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MĀORI PERSPECTIVES ON SYNTHETIC BIOLOGY FOR ENVIRONMENTAL PROTECTION

Results from Group Discussions and a National Survey

DISCLAIMER

[Te Tira Whakamātaki](#) (the authors of this report) wishes to make it clear that we do not have a position on synthetic biology (genetic technology). We are neither for or against the use of these technologies for environmental protection and commissioned this report as a part of a larger study. We want to support communities in gathering information and analysing how Māori participants in this research are thinking and talking about synthetic biology so they are better prepared for debate and decision-making.

We uncompromisingly advocate that Māori have the right to decide on the use of synthetic biology at a local hapū and Iwi level, and that central and local government must respect and abide by that sovereignty.

We also recognise the sensitivity of this topic and, as a result, acknowledge the potential for individuals and agencies to misuse it. We commit to doing what we can to correct any blatant misinformation and disinformation that may come from this report, but Te Tira Whakamātaki can not be responsible for all potential misuse coming from this report.

ACKNOWLEDGEMENTS

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We also want to acknowledge the the [National Conversations on Genetic Technologies for Environmental Purposes research team](#), who helped shape this research and were responsible for gathering Pākehā perspectives.

Finally, and most importantly, we want to acknowledge Matua Hemi Waiwai (Ngāti Hinekura, Te Whānau Pani, Ngāti Ruapani, Ngāi Tuhoe) who shaped our thinking and response to this work many years ago. Without his wisdom, strength and guidance, we would not be in the fortunate position of being able to safely explore this topic. Moe mai rā.

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Introduction and Te Tira Whakamātaki

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 our lives, underpins the formation of Te Tira Whakamātaki, and our 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 synthetic biology, termed genetic technologies for this project*, 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. Our 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.

Methodologies

We used two methods to gauge Māori attitudes to, and beliefs on, genetic technologies. First, we replicated a national survey undertaken by colleagues at the University of Otago, supported by Biological Heritage NSC and funded by the Ministry of Business, Innovation and Employment as “Molecular Opportunities: a national deliberative conversation”. Their methodology and results are published [here](#); our full report is published [here](#) with a brief overview of results given below.

To add to these important insights, we held a series of group discussions in Ōtautahi to coincide with a Predator Free symposium (October 2023) where we explored 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, and the results from these discussions forms the main part of this report.

*Internationally, the accepted term for “genetic technologies” is synthetic biology. However, as this report is meant to inform Aotearoa, we will use genetic technologies throughout.

National Survey

Building on the work by “Molecular Opportunities” colleagues, TTW replicated and added to a survey assessing 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 our networks [TTW paid for an advertisement on Facebook to recruit respondents and also distributed sent 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. In the end, the survey received 537 responses. 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 practicing 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, we separated Māori and Pākehā answers and compared them to one another. Results from Māori respondents will be presented throughout this report along with minimal data comparing Māori to Pākehā respondents. We give an overview of key survey findings below and intersperse key findings with the results from our group discussions where appropriate and direct interested readers to the full report which is complimentary to this report and provides additional context to the themes described [here](#).

Māori Group Discussions: Genetic Technology Scenarios

As noted above, the opportunity to discuss with senior Māori researchers and kaumatua was a unique opening within the Indigenous biosecurity space to explore the diverse views we had surveyed earlier. We structured the discussions around five scenarios developed 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 would be displayed on a screen and read aloud. We recorded what was then said by participants, which began with first reactions and then delved into the ideas that opened up with discussions but with explanations of the tools and prompts to ask again whether participants were comfortable with the

potential tool, and why, or uncomfortable and the reasons for that discomfort. We intentionally designed the scenarios to include pests, taonga and other native species, and the human food chain.

Finally, we designed the group discussion scenarios to be short, sharp, and accessible. We assumed that participants would have varying levels of knowledge about the tools we were using in each scenario, with many of them having limited knowledge. To mimic what participants might come across or read in real life, we would present each scenario (a couple of sentences in length) and ask for initial reactions. We would then explain some of the technicalities behind each tool and ask again for reactions to see if their comfort had changed by knowing more about said tool. We would also frequently play with each scenario to change the timeline and type of species (pest or native) to see if that influenced comfort. Selected results from this design are presented in the sections below.

