Aspirations of Ecological Restoration Success

Melvyn Peter Galbraith

2023

Health and Environmental Sciences

A thesis submitted to
Auckland University of Technology
in fulfilment of the requirements for the degree of Doctor of Philosophy

Abstract

Ecological restoration is central to biodiversity conservation in Aotearoa New Zealand, with community participation in restoration growing rapidly in recent decades. Restoration groups now operate nationwide, undertaking predator control, species protection, and reintroductions. These activities present ecological and social challenges, and raise ongoing questions about how restoration "success" is defined and evaluated. This thesis examines restoration practices and perceptions across community groups, government agencies, and iwi kaitiaki, contributing to a more inclusive understanding of restoration that incorporates scientific, social, and cultural dimensions.

First, 50 community-based projects in northern New Zealand were surveyed to assess the alignment between aspirations and conservation outcomes. While ecological monitoring was common, goals were often generalised, milestones absent, and outcomes anecdotal, highlighting the need for stronger technical support and training. Second, surveys of practitioners at community and agency levels revealed differing emphases: agencies prioritised systems-level indicators, while communities focused on species-based measures. Perceptions of success also shifted as projects matured, underscoring the importance of frameworks that integrate both ecological and social dimensions. Third, the role of citizen science in ecological restoration was investigated through practitioner and agency perspectives. Although its uptake is patchy, reflecting barriers of technology, resourcing, and sustained participation, it remains a valuable means of strengthening scientific literacy and building the evidence base for restoration decisions. Finally, iwi kaitiaki perspectives were gathered to examine and understand how restoration success is framed through a mātauranga Māori lens, in comparison to other practitioner perspectives. Concepts of success centred on kaitiakitanga, mauri, tikanga, and environmental ethics, revealing strong parallels with ecological restoration and demonstrating the essential role of indigenous knowledge in shaping restoration priorities and outcomes.

Collectively, the findings highlight the diverse ways in which restoration success is understood, the tensions and synergies between community and agency practices, and the transformative potential of mātauranga Māori in guiding restoration futures. By advancing a holistic, socially grounded framework for ecological restoration, this thesis contributes to both theoretical debates and applied strategies for sustaining biodiversity in Aotearoa New Zealand and beyond.

Foreword

In about 2013, Mel first raised the possibility of a PhD study that might be conducted part time while at Unitec. Mel came with many attributes: strong motivation, maturity, a proven research record and at least some financial support from his institution. The only disadvantage was the last of these. Would Unitec be able to sufficiently let go for Mel to conduct his studies as agreed with them? As it turned out, respect for dedicated study time was to hinder progress as Unitec went through repeated restructuring. However, Mel battled on. Various delays through institutional roadblocks, Mel's deep commitments to his family, and the appearance of COVID-19 in early 2020 meant that the study outlasted some of his supervisors. His initial co-supervisors of Barbara Bollard-Breen and Edy MacDonald both departed for other positions at various stages in the study. I did not help by retiring from academic duties in January 2020. Mel ended up with the very capable help of Rebecca Jarvis but, I was still there as a shadowy and unpaid presence in the background.

Mel was keen to draw on his experiences with ecological restoration and working within community groups – and this placed him in a unique position to tackle one of the central questions in restoration ecology: how should community groups report on their achievements? Mel realized that he could refine the question into one that examined how to reconcile aspirations of communities with the expectations of other stakeholders, particularly those in local and central government. Of course, communities in Aotearoa New Zealand include iwi. Mel wanted to weave this into his study – particularly given that Treaty of Waitangi settlements required co-management approaches on his favourite island: Tiritiri Matangi.

The complexities involved in addressing these issues did not phase Mel. He seemed to like nothing better than an intractable problem. What is more interesting than digging deeply into a tangled maze, disassembling it and then working out a way to give it sense and structure?

Mel's thesis proposal was approved in the middle of 2016 and impressively his first set of analyses was ready of publication later the same year. A second paper comparing the expectations of community groups and agencies appeared in 2021. Others were in draft. His thesis was ready for completion when he told me of his cancer diagnosis and the prospects of a break from work for treatment. He thought this would be a good time to finish his PhD thesis. We parted with optimism. It was the last time we spoke.

To the great credit of Student Services at AUT, Nick Arnott initiated the process for the degree to be awarded posthumously given that the study was almost complete. The degree

was awarded in late 2023. The following volume collects together the elements of Mel's comprehensive PhD study, with minor editing by his daughter, Josie.

It has been my privilege to know and help guide Mel along the PhD journey. For many PhD candidates it remains their greatest achievement. Such studies and the publications that stem from them are a lasting memorial to years of hard work and patience. Mel demonstrated vast reserves of both. Of course, for those who make use of these publications, their authors are always with them, speaking and enlightening from the past.

David Towns ONZM, Emeritus Professor (Auckland University of Technology).

Contents

List of Figures

List of Tables

Co-Authored Works

Galbraith, M. P., Bollard-Breen, B., & Towns, D. R. (2016). The community-conservation conundrum: is citizen science the answer? *LAND, 5*(4): 37. https://doi.org/10.3390/land5040037

Galbraith, M. P., Towns, D. R., Bollard-Breen, B., & MacDonald, E. A. (2021). Ecological restoration success from community and agency perspectives–exploring the differences. Restoration Ecology, e13405.

Acknowledgements

It is with a mixture of love and pride that we, Mel Galbraith's whānau, include this section on his behalf. We can't know the exact words he would have used in his acknowledgements, however, we do know the depth of his feelings towards all those who supported and encouraged him over the years as he persevered through the challenges and successes that presented on his PhD journey. His heart was full of respect and appreciation for the many ways that his family, friends, colleagues, interviewees and the wider scientific community supported, encouraged and contributed to this work.

Mel would often remark that the most important learning was in the journey, not in completing the formal thesis. He valued the relationships he formed as he undertook this research, the gift of new ideas and open-mindedness as he developed new understandings. As he continued to research and draw conclusions, he wove new concepts into his role as an educator. He lived what he preached and embodied the close relationship between teaching and learning. Mel saw his work as part of a lifelong commitment as kaitiaki for his beloved natural world.

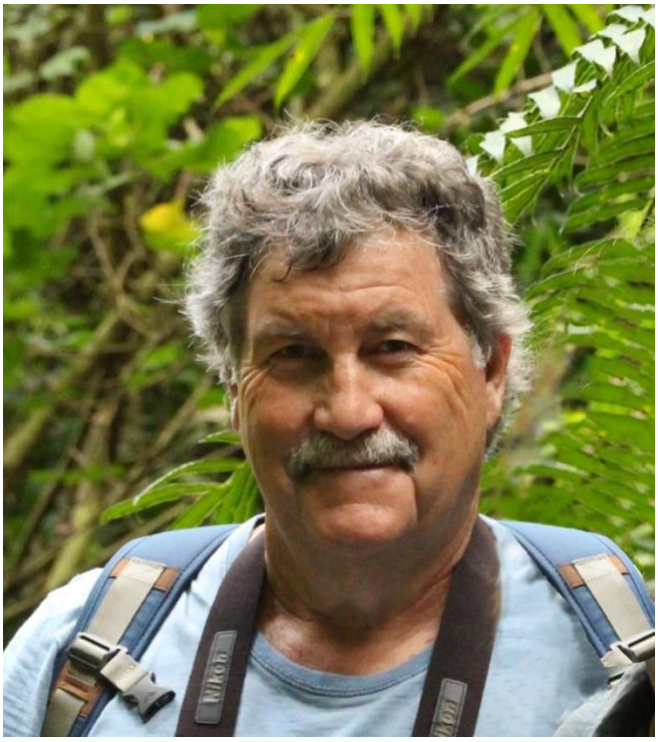
We are indebted to the guidance and wisdom of his supervisors – Barbara Bollard-Breen, Edy MacDonald, Rebecca Jarvis and Dave Towns – who steered Mel through the long process at various stages. Our deepest thanks to Dave Towns for the patience, advice and generosity, through his encouragement to complete this thesis on Mel's behalf. Finally, our hearts are so grateful to Nic Arnott, AUT Student Services, for his efforts in awarding Mel his PhD posthumously.

Whatungarongaro te tangata, toitū te whenua. Kāore ā tātou hīkoi i te mata o te whenua i te roa, heoi anō, he kōwhiringa ki tēnā, ki tēnā o tātou ki te whai take i ō tātou rā, ki te whai rawa rānei. Otirā, ko te tangata nāna nei i whai take, kāore e kore e mau ki te 'rawa' mutunga kore, i te mea ka puawai ngā hua nā tāna mahi, mā te katoa. Ko tō mātou pāpā ko tētahi o ērā tāngata. Nāna i whakapeto ngoi ki te tīaki taiao, ki te hāpai i āna tauira hoki. Ko āna kupu anō ēnei, kua roa kē e noho huna ana i te pō o tāna pukapuka ako reo, ināianei he mea tika ki te whakaputa ki te whaiao, ki te ao marama hei reo whakamihi mōna:

"He kaitiaki ahau o ngā tamariki a Tāne, a Tangaroa. Ki ahau, ko te ngahere me ngā manu he tapu. Ko te 'tohunga manu' taku ingoa."

Our time on the face of this earth is only short, as such, we all have a choice for our lives – seek purpose or seek wealth. However, the person who seeks purpose is actually the person who gains never ending wealth, because their work is for the benefit of all. This was our dad. He worked tirelessly for the protection and care of the environment and for his students. These are his own words, hidden away in his Te Reo workbook, not intended for others, but perhaps to affirm his own path. It seems fitting now, to bring these to the light, and finish with his life purpose:

"I am a guardian of the children of Tāne, of Tangaroa. To me, the forest and the birds are sacred. My name is tohunga manu."



Mel Galbraith, Mo'orea, 29 Sep 2019.
Photo: J. Galbraith.

Chapter 1

General introduction: the issue of ecological restoration success

> *Here is the means to end the great extinction spasm. The next century will, I believe, be the era of restoration in ecology.*
>
> Edward O. Wilson (1992)

Edward Wilson's statement is somewhat prophetic. Since the origins of ecological restoration in the 1980s, both societal interest and expectation, and the science of ecological restoration, have grown rapidly, and are now an integral part of worldwide conservation efforts (Aronson & Alexander, 2013a, 2013b; Gann et al., 2019; Suding, 2011; Young, 2000).

The Society for Ecological Restoration (SER) defines ecological restoration as the intentional process of "assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (Gann et al., 2019, p. 15). Explicit in the SER concept is that the restoration activities are applied to the recovery of indigenous (native) ecosystems (relative to an appropriate reference model) and the functional integrity of those ecosystems.

1.1 The ecological restoration imperative

Human impact on the planet is ubiquitous. Throughout the shift from pre-historic to modern human societies, the global ecological footprint of humans has increased, with immense and innumerable ecological consequences (Goudie, 2013). Humans are the 'ultimate' ecosystem engineers (Smith, 2007, p. 1797). They alter habitats to better their lives, a process that has facilitated geographical expansion of societies across the globe with ever-increasing demands on their respective environments. Through this process, ecosystems have been altered with subsequent impacts on other organisms (Byers et al., 2006).

Although formal commentaries on concerns for the human-induced degradation of environments can be traced back to the 17th and 18th centuries (Goudie, 2013), the concerns intensified throughout the 20th century and, particularly since the 1970s, have become central to multiple disciplines and increasingly gained public exposure (Goudie, 2013). The concept of sustainability has emerged as the paradigm to address the anthropogenic issues of the planet (Edwards, 2005), with social and environmental actions integrated to achieve positive outcomes.

Sustainability actions, however, have not systematically acknowledged the dependence of human societies on natural ecosystems, meaning that many sustainable aspirations have fallen short of the desirable targets (Cairns, 2008). Ongoing global degradation, and increased capacity to model accurately predictions of environmental change, have led to a global environmental restorative imperative (Cairns, 2008). This imperative has led to the designation of 2021–2030 as the UN Decade of Ecosystem Restoration (United Nations Generaly Assembly, 2019). This designation cites effective restoration of degraded terrestrial, freshwater and marine ecosystems across the globe as a 'critical need' (FAO, IUCN, CEM, & SER, 2021, p. 2). Thus ecological restoration is an explicit aspiration and expectation of the UN Decade of Ecosystem Restoration.

The rapid growth of ecological restoration science over the past four decades, has contributed significantly to worldwide conservation efforts (Aronson & Alexander, 2013a, 2013b; Suding, 2011; Young, 2000) – perhaps fulfilling Edward Wilson's prescient statement cited at the start of this chapter. Furthermore, the emergence of the science of ecological restoration has been accompanied by a growth of community-led voluntary participation in ecological restoration, considered to be a global phenomenon (Bramston, Pretty, & Zammit, 2011; Miles, Sullivan, & Kuo, 1998). This community participation in ecological restoration is essential for fulfilling the societal components of principles of the UN Decade of Ecosystem Restoration (FAO, IUCN, CEM, & SER, 2021).

1.2 A brief history of ecological restoration in Aotearoa New Zealand

The historical arrival of humans in new lands worldwide has invariably followed a pattern of catastrophic environmental impacts, dominated by ecological disturbance and extinctions (Sandom, Faurby, Sandel, & Svenning, 2014). Marine island ecosystems hold a significant proportion of global biodiversity, and many are biodiversity hotspots where high levels of endemism are the product of geographical isolation where evolutionary selection within small populations has been maximised (Russell & Kueffer, 2019). Island biotas, generally

characterised by examples of unique functional traits, adaptive radiation and convergent evolution, have been particularly susceptible to rapid human-induced ecological transformations (Russell & Kueffer, 2019). Although natural ecological change is integral to all ecosystems, the rate of ecological change on islands has been shown to have accelerated following the colonisation by humans, and are often irreversible (Nogué et al., 2021).

The pattern of degradation for most islands has been successive phases of human exploitation, first through traditional practices of indigenous peoples, followed by rapid and more extensive ecosystem engineering by European colonists, and subsequent attempts to reverse the cumulative impacts (Russell & Kueffer, 2019). This pattern of anthropogenic change was no different in Aotearoa New Zealand (Diamond, 1990), one of the last land masses to be colonised by humans (Taylor, Stephenson, Cochrane, Smith, & Gibbs, 1997). The description of Aotearoa New Zealand as the “last bus stop on the planet” (Upton, 1999), although intended to explain the role that isolation has on the country’s economy, also has relevance to the role isolation has had in the evolution of the archipelago’s indigenous biodiversity and the subsequent impacts of humans.

Polynesian migrants arriving in the 14th century (Walter, Buckley, Jacomb, & Matisoo-Smith, 2017) initiated a wave of anthropogenic environmental impacts that included habitat modification, fire and species extinctions (McGlone, 1989). The degradation intensified following the colonisation en masse by Europeans from the 1850s (Taylor et al., 1997) as European pastoral practices were introduced. It is against this background of rapid environmental change in Aotearoa New Zealand (hereafter New Zealand) that conservation ethics started to emerge.

As increasing numbers of pākehā (Europeans) settled in New Zealand, Eurocentric ideas of conservation and management also began to spread. The first community conservation groups, led by New Zealand Europeans, emerged in the late 19th century and were mostly local conservation and scenery preservation societies. Factors that prompted this early development of a national environmental conscience and conservation ethic included: increasing awareness of the loss of native plants and animals (Young, 2004); early recognition of the impact of introduced predators and pests (Bell, 2003; Ministry for Culture and Heritage, 2012); concerns around extensive environmental degradation as a result of rapid development, government reforms, and a national transformation towards a pastoral economy (Young, 2004); and views of a small number of well-known individuals, such as Richard Henry, who became active in response to their concerns about the degradation of New Zealand ecosystems (Hill & Hill, 2015).

In the early 20th century, larger conservation groups began to form. These groups were often nationally based, and had a stated intent to lobby politicians for more effective environmental stewardship. For example, the Royal Forest and Bird Society of New Zealand formed in 1923 (under the former name Native Bird Protection Society; Young, 2004) as a response to perceived government mismanagement of the Kapiti Island sanctuary. The Society has since been at the forefront of national environmental issues such as the 1970 *Save Manapouri Campaign* (Young, 2004), and is the country's largest conservation non-governmental organisation (NGO). Even so, there is little evidence of any localised community-led initiatives or conservation groups with formal structure and/or legal status until the late 1900s. Instead, community groups had tended to be a labour force with a focus on tree planting (Young, 2004) and were formed with either a relatively loose organisation (e.g., Associates of the Park; James, 1990), or no formal structure at all (e.g., community planting days; Auckland Council, 2015).

As the number, breadth, and scope of community-based conservation projects developed, there was an increasing dependence on the Department of Conservation (DOC), councils, and other agency staff, to sustain them. However, the work commitments of these staff, and the differing priorities of the agencies they worked for, often limited the time and resources they could dedicate to this supporting role (James, 1990). Autonomous community groups began to emerge outside the jurisdiction of the conventional NGOs. These groups soon realised that they could maximise and consolidate the effectiveness of their volunteer-base by establishing a legally mandated formal structure such as a Trust or Incorporated Society. Early examples of formal arrangements include the Pūkorokoro Miranda Naturalists' Trust (established in 1975; Chambers, 2000) and the Supporters of Tiritiri Matangi (established in 1988; Galbraith, 1990). Buoyed by visible positive ecological outcomes of projects such as Tiritiri Matangi (Rimmer, 2004), and rapid advances in rodent eradication technologies delivering successes in species translocations and invasive species eradications (Butler, Lindsay, & Hunt, 2014; Russell & Broome, 2016), numerous other communities followed suit, initiating additional local conservation programmes with formal groups to support them.

Ecological restoration projects are now commonplace in New Zealand (Bell, 2003; Hardie-Boys, 2010). There are currently at least 3500 conservation projects in New Zealand (New Zealand Plant Conservation Network, 2018) involving an estimated 4000 community-led initiatives and groups (Butler et al., 2014; Peters, Hamilton, & Eames, 2015). These projects, essentially falling under the banner of ecological restoration, have been heralded as crucial in the process of turning back the tide of extinction (Butler et al., 2014).

1.3 The issue of ecological restoration success

Many ecological restoration projects claim to be successful, or demonstrate progress towards a goal that is interpreted as success. Global organisations, government and non-government organisations, research institutions and environmental education organisations all provide examples of 'successful' restoration projects. Anecdotal perspectives from communities of restoration volunteers also often proclaim the success of their projects through non-refereed publications, websites and blogs. Tiritiri Matangi Island (Hauraki Gulf, New Zealand) is an example of a project that is frequently claimed to be successful (Galbraith, 2013) or an exemplar of community-led restoration (Mansfield & Towns, 1997).

Despite such proclamations of successful ecological restoration projects worldwide, there is international debate over what constitutes 'success' in the context of ecological restoration (Bernhardt et al., 2007; Clewell & Rieger, 1997; Palmer et al., 2005; Suding, 2011; Wortley, Hero, & Howes, 2013; Zedler, 2007). The wide use of the word 'success' (and other value-laden terms, for example 'desirable,' 'degraded' and 'intact') to describe ecological restoration outcomes is criticised by authors such as Clewell and Rieger (1997), Zedler (2007) and Suding (2011). They claim that, when used in conjunction with ecological terms, 'success' generates confusion because the criteria determining such a status are not defined and they vary from project to project. In essence, in the context of ecological restoration, 'success' is considered a trite term, lacking real meaning. Zedler (2007) states that the use of 'success' is unnecessary, and advocates omitting the word when referring to ecological restoration projects, or substituting it with a more precise term, to avoid the need to define its meaning each time it is used.

The consequence of poorly defined criteria of restoration 'success' is the difficulty of evaluating benefits, leading to subjective assertions of the outcomes of ecological restoration, particularly as they are often based on anecdotal measures. This difficulty can be compounded when projects lack predetermined goals, criteria for measuring milestones, and fail to monitor appropriate project outcomes (Suding, 2011).

Alleman (2014) states that measurement of progress towards goals needs to consist of tangible evidence and not subjective opinion. There is strong support that ecological restoration projects should adhere to this principle, particularly as it is an applied science (Kondolf et al., 2007; Palmer, Allan, Meyer, & Bernhardt, 2007; Stephens, Brown, & Thornley, 2002; Suding, 2011; Tischew, Baasch, Conrad, & Kirmer, 2010; Wortley et al., 2013). Evidence-based approaches would justify restoration as an option for natural resource management through demonstrated conservation gains, development of best practice in the field, facilitated prioritisation of restoration actions, justified funding and allocation of

resources, and clear accounting for funds committed to do the work (Mansfield & Towns, 1997; Palmer et al., 2007; Stephens et al., 2002; Suding, 2011; Wortley et al., 2013).

The broad attributes (or criteria) expected of a restored ecosystem are frequently articulated in literature. Table 1.1 lists potential restoration attributes collated from literature, and their occurrence in a range of publications. Although attributes of ecological integrity are present in all publications, variation in the occurrence of other attributes as indicators of restoration progress or success is evident. Furthermore, there is little information on empirical measures (or indicators) of these attributes (Palmer et al., 2005).

Few restoration projects reach a pre-determined end point at which, ideally, success can be assessed (Atkinson, 1994). Nevertheless, there is evidence that many projects exhibit positive progress in improving ecological integrity and/or achieving conservation gains (Suding, 2011), an aspect that is very evident within New Zealand projects (Butler et al., 2014; Campbell-Hunt & Campbell-Hunt, 2013). Different stakeholders, however, will likely have differing expectations of restoration outcomes (Hackney, 2000) so it is inevitable that perceptions of restoration success will be based on their respective experience and values (Clewell & Rieger, 1997; Hackney, 2000; Suding, 2011). Effective and meaningful evaluation of the progress of an ecological restoration project requires a framework for systematic ecological monitoring to be in place (Atkinson, 1994). Such a framework is deemed to be a necessary pre-requisite for evidence-based review of restoration actions (Sutherland, Pullin, Dolman, & Knight, 2004).

Ecological monitoring is the “systematic collection of ecological data in a standardised manner at regular intervals over time” (Spellerberg, 2005, p. 2). Although Spellerberg (2005) does not identify ecological restoration specifically as an application of ecological monitoring, the list of reasons for undertaking ecological monitoring (e.g. provision of baseline data for management, and the tracking of the long-term effects of [positive] anthropogenic perturbations) are components of the information suggested for evaluation of restoration progress (Atkinson, 1994; Lee et al., 2005; Ruiz-Jaén & Aide, 2005a; Towns et al., 2009).

- Baseline information about ecological attributes provides an initial status for an ecological restoration project, but needs to be followed by long-term monitoring (Spellerberg, 2005; Strayer et al., 1986). Despite recognition that this need is crucial to gauge the success of restoration projects, there is general admission that monitoring, and reporting of monitoring, is poor and inadequate (Field, O'Connor, Tyre, & Possingham, 2007; Ruiz-Jaén & Aide, 2005a; Suding, 2011; Wortley et al., 2013). A number of factors contribute to this situation:

Table 1.1 – Potential ecological restoration attributes, and their occurrence in a range of publications as indicators of restoration progress or success.

Potential ecological restoration attributes	Atkinson (1994)	SER (2004)	Lee, McGlone, and Wright (2005)	Ruiz-Jaén and Aide (2005a)	Parks Canada (2008)	Towns, Wright, and Stephens (2009)	Lee and Allen (2011)	Keenleyside, Dudley, Cairns, Hall, and Stolton (2012)	Chaves, Durigan, Brancalion, and Aronson (2015)	SER (2016)
Ecosystem representativeness in comparison to reference ecosystem		•	•			•	•	•		•
Ecosystem composition in comparison to reference ecosystem	•	•	•	•	•	•	•	•	•	•
Maintenance of ecosystem processes	•	•	•	•	•	•	•	•	•	•
Integration into a larger ecological matrix		•	•	•	•	•		•		•
Prevention of extinctions and declines	•	•	•			•	•			•
Reduction of spread and dominance of alien species	•		•		•	•	•			•
Re-establishment of landforms and hydrology					•					
Educational, scientific, social benefits	•		•		•		•	•		
Sustainable management and use			•		•		•	•		

- the number of the potential ecological variables far exceeds those that can be practically included in any monitoring programme (Jones & Schmitz, 2009; Society for Ecological Restoration International Science and Policy Working Group, 2004);
- the array and complexity of ecological monitoring methodologies present a range of logistical and analytical challenges (Field et al., 2007);
- ineffective translation of the ‘enormous’ body of knowledge of ecological monitoring into application at the management level;
- monitoring is costly and requires appropriate funding and logistical support (Clewell & Rieger, 1997; Spellerberg, 2005);
- no two ecosystems are identical, so there can be no generic framework for monitoring ecological restoration (Lindenmayer & Likens, 2010b; Society for Ecological Restoration International Science and Policy Working Group, 2004).

Furthermore, because ecological change can be slow, long-term monitoring may be outside the time frame of ecological restoration projects that have been operational only for a short time (Ruiz-Jaén & Aide, 2005a).

Analyses of the reporting of restoration ecology projects in formal publications have indicated that long term monitoring is dominated by vegetation measures (Ruiz-Jaén & Aide, 2005a; Young, 2000), because of the relative speed and ease with which such measures can be completed (Ruiz-Jaén & Aide, 2005a). Recent publications suggest that this is still the case (Berkowitz, 2013; Chaves et al., 2015; Dickinson, Pelz, Giles, & Howie, 2015; MacKay, Wehi, & Clarkson, 2011; Monie, Florentine, & Palmer, 2013).

In addition to the relative ease of measuring vegetational attributes, monitoring that focuses on vegetation alone appears to adopt the premise that the recovery of other taxa will automatically follow the restoration of, and the structure of, the vegetation (Ruiz-Jaén & Aide, 2005b; Toth, Arrington, Brady, & Muszick, 1995; Young, 2000). The assumption inherent in this approach is coined as the 'field of dreams' myth (Hilderbrand, Watts, & Randle, 2005) – that biotic composition and function will self-assemble if the physical structure for a particular ecosystem is restored. Hilderbrand et al. (2005) identified the need for critical assessment of a range of ecological attributes, both during and at an endpoint, as being essential to allow for adaptive management and for increasing knowledge about the restoration process.

In New Zealand, (Stephens et al., 2002) deemed the absence of a framework to measure the effectiveness, or 'difference made', by conservation actions (i.e. ecological restoration) was a barrier to credibility and to the allocation of resources. Such an ecological framework is being developed (Lee & Allen, 2011) but is specifically intended for implementation by government departments or territorial land authorities.

There is no shortage of criteria (e.g. Spellerberg, 2005) that could be measured systematically to assess the ecological attributes identified by SERI (2004) as indicators of ecological restoration success, progress or 'difference made'. Collectively, these attributes are encompassed by the concept of ecological integrity. Although this concept is difficult to define precisely (Westra, 1994), it may be considered as a measure of the extent to which an ecosystem has been changed by anthropogenic activities, and includes composition, structure, functioning and resilience as the key elements (Spellerberg, 2005; Westra, 1994). These elements incorporate the goals of ecological restoration identified by (Suding, 2011): the recovery of degraded systems, compensation for habitat loss, the delivery of ecosystem services, and the assurance of resilience.

Long-term monitoring is needed to track the outcomes of ecological restoration activities. Ecological changes, particularly those sought as desired outcomes of ecological restoration activities, tend to occur over long time scales, may include irregular and rare phenomena, and constitute subtle and complex processes (Strayer et al., 1986). It is thus necessary to distinguish between natural changes and those changes resulting from the intentional interventions that constitute ecological restoration (Spellerberg, 2005).

Authors such as Palmer et al. (2005), Spellerberg (2005), (Ruiz-Jaén & Aide, 2005a), Towns et al. (2009) and Lee and Allen (2011) have identified potential measures for assessing ecological restoration progress, covering a wide range of variables at different ecological levels. However, there is little evidence that such measures have been used to demonstrate positive (or negative) ecological restoration project outcomes. This lack may reflect the difficulties of measuring changes in complex ecological systems (Suding, 2011), but also be compounded by a number of inherent disadvantages of long-term monitoring (Lindenmayer & Likens, 2010a; Spellerberg, 2005; Strayer et al., 1986):

- long-term monitoring requires the commitment of resources over an extended period (e.g. funding, personnel, facilities, planning, logistical support);
- long-term monitoring may be subject to stakeholder pressures;
- monitoring protocols may be subject to debate, with no standardised methodologies established.

The issue of time scales is crucial. Since restoration often includes vegetational succession, the time scales involved in such phenomena will often surpass human lifespans (Strayer et al., 1986). Time scales that are longer than the time period of human participation – and interest – may be a significant barrier to reporting ecological restoration outcomes where communities are one of the stakeholders.

1.4 Why people matter – community-led restoration

Community participation in conservation projects is a global phenomenon that reflects the growing trend of volunteers participating in biodiversity/ecosystem conservation projects (Bramston et al., 2011; Cheng & Sturtevant, 2011), and identified as being a component of an upsurge of organised, private, voluntary and non-profit activity termed the “global associational revolution” (Salamon, Sokolowski, Haddock, & Tice, 2013, p. 1). Community engagement in biodiversity issues is inherent in the targets of the Convention on Biodiversity (1992), currently being implemented by 196 countries. The New Zealand Biodiversity Strategy (Department of Conservation & Ministry for the Environment, 2000) that arose from the Convention has, as its first goal, a focus on community and individual action to raise

public understanding of biodiversity, and to promote active community involvement in biodiversity management:

> "… Enhance community and individual understanding about biodiversity, and inform, motivate and support widespread and coordinated community action to conserve and sustainably use biodiversity; and
>
> … Enable communities and individuals to equitably share responsibility for, and benefits from, conserving and sustainably using New Zealand's biodiversity, including the benefits from the use of indigenous genetic resources."
>
> (Department of Conservation & Ministry for the Environment, 2000, p. 2: 4)

Community-based ecological restoration projects are now commonplace in New Zealand (Bell, 2003; Hardie-Boys, 2010). There are more than 3500 ecological restoration projects in New Zealand (New Zealand Plant Conservation Network, 2012), involving an estimated 4000 community groups (Butler et al., 2014). The projects cover a wide range of stakeholders and restoration types. Of the 78 ecological restoration projects listed or described by Sanctuaries of New Zealand Inc. (www.sanctuariesnz.org) and Butler et al. (2014), the majority (71%) are on public land (see also Peters et al., 2015). These locations include DOC reserves and other Crown land, and both mainland and island sites. Island projects are prominent in Northern New Zealand (22%), a reflection of the number of islands in New Zealand and their importance as refugia for native species (Butler et al., 2014; Towns, Atkinson, & Daugherty, 1990; Wright & Beever, 1986).

Stakeholders include government agencies (e.g. DOC, regional councils), iwi, local communities, environmental societies, schools, clubs, and individuals. Projects may be initiated and/or led by a single entity, or may be a partnership of two or more stakeholders. Butler et al. (2014) note that there is an increasing trend of ecological restoration projects on private land, although these, too, may be in partnership with other stakeholders.

While government agencies may have a statutory obligation to restore degraded environments, most community stakeholders tend to engage in ecological restoration as volunteers. The motivation of voluntary participation in ecological restoration projects is well researched (e.g. Bramston et al., 2011; Grese, Kaplan, Ryan, & Buxton, 2001; Hardie-Boys, 2010; Miles, Sullivan, & Kuo, 2000), and may be summarised as helping the environment, learning more about the environment (ecological literacy), social belonging (social networks) and personal growth. Conservation volunteers often formalise their contribution through the

formation of collectives (e.g. incorporated societies, charitable trusts) dedicated to specific conservation projects.

The involvement of avocational volunteers (or lay ecological restorationists, Reid, Williams, & Paine, 2011) in the measurement of ecological attributes of restoration, an activity with essentially an applied science focus, has implications for both achieving and measuring project outcomes. For many participants in restoration projects, social and recreational motivations may be as important as environmental stewardship (Bramston et al., 2011; Bruyere & Rappe, 2007; Miles et al., 2000; Schroeder, 2000). Their participation in ecological science, therefore, may be unintentional, and develop as a result of a project's management requirements and/or a devolvement of management by governing agencies to communities. In this situation, the participants may be considered as 'accidental scientists' (term coined by Dr J. Perrott, AUT Auckland University of Technology, *pers. comm*.), and raises questions of the desire, and hence capacity, of community groups to engage in ecological science.

A preliminary word cloud analysis (Wordle, Retrieved December 1, 2020, from http://www.wordle.net/) of the objectives of 22 collectives included in the *Sanctuaries of NZ* website (Fig 1.1) suggests that the focus of projects is that of general environmental gains, but words associated with long-term monitoring of ecological attributes are few, and at a low frequency. Lambie (1997) lists 26 generic and case-specific conditions required for success of community-based monitoring programmes. The inability and/or reluctance of community groups to meet these criteria may be a barrier in both completing long-term monitoring and reporting the outcomes.

New Zealand has international recognition in the participation of volunteers in conservation projects (Galbraith, 2013; Towns et al., 2011). However, there is an identified need to better understand the consequences of direct involvement of the public in the management of ecological restoration projects, and, in particular, how to quantify the outcomes of community-based participation (Controller and Auditor-General, 2012; Handford, 2011; Phipps, 2011; Sporle, 2007; Towns et al., 2011; Towns, Bellingham, Mulder, & Lyver, 2012).

In New Zealand, the growing trend of conservation volunteers has been 'harnessed' by the Department of Conservation (DOC) and other territorial authorities to develop strategies that aim for both greater engagement of the public in conservation activities and an increase business partnerships for conservation gain (Department of Conservation, 2013). This trend is consistent with current (and preceding) government priorities (New Zealand Labour Party, 2020; New Zealand National Party, 2014; State Services Commission, 2014), and is linked to a need to improve value-for-money conservation outcomes and to encourage public ownership of environmental issues. For the 2021/22 financial year, the New Zealand

Figure 1.1 – Visualisation of the frequency of words used in the objectives of 22 ecological restoration projects listed in the Sanctuaries of NZ website. Word size is correlated to frequency of occurrence. (Retrieved December 1, 2020, from http://www.wordle.net/).

Government has allocated $36m (approximately 9.5% of the conservation vote) to support community and private initiatives for biodiversity restoration outcomes (The Treasury, 2021).

Another emerging global trend in conservation management is a shift from government funding to that of engaging third parties to achieve operational and policy goals (Jepson, 2005; Office for the Community and Voluntary Sector, n.d.; Waldron et al., 2013). Sources of such funding include non-governmental organizations (NGOs), private and corporate donations, market sponsorship, and communities. Restoration collectives that form legal entities have the ability to manage funds and enter contracts under their own name (Companies Office, 2011), allowing them to generate their own funding (e.g., subscriptions, donations), or raise funding through grant applications. Increasingly, donors and managers of both government and government-independent funding sources are seeking information to account for the way their funds are spent (Christensen, 2003; Nelson, 2007). This expectation of accountability is also evident where public funds are allocated to community groups as grants, with the expenditure of funding being assessed against the goals and aspirations of both Government and NGOs (OCVS, n.d.).

If accountability is a desired and expected component of restoration outcomes, then the need to assign value to the actions of community participation is paramount – in particular the measurement of restoration progress and/or success. Accountability is particularly important where restoration projects are on public lands and restoration outcomes are accountable to society (taxpayers) in general, and/or where parties using outside funding may be held financially responsible for restoring a damaged ecosystem (Holl & Howarth, 2000). DOC analyses of community contribution to conservation have considered conservation (environmental), social and financial outcomes (Hardie-Boys, 2010), but tend to be only from a DOC perspective (e.g., Bell, 2003), and focus on measures of volunteer participation and the contribution of partnerships to conservation outcomes rather than the outcomes achieved for the sites being managed (e.g., The Treasury, 2015).

Ecological restoration is necessarily a local endeavour where stakeholders restore ecosystems to satisfy values that are shared collectively within a culture (Clewell & Aronson, 2013). In New Zealand there is a bicultural component to ecological restoration as the activities of Māori and non-Māori New Zealanders may be motivated by different values whilst sharing the same goal (Moller, Berkes, Lyver, & Kislalioglu, 2004). Relationships between the natural world and indigenous peoples define cultural identity, provide links to history, ancestors, land, art, and environmental philosophy, and may be important for subsistence economies (Lyver, Taputu, Kutia, & Tahi, 2008).

For Māori, mana whenua[1] encompasses kaitiakitanga[2] of their resources (Waitangi Tribunal, 2001), and thus includes an interest in ecological restoration. Natural resources, including species, their habitats and management, are embodied within the following cultural value sets (Kitson & Moller, 2008; Lyver et al., 2015; Tipa & Tearney, 2003; Williams, 2010):

- mauri (life force of the natural world);
- mahinga kai or ahikāroa (resources for food or use);
- kaitiakitanga (cultural stewardship);
- ki uta ki tai (holistic 'mountains to the sea' philosophy);
- whakamana (personal engagement);
- whanaungatanga (connection);
- mātauranga and māramatanga (knowledge and wisdom);
- tikanga / tikanga Māori (customary protocols and practice).

[1] A set of take whenua or customary land rights of a hapū or iwi that denotes their ownership, control and sovereignty over a defined area of land (Wiri, 2013).

[2] The exercise of guardianship by the tangata whenua of an area in accordance with tikanga Māori in relation to natural and physical resources (New Zealand Government, 1991).

The nature of cultural landscapes, particularly the relationship between communities and past lives and activities of that landscape (Puia, 1990; Tipa & Tearney, 2003), means that cultural values and customary uses of resources may be inseparable from restoration values (Lyver et al., 2015). Although mauri may be considered to have equivalence to the concept of ecological integrity (Lyver et al., 2015), other concepts are rooted in cultural dimensions (Tipa & Tearney, 2003).

Thus Māori values and expectations guiding kaitiakitanga may very be different to those of conservation volunteers and community groups participating in ecological restoration projects, although the outcome may be similar. The importance of the need for a better understanding of the differences is recognised (e.g., Lyver et al., 2015; Meurk, Pauling, Ataria, & Kirikiri, 2006). Furthermore, appreciation of the iwi dimension of ecological restoration by community groups working on Crown land will become increasingly important as DOC strengthens its partnerships with iwi through Treaty settlements (Department of Conservation, 2016).

1.5 Summary

Evidence-based evaluation of the progress and success of ecological restoration actions requires multiple measures (Brooks, Waylen, & Mulder, 2013). The measurement of ecological attributes should be at the core of any evaluation since gains in environmental quality are key aspirations for any restoration project. But the multitude of stakeholders and potential partnerships that restoration projects encompass requires recognition of the plurality of values associated with the project – ecological and social (and economic) (Aronson et al., 2010; Brooks et al., 2013; Robinson, 2011). Thus inclusion of societal attributes in assessing ecological restoration outcomes (e.g., historical, cultural, social, political, aesthetic, moral), as advocated by Higgs (1997), Phipps (2011) and Egan, Hjerpe, and Abrams (2011), is necessary to ensure the numerous links between restoration and societal interests are included in measures of accountability.

The consequences of the lack of measurement of conservation (and hence ecological restoration) outcomes is captured by (Stephens et al., 2002), illustrated in Figure 1.2. Failure to assess the outcomes of ecological interventions provides no basis for accountability, and has potential to lead to a lack of credibility of the ecological outcomes and uncertainty of the social benefits.

1.6 Thesis objectives

The overarching research question of this thesis is:

> *How do we reconcile the aspirations of communities involved in ecological restoration projects with measures and expectations of restoration success identified by ecological science or 'governing' stakeholders?*

This socio-ecological study explored the relationship between restoration ecology (the science) and ecological restoration (agency and community aspirations and expectations). This was achieved by reviewing measures of ecological integrity, identifying which measures are appropriate to apply to ecological restoration projects, and comparing stakeholder restoration goals with those in the ecological literature. The value of this research is in identifying objective measures appropriate to determine the progress (and hence 'success') of ecological restoration actions, and comparing these with subjective measures articulated by stakeholders. This knowledge has application to restoration projects worldwide, and is expected to be of particular value in New Zealand given the current aspirations to integrate the collective visions of environmental stakeholders – government, institutions, iwi, communities – into a common, shared ecological future.

1.6.1 Methodological framework

The research question was addressed through five central questions (Table 1.2). This study involved a socio-ecological exploration of the relationship between restoration ecology

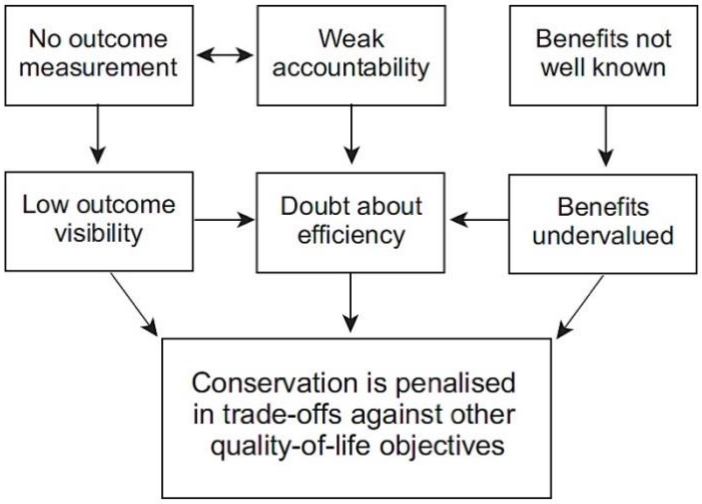


Figure 1.2 – Consequences of the lack of measurement of conservation (i.e., ecological restoration) outcomes (from Stephens et al., 2002).

(the science) and the activities of ecological restoration practitioners (goals, expectations, actions), and involved the collection, analysis, and integration of both quantitative and qualitative data. The study originated from the application of ecology where cause and effect of environmental changes (ecological restoration in this case) are determined through objective observation and measurement. As one of the disciplines of science, ecological research has a postpositive theoretical perspective (Creswell, 2003).

Ecological restoration, however, is a human-initiated and managed activity, and is thus multi-dimensional, influenced by the range of knowledge, values and expectations of the stakeholders. Research of these societal attributes required an exploration of the views and experience of participants as a result of their engagement in restoration activities. Since participants' experiences are the result of actions, situations and consequences (rather than necessarily from antecedent conditions) (Creswell, 2003), a pragmatic theoretical perspective was considered an appropriate approach for this aspect of the study.

The theoretical perspectives that lie behind this study – postpositivism and pragmatism – were addressed through a mixed methods research approach. The advantages of this approach was the opportunity to address a broad range of research questions through a developmental process, which is considered to maximize the generalisability or applicability through better understanding of the findings and, consequently, better transferability of knowledge (Creswell, 2003; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 2009).

The research process followed a sequential explanatory mixed-method model design (Creswell & Plano Clark, 2011; Creswell, Plano Clark, Gutman, & Hanson, 2002; Teddlie & Tashakkori, 2009). This design is considered appropriate (Creswell & Plano Clark, 2011) when:

- a sequence of study starts with a quantitative phase, and is followed by a qualitative phase intended to explain the quantitative results in more depth;
- quantitative results can be used to guide purposeful sampling for a qualitative phase;
- the researcher and research problem are more quantitatively orientated.

Table 1.2 – Central and guiding questions for this thesis.

Central questions	Guiding questions
1. Why is there a need for measurement of ecological restoration success, and what are appropriate measurements?	• What is the history of ecological restoration? • Why is there an issue with the credibility of restoration success claims – NZ & international? • Why is there a crucial need for measuring ecological restoration success – the nature of long-term monitoring? • Definition of ecological integrity? • What are the issues with variable reporting of restoration success?

2. What is the nature of ecological restoration projects in NZ?	• Why people matter – community-led restoration?
	• Review of ecological restoration projects in NZ:
	  ○ which sites – (3500 NZPCN)?
	  ○ restoration types?
	  ○ participants/stakeholders?
	  ○ project goals?
	  ○ communication mechanisms?
	  ○ cf. international projects?

3. How do stakeholder restoration goals compare to ecological goals?	• What are the measures of ecological integrity? • What measures are appropriate/suitable for assessing ecological restoration progress? • What are the current measures used in restoration projects? • What is the relationship of mātauranga to ecological goals? • What goals are held in common? • What are the gaps in goal alignment? • Are there sufficient common goals for communication transfers?
4. What is the relationship between restoration ecology (the science) and ecological restoration (practitioners' aspirations)?	• Are there communication disconnects/gaps/misunderstandings? • What is the role of Mātauranga Māori? • How does the role of participation (volunteerism, citizen science) affect the relationship? • How is restoration progress/ecological science reported?
5. What is the capacity of communities/stakeholders to engage in the science of ecological restoration?	• How does the citizen science concept relate to restoration? • What is the level of ecological literacy of stakeholders? • How does the capacity of practitioners relate to measurement requirements? • Do practitioners fit the concept of 'accidental scientists'? • Can models be developed for practitioners to report restoration progress?

The two phases that characterise this design are:

1. collection and analysis of quantitative data to provide a general understanding of the research problem (Ivankova, Creswell, & Stick, 2006);
2. collection and analysis of qualitative data to help explain and interpret the findings of the first phase though the exploring stakeholders' views in more depth (Creswell, 2003; Ivankova et al., 2006).

Within each phase, an iterative methodological-analytical-inferential loop facilitated conclusions emerging from the inferential stage of the study to lead to further data gathering and analysis stages. It was intended that the two phases will have equal emphasis in the study. A graphic representation of the sequential nature of this study is shown in Figure 1.3.

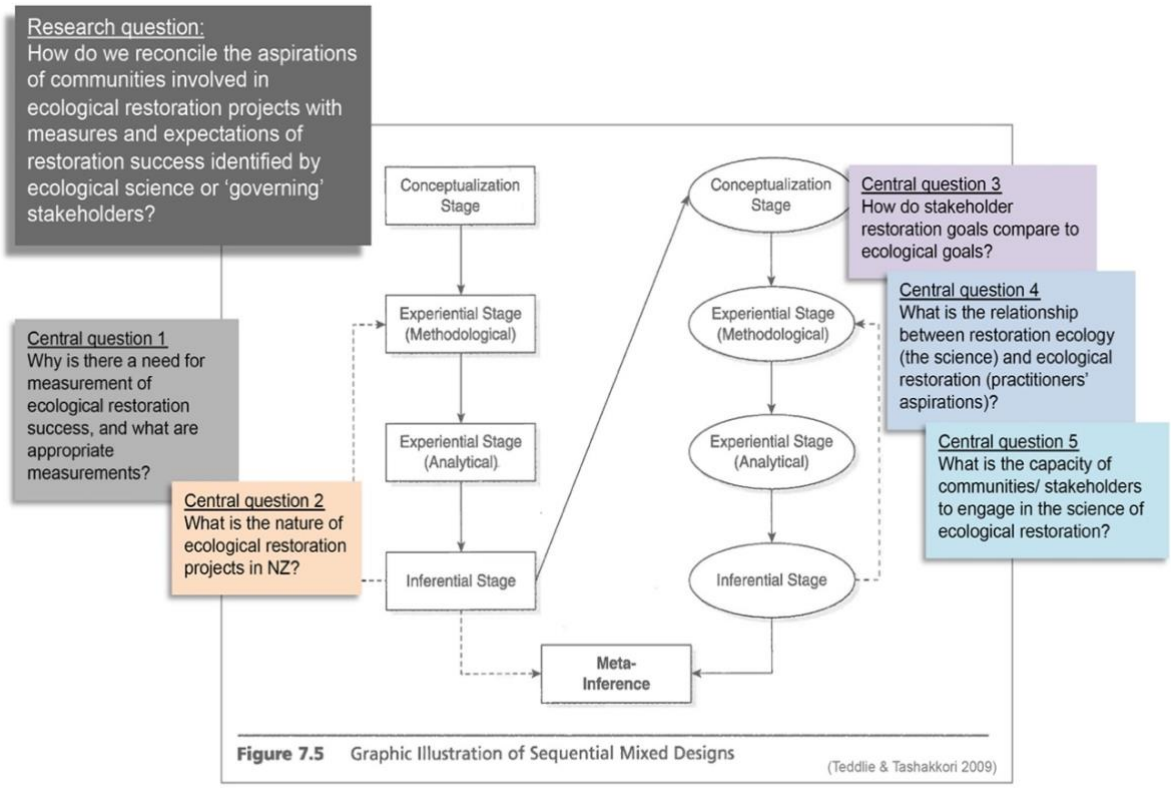


Figure 1.3 – Graphic illustration of a sequential mixed design research pathway (Teddlie & Tashakkori, 2009) with the research and central questions superimposed. Rectangles represent the quantitative phase, ovals represent the qualitative phase, hatched lines represents iterative methodological-analytical-inferential loops.

1.7 Researcher position

As a restoration practitioner with an association with ecological restoration projects in Auckland since the early 1980s, I approached this study, at least partly, as an 'embedded researcher' (Reiter-Theil, 2004, p. 23). Reiter-Theil (2004, p. 23) describes an embedded researcher as "some kind of team member," where the duality of researcher independence and subject familiarity can facilitate open discourse about the research question. Embeddedness is considered to enable the researcher to respond to informers' needs and expectations, while allowing the simultaneous withdrawal and reflection at a distance (Lewis & Russell, 2011). The expected benefits of this embeddedness (Barniskis, 2013; Marshall et al., 2014) include:

- content credibility - an understanding of the established research evidence in the specific field;
- ease of building relationships with those being surveyed;
- increased reflexivity and examination of biases;
- research will be more relevant for practitioners;
- reduction of the gap between the actual events and the studied experiences.

Potential disadvantages of this embedded research position are acknowledged, for example, conflict arising from role duality, including clouded objectivity through familiarity with situations, and assumptions made about events and participant views without seeking clarification (Smyth & Holian, 2008; Unluer, 2012). Limitations of validity resulting from such disadvantages will be addressed and minimised through following procedures suggested by authors in this field (e.g., Smyth & Holian, 2008; Unluer, 2012).

1.8 Thesis outline

The data chapters (Chapters 2–5) are presented as self-contained research papers that may be read independently. As such, some repetition across the thesis is inevitable, however efforts have been made to keep this minimal. Acknowledgements have been combined in a single section at the beginning of the thesis.

Chapter 2 considers 50 community-based ecological restoration projects in New Zealand to gauge the relationship between the aspirations of the participants as collectives and their conservation achievements. This chapter has been published in part as:

> Galbraith, M.P., Bollard-Breen, B., & Towns, D.R. (2016). The community-conservation conundrum: is citizen science the answer? *LAND, 5*(4): 37. https://doi.org/10.3390/land5040037

Chapter 3 explores perceptions of what constitutes restoration 'success' among restoration practitioners in New Zealand at both community and agency levels, and how this is measured. This chapter has been published as:

> Galbraith, M., Towns, D. R., Bollard-Breen, B., & MacDonald, E. A. (2021). Ecological restoration success from community and agency perspectives–exploring the differences. Restoration Ecology, e13405.

Chapter 4 identifies the degree to which communities are engaged in ecological science, surveying both community-based practitioners and employees of government agencies.

Chapter 5 explores an iwi kaitiaki perspective on the outcomes and expectations of ecological restoration. Iwi kaitiaki are interviewed about their views on the relationship between mātauranga Māori and the determination of the success of ecological restoration practices.

This study was approved by the approved by the Auckland University of Technology Ethics Committee (Ref. number 17/167).

References

Alleman, G. B. (2014). *Performance-based project management: Increasing the probability of success*. New York: American Management Association.

Aronson, J., & Alexander, S. (2013a). Ecosystem restoration is now a global priority: Time to roll up our sleeves. *Restoration Ecology, 21*(3), 293-296. https://doi.org/10.1111/rec.12011

Aronson, J., & Alexander, S. (2013b). Steering towards sustainability requires more ecological restoration. *Natureza & Conservacao, 11*(2), 127-137.

Aronson, J., Blignaut, J. N., Milton, S. J., Le Maitre, D., Esler, K. J., Limouzin, A., . . . Lederer, N. (2010). Are socioeconomic benefits of restoration adequately quantified? A meta-analysis of recent papers (2000-2008) in Restoration Ecology and 12 other scientific journals. *Restoration Ecology, 18*(2), 143-154. https://doi.org/10.1111/j.1526-100X.2009.00638.x

Atkinson, I. A. E. (1994). *Guidelines to the development and monitoring of ecological restoration programmes*. Wellington: Department of Conservation.

Auckland Council. (2015). *Volunteers in our regional parks*. Retrieved 8 May 2018, from http://ourauckland.aucklandcouncil.govt.nz/articles/news/2015/01-09/volunteers-in-our-regional-parks/

Barniskis, S. C. (2013). Embedded, participatory research: Creating a grounded theory with teenagers. *Evidence Based Library and Information Practice, 8*(1), 47-58. https://doi.org/10.18438/b8hk6j

Bell, K. (2003). *Assessing the benefits for conservation of volunteer involvement in conservation activities. Science for Conservation 223*. Wellington, NZ: Department of Conservation.

