

USING MEAD'S "FIVE TESTS" PRECEDENT APPROACH FOR GENETIC CONTROL OF RATS

*Raine Hananui**
Ocean Ripeka Mercier†
Alan King-Hunt‡

Abstract

Sir Hirini Moko Mead's Five Tests framework helps identify a te ao Māori response to contemporary challenges. One such issue that Mead confronted, more than two decades ago, was genetic modification. We applied Mead's precedent test to a genetic technology under development in Aotearoa New Zealand called single-sex offspring selection (SSOS). Single-sex offspring selection aims to control rat populations that harm native species either by producing primarily male litters or, by rendering females infertile, through a gene drive. We sought precedents for sex selection of offspring and causing infertility in Māori tradition by surveying whakataukī and 19th- and 20th-century written secondary sources containing mātauranga Māori. The search revealed examples of parents choosing the sex of their future children and of causing infertility in women and in kūrī, indicating that the underlying concepts of SSOS's control methods are not entirely new to te ao Māori, even if the delivery mechanism is. The precedent test invites us to learn about and reconnect with ancestral practice, helps to conceptualise and understand the issue at hand, and helps form a Māori response to complex novel technologies.

Keywords

genetic modification, mātauranga Māori, precedent aspect, sex selection, pest control

Introduction

In 2003, Sir Hirini Moko Mead described contemporary, contentious issues such as genetic modification and xenotransplantation as "ngā ahi e ngiha mai nei: the fires that flare up" (Mead, 2003, p. 335). The "ahi" of genetic modification has been burning in Aotearoa New Zealand since

the 1990s (Brankin, 2021; C. Smith, 2006), forcing Māori across the country to grapple with its potential effects on whakapapa (Reynolds, 2007), mauri (Roberts & Fairweather, 2004), tapu (Satterfield et al., 2005), kaitiakitanga, and rangatiratanga (Cram, 2005). Genetic modification can either support or damage these values (Durie, 2004;

* Waitaha, Kāti Māmoe, Kāi Tahu. Research Assistant, Te Kawa a Māui—School of Māori Studies, Victoria University of Wellington, New Zealand.

† Ngāti Porou. Professor, Te Kawa a Māui—School of Māori Studies, Victoria University of Wellington, New Zealand.
Email: ocean.mercier@vuw.ac.nz

‡ Ngāti Hauā. Kairangahau Māori, Te Kawa a Māui—School of Māori Studies, Victoria University of Wellington, New Zealand.

Hudson et al., 2019), depending on who controls it, who benefits, and how it is used (Durie, 2004; King-Hunt, 2023; Roberts & Fairweather, 2004).

Mead's (2003) statement that "the current debate on genetic modification is a matter of some concern" (p. 343) remains true over 20 years later as advancements in gene editing enable genetic modification to flare up in new forms, such as in pest control (Dearden et al., 2018; McFarlane et al., 2023). Gene editing is a type of genetic modification that allows scientists to alter DNA more precisely and efficiently than was possible with earlier forms of genetic modification (Wang & Doudna, 2023), and it has been proposed as a possible method to reduce the fertility of invasive species (Royal Society Te Apārangi, 2019). Further fuelling the fire is the overhaul and relaxation of Aotearoa's gene technology regulation, which will make it easier to release genetically modified or edited organisms outside of the laboratory (Collins, 2024; New Zealand Parliament, 2024). The rekindled fire of genetic modification cannot be put out—only responded to.

It is important that Māori are able to make informed decisions on new forms of genetic modification by "engag[ing] with tikanga Māori and its knowledge base, mātauranga Māori" (Mead, 2003, p. 335). Mead (2003) provides a framework to help with this by describing five tests that can be used to form "a Māori viewpoint, or a Māori position" (p. 336) on ngā ahi e ngiha mai nei: the tapu aspect, the mauri aspect, the take-utu-ea test, the precedent aspect, and the principles aspect. Mauri, tapu, and other tikanga Māori principles have been discussed in the context of genetic modification across the literature (e.g., Hudson et al., 2019; Roberts & Fairweather, 2004; Satterfield et al., 2005) and take-utu-ea used for biotechnological pest control has been discussed by Palmer et al. (2020). We chose to focus on the precedent aspect (hereafter precedent test) as it remains an area not yet thoroughly examined in the literature in the context of genetic modification, and because out of the five tests, it is most suited for literature-based research.

Of the precedent test, Mead (2003) writes:

When confronted with a new "fire" an obvious response is to look for precedents in the culture. Is there some event in our traditions that might help us understand the issue and help frame a response to it? ... from a Māori perspective the question is whether there is a whakapapa to which the new event can be linked, or whether there is a taura, or model, in our traditions. (pp. 343–344)

A whakapapa in this context could be thought of as a kind of conceptual genealogy (Royal, 1998). While ahi-like genetic modifications may appear to be entirely new, they are built upon established ideas, values, and practices that have been developed over centuries (Munn, 2024). The precedent test directs us to search our culture and traditions for relevant taura of mātauranga and tikanga Māori which can aid in understanding ngā ahi e ngiha mai nei. Traditions might also reveal how the ideas underpinning the issue under consideration have been approached by tūpuna, providing precedents for how one can respond to them in new contexts (Mead, 2003; Munn, 2024).

The whakataukī "titiro ki muri kia whakatika a mua (look to the past to proceed into the future)" (Riley, 2020, p. 821) illustrates the essence of the precedent test, which is flexible and can be applied to many different contemporary challenges in different ways. This versatility can be seen in the wide range of issues the precedent test has been used or suggested for, like invertebrate pest control (Mercier et al., 2022), artificial intelligence (Munn, 2024), pre-birth genetic testing (Henaghan & Tipene-Matua, 2006), representation of iwi members outside their tribal area (Carter, 2006), library collection policies (Banks, 2023), and data sovereignty (Taiuru, 2023).

Pest control

Taonga species and the ecosystems they are a part of are foundational to Māori culture, identity, and practices (Mead, 2003). Introduced animal pests in Aotearoa, such as mammalian predators and *Vespula* wasps, harm native biodiversity by competing with and directly preying and feeding on taonga species (Brockerhoff et al., 2010; Goldson et al., 2015; Innes et al., 2010). For Māori, who have an inherited responsibility to care for the environment, the issue of pests and their control is of significant concern. Māori rangatiratanga over whenua and taonga, guaranteed to hapū by Te Tiriti o Waitangi, needs to be at the heart of addressing the threat of pests (Palmer et al., 2020).

