clean, Green" image was important followed by environmental safety. People were okay with lab testing but very cautious about anything further. **Outcomes:** ● Green Gloves pledge was signed by 3,000 to take non-violent but direct action against the release of GMO's into the environment (whether illegal or not). Sabotages of GMO developments occurred. ● People used specifics to dispute generalisations (e.g., those against onion testing were really against field testing of any kind). ● Environmental Risk Management Authority (ERMA) response to public outcry's however was that "they had heard concerns but satisfied that evidence and material adequately addressed these concerns". ● Despite this, researchers still avoided doing field trials (or at most blur the line between indoor and outdoor testing – a risk not paid attention to).
26	A systematic literature review of attitudes to pest control methods in New Zealand (Kannemeyer, 2017)	Determine what is currently known about the public perceptions of pest control in New Zealand.	**Systematic Literature review (N = 28 articles.** Population-intervention comparator-outcome context (PICOC) framework to assess the current range of pest control approaches, the pest species targeted, the ways in which the public have been characterized, and how public attitudes have been reported over time. **Note:** for the purpose of this report, only general findings as well as	**Overall findings:** ● A wide range of pest species and pest control methods have been targeted when carrying out surveys of public attitudes to pest control over the last 26 years. ● Specific studies of public attitudes to possums, rabbits, and stoats have also been conducted using pest control methods such as aerial 1080, biological control, and biotechnology. ● Of these lethal control methods, <u>poisons are the least preferred method</u>. ● Rationales for <u>preferring existing methods over new technologies</u> include: uncertainty or perceived risks associated with not knowing future impacts. ● 19 articles carried out their research at the national scale using surveys or focus groups, with 8 at the regional scale, and 1 locally. Interviews, focus groups, and surveys were commonly used to elicit data, and two studies also held huis. ● Social, ecological and health considerations as major drivers of risk.

	Reference	Objectives	Methods	Key Findings
			those specific to biotechnologies are reviewed.	● Economic, cultural, and political perceptions of risk relating to pest management are not widely considered. **Biotechnologies specific:** ● The term 'Biotechnology' is often hard to define as often used interchangeably with terms 'genetic engineering', 'genetic manipulation', and 'synthetic biology.' ● Support for biotechnologies ranged from embracing to wanting a complete ban. ● People often could see the benefits [of biotechnologies] for medical purposes but otherwise were cautious, with desires for strong moral and ethical leadership and tight legal/regulatory frameworks. ● Genetic technologies seen as having no place in agriculture, as 'clean, green image' would be tarnished. ● 2 studies (1 using focus groups and 1 using a phone survey), found that fertility control was preferable to as a replacement to 1080 (given that it was seen as being specific, humane and effective) ● Views were tempered by whether how the product would be delivered and by who. ● Fertility control without a genetic component was generally better received. ● Women were in general less favourable than men towards biotechnologies for pest control purposes.
27	Public Opinion Towards Gene Drive as a Pest Control Approach for Biodiversity Conservation and the Association of Underlying Worldviews (MacDonald, et al 2020)	Explore public attitudes towards gene drive GD and two other emerging technologies (the Trojan Female Technique TFT and a pest-specific toxin PST).	**National scale survey**: (n= 8,199) perceptions of 3 novel tech (GD, TFT, PST) and their variation according to worldviews (via segmentation). **Independent variables in segmentation**: Environmental attitudes, conservation/environmental behaviours, scientific knowledge, pest specific knowledge (objective and subjective), trust (in scientists, leaders), personal values, and socio-political views.	**Overall:** ● 32% support for GD as compared to TFT (42%) and PST(52%). ● However, delivery method was more important (36.1%) than the technology itself (30.6%), the outcome (17.9%) or the target species (15.5%) ● Providing technical definitions of technologies shifted the distribution of support from 'mostly undecided' to 'polarised' (with a greater leaning towards opposition). **Segmentation model: Four segments emerged.** ● Worldviews were varied and are a more appropriate approach for framing than demographics (which were not significant). Suggested frames for worldviews are: ● **Humanitarian**: characterised by a desire for social equality and lack of trust in authorities as well as a value the sanctity of all life. Differed little in their view of native and introduced pest species. Less accepting toxins, open towards GD

	Reference	Objectives	Methods	Key Findings
			Dependant variable measures: Support for technologies (with and without definition) and variation according to worldviews. This was followed by choice-based conjoint analysis to see which aspects come out favourable in different scenarios. **Analyses:** choice modelling and segmentation.	and TFR possibly due to non-lethality. Desire for wholistic thriving of life – not native focussed. ● **Pragmatic** - priority is freedom to personal prosperity and concerned with individual livelihood. Support existing methods as likely don't see need for new technologies. Lower concern of the environment and don't see conservation as strong issue. Not too influenced by science/scientists and trust in businesses and church leaders. ● **Individualist:** characterised by desire for radical societal change, extreme distrust in authorities, and a strong sense of self-direction. High pest and pest control knowledge - and acceptance of technologies appears to be more conceptual than practical - rooted in resistance to authority/lack of trust. Strongest avoidance of chemicals. ● **Scientific:** prioritise scientific objectivity in decision making and see society as just and fair. Put trust in science and scientific knowledge and organisations in general. They know about conservation and see pests as an significant issue - but perform many conservation behaviours. Supportive of future and current methods.
28	Opportunities for modern genetic technologies to maintain and enhance Aotearoa: New Zealand's bioheritage (Inwood et al, 2020)	Review of risks and benefits of genetic technologies for conservation purposes.	**Review and analysis of research:** predominately focussing on ecological / technical aspects with acknowledgement of social/cultural aspects. **Note:** for the purpose of this review, only the connection between the technical and social aspects are covered.	**Review:** ● Scientific / technical experts in the genetic technology space for conservation acknowledge that social, cultural and ethical dimensions are imperative. ● See dialogue between scientific, indigenous, stakeholders and wilder public is needed regarding when, whether or how these genetic technologies can and should be used. ● Need to consider that these are taonga and need to be carried out in partnership with Tangata whenua. ● The conversation needs to be upstream (early and influential).
29	Understanding attitudes on new technologies to manage invasive species (Kirk, et al 2020)	Exploring key informant (pest & environmental expert) views on novel technologies for pest control purposes in New Zealand.	**Aim:** see range of perspectives on the risks/benefits of new technologies *before* political decision and economic investments are made to avoid polarisation. **Focus:** ● Explored expert perceptions of 3 novel technologies (the Trojan Female Technique (TFT), the	**Three key questions:** ● What's important to you in a pest control technology? ● What comes to mind when you think of GD, TFT and PST? ● What do you see as risks/benefits of using these technologies? **Overall Findings:** ● Provision of information didn't significantly impact views - likely as the sample is already knowledgeable.