Berkowitz, J. F. (2013). Development of restoration trajectory metrics in reforested bottomland hardwood forests applying a rapid assessment approach. *Ecological Indicators, 34*, 600-606. https://doi.org/10.1016/j.ecolind.2013.06.025

Bernhardt, E. S., Sudduth, E. B., Palmer, M. A., Allan, J. D., Meyer, J. L., Alexander, G., . . . Pagano, L. (2007). Restoring rivers one reach at a time: Results from a survey of U.S. river restoration practitioners. *Restoration Ecology, 15*(3), 482-493. https://doi.org/10.1111/j.1526-100X.2007.00244.x

Bramston, P., Pretty, G., & Zammit, C. (2011). Assessing environmental stewardship motivation. *Environment and Behavior, 43*(6), 776-788.

Brooks, J., Waylen, K. A., & Mulder, M. (2013). Assessing community-based conservation projects: A systematic review and multilevel analysis of attitudinal, behavioral, ecological, and economic outcomes. *Environmental Evidence, 2*(1), 2. https://doi.org/10.1186/2047-2382-2-2

Bruyere, B., & Rappe, S. (2007). Identifying the motivations of environmental volunteers. *Journal of Environmental Planning and Management, 50*(4), 503-516. https://doi.org/10.1080/09640560701402034

Butler, D., Lindsay, T., & Hunt, J. (2014). *Paradise saved: The remarkable story of New Zealand's wildlife sanctuaries and how they are stemming the tide of extinction*. Auckland, NZ: Random House.

Byers, J. E., Cuddington, K., Jones, C. G., Talley, T. S., Hastings, A., Lambrinos, J. G., . . . Wilson, W. G. (2006). Using ecosystem engineers to restore ecological systems. *Trends in Ecology & Evolution, 21*(9), 493-500. https://doi.org/https://doi.org/10.1016/j.tree.2006.06.002

Cairns, J. (2008). Foreword. In M. R. Perrow & A. Davy (Eds.), *Handbook of ecological restoration: Principles of restoration* (Vol. 1, pp. 444). Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/CBO9780511549984

Campbell-Hunt, D., & Campbell-Hunt, C. (2013). *Ecosanctuaries: Communities building a future for New Zealand's threatened ecologies*. Dunedin: Otago University Press.

Chambers, S. (2000). *The story of the Miranda Naturalists' Trust 1973-2000*. Pukekohe: Arun Books.

Chaves, R. B., Durigan, G., Brancalion, P. H. S., & Aronson, J. (2015). On the need of legal frameworks for assessing restoration projects success: New perspectives from São Paulo state (Brazil). *Restoration Ecology, 23*(6), 754-759. https://doi.org/10.1111/rec.12267

Cheng, A. S., & Sturtevant, V. E. (2011). A framework for assessing collaborative capacity in community-based public forest management. *Environmental Management, 49*(3), 675-689. Cheng2011. https://doi.org/10.1007/s00267-011-9801-6

Christensen, J. (2003). Auditing conservation in an age of accountability. *Conservation in Practice, 4*(3), 12-18. https://doi.org/10.1111/j.1526-4629.2003.tb00065.x

Clewell, A. F., & Aronson, J. (2013). *Ecological restoration: Principles, values, and structure of an emerging profession*. Washington, DC: Island Press.

Clewell, A. F., & Rieger, J. P. (1997). What practitioners need from restoration ecologists. *Restoration Ecology, 5*(4), 350-354. https://doi.org/10.1046/j.1526-100X.1997.00548.x

Companies Office. (2011). *What are the advantages of becoming an incorporated society?* Retrieved 6 February 2016, from http://www.societies.govt.nz/cms/customer-support/faqs/incorporated-societies/what-are-the-advantages-of-becoming-an-incorporated-society

Controller and Auditor-General. (2012). *Department of Conservation: Prioritising and partnering to manage biodiversity*. Wellington: Office of the Auditor-General.

Creswell, J. W. (2003). *Research design: Qualitative, quatitative and mixed methods approaches*. Thousand Oaks: Sage Publications.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research*. Los Angeles: SAGE Publications.

Creswell, J. W., Plano Clark, V. L., Gutman, M. L., & Hanson, W. L. (2002). Advanced mixed methods research designs. In A. Tashakkori & C. Teddlie (Eds.), A. Tashakkori & C. Teddlie, *Handbook of mixed methods in social and behavioural research* (pp. 209-239). Thousand Oaks: Sage Publications.

Department of Conservation. (2013). *Annual report for the year ended 30 June 2015*. Wellington: Department of Conservation.

Department of Conservation. (2016). *New Zealand biodiversity action plan 2016-2020*. Wellington: Department of Conservation.

Department of Conservation & Ministry for the Environment. (2000). *New Zealand biodiversity strategy: Our chance to turn the tide*. Wellington, NZ: Department of Conservation; Ministry for the Environment.

Diamond, J. M. (1990). New Zealand as an archipelago: An international persepctive. In D. R. Towns, C. H. Daugherty, & I. A. E. Atkinson (Eds.), *Ecological restoration of New Zealand islands. Conservation Sciences Publication No. 2.* (pp. 3-8). Wellington: Department of Conservation.

Dickinson, Y., Pelz, K., Giles, E., & Howie, J. (2015). Have we been successful? Monitoring horizontal forest complexity for forest restoration projects. *Restoration Ecology, 24*(1), 8-17. https://doi.org/10.1111/rec.12291

Edwards, A. R. (2005). *The sustainability revolution: Portrait of a paradigm shift*. Gabriola Island, BC: New Society.

Egan, D., Hjerpe, E. E., & Abrams, J. (2011). Why people matter in ecological restoration. In D. Egan, E. E. Hjerpe, & J. Abrams (Eds.), *Human dimensions of ecological restoration: Integrating science, nature, and culture* (pp. 1-19). Washington, D.C.: Island Press.

FAO, IUCN, CEM, & SER. (2021). Principles for ecosystem restoration to guide the United Nations Decade 2021–2030. Rome: FAO.

Field, S. A., O'Connor, P. J., Tyre, A. J., & Possingham, H. P. (2007). Making monitoring meaningful. *Austral Ecology, 32*(5), 485-491. https://doi.org/10.1111/j.1442-9993.2007.01715.x

Galbraith, M. (2013). Public and ecology - the role of volunteers on Tiritiri Matangi. *New Zealand Journal of Ecology, 37*(3), 266-271.

Galbraith, M. P. (1990). Volunteers' view of the ecological restoration of an offshore island. In D. R. Towns, C. H. Daugherty, & I. A. E. Atkinson (Eds.), *Ecological restoration of New Zealand islands. Conservation Sciences Publication No. 2* (pp. 170-174). Wellington: Department of Conservation.

Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., . . . Dixon, K. W. (2019). *International principles and standards for the practice of ecological restoration.* (2nd ed.). Washington, D.C.: Society for Ecological Restoration.

Goudie, A. S. (2013). *The human impact on the natural environment: Past, present, and future*. Chichester: John Wiley & Sons.

Grese, R. E., Kaplan, R. S., Ryan, R. L., & Buxton, J. (2001). Psychological benefits of volunteering in stewardship programmes. In P. H. Gobster & R. B. Hull (Eds.), *Restoring nature: Perspectives from the social sciences and humanities* (pp. 265-280). Washington DC, USA: Island Press.

Hackney, C. T. (2000). Restoration of coastal habitats: Expectation and reality. *Ecological Engineering, 15*(3–4), 165-170. https://doi.org/10.1016/S0925-8574(00)00067-7

Handford, P. (2011). *Community conservation in New Zealand: Towards a shared approach*. Wellington: World Wildlife Fund for Nature.

Hardie-Boys, N. (2010). *Valuing community group contributions to conservation. Science for Conservation 299*. Wellington, NZ: Department of Conservation.

Higgs, E. S. (1997). What is good ecological restoration? *Conservation Biology, 11*(2), 338-348. https://doi.org/10.1046/j.1523-1739.1997.95311.x

Hilderbrand, R. H., Watts, A. C., & Randle, A. M. (2005). The myths of restoration ecology. *Ecology and Society, 10*(1).

Hill, S., & Hill, J. (2015). *Richard Henry of Resolution Island*. Christchurch: Cadsonbury Publications.

Holl, K. D., & Howarth, R. B. (2000). Paying for restoration. *Restoration Ecology, 8*(3), 260-267. https://doi.org/10.1046/j.1526-100x.2000.80037.x

Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods, 18*(1), 3-20. https://doi.org/10.1177/1525822x05282260

James, B. (1990). *Project conservation: a sociological evaluation of a community participation and educational programme*. Wellington: Department of Conservation.

Jepson, P. (2005). Governance and accountability of environmental NGOs. *Environmental Science and Policy, 8*(5), 515-524. https://doi.org/10.1016/j.envsci.2005.06.006

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26. https://doi.org/10.3102/0013189x033007014

Jones, H. P., & Schmitz, O. J. (2009). Rapid recovery of damaged ecosystems. *PLoS ONE, 4*(5). https://doi.org/10.1371/journal.pone.0005653.g001

Keenleyside, K. A., Dudley, N., Cairns, S., Hall, C. M., & Stolton, S. (Eds.). (2012). *Ecological restoration for protected areas: Principles, guidelines and best practices*. Gland, Switzerland: IUCN.

Kitson, J. C., & Moller, H. (2008). Looking after your ground: Resource management practice by Rakiura Māori Titi harvesters *Papers and Proceedings of the Royal Society of Tasmania, 142*(1), 161-176.

Kondolf, G. M., Anderson, S., Lave, R., Pagano, L., Merenlender, A., & Bernhardt, E. S. (2007). Two decades of river restoration in California: What can we learn? *Restoration Ecology, 15*(3), 516-523. https://doi.org/10.1111/j.1526-100X.2007.00247.x

Lambie, J. (1997). *Community-based environmental monitoring: Conditions essential for long term provision of quality data*. Lincoln University, Lincoln, NZ.

Lee, W. G., & Allen, R. B. (2011). *Recommended monitoring framework for Regional Councils assessing biodiversity outcomes in terrestrial ecosystems*. Dunedin: Landcare Research.

Lee, W. G., McGlone, M., & Wright, E. F. (2005). *Biodiversity inventory and monitoring: A review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation*. Wellington: Landcare Research.

Lewis, S., & Russell, A. (2011). Being embedded: A way forward for ethnographic research. *Ethnography, 12*(3), 398-416. https://doi.org/10.1177/1466138110393786

Lindenmayer, D. B., & Likens, G. E. (2010a). *Effective ecological monitoring*. Melbourne: CSIRO Publishing.

Lindenmayer, D. B., & Likens, G. E. (2010b). The science and application of ecological monitoring. *Biological Conservation, 143*(6), 1317-1328. https://doi.org/10.1016/j.biocon.2010.02.013

Lyver, P. O'B., Akins, A., Phipps, H. L., Kahui, V., Towns, D. R., & Moller, H. (2015). Key biocultural values to guide restoration action and planning in New Zealand. *Restoration Ecology*, 1-10. https://doi.org/10.1111/rec.12318

Lyver, P. O'B., Taputu, Te M., Kutia, S. T., & Tahi, B. (2008). Tūhoe Tuawhenua mātauranga of kererū (*Hemiphaga novaseelandiae novaseelandiae*) in Te Urewera. *New Zealand Journal of Ecology, 32*(1), 7-17.

MacKay, D. B., Wehi, P. M., & Clarkson, B. D. (2011). Restoration success in urban forest plantings in Hamilton, New Zealand. *Urban Habitats, 6*.

Mansfield, B., & Towns, D. R. (1997). Lesson of the islands. *Ecological Restoration, 15*(2), 138-146. https://doi.org/10.3368/er.15.2.138

Marshall, M., Pagel, C., French, C., Utley, M., Allwood, D., Fulop, N., . . . Goldmann, A. (2014). Moving improvement research closer to practice: The researcher-in-residence model. *BMJ Quality & Safety, 23*, 801-895. https://doi.org/10.1136/bmjqs-2013-002779

McGlone, M. (1989). The Polynesian settlement of New Zealand in relation to environmental and biotic changes. *New Zealand Journal of Ecology, 12 (supplement)*, 115-129.

Meurk, C., Pauling, C., Ataria, J., & Kirikiri, R. (2006). *Hikoi Whakakahu - restoring the mauri*. Lincoln: Landcare Research.

Miles, I., Sullivan, W. C., & Kuo, F. C. (1998). Ecological restoration volunteers: The benefits of participation. *Urban Ecosystems, 2*, 27–41.

Miles, I., Sullivan, W. C., & Kuo, F. E. (2000). Psychological benefits of volunteering for restoration projects. *Ecological Restoration, 18*(4), 218-227. https://doi.org/10.3368/er.18.4.218

Ministry for Culture and Heritage. (2012). *Pressure groups*. Retrieved 15 May 2018, from https://nzhistory.govt.nz/culture/scenery-preservation/pressure-groups

Moller, H., Berkes, F., Lyver, P. O., & Kislalioglu, M. (2004). Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecology and Society, 9*(3), 2.

Monie, K., Florentine, S., & Palmer, G. (2013). Recruitment and functionality traits as bioindicators of ecological restoration success in the Lurg Hills district, Victoria, Australia. *Ecological Processes, 2*(1), 1-11. https://doi.org/10.1186/2192-1709-2-27

Nelson, N. (2007). *The operation of non-governmental organizations (NGOs) in a world of corporate and other codes of conduct*. Cambridge, MA, USA: John F. Kennedy School of Government, Harvard University.

New Zealand Labour Party. (2020). *Our manifesto to keep New Zealand moving*. Wellington, NZ: New Zealand Labour Party.

New Zealand National Party. (2014). *Policy 2014: Conservation*. Wellington, NZ: New Zealand National Party. Retrieved from https://www.national.org.nz/docs/default-source/PDF/2014/policy/conservation-policy.pdf

New Zealand Plant Conservation Network. (2012). Retrieved 20 Jan 2016, 2016, from http://www.nzpcn.org.nz/page.aspx?conservation_restoration_find_a_group

New Zealand Plant Conservation Network. (2018). Retrieved 16 May 2018, from http://www.nzpcn.org.nz/page.aspx?conservation_restoration_find_a_group

Nogué, S., Santos, A. M. C., Birks, H. J. B., Björck, S., Castilla-Beltrán, A., Connor, S., . . . Steinbauer, M. J. (2021). The human dimension of biodiversity changes on islands. *Science, 372*(6541), 488-491. https://doi.org/doi:10.1126/science.abd6706

Office for the Community and Voluntary Sector. (n.d.). *Code of funding practice*. Wellington, NZ: Department of Internal Affairs Te Tari Taiwhenua.

Palmer, M., Allan, J. D., Meyer, J., & Bernhardt, E. S. (2007). River restoration in the twenty-first century: Data and experiential knowledge to inform future efforts. *Restoration Ecology, 15*(3), 472-481. https://doi.org/10.1111/j.1526-100X.2007.00243.x

Palmer, M., Bernhardt, E. S., Allan, J. D., Lake, P. S., Alexander, G., Brooks, S., . . . Sudduth, E. (2005). Standards for ecologically successful river restoration. *Journal of Applied Ecology, 42*(2), 208-217. https://doi.org/10.1111/j.1365-2664.2005.01004.x

Parks Canada. (2008). *Principles and guidelines for ecological restoration in Canada's protected natural areas*. Gatineau, Quebec: Parks Canada.

Peters, M. A., Hamilton, D., & Eames, C. (2015). Action on the ground: A review of community environmental groups' restoration objectives, activities and partnerships in New Zealand. *New Zealand Journal of Ecology, 39*(2), 179-189.

Phipps, H. L. (2011). Preserving plurality: Valuing community-based restoration in New Zealand.

Puia, S. (1990). Protection and cultural use: Māori concepts of the relationship between Māori people and nature. In D. R. Towns, C. Daugherty, & I. A. E. Atkinson (Eds.), *Ecological restoration of New Zealand islands* (pp. 272-277). Wellington: Department of Conservation.

Reid, K. A., Williams, K. J. H., & Paine, M. S. (2011). Hybrid knowledge: Place, practice, and knowing in a volunteer ecological restoration project. *Ecology and Society, 16*(3), 19. https://doi.org/10.5751/ES-04234-160319

Reiter-Theil, S. (2004). Does empirical research make bioethics more relevant? 'The embedded researcher' as a methodological approach. *Medicine, Health Care and Philosophy, 7*(1), 17-29.

Rimmer, A. (2004). *Tiritiri Matangi: a model of conservation*. Auckland: Tandem Press.

Robinson, J. G. (2011). Ethical pluralism, pragmatism, and sustainability in conservation practice. *Biological Conservation, 144*(3), 958-965. https://doi.org/10.1016/j.biocon.2010.04.017

Ruiz-Jaén, M. C., & Aide, T. M. (2005a). Restoration success: How is it being measured? *Restoration Ecology, 13*(3), 569-577. https://doi.org/10.1111/j.1526-100X.2005.00072.x

Ruiz-Jaén, M. C., & Aide, T. M. (2005b). Vegetation structure, species diversity, and ecosystem processes as measures of restoration success. *Forest Ecology and Management, 218*(1–3), 159-173. https://doi.org/10.1016/j.foreco.2005.07.008

Russell, J. C., & Broome, K. G. (2016). Fifty years of rodent eradications in New Zealand: Another decade of advances. *New Zealand Journal of Ecology, 40*(2), 197-204.

Russell, J. C., & Kueffer, C. (2019). Island biodiversity in the Anthropocene. *Annual Review of Environment and Resources, 44*(1), 31-60. https://doi.org/10.1146/annurev-environ-101718-033245

Salamon, L. M., Sokolowski, S. W., Haddock, M. A., & Tice, H. S. (2013). *The State of global civil society and volunteering: Latest findings from the implementation of the UN Nonprofit Handbook. Working Paper No. 49.* Baltimore, MD, USA: Johns Hopkins Center for Civil Society Studies.

Sandom, C., Faurby, S., Sandel, B., & Svenning, J.-C. (2014). Global late Quaternary megafauna extinctions linked to humans, not climate change. *Proceedings of the Royal Society B: Biological Sciences, 281*(1787), 20133254. https://doi.org/doi:10.1098/rspb.2013.3254

Schroeder, H. W. (2000). The restoration experience: Volunteers' motives, values, and concepts of nature. In P. H. Gobster & R. B. Hull (Eds.), *Restoring nature: perspectives from the social sciences and humanities* (pp. 247-264). Washington, DC: Island Press.

Smith, B. D. (2007). The ultimate ecosystem engineers. *Science, 315*(5820), 1797-1798.

Smyth, A., & Holian, R. (2008). Credibility issues is research from within organisations. In P. Sikes & A. Potts (Eds.), *Researching education from the inside* (pp. 33-47). Milton Park: Routledge.

Society for Ecological Restoration Australasia. (2016). *National standards for the practice of ecological restoration in Australia*. Retrieved 4 May 2016, from http://www.seraustralasia.com/standards/contents.html

Society for Ecological Restoration International Science and Policy Working Group. (2004). *The SER primer on international ecological restoration*. Tucson: Society for Ecological Restoration International.

Spellerberg, I. F. (2005). *Monitoring ecological change*. Cambridge, UK: Cambridge University Press.

Sporle, W. (2007). *Long term sustainability of community biodiversity enhancement projects*. New Zealand: NZ Landcare Trust, BNZ Save the Kiwi, Biodiversity Advice Fund.

State Services Commission. (2014). *Performance improvement framework: Review of the Department of Conservation (DOC)*. Wellington, NZ: New Zealand Government.

Stephens, T., Brown, D., & Thornley, N. (2002). *Measuring conservation achievement: Concepts and their application over the Twizel area. Science for Conservation 200.* Wellington, NZ: Department of Conservation.

Strayer, D. L., Glitzenstein, J. S., Jones, C. G., Kolasa, J., Likens, G. E., McDonnell, M. J., . . . Pickett, S. T. A. (1986). *Long-term ecological studies: An illustrated account of their design, operation, and importance to ecology*. Millbrook, NY: Institute of Ecosystem Studies.

Suding, K. N. (2011). Toward an era of restoration in ecology: Successes, failures, and opportunities ahead. *Annual Review of Ecology, Evolution, and Systematics, 42*(1), 465-487. https://doi.org/10.1146/annurev-ecolsys-102710-145115

Sutherland, W. J., Pullin, A. S., Dolman, P. M., & Knight, T. M. (2004). The need for evidence-based conservation. *Trends in Ecology and Evolution, 19*(6), 305-308. https://doi.org/https://doi.org/10.1016/j.tree.2004.03.018

Tashakkori, A., & Teddlie, C. (2009). Integrating qualitative and quantitative approaches to research. In L. Bickman & D. J. Rog (Eds.), *The SAGE Handbook of applied social research methods* (pp. 283-318). Thousand Oaks: SAGE Publications. https://doi.org/10.4135/9781483348858

Taylor, R., Stephenson, B., Cochrane, P., Smith, I. W. G., & Gibbs, N. (1997). *The State of New Zealand's Environment 1997*. Wellington: Ministry for the Environment.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating qualitative and quantitative approaches in the behavioural sciences*. Thousand Oaks: SAGE Publications.

The Treasury. (2015). *The estimates of appropriations 2015/16 - Environment Sector B.5 Vol.3: Vote Conservation*. Wellington: New Zealand Government.

The Treasury. (2021). *Vote Conservation - Environment Sector - Estimates 2021/22*. Wellington: New Zealand Government. Retrieved from https://www.treasury.govt.nz/publications/estimates/vote-conservation-environment-sector-estimates-2021-22-html#section-5

Tipa, G., & Tearney, L. (2003). *A Cultural Health Index for streams and waterways: Indicators for recognising and expressing Maori values*. Wellington: Ministry for the Environment.

Tischew, S., Baasch, A., Conrad, M. K., & Kirmer, A. (2010). Evaluating restoration success of frequently implemented compensation measures: Results and demands for control procedures. *Restoration Ecology, 18*(4), 467-480. https://doi.org/10.1111/j.1526-100X.2008.00462.x

Toth, L. A., Arrington, D. A., Brady, M. A., & Muszick, D. A. (1995). Conceptual evaluation of factors potentially affecting restoration of habitat structure within the channelized Kissimmee River ecosystem. *Restoration Ecology, 3*(3), 160-180. https://doi.org/10.1111/j.1526-100X.1995.tb00168.x

Towns, D. R., Aguirre-Muñoz, A., Kress, S. W., Hodum, P. J., Burbidge, A. A., & Saunders, A. (2011). The social dimension – public involvement in seabird island restoration. In C. P. H. Mulder, W. B. Anderson, D. R. Towns, & P. J. Bellingham (Eds.), *Seabird islands: Ecology, invasion, and restoration* (pp. 358-392). Oxford, UK: Oxford University Press.

Towns, D. R., Atkinson, I. A. E., & Daugherty, C. H. (1990). Ecological restoration of New Zealand islands - introduction. In D. R. Towns, C. H. Daugherty, & I. A. E. Atkinson

(Eds.), *Ecological restoration of New Zealand islands* (pp. iii-iv). Wellington, NZ: Department of Conservation.

Towns, D. R., Bellingham, P. J., Mulder, C. P. H., & Lyver, P. O. B. (2012). A research strategy for biodiversity conservation on New Zealand's offshore islands. *New Zealand Journal of Ecology, 36*(1), 1-20.

Towns, D. R., Wright, E. F., & Stephens, T. (2009). Systematic measurement of effectiveness for conservation of biodiversity on New Zealand islands. In B. D. Clarkson, P. Kurian, T. Nachowitz, & H. Rennie (Eds.), *Proceedings of the Conserv-Vision Conference, University of Waikato, 2-4 July 2007* (pp. 1-22). Hamilton, NZ: The University of Waikato.

United Nations Generaly Assembly. (2019). *Resolution adopted by the General Assembly on 1 March 2019: 73/284. United Nations Decade on Ecosystem Restoration (2021–2030)*. Retrieved from https://daccess-ods.un.org/tmp/2999500.9303093.html

Unluer, S. (2012). Being an insider researcher while conducting case study research. *The Qualitative Report, 17*, 1-14.

Upton, S. (1999, 25 November). *Keynote address to the Royal Society Academy Conference*. Retrieved from https://www.beehive.govt.nz/speech/keynote-address-royal-society-academy-conference

Waitangi Tribunal. (2001). *The Hauraki Gulf Marine Park Report*. Wellington: Waitangi Tribunal. Retrieved from http://www.justice.govt.nz/tribunals/waitangi-tribunal/Reports/wai0728

Waldron, A., Mooers, A. O., Miller, D. C., Nibbelink, N., Redding, D., Kuhn, T. S., . . . Gittleman, J. L. (2013). Targeting global conservation funding to limit immediate biodiversity declines. *Proceedings of the National Academy of Sciences, 110*(29), 12144-12148. https://doi.org/10.1073/pnas.1221370110

Walter, R., Buckley, H., Jacomb, C., & Matisoo-Smith, E. (2017). Mass migration and the Polynesian settlement of New Zealand. *Journal of World Prehistory, 30*(4), 351-376. https://doi.org/10.1007/s10963-017-9110-y

Westra, L. (1994). *An environmental proposal for ethics : The principle of integrity*. Lanham: Rowman & Littlefield.

Williams, J. (2010). Mahika Kai: The husbanding of consumables by Maori in precontact Te Waipounamu. *Journal of the Polynesian Society, 119*(2), 149-180.

Wilson, E. O. (1992). *The diversity of life*. Cambridge, USA: Harvard University Press.

Wortley, L., Hero, J.-M., & Howes, M. (2013). Evaluating ecological restoration success: A review of the literature. *Restoration Ecology, 21*(5), 537-543. https://doi.org/10.1111/rec.12028

Wright, A. E., & Beever, R. E. (1986). Introduction. In A. E. Wright & R. E. Beever (Eds.), *The offshore islands of New Zealand* (pp. v). Wellington, NZ: Department of Lands and Survey.

Young, D. (2004). *Our islands, our selves: a history of conservation in New Zealand*. Dunedin: Otago University Press.

Young, T. P. (2000). Restoration ecology and conservation biology. *Biological Conservation, 92*(1), 73-83. https://doi.org/10.1016/S0006-3207(99)00057-9

Zedler, J. B. (2007). Success: An unclear, subjective descriptor of restoration outcomes. *Ecological Restoration, 25*(3), 162-168. https://doi.org/10.3368/er.25.3.162

Chapter 2

Ecological restoration in Aotearoa New Zealand[1]

> *Everyone in Aotearoa New Zealand is connected with nature, and supports and actively contributes to its protection and restoration.*
>
> Te Mana o Te Taiao - Aotearoa New Zealand Biodiversity Strategy (Department of Conservation, 2020, p. 43)

2.1 Introduction

Public participation theory is the direct or indirect involvement of concerned stakeholders in policies, plans, or programmes in which they have an interest (Barton, 2002; Quick & Bryson, 2016). It is assumed that public participation is beneficial to society in that empowering communities leads to enduring support for new initiatives, that those affected by decisions or actions should be involved in their implementation, and that communities that work together can achieve outcomes that are broader than those that can be achieved by individuals alone (Arnstein, 1969; Creighton, 2005; Forgie, Horsley, & Johnson, 2001; Quick & Bryson, 2016). However, the kinds of decisions that might be appropriate, what is involved in participation and how best to implement it, are often unclear (e.g., Claridge, 2004).

Conservation projects are regarded by many authors (Bixler, Dell'Angelo, Mfune, & Roba, 2015; Forgie et al., 2001; Ockenden, 2007) as ideally suited to participation activities

[1] This chapter has been published in part as:

Galbraith, M.P., Bollard-Breen, B., & Towns, D.R. (2016). The community-conservation conundrum: is citizen science the answer? *LAND, 5*(4): 37. https://doi.org/10.3390/land5040037

because they provide access to local knowledge, sustainable outcomes through on-going motivation, building of capacity through the acquisition of transferable skills, sharing of responsibilities, acceleration of change through growth of education, awareness and trust, economies of scale, and less costly enforcement through self-regulation (Evely, Pinard, Reed, & Fazey, 2011; Forgie et al., 2001). Building on these advantages, community-based voluntary participation in ecological restoration (conservation) has shown global growth (Bramston, Pretty, & Zammit, 2011; Cheng & Sturtevant, 2011; Miles, Sullivan, & Kuo, 1998).

The motivations for voluntary participation in ecological restoration projects are well studied (e.g., Bramston et al., 2011; Grese, Kaplan, Ryan, & Buxton, 2001; Hardie-Boys, 2010; Miles, Sullivan, & Kuo, 2000), and may be summarised as helping the environment, learning more about the environment (ecological literacy), social belonging (social networks), and personal growth. Although government agencies may be legally bound to restore degraded environments, many have taken advantage of this growth of interest in public participation and have included increased engagement of communities in conservation as performance indicators, for example New Zealand Department of Conservation (DOC) (State Services Commission, 2014).

The concept of public participation is implicit in the *New Zealand Biodiversity Strategy* (NZBS, Department of Conservation & Ministry for the Environment, 2000; Forgie et al., 2001) adopted by the New Zealand Government in 2000. The Strategy acknowledges that lack of understanding and awareness of biodiversity is a barrier to biodiversity conservation, and identifies the engagement of communities and individuals to conserve and enhance Aotearoa New Zealand's biodiversity as a potential tool. Citizen science, the engagement of non-professionals in scientific investigations (Cornwell & Campbell, 2012), is not specifically mentioned in the NZBS, but the concept is certainly implied. For example, Goal 1 of the Strategy (Department of Conservation & Ministry for the Environment, 2000, p. 15) refers to communities having to share responsibility "equitably" for the conservation of Aotearoa New Zealand's biodiversity. This encompasses a breadth of potential outcomes of citizen science including: the gain of scientific literacy, fostering and strengthening of relationships between citizens and professional agencies, use of knowledge for advocacy, and influencing political decisions (Cornwell & Campbell, 2012; Ellis & Waterton, 2005). The action plan for Goal 1 advocates community involvement, using 'participatory projects' (Department of Conservation & Ministry for the Environment, 2000, p. 102) as a tool to resolve the threats to native flora and fauna, and to promote the sustainable use of natural resources. Over the last 20 years, community-based ecological restoration groups have proliferated in Aotearoa New Zealand (hereafter New Zealand) (Bell, 2003; Hardie-Boys, 2010), with more than 3500

ecological restoration projects (New Zealand Plant Conservation Network, 2015) involving an estimated 4000 community groups (Butler, Lindsay, & Hunt, 2014; Green & Clarkson, 2005; Peters, Hamilton, & Eames, 2015).

There is general agreement that there are many levels of public participation. For conservation problems, a form of participation called adaptive co-management is advocated to address the socio-ecological complexities of environmental problems (Berkes, 2004). Here, the scale of the partnerships formed, the participants and type of arrangement formed, should reflect the complexity of problems being addressed. The complex nature of conservation problems is evident in New Zealand, where ecological restoration, especially on islands, almost always involves management of invasive species (Department of Conservation & Ministry for the Environment, 2000; Towns, 2011), and the translocation of species to refugia for conservation gains or to fill taxonomic gaps (Miskelly & Powlesland, 2013; Seddon, Maartin Strauss, & Innes, 2012). Both of these activities, increasingly undertaken by community groups, require numerous sequences of complex actions and decisions.

Invasive plants can take some time to naturalise (Kowarik, 1995), and may require an equally lengthy time to eradicate or control (Parkes & Panetta, 2009), but invasive mammalian predators, even in low densities, can have an immediate and drastic impact on native biota (Furness & Monaghan, 1987; Towns, Byrd, et al., 2011). For this reason, many restoration projects in New Zealand prioritise mammal control, even though such strategies seldom have definite end-points unless eradication is achievable (Grice, 2009) and even then, reinvasion may remain a perpetual risk (Russell, Towns, & Clout, 2008). If community groups aim to deal with introduced predators, they are confronted by significant and complex hurdles. The groups may face systematic removal (or control) of multiple species, which requires planning, logistics, technical requirements, and funds—elements that are acknowledged as a challenge for professional managers (Larson et al., 2011), and are potentially beyond most community groups working independently of other stakeholders (Towns, Aguirre-Muñoz, et al., 2011; Towns, West, & Broome, 2013). For example, the eradication of rats from large islands involves the aerial spread of rodenticide using helicopters equipped with sophisticated Global Positioning Systems (Russell & Broome, 2016). In New Zealand, there are restrictions on who can use the rodenticide, and many safety requirements must be met while the products are loaded and spread. There are also regulations about the discharge of toxins into the air and water that usually require resource consent from local authorities.

Like the management of invasive species, translocations of native species involve an array of complex hurdles for practitioners to address (Armstrong, Hayward, Moro, & Seddon, 2015; Ewen, Armstrong, Parker, & Seddon, 2012). Translocation proposals must provide the

rationale and justification for translocation, and consider logistics, viability of both source and transferred populations, habitat requirements, welfare needs during transfer, disease screening needs, and funding (Seddon, Armstrong, Parker, & Ewen, 2012). Increasingly, genetic issues need to be addressed as each translocation event is, potentially, a genetic bottleneck (Jamieson & Lacy, 2012). Furthermore, extended post-release monitoring of both source and transferred populations is often a required component of translocation events (Nichols & Armstrong, 2012; Parker, Ewen, Seddon, & Armstrong, 2013). Community involvement in species translocations as part of the restoration process, whether wholly community-led or joint community/agency initiatives, is increasing (Cromarty & Alderson, 2013; Peters et al., 2015). For approved species translocations in New Zealand during the period of 2002–2012, community participation increased from 16% to 71% (Cromarty & Alderson, 2013). Community groups are unlikely to be fully aware of the complexity of undertaking translocations (Nally & Adams, 2015), although community participation in translocations is now considered to be an essential component of conservation advocacy (Parker, 2008; Seddon, Maartin Strauss, et al., 2012).

These restoration activities have inherent, and potentially unforeseen challenges, which are typical of conservation management worldwide. For example, a fundamental part of halting the biodiversity declines identified in the NZBS is, of necessity, ecological restoration that includes pest eradication (Department of Conservation & Ministry for the Environment, 2000). In a study of ecological restoration groups in New Zealand (Peters et al., 2015), at least 75% were involved in animal pest control. Should communities embark on ambitious habitat restoration projects that involve killing unwanted organisms, they will lurch unsuspectingly into the realm of ‘wicked’ problems (Ludwig, 2001; Rittel & Webber, 1973), which are those with complex and interconnected components, uncertain biological and social outcomes, that may operate over short or long timescales, have ambiguous definition of scope and boundaries, and be subject to controversy and locally variable social constraints (Reed, 2008; Towns, Aguirre-Muñoz, et al., 2011; Weng, 2015).

Reviews of the implementation of the NZBS (Anon., 2003; Green & Clarkson, 2005, 2006) acknowledge the increase in community-sourced participants in conservation activities. Although the NZBS urges agencies to ensure that individuals and communities have the knowledge and technical skills to participate in biodiversity conservation activities (Department of Conservation & Ministry for the Environment, 2000), an initial review recognised that this community participation was dependent on considerable advice and support (Anon., 2003). The challenges that communities and individuals face in addressing wicked problems may explain concerns raised in subsequent NZBS reviews that monitoring

and reporting of biodiversity conservation activities are patchy or lacking (Green & Clarkson, 2005, 2006).

Citizen science volunteer programs are not new to environmental monitoring (e.g., eBird, Sullivan et al., 2009), and are being used increasingly for biodiversity assessment (Couvet & Prevot, 2015). Citizen science is considered to be a developing field for the collection of long-term field data in ecological restoration (Bonney et al., 2009; Bonney et al., 2014; Couvet & Prevot, 2015; Miller-Rushing, Primack, & Bonney, 2012). There are numerous case studies of citizen science activities in 'successful' ecological restoration projects (e.g., Tiritiri Matangi Island, New Zealand, Galbraith, 2013), indicative of the potential for community-sourced participants to use empirical measures to assess progress towards restoration targets. In addition to the generation of ecological data, citizen science also increases science literacy and offers numerous social benefits as a result of members of the public being engaged collaboratively in research experiences (Conrad & Hilchey, 2011; Dickinson & Bonney, 2012; Dickinson et al., 2012).

The attributes expected of a restored ecosystem are frequently articulated, but there is little information on whether—or how—these attributes should be measured. The benefits of community participation in biodiversity management are well established (e.g., Bixler et al., 2015; Forgie et al., 2001; Ockenden, 2007), but, as of yet, the relationship between community group aspirations (their goals/aims) and their conservation achievements is unclear. Here, I reviewed the extent to which community groups involved with selected ecological restoration projects in New Zealand define progress for their projects. The study focused on the aims and goals of these community groups, and considered three key questions:

1. What arrangements and partnerships are currently operating where there is strong community participation in ecological restoration?
2. What are the key aspirations identified by community groups in their ecological restoration goals and/or aims?
3. What activities and strategic milestones are identified by community groups and what progress are they making towards these?

Finally, I consider whether there are appropriate institutional frameworks in support of their endeavours.

2.2 Methods

Data about ecological restoration projects were gathered through online internet research. Internet-mediated research (IMR; Hewson, Yule, Laurent, & Vogel, 2003) has the advantage of facilitating fast and efficient access to a broad selection of specialist information (Hewson, Vogel, & Laurent, 2016). I reviewed ecological restoration projects with community participation through umbrella websites that provide information of community-based projects (Naturespace, (now administered by DOC); NZ Landcare Trust; Sanctuaries of New Zealand). Additional community-based projects were identified through a publication (Butler et al., 2014), and the author's (M.P.G.) knowledge of restoration projects.

The disadvantages that may be attributed to IMR (e.g., non-representative samples, ethical issues, and uncertain reliability; Fletcher, 2012; Hewson & Laurent, 2008; Hewson et al., 2016) were considered to not apply to this study, as only text-based data about the targeted organisations was collected, not personal information. Furthermore, the information I accessed is publicly available.

2.2.1 Types of community group participation

The types of community groups that undertake conservation activities in Aotearoa New Zealand were established through the online audit of community-based projects. The audit included an analysis of the structure and features of community-based groups, identifying attributes such as the physical location of the project, its scale, community interests and demographics, group structure, how the project was initiated, and degree of professional input. Conservation initiatives that were not community-led were excluded from the analysis, and duplicates across websites were removed. The remaining list of groups were then coded systematically into key types, with the types identified during the coding process. This general inductive approach followed the process advocated by Thomas (2006) and had the advantage of being able to condense a wide range of data into a summary format (Lodico, Spaulding, & Voegtle, 2010; Thomas, 2006).

2.2.2 Project aims and aspirations

The aims of 50 community-based projects were reviewed in this study. Forty-one were selected for accessibility of project information through the umbrella websites Sanctuaries of New Zealand and NZ Landcare Trust. The websites of other known restoration projects (n = 9), not listed with the umbrella websites, were targeted individually. A further selection criterion was to limit the geographic range of the projects to the North Island of New Zealand (Fig 2.1) where most of New Zealand's population, and hence the community-based

restoration projects, are concentrated (Statistics New Zealand, 2015). These locations include DOC reserves and other Crown land (71%), island (22%), and mainland sites. The abundance of island projects reflects concentrations of islands around northern New Zealand and their importance as refugia for native species.

In New Zealand, participants in community conservation initiatives often form non-governmental collectives, such as incorporated societies or charitable trusts dedicated to specific conservation projects. This accords legal status to the groups, with an obligation to provide open access to their aims through the New Zealand Companies Office (Companies Office, 2011). Groups are required to update their documents annually, so it is assumed that the available information is current and reliable.

To establish the key elements of the community groups' aspirations, a corpus of comparable data was assembled from their collective goals and aims. This corpus was analysed using Wmatrix (Rayson, 2009), a computer-based tool to calculate key-word frequencies. A word cloud visualisation of the dominant words in the corpus was generated using a web-based text analysis tool, Voyant Tools (Sinclair & Rockwell, 2016). Word clouds show the frequencies of different words in the corpus as different font sizes, with words at higher frequencies being larger relative to other words. Function words that contribute to sentence syntax rather than meaning were excluded from the analysis. Word clouds provide a quick visualisation of the common themes in texts, and are recognised as a supplementary tool for text analyses, particularly for corpora prior to any content manipulation (McNaught & Lam, 2010).

The top key words and multi-word expressions were also analysed for their association with attributes of restored ecosystems. Restoration ecologists have identified the expected outcomes for restoration projects, and empirical measures for the measurement of the progress (or "success") of a restoration process. These broad attributes (or criteria), derived from concepts of ecological integrity, conservation biology, and sustainability, were collated into nine broad groupings (Table 2.1).

Based on the information reported through the projects' websites, an evaluation of the progress made towards strategic ecological restoration milestones was carried out by scoring each project on an ordinal scale to characterize the status (Table 2.2). This evaluation included noting the nature of any ecological monitoring activities that were being reported.

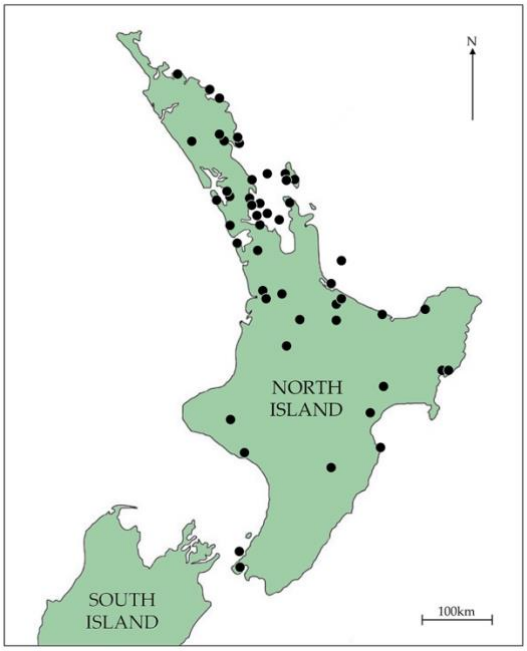


Figure 2.1 – Geographic spread of ecological restoration projects with community participation considered in this study (North Island, Aotearoa New Zealand). Projects were identified via a search of Naturespace, (now administered by DOC), NZ Landcare Trust, and Sanctuaries of New Zealand websites.

Table 2.1 – Broad attributes of ecological restoration success or progress, derived from concepts of ecological integrity, conservation biology, and sustainability.

Potential ecological restoration attributes	Literature sources
Ecosystem representativeness in comparison to reference ecosystem	1–3
Ecosystem composition in comparison to reference ecosystem	1–9
Maintenance of ecosystem processes	1–10
Integration into a larger ecological matrix	1, 3-6, 9, 10
Prevention of extinctions and declines	1–7, 9
Reduction of spread and dominance of alien species	1–7, 9
Re-establishment of landforms and hydrology	1, 4, 6, 9
Educational, scientific, social benefits	1, 6, 7, 9
Sustainable management and use	1, 5, 6

Note. Literature sources: (1) Lee, McGlone, and Wright (2005), (2) Lee and Allen (2011); (3) Towns, Wright, and Stephens (2009); (4) Society for Ecological Restoration Australasia (2016); (5) Society for Ecological Restoration International Science and Policy Working Group (2004); (6) Keenleyside, Dudley, Cairns, Hall, and Stolton (2012); (7) Atkinson (1994); (8) Chaves, Durigan, Brancalion, and Aronson (2015); (9) Parks Canada (2008); (10) (Ruiz-Jaén & Aide, 2005b).

Table 2.2 – Scoring criteria for characterisation of the monitoring status of ecological restoration projects.

Project status	Score				
	1	2	3	4	5
No project aims identifiable	✓				
Project aims identifiable		✓	✓	✓	✓
Evidence of monitoring of populations of invasive species			✓	✓	✓
Evidence of monitoring of populations of indigenous species				✓	✓
Evidence of monitoring of populations of indigenous species; evidence of ecological monitoring to show restoration progress					✓

2.3 Results

2.3.1 Types of community groups

The online audit identified 437 community-groups actively participating in ecological restoration projects. The types of involvement are summarised in Table 2.3.

2.3.2 Project aims and objectives

The projects' objectives, where available, were collated into a corpus of 1490 words and are presented in visual form in Figure 2.2. The key words in the corpus were: "native" (1.61%), "island" (0.87%), "natural" (0.87%), "restore" (0.87%), "provide" (0.81%), "conservation" (0.74%), "ecosystem" (0.60%), "education" (0.60%), "flora" (0.60%), "fauna" (0.60%), "species" (0.60%), and "birds" (0.54%). The two top multi-word expressions in the corpus, "endangered species" and "pest control", were equal in their occurrence (0.13%).

Words associated with the formal disciplines of conservation biology and restoration ecology were present, but at much lower frequencies: for example, "indigenous" (0.27%), "habitat" (0.27%), "monitoring" (0.2%), "ecosystems" (0.2%), "research" (0.2%), "scientific" (0.13%), "populations" (0.13%), "reintroduction" (0.13%), "ecological" (0.13%), and "ecology" (0.13%).

Figure 2.2 – Visualisation of the dominant words in the goals and objectives of 50 selected community groups participating in ecological restoration projects in Aotearoa New Zealand. Word size reflects frequency of occurrence.

Table 2.3 – Typology of community participation in restoration/conservation activities in Aotearoa New Zealand from an online audit of active groups (n = 437).

Type of involvement		Characteristics	Examples
1	Labour only (47%)	No recognised organisation of volunteers; community contribution planned by agencies; volunteers often contribute to costs.	• Local body plantings • Conservation Volunteers New Zealand [1]
2	Support group, remote reserves (1%)	Focussed on remote Crown reserves, generally inaccessible to public; community contribution generally limited to advocacy and funding.	• Hauturu Little Barrier Island Supporters Trust [2] • Fiordland Conservation Trust [3]
3	Management committee, accessible reserves (2%)	Typically focused on local Territorial Land Authority (TLA) reserves; community contribution generally a management/advisory role with limited operational input.	• Diamond Harbour Reserves Management Committee [4] • Lyttleton Reserves Management Committee [5]
4	Support group, accessible reserves (24%)	Typically on Crown or TLA reserves; community contribution includes management, operational and advocacy roles; generally driven and organised by volunteers, potentially with significant levels of internal/external funding.	• Supporters of Tiritiri Matangi [6] • Tawharanui Open Sanctuary Society [6]
5	Independent (1%)	Independently initiated and organised, often with own land and significant levels of internal/external funding; collaborate with iwi/private and Crown landowners; may include QEII covenants.	• Pūkorokoro Miranda Naturalists' Trust [7] • Banks Peninsula Conservation Trust [8]
6	Iwi (2%)*	Iwi-led or co-management agreement between iwi and another agency or group.	• Te Rarawa Taiao - Conservation Projects [9] • Te Ao Tūroa: Environmental kaitiakitanga [10] • Ngati Tahu-Whaoa Environment [11]
7	Private projects (7%)	Landowners initiate, drive and manage conservation activity; minimal assistance from agencies and external funding; may include QEII covenants.	• CUE Haven [2] • Aroha Island Eco Centre [2]
8	Inter-agency/iwi/ community initiatives (14%)	Landscape-scale cooperative conservation activity across a spectrum of land tenure; collective management.	• Sanctuary Mountain Maungatautari [5] • Landcare groups [12]
9	Management trusts (1%)	Conservation activity typically on Crown or TLA land, or with a species-specific focus; driven and managed by an independent Trust Board with stakeholder representatives, but legislated obligations; generally required to be self-funding.	• Motu Kaikoura Trust [6] • Yellow-eyed Penguin Trust [13]
10	Inter-agency/community accord (1%)	Voluntary accord between stakeholders where not all may normally aspire to environmental outcomes; involves a spectrum of land tenure; management outcomes are generally collective and cooperative, principally through information sharing.	• Taranaki Biodiversity Forum Accord [14] • Integrated Kaipara Harbour Management Group [15]

**Note. This proportion was unexpectedly low, and almost certainly is under-representative.*

Examples sources:

[1] conservationvolunteers.co.nz
[2] www.doc.govt.nz/get-involved/volunteer/groups/
[3] fiordlandconservationtrust.org.nz/
[4] diamondharbour.info/dh-reserves-management-committee/
[5] Lyttelton Information Centre (2016)
[6] www.sanctuariesnz.org/projects.asp
[7] shorebirds.org.nz/about-us
[8] www.bpct.org.nz/
[9] www.terarawa.iwi.nz/pou/environmental/projects/
[10] ngaitahu.iwi.nz/environment/
[11] www.tahu-whaoa.iwi.nz/environment/projects
[12] www.landcare.org.nz/
[13] www.yellow-eyedpenguin.org.nz/
[14] Taranaki Regional Council (2012)
[15] kmr.org.nz/

The alignment of the key words and multi-word expressions with broad attributes of ecological restoration are shown in Table 2.4.

2.3.3 Project milestones

The evaluation of the progress made towards strategic ecological restoration milestones, based on the information provided through the projects' websites, is illustrated in Figure 2.3. The project status is based on the scoring system described in Table 2.2. No groups demonstrated evidence of comprehensive ecological monitoring to indicate progress towards a predetermined restoration state.

Table 2.4 – Top 10 key words and top 2 multi-word expressions from community groups' aims and objectives aligned with attributes of restored ecosystems.

Potential ecological restoration attributes	Literature sources	Aims and objective key words/phrases
Ecosystem representativeness in comparison to reference ecosystem	1–3	native, natural, island, restore, ecosystem, flora, fauna, species, birds
Ecosystem composition in comparison to reference ecosystem	1-9	native, natural, island, restore, ecosystem, education, flora, fauna, species, birds
Maintenance of ecosystem processes	1-10	natural, provide, ecosystem, flora, fauna, species, birds
Integration into a larger ecological matrix	1,3–6, 9, 10	natural, island, restore, provide, ecosystem, species
Prevention of extinctions and declines	1–7, 9	native, island, restore, conservation, flora, fauna, species, birds, endangered species
Reduction of spread and dominance of alien species	1–7, 9	native, restore, provide, conservation, ecosystem, education, flora, fauna, species, pest control
Re-establishment of landforms and hydrology	1, 4, 6, 9	restore, ecosystem
Educational, scientific, social benefits	1, 2, 6, 7, 9	conservation, education
Sustainable management and use	1, 2, 6, 7	conservation, ecosystem, education

Note. Literature sources: (1) Lee et al. (2005), (2) Lee and Allen (2011); (3) Towns et al. (2009); (4) Society for Ecological Restoration Australasia (2016); (5) Society for Ecological Restoration International Science and Policy Working Group (2004); (6) Keenleyside et al. (2012); (7) Atkinson (1994); (8) Chaves et al. (2015); (9) Parks Canada (2008); (10) (Ruiz-Jaén & Aide, 2005b).

The reporting of monitoring activities indicated that a majority of the groups (n = 43) were engaged in control or monitoring of introduced mammals. Species reintroduction as a past or intended activity was identified by 31 of the groups. Of the groups that had actually completed species translocations (n = 25), only 13 indicated that monitoring of the translocated species was being undertaken.

Figure 2.3 – Proportion of community-group ecological restoration projects in Aotearoa New Zealand (n = 50) achieving ecological restoration milestones. Italicised numerals within bars indicate the number of groups at each status score.

2.4 Discussion

2.4.1 Typology of ecological restoration groups

The contribution by public to address environmental degradation can take many forms, and reflects the development in New Zealand of a community desire for hands-on participation in ecological restoration (Towns, Aguirre-Muñoz, et al., 2011; Wilson, 2005). Wilson (2005, p. 10) identifies a continuum of community groups between the extremes of ‘informal’ and ‘corporate’. The 10 types of community participation presented here represent these extremes and a range of participation types along the continuum (Table). The ‘informal’ extreme is represented by a labour only contribution (Type 1), and interagency/community accords representing the ‘corporate’ extreme (Type 10).

Where a project is located on public land managed by DOC, or by other agencies, there is a statutory obligation for DOC to retain overview. The community groups in these situations, particularly if localised, will tend to be labour only (Type 1), or a support group on a remote (Type 2) or accessible reserve (Type 4). Projects tend to become more complex as scale (physical, spatial, temporal, or stakeholders) increases. In these cases, management actions are potentially complex, particularly where a variety of land tenure is involved, so inter-stakeholder cooperation is both necessary and important.