Results: Māori Perspectives on Genetic Technologies for Environmental Protection

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

While we are confident that our findings stretch across multiple contexts and communities, we acknowledge that results are representative of those who responded to the survey and the group discussions, and we advise against blanket generalisation of these results to all Māori across the country. We believe these results can guide beginning conversations, understandings, and provide direction for community consultations. However, we also believe that additional consultation with Māori communities is a necessary step for any proposal using genetic technology.

Survey Findings: Support or Opposition to the Use of Genetic Technology

To gain a broad understanding of perspectives on genetic technologies, we posed this open-ended question 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.**

We received 458 responses to this question and analysed Māori and Pākehā responses 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 this report. In our quantitative analysis of these responses, we found that 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).

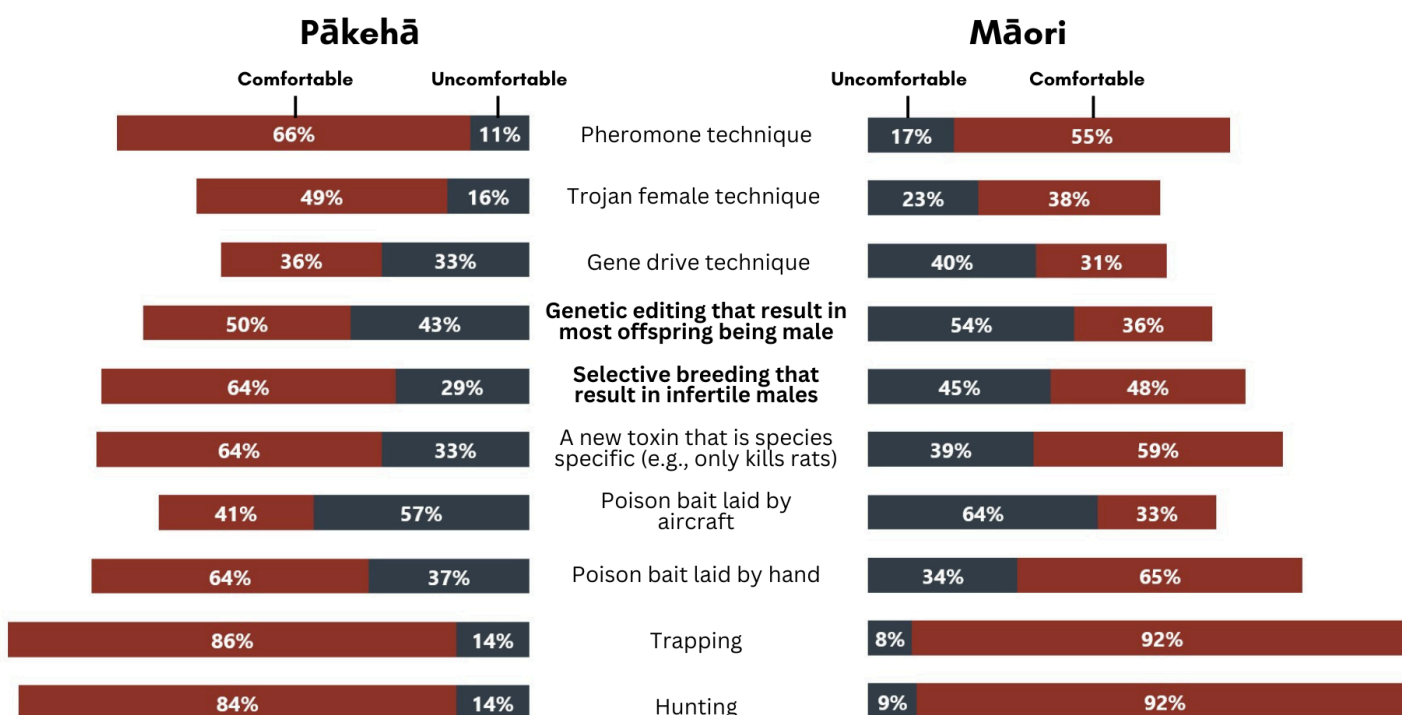
We also designed questions aimed at exploring the comfortability with various genetic technology tools, who is most trusted to give information on genetic tools, as well as the factors that most influence decisions to protect the natural environment. We believe each of these play a role in overall attitudes and behaviours towards genetic technology. As with many of the other questions, we created a list of potential ways to trap pests, some of which were genetic technology tools, and ask respondents to give their comfort rating for each one. 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 if appropriate controls are in place**
- 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 make comparisons slightly easier, 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). We then used this type of analysis to compare comfortability between Māori and Pākehā respondents. In general, Māori respondents were less comfortable with many of the genetic technology techniques we 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 to dropped from aircraft. Speaking generally, 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).