	Reference	Objectives	Methods	Key Findings
			Pest Specific Toxin (PST) and Gene Drives (GD)). ● Vespula wasps and rats were chosen as target species because they are a) seen as destructive and b) previous research tended to focus on possums and rabbits. ● Vespula wasps and rats are also possibly the best case for using GD systems. **Focus groups (N = 7)**: ● (Participant N = 11 largest group and 3 smallest group), 3 locations (Wellington, Nelson and New Plymouth). 2 focus groups with central government agencies (which were pilots), and 5 with stakeholders with an interest in wasp and rat eradication in Nelson and New Plymouth. ● Focussed on people with detailed knowledge of pest control (no claim that it represents the public at large).	● Social Licence to Operate (SLO) should be sought by resource development companies by government for public benefit (clearer lines are needed between government agency formal regulatory process and informal social licence). ● Principles of engagement for obtaining SLO: trust building, information haring, accountability, and two-way communication. ● Social scientists need to work with decision makers for what would constitute a good measure for 'acceptance' and whether that is the same as 'support for'. **Theme 1: Unintended consequences (Came up in all 7 focus groups):** ● Effect of predator loss on ecosystem, spread of technologies beyond borders (possums in Australia), GD jumping species, and 'playing God (we can't go back). Focus on unpredicted effects rather than 'scientifically described risks.' ● Also influenced by how the technologies are introduced and how much control people have over the long-term consequences. **Theme 2: Spatial and temporal scales of control** ● Acknowledgement current tools can't upscale or are okay at best (toxins). ● GD - landscape alternative to 1080 - though a mixture of old and new technologies is preferred. ● Needs to be sustainable over time. **Theme 3: NZ as early adopter of new tech** ● Risks and benefits of being an early adopter. ● Effects our GMO-free status. Negative impact on primary production and tourism. ● However, if eradication success, positive flow on to tourism and industries e.g., beekeeping.
30	Scientifically framed gene drive communication perceived as credible but riskier (MacDonald, Edwards, Balanovic & Medvecky, 2020)	Testing the framing effects on views of gene drive for conservation in New Zealand drawing from previous research (**row 27**)	**Experimental design**: Four articles were framed to align with pre identified segments (row 27) and presented to (N = 1,600) participants who read two frames: one aligned with their worldview, one to another. **Dependent measures:** public support for GD for conservation gains, motivated reasoning, affective	**Overall Findings:** ● Support for GD was 52.8% - greater support for future research into potential application of gene drive (77.7%) ● No support for motivated reasoning or heightened emotional responses to counter frames – likely as GD is a new topic and entrenched opinion hasn't been established. ● Scientific group: more supportive of GD than pragmatic group or individualistic group, with the Humanitarian group being more supportive than the individualist group.

	Reference	Objectives	Methods	Key Findings
			response and risk perception (of unforeseen consequences for humans, mutations in other animals and unknown consequences of using the technique on rats). **Note:** pilot study was conducted with 100 participants from each segment all who read all four frames in randomised order. They rated each in the degree to which they felt each frame would appeal to someone who values a) science, b) animal welfare, c) economics and d, responsible decision making. For all four, the average net score was highest for that aligned to the frame. **Recruitment:** screener questions and an algorithm (N = 400 participants per segment.	● No significant interaction of frame and group and frame for attitudes. ● Scientific group had less motivated reasoning than all other groups, with humanitarian less than pragmatic and individualistic. ● A two-way interaction was found between the Frame x Group for scientists only - lower motivated reasoning when reading with own worldview than framed with other worldview. ● Overall finding for emotional response (regardless of frame) - individualist group less positive than pragmatic, humanitarian, or scientific groups. Pragmatic group less positive than humanitarian and scientific. ● Overall finding for risk (regardless of frame) - individualist group saw more risk than humanitarian, pragmatic or scientific. Humanitarian group was higher than pragmatic group or scientific group. **Frame specific:** ● Scientific frame –seen as more credible but risker by humanitarian group. ● Current support for GD high for the Humanitarian group - long term exposure to scientific framing - may lower this.
31	Underlying beliefs linked to public opinion about gene drive and pest-specific toxin for pest control (MacDonald, Edwards, Balanovic & Medvecky, 2021)	Investigation into underlying beliefs linked to levels of support for a potentially disruptive tool, gene drive, compared with a traditional stepwise tool, aerial distribution of a new pest-specific toxin.	**Based on theory of planned behavior (TPB)**: intention to engage in a behaviour based on attitudes (evaluation of a behaviour), norms (people and groups that perceived as influential) and perceived behavioural control (perception over their control). Each of these controlled by underlying beliefs (theory takes no account/assumptions of the validity of objectivity of beliefs).	**Overall Findings:** ● GD: significant correlation between support for current poison-bait spread by aircraft and support for gene drive to control rats. ● PST: correlation for current support position-bait spread by aircraft and support for aerial distribution of pest specific toxin. ● General attitude (bad/good and safe/risky) is the strongest predictor of support for both forms of novel technology, with the two remaining attitudes (harmful/beneficial and worthless/ valuable) being in the top five of the significant predictors of support. **Key conditional beliefs for support for novel pest control technologies:** ● Concerned about unknown consequences. ● GD human way to rid NZ of rats. ● GD would be going against natural way of life. ● Support If scientific evidence can prove that it works.

	Reference	Objectives	Methods	Key Findings
			Pilot studies and TPB questionnaire: qualitative approaches were used identify the list of salient commonly held attitudes, normalising beliefs and/or perceived controls. Open ended questions - advantages/disadvantages of using gene drive for rats, which groups would be supportive/unsupportive and which factors would enable/make impossible for GD/PST to rid NZ of rats. Variables were then quantitatively tested with 10 participants followed by a full survey (N = 2,159 participants).	**Support unexpectedly not linked to:** ● Use of GD would protect NZ native wildlife by reducing the number of rats. ● Important to reduce the number of rats in NZ.
32	Demographic and psychographic drivers of public acceptance of novel invasive pest control technologies (Eppink, Walsh & MacDonald, 2021)	Investigate potential social and demographic determinants of public perceptions of new methods for pest control.	**National choice experiment** model looking at the weighted decisions of participants when looking at their support for 3 potential novel pest control technologies (GD, TFT, New Toxin (NT). (N = 8200) Representative of the New Zealand population (Included psychometrics and demographics). **Choice models:** respondents' belief in trustworthiness of scientists, their political leaning and degree of religious guidance. **Choice experiment and econometric analysis**: asked respondents to choose between	**Preference was trojan female, new toxin and then gene drive:** ● Rats and stoats preferred as targets over wasps (rats being the number one choice). ● Ground base delivery preferred to aerial – large, positive, significant relationship found across all models. ● <u>Death preferred over infertility.</u> ● Interaction between target species and specific technology did not significantly improve the mode. ● Perceived threat of abundance of rats and stoats alleviated concerns about GD in general. **Demographic and psychographic variables and preferences for GD, TFT and PST:** ● Minor gender differences, with those identified as 'gender diverse' showing stronger preference of GD over TF and NT. ● TF favoured over NT - less so with older respondents. ● GD and NT positive for youngest group

	Reference	Objectives	Methods	Key Findings
			different options with varying attributes. Evaluating bundles of attributes (trade-offs) were used to reveal their preferences - analysed using econometric choice models. Participants shown same sequence of nine choices - asked them to choose between 2 alternatives of attributes of the novel technology. A, B or 'no preference'. Removed those who chose no preference for all questions.	● Education - high school diploma - lowest preference for GD and TF over NT. Tertiary and academic - support for GD and TF. ● As trust in scientists diminished - preferences for GD and TF over NT weakened ● TF and NT positive for all science groups - not for GD. ● Participants who indicated more conservative and religious orientations had lower preference for GD and TF (and tended to prefer PST). ● More liberal respondents preferred GD – more conservative respondents preferred NT. ● Liberal orientated participants preferred ground-based methods, conservative orientated participants preferred less ground based methods.
33	Conservation pest control with new technologies: public perceptions (MacDonald, Neff, Edwards, Medvecky & Balanovic, 2022)	Exploring perceived risks, benefits of novel pest control technologies, how this compares to current technologies and who should be involved in the making the decision.	**Focus groups** (N = 11) with 70 total participants. **Approach:** After general discussion around novel technologies in general and their potential application for pest eradication in New Zealand (i.e., GD, TFT and PST) three key questions were raised: 1. What are the risks and benefits of using gene drive/ trojan female technique/pest specific toxins for conservation in NZ? 2. In what ways would the new technologies be better, worse, and/or the same as compared with what is currently being used? 3. Imagine an appointed panel whose role would be to make decisions about how to control pests that pose a threat to our native plants, animals, and	**Environmental consideration's theme:** ● Potential impact could have on event - waterways, soil, naturalness. ● Specificity considerations (what it will/wont effect) ● Balance of nature - equilibrium disruption (not a big theme) **Practical considerations theme:** ● Maintenance ● Control ● Costs ● Timeframes ● Delivery method **Ethical considerations theme:** ● Right to wipe out 'whole species' ● Humaneness ● Pest definitions ● Societal considerations ● Public opinions ● Livelihood concerns