Only 2% of the community groups identified were iwi-led or were operating under a co-management agreement (Type 6; Table 3). This proportion was unexpectedly low, and almost certainly is under-representative of this type of community participation. This may be due to underlying bias in online presence of these groups, or how these groups organise and communicate their activities in the digital space. It suggests that employing alternative survey methods is required for a deeper understanding of the key aims and aspirations of these groups.

The nature of projects, and the associated community input, is inherently dynamic, and change over time is inevitable as participants change, milestones are passed, and support grows. Thus, although a labour-only contribution dominates community participation in restoration projects, the type of community contribution may shift along the continuum as it develops and in response to changing attributes. Examples of this shift are: the Supporters of Tiritiri Matangi started as an informal Type 1 contribution (labour only) before moving to Type 4 (support group) (Galbraith & Hayson, 1994); the Guardians of the Bay of Islands started as Type 1, but is now mostly Type 4 while operating to a certain extent within Type 8 (inter-agency/iwi/community initiative) (H. Ough Dealy pers. comm.).

More recently, many community restoration groups have recognised the experiences of earlier-established projects, and set themselves up, on inception, near the more complex end of the continuum, or function as a combination of types. Restoration of the Mercury Islands, for example, is a combination of Types 5 and 8 (independent but with interagency and iwi collaboration) (Towns, 2023).

The 10 types of community participation are neither precisely distinct nor exclusive, but they are intended to represent the current state of community-based ecological restoration in New Zealand. This classification is useful for thinking about the different contributions public participants make, however, it is acknowledged that specific groups will likely fit somewhere on a continuum amongst these types.

2.4.2 Elements covered in the goals and/or aims of the community groups

The goals and aims of the ecological restoration groups in the study varied greatly in the quality of information provided. The web-based information contained shortcomings in the use of restoration ecology terminology, and no groups identified specific strategic milestones for their participation and progress towards them. Our study confirms, however, that numerous community groups are involved in ecological restoration activities that fit the concept of 'wicked' problems. Most groups are engaged in the management of mammalian pests (84%), with species reintroduction either being carried out, or on the 'wish list' of activities, for 62% of the groups. Both of these activities are complex, may have uncertain outcomes, and are potentially controversial.

The key words that emerged from the analysis of the aims and objectives of 50 community collectives reinforce studies identifying environmental gain as a significant motivational driver of volunteers participating in ecological restoration projects (Society for Ecological Restoration Australasia, 2016). These key words and phrases were, however, of a relatively general nature, often with a local focus, and did not use the formal language more often associated with the science of restoration ecology. Examples of such generalised aims or objectives are:

- "to restore the natural and cultural landscapes" (Motutapu Restoration Trust);
- "future generations will enjoy a forest alive with native birds, reptiles and insects" (Motuora Restoration Society);
- "a natural environment of indigenous flora and fauna" (Motuihe Trust);
- "a corridor of bush along a pristine stream; a place for birds to live and kids to play" (Waitao-Kaiate Environmental Group);
- "to preserve and enhance the natural beauty, ecosystems and biodiversity" (Whakaangi Landcare Trust);
- "to remove forever, introduced mammalian pests and predators" (Maungatautari Ecological Island Trust).

The generalised aims and objectives may reflect a gap identified in other studies (e.g., Weng, 2015) between a professional perspective of ecological restoration (e.g., that of a government agency, with a legislative obligation to focus on the scientific foundations of restoration), and a community perspective where general restoration objectives support social environmental benefits that to which avocational participants relate. Avocational volunteers (or lay ecological restorationists, New Zealand National Party, 2014; State Services Commission, 2014) have been shown to conceptualise restoration differently to

ecological professionals (Weng, 2015). However, I believe that, despite the general language used in the community groups' goals and aims, the key words and multi-word expressions can still be aligned to the broad attributes of ecological restoration (Table 2.3).

Words associated with long-term monitoring of ecological attributes, however, were few, and, if present, were at particularly low frequency. Although monitoring featured in a minority of objectives, words that might be expected of community-based restoration projects, such as "citizen", "science", and "measure", were absent. This low focus on ecological science likely reflects the avocational status of the community participants who generally lack technical skills and science literacy, particularly where their contribution focuses on practical contribution under the direction of an agency body (Peters, Hamilton, Eames, Innes, & Mason, 2016).

2.4.3 Activities and strategic milestones identified by community groups

Environmental monitoring is a globally common participatory action (e.g., Bixler et al., 2015; Forgie et al., 2001; Ockenden, 2007; Peters et al., 2016). However, although it is evident that some degree of monitoring is undertaken by the community groups I studied, none provide a comprehensive framework of strategic milestones to demonstrate restoration progress. Other studies (Peters et al., 2016) have found similarly that only a minority of groups monitor the outcome of their actions.

Analyses of reports from restoration projects that were studied indicated long-term monitoring activities dominated by assessment of ecological status (e.g., populations) and impacts (e.g., invasive mammals). Aspects of ecological integrity, such as ecosystem composition, structure, and processes, do not feature in the analyses. Ecological status assessment is dominated by vegetation measures, attributed to the relative speed and ease with which such measures can be completed (Ruiz-Jaén & Aide, 2005a; Young, 2000). Recent publications suggest that this is a common characteristic of restoration monitoring (Peters et al., 2016; Ruiz-Jaén & Aide, 2005a). The milestones that were used by the groups in our study focussed on the monitoring of invasive mammal pests (see also Peters et al., 2015). This form of monitoring reflects the impact of invasive mammals in New Zealand, and that their management is now a routine activity and acknowledged as a crucial first phase (and potentially long-term activity) of restoration projects (Clout, 2001). Of the more specific restoration activity of species translocation, only half of the groups that had carried out, or participated in, such events indicated that these species were monitored (despite this being a condition of all translocation permits issued by the Department of Conservation).

There is evidence that many ecological restoration projects do exhibit positive progress in improving ecological integrity and/or achieving conservation gains (Suding, 2011), and this appears to be generally assumed for a large number of New Zealand projects (Butler et al., 2014; Campbell-Hunt & Campbell-Hunt, 2013). Despite such proclamations of successful ecological restoration projects worldwide, however, there is international debate over what constitutes 'success' in the context of ecological restoration (Bernhardt et al., 2007; Clewell & Rieger, 1997; Palmer et al., 2005; Suding, 2011; Wortley, Hero, & Howes, 2013; Zedler, 2007), with some authors criticising the wide use of the word 'success' (and other value-laden terms, for example, 'desirable', 'degraded', and 'intact') to describe ecological restoration outcomes (e.g., Clewell & Rieger, 1997; Suding, 2011; Zedler, 2007). An additional complication, further reducing clarity for community participation in particular, is that different stakeholders will likely have differing expectations of restoration outcomes (Hackney, 2000), so it is inevitable that perceptions of restoration success will be based on their respective experience and values (Clewell & Rieger, 1997; Hackney, 2000; Suding, 2011).

If the measurement of restoration progress and/or success is a desired and expected component of restoration outcomes, then the need to assign value to the actions of community participation is paramount. Accountability is particularly important where restoration projects are on public lands and restoration outcomes are accountable to society (taxpayers) in general, and/or where parties using outside funding may be held financially responsible for restoring a damaged ecosystem (Holl & Howarth, 2000). Effective and meaningful evaluation of the progress of an ecological restoration project requires a framework for systematic ecological monitoring to be in place (Atkinson, 1994). Such a framework is deemed to be a necessary prerequisite for evidence-based review of restoration actions (Sutherland, Pullin, Dolman, & Knight, 2004).

2.4.4 Citizen science

New Zealand has international recognition for the participation of volunteers in conservation projects (Galbraith, 2013; Towns, Aguirre-Muñoz, et al., 2011) with the growing trend in volunteering seen by the Department of Conservation and other territorial authorities as a pathway to greater engagement of the public in conservation activities, as well as increase business partnerships for conservation gain (Department of Conservation, 2013). This trend addresses the goals of the NZBS (Department of Conservation & Ministry for the Environment, 2000), and is consistent with current government priorities (State Services Commission, 2014). Since communities may already be engaged in some level of monitoring, albeit at a low scale, the targeted training of interested individuals as citizen scientists may prove a way to obtain comprehensive measures of restoration outcomes

against community effort. However, citizen science is not listed anywhere in the NZBS (Department of Conservation & Ministry for the Environment, 2000), nor in the index of a comprehensive published account of New Zealand sanctuaries (Butler et al., 2014). Nevertheless, the Strategy emphasises the need to improve the technical knowledge and capacity for communities to become involved in biodiversity management.

Citizen science, however, has its problems. It requires willing engagement of participants in science. This is a likely barrier, as, according to published accounts (e.g., Bramston et al., 2011; Bruyere & Rappe, 2007) most community volunteers are involved in the projects for reasons other than an interest in obtaining data. In addition, volunteers' experiences must be enjoyable to be sustainable (Bell, 2003), and the imposition of science-based activities may counter this need, particularly for avocational participants. The divide between avocational participants and formal science is well recognised (Braunisch, Home, Pellet, & Arlettaz, 2012), and may have developed through the marginalisation of amateur naturalists as a by-product of the professionalisation of science (Miller-Rushing et al., 2012). Furthermore, the quality of data collected by avocational volunteers has often been questioned (Bonney et al., 2014), although recent approaches tend to suggest that citizen science data is useful and important if the research methodologies are well-designed (Cohn, 2008; Dickinson et al., 2012).

The involvement of avocational volunteers in the measurement of ecological attributes of restoration, measures that are essentially an applied science focus, has implications for both achieving and measuring project outcomes. For many participants in restoration projects, social and recreational motivations may be as important as environmental stewardship (Reid, Williams, & Paine, 2011), and are often included in the goals of citizen science projects. Their participation in ecological science, therefore, may be unintentional, and develop as a result of a project's management requirements and/or devolution of management by governing agencies to communities. In this situation, the participants may be considered as 'accidental' scientists rather than citizen scientists (J. Perrott, pers. comm., 26 May 2016), and raises questions of the desire, and hence capacity, of community groups to engage in ecological science.

2.4.5 Conclusion

This study considered 50 community-based ecological restoration projects in New Zealand to gauge the relationship between the aspirations of the participants as collectives (their goals/aims) and their conservation achievements. I found that goals tend to be generalised, and do not identify strategic milestones to gauge project success. Although many groups are

undertaking environmental monitoring and, at least at some level, are engaged effectively in scientific activities, it appears that monitoring of restoration outcomes is given a lower priority than might be expected given the need to provide measures of long-term results, which perhaps is indicative of the avocational nature of most participants.

The consequence of poorly defined criteria of restoration ‘success’ is the difficulty of evaluating benefits, leading to subjective assertions of the outcomes of ecological restoration, particularly as they are often based on anecdotal measures. This difficulty can be compounded when projects lack predetermined goals, criteria for measuring milestones, and fail to monitor appropriate project outcomes (Suding, 2011). Evidence-based approaches would justify restoration as an option for natural resource management through demonstrated conservation gains, development of best practices in the field, facilitated prioritisation of restoration actions, justified funding and allocation of resources, and clear accounting for funds committed to do the work (Mansfield & Towns, 1997; Palmer, Allan, Meyer, & Bernhardt, 2007; Stephens, Brown, & Thornley, 2002; Suding, 2011; Wortley et al., 2013).

Citizen science is accepted as an excellent opportunity to progress ecological restoration, where the participants increase their scientific literacy and skills, and gain social benefit. Such activities can certainly meet the needs of effective monitoring for restoration success. However, although most studies of community groups identify the need for increased technical training for volunteers, including methods for outcome monitoring, such training is not necessarily a priority of the groups themselves (Peters et al., 2015).

The implication from the NZBS (Department of Conservation & Ministry for the Environment, 2000) is that improved capability through training and technical support would derive from professional agencies such as the New Zealand Department of Conservation and regional councils. Many community groups do receive assistance and advice from staff of government agencies or tertiary educational institutes (Peters et al., 2015), sometimes with scientists as members or even instigators of the community groups. Such collaborative processes have been shown to greatly enhance the outcomes for conservation (Arlettaz et al., 2010). However, studies of community participation in ecological restoration do not mention the collaborative approach as a motivation for involvement, although it is perhaps buried within the objective of education and learning about the environment (Peters et al., 2015). Furthermore, two events have conspired to make collaboration increasingly difficult to achieve. First, the number of community groups is now so large it is potentially beyond the agencies' abilities to help them all. Second, technical assistance from DOC has declined as funding has progressively reduced (Butler et al., 2014). In an attempt to improve linkages with the community, DOC has bolstered partnership staff, but in compensation further

reduced its technical capacity. These two events are mirrored globally (e.g., Bramston et al., 2011; Conrad & Hilchey, 2011; Innes, Burns, Sanders, & Hayward, 2015; Waldron et al., 2013).

Ecological restoration involving community groups thus faces a conundrum: participation is an essential component of the goals of conservation agencies. Restoration participants, however, may engage in citizen science if they are already interested in science. If not, many participants, at best, are 'accidental' scientists rather than citizen scientists. There are important implications for managers of existing and future citizen-science projects. Given the 'wicked' problems associated with ecological restoration activities—technical, ethical, and financial—community groups will need more than intermittent technical advice from government agencies. These groups will require substantial training in data gathering and analyses for citizen scientists, with support from institutions and innovative tools, in order to generate the long-term resilience necessary for sustainable ecological restoration projects.

References

Anon. (2003). *New Zealand Biodiversity Strategy: Third annual report 2002/03*. Wellington, NZ: Department of Conservation.

Arlettaz, R., Schaub, M., Fournier, J., Reichlin, T. S., Sierro, A., Watson, J. E. M., & Braunisch, V. (2010). From publications to public actions: When conservation biologists bridge the gap between research and implementation. *BioScience, 60*(10), 835-842. https://doi.org/10.1525/bio.2010.60.10.10

Armstrong, D. P., Hayward, M. W., Moro, D., & Seddon, P. J. (2015). Introduction: The development of reintroduction biology in New Zealand and Australia. In D. P. Armstrong, M. W. Hayward, D. Moro, & P. J. Seddon (Eds.), *Advances in reintroduction biology of Australian and New Zealand fauna* (Vol. 1-6). Melbourne, Australia: CSIRO Publishing.

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Planning Association, 35*(4), 216-224.

Atkinson, I. A. E. (1994). *Guidelines to the development and monitoring of ecological restoration programmes*. Wellington: Department of Conservation.

Barton, B. (2002). Underlying concepts and theoretical issues in public participation in resources development. In D. M. Zillman, A. Lucas, & G. Pring (Eds.), *Human rights in natural resource development: Public participation in the sustainable development of mining and energy resources* (pp. 77-120). New York: Oxford University Press.

Bell, K. (2003). *Assessing the benefits for conservation of volunteer involvement in conservation activities. Science for Conservation 223*. Wellington, NZ: Department of Conservation.

Berkes, F. (2004). Rethinking community-based conservation. *Conservation Biology, 18*(3), 621-630.

Bernhardt, E. S., Sudduth, E. B., Palmer, M. A., Allan, J. D., Meyer, J. L., Alexander, G., . . . Pagano, L. (2007). Restoring rivers one reach at a time: Results from a survey of U.S. river restoration practitioners. *Restoration Ecology, 15*(3), 482-493. https://doi.org/10.1111/j.1526-100X.2007.00244.x

Bixler, R. P., Dell'Angelo, J., Mfune, O., & Roba, H. (2015). The political ecology of participatory conservation: Institutions and discourse. *Journal of Political Ecology, 22*, 164-182.

Bonney, R., Cooper, C. B., Dickinson, J. L., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J. L. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience, 59*(11), 977-984. https://doi.org/10.1525/bio.2009.59.11.9

Bonney, R., Shirk, J. L., Phillips, T. B., Wiggins, A., Ballard, H. L., Miller-Rushing, A. J., & Parrish, J. K. (2014). Next steps for citizen science. *Science, 343*(6178), 1436-1437. https://doi.org/10.1126/science.1251554

Bramston, P., Pretty, G., & Zammit, C. (2011). Assessing environmental stewardship motivation. *Environment and Behavior, 43*(6), 776-788.

Braunisch, V., Home, R., Pellet, J., & Arlettaz, R. (2012). Conservation science relevant to action: A research agenda identified and prioritized by practitioners. *Biological Conservation, 153*, 201-210. https://doi.org/10.1016/j.biocon.2012.05.007

Bruyere, B., & Rappe, S. (2007). Identifying the motivations of environmental volunteers. *Journal of Environmental Planning and Management, 50*(4), 503-516. https://doi.org/10.1080/09640560701402034

Butler, D., Lindsay, T., & Hunt, J. (2014). *Paradise saved: The remarkable story of New Zealand's wildlife sanctuaries and how they are stemming the tide of extinction*. Auckland, NZ: Random House.

Campbell-Hunt, D., & Campbell-Hunt, C. (2013). *Ecosanctuaries: Communities building a future for New Zealand's threatened ecologies*. Dunedin: Otago University Press.

Chaves, R. B., Durigan, G., Brancalion, P. H. S., & Aronson, J. (2015). On the need of legal frameworks for assessing restoration projects success: New perspectives from São Paulo state (Brazil). *Restoration Ecology, 23*(6), 754-759. https://doi.org/10.1111/rec.12267

Cheng, A. S., & Sturtevant, V. E. (2011). A framework for assessing collaborative capacity in community-based public forest management. *Environmental Management, 49*(3), 675-689. Cheng2011. https://doi.org/10.1007/s00267-011-9801-6

Claridge, T. (2004). *Social capital and natural resource management* (Master Natural Resource Studies). University of Queensland, Brisbane, Australia.

Clewell, A. F., & Rieger, J. P. (1997). What practitioners need from restoration ecologists. *Restoration Ecology, 5*(4), 350-354. https://doi.org/10.1046/j.1526-100X.1997.00548.x

Clout, M. N. (2001). Biodiversity conservation and the management of invasive animals in New Zealand. In O. T. Sandlund, P. J. Schei, & Å. Viken (Eds.), *Invasive species and biodiversity management* (pp. 349–361). Dordrecht, Netherlands: Springer.

Cohn, J. P. (2008). Citizen science: Can volunteers do real research? *BioScience, 58*(3), 192-197. https://doi.org/10.1641/B580303

Companies Office. (2011). *What are the advantages of becoming an incorporated society?* Retrieved 6 February 2016, from http://www.societies.govt.nz/cms/customer-support/faqs/incorporated-societies/what-are-the-advantages-of-becoming-an-incorporated-society

Conrad, C. C., & Hilchey, K. G. (2011). A review of citizen science and community-based environmental monitoring: Issues and opportunities. *Environmental Monitoring and Assessment, 176*(1), 273-291. Conrad2011. https://doi.org/10.1007/s10661-010-1582-5

Cornwell, M. L., & Campbell, L. M. (2012). Co-producing conservation and knowledge: Citizen-based sea turtle monitoring in North Carolina, USA. *Social Studies of Science, 42*(1), 101-120. https://doi.org/10.1177/0306312711430440

Couvet, D., & Prevot, A. (2015). Citizen-science programs: Towards transformative biodiversity governance. *Environmental Development, 13*(0), 39-45. https://doi.org/http://dx.doi.org/10.1016/j.envdev.2014.11.003

Creighton, J. L. (2005). *The public participation handbook: Making better decisions through citizen involvement*. Chichester, UK: John Wiley & Sons.

Cromarty, P. L., & Alderson, S. L. (2013). Translocation statistics (2002-2010), and the revised Department of Conservation translocation process. *Notornis, 60*, 55-62.

Department of Conservation. (2013). *Annual report for the year ended 30 June 2015*. Wellington: Department of Conservation.

Department of Conservation. (2020). *Te Mana o Te Taiao - Aotearoa New Zealand Biodiversity Strategy 2020*. Wellington, NZ: Department of Conservation.

Department of Conservation & Ministry for the Environment. (2000). *New Zealand biodiversity strategy: Our chance to turn the tide*. Wellington, NZ: Department of Conservation; Ministry for the Environment.

Dickinson, J. L., & Bonney, R. (2012). Introduction: Why citizen science? In J. L. Dickinson & R. Bonney (Eds.), *Citizen science: Public participation in environmental research* (pp. 1-14). Ithaca, NY, USA: Cornell University Press.

Dickinson, J. L., Shirk, J. L., Bonter, D., Bonney, R., Crain, R. L., Martin, J., . . . Purcell, K. (2012). The current state of citizen science as a tool for ecological research and public engagement. *Frontiers in Ecology and the Environment, 10*(6), 291-297. https://doi.org/10.1890/110236

Ellis, R., & Waterton, C. (2005). Caught between the cartographic and the ethnographic imagination: The whereabouts of amateurs, professionals, and nature in knowing biodiversity. *Environment and Planning D: Society and Space, 23*(5), 673-693. https://doi.org/10.1068/d353t

Evely, A. C., Pinard, M., Reed, M. S., & Fazey, I. (2011). High levels of participation in conservation projects enhance learning. *Conservation Letters, 4*, 116-126.

Ewen, J. G., Armstrong, D. P., Parker, K. A., & Seddon, P. J. (Eds.). (2012). *Reintroduction biology: Integrating science and management*. Chichester, UK: John Wiley & Sons.

Fletcher, W. H. (2012). Corpus analysis of the world wide web. In C. Chapelle (Ed.), *The Encyclopedia of Applied Linguistics*. Chichester, UK: John Wiley & Sons.

Forgie, V., Horsley, P., & Johnson, J. (2001). *Facilitating community-based conservation initiatives*. Wellington, NZ: Department of Conservation.

Furness, R. W., & Monaghan, P. (1987). *Seabird ecology*. Glasgow, UK: Blackie & Son.

Galbraith, M. (2013). Public and ecology - the role of volunteers on Tiritiri Matangi. *New Zealand Journal of Ecology, 37*(3), 266-271.

Galbraith, M., & Hayson, C. (1994). Tiritiri Matangi Island, New Zealand: Public participation in species translocation to an open sanctuary. In M. Serena (Ed.), *Reintroduction biology of Australian and New Zealand fauna* (pp. 149-154). Chipping Norton, NSW, Australia: Surrey Beatty & Sons.

Green, W., & Clarkson, B. D. (2005). *Turning the tide? A review of the first five years of the New Zealand Biodiversity Strategy: The synthesis report*. Wellington, NZ: Department of Conservation.

Green, W., & Clarkson, B. D. (2006). *Review of the New Zealand Biodiversity Strategy themes*. Wellington, NZ: Department of Conservation.

Grese, R. E., Kaplan, R. S., Ryan, R. L., & Buxton, J. (2001). Psychological benefits of volunteering in stewardship programmes. In P. H. Gobster & R. B. Hull (Eds.), *Restoring nature: Perspectives from the social sciences and humanities* (pp. 265-280). Washington DC, USA: Island Press.

Grice, T. (2009). Principles of containment and control of invasive species. In M. N. Clout & P. A. Williams (Eds.), *Invasive species management: A handbook of principles and techniques* (pp. 61-76). Oxford, UK: Oxford University Press.

Hackney, C. T. (2000). Restoration of coastal habitats: Expectation and reality. *Ecological Engineering, 15*(3–4), 165-170. https://doi.org/10.1016/S0925-8574(00)00067-7

Hardie-Boys, N. (2010). *Valuing community group contributions to conservation. Science for Conservation 299*. Wellington, NZ: Department of Conservation.

Hewson, C., & Laurent, D. (2008). Research design and tools for internet research. In R. M. Lee, N. Fielding, & G. Blank (Eds.), *SAGE Handbook of online research methods* (pp. 58-78). London, UK: SAGE Publications.

Hewson, C., Vogel, C., & Laurent, D. (2016). *Internet research methods*. London, UK: Sage Publishing.

Hewson, C., Yule, P., Laurent, D., & Vogel, C. (2003). *Internet research methods: A practical guide for the social and behavioural sciences*. London, UK: SAGE Publications.

Holl, K. D., & Howarth, R. B. (2000). Paying for restoration. *Restoration Ecology, 8*(3), 260-267. https://doi.org/10.1046/j.1526-100x.2000.80037.x

Innes, J., Burns, B., Sanders, A., & Hayward, M. W. (2015). The impacts of private sanctuary networks on reintroduction programs. In D. P. Armstrong, M. W. Hayward,

D. Moro, & P. J. Seddon (Eds.), *Advances in reintroduction biology of Australian and New Zealand fauna* (pp. 185-200). Melbourne, Australia: CSIRO Publishing.

Jamieson, I. G., & Lacy, R. C. (2012). Managing genetic issues in reintroduction biology. In J. G. Ewen, D. P. Armstrong, K. A. Parker, & P. J. Seddon (Eds.), *Reintroduction biology: Integrating science and management* (pp. 441-475). Chichester, UK: John Wiley & Sons.

Keenleyside, K. A., Dudley, N., Cairns, S., Hall, C. M., & Stolton, S. (Eds.). (2012). *Ecological restoration for protected areas: Principles, guidelines and best practices*. Gland, Switzerland: IUCN.

Kowarik, I. (1995). Time lags in biological invasions with regard to the success and failure of alien species. In P. Pyšek, K. Prach, M. Rejmánek, & M. Wade (Eds.), *Plant invasions - General aspects and special problems* (pp. 15–39). Amsterdam, Netherlands: SPB Academic Publishing.

Larson, D. L., Phillips-Mao, L., Quiram, G., Sharpe, L., Stark, R., Sugita, S., & Weiler, A. (2011). A framework for sustainable invasive species management: environmental, social, and economic objectives. *Journal of Environmental Management, 92*(1), 14-22. https://doi.org/http://dx.doi.org/10.1016/j.jenvman.2010.08.025

Lee, W. G., & Allen, R. B. (2011). *Recommended monitoring framework for Regional Councils assessing biodiversity outcomes in terrestrial ecosystems*. Dunedin: Landcare Research.

Lee, W. G., McGlone, M., & Wright, E. F. (2005). *Biodiversity inventory and monitoring: A review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation*. Wellington: Landcare Research.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in educational research: From theory to practice* (2 ed.). San Francisco: Jossey-Bass.

Ludwig, D. (2001). The era of management Is over. *Ecosystems, 4*(8), 758-764.

Lyttelton Information Centre. (2016). Reserve management committees clarification needed. *Lyttleton Review, 163,* 6.

Mansfield, B., & Towns, D. R. (1997). Lesson of the islands. *Ecological Restoration, 15*(2), 138-146. https://doi.org/10.3368/er.15.2.138

Maungatautari Ecological Island Trust. Retrieved 3 May 2016, from http://www.sanctuarymountain.co.nz/

McNaught, C., & Lam, P. (2010). Using Wordle as a supplementary research tool. *The Qualitative Report, 15*(3), 630-643.

Miles, I., Sullivan, W. C., & Kuo, F. C. (1998). Ecological restoration volunteers: The benefits of participation. *Urban Ecosystems, 2*, 27–41.

Miles, I., Sullivan, W. C., & Kuo, F. E. (2000). Psychological benefits of volunteering for restoration projects. *Ecological Restoration, 18*(4), 218-227. https://doi.org/10.3368/er.18.4.218

Miller-Rushing, A., Primack, R., & Bonney, R. (2012). The history of public participation in ecological research. *Frontiers in Ecology and the Environment, 10*(6), 285-290. https://doi.org/10.1890/110278

Miskelly, C. M., & Powlesland, R. G. (2013). Conservation translocations of New Zealand birds, 1863-2012. *Notornis, 60*(1), 3-28.

Motuihe Trust. Retrieved 3 May 2016, from http://www.motuihe.org.nz

Motuora Restoration Society. Retrieved 3 May 2016, from http://motuora.org.nz/

Motutapu Restoration Trust. Retrieved 3 May 2016, from http://www.motutapu.org.nz/

Nally, S., & Adams, L. (2015). Evolution of the translocation approval process in Australia and New Zealand. In D. P. Armstrong, M. W. Hayward, D. Moro, & P. J. Seddon (Eds.), *Advances in reintroduction biology of Australian and New Zealand fauna* (pp. 273-284). Melbourne, Australia: CSIRO Publishing.

Naturespace. *Volunteer for conservation*. Retrieved 17 March 2023, from https://www.doc.govt.nz/volunteer

New Zealand National Party. (2014). *Policy 2014: Conservation*. Wellington, NZ: New Zealand National Party. Retrieved from https://www.national.org.nz/docs/default-source/PDF/2014/policy/conservation-policy.pdf

New Zealand Plant Conservation Network. (2015). Retrieved from http://www.nzpcn.org.nz/

Nichols, J. D., & Armstrong, D. P. (2012). Monitoring for reintroductions. In J. G. Ewen, D. P. Armstrong, K. A. Parker, & P. J. Seddon (Eds.), *Reintroduction biology: Integrating science and management* (pp. 223-255). Chichester, UK: John Wiley & Sons.

NZ Landcare Trust. *Sustainable land and water management through community engagement*. Retrieved 17 March 2023, from https://landcare.org.nz/

Ockenden, N. (2007). *Volunteering in the natural outdoors in the UK and Ireland: A literature review*. London, UK: Institute for Volunteering Research.

Palmer, M., Allan, J. D., Meyer, J., & Bernhardt, E. S. (2007). River restoration in the twenty-first century: Data and experiential knowledge to inform future efforts. *Restoration Ecology, 15*(3), 472-481. https://doi.org/10.1111/j.1526-100X.2007.00243.x

Palmer, M., Bernhardt, E. S., Allan, J. D., Lake, P. S., Alexander, G., Brooks, S., . . . Sudduth, E. (2005). Standards for ecologically successful river restoration. *Journal of Applied Ecology, 42*(2), 208-217. https://doi.org/10.1111/j.1365-2664.2005.01004.x

Parker, K. A. (2008). Translocations: Providing outcomes for wildlife, resource managers, scientists, and the human community. *Restoration Ecology, 16*(2), 204-209. https://doi.org/10.1111/j.1526-100X.2008.00388.x

Parker, K. A., Ewen, J. G., Seddon, P. J., & Armstrong, D. P. (2013). Post-release monitoring of bird translocations: Why is it important and how do we do it? *Notornis, 60*, 85-92.

Parkes, J. P., & Panetta, F. D. (2009). Eradication of invasive species: Progress and emerging issues in the 21st century. In M. N. Clout & P. A. Williams (Eds.), *Invasive species management: A handbook of principles and techniques*. Oxford, UK: Oxford University Press.

Parks Canada. (2008). *Principles and guidelines for ecological restoration in Canada's protected natural areas*. Gatineau, Quebec: Parks Canada.

Peters, M. A., Hamilton, D., & Eames, C. (2015). Action on the ground: A review of community environmental groups' restoration objectives, activities and partnerships in New Zealand. *New Zealand Journal of Ecology, 39*(2), 179-189.

Peters, M. A., Hamilton, D., Eames, C., Innes, J., & Mason, N. W. H. (2016). The current state of community-based environmental monitoring in New Zealand. *New Zealand Journal of Ecology, 40*(3), 279-288.

Quick, K. S., & Bryson, J. M. (2016). Public participation. In J. Torbing & C. Ansell (Eds.), *Handbook in theories of governance* (pp. 158-169). Cheltenham, UK: Edward Elgar Press.

Rayson, P. (2009). *Wmatrix: A web-based corpus processing environment*. Retrieved 21 June 2016, from http://ucrel.lancs.ac.uk/wmatrix/

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*(10), 2417-2431. https://doi.org/http://dx.doi.org/10.1016/j.biocon.2008.07.014

Reid, K. A., Williams, K. J. H., & Paine, M. S. (2011). Hybrid knowledge: Place, practice, and knowing in a volunteer ecological restoration project. *Ecology and Society, 16*(3), 19. https://doi.org/10.5751/ES-04234-160319

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155-169. Rittel1973. https://doi.org/10.1007/bf01405730

Ruiz-Jaén, M. C., & Aide, T. M. (2005a). Restoration success: How is it being measured? *Restoration Ecology, 13*(3), 569-577. https://doi.org/10.1111/j.1526-100X.2005.00072.x

Ruiz-Jaén, M. C., & Aide, T. M. (2005b). Vegetation structure, species diversity, and ecosystem processes as measures of restoration success. *Forest Ecology and Management, 218*(1–3), 159-173. https://doi.org/10.1016/j.foreco.2005.07.008

Russell, J. C., & Broome, K. G. (2016). Fifty years of rodent eradications in New Zealand: Another decade of advances. *New Zealand Journal of Ecology, 40*(2), 197-204.

Russell, J. C., Towns, D. R., & Clout, M. N. (2008). *Review of rat invasion biology: Implications for island biosecurity*. Wellington, NZ: Department of Conservation.

Sanctuaries of New Zealand. *Sanctuary projects*. Retrieved 13 May 2016, from http://www.sanctuariesnz.org/projects.asp

Seddon, P. J., Armstrong, D. P., Parker, K. A., & Ewen, J. G. (2012). Summary. In J. G. Ewen, D. P. Armstrong, K. A. Parker, & P. J. Seddon (Eds.), *Reintroduction biology: Integrating science and management* (pp. 476-481). Chichester, UK: John Wiley & Sons.

Seddon, P. J., Maartin Strauss, W., & Innes, J. (2012). Animal translocations: What are they and why do we do them? In J. G. Ewen, D. P. Armstrong, K. A. Parker, & P. J. Seddon (Eds.), *Reintroduction biology: Integrating science and management* (pp. 1-32). Chichester, UK: John Wiley & Sons.

Sinclair, S., & Rockwell, G. (2016). *Voyant tools*. Retrieved 03 May 2016, from http://docs.voyant-tools.org/

Society for Ecological Restoration Australasia. (2016). *National standards for the practice of ecological restoration in Australia*. Retrieved 4 May 2016, from http://www.seraustralasia.com/standards/contents.html

Society for Ecological Restoration International Science and Policy Working Group. (2004). *The SER primer on international ecological restoration*. Tucson: Society for Ecological Restoration International.

State Services Commission. (2014). *Performance improvement framework: Review of the Department of Conservation (DOC)*. Wellington, NZ: New Zealand Government.

Statistics New Zealand. (2015). *Subnational population estimates: At 30 June 2015 (provisional)*. Retrieved 21 June 2016, from http://www.stats.govt.nz

Stephens, T., Brown, D., & Thornley, N. (2002). *Measuring conservation achievement: Concepts and their application over the Twizel area. Science for Conservation 200.* Wellington, NZ: Department of Conservation.

Suding, K. N. (2011). Toward an era of restoration in ecology: Successes, failures, and opportunities ahead. *Annual Review of Ecology, Evolution, and Systematics, 42*(1), 465-487. https://doi.org/10.1146/annurev-ecolsys-102710-145115

Sullivan, B. L., Wood, C. L., Iliff, M. J., Bonney, R. E., Fink, D., & Kelling, S. (2009). eBird: A citizen-based bird observation network in the biological sciences. *Biological Conservation, 142*(10), 2282-2292.

Sutherland, W. J., Pullin, A. S., Dolman, P. M., & Knight, T. M. (2004). The need for evidence-based conservation. *Trends in Ecology and Evolution, 19*(6), 305-308. https://doi.org/https://doi.org/10.1016/j.tree.2004.03.018

Taranaki Regional Council. (2012). *The Taranaki Biodiversity Forum Accord: A community response to protecting native plants, animals and habitats*. New Plymouth: Taranaki Regional Council.

Thomas, D. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*, 237-246.

Towns, D. (2023). *Ahuahu: A conservation journey in Aotearoa New Zealand*. Christchurch: Canterbury University Press.

Towns, D. R. (2011). Eradications of vertebrate pests from islands around New Zealand: What have we delivered and what have we learned? In C. R. Veitch, M. N. Clout, & D. R. Towns (Eds.), *Island invasives: Eradication and management* (pp. 364-371). Gland, Switzerland and Cambridge, UK: IUCN.

Towns, D. R., Aguirre-Muñoz, A., Kress, S. W., Hodum, P. J., Burbidge, A. A., & Saunders, A. (2011). The social dimension – public involvement in seabird island restoration. In C. P. H. Mulder, W. B. Anderson, D. R. Towns, & P. J. Bellingham (Eds.), *Seabird islands: Ecology, invasion, and restoration* (pp. 358-392). Oxford, UK: Oxford University Press.

Towns, D. R., Byrd, G. V., Jones, H. P., Rauzon, M. J., Russell, J. C., & Wilcox, C. (2011). Impacts of introduced predators on seabirds. In C. P. H. Mulder, W. B. Anderson, D. R. Towns, & P. J. Bellingham (Eds.), *Seabird islands: Ecology, invasions, and restoration* (pp. 56-90). Oxford, UK: Oxford University Press.

Towns, D. R., West, C. J., & Broome, K. G. (2013). Purposes, outcomes and challenges of eradicating invasive mammals from New Zealand islands: An historical perspective. *Wildlife Research, 40*(2), 94-107.

Towns, D. R., Wright, E. F., & Stephens, T. (2009). Systematic measurement of effectiveness for conservation of biodiversity on New Zealand islands. In B. D. Clarkson, P. Kurian, T. Nachowitz, & H. Rennie (Eds.), *Proceedings of the Conserv-Vision Conference, University of Waikato, 2-4 July 2007* (pp. 1-22). Hamilton, NZ: The University of Waikato.

Waitao-Kaiate Environmental Group. Retrieved 3 May 2016, from http://www.landcare.org.nz/Landcare-Community/Waitao-Kaiate-Environmental-Group

Waldron, A., Mooers, A. O., Miller, D. C., Nibbelink, N., Redding, D., Kuhn, T. S., . . . Gittleman, J. L. (2013). Targeting global conservation funding to limit immediate biodiversity declines. *Proceedings of the National Academy of Sciences, 110*(29), 12144-12148. https://doi.org/10.1073/pnas.1221370110

Weng, Y. (2015). Contrasting visions of science in ecological restoration: expert-lay dynamics between professional practitioners and volunteers. *Geoforum, 65*, 134-145.

Whakaangi Landcare Trust. Retrieved 3 May 2016, from http://whakaangi.kiwi/

Wilson, C. (2005). *Developing effective partnerships between the Department of Conservation and community groups. Science for Conservation 248.* Wellington: Department of Conservation.

Wortley, L., Hero, J.-M., & Howes, M. (2013). Evaluating ecological restoration success: A review of the literature. *Restoration Ecology, 21*(5), 537-543. https://doi.org/10.1111/rec.12028

Young, T. P. (2000). Restoration ecology and conservation biology. *Biological Conservation, 92*(1), 73-83. https://doi.org/10.1016/S0006-3207(99)00057-9

Zedler, J. B. (2007). Success: An unclear, subjective descriptor of restoration outcomes. *Ecological Restoration, 25*(3), 162-168. https://doi.org/10.3368/er.25.3.162

Chapter 3

Ecological restoration success from agency and community perspectives[1]

> *Land restoration is the acid test of our ecological understanding.*
> (A. D. Bradshaw, 1984; in Egan, 2001, p. 205)

3.1 Introduction

Since its origins in the 1980s, ecological restoration has become an integral part of conservation efforts worldwide, with projects actioned by government, community and private stakeholders (Bramston, Pretty, & Zammit, 2011; Miles, Sullivan, & Kuo, 1998). These burgeoning initiatives have led to ecological restoration being recognized as a prominent component of long-term global sustainability (Aronson & Alexander, 2013; Higgs et al., 2018), and declaration by the United Nations (UN) General Assembly that 2021–2030 be the "UN Decade of Ecosystem Restoration".

Many ecological restoration projects are already held to be successful, with global organisations, research institutions, government and non-government organisations

1 This chapter has been published as:

Galbraith, M., Towns, D. R., Bollard-Breen, B., & MacDonald, E. A. (2021). Ecological restoration success from community and agency perspectives–exploring the differences. *Restoration Ecology*, e13405.

commonly providing examples of ‘successful’ restoration projects (e.g., Keenleyside, Dudley, Cairns, Hall, & Stolton, 2012; Lefkowitz, 2016; Society for Ecological Restoration Australasia, 2011; U.S. Department of the Interior, n.d.; Unity College Distance Education, 2017). Nonetheless, there has been debate over what constitutes ‘success’ in the context of ecological restoration (Clewell & Rieger, 1997; Palmer, Allan, Meyer, & Bernhardt, 2007; Suding, 2011; Wortley, Hero, & Howes, 2013; Zedler, 2007). The wide use of ‘success’ (and other value-laden terms, for example ‘desirable’, ‘degraded’ and ‘intact’) to describe restoration outcomes is criticized (Clewell & Rieger, 1997; Suding, 2011; Zedler, 2007) because, when used in conjunction with ecological terms, ‘success’ generates confusion if the criteria determining such a status are not defined. Confusion around success can lead to subjective assertions about outcomes of restoration efforts, with consequent loss of support through weak accountability, low outcome visibility and undervalued benefits (Stephens, Brown, & Thornley, 2002). This situation is compounded where projects lack predetermined criteria for success (Galbraith et al., 2016), and thus fail to monitor appropriate outcomes.

Widely accessible tools are available to practitioners to assess ecological restoration success. However, despite a diversity of indicators and methods, a lack of information on restoration success is still evident (Evju, Hagen, Kyrkjeeide, & Köhler, 2020; Willis, 2017). This state may be the result of differing approaches used to develop the tools. For example, The International Union for Conservation of Nature (IUCN) guidelines (Keenleyside et al., 2012) follow a principles-based approach, providing a framework for ecological restoration with aspirational goals based on three underlying principles deemed necessary to achieve success: effectiveness, efficiency, engagement. Although ecological principles form an underlying basis of the guidelines, the intention is to provide a flexible overview of restoration options and best practice rather than precise mechanisms for measuring success. The Society for Ecological Restoration (SER) guidelines (Gann et al., 2019), however, follow a standards-based approach, giving rigid and precise prescriptive measures to asses restoration actions. These standards are based explicitly on the ecological science that underpins restoration, and are intended to provide universal ecological measures for agency and community-based practitioners to evaluate restoration progress. Given that the distinction between principles and standards may be ‘blurred’ (Higgs et al., 2018), the tools resulting from such different approaches may be disparate and non-universal, thereby contributing to confusion over measures of restoration success.

The emergence of ecological restoration as a component of biodiversity conservation has been accompanied by a global growth of community-based voluntary participation in restoration activities (Clewell & Aronson, 2006). In Aotearoa New Zealand (hereafter New

Zealand), ecological restoration stakeholders typically collaborate within a dichotomous structure – governing stakeholders (agencies) and community-based avocational volunteers. Community-based New Zealand restoration projects are estimated to number around 4000 (Butler, Lindsay, & Hunt, 2014), and public involvement in restoration is expanding (Innes et al., 2019; Willis, 2017). This involvement is actively encouraged by government agencies, with legislative obligations for biodiversity management being met increasingly through engagement with local communities (e.g., Auckland Council, 2012; Department of Conservation [DOC], 2016a). The relationship between these stakeholders is not independent as in most projects all stakeholders will have interrelated and vested interests in the restoration outcomes. Nevertheless, the two entities are likely to demonstrate differences in expectations given that avocational practitioners experience restoration quite differently to professionals.

The contribution by avocationals is predominantly at the 'hands-on' level, and potentially motivated by principles and values more than by ecological science. Higgs (2003) coined this participation as "focal restoration", where restoration occurs through community engagement operating within a local social and cultural context. This mobilisation of community-based stakeholders has introduced a social dimension to the global restoration movement, largely unacknowledged in current restoration success criteria. For local communities, rather than being solely ecologically based, restoration aims may include social outcomes (Galbraith et al., 2016). Proclamations by volunteers of the success of their projects are then announced anecdotally through non-refereed publications, websites and blogs. Such informal claims could further confuse what constitutes ecological restoration success.

The growth of the social dimension has highlighted the need to integrate ecological science and the diversity of human aspects of ecological restoration (e.g., Egan, Hjerpe, & Abrams, 2011; Higgs, 2003). Ecological restoration is an intentional human practice, thus takes place within diverse, complex and value-laden social contexts. A dichotomy of perspectives and approaches may arise where these social contexts may be at odds with ecological science, particularly where a legislative overview of the practice is professionalized, for instance, where science and technology dominate restoration practice ("technological restoration", Higgs, 2003).

Martin (2017) suggests the definition of ecological restoration should now include attributes reflecting the ecological/sociological duality of the restoration process. For this to be adopted, the consequences of direct involvement of the public in the management of ecological restoration projects need to be better understood, and, in particular, how to quantify the outcomes of community-based participation (Handford, 2011; Towns, Bellingham, Mulder, & Lyver, 2012). This understanding has application worldwide, where ecological restoration

projects have potential to integrate the collective visions of environmental stakeholders (e.g., government, indigenous people, local communities, institutions) into a common, shared ecological future (Egan et al., 2011).

In this socio-ecological study, I sought the views of restoration practitioners from governing agencies and community-based projects to examine the relationship between restoration ecology (the science) and ecological restoration (practitioners' actions). Surveys and interviews were used to explore whether the actions of communities involved in ecological restoration projects were consistent with measures and expectations of restoration success identified by ecological science. Specifically, I asked respondents:

1. Do you consider your project to be successful?
2. What attributes are used to determine restoration success?
3. What measures are used in monitoring the attributes?

3.2 Methods

Surveys of two groups, 1) government agency, and, 2) community-based practitioners, were undertaken to ascertain their perspectives on ecological restoration success, and how success was measured or identified. An initial anonymous survey was conducted online using Qualtrics© software, followed by a small number of semi-structured interviews.

For the online survey, respondents were provided with a direct URL link to a web-based survey held on an off-site server operated by Qualtrics©. The questionnaires to the two groups had common themes, but wording styles differed and there were questions specific to each group (Supplements S.1 & S.2, Appendix A). Questions relating to restoration success were open-ended, requiring descriptive responses.

Semi-structured interviews were conducted as an elicitation tool (Gill, Stewart, Treasure, & Chadwick, 2008; Johnson & Weller, 2001) to explore respondents' interpretations of responses to the online survey in the context of their experiences in restoration (Supplement S.3, Appendix A). Recruitment protocols for the interviews were as for the online survey, but limited to one person per interview. Interviewees may, or may not, have participated in the online survey. Potential participants who responded to the interview invitation were provided with an information sheet and a consent form. The interviews were carried out in person or electronically depending on the participants' preference and geographical location.

The survey and interviews were approved by the Auckland University of Technology Ethics Committee (Ref. number 17/167), and validated through steps recommended by Creswell and Miller (2000): triangulation, peer review, and debriefing. A participant information sheet was developed to address potential personal and cultural sensitivities, and to ensure informed consent (Supplement S.4, Appendix A).

The term 'native biodiversity' is used to encompass species that are endemic and those that have established naturally. By comparison, many introduced non-native species have an ecological and economic impact, and are referred to as invasive species (Lockwood, Hoopes, & Marchetti, 2013).

3.2.1 Survey participants

Selection of participants was limited geographically to the northern half of the North Island, where 50% of New Zealand's population, and hence community-based restoration projects, are concentrated (Peters, Hamilton, & Eames, 2015; Stats NZ, 2020). This geographic area covered the regions of Northland, Auckland, Bay of Plenty and Waikato (Fig. 3.1). A further consideration of the geographic limitation was in anticipation of the interview logistics. All participants were over 16 years of age.

For the online and interview surveys, participants were targeted through purposive selection (Tongco, 2007). Purposive selection was considered appropriate as this study aimed to determine the knowledge and views of particular people (i.e., restoration stakeholders) with a specific interest (in this case, ecological restoration) (Onwuegbuzie & Leech, 2007; Palys, 2008), and had the advantage of accessing a large number of focussed participants from a wide geographical area (Wimmer & Dominick, 2011; Wright, 2005). Potential participants were employees of a government environmental management agency or voluntary participants in community-based restoration projects. The initial contact with potential participants was made directly by email to agency managers or community-group officers identified through organisation websites. This communication provided potential participants with the research background, and a request to distribute the survey invitation throughout stakeholder networks to initiate snowball sampling (Atkinson & Flint, 2001).

In addition, I considered how the experiences of participants in long-running projects might differ from those of other participants given that evaluating restoration is considered to become harder over time (Halle, 2007; Hughes et al., 2011). For this comparison, responses from practitioners associated with Tiritiri Matangi Island (Fig. 3.1) were analysed separately to other community-based responses. Tiritiri Matangi Island is one of the longest running community-based ecological restoration projects in New Zealand (since 1984; Galbraith &

Cooper, 2013), with volunteer participants organized into a stewardship group, Supporters of Tiritiri Matangi (SoTM), established in 1988 (Galbraith & Hayson, 1994).

3.2.2 Data analysis

The online survey data was imported to MS Excel for comparisons between: community group and agency respondents; and, respondents associated with a long-established restoration project and younger restoration projects. Responses to the open-ended questions were analyzed thematically, with emerging themes categorized into flat coding frames. The measures respondents identified as determinants of project success or progress were coded into 10 attributes. Five ecological attributes of success or progress were identified from literature (Table 3.1, attributes 1–5). This list, however, was refined during the analysis of the survey responses, following a directed content analysis approach (Hsieh & Shannon, 2005) where recurring attributes identified by the respondents (in the "others" category) were coded and added to the list (Table 3.1, attributes 6–10). This analysis approach had the advantage that key concepts established from a theoretical framework were subsequently validated and extended conceptually through the coding process (Potter & Levine-Donnerstein, 1999). A content analysis strategy was also used to code field activities, identified by the respondents as metrics of success, into operational measures.

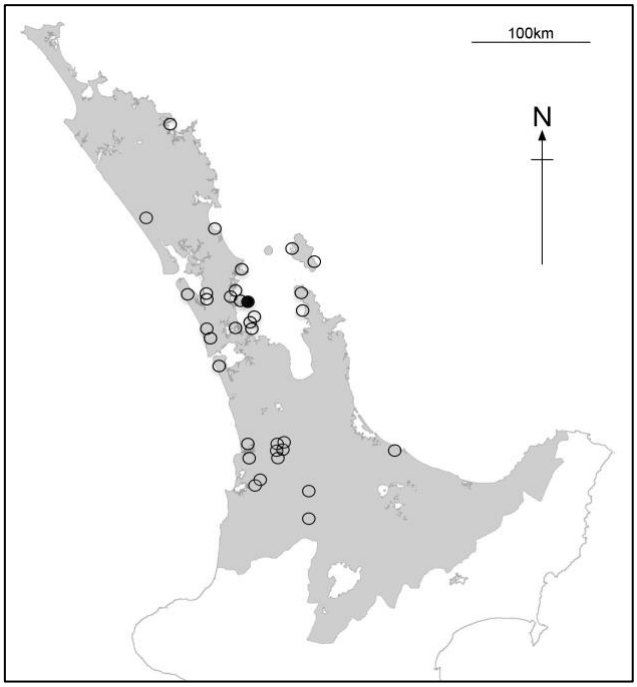


Figure 3.1 – Geographical region (North Island, New Zealand) covered in the survey of government agency and community-based practitioner perspectives on ecological restoration success (shaded area). Approximate location of projects represented by the community group respondents is shown (open circles), along with the location of the Tiritiri Matangi Island project (filled circle).

Table 3.1 – Attributes and measures reported by respondents to determine restoration success of a restoration project.

Attributes of restoration success	Attribute measures	Literature supporting attribute inclusion
Native biodiversity enhanced	Biodiversity improved in some way (e.g., native vegetation cover increased; native invertebrate, reptile and bird species increased; evidence of recolonization by native species).	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Invasive and/or exotic species managed	Reduced spread and dominance of exotic species (e.g., invasive plants & animals are controlled or eradicated; invasion mitigation procedures in place).	1, 2, 3, 4, 5, 6, 7, 8, 10
Species declines/extinctions prevented	Native species managed in order to prevent local extinctions and declines (e.g., threatened species managed; threatened species self-sustaining; project performs a refugium function; native species 'exported' to other projects).	1, 2, 3, 5, 6, 7, 8, 10
Ecosystem condition improved	Maintaining ecosystem processes (e.g., natural nutrient input and cycling; species diversity and functional groups; self-sustaining populations; species gaps addressed; independence from external influences).	1, 2, 3, 4, 5, 6, 7, 8, 10
Ecosystem linked to wider ecological matrix	Ecosystems integrated into a larger ecological matrix, (e.g., evidence of external abiotic and biotic interactions).	2, 3, 4, 5, 8, 10
Community participation and/or visits increased	People associated with the project (volunteers) and/or visitors (including those with educational purpose) increase yearly.	1, 3, 5, 7, 8
Monitoring and research in place	Long-term monitoring of ecosystems is established; research undertaken through educational institutions and by agency professionals.	1, 5, 8
Credibility from advocacy and communications	Credibility gain through positive messages in national, international and social media, and anecdotal accolades.	1, 3, 5, 8
Other projects inspired	Status and progress leads to the establishment and/or support of restoration projects elsewhere.	8
Financial support gained	Additional financial support facilitated through recognizing project outcomes.	3, 8

Note. Literature supporting attribute inclusion: (1) Atkinson (1994); (2) SER (2004); (3) Lee, McGlone, and Wright (2005); (4) Ruiz-Jaén and Aide (2005); (5) Parks Canada (2008); (6) Towns, Wright, and Stephens (2009); (7) Lee and Allen (2011); (8) Keenleyside et al. (2012); (9) Suganuma and Durigan (2015); (10) McDonald, Gann, Jonson, and Dixon (2016).