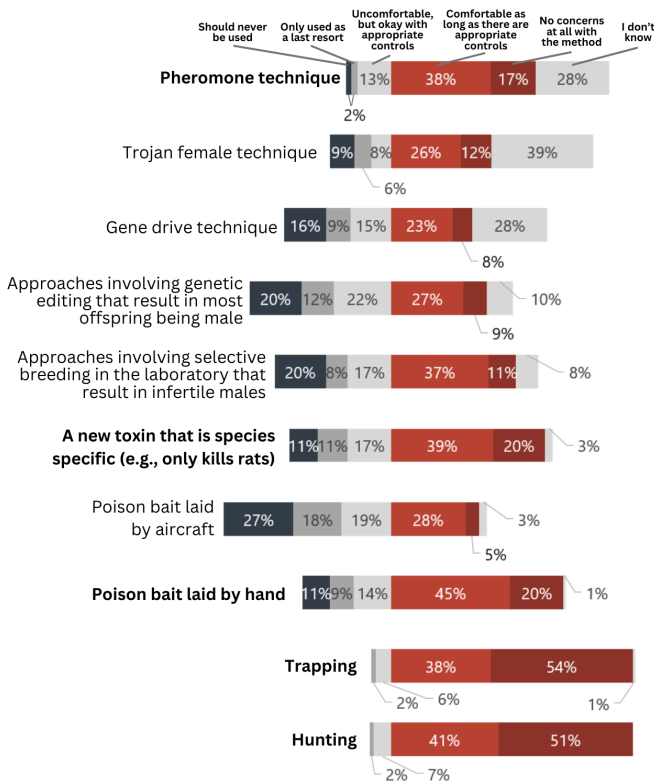
Generally, **Māori** were more likely to be **uncomfortable** with many of the genetic tools listed, but standouts included **genetic editing resulting in offspring being male** and **selective breeding**.



When further breaking down these results, a clearer picture emerges around comfortability 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 said they didn’t know for the trojan female technique). To us, this is evidence showing a general lack of knowledge about these genetic tools. This could also 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 at all with a method vs. those who are comfortable if there are appropriate controls.