	Reference	Objectives	Methods	Key Findings
			natural environment. Which individuals or groups should be represented on this panel? What are the key factors that the panel should consider when thinking about introducing a new pest control tool? **Analysis:** constant comparative content analysis (thematic).	**Fear of genetics theme:** ● Mutations ● Unforeseeable consequences **Social consideration's theme:** ● Transparency ● Need for details about the tool. **Discussion** ● More risk perceived by GD, similar for TFT and PST - not support/opposition but what comes to mind when considering it ● People compared everything almost exclusively to 1080. ● The remaining participants said they didn't know enough about existing ones to have a meaningful perspective. ● Main representatives should be: Government agencies, citizen representatives (particularly younger generations), science and academics, iwi/hapu, environmentalists, farmers, animal activities, recreationists, and marketers. ● **What should be considered:** Societal considerations (most important) - within this, community awareness and involvement/transparency with the public. Also included putting up technology to public vote with education initiatives.
34	Trust in science and scientists: Effects of social attitudes and motivations on views regarding climate change, vaccines and gene drive technology (Dixson et al, 2023)	Investigate how trust interacts with social attitudes and motivations to shape views on scientific issues in New Zealand.	Same survey results from **row 27** **Analysis:** examining specific relationships between perceptions of the three key issues (i.e., climate change, vaccine scepticisms and genetic technology), trust in science/scientists and other social attitudes (uncertainty avoidance, social dominance orientation and system justification).	**Theoretical background**: trust in science goes beyond peoples doubt of fault risk assessments, but about the moral and ethical judgements and motives of individual scientists. Also challenges the assumption that 'trust in science' is the remedy – without considering a need for the 'trust in the public'. **Overall Findings:** ● The majority of participants trust science (51%) but are less trusting of institutions (57%) – including media, government, business and religion. ● Approximately one third (27%) of participants were comfortable with gene drive, while 33% were not (although they might still consider its use with strict controls or as a last resort),30% could not decide and 10% were against it. ● Trust in institutions is more than a logical agreement with scientific findings but is also a function of personal values, worldviews and social motivations. ● Trust does not have a 'one size fits all' effect for all people and/or for all issues.

	Reference	Objectives	Methods	Key Findings
				Relationships: ● No correlation between the three scientific issues (climate change, vaccine-autism link, and support for gene drive in conservation). ● Trust in science and scientists was a stronger predictor of views on gene drive and vaccines than it was for climate change. ● Trust *increased* vaccine scepticism via social dominance orientation. ● Trust *deceased* climate change and vaccine scepticism via system justification (albeit weakly). ● Social attitudes and motivations *did not* influence support for gene drive (but trust in science and scientists did) likely due to its novel status.
35	Beware of the unknown: views on genetic technology in conservation (Dixson, Balanovic, Medvecky, Edwards & MacDonald, 2022).	To inform how conversations about gene technologies should be approached in the New Zealand context	Drawing from the work of MacDonald et al 2020 where four key segments were identified in identifying differing conservation perspectives and relative pest control methods views, the study used focus groups (N = 11 of 6 - 8 participants in each) to delve more deeply into the narratives for each of these segments regarding their opinions on gene technology. Sampling from three key locations, recruitment of participants was conducted using an algorithm to identify the dominant view of each participant and therefore allocation to segment-based focus group.	Employing thematic analytic methods, based on Attride-Stirling's web-like illustration of thematic networks, one central network emerged (beware of the unknown), alongside worldview specific thematic networks (be humane, tread softly, steward responsibly and protect our interests). Specific sub-themes, as they related to the central nodes included: **Beware of the unknown** ● Dangerous DNA (with sentiments around the unpredictability of DNA, its opacity, mutability, and the risk it carries). ● Malefic manipulator (with sentiments around crossing lines, playing God and creation abominations). ● Unleashing chaos (with sentiments around expectations of backfire, expectations of immunity and expectations of interspecies breeding). **Be Humane** ● Hold the line (with sentiments around not playing God and how bait could protect). ● Innocent suffering (with sentiments around potential harm to offspring, harm to pts and the environment, the unwarranted power over 'life' and potential slow deaths of animals). ● Seek balance (with sentiments around halting 'forceful' change of nature, concerns around the imbalance of male to female ratio of species, a desire to 'keep it simple' and belief that life will find a way).

	Reference	Objectives	Methods	Key Findings
				Tread Softly ● Powerful Forces (with sentiments around the potential to 'spread death', the development of 'strange things', feelings that its 'careless play' and that DNA is generally off-putting as its influence is too unknown and powerful). ● Be Transparent (with questions such as – why increase complexity? What is it for? Could the tool be misused? and What is being hidden?) **Steward Responsibly** ● Environmental authority (with sentiments around the sense of ownership of 'our' environment and could it be controlled?). ● Integrity & Dignity of the species (with sentiments around issues and possibilities of genetic splicing, discomfort with speciocide and concerns around having too many targets) ● Simple, quick and safe (with sentiments that were ambivalent about DNA and those who wanted to make the process quick and simple; avoiding too much complexity). **Protect our Interests** ● Maintain the status quo (with sentiments around the desire to preserve other wildlife and agriculture and beware of the nefarious 'who'). ● Reveal the method (with questions around why not have both (current and new) methods at play, as well as sentiments that were ambivalent to DNA and bait). ● Perspective Taking (with sentiments around the need to consider community interests and concerns that someone's pest is another person's pet).

10.5: Collated Social Science Literature with Māori Perspectives

The following table provides a collation of social science literature that contains a focus on or elements of Māori / Te ao Māori and / or mātauranga Māori perspectives, regarding the potential development and use of genetic / biotechnology for environmental management purposes. Key elements were extracted including the reference, objectives of the study/paper, the main methods used and overall outline of contents. Aspects to bear in mind when reading this table:

- While focus was given to Māori perceptions of genetic / biotechnology for environmental management purposes (i.e., conservation and biosecurity), this scope was often situated within broader discussions (e.g. genetic research, science and society, biotechnologies).
- The table should be seen as a collation of works only and not viewed as a review or analysis of the literature.

Table 10.3 Collation of social science literature with Māori/Te Ao Māori/Mātauranga Māori perspectives of the potential development and use of genetic / biotechnologies for environmental management purposes.

	Reference	Objective	Methods	Overall Outline
1	**The Māori perspective (4.2.3) -** within Genetic engineering in New Zealand: science, ethics, and public policy (Macer et al, 1991)	Present a balanced discussion describing the future of Genetic Engineering (GE) – (with some focus on application in environmental spaces)	Commentary regarding the similarities, differences, and applicability of research findings within a Māori perspective. Draws from a variety of sources including the Waitangi Tribunal, Royal Commission on Social Policy, Haukina Development Trust and the Ministry of Environment's hui to discuss GE topics at the Maketu Marae (Kawhia).	A discussion on the contrast between scientific and cultural perspectives regarding GMO's, including difference in key values (e.g., GE from the perspective of Wairua, Whenua, Kaitiakitanga) and key concerns that emerged from hui regarding responsible science and innovation.
2	Caught in the headlights: New Zealanders' reflections on possums, control options, and genetic engineering (Office of the	Have a strategic conversation about genetic science and research with New Zealanders and its potential use for the control of possums.	**Reference group** (4 full day workshops & ongoing input/guidance). Participants included a range of stakeholders including, **Tangata Whenua.** **Public focus groups (4 types)** General public, Special interest groups, a provincial group, and	**Contextual background** was provided regarding the perspective of Tangata Whenua (*section 2.7*) the key values and practices that are of relevance when considering biotechnologies for possum control (e.g., whakapapa, tikanga) as well as statutory considerations (Te Tiriti, iwi policies, and other provisions). **Matters raised by Tangata whenua from the study findings**: included perspectives/values shared between Tangata Whenua and other mother participants (e.g., scientists, farmers, general public) as well as points of difference