To examine differences in the frequency of the responses across groups, the 'N-1' chi-squared test (Campbell, 2007) and two-sample (or two-proportions) Z-test (Healey, 2014) were used for small and large sized samples respectively. The analysis of interviews followed a thematic analysis approach (Hogan, Hinrichs, & Hornecker, 2016) where patterns (themes) of responses were identified and applied to the interpretation of the survey results.

3.2.3 Researcher position

As a restoration practitioner associated with ecological restoration projects since the early 1980s, I approached this study, at least partly, as an embedded researcher. Embeddedness is considered to enable the researcher to respond to informers' needs and expectations, while allowing the simultaneous withdrawal and reflection at a distance (Lewis & Russell, 2011). The expected benefits of this embeddedness include content credibility and relevance, ease of building relationships with informers, increased reflexivity and examination of biases, and reducing the gap between actual events and the studied experiences (Barniskis, 2013; Marshall et al., 2014).

The disadvantages of embedded research are acknowledged, for example, conflict arising from role duality, objectivity clouded through familiarity with situations, assumptions made about events and participant views without seeking clarification (Smyth & Holian, 2008; Unluer, 2012). Potential limitations of validity resulting from such disadvantages were addressed through following procedures suggested by authors in this field (e.g., Rooney, 2005; Smyth & Holian, 2008; Unluer, 2012): participants were informed of the embedded researcher's background, highlighting role duality, participants' assumptions were clarified during interviews, an overview from an external academic supervisor was in place.

3.3 Results

3.3.1 Survey respondents

Invitations to initiate snowball sampling using the online survey were sent to 32 community groups and 18 agency offices. Although with snowball sampling the size of the overall population being sampled is unknown (Morgan, 2008), based on our knowledge of membership of agencies and the larger community groups the potential respondent pool was at least 2000.

There were 142 responses to the online survey, of which 119 completed the community survey, and 23 the agency version. The key demographic information of the survey

respondents is shown in Table 3.2. Respondents represented 13 community groups and four agency offices. Agency respondents were employees of central and regional government authorities. Their locations were not recorded as this information may have compromised their anonymity. Eleven respondents accepted the interview invitation.

Table 3.2 – Key demographic information of the respondents to a survey of government agency and community-based practitioner perspectives on ecological restoration success in northern Aotearoa New Zealand.

Demographic metric	Categories	Proportion of respondents (%)	
		Community (n = 94)	Agency (n = 23)
Age	Under 18 years old	1.1	0
	18–29 years old	1.1	6.7
	30–49 years old	14.9	53.3
	50–64 years old	40.4	40
	65 years or over	42.6	0
Employment status	Employed, working full-time	23.7	100
	Employed, working part-time	28	n/a
	Not employed	4.4	n/a
	Student	3.2	n/a
	Retired	40.9	n/a
Education status	No formal qualification	1.1	0
	School qualification	8.5	0
	National/trade certificate or equivalent	6.4	6.7
	Partially completed degree or diploma	6.4	6.7
	Undergraduate degree or diploma	29.8	20
	Postgraduate qualification	41.5	66.7
	Qualification grounded in ecology	30.4	73.3
Declined demographic questions		4.1	6.7

Forty-three different restoration projects were cited in the survey, with some respondents indicating an association with more than one project. Most of the projects were geographically localized (e.g., island or municipal reserve) on public land administered by a government agency (67%). Other projects were categorized as initiatives of private or non-governmental groups (22%), iwi (indigenous Māori tribal groups, Moorfield, 2011; 11%), associated with a tertiary institution (6%), or having no affiliation (2%). The location of the projects identified by the respondents is shown in Figure 3.1.

For most community respondents (78%) their participation in restoration was through a community collective in partnership with a single agency. The remaining respondents were associated with projects at a broader landscape scale, typically involving multiple community and agency stakeholders (e.g., government agencies, community groups, private land owners). Most community group respondents (70%) identified their role as a "volunteer", those who recorded "other" were those with multiple roles in their respective projects. A significant proportion of community respondents had tertiary qualifications (77%; $P < 0.001$, 2 sample z-test); of these, 30% indicated their degree had a background in ecology.

Fifty-six of the community group respondents indicated an association with the Tiritiri Matangi Island project. Although this represents a large proportion of the respondents, many of the Tiritiri Matangi sub-group also indicated an association with other projects. Overall, 63% of the community group respondents were associated with projects other than Tiritiri Matangi, thus providing a range of experience that I consider representative of ecological restoration in northern New Zealand. I consider that this range of associations also minimized a potential skew of respondents who knew the embedded researcher.

The demographics of the respondents are generally comparable with those of other New Zealand studies of restoration communities (e.g., Cowie, 2010; Peters et al., 2015). Although the age bias may be a result of older people being more willing to respond to surveys (Gigliotti & Dietsch, 2014), this age range also reflects an older volunteer base in communities in general, and is consistent with other studies of community participation in ecological activities (Langenfeld, 2009; Mohan & Bulloch, 2012; Wilson, 2001). The survey age range, however, is unlikely to have biased our study's results as Braun and Shoeb (2011) showed people in all age brackets supported the concept of 'rehabilitation' (i.e., restoration), and those in the age bracket 40–65 were the strongest supporters of the restoration scheme surveyed, and also the best informed.

3.3.2 Restoration success responses

Most (98%) community group respondents considered their ecological restoration projects to be successful, with 96% indicating that their projects were monitored for success. All agency respondents identified their restoration projects to be monitored for success (to meet the goals of the New Zealand Biodiversity Strategy 2000).

Although all respondents identified enhanced diversity of native species as the foremost attribute of restoration success (Fig. 3.2), there were differences between agencies and community groups in the frequency of the other attributes used. Those identified by agency respondents were almost exclusively ecological attributes (Table 3.1, attributes 1–5), with the single exception being community participation (2%). The range of attributes used by community respondents (and added to the attribute list through directed content analysis) was wider, including socially-based attributes (Table 3.1, attributes 6–10), with ecological attributes other than enhanced native biodiversity used less frequently.

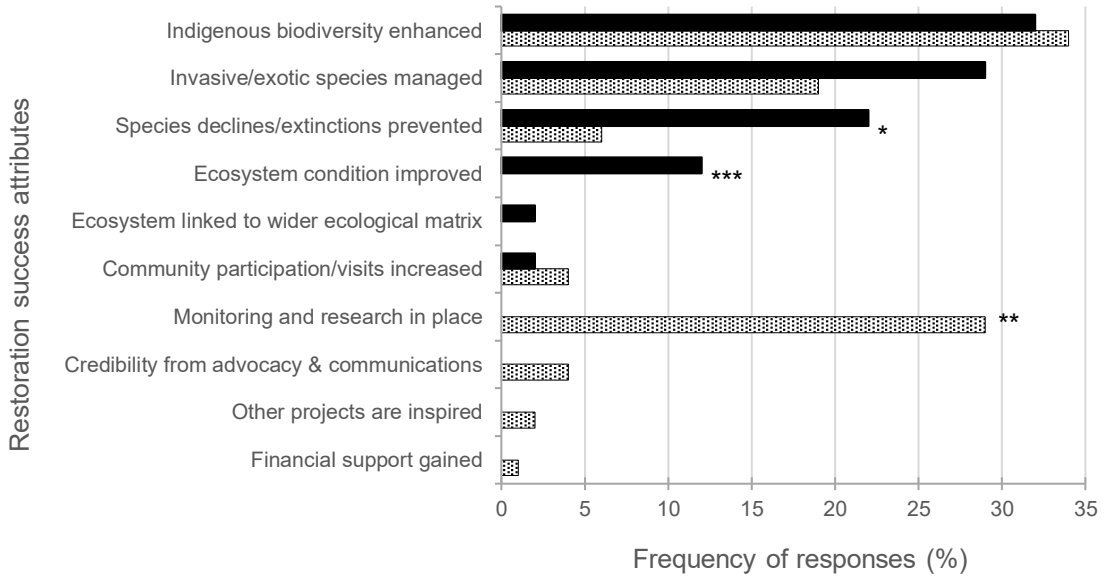


Figure 3.2 – Attributes identified by agencies to determine restoration success compared to those of community restoration participants, from an online survey of practitioners in northern New Zealand. Agencies are shown in black (n = 23) and community respondents are shaded (n = 119). Significant results are indicated by asterisks: *p < 0.05; **p < 0.01; ***p < 0.001 ('N-1' chi-squared test).

The differences between agencies and community groups in the nature and frequency of attributes used to determine restoration success was explored in the interviews (Table 3.3). Despite agencies claiming to work at a systems level, community group interviewees interpreted the agencies' scientific approach to restoration as being "narrow". The interviewees identified agency structures as a reason for this interpretation, in particular the existence of specialized work units, with staff roles associated with specific restoration projects and/or activities rather than landscape-level overviews.

Community group interviewees attributed the difference between community and agency approaches as the result of community participants having a holistic approach to projects. Agency interviewees did acknowledge the potential for community practitioners to perceive agencies' approaches to ecological restoration were narrow, but identified agency structure, rather than philosophical differences, as the origin of such perceptions.

The actual field activities identified by community group respondents being used to measure the restoration success attributes were coded into seven categories (Fig. 3.3). Although monitoring of a range of taxa was represented in the activities, three species-based measures dominated: invasive species, birds, and vegetation. One agency interviewee described the eradication focus by community groups as being *"on a mission"* (Interview 9). There was one social measurement, that of the number of public and educational visits to the project.

All respondents associated with the long-established restoration project, Tiritiri Matangi Island, considered the overall project successful. As with community group respondents as a whole, the leading attributes identified by the respondents associated with Tiritiri Matangi were enhanced native biodiversity and existence of monitoring and research (Fig. 3.4). Two attributes where the long-term project respondents differed significantly to other community respondents in the perception of success were management of invasive/exotic species, and credibility from advocacy and communications. Interviewees attributed these differences to be related to the initial restoration focus and milestones reached throughout the project's progression, and the advocacy roles undertaken by project participants (Table 3.4).

Table 3.3 – Responses of participants in the semi-structured interviews to questions identified from the analysis of the online survey of restoration practitioners' perspectives in northern Aotearoa New Zealand.

Response group and survey outcome being explored	**Comments**
Response by community group interviewees to agency approaches to ecological restoration being dominated by systems-level ecological attributes	*"[Community] groups have a holistic approach, but need to work with specialist agency groups."* (Interview 1) *"Community group objective is to restore overall ecological processes, and management of only one part will lead to imbalance."* (Interview 2) *"Community groups are more passionate, so they have wider perspective."* (Interview 4)
Response by agency interviewees to the assertion by community practitioners that agencies had a narrow approach to ecological restoration	*"Volunteers are focused in their patch, they see all, and are interactive [with whole project]. Volunteers are multifunctional."* (Interview 5) *"Volunteers are broader thinking because they are not motivated for pay."* (Interview 7) *"Agencies have split roles ... outward and holistic, advisory role;... inward, legislative role."* (Interview 10) *"Holistic views are not related to accountability of teams to management*." (Interview 11) "*Agencies have multiple operating areas, but teams have boundaries."* (Interview 11) *"Regardless of how desirable a shift by restoration teams to a broader landscape scale is, agencies are constrained by finances."* (Interview 10)
Response by community group interviewees to agency structure resulting in a narrow approach to ecological restoration	*"Agency staff operated in silos."* (Interview 8) *"Staff were reluctant to engage in areas constituting someone else's job."* (Interview 5)
Response by community group interviewees to the importance of including social attributes for determining restoration success	*"Social side is a strong driver."* (Interview 7) *"Social side important, should be fostered ... some participants have their own Facebook page."* (Interview 8)

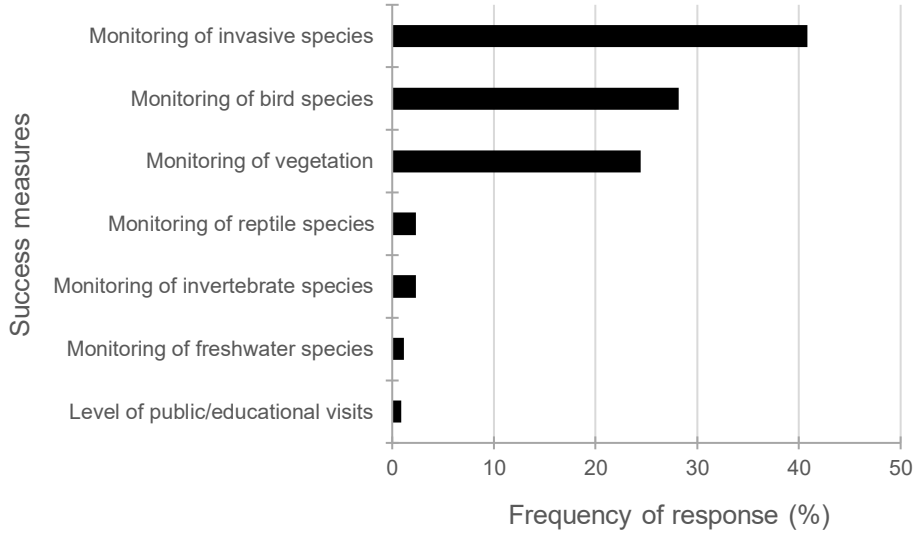


Figure 3.3 – Field measures identified by community group respondents for determining success or progress of restoration projects, from an online survey of restoration practitioners' perspectives in northern New Zealand. There were 348 measures from 119 respondents.

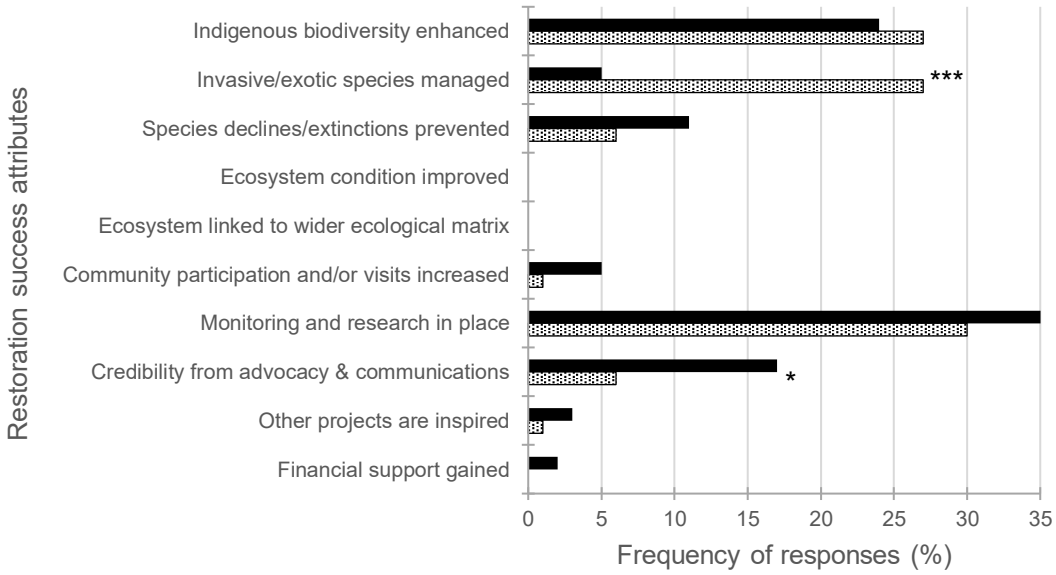


Figure 3.4 – Attributes of restoration success identified by respondents associated with the Tiritiri Matangi project in comparison to respondents associated with other community groups, in an online survey of restoration practitioners' perspectives in northern New Zealand. The Tiritiri Matangi project is shown in black (n = 56) and other community groups are shaded (n = 63). Significant results are indicated by asterisks: *p < 0.05; ***p < 0.001 (two-sample Z-test).

Although eradicating or reducing pest species is a key driver for restoration in New Zealand (Clout, 2001), the importance of this attribute was lower for the Tiritiri Matangi respondents than for those associated with other projects. A Tiritiri Matangi interviewee suggested the early activities of revegetation and invasive species control were routine 'baseline' restoration events, and thus perceived as less relevant to the current pest-free status of the project.

SoTM members play an important role in conservation advocacy through direct communication with visiting public, mainly through formal guided ecotours. Interviewees viewed these interactions, and the positive conservation messages visitors departed with, as the reason for advocacy and communications being identified as an attribute of restoration success. Another of the SoTM advocacy tools is a quarterly magazine, *Dawn Chorus*, a professionally published magazine keeping project stakeholders current with restoration activities. One interviewee believed that this publication alone played a central role in determining the island's success.

Respondents associated with Tiritiri Matangi (and other island projects in the Hauraki Gulf, Auckland) did not identify intact links to a wider ecological matrix as an attribute of success, despite the Hauraki Gulf being considered a global biodiversity hotspot for seabirds (Gaskin & Rayner, 2013). Interviewees explained the lack of a wider perspective of ecological links either as the result of a site-led terrestrial restoration focus from the project's start, or the lack of local knowledge.

3.4 Discussion

3.4.1 Perceptions of success

Restoration stakeholders across northern New Zealand consistently considered projects with which they were associated to be a success. Survey respondents from agencies and community-based projects were common in emphasizing enhanced biodiversity as an attribute to determine restoration success. This was not unexpected since ecological restoration philosophies are the result of universal aspirations to address environmental degradation (Society for Ecological Restoration, 2019) and is consistent with other studies of ecological restoration projects in New Zealand (Butler et al., 2014; Campbell-Hunt & Campbell-Hunt, 2013).

The attributes that management agencies identified as indicators of restoration success were comparable with the SER standards (Gann et al., 2019), grounded in ecological science and a systems approach. This systems overview was anticipated given the legislated obligation

of government agencies to fulfil ecological science outcomes (e.g., Cooke et al., 2018; Department of Conservation & Ministry for the Environment, 2000). However, a systems approach by agencies has direct consequences for public involved in restoration. Although the overarching goals of restoration projects in New Zealand invariably articulate the same ecological aspirations as agencies (Galbraith et al., 2016), community-based practitioners tend to have a species-focus of success with little or no account of the more complex ecological attributes. This absence of functional ecological attributes may reflect that, despite an understanding of ecological knowledge declared by some community respondents, complex elements of ecology were unfamiliar to avocational ecologists, perhaps even intangible, or, alternatively, that ecological science was embraced selectively.

Table 3.4 – Responses of participants associated with the long-running Tiritiri Matangi project to questions identified from the analysis of the online survey of restoration practitioners' perspectives in northern Aotearoa New Zealand.

Survey outcome being explored	Comments
Response to the comparatively low score for invasive species management as an attribute of restoration success	*"Tiritiri Matangi is ahead of other projects – baseline sorted, replaced by enrichment translocation."* (Interview 6)
Response to the comparatively high score of importance of advocacy and communication as an attribute of restoration success	*"People need success – communicable, 'story-telling', talked about."* (Interview 7) *"Feedback through word-of-mouth. ... credibility through Trip Advisor."* (Interview 8) *"Dawn Chorus contains a wide range of info, excellent advocacy and communication tool; paints a 'pretty picture' linking social outcomes and science. [It] reports biodiversity status ... engenders success."* (Interview 6) [*Dawn Chorus* is a quarterly magazine published by SoTM]
Response to the lack of recognition of links with a wider ecological matrix as an attribute of restoration success	*"Founding reasons ... terrestrial focus at [project] initiation."* (Interview 6) *"Volunteers identify with certain aspects, certain species [terrestrial emphasis]."* (Interview 7) *"Non-locals – don't know the bigger picture [of the Hauraki Gulf]."* (Interview 8)

An increasing dominance of science in ecological restoration has been suggested to be responsible for a 'two culture' situation (Higgs, 2005), where ecological science overwhelms societal contributions to restoration. Responses from community-based practitioners seems to confirm the persistence of a duality, though perhaps more a product of agency structures than differences in the attention to science, and potentially accentuated where environmental responsibilities are split within agencies (e.g., in New Zealand, biodiversity and biosecurity roles). Such duality is likely to be compounded where agencies have delegated their restoration obligations, including measurement of standards, to community groups. Here, there is potential for measures of restoration attributes across projects to vary, dependent on the complexity of the metrics, the resources allocated to obtaining the data, and the expertise available (Prach et al., 2019).

Whatever the nature of the experience, our results support other research showing that lay restoration practitioners prioritize restoration standards differently to ecological professionals (Galbraith et al., 2016; Weng, 2015). The universal perception held by community-based practitioners that their restoration projects are successful, regardless of the nature of the environmental gains or whether the project was in its initial stages or well established, may reflect their vested interest in the projects. But the importance volunteer practitioners place on the social aspects of community participation as criteria of ecological restoration emerged from the surveys and interviews as a key difference between community and agency practitioners. For many community participants, the social aspect of volunteering in a restoration project was just as important as any environmental imperative, an aspect consistent with other studies in New Zealand (e.g., Campbell-Hunt & Campbell-Hunt, 2013; Peters et al., 2015) and internationally (e.g., Bramston et al., 2011; Grese, Kaplan, Ryan, & Buxton, 2001; Miles, Sullivan, & Kuo, 2000).

3.4.2 Attributes of restoration success

Attributes of ecological restoration success identified by agency respondents included improvement of ecosystem structure and function, and minimization of stressors such as invasive species. Agency measures covered all three major ecosystem attributes identified by Ruiz-Jaén & Aide (diversity, vegetation structure, and ecological processes; 2005), and the attributes developed by the SER (Gann et al., 2019). The lower importance of ecological processes measures (i.e., improvement of ecosystem condition and links to a wider ecological matrix) is consistent with the findings of Ruiz-Jaén and Aide (2005) who suggested such attributes are rarely measured as they show slower recovery and thus require multiple measurements over extended periods of time. The non-ecological attribute of the level of community participation included by agency respondents in their measures of success can be explained by the growing trend of statutory agencies in New Zealand to

'harness' conservation volunteers as a means to encourage public ownership of environmental issues and to improve value-for-money conservation outcomes (Department of Conservation, 2016b). Measurement of community participation in projects allows agencies to assess their performance in terms of public engagement (e.g., Department of Conservation, 2018).

Three attributes dominated the criteria used by community group respondents for identifying restoration success or progress. These attributes were science-based (improving ecosystem composition, reducing exotic species) and process-based (existence of monitoring and research). The science-based attributes of ecosystem composition are relatively straight forward to measure (such as bird counts, surveys of vegetation plots), and tend to show quick responses to ecological change (Ruiz-Jaén & Aide, 2005). The predominance of such ecological measures in the responses is consistent with other analyses of restoration projects (Galbraith et al., 2016; Peters et al., 2015; Ruiz-Jaén & Aide, 2005). Control of exotic species, invasive mammals in particular, is invariably prioritized in New Zealand restoration projects (Galbraith et al., 2016), and often championed by community-based practitioners (hence the description *"on a mission"* by an agency interviewee). Nevertheless, evidence of management of exotics constitutes a further science-based measure of restoration success. These science-based attributes are, however, all species based.

The process-based measure suggests a perception within community groups that the existence of monitoring or research activities, regardless of what is being monitored or the quality of outputs (if any), are, in themselves, indicators of success. No metrics were placed against the activities other than their existence. Here, participants may see themselves as being outside of the science and, consequently, the application of ecological science by experts (agencies or trained volunteers) then becomes evidence of success. This is supported by studies on attitudes to science showing that, in general, public have confidence in science (e.g., Hipkins, Stockwell, Bolstad, & Baker, 2002; National Science Board, 2018). The identification of monitoring or research as attributes of restoration success, however, may indicate a lack of ecological literacy, indifference to the scientific basis and process, or simply the existence of a gap between ecological research and restoration practice acknowledged in other studies (Jarvis, Borrelle, Breen, & Towns, 2015). Furthermore, the participation of community-based practitioners in ecological science may be unintentional ('accidental scientists', Galbraith et al., 2016) rather than initiated by science, with participation in science a later restoration experience (Higgs, 2005). Thus, the mere involvement in science activities may elevate the perception of the status of research.

Other attributes of restoration success identified by community group respondents and added to the initial coding list of restoration success criteria through directed content analysis were those associated with social aspects of ecological restoration. These aspects tend to influence volunteer participants directly – communication, advocacy and funding. The identification of communication and advocacy as an attribute of restoration success is unsurprising given the demonstration that experiences in any human activity peaks when positive experiences are shared (Lambert et al., 2012).

3.4.3 Comparison between emerging and established restoration projects

The experiences of the volunteers participating in the Tiritiri Matangi project include revegetation, species conservation, biodiversity monitoring and invasive species management, with activities initiated increasingly by the community rather than the managing agency (Galbraith, 2013). This range of experiences is more comprehensive than those of participants in newer projects where the restoration focus is more likely to be dominated by revegetation and control of invasive species (Galbraith et al., 2016). The significantly higher rating of credibility from advocacy and communications as an attribute of success by respondents associated with Tiritiri Matangi may reflect the intentional outreach philosophy maintained by the group since its establishment (Craig et al., 1995; Galbraith, 2013), fostered by confidence gained from the restoration experiences.

As with community group respondents as a whole, respondents associated with Tiritiri Matangi scored the existence of monitoring and research highly as an attribute of success. This is easily explained for participants involved in Tiritiri Matangi as the project was *"born out of scientific research"* (Galbraith, Craig, Mitchell, & Cooper, 2013, p. 257), with a decade of research in place prior to the initiation of community-based restoration (Galbraith & Cooper, 2013). Research continues to have a high profile for the island, supported by community participants both logistically and financially.

The eradication in 1993 of the kiore/Pacific rat (*Rattus exulans*), the only invasive mammal species to establish on Tiritiri Matangi (Galbraith & Cooper, 2013), represented a major milestone for the project. In this situation, where invasive species have been eradicated, management of alien species may not be perceived as an ongoing measure of restoration success as the pest-free status represents the 'norm' for the project. This island situation is in contrast to eradications on mainland projects where the risk of reinvasions of alien species is likely to be greater (Innes et al., 2019), and thus persists as a threat to the restoration process. Attributes for which target milestones are reached and maintained may thus diminish as perceptions of success over time.

Although the lack of recognition of external ecological links was consistent across community-based respondents, the lack of recognition by the Tiritiri Matangi respondents was particularly interesting. Mainland restoration projects are commonly located within a hostile ecological matrix where links to ecosystems outside the project may not be perceived as important, or to exist at all. However, I did not expect this perception for island and coastal projects. In New Zealand, there is increasing advocacy promoting the keystone role seabirds play in transferring nutrients between marine and terrestrial environments (e.g., Auckland Council, 2018). Participants in island and coastal restoration projects will inevitably encounter seabirds, and may even participate in seabird re-establishment activities (Gaskin & Rayner, 2013). Seabirds represent links to the wider marine environment around islands, but the link has yet to be made by most participants in the Tiritiri Matangi project. The failure to recognize external ecological links may represent a focus on the project's habitats, in this case all terrestrial, or restricting consideration of ecological concepts to those pertinent at the time.

Differences in levels of importance of other criteria as attributes of success further suggest a trend towards differences of perception of restoration success between participants associated with projects of differing maturity. Hughes et al. (2011) state that many ecological restoration projects are, to some extent, 'open-ended' as ecological trajectories are uncertain rather than targeting specific ecosystems and species restoration, making prescriptive measures of success ineffective. This may be the case for long-running projects in New Zealand where perceptions held by community-based practitioners may shift as ecological milestones are achieved. Over time, such shifts may trend towards the collaborative participation aspirations advocated in the IUCN guidelines, and ultimately result in social measures of restoration success being valued on a basis equal to complex ecological attributes.

3.4.4 Looking ahead

Our findings are consistent with other studies (Galbraith et al., 2016; Weng, 2015) where avocational participants in ecological restoration are shown to conceptualize restoration differently to ecological professionals. This conceptualization will be influenced by the contrasting technological and focal approaches to restoration identified by Higgs (2005). However, I do not think contrasting perspectives will necessarily lead to tensions, conflicts and challenges between agency professionals and community-based participants as suggested by Weng (2015) given their aspirations for common ecological outcomes. Different perceptions of restoration success, however, will invariably influence how success is measured.

The SER restoration standards are intended to provide a universal tool for all practitioners. However, these standards are grounded in biophysical principles, with limited consideration of social principles. Consequently, existing standards are mainly applicable to restoration professionals. Given the growth of community-based ecological restoration projects, restoration standards now need to include attributes that reflect the strong social elements reported by avocational practitioners. This inclusion would be compatible with the underlying social principles of the IUCN restoration guidelines, and would support the 'principles first' approach advocated by Higgs et al. (2018). These attributes, and the measures used to quantify them, will vary from project to project, and may be best determined locally through mutual agreement by the stakeholders involved. I support the call (Higgs et al., 2018; Martin, 2017; Martin & Lyons, 2018; Waltham et al., 2020) for a standardized framework of restoration success that is sufficiently flexible and robust to reflect the scientific and social duality of restoration, and still meet the needs of the immense range of ecological restoration contexts across variable scales. Such a framework will be imperative to meet the needs of the explicitly people-centred aspirations of the UN Decade of Ecosystem Restoration.

References

Aronson, J., & Alexander, S. (2013). Ecosystem restoration is now a global priority: Time to roll up our sleeves. *Restoration Ecology, 21*(3), 293-296. https://doi.org/10.1111/rec.12011

Atkinson, I. A. E. (1994). *Guidelines to the development and monitoring of ecological restoration programmes*. Wellington: Department of Conservation.

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. *Social Research Update, 33*.

Auckland Council. (2012). *Environmental strategy and policy: Auckland Council's indigenous biodiversity strategy*. Auckland: Auckland Council.

Auckland Council. (2018). *Auckland's seabird hotspots*. Retrieved 30 August 2019, from https://ourauckland.aucklandcouncil.govt.nz/articles/news/2018/1/aucklands-seabird-hotspots/

Barniskis, S. C. (2013). Embedded, participatory research: Creating a grounded theory with teenagers. *Evidence Based Library and Information Practice, 8*(1), 47-58. https://doi.org/10.18438/b8hk6j

Bradshaw, A. D. (1984). *University of Wisconsin – Madison Arboretum.* Symposium conducted at the meeting of the Restoration ecology symposuim, Madison, WI.

Bramston, P., Pretty, G., & Zammit, C. (2011). Assessing environmental stewardship motivation. *Environment and Behavior, 43*(6), 776-788.

Braun, B., & Shoeb, A. (2011). Ecological rehabilitation and public participation: General considerations and empirical evidence from a creek rehabilitation scheme near Cologne, Germany. *Journal of Life and Earth Science, 6*, 1-11. https://doi.org/https://doi.org/10.3329/jles.v6i0.9714

Butler, D., Lindsay, T., & Hunt, J. (2014). *Paradise saved: The remarkable story of New Zealand's wildlife sanctuaries and how they are stemming the tide of extinction*. Auckland, NZ: Random House.

Campbell, I. (2007). Chi-squared and Fisher–Irwin tests of two-by-two tables with small sample recommendations. *Statistics in Medicine, 26*(19), 3661-3675. https://doi.org/10.1002/sim.2832

Campbell-Hunt, D., & Campbell-Hunt, C. (2013). *Ecosanctuaries: Communities building a future for New Zealand's threatened ecologies*. Dunedin: Otago University Press.

Clewell, A. F., & Aronson, J. (2006). Motivations for the restoration of eosystems. *Conservation Biology, 20*(2), 420-428. https://doi.org/10.1111/j.1523-1739.2006.00340.x

Clewell, A. F., & Rieger, J. P. (1997). What practitioners need from restoration ecologists. *Restoration Ecology, 5*(4), 350-354. https://doi.org/10.1046/j.1526-100X.1997.00548.x

Clout, M. N. (2001). Biodiversity conservation and the management of invasive animals in New Zealand. In O. T. Sandlund, P. J. Schei, & Å. Viken (Eds.), *Invasive species and biodiversity management* (pp. 349–361). Dordrecht, Netherlands: Springer.

Cooke, S. J., Rous, A. M., Donaldson, L. A., Taylor, J. J., Rytwinski, T., Prior, K. A., . . . Bennett, J. R. (2018). Evidence-based restoration in the Anthropocene—from acting with purpose to acting for impact. *Restoration Ecology, 26*(2), 201-205. https://doi.org/10.1111/rec.12675

Cowie, C. (2010). *Volunteers matter: The geographies of community-based ecological restoration groups in the Wellington region* (Thesis). Victoria University of Wellington, Wellington, New Zealand.

Craig, J. L., Mitchell, N., Walter, B., Walter, R., Galbraith, M., & Chalmers, G. (1995). Involving people in the restoration of a degraded island: Tiritiri Matangi Island. In D. A. Saunders, J. L. Craig, & E. M. Mattiske (Eds.), *Nature conservation 4: The role of networks.* (pp. 544–541). Chipping Norton, Australia: Surrey Beatty & Sons.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice, 39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Department of Conservation. (2016a). *New Zealand biodiversity action plan 2016–2020*. Wellington: Department of Conservation Te Papa Atawhai.

Department of Conservation & Ministry for the Environment. (2000). *New Zealand biodiversity strategy: Our chance to turn the tide*. Wellington, NZ: Department of Conservation Te Papa Atawhai; Ministry for the Environment.

Department of Conservation. (2016b). *Annual report for the year ended 30 June 2016*. Wellington: Department of Conservation Te Papa Atawhai.

Department of Conservation. (2018). *Annual report for the year ended 30 June 2018*. Wellington: Department of Conservation Te Papa Atawhai.

Egan, D. (2001). A new acid test of ecological restoration. *Ecological Restoration, 19*(4), 205-206.

Egan, D., Hjerpe, E. E., & Abrams, J. (2011). Why people matter in ecological restoration. In D. Egan, E. E. Hjerpe, & J. Abrams (Eds.), *Human dimensions of ecological restoration: Integrating science, nature, and culture* (pp. 1-19). Washington, D.C.: Island Press.

Evju, M., Hagen, D., Kyrkjeeide, M. O., & Köhler, B. (2020). Learning from scientific literature: Can indicators for measuring success be standardized in “on the ground” restoration? *Restoration Ecology, 28*(3), 519-531. https://doi.org/10.1111/rec.13149

Galbraith, M. (2013). Public and ecology - the role of volunteers on Tiritiri Matangi. *New Zealand Journal of Ecology, 37*(3), 266-271.

Galbraith, M., Bollard-Breen, B., & Towns, D. R. (2016). The community-conservation conundrum: Is citizen science the answer? *Land, 5*(4), 37.

Galbraith, M., & Cooper, H. (2013). Tiritiri Matangi – an overview of 25 years of ecological restoration. *New Zealand Journal of Ecology, 37*(3), 258-260.

Galbraith, M., Craig, J., Mitchell, N., & Cooper, H. (2013). Introduction to the special issue on Tiritiri Matangi Island. *New Zealand Journal of Ecology, 37*(3), 257.

Galbraith, M., & Hayson, C. (1994). Tiritiri Matangi Island, New Zealand: Public participation in species translocation to an open sanctuary. In M. Serena (Ed.), *Reintroduction biology of Australian and New Zealand fauna* (pp. 149-154). Chipping Norton, NSW, Australia: Surrey Beatty & Sons.

Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., . . . Dixon, K. W. (2019). *International principles and standards for the practice of ecological restoration* (2nd ed.). Washington, D.C.: Society for Ecological Restoration.

Gaskin, C. P., & Rayner, M. J. (2013). *Seabirds of the Hauraki Gulf: Natural history, research and conservation*. Auckland: Hauraki Gulf Forum.

Gigliotti, L., & Dietsch, A. (2014). Does age matter? The influence of age on response rates in a mixed-mode survey. *Human Dimensions of Wildlife, 19*. https://doi.org/10.1080/10871209.2014.880137

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: Interviews and focus groups. *British Dental Journal, 204*(6), 291-295.

Grese, R. E., Kaplan, R. S., Ryan, R. L., & Buxton, J. (2001). Psychological benefits of volunteering in stewardship programmes. In P. H. Gobster & R. B. Hull (Eds.), *Restoring nature: Perspectives from the social sciences and humanities* (pp. 265-280). Washington DC, USA: Island Press.

Halle, S. (2007). Science, art, or application – the "Karma" of restoration ecology. *Restoration Ecology, 15*(2), 358-361. https://doi.org/10.1111/j.1526-100X.2007.00226.x

Handford, P. (2011). *Community conservation in New Zealand: Towards a shared approach*. Wellington: World Wildlife Fund for Nature.

Healey, J. F. (2014). *Statistics: A tool for social research* (6th ed.). Belmont, CA: Wadsworth/Thomson Learning.

Higgs, E. (2003). *Nature by design: People, natural process, and ecological restoration*. Cambridge, MA: MIT Press.

Higgs, E. (2005). The two-culture problem: Ecological restoration and the integration of knowledge. *Restoration Ecology, 13*(1), 159-164. https://doi.org/10.1111/j.1526-100X.2005.00020.x

Higgs, E., Harris, J. A., Murphy, S., Bowers, K., Hobbs, R., Jenkins, W., . . . Whisenant, S. (2018). On principles and standards in ecological restoration. *Restoration Ecology, 26*(3), 399-403. https://doi.org/10.1111/rec.12691

Hipkins, R., Stockwell, W., Bolstad, R., & Baker, R. (2002). *Commonsense, trust and science: How patterns of beliefs and attitudes to science pose challenges for effective communication*. Wellington: Ministry of Research, Science and Technology.

Hogan, T., Hinrichs, U., & Hornecker, E. (2016). The elicitation interview technique: Capturing people's experiences of data representations. *IEEE Transactions on Visualization and Computer Graphics, 22*(12), 2579-2593. https://doi.org/10.1109/TVCG.2015.2511718

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qual Health Res, 15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687

Hughes, F. M. R., Stroh, P. A., Adams, W. M., Kirby, K. J., Mountford, J. O., & Warrington, S. (2011). Monitoring and evaluating large-scale, 'open-ended' habitat creation projects: A journey rather than a destination. *Journal for Nature Conservation, 19*(4), 245-253. https://doi.org/https://doi.org/10.1016/j.jnc.2011.02.003

Innes, J., Fitzgerald, N., Binny, R., Byrom, A., Pech, R., Watts, C., . . . Burns, B. (2019). New Zealand ecosanctuaries: Types, attributes and outcomes. *Journal of the Royal Society of New Zealand, 49*(3), 370-393. https://doi.org/10.1080/03036758.2019.1620297

Jarvis, R. M., Borrelle, S. B., Breen, B. B., & Towns, D. R. (2015). Conservation, mismatch and the research–implementation gap. *Pacific Conservation Biology, 21*(2), 105-107.

Johnson, J. C., & Weller, S. C. (2001). Elicitation techniques for interviewing. In J. F. Gubrium & J. A. Holstein (Eds.), *Handbook of interview research* (pp. 491-514). Thousand Oaks, CA: SAGE Publications. https://doi.org/10.4135/9781412973588

Keenleyside, K. A., Dudley, N., Cairns, S., Hall, C. M., & Stolton, S. (Eds.). (2012). *Ecological restoration for protected areas: Principles, guidelines and best practices*. Gland, Switzerland: IUCN.

Lambert, N. M., Gwinn, A. M., Baumeister, R. F., Strachman, A., Washburn, I. J., Gable, S. L., & Fincham, F. D. (2012). A boost of positive affect: The perks of sharing positive experiences. *Journal of Social and Personal Relationships, 30*(1), 24-43. https://doi.org/10.1177/0265407512449400

Langenfeld, C. (2009). *The value of ecological restoration volunteer programs: a case sudy in Western Washington State*. The Evergreen State College, Olympia, WA.

Lee, W. G., & Allen, R. B. (2011). *Recommended monitoring framework for Regional Councils assessing biodiversity outcomes in terrestrial ecosystems*. Dunedin: Landcare Research.

Lee, W. G., McGlone, M., & Wright, E. F. (2005). *Biodiversity inventory and monitoring: A review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation*. Wellington: Landcare Research.

Lefkowitz, M. (2016). *Back to nature: 10 best examples of ecological restoration in NEO*. Retrieved 4 Feb 2020, from https://www.gcbl.org/blog/2016/08/back-to-nature-10-best-examples-of-ecological-restoration-in-neo

Lewis, S., & Russell, A. (2011). Being embedded: A way forward for ethnographic research. *Ethnography, 12*(3), 398-416. https://doi.org/10.1177/1466138110393786

Lockwood, J. L., Hoopes, M. F., & Marchetti, M. P. (2013). *Invasion ecology*. Oxford, UK: Wiley-Blackwell.

Marshall, M., Pagel, C., French, C., Utley, M., Allwood, D., Fulop, N., . . . Goldmann, A. (2014). Moving improvement research closer to practice: The researcher-in-residence model. *BMJ Quality & Safety, 23*, 801-895. https://doi.org/10.1136/bmjqs-2013-002779

Martin, D. M. (2017). Ecological restoration should be redefined for the twenty-first century. *Restoration Ecology, 25*(5), 668-673. https://doi.org/10.1111/rec.12554

Martin, D. M., & Lyons, J. E. (2018). Monitoring the social benefits of ecological restoration. *Restoration Ecology, 26*(6), 1045-1050. https://doi.org/10.1111/rec.12888

McDonald, T., Gann, G. D., Jonson, J., & Dixon, K. W. (2016). *International standards for the practice of ecological restoration – including principles and key concepts* (1st ed.). Washington, D.C.: Society for Ecological Restoration International.

Miles, I., Sullivan, W. C., & Kuo, F. C. (1998). Ecological restoration volunteers: The benefits of participation. *Urban Ecosystems, 2*, 27–41.

Miles, I., Sullivan, W. C., & Kuo, F. E. (2000). Psychological benefits of volunteering for restoration projects. *Ecological Restoration, 18*(4), 218-227. https://doi.org/10.3368/er.18.4.218

Mohan, J., & Bulloch, S. (2012). *The idea of a 'Civic Core': What are the overlaps between charitable giving, volunteering, and civic participation in England and Wales? (Working Paper 73)*. Birmingham: Third Sector Research Centre. Retrieved from http://www.birmingham.ac.uk/generic/tsrc/documents/tsrc/working-papers/working-paper-73.pdf

Moorfield, J. C. (2011). *Te aka: Māori-English, English-Māori dictionary and index*. Auckland: Pearson.

Morgan, D. L. (2008). Snowball sampling. In L. M. Given (Ed.), *The SAGE Encyclopedia of qualitative research methods* (pp. 815-816). Los Angeles: Sage Publications.

National Science Board. (2018). Science and technology: Public attitudes and understanding. In *Science and engineering indicators 2018. NSB-2018-1*. Retrieved from https://www.nsf.gov/statistics/indicators/. Retrieved 4 April 2019

Onwuegbuzie, A. J., & Leech, N. L. (2007). Sampling designs in qualitative research: Making the sampling process more public. *The Qualitative Report, 12*(2), 238-254.

Palmer, M., Allan, J. D., Meyer, J., & Bernhardt, E. S. (2007). River restoration in the twenty-first century: Data and experiential knowledge to inform future efforts. *Restoration Ecology, 15*(3), 472-481. https://doi.org/10.1111/j.1526-100X.2007.00243.x

Palys, T. (2008). Purposive sampling. In L. M. Given (Ed.), *The SAGE Encyclopedia of qualitative research methods* (pp. 698-699). Thousand Oaks: SAGE Publications. https://doi.org/10.4135/9781412963909

Parks Canada. (2008). *Principles and guidelines for ecological restoration in Canada's protected natural areas*. Gatineau, Quebec: Parks Canada.

Peters, M. A., Hamilton, D., & Eames, C. (2015). Action on the ground: A review of community environmental groups' restoration objectives, activities and partnerships in New Zealand. *New Zealand Journal of Ecology, 39*(2), 179-189.

Potter, W. J., & Levine-Donnerstein, D. (1999). Rethinking validity and reliability in content analysis. *Journal of Applied Communication Research, 27*(3), 258-284. https://doi.org/10.1080/00909889909365539

Prach, K., Durigan, G., Fennessy, S., Overbeck, G. E., Torezan, J. M., & Murphy, S. D. (2019). A primer on choosing goals and indicators to evaluate ecological restoration success. *Restoration Ecology, 27*(5), 917-923. https://doi.org/10.1111/rec.13011

Rooney, P. (2005). Researching from the inside - does it compromise validity? - A discussion. *Level3, 3*.

Ruiz-Jaén, M. C., & Aide, T. M. (2005). Restoration success: How is it being measured? *Restoration Ecology, 13*(3), 569-577. https://doi.org/10.1111/j.1526-100X.2005.00072.x

Smyth, A., & Holian, R. (2008). Credibility issues is research from within organisations. In P. Sikes & A. Potts (Eds.), *Researching education from the inside* (pp. 33-47). Milton Park: Routledge.

Society for Ecological Restoration. (2019). *About SER*. Retrieved 21 October 2019, from https://www.ser.org/page/about

Society for Ecological Restoration Australasia. (2011). *Case studies*. Retrieved 4 Feb 2020, from http://seraustralasia.com/pages/casestudies.html

Society for Ecological Restoration (SER) International Science and Policy Working Group. (2004). *The SER primer on international ecological restoration*. Tucson: Society for Ecological Restoration International.

Stats NZ. (2020, 12 March 2020). *2018 Census place summaries*. Retrieved from https://www.stats.govt.nz/tools/2018-census-place-summaries/

Stephens, T., Brown, D., & Thornley, N. (2002). *Measuring conservation achievement: Concepts and their application over the Twizel area. Science for Conservation 200.* Wellington, NZ: Department of Conservation Te Papa Atawhai.

Suding, K. N. (2011). Toward an era of restoration in ecology: Successes, failures, and opportunities ahead. *Annual Review of Ecology, Evolution, and Systematics, 42*(1), 465-487. https://doi.org/10.1146/annurev-ecolsys-102710-145115

Suganuma, M. S., & Durigan, G. (2015). Indicators of restoration success in riparian tropical forests using multiple reference ecosystems. *Restoration Ecology, 23*(3), 238-251. https://doi.org/10.1111/rec.12168

Tongco, D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and Applications, 5*, 147-158.

Towns, D. R., Bellingham, P. J., Mulder, C. P. H., & Lyver, P. O. B. (2012). A research strategy for biodiversity conservation on New Zealand's offshore islands. *New Zealand Journal of Ecology, 36*(1), 1-20.

Towns, D. R., Wright, E. F., & Stephens, T. (2009). Systematic measurement of effectiveness for conservation of biodiversity on New Zealand islands. In B. D. Clarkson, P. Kurian, T. Nachowitz, & H. Rennie (Eds.), *Proceedings of the Conserv-Vision Conference, University of Waikato, 2-4 July 2007* (pp. 1-22). Hamilton, NZ: The University of Waikato.

U.S. Department of the Interior. (n.d.). *Restoration success stories*. Retrieved 31 July 2019, n.d., from https://www.doi.gov/restoration/stories

Unity College Distance Education. (2017). *2 examples of ecological restoration to inspire students at environmental school*. Retrieved 4 Feb 2020, from https://online.unity.edu/2-examples-ecological-restoration-inspire-students-environmental-school/

Unluer, S. (2012). Being an insider researcher while conducting case study research. *The Qualitative Report, 17*, 1-14.

Waltham, N. J., Elliott, M., Lee, S. Y., Lovelock, C., Duarte, C. M., Buelow, C., . . . Sheaves, M. (2020). UN Decade on Ecosystem Restoration 2021–2030: What chance for success in restoring coastal ecosystems? *Frontiers in Marine Science, 7*, 71.

Weng, Y. (2015). Contrasting visions of science in ecological restoration: Expert-lay dynamics between professional practitioners and volunteers. *Geoforum, 65*, 134-145.

Willis, G. (2017). *Addressing New Zealand's biodiversity challenge: A Regional Council thinkpiece on the future of biodiversity management in New Zealand*. Wellington: Local Government New Zealand.

Wilson, C. (2001). *The changing face of social service volunteering: A literature review*. Wellington: Ministry of Social Development.

Wimmer, R. D., & Dominick, J. R. (2011). *Mass media research: An introduction* (9 ed.). Boston: Cengage Learning.

Wortley, L., Hero, J.-M., & Howes, M. (2013). Evaluating ecological restoration success: A review of the literature. *Restoration Ecology, 21*(5), 537-543. https://doi.org/10.1111/rec.12028

Wright, K. B. (2005). Researching internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of Computer-Mediated Communication, 10*(3), 00-00. https://doi.org/10.1111/j.1083-6101.2005.tb00259.x

Zedler, J. B. (2007). Success: An unclear, subjective descriptor of restoration outcomes. *Ecological Restoration, 25*(3), 162-168. https://doi.org/10.3368/er.25.3.162

Chapter 4

Capacity for engagement in the science of ecological restoration

> *Restoration science…*
> *it takes a (large, diverse and engaged) village.*
>
> (Newton et al., 2015)

4.1 Introduction to citizen science

The adaptation of the familiar proverb above quoted from Newton et al. (2015) fits the concepts of ecological restoration and citizen science well – both are collective populace activities at a complex level and dependent on shared tasks, outcomes and communication. Citizen science is an 'umbrella' term (European Citizen Science Association, ECSA, n.d.) that encompasses multifaceted ways in which the public participate in scientific research, and is defined broadly as "the active engagement of the general public in scientific research tasks" (Vohland et al., 2021a, p. 1), with Silvertown (2009, p. 467) further specifying that "A citizen scientist is a volunteer who collects and/or processes data as part of a scientific enquiry."

The concept of citizen science is flexible, but generally covers avocational contribution to scientific research at differing levels within many disciplines across diverse situations. Although public contribution to science has expanded exponentially over the last 20 years, demonstrated by the growth of citizen science publications in indexed journals (Pelacho, Ruiz, Sanz, Tarancón, & Clemente-Gallardo, 2021), citizen science is not a new concept. Aono and Kazui (2008) used records from 9th century diaries written by Japanese emperors, aristocrats, politicians, monks, and merchants to reconstruct phenological data on cherry tree flowering, and there are many examples of the voluntary collection of scientific data in

Europe dating from the 15th century (Bonney et al., 2009; Cohn, 2008; Couvet & Prevot, 2015; Miller-Rushing, Primack, & Bonney, 2012). These records are long before the professionalisation of scientists (Vetter, 2011). Throughout this time, scientific observations were dominated by "gentlemanly specialists" (Rudwick, 1985, p.17) who, due to their affluence and social status, could invest time into their hobbies of interest and were accorded high credibility and 'expert' status (Porter, 1978). However, from the mid-1800s into the 20th century, amateur scientists were increasingly marginalised through the systematic academic professionalisation of science (Cooper, Shirk, & Zuckerberg, 2014; Porter, 1978; Vetter, 2011). This professionalisation resulted in a change in the culture of science that tended to exclude the public from specialised knowledge, and generated an 'expert'—'lay' dichotomy of scientific interest (Vetter, 2011).

Early definitions of citizen science were explicit that the lay participation was under the direction of professional scientists or researcher-led (e.g., Bonney et al., 2009; Ludwig, 2001). The citizen scientist was seen to be solely part of the investigation process, data gatherers, rather than participants following the wider scientific method steps of initiating and designing the projects and interpretation and dissemination of results (Cooper, Hochachka, & Dhondt, 2012). Although many definitions still include this perspective (e.g., Gura, 2013; Stevenson, 2015), the recent two decades have seen a rapid global engagement in the practice of citizen science (Dickinson & Bonney, 2012) indicative of a movement towards the democratisation of science (Mahr, Göbel, Irwin, & Vohland, 2018; Strasser, Baudry, Mahr, Sanchez, & Tancoigne, 2018). The demarcation between professional and avocational expertise has thus become blurred, which is a desired outcome of a 1970s movement that had '*science for the people*' as a slogan (Irwin, 1995, p.110). The history of citizen science, and the development of definitions, is further detailed by Ceccaroni, Bowser, and Brenton (2017), Couvet and Prevot (2015) and Mahr et al. (2018).