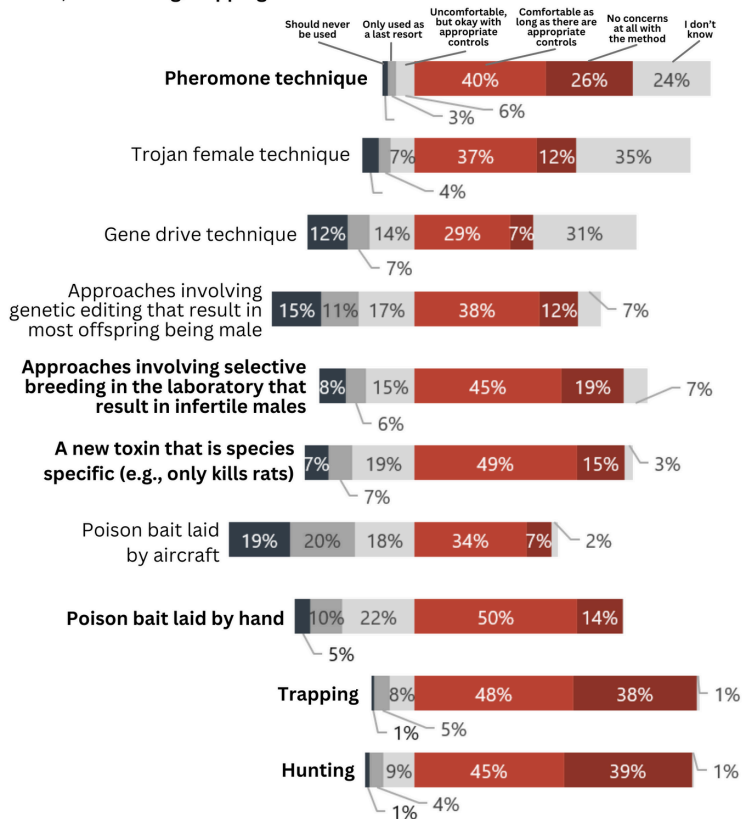
Māori Graph

As long as there was appropriate controls in place, many Māori respondents said that they were **most comfortable** with the **pheromone technique, a new toxin that is species specific, poison bait laid by hand, and trapping/hunting** (including those who indicated they had no concerns at all with the method).



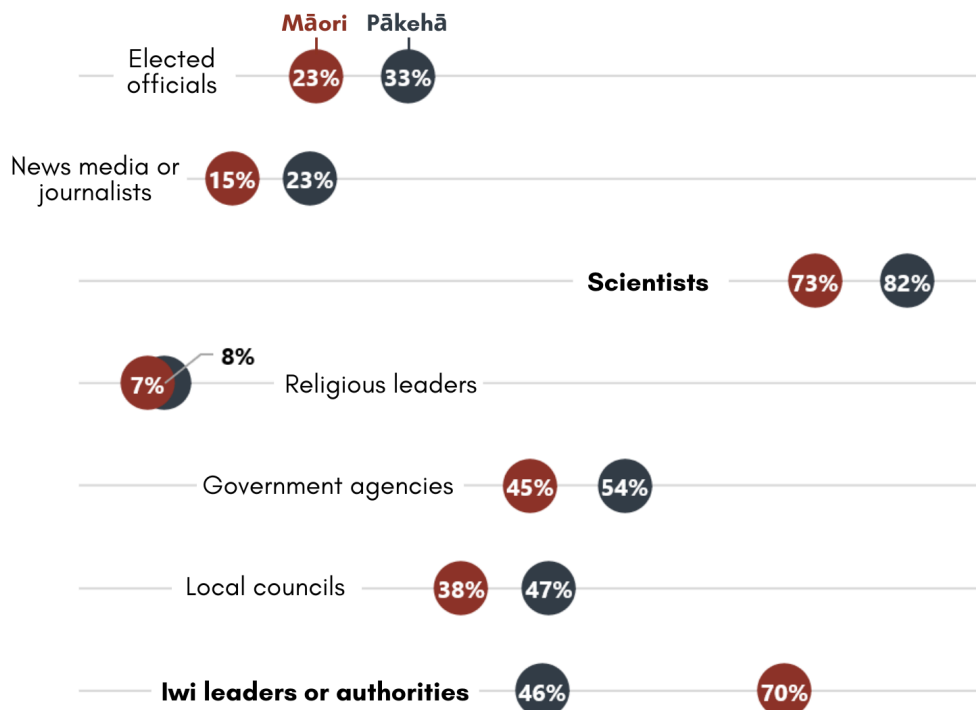
Pākehā Graph

As long as there was appropriate controls in place, many Pākehā respondents were **comfortable** with many pest control methods, including the **pheromone technique, selective breeding, species-specific toxins, poison bait laid by hand, and hunting/trapping**.