	Reference	Objective	Methods	Overall Outline
	Parliamentary Commissioner for the Environment, 2000)		Tangata Whenua. **Note:** the **Tangata whenua hui** was Similar to focus groups but was conducted on a one-on-one interview basis.	(e.g., from the perspective of whakapapa, tikanga, impact on taonga, kaitiakitanga etc).
3	Genetic engineering: The New Zealand Public's Point of View (Gamble, 2001)	To collect, analyse and disseminate information on public perception of transgenic products relevant to needs of NZ policy makers, research planners, appropriate public sector groups and industry.	**Chapter 2. Values (section 2.2.4 Māori worldview) –** collates research regarding Māori values that would be pertinent in a discussion on GE in Aotearoa. **Study 4 (section 4.5)** explored perceptions of Genetic modification – results of a hui held with Ngati Whatua from Orakei (approx. 30 participants including Kaimatua).	**Chapter 2. Values (section 2.2.4 Māori worldview)** brief, general overview of Māoritanga and relevant narratives (e.g., origin stories), values (e.g., mauri) and practices (kaitiakitanga) in discussions on GE in Aotearoa. **Study 4 (section 4.5)** explores the above in more detail including key questions such as level of awareness and understanding of GE among Māori, unique Māori perspective on GE, main risks associated with GE by Māori, desirable information by Māori and what are the implication of use of indigenous genetical material?
4	Public Understandings of Biotechnology in New Zealand: Nature, Clean Green Image, and Spirituality (Coyle, Maslin, Fairweather & Hunt, 2003)	Explore and examine how and why focus group members viewed a series of five selected biotechnologies relate to New Zealand's Clean, Green image and Spirituality.	**Focus groups** (N = 11) conducted using Donna Haraway's dialogic approach - which captures not only text and personal views and attitudes, but the interrelationship between research subjects and their interpretations of the world. **Recruitment:** conducted PTA's across the South and North islands, with Asian, Pacific and Western Europeans. **No specific Māori group but integrated into sessions (to avoid overlap with Dr Mere Roberts (2005) who focussed exclusively on Māori and biotechnology).** **Interview Approach**: presented with a series of exemplars of recent developments biotechnologies (including environmental) pertaining	**Ethnicity section:** reports proportion of NZ Māori participants. **Findings:** presentation of a few quotes from a Māori perspective regarding the key themes that emerged including themes: ● Perversion or progress? ● Biotechnology and nature (wise nature, traditional nature, animated nature, human nature) ● Spirituality ● The development of an ethnically based assessment processes

	Reference	Objective	Methods	Overall Outline
			specifically to New Zealand. **Initial question**: how they would like to see New Zealand in 20 years' time? Followed by discussion into specific examples of new biotechnologies.	
5	New Zealand social research on impacts of genetic modification and related biotechnologies: An international strategic review (Wynne, 2003)	Summary of general themes and future trends of social research of biotechnology, noting any research gaps, in general terms and recommendations for future New Zealand research.	Strategic and comprehensive review of genetic technologies social scientific research in New Zealand (mostly focussed on GMO but with references to broader discussions about biotechnologies and multiple applications, including environmental).	Outlines overall trends and gaps in social research 2003 as relating to Māori, culturally-ethical research and how this compares to international dossiers in this space (with an indigenous perspective). Recommendations for future areas of research focus regarding Māori perspectives are provided.
6	Public understandings of biotechnology in New Zealand: factors affecting acceptability rankings of five selected biotechnologies (Hunt, Fairweather & Coyle, 2003)	Explore and examine how and why focus group members ranked the acceptability of five selected biotechnologies.	*Same methods as Public Understandings of Biotechnology in New Zealand: Nature, Clean Green Image, and Spirituality (Coyle, Maslin, Fairweather & Hunt, 2003 – row 4*) **Analytic focus:** on relative rankings between technologies and the rationale behind them for each stakeholder (including Tangata Whenua).	**Findings:** presentation of a few quotes from a Māori perspective regarding the key themes that emerged including themes: ● Application of GE for Monarch Butterflies and GE corn ● Perceptions of Risk ● Ethical issues ● Key policy implications **Note:** it was explicitly noted that the research did not cover the Māori perspective as this work is being carried out within the same FRST programme by Dr Mere Roberts (2005).
7	New Zealand public acceptance of biotechnology (Cook, Fairweather, Satterfield & Hunt, 2004)	Identify and determine the relative importance of factors involved in perceptions of biotechnology in New Zealand.	**National postal survey** (N = 701) addressed 'to the householder,' with follow up non-response telephone interviews. **Questionnaire:** Began with definition of biotechnologies as well as related terms (GM, GMO, & GE).	**Ethic Representation:** notably poor for Māori participants (section 3.6 reports relative sub-samples). No further analyses by Māori sub-sample are presented, though some discussion is provided regarding the variation of scores regarding 'ethnicity' more broadly (section Risk-Perception and Biotechnology).

	Reference	Objective	Methods	Overall Outline
			Range of items (N = 199) included: Concern of biotechnology as a social issue (and broader issues facing society), Acceptability of 22 biotech items (Incl. for environmental & conservation purposes), Views of biotechnology, NZ identity & Clean, green NZ image, Views about technology in general, Beliefs about nature, Post materialist values, Spiritual beliefs, General viewpoints and Demographics. **Analytic approach**: regression analysis to test two models as explanation of a general attitude towards biotechnologies in New Zealand.	
8	South Island Māori Perceptions of Biotechnology (Roberts & Fairweather, 2004)	Identify and determine the relative importance of factors involved in perceptions of biotechnology in New Zealand (with a specific focus on South Island Māori perspectives).	**22 Focus Groups/Interviews (N= 90 participants)** with a focus on participants responses towards different biotechnologies and their applications, with a view to provide a record of these perspectives, as well as the extraction of key themes. Research aimed to compliment the work conducted by Smith (1999) who focussed on perceptions of biotechnologies from a Māori perspective in the North Island.	**Findings include:** ● Interview/focus group specific findings ● Overall rankings of different biotechnologies (i.e., xenotransplantation, stem cell research, cloning, GMO's and bioprospecting) for different applications (i.e., economic, food, environment, conservation pure research and medical). ● Overall discussion and insights including key themes such as: o Perceptions of risk of technologies o Perceptions that technologies are not right or tika o Perception of negative effects on whakapapa, wairua and mauri o Perceptions that technologies, especially GMO's are merely 'quick fixes' or a 'fad' o Underlying causal factors that contribute to the perception of risk (e.g., lack of information, distrust of science and scientists, fear of uncertainty etc).
9	Whakapapa as a Mäori Mental Construct: Some Implications for the Debate over	Further inform public discussion surrounding genetically modified organisms as well as to provide	Using the **kūmara as a case study**, the authors attempt to seek an understanding of the underlying principles that inform this mental construct in relation to the GMO debate.	**Key areas covered in the discussed include:** ● A description of the cosmological whakapapa ● Classification [of all living things] within a whakapapa framework ● Case study examination of the whakapapa of the kūmara ● The role of narrative in this understanding