It is important to recognise that the term pest is context dependent. A species that is considered a pest in one situation may be valued in another; for instance, the kiore (Pacific rat, *Rattus exulans*) introduced by Māori is both a taonga with whakapapa and considered an ecological pest (Roberts et al., 2004; Wehi et al., 2021). Traditionally, Māori both controlled and made productive use of "pesty" species, situating them within whakapapa and whakataukī (Mercier et al., 2022).

Gene drives for pest control

In this article, we consider how Mead's precedent test can be used to help understand a new genetic pest control tool under development in Aotearoa that aims to harness a gene drive. A gene drive uses a "selfish" gene that increases the probability it will be inherited by the next generation to more than the usual 50%, "driving" itself throughout the population over time until most of the population has received the gene (Bier, 2022; Esvelt et al., 2014). Pest populations could be reduced over time using a gene drive to distort the sex ratio (Prowse et al., 2019; Schliekelman et al., 2005) or to bias the inheritance of genes linked to deleterious traits such as female (Gierus et al., 2022) or male infertility (Lester et al., 2023). In Aotearoa, gene drive has been suggested as a non-lethal, species-specific, and self-perpetuating option to control introduced pests such as rodents, possums, stoats (Dearden et al., 2018; Royal Society Te Apārangi, 2019), and *Vespula* wasps (Lester et al., 2020) at the landscape scale.

Single-sex offspring selection (SSOS) is a gene drive that could control Norway rats (*Rattus norvegicus*) and ship rats (*Rattus rattus*), which were both introduced to Aotearoa during the European contact period and are significant contributors to the decline of native species (Bell et al., 2016; Russell & Innes, 2021). Kiore, due to their status as a taonga for some iwi and current limited distribution in Aotearoa, are not a target of SSOS. Single-sex offspring selection was under early laboratory development at AgResearch Limited in 2022–2025 as part of the Tactical Genetic Control of Rats (TGCR) project, coordinated and funded by Genomics Aotearoa and Predator Free 2050 Limited. Our research falls under the TGCR project and contributes to its aim of understanding how mātauranga Māori applies to genetic predator control.

Single-sex offspring selection aims to reduce the rat population over generations by distorting the sex ratio in favour of males. A secondary option is to render 50% of females infertile. Over time, both approaches should result in the number of reproductive females dropping, leading to population decline or even eradication (McFarlane et al., 2018; Schliekelman et al., 2005).

In the main approach, SSOS would distort the sex ratio by manipulating the process of sex determination, which in rats, humans, and other mammals is controlled by the X and Y chromosomes. During reproduction, the mother (XX) contributes a single X chromosome through her egg, while the father (XY) contributes either an

X or a Y chromosome through his sperm. There is an equal chance that the offspring will be male (XY) or female (XX) under normal Mendelian inheritance.

Single-sex offspring selection would change the inheritance rules in favour of male offspring by using gene editing to artificially combine the rat Y chromosome with a natural gene drive in mice called the *t*-haplotype. The *t*-haplotype makes sperm carrying it and anything linked to it to move faster than non-carrier sperm in the race to fertilise eggs (Bauer et al., 2005; Lindholm et al., 2016). In linking the *t*-haplotype to the Y chromosome, SSOS would increase the percentage of eggs fertilised by Y chromosome-bearing sperm to over 50% and potentially up to 99%, ensuring most offspring are male. Those males, having inherited the *t*-haplotype with the Y chromosome, would then father primarily male offspring through the same mechanism.

For the few females that an SSOS male might father, a potential contingency considered under the TGCR project is to use gene editing to knock out, or disable, the female fertility gene *Nobox*. Half of the few female rats fathered by SSOS males would carry two copies of this knockout gene under Mendelian inheritance and would thus be infertile.

At the time the TGCR project finished in 2025, SSOS was in the very early stages of laboratory development. Years of further work would be needed to determine whether SSOS is scientifically feasible, whether its effects can be contained to prevent negative impacts on non-target populations overseas, and whether legislation and public opinion would ever enable its release (Belcher et al., 2024; Palmer et al., 2022). However, even if it is scientifically achievable, SSOS and similar technologies, as both a form of genetic modification and a potential tool to mitigate the impacts of introduced pests on taonga species, have implications for kaitiakitanga, whakapapa, mauri, tapu, and rangatiratanga. We used the precedent test to investigate whether there are any historical taura that can help in understanding and responding to SSOS, asking, Are there precedents for sex selection of offspring or causing infertility in Māori traditions?

Methods

Rather than being prescriptive in his description of the precedent test, Mead (2003) provides an example in the form of the question of genetic modification and turns to ngā kōrero tuku iho for precedents. Ngā kōrero tuku iho such as

pūrākau, whakataukī, whakapapa, and karakia form crucial sources of mātauranga and tikanga Māori and convey the actions, worldviews, societal norms, and values of tūpuna (Lee, 2009; Marsden & Henare, 1992; Mercier et al., 2022). Mead discusses pūrākau of tūpuna, like Māui, changing their own form or the forms of others to beings such as birds and mountains, as well as whakapapa that includes the creation of both biological and non-biological beings. Mead (2003) then links tradition with genetic modification through the shared idea of changing and creating new forms, writing, "scientists are like demigods who are able to create new forms of life or transform one life form into another" (p. 344). By focusing on ideas rather than literal details, Mead is able to find potential precedents in tradition for a contemporary ahi. Mead does not specify whether and how one should apply precedents found to the issue at hand; rather, he leaves it up to the reader, recognising that how any of his five tests are used will differ depending on the person and their situation.

Informed by Mead's example, we began by pinpointing underlying concepts in SSOS for which there might be precedents in ngā kōrero tuku iho. The primary ideas we identified underlying SSOS were sex selection of offspring, causing infertility, pest control, manipulation of inheritance probabilities, perpetual change to whakapapa, and the crossing of genes between species. Mead's precedent test has already been considered by Mercier et al. (2022) in the context of invertebrate pests and pest control. Here, we focused on sex selection of offspring and causing infertility, as these concepts underpin the two approaches of SSOS. We then established a set of questions to guide our search for precedents for these two concepts:

- How were sexes in flora and fauna understood in traditional Māori society?
- Was one sex ever preferred over others in people or plants and animals?
- Are there any accounts in which one sex was selected for in the context of reproduction?
- Was infertility ever desired, and if so, were there practices to reduce or remove fertility?