Although citizen science projects largely are driven by government agencies, universities, and research centres where projects are conceived and overseen by professionals (Eitzel et al., 2017), in some countries citizen science is promoted as a grassroot activity with a bottom-up approach where activities undertaken at the local scale often focus on supporting outcomes desired by a local community (Eicken et al., 2021). This broadening of public engagement has led to recognition of a range of citizen science participation typologies (Mahr et al., 2018). Different types of participation in citizen science represent a framework for involvement, essentially a ladder of participation (Haklay, 2018), based on variation in project goals, nature of the activities, governance structure, level and degree of public participation, and the nature of the professional–volunteer collaboration. Participation ranges from solely data-gathering activities ('crowdsourcing', Haklay, 2018), through varying hybrids

of avocational participation, to projects where volunteer participants have a high degree of independence ('collegial projects', Shirk et al., 2012). Contemporary definitions of citizen science tend to reflect the now broader social application and be less hierarchical, for example:

> "In citizen science the public participates voluntarily in the scientific process, addressing real-world problems in ways that may include formulating research questions, conducting scientific experiments, collecting and analyzing data, interpreting results, making new discoveries, developing technologies and applications, and solving complex problems." (Holdren, 2015, p. 1)

> "… public participation and collaboration in scientific research with the aim to increase scientific knowledge." (Australian Citizen Science Association, ACSA, 2018)

The global rise of citizen science arguably represents the renaissance of the amateur scientist, with avocational enthusiasts increasingly being accorded high levels of professionalism (Bonney, 2021; Cooper et al., 2014; Tulloch, Possingham, Joseph, Szabo, & Martin, 2013). Accompanying this rise has been the development of principles, strategies and guidelines to aid the implementation of citizen science. Such literature is aimed at both researchers and governance agencies (e.g., Robinson, Cawthray, West, Bonn, & Ansine, 2018) and voluntary participants (e.g., Tweddle, Robinson, Pocock, & Roy, 2012). The culmination of this process is the formulation of 10 principles for citizen science, developed by the European Citizen Science Association (2015), which are considered to underlie good practice in citizen science, and which have widespread adoption, adaptation and promotion (ACSA, 2018; Robinson et al., 2018; Vohland et al., 2021b).

Citizen science, however, is not seen universally as an smooth pathway to democratic participation in science (e.g., Pelacho, Rodríguez, et al., 2021; Weng, 2015). Although the essential tenets of citizen science are recognised (i.e., that research is undertaken, and data are usually collected by non-professional scientists; Pelacho, Rodríguez, et al., 2021), citizen science holds challenges that are inevitable where groups with diverse interests, backgrounds and motivations interact (Bonney, 2021). From a community participant's perspective, citizen science projects are readily accessible and seldom require sophisticated skills and resources to participate (Frigerio, Richter, Per, Pruse, & Vohland, 2021). Reservations expressed by professionals often focus on the quality of data collected by the public (Pelacho, Rodríguez, et al., 2021), and there may be conflicting views between groups on access to data (intellectual property) gathered by volunteers (Ganzevoort, van den Born, Halffman, & Turnhout, 2017). Consequently, an expert—lay dichotomy may persist between collaborating parties (such as agency professionals and community groups) rather than the

public participating in activities as true collaborators (Weng, 2015). An exploration of this potential dichotomy in ecological restoration projects in Aotearoa New Zealand (hereafter New Zealand) is the essence of this study.

Many authors have advocated networks of citizen science volunteers as a means to gather ecological field data (e.g., Cooper et al., 2012; Dickinson et al., 2012; Dickinson, Zuckerberg, & Bonter, 2010; McKinley et al., 2017; Silvertown, 2009). Large numbers of volunteers have already contributed to observational data over spatial and temporal scales not normally associated with conventional studies and difficult for individual ecologists to achieve through other means (Kobori et al., 2016; Sullivan et al., 2009). The examples of research areas cited include patterns of species distribution and abundance, geographic and temporal trends in populations, and impacts of changing landscape. There is no doubt that the unrelenting advance of technological tools, and the ease of access to such tools, has aided the growth of citizen science (Silvertown, 2009). Sophisticated mobile technologies, sensors and remote data collection and storage have provided novel opportunities for the citizen scientist to collect ecological field observation at ever increasing scales and resolution (Kobori et al., 2016; Shirk & Bonney, 2020).

Since ecological restoration is an applied aspect of the discipline of ecology, it is not surprising that citizen science is strongly advocated for field measurement of ecological attributes (see Chapter 3) that can gauge the success and/or progress of community-based restoration projects (Ballard, Phillips, & Robinson, 2018; Edwards, Shaloum, & Bedell, 2018; Huddart, Thompson, Woodward, & Brooks, 2016). A particular value of citizen science is the potential for generating longitudinal datasets (Dickinson et al., 2010). Most ecological changes occur over extended timescales (Spellerberg, 2005) so outcomes of intentional ecological interventions may not be evident within the period of any one research study or a volunteer's contribution, or even human lifespans. Through the long-term commitment of sustained sequences of citizen scientists, the collection of ecological data throughout the timescale of the restoration project may be assured. For example, the Beach Patrol Scheme run by Birds New Zealand has resulted in a biological database of systematic observations by volunteers spanning over 70 years (Birds New Zealand, 2019).

Citizen science is already well established in community-based ecological restoration projects (e.g., Edwards et al., 2018; Huddart et al., 2016). Furthermore, citizen science is considered to be part of a transdisciplinary approach to understand and address future global environmental change (Abhilash, 2021), and the involvement in ecological science by avocational practitioners may well be set to increase. The engagement of the general populace in restoration action is an explicit intention of the Decade for Ecosystem

Restoration 2021–2030 (United Nations General Assembly, 2019). Investment in restoration research, including citizen science and the capacity for communities to engage in the science, is identified as an essential element of the restoration decade (Abhilash, 2021; Science Task Force for the UN Decade on Ecosystem Restoration, 2021), thus it is inevitable that the implementation of the strategy will lead to increased participation in the science of restoration.

Ecological restoration projects in New Zealand mirror the global trend of increasing citizen engagement in ecological science (Galbraith, Bollard-Breen, & Towns, 2016; Peters, 2018; Peters, Eames, & Hamilton, 2015; Peters, Hamilton, Eames, Innes, & Mason, 2016). Although this engagement may be dominated by the monitoring of introduced mammalian predators (Galbraith et al., 2016), for long running community-based restoration projects, for example Tiritiri Matangi Island, the participation by volunteers in ecological science may be substantial and varied (Galbraith, 2013).

The number of volunteers participating in citizen science is identified in the New Zealand Biodiversity Strategy (Department of Conservation, 2020) as a potential national indicator to measure the progress towards the outcomes of the strategy. Citizen science is already promoted actively to a wide spectrum of New Zealand society by many stakeholders through a multitude of means, for example:

- advocacy by agencies (e.g., Department of Conservation, n.d.-a; Department of Conservation, n.d.-b; Manaaki Whenua Landcare Research, 2022);
- educational perspectives and resources (e.g., Buntting, Doyle, Anderson, & Luczak-Roesch, 2020; LEARNZ, n.d.; Pierson, Anderson, & Luczak-Roesch, 2020);
- community-based initiatives and activities (e.g., Pest Free Kaipātiki, 2021; Peters, 2018; Predator Free NZ, n.d.);
- journalism (e.g., Rykers, 2020; White, 2018); and,
- social media contributions (e.g., Candler, n.d.; Citizen Science Association of Aotearoa New Zealand, 2016).

While the extent of such promotions highlights the opportunities to engage the public in restoration as citizen scientists (as advocated by Cooke, Bennett, & Jones, 2019), the persistence of poor alignment of restoration science and practice (Miller et al., 2017) still generates global debate of the efficacy of such public engagement. Studies exploring the expert—lay dichotomy have tended to take a discipline view (e.g., Lee, Lee, & Bell, 2020), or investigated the perspectives and attitudes of restoration of the professional scientists (e.g., Golumbic, Baram Tsabari, & Fishbain, 2020; Riesch & Potter, 2014), not those of the citizen

scientist. In this socioecological study, the expert—lay dichotomy of citizen science was explored through the aspirations and expectations of two stakeholder groups representing the dichotomy: community-based participants involved in ecological science (the citizen scientists) and professional ecologists from the 'governing' stakeholders. Specifically, I sought views on:

1. project details and the nature of any ecological science in place;
2. how citizens were involved in ecological science;
3. whether citizen science activities were considered important;
4. actual or potential barriers to community participation in ecological science activities; and,
5. how ecological science was communicated to community participants.

4.2 Methods

Surveys were employed for both community-based practitioners and employees of government agencies to identify the degree to which communities are engaged in ecological science ('citizen science'). An initial anonymous survey was conducted online using Qualtrics© software, followed by a small number of semi-structured interviews. The survey and interviews were approved by the Auckland University of Technology Ethics Committee (Ref. number 17/167), and validated through steps recommended by Creswell and Miller (2000): triangulation, peer review, and debriefing.

4.2.1 Survey participants

Selection of participants was limited geographically to the northern half of the North Island where most of New Zealand's population, and hence the community-based restoration projects, are concentrated (Peters, Hamilton, & Eames, 2015; Stats NZ, 2020). This geographic area covered the regional areas of Northland, Auckland, Bay of Plenty and Waikato (Fig. 4.1). A further consideration of the geographic limitation was in anticipation of the practicalities of interviews with practitioners. All participants were over 16 years of age.

For the online and interview surveys, participants were targeted through purposive selection (Tongco, 2007), and were either employees of an environmental management agency (either regional council or the Department of Conservation) or voluntary participants in a community-based ecological restoration project. The initial contact with potential participants was made through direct email contact with agency managers or community-group officers, identified through agency and organisation websites. The initial communication provided a research

background, and a request to distribute the survey invitation throughout the stakeholders' networks to initiate snowball sampling (Atkinson & Flint, 2001). Purposive selection was considered appropriate as this study was interested in the knowledge and views that particular people and groups (i.e., restoration stakeholders) have with respect to a specific interest (in this case, ecological restoration) (Onwuegbuzie & Leech, 2007; Palys, 2008), and had the advantage of accessing a large focussed number of participants from a wide geographical area (Wimmer & Dominick, 2011; Wright, 2005).

Semi-structured interviews were conducted as an elicitation tool (Johnson & Weller, 2001) to explore respondents' understandings and interpretations of responses made to questions on citizen science in the online survey in the context of their experiences in ecological restoration. Interviewees may, or may not, have participated in the online survey. Recruitment protocols for the interviews were as for the online survey, but limited to one person per interview. Potential participants responded to the interview invitation by email or phone, and were provided with an information sheet and a consent form (see Supplement S.4, Appendix A).

4.2.2 Survey structure

For the online survey respondents were provided with a direct URL link to a web-based survey held on an off-site server operated by Qualtrics©. There were two online questionnaires, one to employees of environmental management agencies and one to members of community-based restoration organizations. The two questionnaires had common themes, but the wording styles of the questions differed and there were questions that were specific to the two groups. See Supplements S.1 and S.2, Appendix A, for the full list of questions. The questionnaires included:

- multiple choice questions – predetermined lists with a text-entry option to add to the list;
- open questions;
- rating-scale questions (Likert response scales) to measure opinions;
- contingency questions to direct the respondent to skip unnecessary questions; and,
- demographic questions.

The questionnaires sought views from respondents on restoration success and ecological science. For ecological science, I asked respondents:

1. Details about their projects – respondent role, was the project affiliated to a governmental or management agency?

2. What ecological field measures were undertaken?
3. If any activities with their projects involved community participants in ecological science and, if so:
    - Who initiated these projects?
    - Who contributed expertise to these activities?
    - What style of community participation described these activities?
    - If they (the respondent) participated in ecological science activities and, if so, what time was involved?
4. How was ecological science information and outcomes communicated to participants?

The model of community participation used was that proposed by Shirk et al. (2012) (Table 4.1). The models proposed by other authors, summarised by Schrögel and Kolleck (2019), differ in the bases of the classification of citizen science, including the type, origin and goals of the activities, and the relationship between professionals and the avocational participants. However, the five categories of participation identified by Shirk et al. (2012) were considered a better representation of the range of activities known to be in place in New Zealand restoration projects and, as a linear hierarchy of categories, conceptually easier to describe to community-based survey participants.

Table 4.1 – Five models of citizen science based on the nature of the interaction between public participants and scientists (after Shirk et al., 2012).

Type of participation	Role of the citizen
Contractual	Communities ask professional researchers to conduct a specific scientific investigation and report on the results.
Contributory	Projects are generally designed by scientists and for which members of the public primarily contribute data.
Collaborative	Projects are generally designed by scientists and for which members of the public contribute data but also help to refine project design, analyse data, and/or disseminate findings.
Co-Created	Projects are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all aspects of the research process.
Collegial	Non-credentialed (avocational) individuals conduct research independently with varying degrees of expected recognition by institutionalized science and/or professionals.

A range of aspects of community participation in ecological science were rated for importance, developed from the outcomes of other studies (e.g., Dickinson et al., 2010; McKinley et al., 2015; Merenlender, Crall, Drill, Prysby, & Ballard, 2016; Nerbonne & Nelson, 2004; Peters, Hamilton, et al., 2015). These were:

- what benefits were gained through community participation;
- community participation, training and support activities for the development of ecological science in New Zealand; and,
- actual or potential barriers to community participation, scientific analysis and support activities in ecological science activities.

The follow-up elicitative interviews were recorded for subsequent confirmation of the conversation, either by electronic recording where consent had been given, or by answering on a question sheet provided, depending on the participants' preference and geographical location, and the most practicable option. See Supplement S.3, Appendix A for the full list of indicative questions for follow up interviews.

4.2.3 Data analysis

Responses to the open-ended question on the benefits of community participation in ecological restoration and associated citizen science were analysed thematically, following a conventional content analysis approach (Hsieh & Shannon 2005). To establish the key elements of the responses, corpora were assembled from the answers to the questions, which were then were analysed using Wmatrix (Rayson, 2008), a computer-based tool to calculate keyword frequencies. Word cloud visualisations of the dominant words in the corpora were generated using a web-based text analysis tool, Voyant Tools (Sinclair & Rockwell, 2016). Word clouds, where the frequencies of different words in the corpus are shown as different font sizes, provide a quick visualisation of the common themes in texts, and are recognised as a supplementary tool for text analyses, particularly for corpora prior to any content manipulation (McNaught & Lam, 2010). Function words that contribute to sentence syntax rather than meaning were excluded from the analysis.

The online survey data were imported to MS Excel to explore the relationship between perceptions recorded from the agency and community-based respondents. Likert response categories were ranked (assigned values 1–5) and treated as interval data (Allen & Seaman, 2007; Boone & Boone, 2012). Analysis included descriptive statistics, for example stacked bar charts to visualize the responses and medians to illustrate the central tendencies (Bhandari & Nikolopoulou, 2022; Streiner, 2000). Although some authors do not recommend

stacked bar charts for the visualisation of proportions (e.g., Robbins & Heiberger, 2011), others have shown that they perform well in comparison to other visualisation forms, particularly where only a small number of attributes are being considered (Indratmo, Howorko, Boedianto, & Daniel, 2018; Siirtola, 2014). The agency and community group proportional responses were compared using paired 100% stacked bar charts for each survey attribute considered.

Where survey data was expressed as proportions of responses, Fisher's exact test of independence was used to examine the relationship of the proportions between the agency and community respondents. The rationale for using this test was that one of the sample sizes was small, with the test specifically identified as being the most accurate method when more than 20% of samples have frequencies less than five (Kim, 2017; McDonald, 2009; Salkind, 2011). Although Fisher's exact test is generally applied to analysis of small samples, it is also valid for all sample sizes (Kim, 2017), so for consistency it was used for all tests of independence. An online calculator was used for the Fisher's exact tests (Vasavada, 2016).

Interview analysis followed a thematic analysis approach (Hogan, Hinrichs, & Hornecker, 2016) where patterns (themes) of the survey responses were identified and applied to the interpretation of the survey results. Not all interviews were recorded due to interviewee choice, or where the interview location chosen by the interviewee was not suitable (e.g., café noise levels). In these instances, a written record was made of the interviewee's key points and statements.

4.3 Results

4.3.1 Survey participants

There were 23 agency respondents from both central government and territorial land authority agencies. Their location was not recorded as this information may have compromised their anonymity. The key demographic information of the agency respondents was: 27% female, 73% male; 93% 30 years old or over. Most respondents had tertiary qualifications (87%); of these, 73% indicated their degree had a background in ecology.

There were 118 community group respondents (142 responses, but 26 contained no data). Many community group respondents were associated with multiple projects. The location of projects represented by the 118 respondents is shown in Figure 4.1. The key demographic

information of the community group respondents is described in Chapter 3 (Section 3.3.1, p. 63).

4.3.2 Participation in citizen science

Agency respondents indicated that all of their ecological restoration projects involved community participation; however, community participation in citizen science activities was identified by only 67% of the agency respondents. In the corpus of the outcomes of facilitating community participatory ecological restoration projects identified by agency respondents, there was no inclusion of the phrase “citizen science”, although words and phrases associated with ecological science had a relative frequency of 3.9%. The concept of community stewardship dominated the corpus with a relative frequency of 6%. The dominant words of the corpus are presented in a visual form in Figure 4.2.

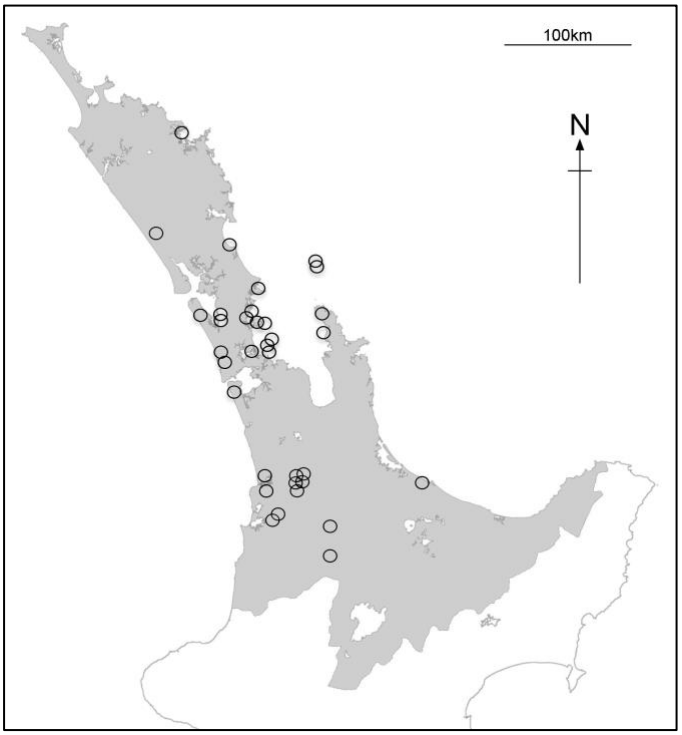


Figure 4.1 – Geographical region (North Island, New Zealand) covered by the survey. Shaded area indicates the limit of the invitation distribution; circles indicate the approximate location of projects represented by the community group respondents.

Figure 4.2 – Visual comparison of word frequencies in the corpus of the benefits of community participation in ecological restoration identified by agency respondents, in a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand.

An association of ecological science activities with restoration projects was indicated by 73% of the community respondents, with 62% indicating that they personally participated in the activities. A significant proportion of the respondents indicated that ecological science was not part of their projects (9%; $p < 0.0001$; Fisher's exact test), or did not know if their projects included ecological science (18%; $P < 0.0001$; Fisher's exact test).

In the corpus of benefits of participation in ecological science experienced by community respondents (776 words), words and phrases were dominated by personal benefits of increased knowledge (4.4%) and mental well-being resulting from satisfaction of contribution (2.8%). Words associated with ecological science had a relative frequency of 2.2%. The dominant words of the corpus are presented in a visual form in Figure 4.3.

A thematic analysis of the corpora of outcomes and benefits experiences by agency and community respondents respectively showed consistency in identifying increased ecological literacy as a result of community participation in citizen science. There were, however, significant differences between the two groups with respect to physical and mental well-being, community environmental stewardship, and gains in project efficiency (Fig. 4.4).

Figure 4.3 – Visual comparison of word frequencies in the corpus of the benefits of participation in ecological science identified by community respondents, in a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand.

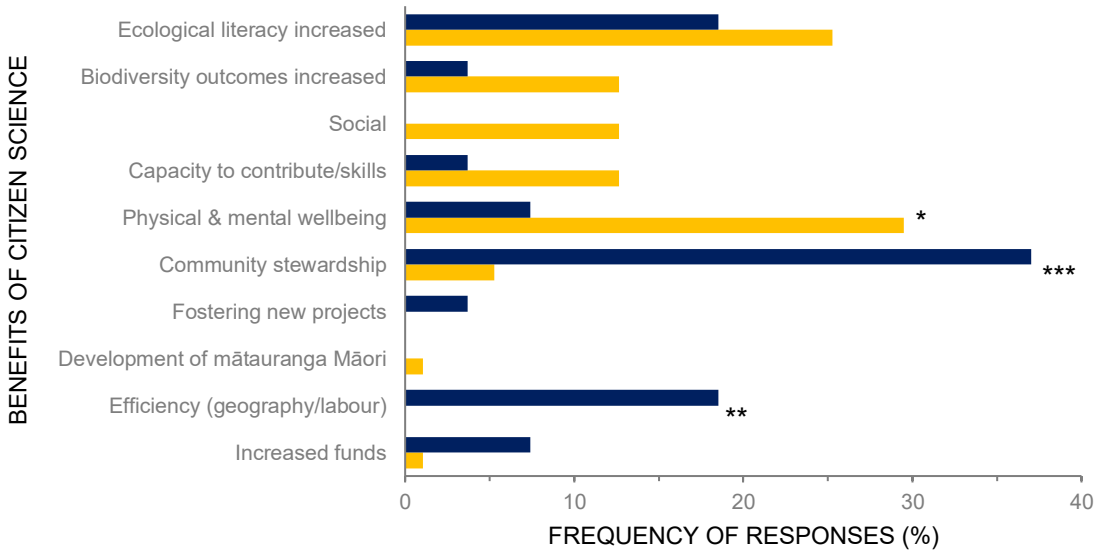


Figure 4.4 – Benefits of community participation in ecological science activities identified by agency and community respondents, in a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand. *p < 0.05. **p < 0.01. ***p < 0.001. (Fisher's exact test). Agency group responses are shown in dark blue, community groups responses in yellow.

The ecological science activities that the community respondents undertook were all species-based field measures, primarily used as a basis to determine success or progress (Fig. 4.5). These were presence/absence or abundance measures, dominated by the monitoring of invasive species, vegetation, and birds.

The science activities identified by community respondents (that knew of citizen science activities) and agency respondents covered all types of citizen science typologies, with no significant difference between the proportions of responses of the two groups (Table 4.2).

There was no significant difference between respondent groups with respect to the origin of the expertise contributing to the citizen science activities and who initiated the activities (Table 4.3 and Table 4.4).

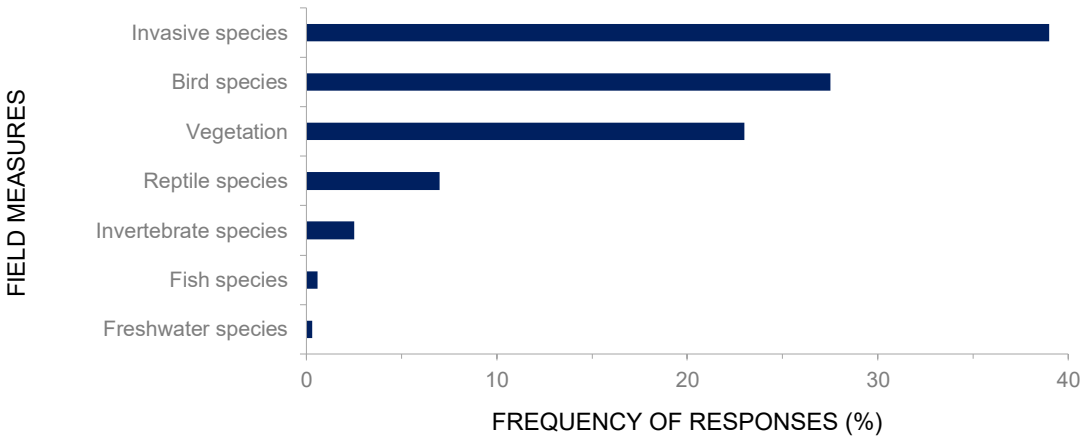


Figure 4.5 – Ecological field measures identified by community-based respondents being undertaken in restoration projects, in a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand.

Table 4.2 – Proportions of types of citizen science activities identified by respondents to a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand.

Type of citizen science association	Agency respondents (%) (n = 23)	Community respondents (%) (n = 118)
Contributary	24	27
Co-created	14	25
Collaborative	24	20
Collegiate	24	15
Contractual	14	12

Table 4.3 – Initiators of science in ecological restoration projects identified by respondents to a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand.

Origin of expert contribution	Agency respondents (%) (n = 23)	Community respondents (%) (n = 118)
Agency employees	36	20
Community participants	36	40
Professional researchers (incl. students)	20	39
Private ecologists	8	1

Table 4.4 – Origin of scientific expertise contribution identified by respondents to a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand.

Origin of expert contribution	Agency respondents (%) (n = 23)	Community respondents (%) (n = 118)
Agency employees	36	27
Community participants	36	33
Professional scientists	28	36
Tertiary institution students	0	1
No outside expertise	0	1
Don’t know	0	2

4.3.3 Importance of elements of participation in ecological science

Respondents were universal in considering that citizen science was important in promoting increased environmental awareness, fostering community engagement in environmental activities and influencing a change in participant behaviours (Fig. 4.6).

The two groups of respondents showed significantly different levels of importance with respect to increased environmental awareness, citizen—citizen interactions, scientist—citizen interactions, and linking activities to policy changes.

4.3.4 Importance of barriers to citizen science

Agency respondents rated all potential barriers to community participation in ecological science higher than community group respondents (Fig. 4.7).

The two groups of respondents showed significantly different views of the barriers with respect to training and recruiting volunteers, lack of understanding of ecological science, data aspects (management, reliability and statistical analysis) and access to training resources.

4.3.5 Importance of development needs for community participation in ecological science in New Zealand

The responses to the needs for development of community participation in ecological science in New Zealand were relatively consistent in magnitude and priority across both groups, with all elements being considered to be moderately important or higher (Fig. 4.8). The only significant difference was the community groups placed higher importance on the need for access to funding than did agency respondents. The elements considered to be least important for both groups were dedicated publications for citizen science practitioners and international links.

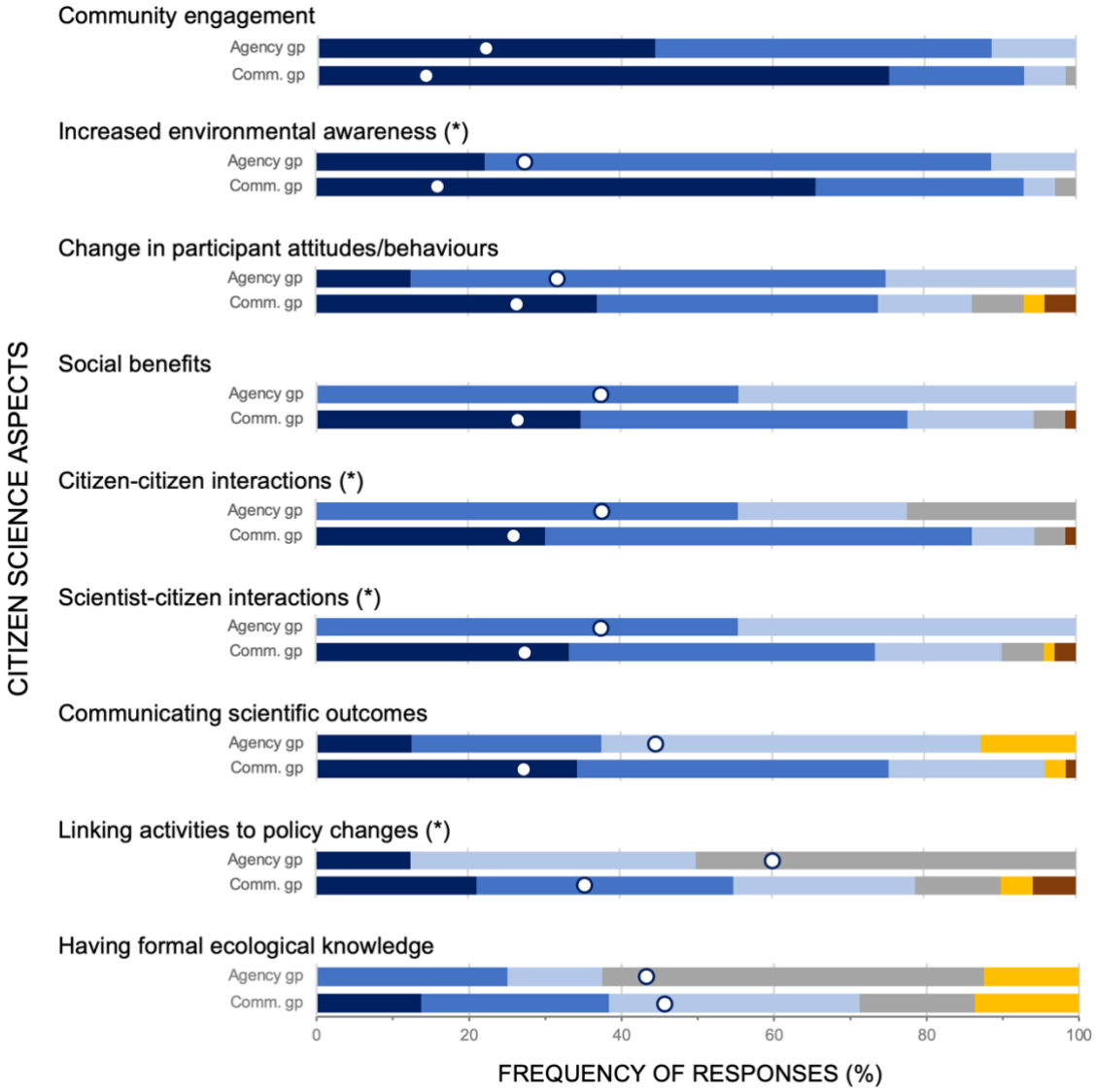


Figure 4.6 – Comparison of agency and community groups' views of importance of aspects of community participation in ecological citizen science activities. *p < 0.05. (Fisher's exact test). Central tendency (median) of the groups' responses indicated by circles on the bars.

Response descriptors key:

Extremely important | Very important | Moderately important | Slightly important | Not at all important | Unsure/don't know

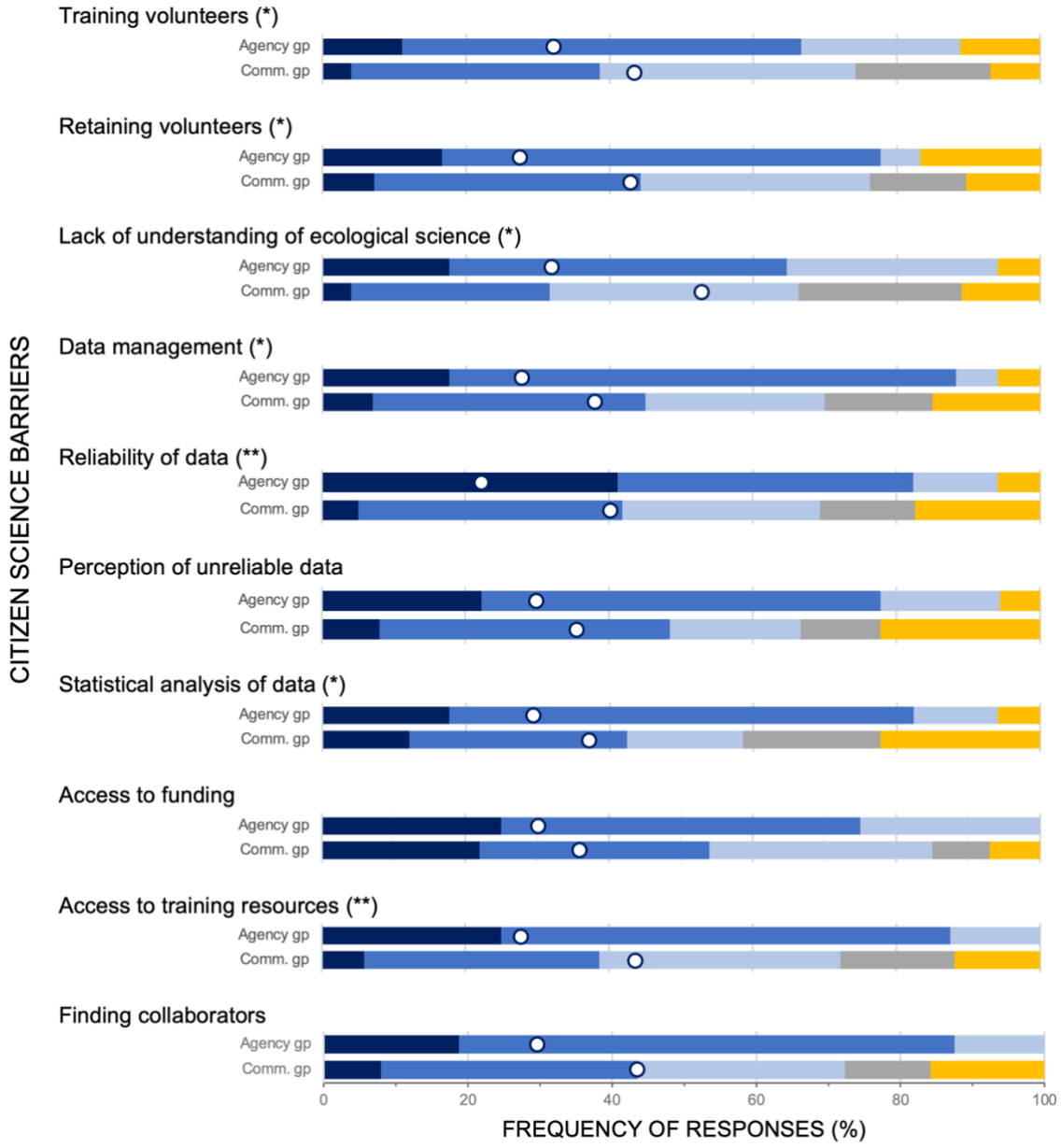
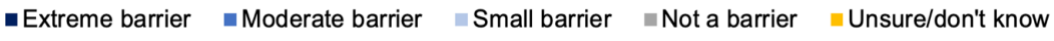


Figure 4.7 – Comparison of agency and community group ratings of actual or potential barriers to running and/or community participation in ecological citizen science activities. *p < 0.05. **p < 0.01. (Fisher's exact test). Central tendency (median) of the groups' responses indicated by circles on the bars.

Response descriptors key:



4.3.6 Communication of ecological science

Overall, a wide range of mechanisms was identified for the dissemination of ecological science to restoration project stakeholders, covering written, oral, and electronic methods. However, although both respondent groups rated communicating science relatively highly (Fig. 4.6 and Fig. 4.8), there were significant differences between the respondent groups in the use of some communication types (Fig. 4.9).

Agency respondents identified media reports as the most used mechanism for communicating ecological science to stakeholders, although use of formal research dissemination mechanisms (published papers and conferences) were significantly higher compared to community groups. Personal contact had little use in agencies. For community respondents, project reports and media articles dominated the communication of ecological science information to their stakeholders. Other mechanisms were used at similar frequencies, although organisational newsletters (produced by the community groups themselves) and personal contact were used at higher frequencies than in agencies.

4.3.7 “Don’t know” answers

Following the framework advocated by Mirzaei, Carter, Patanwala, and Schneider (2022, p. 2312, Fig.1), “don’t know” (DK) responses less than 10% were considered as negligible. The questions where the proportion of DK answers exceeded 10% were those pertaining to the barriers to citizen science (Fig. 4.7). Here a theoretical qualitative consideration of the answers was undertaken to consider potential reasons for the high level of DK responses (Mirzaei et al., 2022).

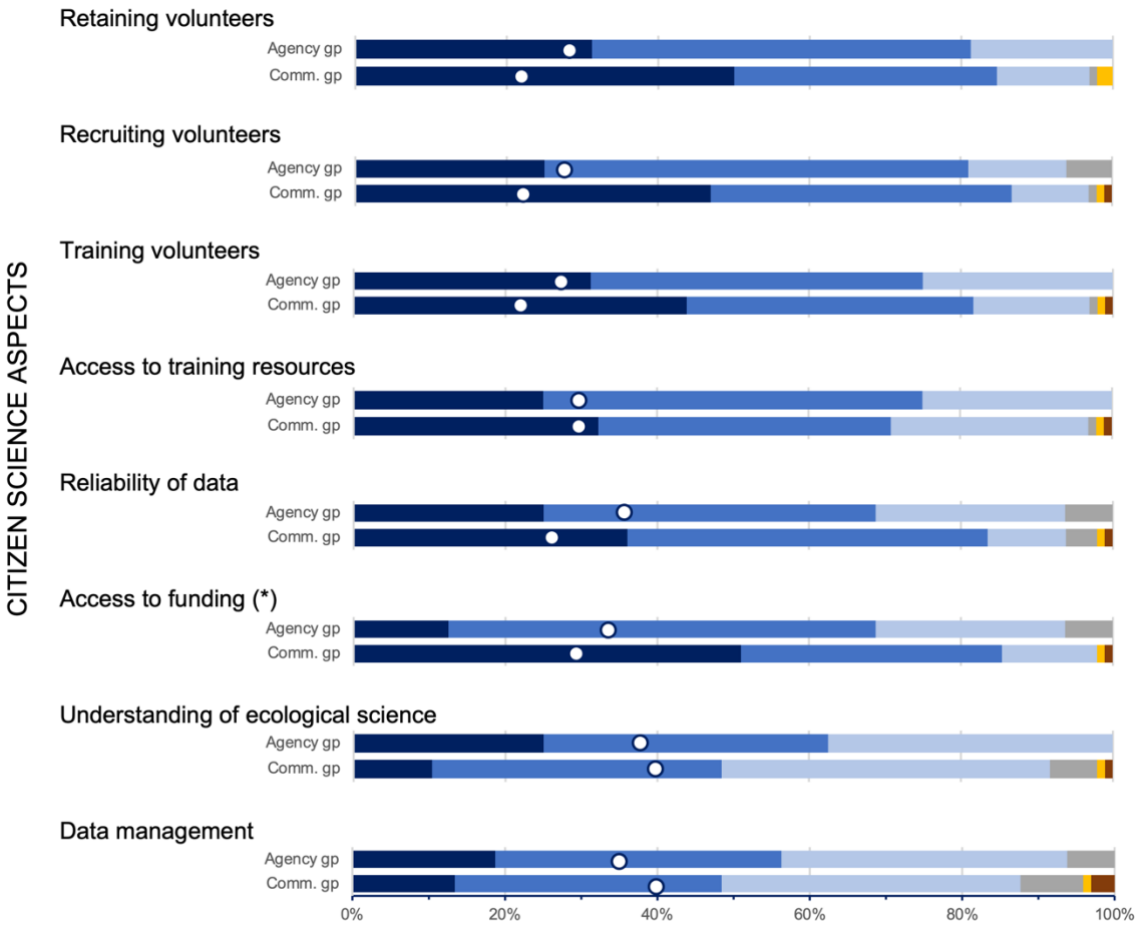


Figure 4.8 – Comparison of agency and community groups' views of the importance of development needs of citizen science in New Zealand. *p < 0.05. (Fisher's exact test). Central tendency (median) of the groups' responses indicated by circles on the bars.

Response descriptors key:

Extremely important | Very important | Moderately important
Slightly important | Not at all important | Unsure/don't know

4.3.8 Elicitation interviews

The follow-up interviews explored differences in survey responses by agency and community groups respondents with respect to the application and nature of citizen science (Table 4.5 and Table 4.6). Not all similarities or differences in the survey themes generated a response from interviewees. The themes that elicited interviewee responses were:

1. Importance of citizen science activities:

- for agencies the engagement of public with science and scientists was considered a lower priority than for community group respondents – agencies appeared more focussed in merely getting people involved in projects; and,

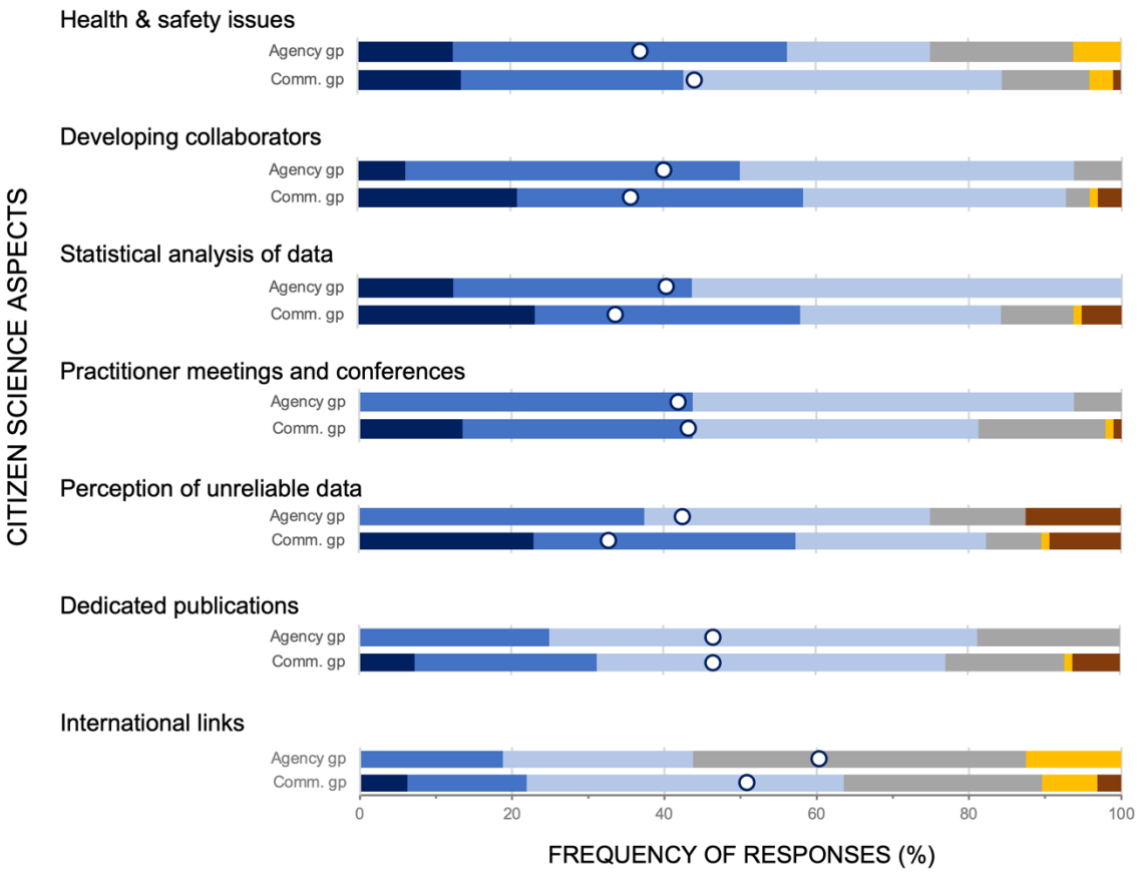


Figure 4.8 ***(continued)***

- having ecological knowledge is seen by both agency and community respondents as having low priority for involvement in citizen science.

2. Potential barriers to community participation in citizen science activities:

- issues leading to the retention of volunteers; and,
- availability of data, and issues with data dissemination.

3. Mechanisms of communication of ecological science to project stakeholders:

- communicating science through formal mechanisms (published papers and conferences) was considered a higher importance by agency respondents then community respondents;
- agency respondents considered conferences to be of high value for restoration stakeholders; and,
- for community respondents, project reports, the mechanisms of communicating ecological science information to stakeholders organisational was dominated by newsletters and personal contacts.

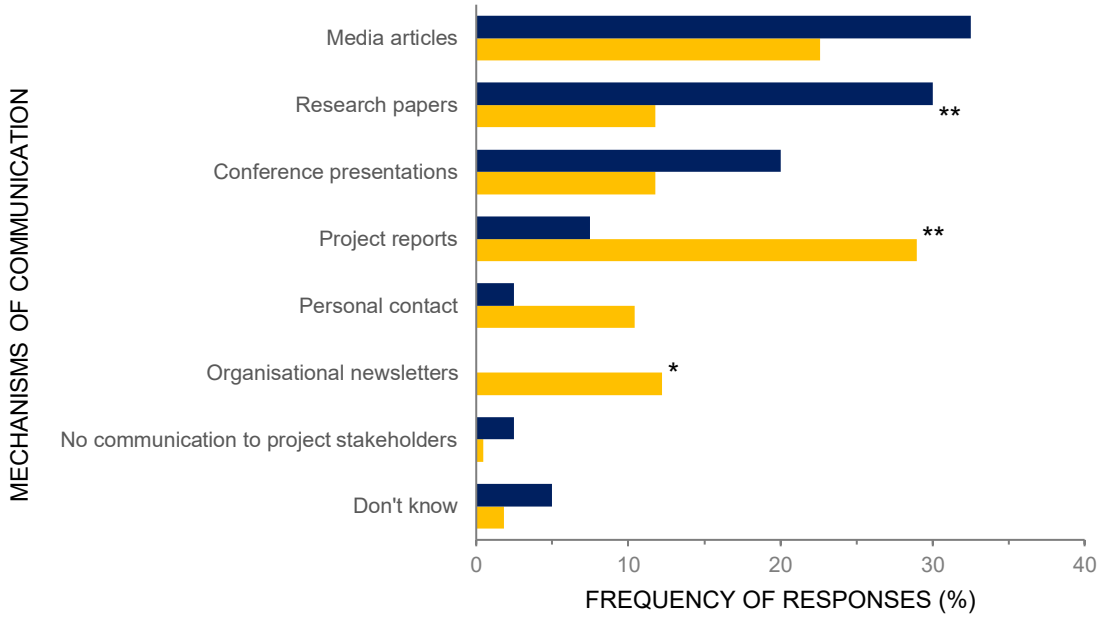


Figure 4.9 – Mechanisms used to communicate ecological science to project stakeholders, identified in a survey of community engagement in ecological science in the northern North Island, Aotearoa New Zealand. *p < 0.05. **p < 0.01. (Fisher's exact test). Agency group responses are shown in dark blue, community group responses in yellow.

Table 4.5 – Responses of agency interviewees to questions identified from the analysis of the online surveys on citizen science.

	Survey outcome being explored	Interviewee comments
A.	Response to agencies being focussed on merely getting people involved in projects, with engagement of public with ecological science and scientists considered a lower priority than for community group respondents	[Agreed] … invitations extended to friends and neighbours, opportunity to brag about number of rats caught. (Interview 9) Community interest and place equals community interaction, but a range of values. (Interview 11)
B.	Response to potential barriers to community participation in ecological science - retention of volunteers	Groups tend to be led by retirees – motivators impact the whole group. (Interview 9) [Agreed] Time issues – lack of understanding and commitment. As the project progresses, some work gets harder, more physical. Demoralising outcomes can be the cause of retention issues. (Interview 10) Landscape scale – need all (secondary) households to engage. … agencies were blind to the power of community groups. (Interview 11)
C.	Response to potential barriers to community participation in ecological science - data management	Dissemination of data difficult (7,000 covenants). … a national issue, but depends on data type, perhaps species specific? (Interview 10) Data must be available for the community for decision making, e.g. [specified] weed project, scientists work with the community to interpret data. (Interview 11)
D.	Response to the need to raise the priority of agency-initiated local conference or workshop events for communicating science	… local science for local people" (Interview 9). … localised science provides information nuggets. (Interview 10) [Community] groups invested in science in different ways. Workshops, or guidance based on science, offer an opportunity to opt into science networks of expertise. (Interview 11)

Table 4.6 – Responses of community group interviewees to questions identified from the analysis of the online surveys on citizen science.

	Survey outcome being explored	Interviewee comments
A.	Response to agencies being focussed on merely getting people involved in projects, with engagement of public with ecological science and scientists considered a lower priority than for community group respondents	The 'Oh, that's why' [the science] comes later [in participation]. (Interview 1) Social side is important, should be fostered. [Volunteers] spend time in the bush with like-minded people to do good. Being part of an ecological restoration project is tramping with a purpose. (Interview 5) Relationships are important – champions sharing with people of like mind. (Interview 6) Social side is a strong driver. (Interview 7)
B.	Response to the need for having formal ecological knowledge	Volunteers need to know what they are doing is meaningful and getting results. (Interview 5) Expectation of prior knowledge and interest for the project. (Interview 5)
C.	Response to the importance and adequacy of communication of ecological science information	[Adequate access] … through the employment of qualified and/or experienced ecologists. (Interview 2) [Inadequate access] … information is important, but it depends on the volunteer's personality. (Interview 3) [Inadequate access] … but lots of local conferences. Information is not easily accessed, e.g., research papers online but at a cost; technical information not necessarily pertinent to the public. (Interview 4) Champions form the group and impart knowledge to the group. Often a newsletter is sufficient, don't want details. But some people always want more information. (Interview 5) Ecological restoration history is reinforced but is often anecdotal. (Interview 6) ... need to search for information – don't know where to look, may not be accessible. (Interview 7)

4.4 Discussion

The success and/or progress of an ecological restoration project requires systematic ecological monitoring to be in place for effective and meaningful evaluation of the restoration activities undertaken (Atkinson, 1994a; Méndez-Toribio, Martínez-Garza, & Ceccon, 2021; Sutherland, Pullin, Dolman, & Knight, 2004). Although ecological systems are well recognised to be extremely complex (Moreno-Mateos et al., 2020), citizen science is strongly advocated as a means to ecological monitoring outcomes, particularly for community-based restoration projects (Ballard et al., 2018; Edwards et al., 2018; Huddart et al., 2016).

Practitioners in community-based restoration projects come from a spectrum of society and invariably participate on a voluntary basis (Peters, Hamilton, et al., 2015; Ritchie, 2011). Their participation in ecological monitoring activities as part of the restoration process fulfil the definition of citizen scientists (Australian Citizen Science Association, 2018). This participation in citizen science may be intentional or accidental, thus has potential to lead to a range of attitudes and responses to the application of scientific principles.

In this study, I explored the nature of ecological science in place in restoration projects, the role of practitioners in the science, and whether the New Zealand experiences were consistent with the expert-lay dichotomy reported by other researchers (e.g., Lee et al., 2020; Vetter, 2011).

4.4.1 Citizen science in ecological restoration

Community group and agency respondents identified that citizen science was in place in essentially all of their projects, with all types of citizen science represented. This is consistent with the global pattern of public participation in ecological science (summarised by Edwards et al., 2018) where participation is acknowledged as already playing a crucial role in both implementing restoration monitoring and facilitating gains in ecological literacy.

Overall responses between community-based and agency respondents to types of citizen science, initiators of activities and source of expertise were consistent, suggesting that awareness of, and potentially engagement in, ecological science is relatively high in New Zealand projects. The types of field activities identified by the respondents fit the level of “high” participant engagement (Hobbs & White, 2016, p. 608), as they constitute active or hands-on involvement. However, the field activities were focussed on ecological measurements at the species level (or 'diversity' attributes, Ruiz-Jaén & Aide, 2005, p. 569), fulfilling only two out of the six attributes advocated by SER to characterise a restored ecosystem relative to a reference ecosystem – the attributes of species composition and absence of threats (Gann et al., 2019). This limited focus is consistent with an analysis of

measurement of restoration success that indicated that diversity and vegetation structure attributes are monitored more frequently than complex and longer responding ecological processes (Ganzevoort et al., 2017; Ruiz-Jaén & Aide, 2005). Species-level attributes are favoured for avocational citizen scientists to measure as they are potentially the least complex methodologies and show responses in a relatively short time (Geoghegan, Dyke, Pateman, West, & Everett, 2016; Ruiz-Jaén & Aide, 2005) – aspects that are deemed key for successful citizen science projects (Pocock, Chapman, Sheppard, & Roy, 2014). Furthermore, in Aotearoa New Zealand extensive advocacy nationwide of the impacts of habitat degradation and invasive species (e.g., Predator Free New Zealand Trust) may well be contributing to the diversity and vegetation focus amongst citizen scientists active in restoration projects.

The areas where agency and community-based respondents differed can be partly explained by the legislative role of agencies and the personal experiences of individual participants.