	Reference	Objective	Methods	Overall Outline
	Genetic Modification of Organisms (Roberts et al, 2004).	decision makers with a better understanding of a key Māori cultural concept that is central to this debate.	General summary of literature and analysis thereof is presented.	● The moral imperatives provided by the narrative ● Overall discussion (including the whakapapa as a folk taxonomy, whakapapa as phylogeny, and how might knowledge of whakapapa and narratives inform the GMO debate).
10	Space, time, and nature: exploring the public reception of biotechnology in New Zealand (Coyle & Fairweather, 2005)	Explore the meanings of various "natures", the ways they impact upon how people draw boundary lines between "natural and unnatural / artificial" and how these boundary lines impact acceptability of new biotechnologies	*Same methods as Public Understandings of Biotechnology in New Zealand: Nature, Clean Green Image, and Spirituality (Coyle, Maslin, Fairweather & Hunt, 2003 – row 4*) **Analytic focus:** on differing views and definitions of 'nature' and how this shapes people's perceptions of 5 biotechnologies **Note:** For the purposes of this research, aspects pertaining to Māori perspectives regarding biotechnologies for non-commercial, environmental purposes are outlined (i.e., the remediation of soil from DDT and the reduction of methane production in sheep using bacteria).	Findings are not specified according to māori/non-māori participants so, for the most part, it is not discernible which themes/topics are shared by both cohorts nor differences across them. A quote from a Māori specific participant was mentioned however including on topics pertaining to concepts of 'Complex Nature' namely : "*Is that the outcome that we want, is for the population to die out? Because there are other options. Like for instance, I would say it's unnatural because everyone's got the right to reproduce, whatever, and there are other options, like we treat sheep. We kill them, and you can skin and them and you can use them for meat. So, and a while ago, I heard people talking about that and how popular the fur was actually. So, there are other options*. (Māori Female, Dunedin)'
11	From dialogue to engagement? Learning beyond cases Cross Case Study Learning Group (Winstanley, Tipene-Mapua, Kilvington, Allen & Du Plessis 2005)	Aim of the Dialogue Fund Evaluation Team (later called the Cross Case Study Learning Group) was to produce an integrated analysis of all information available from the project teams. This	Summary of key projects conducted as part of the Dialogue fund and present an integrated analysis of all information available from the project teams. Section 2.4 examines '**Working with Māori and Tikanga Māori'** specifically.	Overall insights about how Māori engage in dialogue and what is effective for Māori dialogue touched on: ● Tikanga Māori based dialogue processes (e.g., powhiri, te kai a te Rangatira, he korero, manaakitanga, mihimi, whanaugahau etc). ● Breaking down barriers, stereotypes, and misconceptions (both of Māori participants and researchers as well as of scientists/science by Māori) ● Future directions (e.g., movement away from one-way, -predetermined consultation towards two-way, ongoing dialogue).

	Reference	Objective	Methods	Overall Outline
		report presents 'learnings' beyond cases of this work.		
12	Walking backwards into the future: Māori views on genetically modified organisms (Roberts, 2005).	To present a broader approach to the weighing and balancing of perceived risks and benefits associated with GMO's from a Māori perspective.	Results presented from two studies: **Study 1)** Investigated the perceived effects of different GMOs on Māori culture, values and beliefs. Method was a series of focus groups/interviews N = 90 participants). **Study 2**) Perceptions of the risks/benefits to Māori of various forms of biotechnology (including xenotransplantation, cloning, stem-cell research, and bioprospecting. Method was 16 interviews, 7 focus groups N = 47 participants).	Results are presented thematically which cover key Māori values, principles and practices as relating to GMO and biotechnologies including: ● Whakapapa ● Mauri ● He tangata, he tangata ● Tika/Tikanga/Kaitiakitanga A value-based framework for cultural risk assessment of novel biotechnologies is presented with evaluation of the proposed research using cultural principles/key value as well as incorporating tikanga.
13	Culture, risk, and the prospect of GMO as viewed by tāngata whenua (Satterfield, Roberts, Henare, Finucane, Benton & Henare, 2005)	Provide an in-depth insight into the values and beliefs of a wide range of tangata whenua concerning genetically modified organisms.	A presentation of background context regarding GMO research and legislation, and relevance to a Māori context as well as findings from a series of focus groups (N = 13) and interviews (N= 13) across 3 phases of research encompassing a total of 90 participants.	Findings across these sources are presented thematically including key philosophical beliefs (e.g., mauri), norms and cultural forms and institutions (particularly whakapapa), values as broadly constructed (e.g., Kaupapa) as well as key socio-political concerns. Areas of concern include: ● I nga wā o mua ● Risk taking ● He tangata, he tangata ● Spiritual Matrix A – tapu, mana, noa ● Spiritual Matrix B – mauri, wairua 6. Taonga ● Whakapapa 8. Kaitiakitanga ● Kia tūpato ● Kimihia te mātauranga/mōhiotanga ● Kōrero tahi ● Tino rangatiratanga and Treaty Principles ● Individual choice is important ● Tikanga ● Kaupapa

	Reference	Objective	Methods	Overall Outline
				● Karakia Culture, Risk & the Prospect of Genetically Modified Organisms ● Pro/Anti Explanations for Response to GM o Use of Human Genes o GM Food o Natural v Unnatural o Situational Acceptability (e.g. a medical application)
14	Backgrounding Māori Views on Genetic Engineering (Cram, 2005)	Provide a historic and socio-political overview of Māori views on Genetic Engineering (Chapter within *Sovereignty Matters: Locations of Contestation and Possibility in Indigenous Struggles for Self-Determination by Joanne Barker)*	A review of key historical narratives and literature and the contextualisation of the conversation with Tangata Whenua regarding the potential development and use of genetically modified organisms in Aotearoa New Zealand.	**Key aspects covered:** ● The context set by Te Tiriti and its use and misuse in New Zealand history. ● Specific research and context regarding Māori and genetic engineering (including the contextualisation within māori cosmology (e.g. the story of Papatuanuku and Ranginui, key philosophies (e.g., mauri) and values (e.g., whakapapa). ● Responsibilities of tangata whenua (e.g., kaitiaki and tikanga Māori). ● The expression of Māori views on Genetic engineering (including relevant research and engagement).
15	Culture and science: A critical assessment of public consultation about biotechnology in New Zealand (Sivak, 2006)	Explores the dialogue surrounding biotechnologies and their impact upon society.	A review of several main findings from anthropological research examining the concept of culture within the context of New Zealand's Royal Commission of inquiry into genetic modification (RCGM).	**Key points of discussion include:** ● **The RCGM as a cultural text** (and the intersection with New Zealand's socio-political and bicultural history) ● **Navigating biculturalism** (including reference to Te Tiriti and approaches to including a bicultural perspective) ● Science and culture: science as culture (a discussion on the structuring of the 'scientific frame' as 'normal' and 'rational'). ● **Managing culture** (discussion about how cultural views were incorporated/not incorporated into the decision-making process and the conflation with other issues such as ethics). ● **Concluding comments** and critiques.
16	Biotechnology: the language of multiple views in Māori communities (Te Momo, 2007)	To better understand effective communication regarding	Qualitative content analysis of data gathered in the community including the examining of text from participant interviews, focus groups, government documents,	Findings pertained to overall differences in Māori views regarding the subject of biotechnology.

	Reference	Objective	Methods	Overall Outline
		biotechnology for different sectors of the community (from 2003 to 2006) with a specific focus on Māori communities.	newspapers, Internet sites, and current literature (of Māori participants). Common themes were explored in the English and the Māori language including Words such as genetic modification (GM), genetic engineering (GE), and biotechnology.	
17	An Indigenous Perspective on Biotechnology in New Zealand: A Māori scientist perspective (Haar, 2007)	To further explore and understand the debate on the importance of understanding indigenous perspectives towards science in general, and biotechnology specifically.	**Interviews** (N = 12) with Māori scientists involved in biotechnology research – seeking to answer the question "how does biotechnology fit in the Māori world?"	The paper offers background context with an overview of; biotechnology; indigenous/Māori knowledge, nature, science and biotechnology particularly in the New Zealand context. Views regarding biotechnology from the māori scientists are explored thematically, eliciting themes such as: ● Personal views on biotechnology ● Cultural links ● Tikanga and science ● Benefits and costs ● Commercialisation
18	"Having honest conversations about the impact of new technologies on Indigenous people's knowledge and values," Tipene-Matua *in Mātauranga Taketake: Traditional Knowledge Indigenous Indicators of Wellbeing: Perspectives, Practices, Solutions*	Part of a larger project which aims responds to the need for better information about the cultural, social, spiritual and ethical elements of new health biotechnologies and the need to find new ways of engaging people in dialogue.	Draws from the conversations and experiences [Constructive Conversations: Korero Whakaaetanga] with Māori over a 2-year period concerning the impact of genetic testing on their lives and cultural [Māori] values.	The author extracts key themes and insights from these conversations pertaining to the inclusion/exclusion of Māori voices in the discussion and debate regarding biotechnologies and genetic testing. Key aspects that emerged included: ● Genetic research on Māori and research about genetics and Māori (e.g., Māori and PPL Therapeutics) ● The Rākaipaaka health and ancestry study ● Mana – the foundation of genetic research (including Mana Atua, Mana Whenua and Mana Tangata)