We drafted a list of keywords that related to the above questions, adding to them as we researched. Below is a list of these keywords, paired when appropriate with the word "Māori" or species-specific names:

Female, male, female/male child, wahine, tāne, women, men, gender, uha, sexes, infertile, childless, barren, sterile, sterilisation, castrate, conceive, conception, reproduction, pregnancy, birth, fertilise, offspring, breed, cultivate, litter, husbandry, mahinga kai, kurī, Māori dog

Using the list of keywords as search terms, we examined written secondary sources containing ngā kōrero tuku iho, particularly 19th- and 20th-century texts available in the Te Herenga Waka—Victoria University of Wellington library and online. The New Zealand Electronic Text Collection and early editions of *The Journal of the Polynesian Society* (JPS) were significant databases. We also searched whakataukī contained in Mead and Grove (2003) and Riley (2020). Due to time, language, and knowledge constraints, we did not canvass sources available only in te reo Māori, nor non-written sources such as whakairo. We collated relevant information in excerpt and note form and used EndNote for bibliographical details, then analysed the gathered tikanga and mātauranga Māori for potential precedents for sex selection of offspring and causing infertility. We then compared the precedents to SSOS with context in mind.

For this research, we use a binary male–female framework and refer to sex and gender interchangeably to accommodate the comparison of manipulating sexes in rats with approaches to sex and gender recorded in ngā kōrero tuku iho. We acknowledge that this does not reflect the complex relationships between sex and gender seen in both te ao Pākehā and te ao Māori, nor account for gender diversity, which is an emerging area of discussion in Māori scholarship (Berryman-Kamp, 2024).

One challenge to using the precedent test is the fragmented recording and loss of intergenerational transmission of mātauranga Māori due to colonisation (Mead, 2003). Often, ngā kōrero tuku iho survives only in the work of Eurocentric ethnographers, who selectively recorded and (re)interpreted mātauranga Māori through their own patriarchal, reductionist, colonial lens (Pihama, 2020; L. T. Smith, 2021). Unfortunately, the majority of relevant ngā kōrero tuku iho available to us for this research were contained in the work of ethnographers, particularly that of Elsdon Best, whose influence in today's understandings of traditional Māori society is pervasive (Holman, 2008). Ethnographers such as Best diminished the mana of wāhine Māori (Kern, 2024; Pihama, 2020; Pihama et al., 2021) and imposed rigid concepts

of gender roles and identities (Berryman-Kamp, 2024; Mitchell & Olsen-Reeder, 2021) onto te ao Māori by applying their own misogynistic frameworks to ngā kōrero tuku iho.

A tension thus exists in using the precedent test for issues where much of the available ngā kōrero tuku iho resides within ethnographic accounts. It is beyond the scope of this article to discuss in depth the complexities of the role ethnographic work plays in understanding how our tūpuna lived, but we note that Mead (2003) himself cites pūrākau and whakapapa recorded by Best in his discussion on the precedent test, indicating that precedents drawn from ethnographic work can be valuable if considered critically.

Results

Sex selection of offspring in flora and fauna

Birds, mammals, fish, and trees were traditionally perceived by Māori as possessing distinct male and female sexes (Beattie, 2009; Best, 1941, 1977; Mead & Grove, 2003, p. 237; H. W. Williams, 1906) and were sometimes given sex-specific names (Beattie, 2009; Best, 1941; H. W. Williams, 1906). No clear precedent for sex selection of offspring was uncovered for flora or fauna, although a potential example exists in tūi. Best (1934) states that only male tūi, called tākaha or tute (H. W. Williams, 1906, p. 200), were trained to talk. Young tūi were taken from nests for this purpose (Best, 1941), but as Oporo Paerata of Te Karaka told Best (1977), the sexes of tūi chicks were difficult to determine, so it is uncertain whether only male chicks were removed from nests or whether both sexes were taken and sorted when older. We were unable to determine whether tūi were bred in captivity in traditional Māori society.

Sex selection of offspring in people

The first human was created female by the atua in a pūrākau describing the origin of humanity. There are numerous versions of this pūrākau, but the essence is as follows: the sons of Papatūānuku wished to produce a mortal people that resembled themselves to inhabit the world. They determined that as they were all male, they required the uha, or female element, for the creation of the ira tangata to be successful (Best, 1923). They sought the uha in the 12 heavens among the female inhabitants, but couplings between the sons of Papatūānuku and female atua resulted only in offspring that possessed ira atua, not ira tangata. Tāne, the atua of forests who is usually described as the main seeker of the uha (Best, 1923, 1924; Hīroa, 1949; White, 1887), fathered many offspring in these

attempts to produce the ira tangata (Best, 1923, 1924).

After a long, fruitless quest, Tāne and his brothers realised that the uha could not be found in the 12 heavens. Eventually, Papatūānuku directed her sons to Kurawaka and told them that the uha required to create ira tangata could be found there in her fertile red soil (Tikao, 2020; White, 1887). From Papatūānuku's soil, Tāne moulded a female human form. Tāne's brothers contributed various parts of the human body, including the female sexual organs (Hīroa, 1949; S. P. Smith, 1922; White, 1887). In most accounts, it is Tāne who breathed life into the earth-sculpted form, and the woman Hine-ahu-one awakened with a sneeze as the first human being.

In this version of the creation of humanity, it is the atua who selected for sex when forming Hine-ahu-one. Sex selection, however, did not seem to be restricted to atua. We found multiple examples of practices used by humans to select the sex of their future children, usually as part of fertility rites (termed "whakatō tamariki" by Best, 1906) to aid women who were struggling to conceive. Most of the following examples come from hapū and iwi of the central and eastern North Island.

Plants played a role in several conception rites involving sex selection. To increase fertility and the chances the future child would be male, during karakia karamū bark and leaves were held over a woman seeking help to conceive (Tikao, 2020). In another conception rite, a tohunga would cut the shape of a human figure into a leaf, marking sexual organs that matched the sex desired by the parents. The leaf would then be placed onto the mother's torso while karakia were recited, then kept by the tohunga until labour, when it was placed under her pillow (Best, 1941, 1975). Best (1906) records a fertility karakia recited by a tohunga over a bunch of kāretu that had been handled by the woman requesting assistance to increase her fertility. The wording of the karakia differed depending on the desired sex. For the conception of a son, the child was dedicated to Tūmatauenga, while for females, the child was dedicated instead to Hine-te-iwaiwa.

According to Best (1906) and Tregear (1904), a hīnau tree at Ruatāhuna called Te Iho o Kataka contained the iho of the tohunga Tāne-atua's daughter Kataka. Tāne-atua gave the tree the power to cause women to conceive (Best, 1906; Tregear, 1904). A wahine would embrace the tree on the eastern side if she wished to have a male child and on the western side for a female (Best, 1906; Tregear, 1904). A tohunga would recite a karakia as she did so (Best, 1906). Similarly, bark

or twigs from the eastern branch of the tapu tree Te Hunahuna-a-Pou taken by the husband and placed under his wife before intimate activity resulted in a male child, while material from the western branch resulted in a daughter (Best, 1906). The association of the female element with the west and the male with the east is also seen in an opening ceremony for the kiore trapping season (Downes, 1926).