The benefits that agency respondents rated significantly higher than community-based respondents, those of community stewardship and project efficiency, reflect policies that invest in localised environmental stewardship ("policy-driven citizen science"; Dillon, Stevenson, & Wals, 2016, p. 450), an approach that is considered to deliver sustainability outcomes (Bennett et al., 2018). The reference to “efficiencies” acknowledges that, while community contributions support agencies’ goals, their contribution as volunteers allows agencies to expand their capacity for environmental management while minimising their financial input. Thus, participation of local communities in environmental stewardship activities facilitates government agencies to take advantage of cost-benefit outcomes of citizen science (Göbel, Nold, Berditchevskaia, & Haklay, 2019) and to meet the expectations of fiscal responsibility (Gill, 2012; Local Government Act 2002).

Community-based participants implied that activities tend to be led by other volunteers, especially experienced retirees, not agency employees. Although community groups are reputedly supported by agencies (Peters, Hamilton, et al., 2015), this support is not necessarily through face-to-face contact at the project sites. Agency policies and performance measures are focussed more at an overview operational level rather than that of the individual participants in citizen science. Thus the personal and social benefits of citizen science were rated higher by community-based respondents than by agency respondents. This reflects the personal philosophies, and emotionally-charged values (DiEnno & Thompson, 2013), held by volunteers that lead to the engagement in ecological restoration in the first place. Such motivations are generally consistent worldwide (Measham & Barnett, 2008; Miles, Sullivan, & Kuo, 1998; Miles, Sullivan, & Kuo, 2000). The high value

placed on physical and mental well-being can account for the value of investing time into voluntary participation in science activities that may, at least initially for some, be inherently alien.

4.4.2 Barriers to citizen science

Although citizen science was supported and valued, actual and potential barriers to community participation in ecological science activities were generally rated highly by all respondents, and reflect issues identified in global research in this field (Conrad & Hilchey, 2011; Cooper et al., 2012; Geoghegan et al., 2016). In all instances where there was a significant difference between the responses of the two groups, agency respondents rated the barriers higher than community-based respondents. This may be explained by institutional constraints associated with agency governance roles.

Although agencies may recognise and utilise the cost–benefit outcomes of citizen science to achieve environmental targets (Göbel et al., 2019; Haklay, Antoniou, Basiouka, Soden, & Mooney, 2014), citizen science is inextricably linked to political elements that determine how the agencies function (Göbel et al., 2019; Schade et al., 2021). Reliance by an agency on citizen science volunteers with no institutional links poses risks to the legal and regulatory functions of the agency, particularly where the citizen scientists have expectations different to those of the agency, a degree of financial independence, and/or variable scientific understandings (Gellman, 2015; Guerrini, Majumder, Lewellyn, & McGuire, 2018). Agency employees who are measured through key performance indicators may, therefore, have ambivalent views on the efficacy of citizen science.

Ambivalent respondents have been shown to display conservative decision tendencies favouring the status quo (Ready, Whitehead, & Blomquist, 1995; Samuelson & Zeckhauser, 1988). This suggests that, applied to this situation, the higher rating of barriers to community participation in citizen science shown by agency respondents represented a bias towards the status quo (i.e., a dominance of agency governance). These barriers were those associated with volunteer participation (mobilisation and training), data quality and management, and the need for specialist knowledge.

Issues with citizen science at the organisational level, particularly in relation to the recruitment and training of volunteer participants, is well recognised (Bonney et al., 2009; Conrad & Hilchey, 2011). However, where citizen science projects assist agencies to meet accountability targets generated from their legal obligations and community expectations, the outcomes of the projects need to be of a sufficient standard and run for long enough to

satisfy the targets. To achieve this, the contribution of the volunteers must be continuous and enduring.

The desire of volunteers to contribute to project goals is certainly significant motivation to participate in citizen science projects (Larson et al., 2020), with personal interests and expertise (in a 'hobby' context) and participation for personal gain and leisure (Esteves, Uchoa, de Souza, Pereira, & Antelio, 2017) also generating participation. The variety of motivations, entangled with a myriad of societal and social diversions, spread of participant demographics and health and safety considerations (Fraisl et al., 2022; Geoghegan et al., 2016) will inevitably impact on individuals' abilities to contribute, and lead to participant turnover. A consequence of high participant turnover is the potential disruption to citizen science projects, and the need for ongoing recruitment and training of new participants (Esteves et al., 2017; West & Pateman, 2016).

A further potential barrier to citizen science sustainability exists where the volunteer's participation is low-commitment and intermittent, known as a "dabbler" (Eveleigh, Jennett, Blandford, Brohan, & Cox, 2014, p. 2985), a status claimed by Parrish et al. (2019) to dominate volunteer groups. Dabblers may become unintentional participants in science activities ("accidental scientists"; Galbraith et al., 2016, p.10; see also Chapter 2), and lack the motivation to persist with long-term contributions to field activities. Variable engagement by individual volunteers to projects may compromise the capacity of communities to engage in citizen science. Thus reliance on citizen scientists by agencies to meet their accountability targets may not be guaranteed, and may explain the significantly greater concerns of agency employees towards citizen science factors that are barriers to project sustainability.

Key global debates have centred around the integrity of data gathered by avocational citizen scientists and how it is used. The variability of the collective demographics and expertise of citizen scientists, even with training and standardised methodologies in place, will invariably influence data accuracy through differences in observational, identification and recording skills (Cooper et al., 2012; Dickinson et al., 2010). Furthermore, inadvertent data selection by observers during the recording process, and/or interpretation of the data value (e.g., discounting the value of nil results, Cooper et al., 2012), may contribute to data biases of the citizen scientist that require additional analyses to detect and validate (Esteves et al., 2017). Although data quality can be managed to minimise the issues (Dickinson et al., 2010), the logistical requirements may generate a further burden where the volunteer force is large (Esteves et al., 2017).

Professional and community participants may also have differing expectations of the access and dissemination of data gathered through citizen science. For a professional scientist, data is traditionally confidential pending formal publication, usually to protect personal intellectual property interests. A citizen scientist, however, may have an expectation that the data that they had collected about their project would be made available for re-use by anyone to serve a wider public interest (Scassa & Chung, 2015). Although the access to scientific knowledge and sharing its benefits are principles advocated for citizen science (Robinson et al., 2018), avocational practitioners may not be aware, understand, nor necessarily appreciate, the conventional stewardship of data. This has potential to generate ethical differentials between professional and lay restoration participants (Cooper, Rasmussen, & Jones, 2021), although Scassa and Chung (2015) suggest that forethought, planning and transparency can address such barriers.

4.4.3 Communication of ecological science

Whilst having formal ecological knowledge was not seen as a prerequisite for participation in citizen science by either agency or community-based respondents, it was acknowledged that an understanding of ecological science was important, and that dissemination of ecological science was valuable for all projects.

Community-based survey participants indicated that ecological science knowledge was essential for their projects, and valued its application to their projects. This position highlights an awareness that ecological restoration practices need to be based on sound ecological science advocated by restoration scientists (e.g., Atkinson, 1994b; Ruiz-Jaén & Aide, 2005), and reflects research that shows, in general, that citizen science participants value knowing the scientific outcomes they contributed to (Golumbic, Baram-Tsabari, & Koichu, 2020). However, the means by which ecological science knowledge was disseminated and received varied between agency and community-based practitioners.

Both groups of respondents identified media articles as an important means of communicating ecological science to practitioners. Modern media articles, consisting of a variety of forms that integrate with an interactive network (Castells, 2010), are generally widely distributed and freely available, often at minimal or no cost. However, it is surprising that agency respondents considered this as the main mechanism to communicate ecological science to project stakeholders as research has shown that in New Zealand science professionals, in general, consider science reporting to be poor (Ashwell, 2014). Media articles, although their distribution may be extensive, do not necessary represent quality information as they may follow journalistic norms including sensationalism, lack of relevant

details considered too complex for the public, and misbalance of disparate views (Ashwell, 2014; Dunwoody, 2021).

Research papers were indicated by agency respondents as a significant mechanism to communicate ecological science to project stakeholders. Research papers are subjected to rigorous quality assurance review processes, and follow a formal format and discipline-specific language that may be unfamiliar to community-based practitioners (Anderson, 2014). Although some community-based stakeholders did identify research papers as sources of ecological science knowledge, such sources did not rate highly. Issues with formal publications identified by community-based respondents was that where and/or how to access formal publications was not common knowledge, not all journal papers were open-access, and those that community-based practitioners could access were considered inadequate for their purposes. These views reflect the outcomes of research elsewhere on public access to formal research papers (Anderson, 2014). Thus formal publications may not be reaching audiences that might apply the research in the field, and contribute to a "research-implementation gap" identified by Anderson (2014, p. 1148).

Communication options relied upon by community-based participants for sharing of science information, personal contact and organisational newsletters, will vary in quality and accuracy. Information passed between personal contacts, "environmental narrative" accounts (Turner, 2011, p.28), perhaps a product of the social side of volunteering, are at risk of variable selection and interpretation by both the source and end-point parties. Practitioners engaging in narratives may not have engaged sufficiently with the scientific processes that underlie production of scientific explanations, and narratives can be biased to serve particular interests (Turner, 2011). Such orally disseminated information is essentially anecdotal and, although it can be accurate and useful particularly in the early stages of a scientific process (Lilienfeld, Lynn, & Lohr, 2015), interpretation is likely to lack evidential validation and thus could potentially undermine the essence of basing ecological restoration on ecological science.

Project reports and organisational newsletters, informal publications generally produced by the community participants for their own volunteers, also represent a major way that information is disseminated to community-based practitioners. Media of these types are generally distributed electronically, and often stored on organisational websites, facilitating wide distribution and easy access to both local and distant practitioners. The proliferation of media-based sources, however, is recognised as a challenge to scientific accuracy and credibility (Hansen, 2016). Media reports, even if written by ecological professionals or experts, may be biased towards topics perceived to be those the volunteers 'want' to read

(e.g., the iconic species), and therefore may not represent adequately the complexities of ecological science.

Informal science communication, however, can stimulate science interest and knowledge for non-professionals, and lead to participants being more comfortable and receptive to ecological science concepts (National Research Council, 2009). Such benefits can be maximised through the use of everyday language and experiences (National Research Council, 2009), the very type of communications likely to be used in informal media. The National Research Council (2017, p. 309) recommends that professionals should use a diversity of tools to link science with the everyday experiences of practitioners, in this case experience in restoration activities.

For many respondents, from both community groups and agencies, the communication of ecological science through local conference or workshop events was considered to be effective, and these events were clearly valued and enjoyed by participants. Although the predominant theme of the events has been pest management, other aspects of ecological restoration were on show. The events offered lectures from professionals, and displays by community groups, educators, and commercial businesses on a spectrum of ecological restoration.

An example of a regular Auckland Council event is “Pestival” (Auckland Council, 2019), with aims that include showcasing community-led conservation activities, introducing new innovations and best practice methods, and introducing Council’s proposals for community-led conservation initiatives. The 2018 Auckland Council Pestival event was attended by more than 500 people was considered to be a success by an agency interviewee as it provided the opportunity for community-based practitioners to opt into a broad range of aspects of ecological science. The term “Pestival” [1] has also been adopted for other local body and schools’ environmental events (e.g., Aotea Great Barrier Environmental Trust, 2022; Botany Downs Secondary College, 2019) (Fig. 4.10).

[1] Note. A like-named event held in London has quite different intentions – the London Pestival event is an international arts festival dedicated to ‘the art of being an insect' (The Guardian, 2019). The New Zealand Pestival events focus on management of unwanted species (“pests”), reflecting the impact of invasive species on indigenous New Zealand biota and the necessary prioritisation of their management in restoration projects (Galbraith et al., 2016).

Figure 4.10 – Example of a "Pestival" promotion (Aotea Great Barrier Environmental Trust, 2022).

Local conferences and workshops represent the science communities reaching out to community practitioners and go some way towards addressing the research-implementation gap. At the national level, the New Zealand Ecological Society (NZES) has adopted a strategy to invite community restoration groups to society conferences. The intentions of this strategy include informing public opinion, making ecology approachable and interesting to the public and, specifically, to improve the effectiveness and efficiency of restoration projects (NZES, 2007). However, such events may engage with only a small proportion of their target audience (Anderson, 2014), particularly if they are infrequent or held in central locations.

Some agency initiatives use social incentives to facilitate information sharing with members of a community other than on a basis of environmental motivation. Interviewees specifically highlighted "Wine & Weeds" events (Fig. 4.11) as an example of using a social incentive to engage with public and encouraging them to participate in the less popular activity of weed control. The intention of these events is to promote weed identification, examine best practice for control, and/or to participate in weeding activities. Using this type of social event to engage with local communities for the management of invasive plants appears to have started in Auckland, New Zealand, in 2017. There is, however, a similar concept in place in the USA (e.g., Ammons, 2016; Eventbrite, 2021; Trees Atlanta, 2023), generally with similarly intended biodiversity outcomes.

Figure 4.11 –"Wine & Weeds" promotions from social media (Beyond the Fence, 2019; Greenhithe Ecology Network, 2020).

A potential drawback where citizens become participants in restoration projects as a response to social invitations, is that ecological science will not be the motivator, nor may ever be. These events may favour the dabbler, whose participation may be associated only with periodic social events and will make only intermittent contributions to citizen science at best.

Citizen scientists welcome quality information to boost their ecological knowledge, and to give purpose to their restoration endeavours. Access to scientific information takes the community-based participant's experience beyond that of simply a positive feel-good action for the environment, to one of action supported by a sound rationale, for instance the "tramping with a purpose" (Interview 5) philosophy. Outreach initiatives by professional scientists are welcomed by community-based practitioners who are aware that much of the information that they receive is anecdotal and not necessarily quality information.

4.4.4 "Don't know" answers

Approaches to the interpretation of "don't know" (DK) answers are variable. Some authors argue that DK responses may be non-substantive responses, potentially the result of indifference to the questions or a self-satisfying action, and should be treated as missing data (e.g., Holbrook, 2008; Iannario, Manisera, Piccolo, & Zuccolotto, 2020; Krosnick, 1991). There is, however, considerable evidence that DKs generally represent a genuine lack of information on the topic being questioned (Grichting, 1994; Iannario et al., 2020), and that the DK response is essentially a legitimate expression of ignorance by the participant (Beatty, Herrmann, Puskar, & Kerwin, 1998; Grichting, 1994).

I treated DK answers as legitimate responses, assuming that the requested information was not known by the survey participant. This approach was based on confidence that the survey participants, being a purposive targeted group that had showed truthful responses across the survey, were not indifferent to the questions being asked. This confidence is supported by van Es, Lorence, Morgan, and Church (1996), who suggest that DK responses to environmental issues, even those recognised as having importance, indicate that information may not have been sufficiently circulated within communities for opinions to have been formed. DK data were considered for important insights into the responses, but were excluded from substantive analysis as recommended by Grichting (1994).

4.4.5 Conclusion

This study showed that the views on the importance and inclusion of ecological science expressed by restoration participants were consistent with those documented in international research. Citizen science activities are often advocated for gathering ecological data to show restoration progress and success (Dickinson et al., 2010), and have potential to support the conventional, robust science deemed necessary for a restoration project to succeed (Higgs, 2005). There are many well-established examples demonstrating the benefits and outcomes of this approach (e.g., Tiritiri Matangi Island; Graham, Veitch, Aguilar, & Galbraith, 2013).

However, not everything can be monitored by citizen science (Chase & Levine, 2016) because of technological complexities and variable commitment of participants to the activities. The current application of citizen science in restoration demonstrates this, as it is dominated by data collected at the diversity level of ecology, with evidence suggesting that high profile or iconic species may elicit a greater tendency for engagement in citizen science than other taxa (Ganzevoort et al., 2017). Nonetheless, citizen science is expected to be a future growth area to optimise restoration practice, particularly to fulfil the UN Decade for Ecological Restoration action plan (Abhilash, 2021), and invitations promoting opportunities to attract public to citizen science are now commonplace and wide-ranging (e.g., National Geographic Society, 2023).

The issues associated with participation in citizen science identified by the respondents appear to be universal, and it is likely as more people engage in ecological restoration projects that these barriers will intensify correspondingly. Robinson et al. (2018) propose the adoption of ten principles for citizen science initiatives, intended to provide a framework that fosters collaborative and open relationships between stakeholders to maximise the benefits of citizen science. Application of the principles to citizen science in ecological restoration would include the upskilling of community-based participants in their capacities for ecological science and the facilitation of ready access to knowledge to sustain the initial interests in the

science elements identified in this study as essential to citizen science to contribute to the success of ecological restoration projects.

References

Abhilash, P. C. (2021). Restoring the unrestored: Strategies for restoring global land during the UN Decade on Ecosystem Restoration (UN-DER). *Land, 10*(2). https://doi.org/10.3390/land10020201

Allen, I. E., & Seaman, C. A. (2007, Jul 2007). Likert scales and data analyses. *Quality Progress, 40*(7), 64-65.

Ammons, J. (2016). Wine + weeds. *Walter*. Retrieved 30 July 2021 Retrieved from https://waltermagazine.com/community/people/the-usual-wine-and-weeds-on-wednesdays/

Anderson, P. (2014). Practitioner's perspective: Bridging the gap between applied ecological science and practical implementation in peatland restoration. *Journal of Applied Ecology, 51*(5), 1148-1152. https://doi.org/10.1111/1365-2664.12258

Aono, Y., & Kazui, K. (2008). Phenological data series of cherry tree flowering in Kyoto, Japan, and its application to reconstruction of springtime temperatures since the 9th century. *International Journal of Climatology, 28*(7), 905-914. https://doi.org/https://doi.org/10.1002/joc.1594

Aotea Great Barrier Environmental Trust. (2022). *Pestival Aotea Great Barrier*. Retrieved 21 December 2022, from https://www.gbiet.org/aotea-pestival

Ashwell, D. (2014). The challenges of science journalism: The perspectives of scientists, science communication advisors and journalists from New Zealand. *Public Understanding of Science, 25*(3). https://doi.org/10.1177/0963662514556144

Atkinson, I. A. E. (1994a). *Guidelines to the development and monitoring of ecological restoration programmes*. Wellington: Department of Conservation.

Atkinson, I. A. E. (1994b). *Guidelines to the development and monitoring of ecological restoration programmes.* Wellington: Department of Conservation.

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. *Social Research Update, 33*.

Australian Citizen Science Association. (2018). *10 Principles of citizen science*. Sydney: Australian Citizen Science Association. Retrieved from

https://citizenscience.org.au/wp-content/uploads/2018/09/10-Principles-of-Citizen-Science.pdf

Ballard, H. L., Phillips, T. B., & Robinson, L. (2018). Conservation outcomes of citizen science. In S. Hecker, M. Haklay, A. Bowser, Z. Makuch, J. Vogel, & A. Bonn (Eds.), *Citizen science* (pp. 254-268). London: UCL Press.

Beatty, P., Herrmann, D., Puskar, C., & Kerwin, J. (1998). 'Don't know' responses in surveys: Is what I know what you want to know and do I want you to know it? *Memory, 6*(4), 407-426. https://doi.org/10.1080/741942605

Bennett, N. J., Whitty, T. S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., & Allison, E. H. (2018). Environmental stewardship: A conceptual review and analytical framework. *Environmental Management, 61*(4), 597-614. https://doi.org/10.1007/s00267-017-0993-2

Beyond the Fence. (2019). *Wine & Weeds*. Retrieved 30 July 2021, from https://www.facebook.com/events/ravenhill-caferestaurant/wine-weeds/2502123466682242/

Bhandari, P., & Nikolopoulou, K. (2022). *What Is a likert scale?* | *Guide & examples*. Retrieved 16 November, 2022, from https://www.scribbr.com/methodology/likert-scale/

Birds New Zealand. (2019). *Why is beach patrolling so important?* Retrieved 25 November 2022, from https://www.birdsnz.org.nz/schemes/beachpatrolscheme/why-is-beach-patrolling-so-important/

Bonney, R. (2021). Expanding the impact of citizen science. *BioScience, 71*(5), 448-451. https://doi.org/10.1093/biosci/biab041

Bonney, R., Cooper, C. B., Dickinson, J. L., Kelling, S., Phillips, T., Rosenberg, K. V., & Shirk, J. L. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience, 59*(11), 977-984. https://doi.org/10.1525/bio.2009.59.11.9

Boone, H. N., & Boone, D. A. (2012). Analyzing likert data. *Journal of Extension, 50*(2), 1-5.

Botany Downs Secondary College. (2019). *Botany pestival*. Retrieved 15 April 2019, from http://www.bdsc.school.nz/event/botany-pestival/

Buntting, C., Doyle, C., Anderson, D., & Luczak-Roesch, M. (2020). Weaving a web of connections through online citizen science *New Zealand Annual Review of Education, 26*, 69-75.

Candler, G. [Pinterest]. (n.d.). Citizen science projects. Retrieved 22 October 2021 from https://www.pinterest.nz/gilliancandler/citizen-science-projects/

Castells, M. (2010). *The rise of the network society*. Chichester, UK: Wiley-Blackwell. https://doi.org/https://doi.org/10.1002/9781444319514.ch5

Ceccaroni, L., Bowser, A., & Brenton, P. (2017). Civic education and citizen science: Definitions, categories, knowledge representation. In C. Luigi & P. Jaume (Eds.), *Analyzing the role of citizen science in modern research* (pp. 1-23). Hershey, PA, USA: IGI Global. https://doi.org/10.4018/978-1-5225-0962-2

Chase, S. K., & Levine, A. (2016). A framework for evaluating and designing citizen science programs for natural resources monitoring. *Conservation Biology, 30*(3), 456-466. https://doi.org/https://doi.org/10.1111/cobi.12697

Citizen Science Association of Aotearoa New Zealand. [#CitSciNZ]. (2016). Citizen Science New Zealand. Retrieved 21 November 2022 from https://www.facebook.com/CitizenScienceNewZealand

Cohn, J. P. (2008). Citizen science: Can volunteers do real research? *BioScience, 58*(3), 192-197. https://doi.org/10.1641/B580303

Conrad, C. C., & Hilchey, K. G. (2011). A review of citizen science and community-based environmental monitoring: Issues and opportunities. *Environmental Monitoring and Assessment, 176*(1), 273-291. Conrad2011. https://doi.org/10.1007/s10661-010-1582-5

Cooke, S. J., Bennett, J. R., & Jones, H. P. (2019). We have a long way to go if we want to realize the promise of the “Decade on Ecosystem Restoration”. *Conservation Science and Practice, 1*(12), e129. https://doi.org/https://doi.org/10.1111/csp2.129

Cooper, C. B., Hochachka, W. M., & Dhondt, A. A. (2012). The opportunities and challenges of citizen science as a tool for ecological research. In J. L. Dickinson & R. Bonney (Eds.), *Citizen sScience: Public participation in environmental research* (pp. 99-113). Ithaca, NY: Cornell University Press.

Cooper, C. B., Rasmussen, L. M., & Jones, E. D. (2021). Perspective: The power (dynamics) of open data in citizen science. *Frontiers in Climate, 3*(57). https://doi.org/10.3389/fclim.2021.637037

Cooper, C. B., Shirk, J. L., & Zuckerberg, B. (2014). The invisible prevalence of citizen science in global research: Migratory birds and climate change. *PLoS ONE, 9*(9), e106508. https://doi.org/10.1371/journal.pone.0106508

Couvet, D., & Prevot, A. (2015). Citizen-science programs: Towards transformative biodiversity governance. *Environmental Development, 13*(0), 39-45. https://doi.org/http://dx.doi.org/10.1016/j.envdev.2014.11.003

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice, 39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Department of Conservation. (2020). *Te Mana o Te Taiao - Aotearoa New Zealand Biodiversity Strategy 2020*. Wellington, NZ: Department of Conservation.

Department of Conservation. (n.d.-a). *Become a citizen scientist*. Retrieved 8 October 2021, from https://www.doc.govt.nz/parks-and-recreation/places-to-go/toyota-kiwi-guardians/take-action/citizen-scientist/

Department of Conservation. (n.d.-b). *Get involved with citizen science*. Retrieved 8 October 2021, from https://www.doc.govt.nz/news/events/conservation-week/do-an-activity/get-involved-with-citizen-science/

Dickinson, J. L., & Bonney, R. (2012). Introduction: Why citizen science? In J. L. Dickinson & R. Bonney (Eds.), *Citizen science: Public participation in environmental research* (pp. 1-14). Ithaca, NY, USA: Cornell University Press.

Dickinson, J. L., Shirk, J. L., Bonter, D., Bonney, R., Crain, R. L., Martin, J., . . . Purcell, K. (2012). The current state of citizen science as a tool for ecological research and public engagement. *Frontiers in Ecology and the Environment, 10*(6), 291-297. https://doi.org/10.1890/110236

Dickinson, J. L., Zuckerberg, B., & Bonter, D. N. (2010). Citizen science as an ecological research tool: Challenges and benefits. *Annual Review of Ecology, Evolution, and Systematics, 41*(1), 149-172. https://doi.org/10.1146/annurev-ecolsys-102209-144636

DiEnno, C. M., & Thompson, J. L. (2013). For the love of the land: How emotions motivate volunteerism in ecological restoration. *Emotion, Space and Society, 6*, 63-72. https://doi.org/https://doi.org/10.1016/j.emospa.2012.02.002

Dillon, J., Stevenson, R. B., & Wals, A. E. J. (2016). Introduction to the special section: Moving from citizen to civic science to address wicked conservation problems. *Conservation Biology, 30*(3), 450-455. https://doi.org/https://doi.org/10.1111/cobi.12689

Dunwoody, S. (2021). Science journalism: Prospects in the digital age. In M. Bucchi & B. Trench (Eds.), *Routledge Handbook of Public Communication of Science and Technology (3rd ed.).. https://doi.org/10.4324/9781003039242* (3 ed., pp. 14-32). London: Routledge.

Edwards, P. M., Shaloum, G., & Bedell, D. (2018). A unique role for citizen science in ecological restoration: A case study in streams. *Restoration Ecology, 26*(1), 29-35. https://doi.org/10.1111/rec.12622

Eicken, H., Danielsen, F., Sam, J., Fidel, M., Johnson, N., Poulsen, M., . . . Enghoff, M. (2021). Connecting top-down and bottom-up approaches in environmental observing. *BioScience, 71*(5), 467-483. https://doi.org/10.1093/biosci/biab018

Eitzel, M. V., Cappadonna, J. L., Santos-Lang, C., Duerr, R. E., Virapongse, A., West, S. E., . . . Jiang, Q. (2017). Citizen science terminology matters: Exploring key terms. *Citizen Science: Theory and Practice, 2*(1), 1-20.

Esteves, M. G. P., Uchoa, A. P., de Souza, J. M., Pereira, C. V., & Antelio, M. (2017). Smart activation of citizens: Opportunities and challenges for scientific research. In C. Luigi & P. Jaume (Eds.), *Analyzing the role of citizen science in modern research* (pp. 262-284). Hershey, PA, USA: IGI Global. Retrieved from http://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/978-1-5225-0962-2. https://doi.org/10.4018/978-1-5225-0962-2

European Citizen Science Association. (2015). *Ten principles of citizen science*. Berlin: European Citizen Science Association. https://doi.org/10.17605/OSF.IO/XPR2N

European Citizen Science Association. (n.d.). *What is citizen science?* Retrieved 19 August 2021, from https://ecsa.citizen-science.net/

Eveleigh, A., Jennett, C., Blandford, A., Brohan, P., & Cox, A. L. (2014). *Designing for dabblers and deterring drop-outs in citizen science*. Paper presented at the meeting of the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Toronto, Ontario, Canada. https://doi.org/10.1145/2556288.2557262

Eventbrite. (2021). *Wednesday wine + weeds Penns Grove Retreat Summerfield*. Retrieved 5 August 2021, from https://www.eventbrite.com/e/wednesday-wine-weeds-penns-grove-retreat-summerfield-tickets-151332191659

Fraisl, D., Hager, G., Bedessem, B., Gold, M., Hsing, P.-Y., Danielsen, F., . . . Haklay, M. (2022). Citizen science in environmental and ecological sciences. *Nature Reviews Methods Primers, 2*(1), 64. https://doi.org/10.1038/s43586-022-00144-4

Frigerio, D., Richter, A., Per, E., Pruse, B., & Vohland, K. (2021). Citizen science in the natural sciences. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, . . . K. Wagenknecht (Eds.), *The science of citizen science* (pp. 79-96). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_5

Galbraith, M. (2013). Public and ecology - the role of volunteers on Tiritiri Matangi. *New Zealand Journal of Ecology, 37*(3), 266-271.

Galbraith, M., Bollard-Breen, B., & Towns, D. R. (2016). The community-conservation conundrum: Is citizen science the answer? *Land, 5*(4), 37.

Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., . . . Dixon, K. W. (2019). *International principles and standards for the practice of ecological restoration* (2nd ed.). Washington, D.C.: Society for Ecological Restoration.

Ganzevoort, W., van den Born, R. J. G., Halffman, W., & Turnhout, S. (2017). Sharing biodiversity data: Citizen scientists' concerns and motivations. *Biodiversity and Conservation, 26*(12), 2821-2837. https://doi.org/10.1007/s10531-017-1391-z

Gellman, R. (2015). *Crowdsourcing, citizen science, and the law: Legal issues affecting federal agencies*. Washington, DC: Woodrow Wilson International Center for Scholars.

Geoghegan, H., Dyke, A., Pateman, R., West, S., & Everett, G. (2016). Understanding motivations for citizen science. *Final report on behalf of UKEOF, University of*

Reading, Stockholm Environment Institute (University of York) and University of the West of England.

Gill, D. (2012). *Fiscal measures, parameters and benchmarks: Measuring fiscal prudence in New Zealand local government*. Wellington: New Zealand Institute of Economic Research.

Göbel, C., Nold, C., Berditchevskaia, A., & Haklay, M. (2019). How does citizen science "do" governance? Reflections from the DITOs project. *Citizen Science: Theory and Practice, 4*(1), 31. https://doi.org/http://doi.org/10.5334/cstp.204

Golumbic, Y., Baram Tsabari, A., & Fishbain, B. (2020). Engagement styles in an environmental citizen science project. *Journal of Science Communication, 19*. https://doi.org/10.22323/2.19060203

Golumbic, Y. N., Baram-Tsabari, A., & Koichu, B. (2020). Engagement and communication features of scientifically successful citizen science projects. *Environmental Communication, 14*(4), 465-480. https://doi.org/10.1080/17524032.2019.1687101

Graham, M., Veitch, D., Aguilar, G., & Galbraith, M. (2013). Monitoring terrestrial bird populations on Tiritiri Matangi Island, Hauraki Gulf, New Zealand, 1987-2010. *New Zealand Journal of Ecology, 37*(3), 359-369.

Greenhithe Ecology Network. (2020). *Caring for Greenhithe's environment … be part of it*. Retrieved 23 November 2020, from https://www.facebook.com/GreenhitheEcologyNetwork/photos/a.986589344753535/3450632185015893/

Grichting, W. L. (1994). The meaning of "I don't know" in opinion surveys: Indifference versus ignorance. *Australian Psychologist, 29*(1), 71-75. https://doi.org/10.1080/00050069408257324

Guerrini, C. J., Majumder, M. A., Lewellyn, M. J., & McGuire, A. L. (2018). Citizen science, public policy. *Science, 361*(6398), 134-136. https://doi.org/10.1126/science.aar8379

Gura, T. (2013). Citizen science: Amateur experts. *Nature, 496*(7444), 259-261. https://doi.org/10.1038/nj7444-259a

Haklay, M. (2018). Participatory citizen science. In M. Haklay, S. Hecker, A. Bowser, Z. Makuch, J. Vogel, & A. Bonn (Eds.), *Citizen Science* (pp. 52-62): UCL Press. Retrieved from . Retrieved 2020/07/01/

Haklay, M., Antoniou, V., Basiouka, S., Soden, R., & Mooney, P. (2014). *Crowdsourced geographic information use in government, Report to GFDRR*

Hansen, A. (2016). The changing uses of accuracy in science communication. *Public Understanding of Science, 25*(7), 760-774.

Higgs, E. (2005). The two-culture problem: Ecological restoration and the integration of knowledge. *Restoration Ecology, 13*(1), 159-164. https://doi.org/10.1111/j.1526-100X.2005.00020.x

Hobbs, S. J., & White, P. C. L. (2016). Achieving positive social outcomes through participatory urban wildlife conservation projects. *Wildlife Research, 42*(7), 607-617. https://doi.org/10.1071/WR14184

Hogan, T., Hinrichs, U., & Hornecker, E. (2016). The elicitation interview technique: Capturing people's experiences of data representations. *IEEE Transactions on Visualization and Computer Graphics, 22*(12), 2579-2593. https://doi.org/10.1109/TVCG.2015.2511718

Holbrook, A. (2008). Don’t knows (DKs). In P. J. Lavrakas (Ed.), *Encyclopedia of survey research methods*. Thousand Oaks, California: SAGE Research Methods. https://doi.org/10.4135/9781412963947

Holdren, J. P. (2015). *Addressing societal and scientific challenges through citizen science and crowdsourcing. Memorandum to the Heads of Executive Departments and Agencies.*

. Washington DC: White House Office of Science and Technology Policy. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/holdren_citizen_science_memo_092915_0.pdf

Huddart, J. E. A., Thompson, M. S. A., Woodward, G., & Brooks, S. J. (2016). Citizen science: From detecting pollution to evaluating ecological restoration. *WIREs Water, 3*(3), 287-300. https://doi.org/https://doi.org/10.1002/wat2.1138

Iannario, M., Manisera, M., Piccolo, D., & Zuccolotto, P. (2020). Ordinal data models for no-opinion responses in attitude survey. *Sociological Methods & Research, 49*(1), 250-276. https://doi.org/10.1177/0049124118769081

Indratmo, Howorko, L., Boedianto, J. M., & Daniel, B. (2018). The efficacy of stacked bar charts in supporting single-attribute and overall-attribute comparisons. *Visual Informatics, 2*(3), 155-165. https://doi.org/https://doi.org/10.1016/j.visinf.2018.09.002

Irwin, A. (1995). *Citizen science : A study of people, expertise and sustainable development*. London, UK: Taylor & Francis Group. Retrieved from http://ebookcentral.proquest.com/lib/unitec/detail.action?docID=180038

Johnson, J. C., & Weller, S. C. (2001). Elicitation techniques for interviewing. In J. F. Gubrium & J. A. Holstein (Eds.), *Handbook of interview research* (pp. 491-514). Thousand Oaks, CA: SAGE Publications. https://doi.org/10.4135/9781412973588

Kim, H.-Y. (2017). Statistical notes for clinical researchers: Chi-squared test and Fisher's exact test. *Restorative Dentistry and Endodontics, 42*(2), 152-155. https://doi.org/10.5395/rde.2017.42.2.152

Kobori, H., Dickinson, J. L., Washitani, I., Sakurai, R., Amano, T., Komatsu, N., . . . Miller-Rushing, A. J. (2016). Citizen science: A new approach to advance ecology, education, and conservation. *Ecological Research, 31*(1), 1-19. https://doi.org/10.1007/s11284-015-1314-y

Krosnick, J. A. (1991). Response strategies for coping with the cognitive demands of attitude measures in surveys. *Applied Cognitive Psychology, 5*(3), 213-236. https://doi.org/https://doi.org/10.1002/acp.2350050305

Larson, L. R., Cooper, C. B., Futch, S., Singh, D., Shipley, N. J., Dale, K., . . . Takekawa, J. Y. (2020). The diverse motivations of citizen scientists: Does conservation emphasis grow as volunteer participation progresses? *Biological Conservation, 242*, 108428. https://doi.org/https://doi.org/10.1016/j.biocon.2020.108428

LEARNZ. (n.d.). *Citizen science at marine reserves*. Retrieved from https://www.learnz.org.nz/marinereserves191/bg-easy-f/citizen-science-at-marine-reserves

Lee, K. A., Lee, J. R., & Bell, P. (2020). A review of citizen science within the earth sciences: Potential benefits and obstacles. *Proceedings of the Geologists' Association, 131*(6), 605-617. https://doi.org/https://doi.org/10.1016/j.pgeola.2020.07.010

Lilienfeld, S. O., Lynn, S. J., & Lohr, J. M. (2015). Science and pseudoscience in clinical psychology: Initial thoughts, reflections, and considerations. In S. O. Lilienfeld, S. J. Lynn, & J. M. Lohr (Eds.), *Science and pseudoscience in clinical psychology*. New York: The Guilford Press.

Local Government Act 2002. Retrieved from https://www.legislation.govt.nz/act/public/2002/0084/latest/whole.html#DLM172357

Ludwig, D. (2001). The era of management Is over. *Ecosystems, 4*(8), 758-764.

Mahr, D., Göbel, C., Irwin, A., & Vohland, K. (2018). Watching or being watched. In M. Haklay, S. Hecker, A. Bowser, Z. Makuch, J. Vogel, & A. Bonn (Eds.), *Citizen science* (pp. 99-109). London: UCL Press.

Manaaki Whenua Landcare Research. (2022). *Get involved*. Retrieved 21 November 2022, from https://www.landcareresearch.co.nz/tools-and-resources/get-involved/

McDonald, J. H. (2009). *Handbook of biological statistics* (3 ed., Vol. 2). Baltimore, MD: Sparky House Publishing.

McKinley, D. C., Miller-Rushing, A., Ballard, H., Bonney, R., Evans, D., French, R., . . . Soukup, M. (2015). Investing in citizen science can improve natural resource management and environmental protection. *Issues in Ecology*(19). https://doi.org/10.1016/j.biocon.2016.05.015

McKinley, D. C., Miller-Rushing, A. J., Ballard, H. L., Bonney, R., Brown, H., Cook-Patton, S. C., . . . Soukup, M. A. (2017). Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation, 208*, 15-28. https://doi.org/https://doi.org/10.1016/j.biocon.2016.05.015

McNaught, C., & Lam, P. (2010). Using Wordle as a supplementary research tool. *The Qualitative Report, 15*(3), 630-643.

Measham, T. G., & Barnett, G. B. (2008). Environmental volunteering: Motivations, modes and outcomes. *Australian Geographer, 39*(4), 537-552.

Méndez-Toribio, M., Martínez-Garza, C., & Ceccon, E. (2021). Challenges during the execution, results, and monitoring phases of ecological restoration: Learning from a country-wide assessment. *PLOS ONE, 16*(4), e0249573. https://doi.org/10.1371/journal.pone.0249573

Merenlender, A. M., Crall, A. W., Drill, S., Prysby, M., & Ballard, H. (2016). Evaluating environmental education, citizen science, and stewardship through naturalist programs. *Conservation Biology, 30*(6), 1255-1265. https://doi.org/10.1111/cobi.12737

Miles, I., Sullivan, W. C., & Kuo, F. C. (1998). Ecological restoration volunteers: The benefits of participation. *Urban Ecosystems, 2*, 27–41.

Miles, I., Sullivan, W. C., & Kuo, F. E. (2000). Psychological benefits of volunteering for restoration projects. *Ecological Restoration, 18*(4), 218-227. https://doi.org/10.3368/er.18.4.218

Miller, B. P., Sinclair, E. A., Menz, M. H. M., Elliott, C. P., Bunn, E., Commander, L. E., . . . Stevens, J. C. (2017). A framework for the practical science necessary to restore sustainable, resilient, and biodiverse ecosystems. *Restoration Ecology, 25*(4), 605-617. https://doi.org/https://doi.org/10.1111/rec.12475

Miller-Rushing, A., Primack, R., & Bonney, R. (2012). The history of public participation in ecological research. *Frontiers in Ecology and the Environment, 10*(6), 285-290. https://doi.org/10.1890/110278

Mirzaei, A., Carter, S. R., Patanwala, A. E., & Schneider, C. R. (2022). Missing data in surveys: Key concepts, approaches, and applications. *Research in Social and Administrative Pharmacy, 18*(2), 2308-2316. https://doi.org/https://doi.org/10.1016/j.sapharm.2021.03.009

Moreno-Mateos, D., Alberdi, A., Morriën, E., van der Putten, W. H., Rodríguez-Uña, A., & Montoya, D. (2020). The long-term restoration of ecosystem complexity. *Nature Ecology & Evolution, 4*(5), 676-685. https://doi.org/10.1038/s41559-020-1154-1

National Geographic Society. (2023). *Citizen science projects*. Retrieved 19 April 2023, from https://education.nationalgeographic.org/resource/citizen-science-projects/

National Research Council. (2009). Conclusions and recommendations. In P. Bell, B. Lewenstein, A. W. Shouse, & M. A. Feder (Eds.), *Learning science in informal*

environments: People, places, and pursuits (pp. 291-314). Washington, D.C.: National Academies Press.

Nerbonne, J., & Nelson, K. (2004). Volunteer macroinvertebrate monitoring in the United States: Resource mobilization and comparative state structures. *Society & Natural Resources - SOC NATUR RESOUR, 17*, 817-839. https://doi.org/10.1080/08941920490493837

New Zealand Ecological Society. (2007). *Communicating ecological science - A strategy for the New Zealand Ecological Society: 2007-2017*. Retrieved from http://nzes-d7.fuzion.co.nz/sites/all/files/Communicating%20Ecological%20Science%202007-2017_0.pdf

Newton, R., Birney, L., Janis, S., Groome, M., Palmer, M., Bone, E., . . . Woods, N. (2015). *Restoration science in New York Harbor: It takes a (large, diverse and engaged) village*. Paper Paper presented at the meeting of the American Geophysical Union, Fall Meeting 2015, San Francisco. Retrieved from https://ui.adsabs.harvard.edu/abs/2015AGUFMED53G..07N/abstract

Onwuegbuzie, A. J., & Leech, N. L. (2007). Sampling designs in qualitative research: Making the sampling process more public. *The Qualitative Report, 12*(2), 238-254.

Palys, T. (2008). Purposive sampling. In L. M. Given (Ed.), *The SAGE Encyclopedia of qualitative research methods* (pp. 698-699). Thousand Oaks: SAGE Publications. https://doi.org/10.4135/9781412963909

Parrish, J. K., Jones, T., Burgess, H. K., He, Y., Fortson, L., & Cavalier, D. (2019). Hoping for optimality or designing for inclusion: Persistence, learning, and the social network of citizen science. *Proceedings of the National Academy of Sciences, 116*(6), 1894-1901. https://doi.org/doi:10.1073/pnas.1807186115

Pelacho, M., Rodríguez, H., Broncano, F., Kubus, R., García, F. S., Gavete, B., & Lafuente, A. (2021). Science as a commons: Improving the governance of knowledge through citizen science. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, . . . K. Wagenknecht (Eds.), *The science of citizen science* (pp. 57-78). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_4

Pelacho, M., Ruiz, G., Sanz, F., Tarancón, A., & Clemente-Gallardo, J. (2021). Analysis of the evolution and collaboration networks of citizen science scientific publications. *Scientometrics, 126*(1), 225-257. https://doi.org/10.1007/s11192-020-03724-x

Pest Free Kaipātiki. (2021). *Citizen science month - July 2021*. Retrieved 22 October 2021, from https://www.pestfreekaipatiki.org.nz/citizensciencemonth

Peters, M. A. (2018). *Citizen science inventory: Programmes, projects, resources and learning opportunities*. Hamilton, New Zealand.

Peters, M. A., Eames, C., & Hamilton, D. (2015). The use and value of citizen science data in New Zealand. *Journal of the Royal Society of New Zealand, 45*(3), 151-160. https://doi.org/10.1080/03036758.2015.1051549

Peters, M. A., Hamilton, D., & Eames, C. (2015). Action on the ground: A review of community environmental groups' restoration objectives, activities and partnerships in New Zealand. *New Zealand Journal of Ecology, 39*(2), 179-189.

Peters, M. A., Hamilton, D., Eames, C., Innes, J., & Mason, N. W. H. (2016). The current state of community-based environmental monitoring in New Zealand. *New Zealand Journal of Ecology, 40*(3), 279-288.

Pierson, C. M., Anderson, D., & Luczak-Roesch, M. (2020). Developing science capabilities for citizenship through participation in online citizen science (OCS) projects. *Set: Research Information for Teachers, 1*. https://doi.org/10.18296/set.0157

Pocock, M. J. O., Chapman, D. S., Sheppard, L. J., & Roy, H. E. (2014). *Choosing and using citizen science: A guide to when and how to use citizen science to monitor biodiversity and the environment*. Wallingford: NERC/Centre for Ecology & Hydrology.

Porter, R. (1978). Gentlemen and geology: The emergence of a scientific career, 1660-1920. *The Historical Journal, 21*(4), 809-836.

Predator Free New Zealand Trust. *Get involved*. Retrieved 10 February 2023, from https://predatorfreenz.org/

Predator Free NZ. (n.d.). *Citizen science monitoring method outlined and tested*. Retrieved from https://predatorfreenz.org/research/distance-sampling-bushy-park/

Rayson, P. (2008). From key words to key semantic domains. *International Journal of Corpus Linguistics, 13*(4), 519-549. https://doi.org/10.1075/ijcl.13.4.06ray

Ready, R. C., Whitehead, J. C., & Blomquist, G. C. (1995). Contingent valuation when respondents are ambivalent. *Journal of Environmental Economics and Management, 29*(2), 181-196. https://doi.org/https://doi.org/10.1006/jeem.1995.1040

Riesch, H., & Potter, C. (2014). Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions. *Public Understanding of Science, 23*(1), 107-120. https://doi.org/10.1177/0963662513497324

Ritchie, H. (2011). *From eyesore to asset: Care groups review. Report no. 24.* Hamilton: Waikato Regional Council.

Robbins, N. B., & Heiberger, R. M. (2011). Plotting Likert and other rating scales. In *Proceedings of the 2011 joint statistical meeting* (Vol. 1, pp. 1058-1066). Alexandria, VA: American Statistical Association.

Robinson, L. D., Cawthray, J. L., West, S. E., Bonn, A., & Ansine, J. (2018). Ten principles of citizen science. In M. Haklay, S. Hecker, A. Bowser, Z. Makuch, J. Vogel, & A. Bonn (Eds.), *Citizen science* (pp. 27-40): UCL Press. Retrieved from www.jstor.org/stable/j.ctv550cf2.11. Retrieved 2020/07/01/

Rudwick, M. J. S. (1985). *The great Devonian controversy: The shaping of scientific knowledge among gentlemanly specialists*. Chicago: University of Chicago Press.

Ruiz-Jaén, M. C., & Aide, T. M. (2005). Restoration success: How is it being measured? *Restoration Ecology, 13*(3), 569-577. https://doi.org/10.1111/j.1526-100X.2005.00072.x

Rykers, E. (2020, 21 November 2022). On the trail of science. *Wilderness Magazine*. Retrieved from https://www.scoop.co.nz/stories/AK2006/S00388/new-zealands-first-nationwide-citizen-science-whale-and-dolphin-census-this-weekend.htm

Salkind, M. J. (2011). Fisher exact probability test. In M. J. Salkind (Ed.), *Encyclopedia of measurement and statistics* (pp. 355-359). Thousand Oaks: SAGE Publications.

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty, 1*(1), 7-59. https://doi.org/10.1007/BF00055564

Scassa, T., & Chung, H. (2015). *Managing intellectual property rights in citizen science: A guide for researchers and citizen scientists*. Washington, DC: Woodrow Wilson International Center for Scholars.

Schade, S., Pelacho, M., van Noordwijk, T., Vohland, K., Hecker, S., & Manzoni, M. (2021). Citizen science and policy. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, . . . K. Wagenknecht (Eds.), *The Science of Citizen Science* (pp. 351-371). Cham: Springer International. https://doi.org/10.1007/978-3-030-58278-4_18

Schrögel, P., & Kolleck, A. (2019). The many faces of participation in science: Literature review and proposal for a three-dimensional framework. *Science & Technology Studies, 32*(2), 77-99. https://doi.org/10.23987/sts.59519

Science Task Force for the UN Decade on Ecosystem Restoration. (2021). *Science-based ecosystem restoration for the 2020s and beyond*. Gland, Switzerland: IUCN.

Shirk, J. L., Ballard, H. L., Wilderman, C. C., Phillips, T., Wiggins, A., Jordan, R., . . . Bonney, R. (2012). Public participation in scientific research: A framework for deliberate design. *Ecology and Society, 17*(2). https://doi.org/10.5751/ES-04705-170229

Shirk, J. L., & Bonney, R. (2020). What is citizen science? In C. A. Lepczyk, O. D. Boyle, & T. L. V. Vargo (Eds.), *Handbook of citizen science in ecology and conservation* (pp. 7-16). Berkeley: University of California Press.

Siirtola, H. (2014). Bars, pies, doughnuts & tables – visualization of proportions. In *Proceedings of the 28th International BCS Human Computer Interaction Conference* (pp. 240-245). Southport: BCS Learning and Development Ltd.

Silvertown, J. (2009). A new dawn for citizen science. *Trends in Ecology & Evolution, 24*(9), 467-471. https://doi.org/10.1016/j.tree.2009.03.017

Sinclair, S., & Rockwell, G. (2016). *Voyant tools*. Retrieved 03 May 2016, from http://docs.voyant-tools.org/

Spellerberg, I. F. (2005). *Monitoring ecological change*. Cambridge, UK: Cambridge University Press.

Stats NZ. (2020, 12 March 2020). *2018 Census place summaries*. Retrieved from https://www.stats.govt.nz/tools/2018-census-place-summaries/

Stevenson, A. (Ed.). (2015). *Oxford dictionary of English* (3rd ed.). Oxford, UK: Oxford University Press.

Strasser, B., Baudry, J., Mahr, D., Sanchez, G., & Tancoigne, E. (2018). “Citizen science”? Rethinking science and public participation. *Science & Technology Studies*, 52-76. https://doi.org/10.23987/sts.60425

Streiner, D. L. (2000). Do you see what I mean? Indices of central tendency. *The Canadian Journal of Psychiatry, 45*(9), 833-836. https://doi.org/10.1177/070674370004500908

Sullivan, B. L., Wood, C. L., Iliff, M. J., Bonney, R. E., Fink, D., & Kelling, S. (2009). eBird: A citizen-based bird observation network in the biological sciences. *Biological Conservation, 142*(10), 2282-2292.

Sutherland, W. J., Pullin, A. S., Dolman, P. M., & Knight, T. M. (2004). The need for evidence-based conservation. *Trends in Ecology & Evolution, 19*(6), 305-308. https://doi.org/https://doi.org/10.1016/j.tree.2004.03.018

The Guardian. (2019). *Pestival: The festival of bugs and insects* Retrieved 15 April 2019, from https://www.theguardian.com/environment/gallery/2009/sep/06/wildlife-insects

Tongco, D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and Applications, 5*, 147-158.

Trees Atlanta. (2023). *Weeds and wine returns for summer 2022*. Retrieved 10 February 2023, from https://www.treesatlanta.org/news/weeds-and-wine-returns-for-summer-2022/

Tulloch, A. I. T., Possingham, H. P., Joseph, L. N., Szabo, J., & Martin, T. G. (2013). Realising the full potential of citizen science monitoring programs. *Biological Conservation, 165*, 128-138. https://doi.org/https://doi.org/10.1016/j.biocon.2013.05.025

Turner, M. D. (2011). Production of environmental knowledge: Scientists, complex natures, and the question of agency. In M. J. Goldman & P. Nadasdy (Eds.), *Knowing nature: Conversations at the Intersection of political ecology and science studies* (pp. 25-29). Chicago, UNITED STATES: University of Chicago Press.

Tweddle, J. C., Robinson, L. D., Pocock, M. J. O., & Roy, H. E. (2012). *Guide to citizen science: Developing, implementing and evaluating citizen science to study biodiversity and the environment in the UK*. London: Natural History Museum & NERC Centre for Ecology & Hydrology for UK-EOF.

United Nations General Assembly. (2019). United Nations Decade on Ecosystem Restoration (2021-2030): Resolution. New York: UN.

van Es, J. C., Lorence, D. P., Morgan, G. W., & Church, J. A. (1996). Don't know responses in environmental surveys. *The Journal of Environmental Education, 27*(4), 13-18. https://doi.org/10.1080/00958964.1996.9941470

Vasavada, N. (2016). *Fisher's test for exact count data*. Retrieved 07 October 2022, from https://astatsa.com/FisherTest/

Vetter, J. (2011). Introduction: Lay participation in the history of scientific observation. *Science in Context, 24*(2), 127-141. https://doi.org/10.1017/S0269889711000032

Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., . . . Wagenknecht, K. (2021a). The science of citizen science evolves. In K. Vohland, A. Land-Zandstra, L. Ceccaroni, R. Lemmens, J. Perelló, M. Ponti, . . . K. Wagenknecht (Eds.), *The science of citizen science* (pp. 1-12). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-58278-4_1

Vohland, K., Land-Zandstra, A., Ceccaroni, L., Lemmens, R., Perelló, J., Ponti, M., . . . Wagenknecht, K. (Eds.). (2021b). *The science of citizen science*. Cham: Springer Nature.