	Reference	Objective	Methods	Overall Outline
	(Ngā Pae o te Māramatanga, 2007)			
19	Māori culture and biotechnology: Conflicts and similarities (Anderson, 2008)	To understand the conflicts and similarities in views between Māori and non-Māori working in the science community and how these could aid future empowerment of Māori in this space (particularly regarding natural resource management).	**Interviews** (N = 8) with professionals in the scientific community – 4 Māori and 4 non-Māori participants (with some demographic spread).	The findings are contextualised within a wider historical and socio-political frame regarding: the definition of Māori and indigenous knowledge, the relationship between indigenous people and nature, indigenous knowledge vs science, exploring the current interface, genetic modification in New Zealand and issues of intellectual property. **Key themes are analysed according to:** a) About the use and development of biotechnology science b) The nature of the interface between science and the Māori culture c) The future of this interface, including potential issues and ways forward.
20	Traditional Knowledge and Decision Making: Māori Involvement in Aquaculture and Biotechnology (Cram, Prendergast, Taupo, Phillips & Parsons) *in Te Tatau Pounamu The Greenstone Door – traditional knowledge and gateways to balanced relationships* Ngā Pae o te Māramatanga, 2010).	To set the context for understanding of why it is important to examine these decision-making processes within the current aquaculture climate in this country [with specific focus on the socio-political, environmental, and cultural aspects in aquaculture and their representation within hapū and Iwi decision making processes].	A **profile** is provided regarding Māori engagement with the marine environment (incl. aquaculture), followed by an **overview** of aquaculture more generally, including legislation and the prospects that exist for biopharming. A **research programme is then described**, and **five themes are explored** as a way of providing a “heads-up” on issues that potentially impact on Māori decision making.	**Key sections include:** ● An outline of traditional aquaculture ● An outline of modern aquaculture ● Biotechnology and aquaculture ● The research programme outlined by the paper (aiming to examine Māori decision-making processes and the potential impact of new technologies on the decision-making processes themselves as well as the decisions that are made) ● Emerging themes: o Mana moana o Kaitiakitanga o Resource constraints o Commodification o Tino Rangatiratanga

	Reference	Objective	Methods	Overall Outline
21	Guardians of our future: New Zealand mothers and sustainable biotechnology (Gamble, 2009)	Seek to understand mothers' views on specific 'sustainable technologies (*as identified in Kassardjian and Gamble, 2005*) 'in more depth and the values underlying them.	**Focus groups (N = 10**) with women with at least one child 10 years or younger (**15% identified as Māori or Māori/European**). **Topics of discussion included:** ● Bioremediation/bioprospecting, ● Developing genetically modified pest-resistant trees. **Prompts included:** What are the key issues? What values they felt informed their views? What the groups felt would be most impacted on? Under what circumstances the application could be sustainable? Which aspect of sustainable development should take precedence in deciding what is an acceptable (e.g., economic, social, environmental, cultural, or ethical).	Findings are not specified according to māori/non-māori participants so, it is not discernible which themes/topics are shared by both cohorts nor differences across them. The overall themes however may be shared with Māori and non-Māori participants (which may be of interest for future research) including views on ● Developing non-transgenic genetically modified plants ● Bioremediation ● Pre-implantation genetic diagnosis ● Developing genetically modified pest-resistant trees ● Which aspects of sustainable biotechnology should take precedence?
22	Old ways of having new conversations: Basing qualitative research within Tikanga Māori (Tipene-Matua, Phillips, Cram, Parsons & Taupo, 2009)	To explore how Māori cultural processes can guide research processes (within the context of the Kōrero Whakaaetanga project – to facilitate a safe context for sharing thoughts & feelings about new biotechnologies).	Review of key Māori concepts and relevant research literature as relating to effective cultural research processes)	Key concepts/practices are highlighted as recommended elements to include in cultural research process when discussing biotechnologies. General themes include: ● Tikanga Māori ● Powhiri/Whakatau (welcome ceremony) ● Sharing of Kai (food) ● Mihimihi (introductions/setting the scene) ● Poroporoaki (Farewells and acknowledgements) ● Key Learnings

	Reference	Objective	Methods	Overall Outline
23	The “Citizen Scientist”: Reflections on the Public Role of Scientists in Response to Emerging Biotechnologies in New Zealand (Cronin, 2010)	Exploring the role and positioning of scientists in the engagement dialogue about biotechnology with community groups in New Zealand.	**Review and discussion** of: “The Hands across the water project” with an analytical focus on the ‘citizen scientist’ and ‘scientific citizen’. **Note:** The ‘hands across water’ project was not covered specifically in this report as its focus was outside the scope (i.e., on Genetic Engineering for commercial / agricultural applications). However, key aspects are highlighted regarding broader communication of biotechnologies from qualitative discussion with N = 45 science participants (which included Māori groups with concerns about GE).	Findings are not specified according to māori/non-māori participants so, it is not discernible which themes/topics are shared by both cohorts nor differences across them. The overall topics however may be relevant with Māori and non-Māori participants (which may be of interest for future research) including aspects such as: ● Scientific reflexivity and social engagement ● New Zealand scientists’ views on the social dimensions of science. ● A review ‘Hands across the water’ project - scientists engaging in a dialogue with citizens on biotechnology in New Zealand. ● An emerging ‘citizen scientist’ identity ● Implications for future science and society engagement practice.
24	Science and technology development and the depoliticization of the public space: The case of socially and culturally sustainable biotechnology in New Zealand (Macdonald, Varey & Barker, 2010)	Analysis of the MoRST five-year, research study in 2003 designed to create public dialogue regarding sustainable biotechnology in New Zealand and use the findings to shape public policy.	**Aim:** explore of why such a successful stream of research failed to influence policy and public debate. **Analytical approach:** Findings and critical review of 21 publications (including peer reviewed publications as well as workshops, end-user presentations, academic articles, conference presentations). First author summarised key contributions and was checked by second and third authors. The findings where then thematically analyzed. Regular meetings between authors occurred in assessment and debate of themes.	Considerations of Māori values, beliefs and interests are interwoven into the discussion of the paper. Of particular mention is the consideration of Māori views within the context of the importance of ‘values’ and ‘participation and engagement’ throughout the New Zealand dialogue on biotechnologies (with considerable overlap with New Zealand identity).