To determine what the best type of communication of such tools would be for the public, we asked respondents to indicate how much they trusted various sources to give them information about a new genetic technology tool. They did so on a scale from 1 (strongly distrust) to 7 (strongly trust) but 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 up by Iwi leaders or authorities (70%) and this was also the largest difference between groups in this set of results (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.

When asked how much they would **trust** different sources to give information about a potential genetic technology tool, both **Māori** and **Pākehā** trusted **scientists** the most. However, there was a **difference** in how much **Māori** trusted **iwi leaders and authorities when** compared to **Pākehā**.



Group Discussion Results

To assist the reader in understanding how the design of each scenario affected participants' responses to it, we have broken each down into the tool it utilised, the full scenario text, and the key elements that went into its design. We anticipate that this will help illustrate how comfort varied across circumstances and contexts.

Scenario 1: Bringing back the Huia (“De-extinction”)

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.

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 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 to a bigger system rather than a single bird). When taken together, this reaction is evidence to 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. Evenif 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**

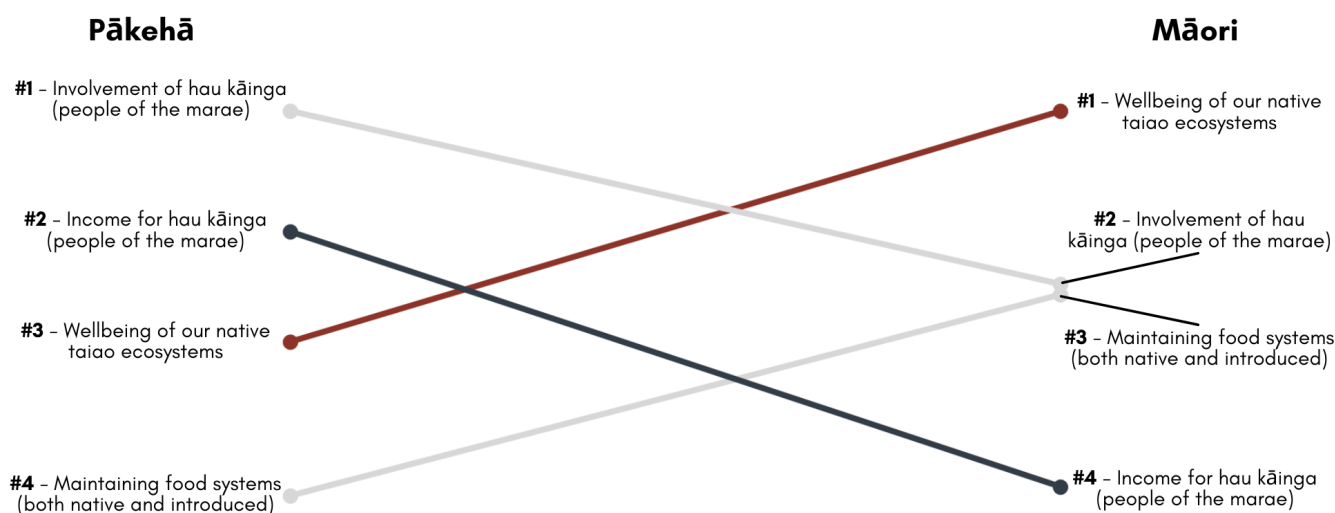
“There's something that is stopping me from feeling comfortable with it, and I think one of those things is the fact that the way that land is so completely different to when they were here, that they potentially wouldn't have developed the right evolutionary things to sustain themselves or to stick 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 in the environment and their responsibilities tied to that.

There were **differences** between **Māori** and **Pākehā** when asked to prioritize what is most important when planning pest control. Most notably, the **wellbeing of native taiao ecosystems** was the most important to Māori, but third for Pākehā respondents. **Income for the hau kāinga** was second for Pākehā but last for Māori respondents.



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. Once again speaking 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 peoples 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 our 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**

Scenario 2: Mānuka and Pōhutakawa Resistance to Myrtle Rust (Genome Editing)

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.