Weng, Y.-C. (2015). Contrasting visions of science in ecological restoration: Expert-lay dynamics between professional practitioners and volunteers. *Geoforum, 65*, 134-145.

West, S., & Pateman, R. (2016). Recruiting and retaining participants in citizen science: What can be learned from the volunteering literature? *Citizen Science: Theory and Practice, 1*(2), 15. https://doi.org/10.5334/cstp.8

White, R. (2018). Citizen science. *New Zealand Geographic, 154*. Retrieved 22 October 2021 Retrieved from https://www.nzgeo.com/stories/citizen-science/

Willis, G. (2017). *Addressing New Zealand's biodiversity challenge: A Regional Council thinkpiece on the future of biodiversity management in New Zealand*. Wellington: Local Government New Zealand.

Wimmer, R. D., & Dominick, J. R. (2011). *Mass media research: An introduction* (9 ed.). Boston: Cengage Learning.

Wright, K. B. (2005). Researching internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of Computer-Mediated Communication, 10*(3), 00-00. https://doi.org/10.1111/j.1083-6101.2005.tb00259.x

Chapter 5

Mātauranga Māori and ecological restoration

> *Ecological restoration is inseparable from cultural and spiritual restoration, and is inseparable from the spiritual responsibilities of care-giving and world-renewal.*
>
> David Martinez (1992)

5.1 Introduction

The statement by David Martinez (1992) encapsulates a holistic world view characteristic of indigenous peoples worldwide, where the relationships with the natural world define cultural identity, and provide links to history, ancestors, land, art, and environmental philosophy (Lyver, Taputu, Kutia, & Tahi, 2008). These relationships are interdependent and inextricably interwoven, with people considered as part of the natural world – an "extended ecological family that shares ancestry and origins" (Salmón, 2000, p. 1332). This cultural relationship between people and the natural world is termed "kincentric ecology" (Salmón, 2000, p. 1327).

The interdependence of the elements of this holistic world view is often articulated in various forms of the indigenous principle of "what we do to the land we do to ourselves" (Kimmerer, 2011, p. 258). Thus, fundamental to kincentricity is the concept of reciprocity with the environment, an obligatory responsibility for environment quality and renewal (Kimmerer, 2011; Zedler & Stevens, 2018). This reciprocity includes not only care for guardianship of resources (including biodiversity conservation), but also cultural and spiritual elements (Kimmerer, 2011; Turner, Ignace, & Ignace, 2000). Reciprocal dependency between people and the natural world has gained institutional recognition in Ecuador and Aotearoa New Zealand through the establishment of "Rights of Nature" laws granting nature the rights

equivalent to that of a living being (Kauffman & Martin, 2018; Tanasescu, 2013). In Aotearoa New Zealand, legal personality has been established for Te Urewera forest and Te Awa Tupua (Whanganui River) (Kauffman & Martin, 2018; Magallanes, 2015). Magallanes (2015, p. 10) states that the most significant aspect of this status is the recognition in law of "Māori relationships with the natural world and the concomitant responsibilities to care for it as kin".

Kincentric relationships with the natural world are a product of a society's experience over many generations (Salmón, 2000), where relational reciprocity is supported through in-depth and comprehensive understanding of biodiversity and the complexity of ecosystem function (Berkes, 1993; Huntington, 2000; Kimmerer, 2011; Sillitoe, 2017; Zedler & Stevens, 2018). Given that ecological restoration is essentially an intentional human caring act of reciprocity towards the land (Kimmerer, 2011), such intent should fit comfortably within the context of kincentricity.

Kincentric understanding of the natural world is generally articulated as traditional ecological knowledge (TEK), and defined as:

> "Indigenous knowledge emerges from careful long-term observation of natural phenomena. The "data" collected using this approach are basically an understanding of relationships between specific biological entities (plants, mammals, birds, insects, fish) and among biological and physical entities (rocks, bodies of water) landforms (mountains isolated hills, unusual rock formations), and meteorological phenomena." (Barsh, 2000)

Aspects of environmental guardianship embodied in TEK are considered to parallel the philosophies of ecological restoration (Robinson et al., 2021), but cultural values and traditional protocols may not necessarily be included in the restoration process, particularly if the dominant restoration participants consider the protocols to be subjective and lack scientific rigour (Huntington, 2000; Mistry & Berardi, 2016). However, wider recognition of the contribution that TEK can make to restoration is increasing (Uprety, Asselin, Bergeron, Doyon, & Boucher, 2012).

Clewell and Aronson (2013) state that ecological restoration is necessarily a local endeavour where stakeholders restore ecosystems to satisfy values that are shared collectively within a culture. It is also accepted that restoration is dependent on local knowledge and experience (Higgs, 2005). Thus TEK, where it is in place, has potential to provide a strong cultural foundation for local ecological restoration (Long, Tecle, & Burnette, 2003; Turner et al., 2000) and, with incorporation into ecological science, can facilitate achieving the cultural and social

needs of a local culture (Garibaldi & Turner, 2004; Higgs, 2005; Turner et al., 2000; Uprety et al., 2012).

Uprety et al. (2012) explore the elements of TEK that could contribute to ecological restoration. These include traditional land management practices (e.g., harvest, fire, and fallow tools) and elements that fit within a pure ecological approach (e.g., revegetation site and species selection, management of alien invasive species, monitoring and assessment). The integration of TEK and ecological science therefore can facilitate the stakeholder partnerships and collaboration deemed necessary for successful restoration (Higgs, 2005; Uprety et al., 2012).

In Aotearoa New Zealand (hereafter New Zealand), Te Ao Māori has a kincentric perspective characteristic of indigenous peoples (Roberts, Norman, Minhinnick, Wihongi, & Kirkwood, 1995). The Māori cultural knowledge base – mātauranga Māori – includes Māori TEK, and is the product of their Pacific origins, trans-Pacific migrations, and extended intergenerational experiences of ecosystems (Harmsworth & Awatere, 2013). The fundamental kincentric element of mātauranga Māori is that people are an integral part of ecosystems rather than a separate entity (Kahui & Cullinae, 2019), with genealogical and spiritual connections to the environment (McAllister et al., 2019). These connections, expressed as whakapapa, are not only human lineages of descent (Roberts et al., 2004), but also represent relationships and connections between all life forms (including people), natural resources and the metaphysical elements of Te Ao Māori, the Māori world (Harmsworth, Awatere, & Robb, 2016; Roberts et al., 1995).

The nature of cultural landscapes, particularly the relationship between communities and past lives and activities of that landscape (Puia, 1990; Tipa & Tearney, 2003), means that cultural values and customary uses of resources may be inseparable from ecological values (Lyver et al., 2015). This socioecological overlap is explicit in the New Zealand Biodiversity Strategy (Department of Conservation & Ministry for the Environment, 2000), which recognises the importance of the relationship between Māori and New Zealand's indigenous biodiversity, and the role that this relationship has in the process of conserving biodiversity. A desired outcome of the strategy is:

"… Māori are managing their interests in biodiversity reflecting different iwi and hapu priorities, and sharing in the benefits of its use, to support their economic and social aspirations and fulfil their responsibilities as kaitiaki." (Department of Conservation & Ministry for the Environment, 2000, p. 93)

For Māori, natural resources, including species, their habitats and management, are embodied within the following cultural value sets (Kitson & Moller, 2008; Lyver et al., 2015; Tipa & Tearney, 2003; Williams, 2010):

- mauri (life force of the natural world);
- mahinga kai or ahikāroa (resources for food or use);
- kaitiakitanga (cultural stewardship);
- ki uta ki tai (holistic 'mountains to the sea' philosophy);
- whakamana (personal engagement);
- whanaungatanga (connection);
- mātauranga and māramatanga (knowledge and wisdom);
- tikanga / tikanga Māori (customary protocols and practice).

Of these, kaitiakitanga is the value that incorporates the process of environmental care and sustainability (Morad & Jay, 2000), and thus putatively embraces ecological restoration. Kaitiakitanga and ecological restoration are both intentional collective human activities, with aspirations to return degraded, damaged or destroyed environments, including ecological systems, ecological services and biodiversity, to a former and/or enhanced state (Kawharu, 2000; Lyver et al., 2015; Society for Ecological Restoration International Science and Policy Working Group, 2004). However, although kaitiakitanga and ecological restoration invariably have practices in common, the rationale and motivation behind the practices differ. Kaitiakitanga involves cultural practices that nurture human well-being in a complex socio-environmental context (Kawharu, 2000; Walker, Wehi, Nelson, Beggs, & Whaanga, 2019).

For Māori, the ethic of kaitiakitanga is encompassed by the status of mana whenua (denoting ownership, control, and sovereignty over a defined area of land, Wiri, 2013). It is the exercise of cultural guardianship of taonga (treasured things) in accordance with tikanga Māori, where taonga include places, waterways, and biodiversity (Kawharu, 2000; New Zealand Government, 1991; Spiller, Pio, Erakovic, & Henare, 2011). Kaitiakitanga is practised by iwi kaitiaki, environmental practitioners with special knowledge in relation to the management of resources within their ancestral lands (Harmsworth et al., 2016; Morad & Jay, 2000). There is an expectation that iwi kaitiaki will protect the integrity of those resources in trust for future generations, by drawing on their traditional ecological knowledge (Morad & Jay, 2000).

Many New Zealand authors advocate the inclusion of TEK and social principles in the restoration and management of degraded ecosystems (e.g. Wehi & Lord, 2017), views that are echoed globally (e.g. Uprety et al., 2012). This is already the case for many Māori communities throughout Aotearoa New Zealand where active kaitiakitanga within their rohe

is profiled, for example Ngāti Kuri (Gibson, 2019), Ngāti Whātua Ōrākei (Ngāti Whātua Ōrākei Trust, 2022), Te Arawa (MacDonald & Anaru, 2020), Taranaki Whānui (Michel, Dobson-Waitere, Hohaia, McEwan, & Shanahan, 2019) and Ngāi Tahu (McClelland et al., 2011).

Since kaitiakitanga encompasses the essential tenets of ecological restoration, iwi-led restoration practices provide an opportunity to explore an iwi kaitiaki perspective on the outcomes and expectations of the practitioners' actions in terms of ecological restoration. In this socioecological study, I asked iwi kaitiaki about their views on the relationship between mātauranga Māori and the determination of the success of ecological restoration practices. Specifically, I asked:

1. What iwi-lead ecological restoration activities were being undertaken?
2. What taonga were being restored, or enhanced, through restoration?
3. What benefits were expected as a result of the restoration activities?
4. What indicators would signify the success of the restoration activities?

5.2 Methods

This study was based on a survey of practitioners in iwi-led ecological restoration projects. Prior to the start of this research and any contact with iwi, a Vision Mātauranga statement (see Supplement S.5, Appendix A) was prepared to establish the protocols for engagement with iwi participants. The purpose of the Vision Mātauranga was to ensure that the methodological approach prioritised the principles of tikanga Māori advocated by the Health Research Council of New Zealand (Hudson, Milne, Reynolds, Russell, & Smith, 2010) and adopted by the Auckland University of Technology. The intended outcomes were that the process followed an appropriate kaupapa (process) throughout the consultation, implementation and reporting phases of the research. The consultation process was a minimum requirement.

Qualitative interviews were used as the survey method. This interview method is used widely where expert knowledge about a specific research field is sought (Hopf, 2004). The interview style adopted was a kōrero, kanohi ki te kanohi, tangata ki te tangata (face-to-face conversation, Pipi et al., 2004), essentially an informal discourse termed "conversational interview" (Roulston, 2008, p. 128). This approach was considered appropriate as it is consistent with a culture where oral transmission of knowledge is traditional (Kovach, 2010). Like any informal conversation, a kōrero invariably includes introductory pleasantries and

small talk, with the process itself aiding the lowering of barriers where the participants are strangers. Within Te Ao Māori, such informal conversations are commonplace and highly valued, and often referred to colloquially as “kapu tī” – talking over a cup of tea and biscuits (Van Schravendijk-Goodman, 2017, p. 14). The conversations were confidential, and an audio recording was made of the conservation where consented by the participant and practicable in the meeting location.

In a conversational interview, participants are free to participate in extended discussions in a less hierarchical setting than that of formally structured interview settings (Given, 2012; Roulston, 2008). The informal, non-hierarchical setting favours the development of rapport and trust, and the establishment of an empathetic relationship between researcher and interviewee (Swain & Spire, 2020). This is considered to promote participants to respond in an open and authentic way throughout the conversation and to allow the conservation to be flexible for both researcher and participants (de Leeuw, 2008; Roulston, 2008).

The conversational interviews followed a narrative interview format (Hopf, 2004). Although the core element of any conversation is an impromptu independent narrative (Hopf, 2004), four open questions (an "interview guide", Patton, 2015, p. 439) were used to open and stimulate the narrative. These were not intended to be followed rigorously, rather to introduce the context of the conversation, and also served to ensure consistency across all interviews (Patton, 2015).

Disadvantages of conversational interviews include the extended time required to arrange the time and place for talking with the participants and that formal procedures for obtaining informed consent may contradict the expectations of everyday conversation (Kelley, Clark, Brown, & Sitzia, 2003; Roulston, 2008). However, Swain and Spire (2020) suggest that ethical issues constitute the greatest challenge for qualitative interviews. Ethical issues were addressed through the provision to participants of a participant information sheet and consent form in advance of the interview meeting. In accordance with the philosophies outlined in the Vision Mātauranga document, the intention of these forms was to assure participants that potential personal and cultural sensitivities were recognised, and to ensure informed consent (see Supplement S.4, Appendix A).

Specific names of iwi, places and stakeholders used in the kōrero have been removed from the quotations in Section 5.3 to preserve the anonymity of the kōrero participants. The research was approved by the Auckland University of Technology Ethics Committee (Ref. number 17/167),

5.2.1 Survey participants

The geographic area covered for the selection of participants was the northern half of the North Island, including the regions of Northland, Auckland, Bay of Plenty and Waikato (Fig. 5.1). This geographic limitation for the selection of participants was consistent with the surveys carried out for Chapter 3 to validate comparisons. A further consideration of the geographic limitation was in anticipation of the interview logistics.

Participants were targeted through purposive selection (Tongco, 2007) as this study aimed to determine the knowledge and views of particular people with a specific interest (Onwuegbuzie & Leech, 2007; Palys, 2008), in this case, iwi restoration practitioners. Iwi to be approached were identified through restoration projects featured on websites, through personal contacts, or through recommendations by colleagues and other participants. All participants were over 16 years of age.

It is recognized that sampling sizes using conversational methods will always be small (Kelley et al., 2003). However, there is considerable variation in literature of opinions of the minimum number of survey participants required for valid themes analysis, with authors recommending flexibility within the range of 2 to 25 participants (e.g. Boyd, 2001; Guest, Bunce, & Johnson, 2006; Polkinghorne, 1989). My goal was to obtain 20 participants, consistent with the number of interviews conducted with iwi about aspects of biodiversity in other New Zealand studies, for example Dick, Stephenson, Kirikiri, Moller, and Turner (2012), Kitson and Moller (2008) and Lyver et al. (2015).

5.2.2 Data analysis

The analysis of the conversational interviews followed a thematic analysis approach (Braun & Clarke, 2012), where recurring collective or shared patterns (themes) in the participants' responses were identified through a systematic process of organisation and coding of the data. An advantage of thematic analysis is the flexibility to accommodate both an inductive approach, where themes are derived from the data content, and deductive approach where the researcher's ideas are used to interpret the conversational content. Since the content of conversations are generally wide-ranging, a combination of analytical approaches is not unusual as it ensures that data being coded is relevant to the study (Braun & Clarke, 2012).

To assist identification of the dominant kōrero themes, the recorded kōrero dialogues were collated into a text corpus for analysis. This corpus was analysed using Voyant Tools (Sinclair & Rockwell, 2016), a computer-based tool to calculate keyword frequencies, and WordItOut (2022) to produce a word cloud visualisation of the dominant words. Word clouds are recognised as a supplementary tool to provide a visualisation of the dominant themes in

texts (Henderson & Segal, 2013; McNaught & Lam, 2010), and specifically applicable to the early stages of interview analysis (Henderson & Segal, 2013). Junction words that contribute to sentence syntax rather than meaning were excluded from the analysis, as were the words “ecological” and “restoration” since they were the subject of the kōrero and their inclusion would have skewed the relative word frequencies.

Validation of data quality was through triangulation, using a variety of methods (Jick, 1979). The triangulation methods used were those recommended by Baxter and Eyles (1997), Creswell and Miller (2000), Haynes (2012), Lewis and Russell (2011) and Chilisa (2020):

- Use of an interview guide across all participants to standardise the initiation of the kōrero;
- Verification of the interpretation of kōrero themes through re-visiting respondents (also a component of the Vision Mātauranga statement requiring reciprocity between the kōrero parties). This action is considered by Chilisa (2020) as the most important criterion for establishing validity in indigenous research;
- Peer review and debriefing;
- Comparison of ideas from multiple studies; and,
- Reflexivity, maximised through my position as an embedded researcher.

5.3 Results

5.3.1 Survey respondents

Invitations to participate in the research were sent to 21 iwi, covering most of the study area, with 12 people accepting the invitation to participate. The indicative geographic location of the rohe (tribal territory) represented by the respondents is shown in Figure 5.1.

The number of respondents was lower than expected due to the impact of the Covid-19 pandemic on field research. Institutional research restrictions preventing data gathering through in-person contact were imposed in response to Government mandates throughout successive Covid-19 disruptions 2020–2021. While these restrictions were intended to minimise the medical impact of the Covid-19 pandemic through direct personal contacts, remote data gathering through electronic communication was still permitted. However, I decided not to pursue non-contact electronic communication as the priorities for iwi community members at this time were to the health and well-being of their respective whānau, and any unwarranted research intrusion may have generated resentment. In retrospect, I am comfortable that this approach was appropriate as research has shown that the psychological impact of the Covid-19 pandemic has been more substantial than the medical impact (Mattos dos Santos, 2020; Taylor et al., 2020), with New Zealanders being affected more than other societies (Gasteiger et al., 2021). In addition, it was considered inappropriate to engage with iwi through impersonal electronic media given the importance placed on the kanohi ki te kanohi conversation (Pipi et al., 2004) and the advantages associated with the process.

Not all kōrero were recorded. Although no interviewees declined permission to be recorded, in some locations where the interviewee chose to meet for convenience and comfort (e.g., a

Figure 5.1 – Geographical breadth of mātauranga Māori represented in a kanohi ki te kanohi survey of iwi kaitiaki views on the relationship between mātauranga Māori and the success of ecological restoration practices in the North Island, Aotearoa New Zealand. Area shaded grey represents the overall survey area, circles represent the general locations of the rohe of the kōrero participants.

café), the background noise was such that recording the kōrero was not practicable. This is recognised as a potential disadvantage of conducting interviews in a public location (Edwards & Holland, 2013). In such instances, notes were recorded manually. One interviewee opted to respond to the questions electronically following a Covid-19 lockdown of their region.

5.3.2 Survey responses

There was significant similarity in the interview responses, with the responses to the interview guide questions generally integrated as a continuous narrative. The restoration activities identified by interviewees were described in general terms (e.g., improvement of waters, forests, wetlands), with a number of specific landscape-scale projects identified (e.g., Te Ara Whānui – The Flightpath, Project Island Song, Lake Omapere, Kaipara Moana Remediation Programme, Tū Mai Taonga Aotea, Ōkahu Catchment, Harbourview-Orangihina Park, Hunua Ranges).

All references to native biodiversity were within a cultural context. The species named were: rimurimu (seaweed species), pīngao (golden sand sedge *Ficinia spiralis*), tāiko (black petrel *Procellaria parkinsoni*), kuaka (bar-tailed godwit *Limosa lapponica*), kūkupa (kererū, NZ pigeon *Hemiphaga novaeseelandiae*), kōkako (North Island sp., *Calleas wilsoni*), kōmako (bellbird *Anthornis melanura*), tuna (eel *Anguilla* spp.), and peketua (Hochstetter's frog *Leiopelma* hochstetteri). The management of invasive mammals, including eradication, was identified as an integral part of the ecological restoration process, particularly for the restoration of taonga species. The mammals named were the common brush-tailed possum (*Trichosurus vulpecula*), feral cat (*Felis catus*), and rats (*Rattus* spp.).

Although fourteen codes of restoration success emerged from the analysis of the kōrero, the points raised represented a complex continuum of overlapping concepts and rather than distinct elements (Table 5.1).

Table 5.1 – Initial codes of restoration success emerging from the kōrero analysis in a kanohi ki te kanohi survey of iwi kaitiaki views on the relationship between mātauranga Māori and the success of ecological restoration practices in the North Island, Aotearoa New Zealand.

Code	Description
Ngā tāngata; the people	Restoration activities had direct benefits for the iwi
Kaitiakitanga; cultural stewardship	Restoration fulfilled cultural obligations to care for the environment
Rawa taiao; resource use	Species being restored represent resources for the iwi
Mauri; life force	The life essence of the land had been recognised
Whakapapa; connections	Restoration had acknowledged the whakapapa of the people and species involved
Mātauranga; knowledge and wisdom	Restoration had accessed, improved, or shared cultural knowledge and wisdom
Rerenga rauropi; biodiversity and ecological integrity	Diversity and population levels of native flora and fauna had been increased
Ecological services	Natural services carried out by biodiversity that support human life had been improved
Restoration order	Restoration order had followed appropriate cultural protocols
Capacity	Restoration facilitated the building of capacity for iwi self determination
Collectivism	Restoration action was undertaken at a collective iwi/hapu level rather than by individuals
Tau huripoki; reciprocity	Evidence of improvement of the reciprocal nature of the human-environment relationship
Ako torowhanuī; holism	Restoration action followed a holistic approach
Mahi tahi; collaborative partnerships	Restoration process had facilitated the engagement with professional ecologists

A corpus of 2,760 words was collated from the recorded kōrero. The top 50 words are presented in visual form in Figure 5.2. The dominant words in the corpus were: “people” (1.27%), “iwi” (0.62%), “whakapapa” (0.62%), “relationships” (0.58%), and “narrative” (0.47%). Although this was not a comprehensive representation of the interviews, it was useful as a preliminary indicative tool for exploring themes.

Five dominant themes of restoration success were identified from the codes and corpus analysis. None of the themes were discrete concepts, as all contained overlapping elements and concepts. However, they were considered separately for clarity. The themes were:

- Rerenga rauropi / ecology: elements with direct and clear association with ecological science and its application;
- Ngā tāngata: elements relating to the people as a collective;
- Whakapapa and whanaungatanga: elements relating to relationships, kinship, connections and reciprocity;
- Kaitiakitanga: elements relating to guardianship of taonga;
- Ako torowhanuī: ecological restoration followed a holistic approach; and,
- Mahi tahi: collaborative partnerships and capacity building.

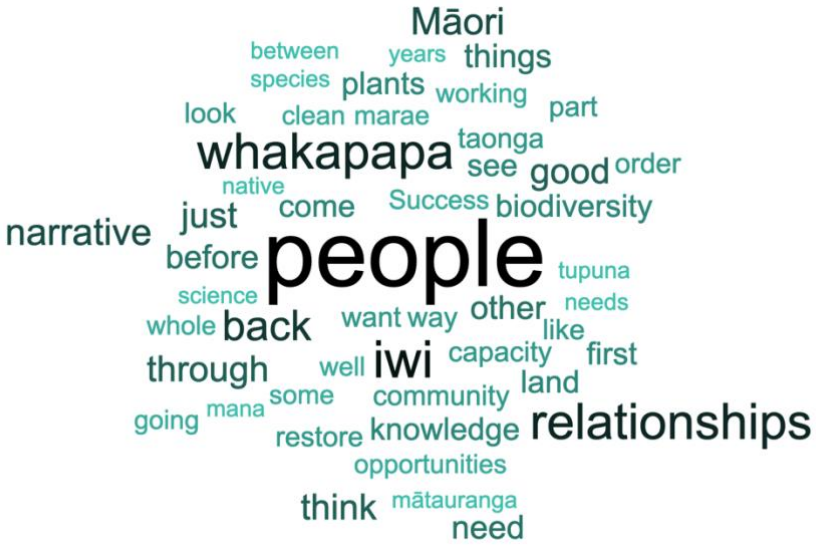


Figure 5.2 – Visualisation of the dominant words of the kōrero with participants in iwi-led ecological restoration projects. Word size indicates word frequency in the corpus.

5.3.2.1 Rerenga rauropi / Ecology

Respondents recognised the importance of restoring lost biodiversity and ecological integrity with restorative actions considered to represent *"the restoration of taonga" (Interview 3)*. Measures of ecological success included the restoration of biodiversity, the scale of restoration, restoration order, selection of species for restoration and restoration of species association, and was invariably qualified in terms of a cultural perspective, or through reference to taonga species (Table).

5.3.2.2 Ngā tāngata

The importance of ecological restoration to ngā tāngata, the people, and their role in the process of ecological restoration, was explicitly expressed and stressed by interviewees, and indicated by the frequency of their use of the word "people" in their responses. Ecological restoration was considered as an extension of the integral relationship between ngā tāngata and their environment such that any actions that benefitted the environment also benefitted the people (and vice versa). Ecological restoration was considered to be one of the mechanisms of maintaining the people—environment relationship, and a contributor to the well-being of the people:

> *"When you are talking about restoration of ecological systems that, if we're going to do part of the restoration, we've got other things to restore first. And for [named iwi], it's about us knowing that that is ours. So, you know, we reclaim that. And not too long ago, [named iwi] were a landless people. So when we are talking about restoring ecological, or ecosystems or whatever, we have to become familiar with what is ours first. The whakapapa, that relationship and building that whakapapa relationship with our whenua, with our wai, with our moana, with each other and beginning to trust. It's all of those, you know, reconnecting and some of the things that, one of the words [named iwi] uses is this word called 'recalibrating'. What is that to recalibrate [named iwi]? We have to do that for ourselves." (Interview 2)*

> *"For the people. Good for the people, good for all biodiversity." (Interview 8)*

> *"[Benefits of ecological restoration] … local employment; ecotourism potential; enhancing mana of people if [biodiversity] populations flourish; economic opportunities. Needs every one working together." (Interview 10)*

Table 5.2 – Ecological elements identified by participants as criteria for restoration success, in a kanohi ki te kanohi survey of iwi kaitiaki views on the relationship between mātauranga Māori and the success of ecological restoration practices in the North Island, Aotearoa New Zealand.

Criteria indicating ecological restoration success	**Comments**
Return of ecosystem composition, species diversity and abundance towards an historical state	"… knowing what has come before to get to current state." (Interview 2) "Correction to original system. Narratives and ancestral overlays should determine what it used to be like." (Interview 4) "… return to historic state, what is was like compared to now; improve it for our children." "It's the before. Our picture, or my picture, through mātauranga, is what was this place before? I see that. I go along [local river] and see before we came. I don't sit there and think about the pollution coming out of the drains and all that, I think about how it was back then. How beautiful it would have [been to see] those waka going down that [*sic*]. How beautiful it would have been beyond the waka! And I think that's what we see, Māori see. And we just want to see that come back." (Interview 8) "Benefits … species diversity & abundance." (Interview 10)
Restoration actions were applied at a landscape scale, not just at localised sites	"Decisions about restoration ecology come from iwi, they are not made in isolation, they relate to the whole system." (Interview 2) "… connections to harbour, forest to sea, between small stands of forest." (Interview 4) "Mountains-to-the-sea connectivity." (Interview 7) "… restoration of healthy whenua or landscape, native birds, plants, waterways, and trees." (Interview 12)
Restoration had followed an appropriate sequence	"[Restoration] order has to weave in with [local iwi] methods." (Interview 2) "… place first, regeneration approach." (Interview 4) "Restoration should follow the appropriate order. Whakapapa determines the order of any activity." (Interview 5) "We'll just clean up the waterways up. Well hang on, where does all that mess come from? It comes off the land, so don't you think you should clean all the land up first, and then work on the awa second? So everything runs off to the awa, so fix the land up." (Interview 8)

Table 5.2 *(continued)*

Restoration had re-established species associations; plants for revegetation were eco-sourced, indigenous species	"This is our [named rohe] ... we want to restore that, and we want birds to come back and they're the first ones that begin to re-associate (and I don't want to use colonise) with those lands. Once these pests are starting to move out they are starting to go back in there. But when we look at specificity, we look at kūkupa as an example, there's no kai there so we can't reintroduce, we can't have that relationship formulated. What do we have to do to re-engage? So we've got a huge replanting programme to do." (Interview 2) "[Named iwi] 100% support all restoration projects providing it's native restoration, and they use whakapapa planting, i.e., they put back what used to be there, they don't bring in shit from 200 to 500 miles away because it looks pretty but it never grew here in the first place." (Interview 3) "No more of those possums. Just bring all our native plants and, just bring all our native plants out 'cos thats how it was before this happened. And that's why we talk 'plant our natives'. Get rid of all the wattle, all the rubbish that you fellas have planted in our gardens – get rid of all that and put our natural stuff in there." (Interview 8)

> *"But more importantly for us the main taonga we are hoping to restore is the taonga tuku iho, that is the mātauranga Māori (Māori knowledge) that has been lost over time. As biodiversity disappears so too do the kaumātua and kuia that hold the knowledge and the Reo (language) handed down over generations. Once all of that disappears then so too does a culture and a people if nothing is done to keep them extant. Restoration and retention of traditional knowledge and culture that helped hunga Māori flourish and survive for centuries – personal and community well-being." (Interview 12)*

Improvements in ecosystem services (the ways natural systems sustain and fulfill human life, Daily, 1997) through ecological restoration actions were also recognised as having direct benefits to ngā tāngata. Ecosystem services include the provision and support of harvested and traded goods, environmental regulatory processes, and non-material aesthetic and cultural benefits (Harmsworth & Awatere, 2013). Interviewees considered the success of ecological restoration contributed to improved ecosystem services, reflected in the following comments:

> *"[Named iwi] 100% support all restoration projects. Too many wetlands are just being drained and wrecked for development, and so we're losing really precious ecosystems. And not are only losing precious ecosystems, we're losing what we refer*

to as the lungs of Papatuanuku, the wetlands are – or the kidneys, sorry, the kidneys that flush and take out all of the toxins ...

[Measure of restoration success] ... a thriving community, and I don't mean a people community, a thriving ecological community – the birds are healthy, the fish are healthy, the water's clean obviously. You know we talk about the health and well-being of people all the time, but they forget that you cannot have a healthy people if you don't have a healthy environment. It's not possible, people get very sick if they are living in contaminated areas." (Interview 3)

"Restoration success ... biodiversity increased, reflects on people ... food from moana pōtaka, for example kōura." (Interview 4)

"… restore taonga, for example tuna, that sustain human health." (Interview 5)

"Biodiversity function, human outcomes." (Interview 7)

"When you look at it [ecological restoration] from a Māori presective, its good for the environment, its good for the people, its good for the animals. ... feed the people." (Interview 8)

"My mahi relates to what is needed in te taiao in order for customary harvest of all things that hunga Māori consider to be taonga become a reality." (Interview 12)

The long term commitment necessary for landscape-scale ecological restoration, invariably surpassing the span of human lifetimes, was recognised through the intergenerational connection that ngā tāngata have with their own lands:

"If [named iwi] say that we've been here for a thousand years, we're also saying that we're going to be here for another thousand years, and another thousand years. Our [restoration] vision isn't five, ten or fifteen years, or twenty years. It can't be. [Named iwi] has no where else to go. That's, you know, a finite statement. So we have to do, now, the very best with what we've got, and our endeavour, you know, through our trust boards, through our marae, is to achieve that." (Interview 2)

A well-known whakatauakī was cited (Interview 6) as being representative of the process of ecological restoration:

"Hutia te rito o te pā harakeke	*"If you pull up the new shoot of the*
Kei hea te kōmako, e kō?	*harakeke whānau, the mokopuna,*
Kī mai ki ahau	*where will the bellbird sing?*
He aha te mea nui o te ao	*If you ask to me what is of most*
Māku e kī atu	*importance in this world?*
He tāngata, he tāngata, he tāngata"	*I will respond:*
	It is people, it is people, it is people."

The explanation of the relevance of the whakatauakī was that the relationship between the kōmako/bellbird and the flax is indicative of ecological associations, with the reference to ngā tāngata indicating the dependence of appropriate environmental management (and therefore ecological restoration) on the actions on people. Inherent in the reference to ngā tāngata are whakapapa and kaitiakitanga.

5.3.2.3 Whakapapa and whanaungatanga

The connections between ngā tāngata and the environment were identified as the reason for ecological restoration, and as criteria of restoration success. Such connectivity was embodied in references to whakapapa:

> *"We have a relationship through our tūpuna, through our whakapapa, through our narrative with the piece of water. Because our people then understand who they are and their relationship to that water.*
>
> *What taonga are being restored? If I'm looking at specific [sic], you can't. Because one is related to the other, it's as simple as that. If we are then going to look at birds and their needs, what are the plants' needs? What are, you know, under the litter needs? That's why I started with whakapapa." (Interview 2)*

Cultural narratives were identified as a significant source of the knowledge of whakapapa and the connections between iwi and their rohe. Kōrero with communities were seen as ways to access the local narratives that would provide restoration targets, and also to generate a cultural interest, and thus support, within communities for a restoration process and activities:

> *"What's the [named iwi] narrative? 'Cos narrative is a big part of the culture, what is [named iwi] language? Language is a big part of our culture, not just that I'm using te reo. They are all integral to this thing called tangata, person. That's how important I believe narrative is, 'cos it carries the whole essence of information. Then we can formulate this relationship, and then we have then an excitement, an ability to say 'That's mine, I want to help with that. I want to do something about that.' That's what I*

think is important in restoration for my people, and that's where this recalibration is happening as well – formulating these relationships through the narrative so that people can personalise it, become excited because of that. … This is how we actually move forward. Using our historical narrative, a way forward for [named iwi]. There is no other way that gives direction more clearly than our own mātauranga.'' (Interview 2)

"... community stories of connection and issues observed from centuries of knowledge." (Interview 5)

"Working with local marae, [named marae], helping them to increase their capacity, capability, helping them to exercise kaitiakitanga ... we were piloting cultural monitoring, mātauranga Māori approach to monitoring. ... Basically it was going to the kaumātua of the marae, people who have been around a long time, asking them to comment on various things like the plant life, and whatever fauna and the water quality and ask 'Back in your early childhood, what was it like? What sort of plants were flourishing ... what are your memories of catching eels, or something ... and where are we now?' So what's the difference and what do we need to do to get back to that? So just the mātauranga Māori cultural monitoring ... you could measure it [ecological restoration] in that way. Ask the elders, 'What were your early memories? Has it got better? Has it got worse?' I suspect its got worse, very different to the conventional western science where you'd measure things. 'What are your memories of the plant life and the birds, the fish?' " (Interview 10)

Whakataukī (proverbs) and pūrākau (legends) were included as sources of cultural narratives. A pūrākau was related in Interview 5 as an example of how whakapapa should inform ecological restoration was that of Pīngao and Rimurimu (pīngao - golden sand sedge, *Desmoschoenus spiralis*; rimurimu – seaweed species).

This pūrākau pertains to the health of shellfish populations (specifically toheroa *Paphies ventricosa* and tuatua *Paphies subtriangulata*), in which Pīngao plays an essential role. Pīngao and Rimurimu originally lived together on the sand dunes above the beach. However, Rimurimu was interested in many things and wandered to the ocean where he became so enamoured with the life there, he changed his form to live there permanently. Pīngao was devasted by her loss. Eggs produced by the shellfish are protected by Pīngao until the point at which they are gathered by Tāwhiri-mātea (atua [deity, ancestor] of winds) and blown out to sea. The shellfish eggs that Pīngao protected become her tears that she uses to search for Rimurimu. In the ocean, the eggs are caught in the waiting arms of Rimurimu and germinated by Tangaroa (atua of sea and fish) to be returned back to the shellfish beds on

the beach. The return of the eggs is taken by Pīngao as a sign that her message of love has reached Rimurimu successfully.

Interviewee 5 suggested that the pūrākau is indicative of the appropriate order of restoration for coastal systems. In order to have healthy shellfish populations, healthy coastal margins (e.g., pīngao on sand dunes) and oceans (e.g., rimurimu below the tides) are a prerequisite, and should thus be restored first.

Reciprocity was identified as an obligatory component of a community's relationship with their environment, and a rationale for undertaking ecological restoration:

> *"Expectation of reciprocity ... responsibility for taonga." (Interview 4)*

> *"… we not only restore biodiversity, customary knowledge, and an indigenous culture, but we also return the generosity bestowed upon us by our tupuna kuia Papatūānuku (reciprocity). By showing manaaki (generosity) back to her she then e whakautu ana (reciprocates) by providing us with the resources we as humans need for our environmental, cultural, social, and economic well-being." (Interview 12)*

5.3.2.4 Kaiktiakitanga

The enhancement of mauri, and protection of taonga species, was expressed by interviewees as being an inherent expectation in their relationship with the environment, and thus an indicator of the success of ecological restoration:

> *"[Restoration purpose] ... to enhance, protect, sustaining the mauri. Manaaki mauri, acknowledge and identify signifiers of mauri."* (Interview 6)

> *"[Restoration purpose] ... to focus some conservation effort in the [named rohe], to protect those precious taonga in the north – [named rohe] is full of frogs and reptiles, aspirations to get kōkako [named species] back in there. So all of those reasons, not to mention all those ecosystem values."* (Interview 10)

The term *"manaaki mauri"* (Interview 6) was emphasised as a term synonymous with ecological restoration. Since mauri existed everywhere, it did not need to be restored, but it could be enhanced through ecological restoration actions.

Some interviewees indicated that their people needed to build knowledge and capacity to exercise effective kaitiakitanga, either within their iwi or through collaboration with outside

stakeholders. For them, this increase in capacity to deliver restoration outcomes was itself an indicator of ecological restoration success:

> *"I'd say that working alongside of the scientists and [named stakeholder] has been particularly good for [named iwi], just growing our awareness, but the capacity just isn't in [named iwi] so how else can we actually grow that capacity without having to actually grow it in [named iwi] itself? And its bringing people, scientists, in to do that. ... Our capacity is just so limited. I want your university to come and help us to do this, honestly, we need to be formulating relationships."* (Interview 2)

> *"How do you do that [restoration]? By teaching people what is the right way to do things."* (Interview 8)

> *"My interest was to be a constructive iwi voice working with the council, DOC and the community at large. All working together nicely."* (Interview 10)

> *"Success indicators in this context will invariably be true 'kotahitanga', not only between Māori and non-Māori in regard to Te Tiriti and The Treaty, but also true collaboration between knowledge bases of what is considered Western Science and mātauranga Māori." (Interview 12)*

5.3.2.5 Ako torowhanuī

A number of comments made by kōrero participants serve as an overview of the application of mātauranga Māori to ecological restoration. In particular, they emphasised the nature of the relationship between people and the environment, and that for ecological restoration to be successful, a holistic approach was essential for restoration to be successful:

> *"Good kaupapa not just Māori, but for everybody ... learn from each other. Te ao Māori good place to start, the holism, use everything available to us."* (Interview 8*)*

> *"Looking at the maunga in the distance ... a great way of talking about what they do and why [restoration]. All about, ... these maunga are the place to go and walk the dog and get up a sweat. These are ancestors. We are looking after our ancestors. A great way of explaining and describing mind set and how, why its so important to control the pests and recloak with whatever plants. A maunga is a discrete thing to help you understand that, I think. That's an example of that holistic sort of thinking."* (Interview 10)

In one kōrero (Interview 7), the interviewee used a sketch to emphasise the potential for a holistic approach to ecological restoration. The sketch illustrated how a holistic approach across all ecosystems could be achieved by restoration stakeholders, including central and local government agencies (e.g., DOC, Watercare), and community and interest groups (e.g., Birds NZ, Waicare, Sustainable Coastlines), could work collectively and collaboratively with local iwi under a mātauranga Māori umbrella. This sketch is reconstructed in Figure 5.3.

5.3.3 Survey validity

The sample size was within the range for conversational research methods suggested by other authors (e.g., Boyd, 2001; Guest et al., 2006; Polkinghorne, 1989). There are also views that, for conversational research data, theme saturation is often achieved after a relatively small number of interviews (Hennink & Kaiser, 2022). This view was particularly apparent for my interviews as new themes stopped emerging midway through the interview sequence, a pattern suggested by Marshall et al. (2014) to be indicative of theme saturation. Theme saturation is also illustrated by a cumulative audit trail of the analysis (Fig. 5.4), a method used by Guest et al. (2006) to demonstrate validity in small samples.

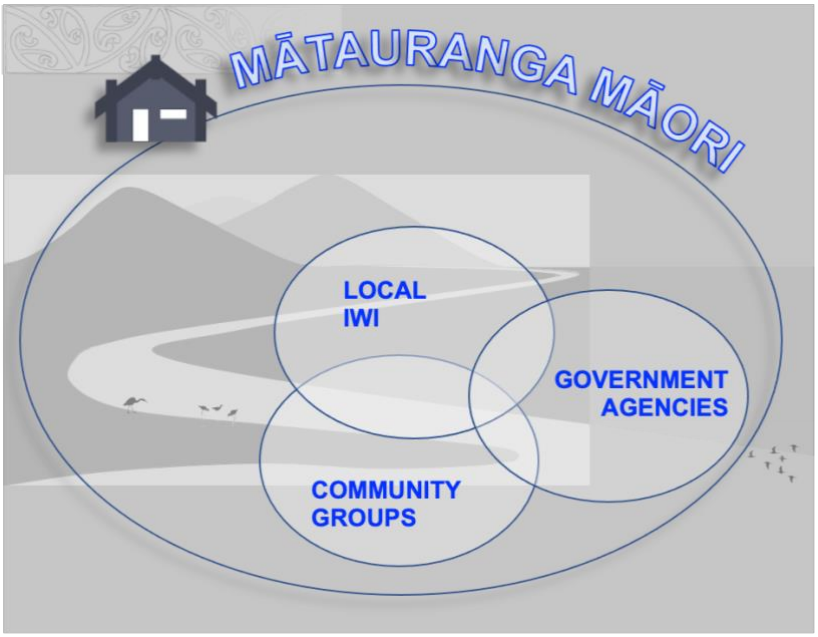


Figure 5.3 – Reconstruction of a sketch (Interview 7) depicting how ecological restoration stakeholders could work collectively and collaboratively with local iwi under a mātauranga Māori umbrella (included with permission, concept from Te Atatu Marae Whānau).

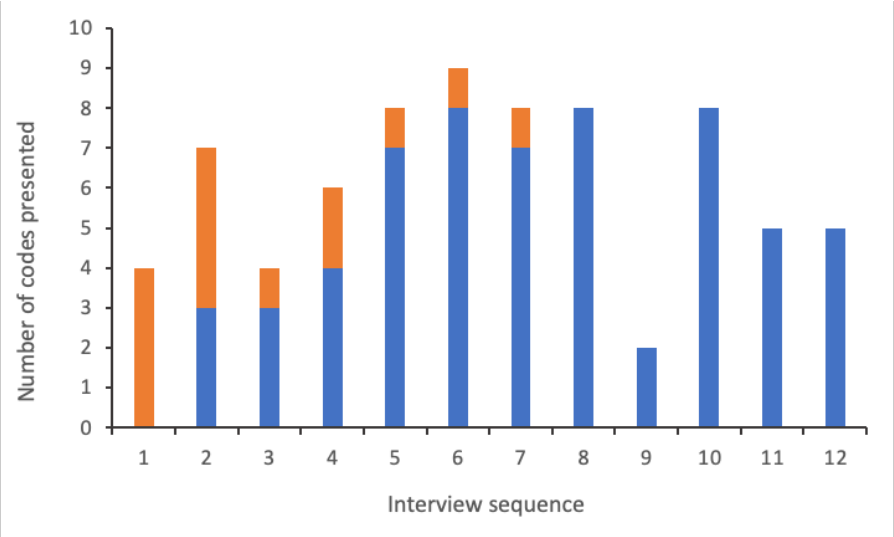


Figure 5.4 – Cumulative audit trail of codes emerging from interview analyses (after Guest et al., 2006), in a kanohi ki te kanohi survey of iwi kaitiaki views on the relationship between mātauranga Māori and the success of ecological restoration practices in the North Island, Aotearoa New Zealand. Orange bars indicate new codes introduced by interviewees, blue bars represent codes common to earlier interviews.

Other New Zealand authors working with iwi have low interview numbers, for example Lyver et al. (2008) and Michel et al. (2019). Lyver et al. (2008) state that the repetition of ideas and patterns of knowledge that emerged from 12 interviews was indicative that they had sufficient narratives for the information to be considered reliable. Chilisa (2020) suggests that, given the uniqueness of the experiences of each kōrero participant, dependability of research outcomes is a function of data consistency, not simply replication. I am confident that the consistency of my respondents' contributions, and their experiences from iwi across the study region, adequately represents iwi kaitiaki perspectives of ecological restoration.

A condition of the ethics approval was that the hui participants would be sent a summary of the results of the kōrero, intended to reflect the reciprocity within the principles of manaakitanga and mana (Hudson et al., 2010). This process (a "member check", Chilisa, 2020, p. 214) sought to ensure that the participants' contribution to the study had been recorded appropriately and accurately, and that themes and patterns emerging from the analysis reflected the data collected. The member check also served to confirm that the format of the presentation of results and language used preserved anonymity of the kōrero participants.

Five of the twelve kōrero participants provided feedback to the draft summary of results. All responses were positive and complimentary about the presentation of the content, with one offering a constructive suggestion on information missing from the report. This suggestion

was accepted, and the manuscript adjusted accordingly. The same respondent initiated a discussion about the intention and accuracy of the map (Fig. 5.1), but concluded that, as indicative of the iwi affiliations of the kōrero participants, the map fulfilled this purpose satisfactorily. The positive and constructive responses of the kōrero participants further validates these research results.

5.4 Discussion

Perspectives of the iwi kaitiaki on the success of ecological restoration presented throughout the kōrero were centred universally on relationships with, and between, the components of the wider environment, and explicitly included people in the restoration rationale and process. The attributes considered by participants to be important indicators of restoration success represent elements of the holistic and kincentric world view of mātauranga Māori, and fall into three key (though interconnected) areas:

- the need to sustain the vital essences of life (mauri) through guardianship (kaitiakitanga) and action (manaaki);
- the enrichment of communities (ngā tāngata) through participation in restoration within their own rohe, and on their own land; and,
- the importance of following an appropriate order of restoration action (tikanga) to re-establish relationships between people and the ecology, with ecological associations determined by cultural foundations (whakapapa).

Interwoven throughout these areas are an obligation to restore environmental quality (including lost or degraded taonga species) and social well-being, which is consistent with other commentaries on the relationship of mātauranga Māori with environmental management (e.g., Poa, 2020; Walker et al., 2019) where ecological restoration is encapsulated by cultural environmental practices.

5.4.1 Indicators of restoration success and progress

5.4.1.1 Mauri and kaitiakitanga

Kaitiakitanga is a “practical philosophy” (Walker et al., 2019, p. 2) of the relationship of Māori with their environment. The environmental care activities associated with kaitiakitanga are intentional and practical, and thus align with the concept of ecological restoration. However, although the ethic of kaitiakitanga does encapsulate ecological restoration, it is not solely the biophysical scientific process of environmental guardianship that is often implied when the

word is linked to ecological restoration (e.g., WAI Wānaka, 2022), or where the word "kaitiaki" is used for commercial restoration ventures (e.g., Kaitiaki Consulting Ltd, 2022; Kaitiaki o Ngahere, n.d.). The philosophy links the local environment and its management to the people through interconnected and interdependent elements such as whakapapa, cultural narratives, kincentric relationships, spiritual connections, knowledge and te reo (Walker et al., 2019). The kōrero of the iwi-based restoration practitioners was clear that ecological restoration was kaitiakitanga, but they were equally clear that kaitiakitanga was an obligate part of the complex interrelated attributes that are mātauranga Māori.

Integral to the philosophy of kaitiakitanga is mauri. Mauri is the "vital essence" of an entity, including objects, individuals, social groupings and ecosystems (Moorfield, 2011). It is recognised that conservation rāhui, an example of the enactment of kaitiakitanga, can promote the revitalisation of mauri (Barlow, 1991; Kawharu, 2000; Wheen & Ruru, 2011): "… when it comes down to what the purpose of kaitiakitanga is, to me it's about restoring mauri." (Dr Dan Hikuroa, in Warne, 2021).

Mauri is considered to have equivalence to ecological integrity (Lyver et al., 2015) and ecological balance (Meurk, Pauling, Ataria, & Kirikiri, 2006), thus it encompasses ecological attributes that are the targets of restoration. These attributes include the enhancement of native biodiversity, management of invasive and exotic species, prevention of species declines and extinctions, strengthening of species relationships, and re-establishing ecosystem links to wider the ecological matrix (see Table 3.1). The enhancement of any of these attributes is an enrichment of mauri, and is an indicator of restoration success.

For Māori, ecological restoration represents a fulfilment of the obligation of kaitiakitanga, to protect and enhance the mauri and whakapapa (Walker et al., 2019). The phrase "manaaki mauri", introduced by an interviewee, can be literally translated as "taking take care of, and supporting, the vital essence of life" (after Moorfield, 2011). As this term is inclusive of the life essence of the natural world and of people as individuals or social groups, it may be an appropriate concept for ecological restoration in te reo Māori (the phrase "manaaki mauri" is used in this context elsewhere, e.g., Mountains-To-Sea Conservation Trust, 2022).

5.4.1.2 Mātauranga Māori: an holistic view

Although kōrero participants identified improved access to local traditional ecological resources, especially kai (food), to be a prime indicator of ecological restoration success, a closer personal connection to the land was also seen as an indicator of restoration success. This closer connection included mental and spiritual enrichment, deriving income, and understanding of tribal narratives (e.g., origin of place names). The potential to generate an interest in learning about the history and features of the rohe, and thus establish, or

revitalise, tribal connections with their land was specifically identified as an outcome of physical participation in restoration actions. To facilitate this revitalisation, or “recalibration” (Interview 2), it was considered essential that restoration projects had a local focus and local (iwi) participants, a view also promoted by Walker et al. (2019).

Accompanying the comments for iwi to lead restoration on their land, kōrero participants identified a need for investment in resourcing of their communities in ecological expertise to increase their capacity to fulfil the obligations of kaitiakitanga. A shortfall in capacity, and the need to better resource iwi for environmental management, has been recognised by other authors (e.g., Ratana, Herangi, & Murray, 2019; Taiepa et al., 1997; Walker et al., 2019). Mātauranga-driven processes are already in place, or being developed, for some ecological restoration projects, for example Ngāti Maniapoto wetlands (Ratana et al., 2019), Kaiwharawhara catchment (Michel et al., 2019), Waitaua catchment (Walker et al., 2019), and Okahu Bay (Walker et al., 2019). The building of restoration knowledge and capacity within these projects is through iwi collaboration with other practitioners, primarily government agencies, tertiary institutions and private consultants.

Mātauranga Māori attributes of success identified by the kōrero participants collectively incorporated local and landscape ecological outcomes, and social benefits. Combined, these elements constitute a holistic perspective consistent with indigenous peoples’ world views globally (Salmón, 2000). The representation of ecological restoration sketched in Interview 7 (Fig. 5.3) that depicts a mountains-to-the-sea continuum with environment, biodiversity and human interactions throughout a catchment encapsulates this holistic perspective. The catchment representation echoes the mountains-to-the-sea management philosophy advocated by Ngāi Tahu iwi (Kāi Tahu ki Otago, 2005), and reinforced in the New Zealand Biodiversity Strategy (Department of Conservation, 2020).

Figure 5.5 – A mountains-to-the-sea representation of a holistic approach to community and ecosystem well-being (from WAI Wānaka, 2022).

The mountains-to-the-sea concept appears to be accepted and applied widely as a number of kōrero participants specifically mentioned and emphasised a mountains-to-the-sea continuum (or an equivalent) as part of their expectations of success for restoration projects. Other restoration projects throughout New Zealand (e.g., Kaiwharawhara Sanctuary to Sea restoration project, Michel et al., 2019) also advocate a catchment restoration approach, and diagrams promoting the breadth of community responsibilities needed for successful environmental management, for example WAI Wānaka (2022) (Fig. 5.5) and Ministry for the Environment & Stats NZ (2022), frequently use the mountains-to-the-sea representation.