	Reference	Objective	Methods	Overall Outline
25	Consultation concerning novel biotechnologies: who speaks for Māori? (Roberts, 2009)	Providing a critical view on the representation of Māori voices on the topic of biotechnologies.	Historical and social scientific review of biotechnology developments and uses in Aotearoa, New Zealand.	Exploration of a variety of vantage points using a case study of GMO's in Aotearoa (**Consultation with Māori concerning GMOs: a case study**) as well as exploration of diversity of views among Māori and who has the 'right' to offer collective vs individual representation of views (**Balancing individual and collective rights concerning genes**).
26	The art of dialogue with indigenous communities in the new biotechnology world (Hudson, Roberts, Smith, Tiakiwai & Hemi, 2012)	To negotiate spaces for and develop dialogue processes that allow a deeper interaction between mātauranga Māori and science – with a specific focus on the wānanga held regarding discussions on novel technologies that involved Māori scientists and people with mātauranga expertise.	Employed a **kaupapa Māori methodology** – using culturally appropriate and participatory processes in the research, recognising indigenous knowledge as valid and legitimate. **Findings were thematically presented**, drawing from literature reviews, semi-structured workshops, or dialogue events (often as informed by literature reviews).	The paper first presents an **outline of key kaupapa māori and mātauranga Māori guiding principles** for the research (including a) understanding of appropriate Māori concepts, b) creating a safe space for indigenous knowledge to be expressed and heard, c) developing a framework of Māori terminology, d) an understanding of the Māori worldview and e) the establishment of a mutually beneficial relationship between science and Mātauranga Māori) Key findings are presented thematically according to the guiding principles for engaging discussion on a set of biotechnological applications including **use of embryos in research**, **use of brain tissue in research** and the **research into future foods**.
27	Te mata ira-faces of the gene: Developing a cultural foundation for biobanking and genomic research involving Maori (2016)	Explored Māori views on genomic research and biobanking for the development of culturally appropriate guidelines.	A series of **qualitative approaches** were used (literature searches, 9 key informant interviews, five stakeholder workshops, five iwi hui and four case studies) These were conducted **to make sense of the Māori concepts** that emerged from other data-collection activities. Wāngana and research followed **kaupapa māori research principles** (e.g., recruitment occurred through whanaungatanga).	Key areas for the development of a cultural foundation for biobanking and genomic research were explored including concepts such as: ● Mana ● Taonga ● Tākoha ● Kawa ● Tikanga ● Mauri ● Wairua ● Whakapapa Exploration of the relationship and importance of these aspects are discussed.

	Reference	Objective	Methods	Overall Outline
28	Dialogue at a Cultural Interface: A Report for Te Hau Mihi Ata: Mātauranga Māori, Science & Biotechnology Summary (Smith, 2013) *in Bridging cultural perspectives (Superu, 2018)*	To explain the research project Te Hau Mihi Ata that is a pivotal piece in examining the interface between mātauranga Māori and science.	The research team described the spaces created through the willingness of people to come together to explore and exchange convergent and divergent positions in an environment where mātauranga Māori and scientific knowledge are equally respected as significant systems of knowledge.	The report presented here only provided an outline summary with the only key result reported being that there was a development of a conceptual model called 'Negotiation spaces. Follow up with the original document is necessary for further detail. **Note:** While the scope was broadly focussed on dialogue, the research was prompted by the need to engage in the debate and discussion on new biotechnologies, and how they interact with and impact upon mātauranga Māori/ Māori communities.
29	A systematic literature review of attitudes to pest control methods in New Zealand (Kannemeyer, 2017)	Determine what is currently known about the public perceptions of pest control in New Zealand.	**Systematic Literature review (N = 28 articles.** Population-intervention comparator-outcome context (PICOC) framework to assess the current range of pest control approaches, the pest species targeted, the ways in which the public have been characterized, and how public attitudes have been reported over time. **Note:** for the purpose of this report, only general findings as well as those specific <u>to biotechnologies are reviewed</u>.	Throughout the review, discussions about how findings vary according to a **Māori and non-Māori perspectives** are included, particularly with reference to existing pest control methods (e.g., 1080) as well as the cultural values and principles that going into decision-making about pest control technologies. While no specific mention is given of Māori views towards biotechnology specifically, the themes are inclusive of these views (and the paper "Consultation concerning novel biotechnologies: who speaks for Māori? "is included in the review list; see row 25).
30	The potential for the use of gene drives for pest control in New Zealand: a perspective (Dearden, 2017)	Explore the potential use of Gene Drives in New Zealand for conservation purposes, as well as barriers and risks (social included)	Review and analysis of relevant technical and social research. Note: for the purpose of this report, <u>only the social insights/commentary</u> are extracted.	In their acknowledgement of the need for a social lens on consideration of genetic technologies for conservation purposes, the authors mention the importance of including Māori perspectives and reference a few studies which present insights in the broader field of Māori views towards genetic modification and Māori engagement with science and research more generally (e.g., Roberts & Fairweather, 2004; Mead 2003; Haar, 2007; Mead & Ratuva, 2007; Harry, 2001; Durie, 2005). While this is somewhat beyond the scope of this particular reference point, these papers and views may share similar values and principles that could be drawn from.

	Reference	Objective	Methods	Overall Outline
31	Indigenous Perspectives and Gene Editing in Aotearoa New Zealand (Hudson et al, 2019)	Outlines previously articulated Māori perspectives on genetic modification and considers the continuing influence of cultural and ethical arguments within the new context of gene editing.	a) Review of relevant literature re: lessons learned from the responses of Māori to genetic modification b) Interviews of selected 'key Māori informants' c) Surveys of self-selected individuals from groups with interests in either genetics or environmental management.	The study presents relevant context prior to the overall results which are thematically grouped by key questions including: ● What do you see are the potential applications /opportunities associated gene editing? ● What do you see are the key Issues/concerns that arise from use of gene editing? ● Do you think gene editing can support kaitiaki responsibilities and under what circumstances? ● Do you think whakapapa is affected if you introduce DNA into once species from another species? Is this the same case if you edited DNA within the same species? ● Is there a difference between applying gene-editing for 'taonga species' and introduced or commercially produced species? ● Is mauri of a species/person affected if the gene-edit mimics a natural mutation/variant?
32	Embedding indigenous principles in genomic research of culturally significant species: a conservation genomics case study (Collier-Robison et. Al., 2019)	Reflect on our [authors'] experience embedding Māori principles in genomics research as leaders of a BioHeritage National Science Challenge project entitled 'Characterising adaptive variation in Aotearoa New Zealand's terrestrial and freshwater biota.	A discussion of key gene editing topics and concepts through a te ao Māori lens as offered by the authors.	The authors work towards the co-development of a culturally responsive evidence-based position statement regarding the benefits and risks of prioritising adaptive potential to build resilience in threatened taonga species, including species destined for customary or commercial harvest. To achieve this, the authors look through a research programme with a local sub-tribe, Ngāi Tūāhuriri, that integrates Māori knowledge with emerging genomic technologies and extensive ecological data for two taonga species, kōwaro (Canterbury mudfish; Neochanna burrowsius) and kēkēwai (freshwater crayfish; Paranephrops zealandicus). The foundation of our research programme is an iterative decision-making framework that includes tissue sampling as well as data generation, storage and access.
33	Novel biotechnologies for eradicating wasps: seeking Māori studies students'	As part of a National Science Challenge: Our Biological Heritage project, this	Māori-centred, with a kaupapa Māori orientation was adopted, guided by the 5-category Vision Mātauranga classification in this assertion. Research methods were designed	The results are analysed according to key Q method statements and reported according to the different exercises used in the methods including: ● Human–wasp relations–narrative positioning ● Focus groups–identifying participant clusters from Q-sorts