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 is 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 that it wasn't an overly necessary or needed path to go down. Instead, they would rather rely on tried-and-tested 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 were so because they 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**

Scenario 3: Fruit Fly Invasion (Sterile Insect Technique)

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.

This scenario was intentionally created to test comfort with a tool that seems like it 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 was 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, bringing us to another common theme. That is, there was predictably 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 a use of a 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.

Scenario 4: Kūmara Resistance to Insects (Transgenics)

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)

While the third scenario might have been the most comfortable for participants, this scenario was certainly the least comfortable for participants. We struggled to find anyone who would be okay with the use of this tool on the kūmara. We intentionally used the kūmara 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 cases, a participant even preferred to use chemicals that they knew caused harm over using genetic technology to protect the kūmara. We believe that this is because 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**

Scenario 5: Possum Infertility (Gene Drive using CRISPR)

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.

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 they 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**

“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. We told participants that a large number of genetically modified possums (upwards of 250,000*) 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 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**

*Gene editing for pest control - Predator Free NZ Trust

“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 escape 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**

Overall Reflections: What are the Results from the Group Discussions and Survey Saying?

While there were unique results for each scenario and in the survey, there were also several common themes. These were factors, regardless of the specific context or situation, seemed to be driving respondents' attitudes around the use of genetic technology for environmental protection.

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**

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 but 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**

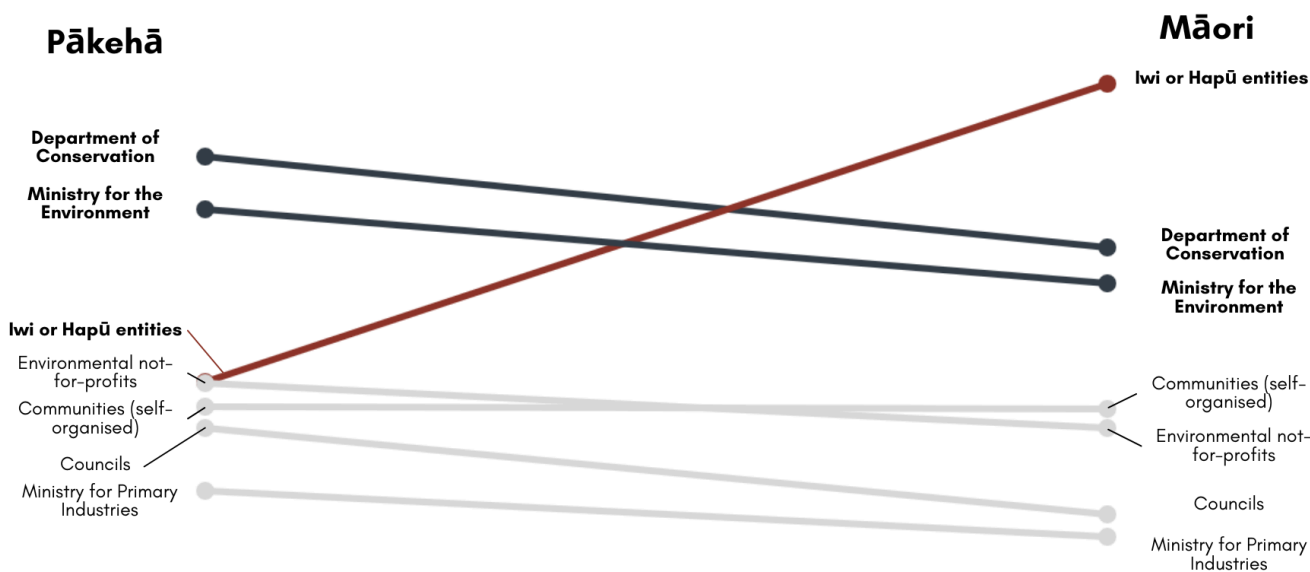
“Tikanga Māori is important as a guide for new technologies.” – **Māori Survey Respondent**

“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, we also asked respondents 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.