Mitira (1972) describes how Tonoa-ki-Aua, an ancestor of the hapū Te Whānau a Taupara, sought help from her taniwha ancestors so that her child would be a son, as desired by her people. Her tūpuna advised her to avoid contact with rivers entirely, and to use only special wells or springs for drinking and bathing. She followed these instructions, and as a result, she had a male child, who was named Tama-i-uia. Mitira (1972) translates this name as "a son inquired after".

Other whakatō tamariki methods involving sex selection we found in our research include piki whenua, when a woman who wished to have a child of a specific sex would stand over the placenta of a newborn of that sex for a time (Best, 1906; Mākereti, 1938), and the use of carved figures representing either a male or female child in fertility rites (Heuer, 1969).

Some records claim that male children were generally preferred over female children, as they would become warriors and continue their father's family line (Best, 1941; Heuer, 1969; Mākereti, 1938). A whakataukī recorded in Mead and Grove (2003) contains the response of Waitapu II to her husband Te Rangīta, who was angered she birthed no sons, only daughters. She replied, "He aha koa, kai te tuhera tonu te awa i Nukuhau ... What of that, the river is always open at Nukuhau", and went back to her people (p. 62). A further three whakataukī in Mead and Grove (2003) recall a similar situation involving Rākeiti, who faced the same complaints from her husband Pikiāo (p. 292) or from her father-in-law, depending on the whakataukī. In the different versions of the narrative, either Rākeiti (p. 72) or Pikiāo (p. 388) gave a similar response to that of Waitapu II.

Mākereti (Maggie) Papakura, a Māori ethnographer, commented in her book *The Old Time Māori*, "It was a great blow to a tangata rangatira not to have a son to carry on his kawai (line)" (p. 81), although she also asserts that children of both sexes were welcomed (Mākereti, 1938). While Heuer (1969) states that sons were preferred, she also comments that daughters were embraced for their ability to contribute to alliances between iwi, while an oriori sung to a

wooden figure representing a child by Hine-kiore, a childless woman left behind in war, appears to convey the wish for a daughter rather than a son (Downes, 1936).

While these records may give the impression that sons were generally preferred over daughters, it is important to recognise the influence of ethnographic patriarchal bias in how ngā kōrero tuku iho relating to gender was recorded and presented. Mana wāhine scholarship provides a counter-narrative to the ethnographic framing of Māori society as misogynistic, instead asserting the mana of wāhine (Kern, 2024; Pihama, 2020) and highlighting how wāhine and tāne were considered equal and in dynamic balance (Sharman, 2019; Stewart, 2021). This balance can be seen in Papatūānuku and Ranginui, the ancestral parents in some traditions of all that exists today (Sharman, 2019; Stewart, 2021), and in the creation of humanity, which required both female and male essences; it could not be done with one alone (Reed & Calman, 2021; Sharman, 2019).

Causing infertility

We discovered several instances of causing infertility in tradition. In humans, karakia would be recited over a woman to prevent pregnancy in a ceremony called taupā (Best, 1914, 1975), also referred to as tuapa (Best, 1941; Mākereti, 1938), whakapā (Best, 1906) or kokoti-uru (Best, 1975, p. 13). A stone was sometimes included to symbolise infertility (Best, 1941, 1975). The ceremony was rarely employed, according to Best (1906), although he states that Paora Horomata of Tūhoe was apparently well known for performing it. Best suggests that the karakia Horomata used was a part of Hauhauism rather than a pre-European rite. The ceremony as practised by Horomata was done when the mother was giving birth and involved Horomata casting blood she had passed into a small fire while reciting karakia (Best, 1906). Taupā is generally discussed in these sources as being used for women who had already borne children.

There is also a reported instance of taupā being used to ensure male-only descent. Huiarei underwent taupā to guarantee she would have no daughters after giving birth to her first child, her son Ruarangi (Best, 1914, 1975).

One example of causing infertility in animals was found in kurī, which were introduced to Aotearoa by the ancestors of Māori in the late 14th century (Anderson & Clark, 2001). While information on kurī husbandry is scarce, it is

recorded that they were kept in villages and bred in captivity (Beattie, 2009; J. Williams, 2012). In 1920, Te Kahupuku from Nelson informed James Herries Beattie that male kurī pups were whakapoka, to “fatten them up for food” (Beattie, 2009, p. 510). Teone Taare Tikao of Kāi Tahu also told Beattie that kurī were whakapoka but said it did not affect how kurī were to eat and that he “did not think [whakapoka] was an ancient custom” (p. 351). J. Williams (2012) states that male pups which exhibited favourable attributes such as fur length would be set aside for mating with females while the rest would be castrated. In contrast to Tikao, J. Williams (2012) asserts that whakapoka was a traditional practice.

Discussion

Our results indicate that the concepts of selecting the sex of offspring and of causing infertility are not foreign to te ao Māori. Sex selection of offspring has a whakapapa in Māori tradition that stretches back to the atua Tāne’s creation of the first human, the woman Hine-ahu-one. The multiple methods used by human parents to predetermine the sex of their future children suggest that in certain circumstances it was a socially acceptable practice that was not restricted to the domain of atua. Despite the importance of reproduction in te ao Māori (Henaghan & Tipene-Matua, 2006; Mākereti, 1938; Rarere, 2022), there are also precedents for causing infertility in the whakapoka of male kurī pups and the use of taupā for women who wished to prevent further pregnancy. Taupā is also referred to as kokoti-uru in Best (1975, p. 13) and is likely the origin of the modern usage of kokoti-uru in medicine for sterilisation (He Kupenga Hao i te Reo, 2025; Moorfield, 2025).

How do these results relate to SSOS? A comparison could be made between the aim of the main approach of SSOS to produce male offspring and the desire of some tūpuna to have male children. Parallels could also be drawn between the timing of sex selection in SSOS, which occurs before fertilisation, and the timing in examples of sex selection of future children in tradition, which usually happened before conception as part of fertility rites.

Considering the context of these precedents provides further information with which to make informed decisions on SSOS. As stated above, sex selection in people most often occurred during conception rites and so was tied with continuing whakapapa, increasing fertility, and creating new life. While the sex selection approach of SSOS does not seek to impact the fertility of individuals, it

does aim to *reduce* the reproductive success of the rat population, and thus its abundance, over time. However, reducing the rat population will in turn protect the mauri and whakapapa of some taonga species, such as tīeke. In relation to precedents for causing infertility, it is important to recognise that taupā is usually discussed in the context of women who have already continued their whakapapa by having children and want no more, whereas the infertility approach of SSOS would prevent female rats or pests from being able to reproduce at all. Whakapoka of male kurī pups presumably occurred before they fathered pups themselves and so may be a clearer precedent.