	Reference	Objective	Methods	Overall Outline
	perspectives with Q method (Mercier, King-Hunt & Lester, 2019)	research sought to investigate Māori perceptions of five different novel biotechnologies.	and led by two Māori researchers working alongside a Pākehā researcher which involved mixed-methods approach of face-to-face interactions with inclusion quantitative ranking exercises (i.e., the Q method).	● Q-sort consensus statements ● Student Assignment Choice (Which Biotechnology?) ● Focus group–ranking exercise (Which biotechnology?) ● Focus group–specific responses (Which biotechnology?) ● Focus group–general responses (Which biotechnology?)
34	Opportunities for modern genetic technologies to maintain and enhance Aotearoa New Zealand's bioheritage (Inwood et al, 2020)	Provide source material to support future decision making around the use of new genetic technologies in bioheritage.	A discussion is presented regarding genetic technologies, focussing on scientific benefits and risks of each as well as an acknowledgement of the social, cultural, ethical and regulatory constraints on their use, with emphasis on the importance of partnership with tangata whenua to determine when, whether or how these technologies should be used in enhancing New Zealand's bioheritage.	Māori perspectives, considerations and research are mentioned throughout the paper, on topic discussions such as genome sequencing of native species and regulatory status of gene editing technologies in New Zealand.
35	Towards rangatiratanga in pest management? Māori perspectives and frameworks on novel biotechnologies in conservation (Palmer, Mercier & King-Hunt, 2021)	To address the critical need for Indigenous wisdom and perspectives on conservation biology.	**Three key studies led by Māori researchers** **Study 1:** examined the perspectives of second- and third-year Māori university students university studying courses that examine the challenges and opportunities of science and Indigenous knowledge to Māori and Indigenous people (included a guest lecture on biodiversity and biotechnology) including Q method and focus group methodology. **Study 2**: surveys and interviews with Māori businesses in industries that might benefit from, or be impacted by, large-scale pest wasp management. **Study 3**: explored the perspectives of Māori participants chosen for their	Findings are presented thematically drawing from existing research/knowledge as well as across the three studies to establish an understanding of rangatiratanga. Key themes/topics that emerged included: ● Key ideas from previous studies. ● Consent and Social Licence to operate and; ● Key Māori concepts such as Rangatiratanga, Take, Utu and Ea.

	Reference	Objective	Methods	Overall Outline
			strong religious and/or spiritual beliefs and practices using Q methodology.	
36	Underlying beliefs linked to public opinion about gene drive and pest-specific toxin for pest control (MacDonald, Edwards, Balanovic & Medvecky, 2021)	Investigation into underlying beliefs linked to levels of support for a potentially disruptive tool, gene drive, compared with a traditional stepwise tool, aerial distribution of a new pest-specific toxin.	**Pilot studies and TPB questionnaire:** qualitative approaches were used identify the list of salient commonly held attitudes, normalising beliefs and/or perceived controls. Open ended questions - advantages/disadvantages of using gene drive for rats, which groups would be supportive/non supportive and which factors would enable/make impossible for GD/PST to rid NZ of rats. Variables were then quantitatively tested with 10 participants followed by a full survey (N = 2159 participants). While **Māori were not targeted specifically, quota targets were set in each region to ensure that the region was broadly representative of the adult population** (18 years and over) in that region by age and gender, as well as ethnicity within subregion, on the basis of the census projections for 2017 (Statistics New Zealand2017). Participants were made aware that these tools were not yet available for use (if ever) in New Zealand.	As no distinction was made across cultural/ethnic groupings of participants, no specific findings can be mentioned regarding māori views specifically. In saying this, as the sample was such that it was broadly representative demographically (including ethnicity) by region and sub-region, the findings may be broadly applicable to Māori views regarding what is commonly held across population groups. Findings of key beliefs and their influence on behaviour are reported according to the two example novel technologies for conservation purposes (namely, gene drive and a pest specific toxin).

	Reference	Objective	Methods	Overall Outline
37	Te Nohonga Kaitiaki Guidelines for Genomic Research on Taonga Species (with Background; Hudson et al, 2021)	Te Nohonga Kaitiaki guidelines apply to genomic research involving taonga species, providing a comprehensive framework for research positioned at the intersection of genomics, innovation and Te Ao Māori.	A multi-layered and integrative approach was adopted, drawing from a cross Māori perspectives and research.	The report presents a set of guiding principles and operational principles as well as an overarching engagement framework by which to connect with Tangata Whenua on the topic of genomic research on Taonga species. Broadly, the engagement framework encompasses a variety of areas including: ● levels of Responsibility ● Project Level responsiveness ● Engagement/communication ● Project outcomes ● Level of involvement ● Intellectual contribution of Māori/Mana whenua ● Organization level responsiveness ● Sample/Data access and governance ● Benefit sharing ● Capacity building ● Embedding relationships ● System level responsiveness ● Research networks and consortia ● International agreements ● Research funding ● End users
38	Gene drive and RNAi technologies: a bio-cultural review of next-generation tools for pest wasp management in New Zealand (Palmer, Dearden, Mercier, King-Hunt & Lester, 2022)	To present a review of research concerning the feasibility and technical progress on both RNAi and gene drives, and the current perceptions of these technologies among a variety of Māori voices.	Two reviews of work **regarding:** ● Potential step-changing technologies for large landscape (>1000 hectares) pest management of social Vespula wasps. ● Māori perspectives on these novel controls to gauge social and cultural acceptability of the research, testing and use of novel controls.	The reviews are broken down into sub-sections exploring both the technical and social considerations of the use of RNAi gene technologies for wasp management. Key topics include: ● Ethical considerations ● Feasibility and society ● RNA interference (RNAi) ● Gene drives ● Bridging themes

	Reference	Objective	Methods	Overall Outline
39	Conservation pest control with new technologies: public perceptions (MacDonald, Neff, Edwards, Medvecky & Balanovic, 2022)	Exploring perceived risks, benefits of novel pest control technologies, how this compares to current technologies and who should be involved in the making the decision.	**Focus groups** (N = 11) with 70 total participants. **Approach:** After general discussion around novel technologies in general and their potential application for pest eradication in New Zealand (i.e., GD, TFT and PST) three key questions were raised: 1. What are the risks and benefits of using gene drive/ trojan female technique/pest specific toxins for conservation in NZ? 2. In what ways would the new technologies be better, worse, and/or the same as compared with what is currently being used? 3. Imagine an appointed panel whose role would be to make decisions about how to control pests that pose a threat to our native plants, animals, and natural environment. Which individuals or groups should be represented on this panel? What are the key factors that the panel should consider when thinking about introducing a new pest control tool? **Analysis:** constant comparative content analysis (thematic). While **Māori were not targeted specifically,** sampling was conducted to be broadly	As no distinction was made across cultural/ethnic groupings of participants, no specific findings can be mentioned regarding Māori views specifically. In saying this, as the sample was such that it was broadly representative demographically, the findings may be broadly applicable to Māori views regarding what is commonly held across population groups. Results were analysed according to key themes including areas such as: ● Environmental considerations ● Ethical considerations ● Practical considerations ● Societal considerations Transparency ● Fear of Genetics Additional perspectives were sought regarding the participants views on: ● Each of the three novel pest control technologies explored (i.e., Pest specific toxin, trojan female technique and gene drive) ● Comparison to current methods ● Who the participants would want to decide on the development and use of these technologies and what they should consider (i.e., Panel makeup and panel considerations.

	Reference	Objective	Methods	Overall Outline
			representative of key demographics. **Note:** A complimentary set of focus groups dedicated to self-identified Māori were conducted by collaborating Mātauranga Māori experts. Findings of this work is not reported here however.	
40	Trust in science and scientists: Effects of social attitudes and motivations on views regarding climate change, vaccines, and gene drive technology	Investigate how trust interacts with social attitudes and motivations to shape views on scientific issues in New Zealand.	**National scale survey**: (n= 8,199) perceptions of gene drive for conservation purposes and variation in their acceptance according to key issues (i.e., climate change, vaccine scepticisms and genetic technology), and psychographic variables (i.e., trust in science/scientists, uncertainty avoidance, social dominance orientation and system justification. **Sampling:** while Māori participants were not specifically targeted, ethnic breakdowns included 5.8% Māori and Cook Islands Māori, 6.1% Mixed and [NZ European and Māori].	As no distinction was made across cultural/ethnic groupings of participants, no specific findings can be mentioned regarding Māori views specifically. In saying this, as the sample included some Māori participants, the findings may be broadly applicable to Māori views regarding what is commonly held across population groups. Results were analysed according to key patterns and analyses including: ● Overall trust levels ● Trust, social attitudes/motivations, and views ● Multivariate analyses exploring the relationships between views on Vaccines, climate change and gene drive.