When asked who should **lead environmental decision-making**, the **Department of Conservation, Ministry for the Environment**, and **iwi or Hapū entities** were in the top three for both Māori and Pākehā. However, Māori put Iwi or Hapū entities as the **first** body who should lead, whereas Pākehā put them as **third**.



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**

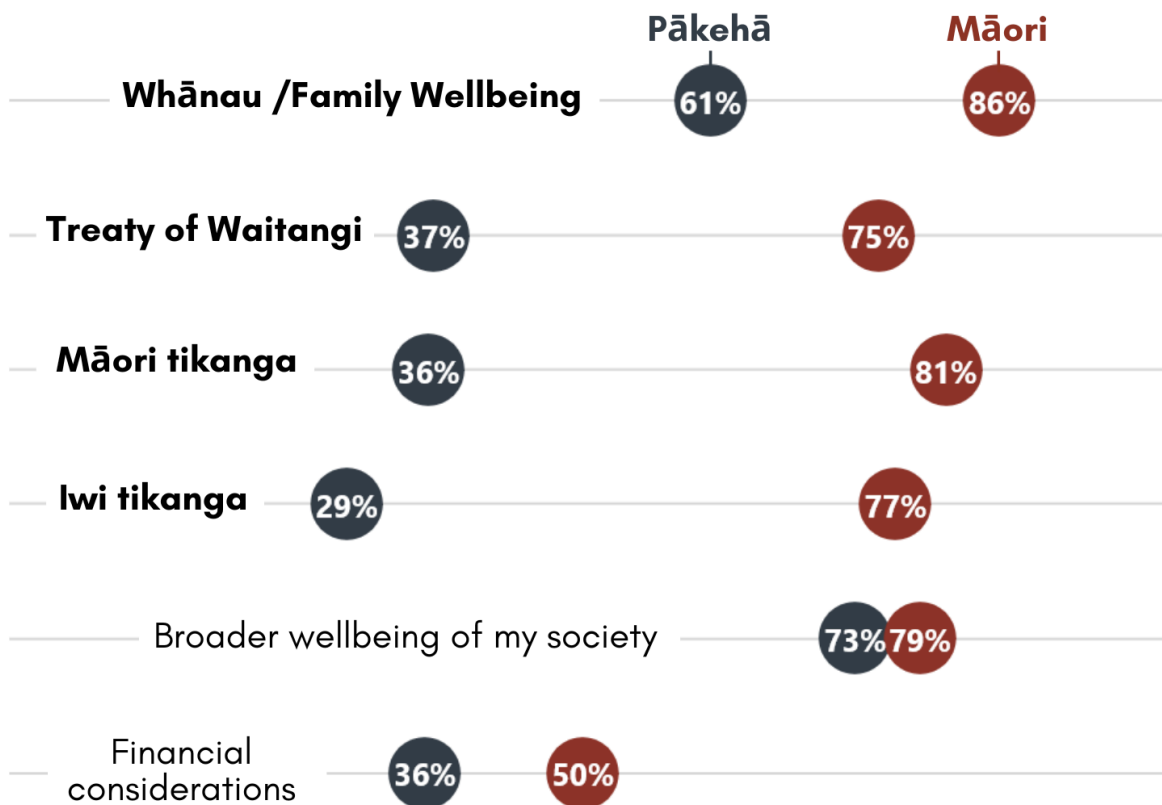
“There's the understanding in a scientific way, but it's totally disconnected from understanding about whakapapa and there's a long way to go before we've got enough Māori with cultural knowledge and doing the science to actually be able to even really have these conversations.” – **Group Discussion 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).

When asked what factors influence their decisions to protect the natural environment, there were large **differences** between **Māori** and **Pākehā** responses, most notably when asked about the **Treaty of Waitangi**, **tikanga**, and **whānau wellbeing**.



Whakapapa and Its Implications for Genetic Technology

Evidence across methods suggests that one integral part that forms the backbone 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. For example, 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**

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**

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**

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.