We did not discover any clear examples in tradition of Māori predetermining the sex of plant or animal offspring. The lack of clear precedent in animals prompts the question, Can the cases of sex selection and causing infertility in human ancestors be a taurira for introduced European animals? Likewise, can the castration of *male* kurī pups be a model for the rendering of *female* rats infertile from birth? These questions and the contextual nature of our examples of sex selection and causing infertility in Māori tradition underline the complexity of using taurira from the past as precedents to inform present issues.

The precedent test does not provide a singular, definitive response to the issue under consideration. While there are taurira in tradition for the sex selection of offspring and causing infertility, key elements of SSOS, it cannot be said that these form a precedent for SSOS itself, as this technology and its underlying concepts have their own unique context. How our results might be used to understand and respond to SSOS, and indeed what precedents are uncovered in the first place, will differ depending on the individual, whānau, or group, shaped by their own values and what mātauranga they have access to. We have presented these results indicating that traditional Māori society did practise sex selection of offspring and cause infertility in certain contexts as an example of how the precedent test can be applied to contemporary challenges and as a resource to be used alongside other information when evaluating and forming a Māori perspective on SSOS and similar genetic technologies that might arise in the future.

An interesting aspect of Mead’s (2003) discussion on genetic modification is his focus on the creation aspects of the technology rather than on the risks:

Genetic [modification] is concerned with the creation of new elements or new characteristics in

existing life forms. The sorts of changes scientists are bringing about through the utilising of genes from other life forms could result one day in the creation of new life forms. (p. 344)

If successful, SSOS would create a new form of rat and eventually a new form of our environment where taonga species are less threatened by rats. What could be achieved if we approach the ahi of genetic modification and of pests not through a lens of destruction but through a lens of creation, kaitiakitanga, and tikanga? Mead's emphasis on creation invites us to move from a risk and destruction-based assessment of genetic modification to a more holistic view of the implications of genetic modification for our tikanga. Durie (2004) suggests moving the debate on genetic modification from a risk paradigm to a paradigm of potential, in which the "essential question is not so much whether Māori values will be compromised by [genetic modification] research, but how Māori values and concepts can provide a basis for assessing the relevance and potential benefits of research" (p. 24). From this perspective, the ahi of genetic technologies like SSOS presents not only a challenge but also an opportunity to "sharpen" our tikanga in new contexts (Mead, 2003, p. 335).

Conclusion

At first glance, SSOS appears to be completely foreign to te ao Māori, concerned as it is with reducing the number of pest rats by permanently altering their DNA and combining it with genes of another pest species, mice. By applying Mead's precedent test to SSOS, we discovered that while SSOS might be novel, the ideas of sex selection of offspring and causing infertility underpinning its two approaches to controlling pests are not. Analysing ngā kōrero tuku iho led us to examples in traditional Māori society of sex selection of future children, the use of taupā for women who wished to prevent further pregnancy, and whakapoka of male kurī pups. Considering the context of the precedents and the similarities and differences between them and SSOS created the opportunity to more deeply examine SSOS. While our examples of sex selection and causing infertility in tradition do not form precedents for SSOS itself, they do illustrate that even the most novel technologies do not spring from nothing; rather, their underlying ideas have a whakapapa that we can investigate to further our understanding.

The ongoing change from a precautionary to enabling regulatory environment for gene technologies, coupled with the approaching Predator

Free 2050 deadline, make it more likely that SSOS and similar gene technologies could one day be fully developed and considered for environmental release in Aotearoa. Discourse on gene technologies is often future-focused and dominated by scientific and economic considerations but, as Māori, we cannot make decisions based only on information from te ao Pākehā. It is crucial that if the question of trialling or releasing SSOS or other gene technologies is posed in the future, Māori are "in front and influential" (Brankin, 2021, p. 55) and able to respond in ways that are shaped by and reflect our own mātauranga, values, and aspirations, not only those of others. Mead's precedent test offers us a versatile framework to assess and understand complex technologies from our own worldview, ensuring we are better able to exercise our rangatiratanga in the face of the ahi of gene technology at our doorstep.

Glossary

ahi	fire, issue, opportunity
Aotearoa	New Zealand
atua	ancestor with continuing influence, god
hapū	kinship group, clan
hīnau	<i>Elaeocarpus dentatus</i>
Hine-ahu-one	the first human and first woman
Hine-te-iwaiwa	atua of weaving and childbirth
iho	umbilical cord
ira atua	supernatural life
ira tangata	human essence
iwi	extended kinship group, place-specific tribe
Kāi Tahu	Ngāi Tahu, an iwi of the South Island
kaitiakitanga	guardianship
karakia	incantation, to recite ritual chants
karamū	<i>Coprosma robusta</i>
kāretu	<i>Hierochloe redolens</i>
kiore	Pacific rat, <i>Rattus exulans</i>
kokoti-uru	a traditional rite to prevent pregnancy
kurī	Māori dog, Polynesian dog
mahinga kai	garden
mana	prestige, status, authority, influence, integrity; honour, respect

mātauranga Māori	Māori knowledge, wisdom, ways of knowing	whakapapa	genealogy, folk taxonomy
mauri	energy, life force	whakapoka	castration, to castrate
ngā ahi e ngiha mai nei	the fires that flare up; contemporary issues that challenge Māori values and thinking	whakataukī	ancestral saying, proverb
ngā kōrero tuku iho	traditions, oral history	whakatō tamariki	lit. “child implanting”, a ceremony to help a woman conceive
oriori	lullaby	whānau	family
Papatūānuku	atua of the earth, Mother Earth	whenua	placenta, land
piki	to stand		
pūrākau	narrative, story		
rangatira	a Māori leader		
rangatiratanga	self-determination		
tākaha	male tūi		
take-utu-ea	principle of cause, reciprocation, balance		
Tāne	atua of the forests		
tāne	male, man		
tangata	human, individual		
taniwha	water spirit		
taonga	cultural treasure, resource		
tapu	sacred, state of restriction		
tauirā	model, precedent		
taupā	a traditional rite to prevent pregnancy		
te ao Māori	the Māori world(view)		
te ao Pākehā	the Western world(view)		
Te Tiriti o Waitangi	the Treaty of Waitangi		
Te Whānau a Taupara	a hapū of the Gisborne iwi Te Aitanga a Māhaki		
tīeke	saddleback, <i>Philesturnus rufusater</i> and <i>Philesturnus carunculatus</i>		
tikanga	protocols, customs		
tohunga	skilled person; expert		
tuapa	a traditional rite to prevent pregnancy		
Tūhoe	an iwi of the Bay of Plenty		
tūi	tui, <i>Prothemadera novaeseelandiae</i>		
Tūmataurangi	atua of war and humans		
tūpuna	ancestors		
tute	male tūi		
uha	uwha, female element		
wahine	woman, female		
wāhine	women, females		
whakairo	carving		
whakapā	a traditional rite to prevent pregnancy		

References

- Anderson, A. J., & Clark, G. (2001). Advances in New Zealand mammalogy 1990–2000: Polynesian dog or kuri. *Journal of the Royal Society of New Zealand*, 31(1), 161–163. <https://doi.org/d8pqx6>
- Banks, K. (2023). Ngā matatiki mātauranga: Tikanga, policies and libraries. *The Serials Librarian*, 84(5–8), 103–118. <https://doi.org/q6dv>
- Bauer, H., Willert, J., Koschorz, B., & Herrmann, B. G. (2005). The t complex–encoded GTPase-activating protein Tagap1 acts as a transmission ratio distorter in mice. *Nature Genetics*, 37(9), 969–973. <https://doi.org/b6ftjv>
- Beattie, J. H. (2009). *Traditional lifeways of the Southern Māori: The Otago University Museum ethnological project, 1920* (A. Anderson, Ed., 3rd ed.). Otago University Press in association with Otago Museum.
- Belcher, S., Hananui, R., & Mercier, O. R. (2024). Legislating for gene technologies: A Māori view of the Hazardous Substances and New Organisms Act. *Policy Quarterly*, 20(4), 54–60. <https://doi.org/q6dw>
- Bell, E. A., Bell, B. D., & Merton, D. V. (2016). The legacy of Big South Cape: Rat irruption to rat eradication. *New Zealand Journal of Ecology*, 40(2), 212–218. <https://doi.org/gzr65v>
- Berryman-Kamp, M. (2024). Tikanga-informed considerations for Māori gender diversity. *MAI Journal*, 13(1), 115–125. <https://doi.org/q6dz>
- Best, E. (1906). The lore of the whare-kohanga. Part II. *The Journal of the Polynesian Society*, 15(1), 1–26. <https://www.jstor.org/stable/20700776>
- Best, E. (1914). Ceremonial performances pertaining to birth, as performed by the Maori of New Zealand in past times. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland*, 44, 127–162. <https://doi.org/dhnsvd>
- Best, E. (1923). Maori personifications. Anthropogeny, solar myths and phallic symbolism: As exemplified in the demiurgic concepts of Tane and Tiki. *The Journal of the Polynesian Society*, 32(127), 53–69. <https://www.jstor.org/stable/20701917>
- Best, E. (1924). *The Maori—Volume I*. Board of Maori Ethnological Research for the Author and on behalf of the Polynesian Society. <http://nzetc.victoria.ac.nz/tm/scholarly/tei-Bes01Maor.html>
- Best, E. (1934). *The Maori as he was: A brief account of life as it was in pre-European days*. Dominion

- Museum. <http://nzetc.victoria.ac.nz/tm/scholarly/tei-BesMaor.html>
- Best, E. (1941). *The Maori—Volume II*. Polynesian Society. <http://nzetc.victoria.ac.nz/tm/scholarly/tei-Bes02Maor.html>
- Best, E. (1975). *The whare kohanga (the “nest house”) and its lore*. A. R. Shearer, Government Printer. <http://nzetc.victoria.ac.nz/tm/scholarly/tei-BesWhar.html>
- Best, E. (1977). *Forest lore of the Maori* (J. C. Andersen, Ed.). E. C. Keating, Government Printer. <http://nzetc.victoria.ac.nz/tm/scholarly/tei-BesFore.html>
- Bier, E. (2022). Gene drives gaining speed. *Nature Reviews Genetics*, 23(1), 5–22. <https://doi.org/gm62tc>
- Brankin, A. (2021, 29 June). GMO: A matter of rangatiratanga. *TE KARAKA*, (88), 54–55. <https://ngaitahu.iwi.nz/opportunities-and-resources/publications/te-karaka/gmo-a-matter-of-rangatiratanga/>
- Brockerhoff, E. G., Barratt, B. I. P., Beggs, J. R., Fagan, L. L., Kay, M. K., Phillips, C. B., & Vink, C. J. (2010). Impacts of exotic invertebrates on New Zealand's indigenous species and ecosystems. *New Zealand Journal of Ecology*, 34(1), 158–174. <https://newzealandecology.org/nzjel/2916>
- Carter, L. (2006). He muka o te taura whiri: Taura here and the hau kāinga: Issues of representation and participation for iwi members living outside their iwi territory. *AlterNative: An International Journal of Indigenous Peoples*, 2(1), 66–89. <https://doi.org/cktz>
- Collins, J. (2024, 17 December). *Gene Technology Bill passes first reading* [Press release]. <https://www.beehive.govt.nz/release/gene-technology-bill-passes-first-reading>
- Cram, F. (2005). Backgrounding Maori views on genetic engineering. In J. Barker (Ed.), *Sovereignty matters: Locations of contestation and possibility in indigenous struggles for self-determination* (pp. 51–65). University of Nebraska Press. <https://doi.org/q6d5>
- Dearden, P. K., Gemmell, N. J., Mercier, O. R., Lester, P. J., Scott, M. J., Newcomb, R. D., Buckley, T. R., Jacobs, J. M., Goldson, S. G., & Penman, D. R. (2018). The potential for the use of gene drives for pest control in New Zealand: A perspective. *Journal of the Royal Society of New Zealand*, 48(4), 225–244. <https://doi.org/ggh456>
- Downes, T. W. (1926). Maori rat-trapping devices: Whanganui District. From data contributed by Puanaki, of Ohura. *The Journal of the Polynesian Society*, 35(3), 228–234. <https://www.jstor.org/stable/20702095>
- Downes, T. W. (1936). Notes on Topine-Te-Mamaku. *The Journal of the Polynesian Society*, 45(1), 5–8. <https://www.jstor.org/stable/20702625>
- Durie, M. (2004). Mana tangata: Culture, custom and transgenic research. In *Reflections on the use of human genes in other organisms: Ethical, spiritual and cultural dimensions* (pp. 20–25). The Bioethics Council.
- Esvelt, K. M., Smidler, A. L., Catteruccia, F., & Church, G. M. (2014). Emerging technology: Concerning RNA-guided gene drives for the alteration of wild populations. *eLife*, 3, Article e03401. <https://doi.org/gfphx6>
- Gierus, L., Birand, A., Bunting, M. D., Godahewa, G. I., Piltz, S. G., Oh, K. P., Piaggio, A. J., Threadgill, D. W., Godwin, J., Edwards, O., Cassey, P., Ross, J. V., Prowse, T. A. A., & Thomas, P. Q. (2022). Leveraging a natural murine meiotic drive to suppress invasive populations. *Proceedings of the National Academy of Sciences*, 119(46), Article e2213308119. <https://doi.org/gq7f55>
- Goldson, S. L., Bourdôt, G. W., Brockerhoff, E. G., Byrom, A. E., Clout, M. N., McGlone, M. S., Nelson, W. A., Popay, A. J., Suckling, D. M., & Templeton, M. D. (2015). New Zealand pest management: Current and future challenges. *Journal of the Royal Society of New Zealand*, 45(1), 31–58. <https://doi.org/gdf4zc>
- He Kupenga Hao i te Reo. (2025). Kokoti-uru. *Paekupu*. In Retrieved 31 March 2025 from <https://paekupu.co.nz/word/kokoti-uru>
- Henaghan, M., & Tipene-Matua, B. (2006). Māori perspectives on pre-birth genetic testing with particular focus on PGD. In M. Henaghan (Ed.), *Choosing genes for future children: Regulating preimplantation genetic diagnosis* (pp. 69–158). Human Genome Research Project. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1604278
- Heuer, B. N. (1969). Maori women in traditional family and tribal life. *The Journal of the Polynesian Society*, 78(4), 448–494. <https://www.jstor.org/stable/20704659>
- Hiroa, T. R. (1949). *The coming of the Maori*. Māori Purposes Fund Board. <https://nzetc.victoria.ac.nz/tm/scholarly/tei-BucTheC.html>
- Holman, J. (2008). Elsdon Best, 1856–1931. *Kōtare: New Zealand Notes & Queries*, 7(2), 93–100. <https://doi.org/q6d8>
- Hudson, M., Mead, A. T. P., Chagné, D., Roskruge, N., Morrison, S., Wilcox, P. L., & Allan, A. C. (2019). Indigenous perspectives and gene editing in Aotearoa New Zealand. *Frontiers in Bioengineering and Biotechnology*, 7, Article 70. <https://doi.org/ggbgdv>
- Innes, J., Kelly, D., Overton, J. M., & Gillies, C. (2010). Predation and other factors currently limiting New Zealand forest birds. *New Zealand Journal of Ecology*, 34(1), 86–114. <http://www.jstor.org/stable/24060715>
- Kern, L. (2024). Mana Wāhine: Decolonising feminism and patriarchy in Aotearoa. *Plurality*, 1, 50–56. <https://doi.org/q6d9>
- King-Hunt, A. (2023). *Novel biotechnological controls for social wasp eradication: Exploring religious and spiritual Māori perceptions using a Q-Method and kaupapa Māori methodology*. [MA thesis, Te Herenga Waka—Victoria University of Wellington]. Open Access. <https://doi.org/q6fb>
- Lee, J. (2009). Decolonising Māori narratives: Pūrākau as a method. *MAI Journal*, (2), Article 3. <https://journal.mai.ac.nz/system/files/maireview/242-1618-1-PB.pdf>

- Lester, P. J., Bulgarella, M., Baty, J. W., Dearden, P. K., Guhlin, J., & Kean, J. M. (2020). The potential for a CRISPR gene drive to eradicate or suppress globally invasive social wasps. *Scientific Reports*, 10(1), Article 12398. <https://doi.org/gqp7dv>
- Lester, P. J., O'Sullivan, D., & Perry, G. L. W. (2023). Gene drives for invasive wasp control: Extinction is unlikely, with suppression dependent on dispersal and growth rates. *Ecological Applications*, 33(7), Article e2912. <https://doi.org/gvzs4h>
- Lindholm, A. K., Dyer, K. A., Firman, R. C., Fishman, L., Forstmeier, W., Holman, L., Johannesson, H., Knief, U., Kokko, H., Larracuente, A. M., Manser, A., Montchamp-Moreau, C., Petrosyan, V. G., Pomiankowski, A., Presgraves, D. C., Safronova, L. D., Sutter, A., Unckless, R. L., Verspoor, R. L., ... Price, T. A. R. (2016). The ecology and evolutionary dynamics of meiotic drive. *Trends in Ecology & Evolution*, 31(4), 315–326. <https://doi.org/f3rxrw>
- Mākereti. (1938). *The old-time Maori*. Victor Gollancz Limited. <https://nzetc.victoria.ac.nz/tm/scholarly/tei-MakOldT.html>
- Marsden, M., & Henare, T. A. (1992). *Kaitiakitanga: A definitive introduction to the holistic world view of the Māori*. Ministry for the Environment.
- McFarlane, G. R., Whitelaw, C. B. A., & Lillico, S. G. (2018). CRISPR-based gene drives for pest control. *Trends in Biotechnology*, 36(2), 130–133. <https://doi.org/ggjc23>
- McFarlane, G. R., Whitelaw, C. B. A., & Lillico, S. G. (2023). Gene drive: Past, present and future roads to vertebrate biocontrol. *Applied Biosciences*, 2(1), 52–70. <https://doi.org/q6fc>
- Mead, H. M. (2003). *Tikanga Māori: Living by Māori values*. Huia Publishers.
- Mead, H. M., & Grove, N. (2003). *Ngā pepeha a ngā tīpuna: The sayings of the ancestors* (2nd ed.). Victoria University Press.
- Mercier, O. R., Palmer, S., & King-Hunt, A. (2022). Hōhā Riha: Pest insect control in Māori tradition. *The Journal of the Polynesian Society*, 131(3), 261–287. <https://thepolynesiansociety.org/index.php/JPS/article/view/592/428>
- Mitchell, K., & Olsen-Reeder, V. (2021). Tapu and noa as negotiators of Māori gender roles in precolonial Aotearoa and today. *MAI Journal*, 10(2), 84–92. <https://doi.org/jz5r>
- Mitira, T. H. (1972). *Takitimu*. Reed Publishing (NZ) Ltd. <https://nzetc.victoria.ac.nz/tm/scholarly/tei-MitTaki-t1-body-d2-d11-d8.html>
- Moorfield, J. C. (2025). Kokoti-uru. In *Te Aka Māori Dictionary*. <https://maoridictionary.co.nz/word/50190>
- Munn, L. (2024). The five tests: Designing and evaluating AI according to indigenous Māori principles. *AI & SOCIETY*, 39(4), 1673–1681. <https://doi.org/q6ff>
- New Zealand Parliament. (2024). Gene Technology Bill. *New Zealand Legislation*. <https://www.legislation.govt.nz/bill/government/2024/0110/7.0/whole.html#d5948871e2>
- Palmer, S., Dearden, P. K., Mercier, O. R., King-Hunt, A., & Lester, P. J. (2022). Gene drive and RNAi technologies: A bio-cultural review of next-generation tools for pest wasp management in New Zealand. *Journal of the Royal Society of New Zealand*, 52(5), 508–525. <https://doi.org/gqp7f2>
- Palmer, S., Mercier, O. R., & King-Hunt, A. (2020). Towards rangatiratanga in pest management? Māori perspectives and frameworks on novel biotechnologies in conservation. *Pacific Conservation Biology*, 27(4), 391–401. <https://doi.org/qv3g>
- Pihama, L. (2020). Mana Wahine: Decolonising gender in Aotearoa. *Australian Feminist Studies*, 35(106), 351–365. <https://doi.org/jz5q>
- Pihama, L., Mikaere, A., Greensill, A., Pitman, M., Halkyard-Harawira, H., & Hata, T. (2021). *Brief of evidence of Leonie Pihama* (Wai 2700, A19). Waitangi Tribunal. https://forms.justice.govt.nz/search/Documents/WT/wt_DOC_198605587/Wai%202700%2C%20A019.pdf
- Prowse, T. A., Adikusuma, F., Cassey, P., Thomas, P., & Ross, J. V. (2019). A Y-chromosome shredding gene drive for controlling pest vertebrate populations. *eLife*, 8, Article e41783. <https://doi.org/gfv4zp>
- Rarere, M. (2022). The importance of whakapapa for understanding fertility. *Genealogy*, 6(2), Article 26. <https://doi.org/q6fg>
- Reed, A. W., & Calman, R. (2021). *He atua, he tangata: The world of Māori mythology*. Oratia Media.
- Reynolds, P. (2007). The sanctity and respect for whakapapa: The case of Ngāti Wairere & AgResearch. In A. T. P. Mead & S. Ratuva (Eds.), *Pacific genes & life patents: Pacific Indigenous experiences & analysis of the commodification & ownership of life* (pp. 60–73). Call of the Earth Llamado de la Tierra and The United Nations University Institute of Advanced Studies. <https://calloftheearth.wordpress.com/wp-content/uploads/2009/07/coe-publication-final.pdf>
- Riley, M. (2020). *Wise words of the Māori: Revealing history and traditions* (2nd ed.). Viking Sevenses.
- Roberts, M., & Fairweather, J. R. (2004). *South Island Maori perceptions of biotechnology* (Research Report No. 268). Lincoln University. <https://hdl.handle.net/10182/745>
- Roberts, M., Haami, B., Benton, R., Satterfield, T., Finucane, M. L., Henare, M., & Henare, M. (2004). Whakapapa as a Māori mental construct: Some implications for the debate over genetic modification of organisms. *The Contemporary Pacific*, 16(1), 1–28. <https://doi.org/d2hk22>
- Royal, T. A. C. (1998, 13 January). *Mātauranga Māori: Paradigms and politics* [Paper presentation]. Ministry for Research, Science and Technology. <https://www.mcguinnessinstitute.org/wp-content/uploads/2016/10/Politics-and-Paradigms-Charles-Royal.pdf>
- Royal Society Te Apārangi. (2019). *Gene editing: Scenarios in pest control*. <https://www.royalsociety.org.nz/what-we-do/our-expert-advice/all-expert-advice-papers/gene-editing-for-pest-control/>
- Russell, J. C., & Innes, J. G. (2021). *Rattus norvegicus*. In C. King & D. Forsyth (Eds.), *The handbook of New Zealand mammals* (3rd ed., pp. 161–240). CSIRO Publishing.

- Satterfield, T., Roberts, M., Henare, M., Finucane, M., Benton, R., & Henare, M. (2005). *Culture, risk, and the prospect of genetically modified organisms as viewed by tāngata whenua*. <http://hdl.handle.net/1794/20637>
- Schliekelman, P., Ellner, S., & Gould, F. (2005). Pest control by genetic manipulation of sex ratio. *Journal of Economic Entomology*, 98(1), 18–34. <https://doi.org/q6fh>
- Sharman, A. R. (2019). *Mana wahine and atua wāhine* [Master's thesis, Te Herenga Waka—Victoria University of Wellington]. Open Access. <https://doi.org/q6fj>
- Smith, C. (2006). Na takoto ana a Papatūānuku: The state of biotechnologies and Māori. In M. Mulholland (Ed.), *State of the Māori nation: Twenty-first-century issues in Aotearoa* (pp. 199–209). Reed Publishing.
- Smith, L. T. (2021). *Decolonizing methodologies: Research and indigenous peoples*. Bloomsbury Publishing.
- Smith, S. P. (1922). The Maori philosophy of life and matter according to the teaching of Nepia Pohuhu. Part II: The creation of man. *The Journal of the Polynesian Society*, 31(1), 45–49. <https://www.jstor.org/stable/20701858>
- Stewart, G. T. (2021). Academic-Māori-woman: The impossible may take a little longer. *Educational Philosophy and Theory*, 55(9), 990–993. <https://doi.org/q6fk>
- Taiuru, K. (2023). Māori data is a taonga. In E. Sumida Huaman & N. D. Martin (Eds.), *Indigenous research design: Transnational perspectives in practice*. Canadian Scholars.
- Tikao, K. W. (2020). *Raro timu raro take: Ngāi Tahu birthing traditions* [Doctoral thesis, University of Canterbury]. UC Research Repository. <https://hdl.handle.net/10092/101118>
- Tregear, E. (1904). *The Maori race*. Archibald Dudingston Willis. <https://nzetc.victoria.ac.nz/tm/scholarly/tei-TreRace-t1-body-d4.html>
- Wang, J. Y., & Doudna, J. A. (2023). CRISPR technology: A decade of genome editing is only the beginning. *Science*, 379(6629), Article eadd8643. <https://doi.org/grpchk>
- Wehi, P. M., Wilson, D. J., Stone, C., Ricardo, H., Jones, C., Jakob-Hoff, R., & Lyver, P. O. B. (2021). Managing for cultural harvest of a valued introduced species, the Pacific rat (*Rattus exulans*) in Aotearoa New Zealand. *Pacific Conservation Biology*, 27(4), 432–441. <https://doi.org/q6fm>
- White, J. (1887). *The ancient history of the Maori, his mythology and traditions: Horo-Uta or Taki-Tumu migration* (Vol. 1). George Didsbury, Government Printer. <https://nzetc.victoria.ac.nz/tm/scholarly/tei-Whi01Anci.html>
- Williams, H. W. (1906). Maori bird names. *The Journal of the Polynesian Society*, 15(4), 193–208. <https://www.jstor.org/stable/20700795>
- Williams, J. (2012). Ngāi Tahu kaitiakitanga. *MAI Journal*, 1(2), 89–102. <https://journal.mai.ac.nz/content/ng%C4%81i-tahu-kaitiakitanga>