A further consideration of the holistic mountains-to-the-sea concept is the significance of the mountains that head a catchment and the names of features within the catchment. The mountains and rivers themselves are ancestors (Magallanes, 2015). They are symbolic kaitiaki of the Māori communities living in their shadow or path, and every catchment will be mapped with names associated with ancestors and a multitude of historical events (Kawharu, 2000). Thus a philosophy of holistic environmental care (and hence restoration) at the catchment scale not only meets the responsibilities of care of the ecological elements, but

also of ancestors and wāhi tapu (sacred places, Moorfield, 2011) and the cultural obligations associated with them (Walker et al., 2019).

5.4.2 The role of cultural narratives

Many kōrero participants referred to exercising kaitiakitanga on their own rohe pōtae (tribal land, Moorfield, 2011) as mana whenua (people with authority over land, Moorfield, 2011). The historical relationship between a rohe and its mana whenua is defined by cultural narratives (P. Davis, in New Zealand Ministry of Education, 2022). Cultural narratives are part of all societies, and are particularly central to societies where oral traditions are the main source of knowledge about the past (Vansina, 2006). Narratives, through a range of genres, allow people to examine events and understandings in ways consistent with their traditional world views (Iseke, 2013), and subsequently pass the knowledge to following generations.

For Māori, cultural narratives include oral traditions (old world knowledge retold over generations, McRae, 2017) and oral histories (reported statements from conversations, Vansina, 2006). Kōrero participants drew on cultural narratives to justify and apply the concept of ecological restoration from a mātauranga Māori perspective.

Kōrero participants cited pūrākau (customary stories) and whakataukī (proverbs), traditional oral forms of codified narratives (Hikuroa, 2017; Whaanga, Wehi, Cox, Roa, & Kusabs, 2018), as evidence of how the traditional ways generated through intergenerational experiences aligned with ecological restoration. Kōrero participants indicated that such narratives held the knowledge that should inform the nature and order of any restoration practical activities and thus guide practitioners towards targets for restoration practice against which restoration success can be assessed – including the composition of natural communities (reference ecosystems), species associations and restoration order. Although pūrākau and whakataukī narratives are contextualised within a Māori world view and usually incorporate cultural and social values, they do represent accurate knowledge of natural phenomena based on field observations (Hikuroa, 2017).

Pūrākau are a standard way of transmitting knowledge within mātauranga Māori. They are narratives, often in a metaphorical format, condensed intentionally to encapsulate complex knowledge into easily understood forms (Lee, 2008; Marsden, 2003), and function as explanations of ancient customs and practice (McRae, 2017) and expressions of expectations for cultural norms (Standing & Kahu, 2021). Although frequently misrepresented as “myths and legends” (Lee, 2009, p. 1), Hikuroa (2017, p. 5) states that pūrākau are based on “critically verified knowledge, continually updated through time.”

Whakataukī (or whakatauākī if the author is known) are personal or community proverbs that generally convey messages of wisdom through reference to values, spiritual and philosophical concepts, tribal history and social characteristics, and provide guidelines for behaviour (McRae, 2017; Whaanga et al., 2018). Although there can be numerous interpretations for any one whakataukī, McRae (2017, p. 81) refers to them as “an archive of information about the old world.” Many whakataukī contain species observations that, although often paired with cultural messages, represent a wealth of ecological observations (Wehi, Cox, Roa, & Whaanga, 2013; Whaanga et al., 2018). These observations may include species behaviours, associations and needs, and are recognised as a source of traditional ecological knowledge (Wehi, Cox, Roa, & Whaanga, 2018; Whaanga et al., 2018).

The accuracy and relevance of the pūrākau and whakataukī as models for ecological restoration, and their potential for being used as criteria to determine ecological restoration success, can be demonstrated through activities occurring at long-established ecological restoration projects. In Tawharanui Regional Park, Auckland, coastal restoration conforms to the restoration order implicit in the pūrākau of Pīngao and Rimurimu. In the park, pīngao vegetation is being restored to stabilise the sand dunes (Stanes, 2017), and the adjacent marine environment has been protected through a marine park designation (Department of Conservation, n.d.), arguably contributing to an improved state of the natural coastal communities between the two realms and contributing to the ecological restoration success of the park (Fig. 5.6).

Figure 5.6 – Marine—terrestrial ecological relationship depicted in Tawharanui Regional Park advocacy material (Auckland Council, 2022).

An analysis of whakataukī suggests that Māori recognised the impacts of the loss of animal resources (Wehi et al., 2018), so it is not surprising that a whakatauakī referring to the fate of a species was presented in the kōrero. The “He Tangata” whakatauakī referenced in Interview 6 (Section 5.3.2.2) not only recognises the ecological associations between the bellbird and its nectar resources, but also the impact on the species of the loss of the resource through human activity. The wisdom contained in the whakatauakī is that humans have responsibility to address the degraded situation, hence the link to ecological restoration.

On Tiritiri Matangi Island, the importance of restoring plant—bird species associations has always been a restoration priority. The planting of trees that would provide nectar and fruit resources for birds (such as the kōmako/bellbird, Fig. 5.7) on the island and for those with potential to be translocated to the island, termed “habitat enhancement” (Department of Lands and Survey, 1982, p. 47), was advocated prior to the project starting, and implemented over a decade of restoration planting (Hawley, 1997). Long-term monitoring has confirmed that this restoration action has successfully enhanced the island for birds as intended (Graham, Veitch, Aguilar, & Galbraith, 2013).

Figure 5.7 – Female kōmako (bellbird Anthornis melanura) feeding on nectar at harakeke flowers (flax Phormium tenax), Tiritiri Matangi Island (Photo: Neil Fitzgerald).

Ecological restoration is dependent on accurate knowledge of reference ecosystems to establish targets for restoration action (Wehi, 2009). Oral traditions provide local insights into past ecosystems no longer evident due to the extent of environmental degradation (Michel et al., 2019; Wehi, 2009), and may contribute to the establishment of restoration targets. However, oral traditions are multilinear representations of historical accounts. They are from, potentially, disparate sources, may be subject to modification over time (Finnegan, 1970), usually anonymous (Vansina, 2006), and generally do not relate to specific geographical locations (Wehi, 2009). Oral histories, however, are structured personal conversations that follow defined unilinear directions (Egan & Howell, 2001; Grele, 2007).

Oral histories are verbal testimonies passed from one person to another (Vansina, 2006), and constitute complex individual and collective memories of past events and conditions (Finnegan, 1970; Grele, 2007). Although some accuracy may be lost with each successive transmission, testimonies that refer to relatively recent events still have the potential to be reliable accounts (Vansina, 2006). This is because verbal testimonies tend to be unilinear storylines, and are considered by some authors as being at least as accurate, if not more accurate, than multilinear histories written by any number of observers (Finnegan, 1970; Grele, 2007). However, Maude (1971, p. 9) suggests that oral histories may only be accurate, at best, for “a few centuries”.

Aotearoa New Zealand was one of the last land masses to be colonised by humans (Taylor, Stephenson, Cochrane, Smith, & Gibbs, 1997). Although Polynesian migrants arriving in the 14th century (Walter, Buckley, Jacomb, & Matisoo-Smith, 2017) initiated a wave of anthropogenic environmental impacts (McGlone, 1989), degradation intensified following the colonisation en masse by Europeans from the 1850s (Taylor et al., 1997). Māori oral histories may thus be sufficiently recent (at least within the time envelope suggested by Maude (1971) and Egan and Howell (2001) for accuracy) to provide accurate commentaries on the environmental degradation since European arrival, and serve as a record of lost ecosystems. Kōrero participants made reference to talking with kaumātua (elders, Moorfield, 2011) – tapping into their oral histories – to use their memories of past environments (e.g., “what was there before”, Interview 10) as a means to establish rationales and targets for restoration action.

In ecological restoration, cultural narratives in any form offer an accurate source of ethnobiological knowledge for defining conceptual reference ecosystem models (Anderson, 2001; Egan & Howell, 2001), and constitute a valuable tool particularly if analogous reference sites no longer exist. In New Zealand, the wealth of Māori cultural narratives,

described as “a remarkable representation” of te ao tawhito, the Māori ancient world (McRae, 2017, p. 11), are a rich legacy of knowledge for application to ecological restoration projects.

The relationships between humans and nature, defined by whakapapa and described through narratives, define the Māori connection to land, the whenua. This connection is vital to Māori society. Māori communities have both physical and spiritual connections to their lands (Ministry for the Environment & Stats NZ, 2021), places that, traditionally, would have provided a place to live and the resources to survive. Thus, invariably, the state of the land and waters have a direct influence on the well-being of the members of the local communities. The potential, and need, for physical participation in kaitiakitanga projects to encourage a sense of responsibility to nature, and strengthen links to the land through exposure to cultural narratives, was highlighted by kōrero participants, a need well within Māori communities (Walker et al., 2019; Wehi & Wehi, 2010).

5.4.3 Conclusion

The views expressed by the kōrero participants on applying mātauranga Māori to the principles of ecological restoration mirror those expressed about biodiversity conservation presented by other New Zealand authors, for example Lyver et al. (2008), Dick et al. (2012), and Lyver et al. (2015).

Attributes of ecological restoration success presented by the kōrero participants embody the individual and collective responsibilities of kaitiakitanga, and the six elements identified by Taiepa et al. (1997) that represent ecological understanding: ecosystem health and renewal, return of mauri, traditional knowledge, tikanga, ecology, and environmental ethics. A summary of the application of mātauranga Māori to the principles underpinning ecological restoration developed from the kōrero is shown in Table 5.3.

Wehi, Beggs, and McAllister (2019) highlight the central role that mātauranga Māori has in environmental protection. The inclusion of Māori environmental philosophies in ecological restoration projects is promoted by Walker et al. (2019) as a means to achieve multi-method transdisciplinary approaches to restoration, with potential for improving environmental outcomes.

Practices promoting the sustainable use of resources, and opportunities to allow resources to recover from human impact, are inherent in indigenous societies, usually achieved through cultural norms developed to maintain sustainable traditional practices (Sasaoka, 2017; Ulluwishewa, Roskruge, Harmsworth, & Antaran, 2008). In Polynesian societies, for

example, rāhui are one such norm, that act to separate people physically from locations and resources for a variety of purposes including that of conservation (Barlow, 1991; Fabre, Bambridge, Claudet, Sterling, & Mawyer, 2021).

In Māori culture, a conservation rāhui (Mead, 2016), is a temporary limitation of access to geographical areas or resources (Barlow, 1991; Moorfield, 2011) with the purpose described by Best (1904, p. 86) to "restore and retain the productiveness, health, welfare, &c., of the food products, as also of the land and people." Although literature often suggests that the use of conservation rāhui is focussed on the sustainable use of the food resources of land and water (Garven, Nepia, & Ashwell, 1997; Mead, 2016; Whaanga & Wehi, 2017), the inclusion of "land" and "people" in Best's (1904) definition suggests that wider elements of social well-being and ecological state are inherent in this cultural norm. Although no kōrero participants specifically referred to the traditional practice of conservation rāhui, their views of environmental management, encompassing the need to reverse anthropogenic degradation through intentional and targeted restorative actions, were inclusive of the purposes of conservation rāhui.

Ecological restoration involves intentional actions that align with those of conservation rāhui. That the practice of ecological restoration fits conceptually into the Māori world view is evident in the ease and readiness that the kōrero participants shared their views and experiences using the language and components of mātauranga Māori. Although words for ecology and associated contexts (such as ecosystem, biodiversity, ecological restoration) do not exist in the traditional te reo Māori lexicon (Harmsworth & Awatere, 2013), the kōrero participants' application of traditional knowledge comfortably encompassed concepts of ecological restoration[1].

[1] Modern English–Māori dictionaries (e.g., He Kupenga Hao i te Reo & Ministry of Education, 2009; Moorfield, 2011) do include ecology-related words, but they are recent additions to te reo Māori. The additions are either new words or phrases that provide an equivalent concept or describe a literal construct of scientific contexts, developed to meet the emerging needs of teaching a modern science curricula (He Kupenga Hao i te Reo & Ministry of Education, 2009; Smallbone, Rofe, & Moeed, 2017). None of the kōrero participants used modern ecology-related Māori words in their kōrero.

Table 5.3 – Summary of the application of mātauranga Māori to the principles underpinning ecological restoration (restoration principles from Gann et al., 2019).

Principles of ecological restoration	How mātauranga Māori fulfils this principle	Examples of mātauranga Māori information	Examples of indicators of restoration success
Engages stakeholders	Collective initiatives Kinship and spirituality	Tribal knowledge, cultural narratives, kaitiakitanga	Iwi engaged in collective restoration actions Monitoring undertaken by iwi
Draws on many types of knowledge	TEK, intergenerational knowledge, deep understanding of the environment	Tribal knowledge, cultural narratives, whakapapa	Species management informed by mātauranga Māori
Informed by reference ecosystem	Establishes place-specific characteristics of historical ecosystems and restoration goals	Oral traditions, oral histories, whakapapa	Restoration progress towards ecosystems described by oral traditions or oral histories
Supports ecosystem recovery processes	Establishes characteristics of target ecosystems, determines the sequence of restoration actions	Local knowledge, oral traditions, oral histories, whakapapa, kaitiakitanga	Enhancement of mauri Healthy populations of taonga and kai species
Is assessed against clear goals and objectives.	Identification of attributes that influence community wellness; provides knowledge of taonga species at risk	Identification of keystone/taonga species to monitor	Iwi have capacity to undertake monitoring
Seeks highest level of recovery possible	Identification of ecological stressors	Oral histories	Ecological stressors reduced/eliminated
Gains cumulative value when applied to large scales	Kinship and spirituality	Tribal knowledge, cultural narratives, whakapapa, wāhi tapu	Well-being of Māori communities
Is part of a continuum of restorative actions	Holistic philosophy	Whakapapa, mauri, tribal knowledge, cultural narratives	Restoration achieves mountains-to-the-sea (catchment) outcomes

The New Zealand Biodiversity Strategy 2020 acknowledges the relationship between Māori and the natural world, and advocates mātauranga Māori as a crucial collaborative tool to achieve its goals. Central to the strategy is revitalising the kinship ties of people to their lands. For iwi-led ecological restoration that constitutes "manaaki mauri," or where the restoration processes are informed by mātauranga Māori, the benefits for the practitioners include the strengthening of cultural connections to the whenua through learning about the rohe, its history and origin of names, as well as its ecosystems.

These benefits are explicitly expressed in the overarching philosophy of the strategy (Department of Conservation, 2020, p. 6):

"Me te mōhio hoki ki te whakaora tātou i ērā mea, me whakaora hoki tātou i ngā taura here a te tangata ki ōna whenua, mai i ōna maunga, tae noa ki te moana."	*"We know full well that if we restore those things [biodiversity], we must also reinvigorate the kinship ties of people to their lands, from the mountains to the sea."*

The kincentric and holistic nature of mātauranga Māori, and environmental philosophies of indigenous peoples generally, dictate that consideration of what constitutes ecological restoration progress and success must account for both ecological and cultural outcomes. This requirement is evident in the holistic guiding principles advocated for in the 2021–2030 UN Decade for Ecosystem Restoration, where social expectations arguably dominate ecological expectations. David Martinez's statement (1992) quoted at the beginning of this chapter, published almost 30 years prior to the UN Decade for Ecosystem Restoration, has proved somewhat prophetic in highlighting the inseparability of ecological restoration and cultural and spiritual restoration in the global imperative to reverse the anthropomorphic degradation of our planet.

References

Anderson, M. K. (2001). The contribution of ethnobiology to the reconstruction and restoration of historic ecosystems. In D. Egan & E. A. Howell (Eds.), *The historical ecology handbook: A restorationist's guide to reference ecosystems* (pp. 55-72). Washington, D.C.: Island Press.

Auckland Council. (2022). *Auckland design manual: Tawharanui Regional Park*. Retrieved 25 August 2022, from https://content.aucklanddesignmanual.co.nz/resources/case-studies/tawharanui-regional-park/Pages/default.aspx

Barlow, C. (1991). *Tikanga whakaaro: Key concepts in Māori culture*. Auckland: Oxford University Press.

Barsh, R. L. (2000). *Protecting knowledge: Traditional resource rights in the new millennium*. University of British Columbia: Union of British Columbia Indian Chiefs.

Baxter, J., & Eyles, J. (1997). Evaluating qualitative research in social geography: Establishing 'rigour' in interview analysis. *Transactions of The Institute of British Geographers, 22*(4), 505-525. https://doi.org/10.1111/j.0020-2754.1997.00505.x

Berkes, F. (1993). Traditional ecological knowledge in perspective. In J. T. Inglis (Ed.), *Traditional ecological knowledge: Concepts and cases* (pp. 1 - 9). Ottawa: Canadian Museum of Nature and International Development Research Centre.

Best, E. (1904). Notes on the custom of rahui, its application and manipulation, as also its supposed powers, its rites, invocations and superstitions. *Journal of the Polynesian Society, 13*(2), 83-88.

Boyd, C. O. (2001). Phenomenology: The method. In P. L. Munhall (Ed.), *Nursing research: A qualitative perspective* (pp. 93-122). Sudbury, MA: Jones & Bartlett Learning.

Braun, V., & Clarke, V. (2012). Themantic analysis. In H. Cooper (Ed.), *APA Handbook of research methods in psychology* (Vol. 2. Research Designs). Washington, DC: American Psychological Association.

Chilisa, B. (2020). *Indigenous research methodologies*. Thousand Oaks, CA: SAGE Publications.

Clewell, A. F., & Aronson, J. (2013). *Ecological restoration: Principles, values, and structure of an emerging profession*. Washington, DC: Island Press.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice, 39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Daily, G. C. (1997). Introduction: What are ecosystem services? In G. C. Daily (Ed.), *Nature's services: Societal dependence on natural ecosystems* (pp. 1-10). Washington, D.C.: Island Press.

de Leeuw, E. (2008). Self-administered questionnaires and standardized interviews. In P. Alasuutari, L. Bickman, & J. Brannen (Eds.), *Handbook of social research methods* (pp. 313-327). Thousand Oaks, CA: SAGE Publications.

Department of Conservation. (2020). *Te Mana o Te Taiao - Aotearoa New Zealand Biodiversity Strategy 2020*. Wellington, NZ: Department of Conservation.

Department of Conservation. (n.d.). *Tāwharanui Marine Reserve*. Retrieved 27 May 2022, from https://www.doc.govt.nz/parks-and-recreation/places-to-go/auckland/places/tawharanui-marine-reserve/

Department of Conservation & Ministry for the Environment. (2000). *New Zealand biodiversity strategy: Our chance to turn the tide*. Wellington, NZ: Department of Conservation; Ministry for the Environment.

Department of Lands and Survey. (1982). *Tiritiri Matangi Island working plan*. Auckland: Hauraki Gulf Maritime Park Board.

Dick, J., Stephenson, J., Kirikiri, R., Moller, H., & Turner, R. (2012). Listening to the kaitiaki: Consequences of the loss of abundance and biodiversity of coastal ecosystems in Aotearoa New Zealand. *MAI Journal, 1*(2), 117-130.

Edwards, R., & Holland, J. (2013). *What is Qualitative Interviewing?* London: Bloomsbury Publishing. https://doi.org/10.5040/9781472545244

Egan, D., & Howell, E. A. (2001). Introduction. In D. Egan & E. A. Howell (Eds.), *The historical ecology handbook: A restorationist's guide to reference ecosystems* (pp. 1-23). Washington, D.C.: Island Press.

Fabre, P., Bambridge, T., Claudet, J., Sterling, E., & Mawyer, A. (2021). Contemporary rāhui: Placing indigenous, conservation, and sustainability sciences in community-led conservation. *Pacific Conservation Biology, 10.1071/PC20087*.

Finnegan, R. (1970). A Note on Oral Tradition and Historical Evidence. *History and Theory, 9*(2), 195-201. https://doi.org/10.2307/2504126

Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., . . . Dixon, K. W. (2019). *International principles and standards for the practice of ecological restoration* (2nd ed.). Washington, D.C.: Society for Ecological Restoration.

Garibaldi, A., & Turner, N. (2004). Cultural keystone species: Implications for ecological conservation and restoration. *Ecology and Society, 9*(3). https://doi.org/10.5751/ES-00669-090301

Garven, P., Nepia, M., & Ashwell, H. (1997). *Te whakatau kaupapa o Murihiku: Ngai Tahu resource management strategy of the Southland region*. Wellington: Aoraki Press.

Gasteiger, N., Vedhara, K., Massey, A., Jia, R., Ayling, K., Chalder, T., . . . Broadbent, E. (2021). Depression, anxiety and stress during the COVID-19 pandemic: Results from a New Zealand cohort study on mental well-being. *BMJ Open, 11*(5), e045325. https://doi.org/10.1136/bmjopen-2020-045325

Gibson, J. (2019). *Ngāti Kuri takes flight*. Retrieved 17 April 2022, from https://e-tangata.co.nz/korero/ngati-kuri-takes-flight/

Given, L. M. (2012). Conversational interviewing. In *The SAGE Encyclopedia of qualitative research methods* (pp. 128-129). https://doi.org/https://dx.doi.org/10.4135/9781412963909

Graham, M., Veitch, D., Aguilar, G., & Galbraith, M. (2013). Monitoring terrestrial bird populations on Tiritiri Matangi Island, Hauraki Gulf, New Zealand, 1987-2010. *New Zealand Journal of Ecology, 37*(3), 359-369.

Grele, R. J. (2007). Reflections on the practice of oral history: Retrieving what we can from an earlier critique. *Journal of the Finnish Anthropological Society, 32*, 4.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field Methods, 18*(1), 59-82. https://doi.org/10.1177/1525822x05279903

Harmsworth, G., Awatere, S., & Robb, M. (2016). Indigenous Māori values and perspectives to inform freshwater management in Aotearoa-New Zealand. *Ecology and Society, 21*(4). https://doi.org/10.5751/ES-08804-210409

Harmsworth, G. R., & Awatere, S. (2013). Indigenous Māori knowledge and perspectives of ecosystems. In J. R. Dymond (Ed.), *Ecosystem services in New Zealand—conditions and trends* (pp. 274-286). Lincoln: Manaaki Whenua Press.

Hawley, J. (1997). *Tiritiri Matangi Island working plan*. Auckland: Department of Conservation.

Haynes, K. (2012). Reflexivity in qualitative research. In G. Symon & C. Cassell (Eds.), *Qualitative organizational research: Core methods and current challenges* (pp. 72-89). London: SAGE Publications.

He Kupenga Hao i te Reo, N. Z., & Ministry of Education. (2009). *Te reo pūtaiao: Taumata 1-5 o Te Pūtaiao i roto i Te Marautanga o Aotearoa = A Māori language dictionary of science*. Papaioea, Aotearoa: Mā Te Tāhuhu o te Mātauranga e He Kupenga Hao i te Reo.

Henderson, S., & Segal, E. H. (2013). Visualizing qualitative data in evaluation research. In T. Azzam & S. Evergreen (Eds.), *Data visualisation, Part 1* (pp. 53-71)

Hennink, M., & Kaiser, B. N. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine, 292*, 114523. https://doi.org/https://doi.org/10.1016/j.socscimed.2021.114523

Higgs, E. (2005). The two-culture problem: Ecological restoration and the integration of knowledge. *Restoration Ecology, 13*(1), 159-164. https://doi.org/10.1111/j.1526-100X.2005.00020.x

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

Hopf, C. (2004). Qualitative interviews: An overview. In U. Flick, E. von Kardoff, I. Steinke, & B. Jenner (Eds.), *A companion to qualitative research* (pp. 203-208). London: SAGE Publications.

Hudson, M., Milne, M., Reynolds, P., Russell, K., & Smith, B. (2010). *Te Ara Tika. Guidelines for Māori research ethics: A framework for researchers and ethics committee members*. Auckland: Health Research Council of New Zealand.

Huntington, H. P. (2000). Using traditional ecological knowledge in science: Methods and applications. *Ecological Applications, 10*(5), 1270-1274. https://doi.org/10.2307/2641282

Iseke, J. (2013). Indigenous storytelling as research. *International Review of Qualitative Research, 6*(4), 559-577. https://doi.org/10.1525/irqr.2013.6.4.559

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly, 24*(4), 602-611. https://doi.org/10.2307/2392366

Kahui, V., & Cullinae, A. (2019). The ecosystem commons. *New Zealand Journal of Ecology, 43*(3), 1-5.

Kāi Tahu ki Otago. (2005). *Natural resource management plan*. Dunedin: Kāi Tahu ki Otago.

Kaitiaki Consulting Ltd. (2022). *Conserve. Restore. Thrive.* Retrieved 26 April 2022, from https://kaitiakiconsulting.com/

Kaitiaki o Ngahere. (n.d.). *Kaitiaki o Ngahere Ltd: Ecological restoration and biosecurity*. Retrieved 26 April 2022, from https://www.kaitiakirestoration.co.nz/

Kauffman, C., & Martin, P. (2018). Constructing rights of nature norms in the US, Ecuador, and New Zealand. *Global Environmental Politics, 18*, 43-62. https://doi.org/10.1162/glep_a_00481

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

Kelley, K., Clark, B., Brown, V., & Sitzia, J. (2003). Good practice in the conduct and reporting of survey research. *International Journal for Quality in health care, 15*(3), 261-266.

Kimmerer, R. (2011). Restoration and reciprocity: The contributions of traditional ecological knowledge. In D. Egan (Ed.), *Human dimensions of ecological restoration* (pp. 257-276). Washington, DC: Island Press.

Kitson, J. C., & Moller, H. (2008). Looking after your ground: Resource management practice by Rakiura Māori Titi harvesters *Papers and Proceedings of the Royal Society of Tasmania, 142*(1), 161-176.

Kovach, M. (2010). Conversational method in indigenous research. *First Peoples Child and Family Review, 5*(1), 40-48.

Lee, J. (2009). Decolonising Māori narratives: Pūrākau as a method. *MAI Review, 2*(3), 1-12.

Lee, J. B. J. (2008). *Ako: Pūrākau of Māori teachers' work in secondary schools* (Doctoral thesis, University of Auckland). Available from http://www.rangahau.co.nz/methodology/185/ database.

Lewis, S., & Russell, A. (2011). Being embedded: A way forward for ethnographic research. *Ethnography, 12*(3), 398-416. https://doi.org/10.1177/1466138110393786

Long, J., Tecle, A., & Burnette, B. (2003). Cultural foundations for ecological restoration on the White Mountain Apache Reservation. *Conservation Ecology, 8*. https://doi.org/10.5751/ES-00591-080104

Lyver, P. O'B., Akins, A., Phipps, H. L., Kahui, V., Towns, D. R., & Moller, H. (2015). Key biocultural values to guide restoration action and planning in New Zealand. *Restoration Ecology*, 1-10. https://doi.org/10.1111/rec.12318

Lyver, P. O'B., Taputu, Te M., Kutia, S. T., & Tahi, B. (2008). Tūhoe Tuawhenua mātauranga of kererū (*Hemiphaga novaseelandiae novaseelandiae*) in Te Urewera. *New Zealand Journal of Ecology, 32*(1), 7-17.

MacDonald, L., & Anaru, W. (2020). Iwi and local government partnerships in biosecurity: A case study of Te Arawa Catfish Killas in response to a pest fish incursion in the Bay of Plenty, New Zealand. *Perspectives in biosecurity, 5*, 18-23.

Magallanes, C. J. I. (2015). Nature as an ancestor: Two examples of legal personality for nature in New Zealand. Victoria University of Wellington Legal Research Paper No. 54/2020, http://dx.doi.org/10.2139/ssrn.3532319

Marsden, M. (2003). Kaitiakitanga: a definitive introduction to the holistic worldview of the Māori. In T. A. C. Royal (Ed.), *The woven universe* (pp. 54-72).

Marshall, M., Pagel, C., French, C., Utley, M., Allwood, D., Fulop, N., . . . Goldmann, A. (2014). Moving improvement research closer to practice: The researcher-in-residence model. *BMJ Quality & Safety, 23*, 801-895. https://doi.org/10.1136/bmjqs-2013-002779

Martinez, D. (1992). *Protecting mother earth*. Paper presented at the meeting of the Indigenous Environmental Network, Celilo Falls, Oregon, USA.

Mattos dos Santos, R. (2020). Isolation, social stress, low socioeconomic status and its relationship to immune response in Covid-19 pandemic context. *Brain, Behavior, & Immunity - Health, 7*, 100103. https://doi.org/10.1016/j.bbih.2020.100103

Maude, H. E. (1971). Pacific history - past, present and future. *Journal of Pacific History, 6*, 3-24.

McAllister, T., Beggs, J., Ogilvie, S., Kirikiri, R., Black, A., & Wehi, P. (2019). Kua takoto te mānuka: Mātauranga Māori in New Zealand ecology. *New Zealand Journal of Ecology, 43*. https://doi.org/10.20417/nzjecol.43.41

McClelland, P., Coote, R., Trow, M., Hutchins, P., Neviins, H., Adams, J., . . . Moller, H. (2011). The Rakiura Tītī Islands Restoration Project: community action to eradicate Rattus rattus and Rattus exulans for ecological restoration and cultural wellbeing. *Island Invasives: Eradication and Management,.(Eds CR Veitch, MN Clout and DR Towns.) pp*, 451-454.

McGlone, M. (1989). The Polynesian settlement of New Zealand in relation to environmental and biotic changes. *New Zealand Journal of Ecology, 12 (supplement)*, 115-129.

McNaught, C., & Lam, P. (2010). Using Wordle as a supplementary research tool. *The Qualitative Report, 15*(3), 630-643.

McRae, J. (2017). *Māori oral tradition : He kōrero nō te ao tawhito*. Auckland: Auckland University Press.

Mead, S. (2016). *Tikanga Māori : living by Māori values*. Wellington: Huia Publishers.

Meurk, C., Pauling, C., Ataria, J., & Kirikiri, R. (2006). *Hikoi Whakakahu - restoring the mauri*. Lincoln: Landcare Research.

Michel, P., Dobson-Waitere, A., Hohaia, H., McEwan, A., & Shanahan, D. F. (2019). The reconnection between mana whenua and urban freshwaters to restore the mouri/life force of the Kaiwharawhara. *New Zealand Journal of Ecology, 43*(3), 1-10.

Ministry for the Environment & Stats NZ. (2021). *New Zealand's environmental reporting series: Our land 2021*. Wellington: Ministry for the Environment and Stats NZ.

Ministry for the Environment & Stats NZ. (2022). *New Zealand's Environmental Reporting Series: Environment Aotearoa 2022*. Wellington: Ministry for the Environment & Stats NZ.

Mistry, J., & Berardi, A. (2016). Bridging indigenous and scientific knowledge. *Science, 352*(6291), 1274-1275.

Moorfield, J. C. (2011). *Te aka: Māori-English, English-Māori dictionary and index*. Auckland: Pearson.

Morad, M., & Jay, M. (2000). Kaitiakitanga: Protecting New Zealand's native biodiversity. *Biologist (London), 47*(4), 197-201.

Mountains-To-Sea Conservation Trust. (2022). *Strategic vision 2022-2025*. Retrieved from https://www.mountainstosea.org.nz/images/msct/docs/Mountains-to-Sea-Vision_2022-2025.pdf

New Zealand Government. (1991). *Resource Management Act*. Retrieved from http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html

New Zealand Ministry of Education. (2022). *Embracing cultural narratives*. Retrieved 14 July 2022, from https://www.educationalleaders.govt.nz/Leading-change/Maori-education-success/Embracing-cultural-narratives

Ngāti Whātua Ōrākei Trust. (2022). *Ōkahu rākau: Native bush care and nursery*. Retrieved 17 April 2022, from https://ngatiwhatuaorakei.com/whenua-toi/okahu-rakau-2/

Onwuegbuzie, A. J., & Leech, N. L. (2007). Sampling designs in qualitative research: Making the sampling process more public. *The Qualitative Report, 12*(2), 238-254.

Palys, T. (2008). Purposive sampling. In L. M. Given (Ed.), *The SAGE Encyclopedia of qualitative research methods* (pp. 698-699). Thousand Oaks: SAGE Publications. https://doi.org/10.4135/9781412963909

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Thousand Oaks, California: SAGE Publications, Inc.

Pipi, K., Cram, F., Hawke, R., Hawke, S., Huriwai, T., Mataki, T., . . . Tuuta, C. (2004). A research ethic for studying Māori and iwi provider success. *Social Policy Journal of New Zealand, 23*(3), 141-153.

Poa, T.-W. (2020). *Mātauranga Māori: Applying a Māori lens to environmental management*. Retrieved 21 June 2020, from https://www.epa.govt.nz/community-involvement/science-corner/matauranga-maori/

Polkinghorne, D. E. (1989). Phenomenological research methods [Polkinghorne1989]. In R. S. Valle & S. Halling (Eds.), *Existential-phenomenological perspectives in psychology: Exploring the breadth of human experience* (pp. 41-60). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4615-6989-3_3

Puia, S. (1990). Protection and cultural use: Māori concepts of the relationship between Māori people and nature. In D. R. Towns, C. Daugherty, & I. A. E. Atkinson (Eds.), *Ecological restoration of New Zealand islands* (pp. 272-277). Wellington: Department of Conservation.

Ratana, K., Herangi, N., & Murray, T. (2019). Me pēhea te whakarauora i ngā repo o Ngāti Maniapoto? How do we go about restoring the wetlands of Ngāti Maniapoto? *New Zealand Journal of Ecology, 43*(3), 1-12.

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.

Roberts, M., Norman, W., Minhinnick, N., Wihongi, D., & Kirkwood, C. (1995). Kaitiakitanga: Māori perspectives on conservation. *Pacific Conservation Biology, 2*, 7-20.

Robinson, J. M., Gellie, N., MacCarthy, D., Mills, J. G., O'Donnell, K., & Redvers, N. (2021). Traditional ecological knowledge in restoration ecology: A call to listen deeply, to engage with, and respect indigenous voices. *Restoration Ecology, 29*(4), e13381.

Roulston, K. J. (2008). Conversational interviewing. In L. M. Given (Ed.), *The SAGE Encyclopedia of qualitative research methods* (pp. 128-129). Thousand Oaks, California. https://doi.org/http://dx.doi.org/10.4135/9781412963909.n70

Salmón, E. (2000). Kincentric ecology: Indigenous perceptions of the human–nature relationship. *Ecological Applications, 10*(5), 1327-1332.

Sasaoka, M. (2017). Indigenous resource management practices and the local social-cultural context: An insight towards self-directed resource management by people who 'coexist' with supernatural agents. In P. Venkatesan (Ed.), *Indigenous people* (pp. 77-104). London: IntechOpen. https://doi.org/10.5772/intechopen.70104

Sillitoe, P. (2017). Indigenous knowledge and natural resources management: An introduction featuring wildlife. In P. Sillitoe (Ed.), *Indigenous knowledge: Enhancing its contribution to natural resources management*. Wallingford, UK: CAB International.

Sinclair, S., & Rockwell, G. (2016). *Voyant tools*. Retrieved 03 May 2016, from http://docs.voyant-tools.org/

Smallbone, C., Rofe, C., & Moeed, A. (2017). Learning science: Pūtaiao in an indigenous school: A review of the theory and practice. *Science Education International, 28*(3), 199-206.

Society for Ecological Restoration International Science and Policy Working Group. (2004). *The SER primer on international ecological restoration*. Tucson: Society for Ecological Restoration International.

Spiller, C., Pio, E., Erakovic, L., & Henare, M. (2011). Wise up: Creating organizational wisdom through an ethic of Kaitiakitanga. *Journal of business ethics, 104*(2), 223-235.

Standing, M., & Kahu, E. R. (2021). Story, myth, and pūrākau: An exploration of the use of narrative in the therapeutic setting in Aotearoa New Zealand. *New Zealand Journal of Psychology, 50*, 29+.

Stanes, A. (2017). Dune 'sea face' restoration. *Tāwharanui Open Sanctuary Society Inc. Newsletter*(62)*,* 5.

Swain, J., & Spire, Z. (2020). The role of informal conversations in generating data, and the ethical and methodological issues they raise. *Qualitative Content Analysis II, 21*(1). https://doi.org/10.17169/fqs-21.1.3344

Taiepa, T., Lyver, P. O. B., Horsley, P., Davis, J., Brag, M., & Moller, H. (1997). Co-management of New Zealand's conservation estate by Maori and Pakeha: A review. *Environmental Conservation, 24*(03), 236-250.

Tanasescu, M. (2013). The rights of nature in Ecuador: the making of an idea. *International Journal of Environmental Studies, 70*(6), 846-861. https://doi.org/10.1080/00207233.2013.845715

Taylor, R., Stephenson, B., Cochrane, P., Smith, I. W. G., & Gibbs, N. (1997). *The State of New Zealand's Environment 1997*. Wellington: Ministry for the Environment.

Taylor, S., Landry, C. A., Paluszek, M. M., Fergus, T. A., McKay, D., & Asmundson, G. J. G. (2020). COVID stress syndrome: Concept, structure, and correlates. *Depression and Anxiety, 37*(8), 706-714. https://doi.org/https://doi.org/10.1002/da.23071

Tipa, G., & Tearney, L. (2003). *A Cultural Health Index for streams and waterways: Indicators for recognising and expressing Maori values*. Wellington: Ministry for the Environment.

Tongco, D. C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and Applications, 5*, 147-158.

Turner, N. J., Ignace, M. B., & Ignace, R. (2000). Traditional ecological knowledge and wisdom of aboriginal peoples in British Columbia. *Ecological Applications, 10*(5), 1275-1287. https://doi.org/https://doi.org/10.1890/1051-0761(2000)010[1275:TEKAWO]2.0.CO;2

Ulluwishewa, R., Roskruge, N., Harmsworth, G., & Antaran, B. (2008). Indigenous knowledge for natural resource management: A comparative study of Māori in New Zealand and Dusun in Brunei Darussalam. *GeoJournal, 73*(4), 271-284. https://doi.org/10.1007/s10708-008-9198-9

Uprety, Y., Asselin, H., Bergeron, Y., Doyon, F., & Boucher, J.-F. (2012). Contribution of traditional knowledge to ecological restoration: Practices and applications. *Écoscience, 19*(3), 225-237. https://doi.org/10.2980/19-3-3530

Van Schravendijk-Goodman, C. (2017). Kapu tī 101: Cuppa teas and cross cultural conversations. In Y. Taura, C. Van Schravendijk-Goodman, & B. Clarkson (Eds.), *Te Reo o Te Repo: The voice of the wetland* (pp. 13-22). Hamilton: Manaaki Whenua - Landcare Research; Waikato Raupatu River Trust.

Vansina, J. (2006). *Oral tradition: A study in historical methodology*. Milton Park: Routledge.

WAI Wānaka. (2022). *WAI Wānaka turns 5*. Retrieved 10 May 2022, from https://waiwanaka.nz/wai-wanaka-turns-5/

Walker, E. T., Wehi, P. M., Nelson, N. J., Beggs, J. R., & Whaanga, H. (2019). Kaitiakitanga, place and the urban restoration agenda. *New Zealand Journal of Ecology, 43*(3), 1-8.

Walter, R., Buckley, H., Jacomb, C., & Matisoo-Smith, E. (2017). Mass migration and the Polynesian settlement of New Zealand. *Journal of World Prehistory, 30*(4), 351-376. https://doi.org/10.1007/s10963-017-9110-y

Warne, K. (2021). Kōrero: Restoring mauri is what drives me. *E-Tangata*. Retrieved from https://e-tangata.co.nz/korero/restoring-mauri-is-what-drives-me/

Wehi, P., Cox, M., Roa, T., & Whaanga, H. (2013). Marine resources in Māori oral tradition: He kai moana, he kai mā te hinengaro. *Journal of Marine and Island Cultures, 2*(2), 59-68. https://doi.org/https://doi.org/10.1016/j.imic.2013.11.006

Wehi, P. M. (2009). Indigenous ancestral sayings contribute to modern conservation partnerships: Examples using *Phormium tenax*. *Ecological Applications, 19*(1), 267-275.

Wehi, P. M., Beggs, J. R., & McAllister, T. G. (2019). Ka mua, ka muri: The inclusion of mātauranga Māori in New Zealand ecology. *New Zealand Journal of Ecology, 43*(3), 1-8.

Wehi, P. M., Cox, M. P., Roa, T., & Whaanga, H. (2018). Human Perceptions of Megafaunal Extinction Events Revealed by Linguistic Analysis of Indigenous Oral Traditions. *Human Ecology, 46*(4), 461-470. https://doi.org/10.1007/s10745-018-0004-0

Wehi, P. M., & Lord, J. M. (2017). Importance of including cultural practices in ecological restoration. *Conservation Biology, 31*(5), 1109-1118. https://doi.org/https://doi.org/10.1111/cobi.12915

Wehi, P. M., & Wehi, W. L. (2010). Traditional plant harvesting in contemporary fragmented and urban landscapes. *Conservation Biology, 24*(2), 594-604.

Whaanga, H., & Wehi, P. (2017). Rāhui and conservation? Māori voices in the nineteenth century niupepa Māori. *Journal of the Royal Society of New Zealand, 47*(1), 100-106. https://doi.org/10.1080/03036758.2016.1252408

Whaanga, H., Wehi, P., Cox, M., Roa, T., & Kusabs, I. (2018). Māori oral traditions record and convey indigenous knowledge of marine and freshwater resources. *New Zealand Journal of Marine and Freshwater Research, 52*(4), 487-496. https://doi.org/10.1080/00288330.2018.1488749

Wheen, N., & Ruru, J. (2011). Providing for rāhui in the law of Aotearoa New Zealand. *Journal of the Polynesian Society, 120*(2), 169-182.

Williams, J. (2010). Mahika Kai: The husbanding of consumables by Maori in precontact Te Waipounamu. *Journal of the Polynesian Society, 119*(2), 149-180.

Wiri, R. (2013). Mana whenua and the settlement of Treaty of Waitangi claims in the central North Island of New Zealand. *AlterNative, 9*(1), 4-15.

WordItOut. (2022). Retrieved 1 April 2022, from https://worditout.com

Zedler, J. B., & Stevens, M. L. (2018). Western and traditional ecological knowledge in ecocultural restoration. *San Francisco Estuary and Watershed Science*.

Appendix A

Supplement S.1 – Survey questions for community-based restoration practitioners on ecological restoration (pertaining to restoration success).

Q1.1

Q1.2 WELCOME COMMUNITY-BASED ECOLOGICAL RESTORATION

You are invited to participate in a survey about aspects of a community-based ecological restoration project that you are involved with. This online survey should take about 10 minutes to complete. Participation is voluntary, and responses will be anonymous to the degree permitted by the technology being used. You have the option to not respond to any questions that you choose. Submission of the survey will be interpreted as your informed consent to participate and that you affirm that you are at least 18 years of age. The findings of the survey will be used for academic publications and presentations. This survey has been approved by the Auckland University of Technology Ethics Committee (reference AUTEC 17/167, 28/06/2017). If you have any questions about the research, please contact the Principal Researcher, Mel Galbraith ({ HYPERLINK "mailto:mgalbraith@unitec.ac.nz" }), or Prof. David Towns ({ HYPERLINK "mailto:dtowns@aut.ac.nz" }). If you have any questions regarding your rights as a research subject, contact Auckland University of Technology Ethics Committee at { HYPERLINK "http://www.aut.ac.nz/researchethics" }. Please print or save a copy of this page for your records.

Q1.3 * I have read the above information and agree to participate in this research project.

- ❍ ENTER SURVEY (1)
- ❍ LEAVE SURVEY (2)

Condition: LEAVE SURVEY Is Selected. Skip To: End of Survey.

Q2.1 Are you associated with a particular ecological restoration project?

- ❍ Yes (1)
- ❍ No (3)

Condition: No is selected. Skip To: End of Survey

Q3.1 PROJECT DETAILS

This section asks questions about details of your ecological restoration project. We are interested in the nature of your participation, who else is involved, and what are some of the activities being undertaken.

Q3.2 Where is/are your restoration project(s) located? _____

Q3.3 How would you best describe your role in the project(s)?

- ❍ Management team member (1)
- ❍ Volunteer worker (2)
- ❍ Technical advisor (3)
- ❍ Consultant (4)
- ❍ Researcher (5)
- ❍ Other ...? (6) _____

Q3.4 Is your project associated with, or affiliated to, a management agency?

- ❍ Yes (1)
- ❍ No (2)

Supplement S.1 *– continued*

Display This Question:
If Is your project associated with, or affiliated to, a management agency? Yes Is Selected

Q3.5 What agency, or agencies, are you associated or affiliated with? Select any that apply:

- ❍ Central government agency (1)
- ❍ Local government agency (2)
- ❍ Iwi authority (5)
- ❍ Non-governmental agency (3)
- ❍ Tertiary institution (4)
- ❍ Other ...? (6) _____

Q3.6 With the project where you spend the most time, do you, or anyone else, record progress towards restoration success?

- ❍ Yes (1)
- ❍ No (2)

Q3.7 What monitoring activities are used to monitor progress? Select any that apply:

- ❍ Vegetation monitoring (1)
- ❍ Bird distribution and abundance (2)
- ❍ Plant pest distribution (5)
- ❍ Animal pest distribution and abundance (3)
- ❍ Others ...? (4) _____

Q3.8 How long has your restoration project been monitored?

- ❍ < 1 year (1)
- ❍ 1-2 yrs (2)
- ❍ 3-5 yrs (3)
- ❍ 6-10 yrs (4)
- ❍ >10 yrs (5)

Q3.9 Do you use any of the following measures of restoration progress? Select any that apply:

- ❍ The condition of the project's ecosystem is improving (eg. nutrient inputs are natural; populations are self-sustaining) (1)
- ❍ The project is moving towards a recognised and appropriate target ecosystem (6)
- ❍ The project's biodiversity is improved in some way (eg. native vegetation cover increased; native invertebrate, reptile and bird species increased; evidence of recolonisation by native species). (5)
- ❍ The project's ecosystem has links to other ecological systems (2)
- ❍ Native species are managed to prevent extinctions and declines (eg. species exported to other projects; threatened species are assisted in some way) (4)
- ❍ Exotic and invasive species are managed in some way (3)
- ❍ Others … (7) _____

Q3.10 Do you consider your ecological restoration project to be successful?

- ❍ Yes (1)
- ❍ No (2)

Display This Question:
If Do you consider your ecological restoration project to be successful? Yes Is Selected

Q3.11 How does your organisation know that the project is successful or making progress? _____

NOTE: Section 4 questions are omitted as they are outside the scope of this analysis

Q5.1 A LITTLE ABOUT YOU

This section asks questions about you. This information is necessary to provide an insight into the participants in restoration projects. The data you share with us will not be used to personally identify you, and will not be passed on to anyone else. If you prefer not to answer these questions, please indicate below or leave the question blank:

- ❍ Continue with questions (1)
- ❍ Prefer not to say (2)

Condition: Prefer not to say Is Selected. Skip To: End of Survey.

Q5.2 What is your gender?

- ❍ Female (1)
- ❍ Male (2)

Q5.3 What is your age?

- ❍ Less than 18 years old (4)
- ❍ 18-29 years old (5)
- ❍ 30-49 years old (6)
- ❍ 50-64 years old (7)
- ❍ 65 years or over (8)

Q5.4 Which of these qualifications, if any, do you have?

- ❍ No formal qualification (4)
- ❍ School qualification (5)
- ❍ National/trade certificate or equivalent (6)
- ❍ Partially completed degree or diploma (7)
- ❍ Undergraduate degree or diploma (8)
- ❍ Postgraduate qualification (9)
- ❍ Other (please specify): (10) _____

Display This Question:
If Which of these qualifications, if any, do you have? National/trade certificate or equivalent Is Selected
Or Which of these qualifications, if any, do you have? Partially completed degree or diploma Is Selected
Or Which of these qualifications, if any, do you have? Undergraduate degree or diploma Is Selected
Or Which of these qualifications, if any, do you have? Postgraduate qualification Is Selected

Q5.5 Does your qualification have a background in ecology?

- ❍ Yes (1)
- ❍ No (3)

Q5.6 Which of the following categories best describes your employment status?

- ❍ Employed, working full-time (3)
- ❍ Employed, working part-time (4)
- ❍ Not employed, looking for work (2)
- ❍ Not employed, NOT looking for work (1)
- ❍ Student (7)
- ❍ Retired (5)

Q5.7 Which ethnic group do you belong to? Select the space, or spaces, that apply to you.

- ❍ New Zealand European (4)
- ❍ Māori (5)
- ❍ Samoan (6)
- ❍ Cook Islands Maori (7)
- ❍ Tongan (8)
- ❍ Niuean (9)
- ❍ Chinese (10)
- ❍ Indian (11)
- ❍ Other (e.g. Dutch, Japanese, Tokelauan) ... (12) _____

Supplement S.2 – Survey questions for agency-based restoration practitioners on ecological restoration (pertaining to restoration success).

Q1.1

Q1.2 WELCOME COMMUNITY-BASED ECOLOGICAL RESTORATION

You are invited to participate in a survey about aspects of a community-based ecological restoration project that you are involved with. This online survey should take about 10 minutes to complete. Participation is voluntary, and responses will be anonymous to the degree permitted by the technology being used. You have the option to not respond to any questions that you choose. Submission of the survey will be interpreted as your informed consent to participate and that you affirm that you are at least 16 years of age. The findings of the survey will be used for academic publications and presentations. This survey has been approved by the Auckland University of Technology Ethics Committee (reference AUTEC 17/167, 28/06/2017). If you have any questions about the research, please contact the Principal Researcher, Mel Galbraith ({ HYPERLINK "mailto:mgalbraith@unitec.ac.nz" }), or Prof. David Towns ({ HYPERLINK "mailto:dtowns@aut.ac.nz" }). If you have any questions regarding your rights as a research subject, contact Auckland University of Technology Ethics Committee at { HYPERLINK "http://www.aut.ac.nz/researchethics" }. Please print or save a copy of this page for your records.

Q1.3 * I have read the above information and agree to participate in this research project.

- ❍ ENTER SURVEY
- ❍ LEAVE SURVEY

Condition: LEAVE SURVEY Is Selected. Skip To: End of Survey.

Q1.4 Do you work for a land-management agency?

- ❍ Yes (1)
- ❍ No (2)

Condition: No is selected. Skip To: End of Survey

Q2.1 ECOLOGICAL RESTORATION IN YOUR REGION

This section asks questions about details of community-based ecological restoration projects in your region. We are interested in the number of projects, your agency's role, and the nature of community engagement in the projects.

Q2.2 What type of agency do you work for?

- ❍ Central government agency (1)
- ❍ Territorial land authority (2)

Q2.3 How many ecological restoration projects are you associated with?

- ❍ None (1)
- ❍ 1-20 (2)
- ❍ 21-40 (3)
- ❍ 41-60 (4)
- ❍ 61-80 (5)
- ❍ More than 80 (6)

Q2.4 Do you actively seek community participation in ecological restoration projects?

- ❍ Yes (1)
- ❍ No (2)

Condition: No Is Selected. Skip To: Please rate each of the following act....

Q2.5 Approximately what proportion of ecological restoration projects involve community participation?

- ❍ None (1)
- ❍ 1-20% (2)
- ❍ 21-40% (3)
- ❍ 41-60% (4)
- ❍ 61-80% (5)
- ❍ 81-100% (6)

Q2.6 What results or benefits do you seek by facilitating community participatory ecological restoration projects? _____

Q2.7 Are ecological restoration projects monitored for success by you or anyone else?

- ❍ Yes (1)
- ❍ No (2)

Condition: No Is Selected. Skip To: If NO, how does your agency know that....

Q2.8 What criteria do you use to determine restoration success?

- ❍ Maintaining ecosystem processes (eg. natural nutrient input and cycling; species diversity and functional groups; self-sustaining populations; species gaps; independence from external influences). (1)
- ❍ Ecosystem is integrated into a larger ecological matrix (eg. evidence of external abiotic / biotic interactions) (2)
- ❍ Reducing spread and dominance of exotic species (eg. invasive plants & animals controlled/eradicated; invasion mitigation proceedures in place). (3)
- ❍ Preventing extinctions and declines (eg. indigenous spp. exported; threatened spp. managed; threatened spp. self-sustaining; project performing refugium function). (4)
- ❍ Improving ecosystem composition (eg. indigenous vegetation cover increased; indigenous invertebrate, reptile and bird species increased; evidence of recolonisation by indigenous species). (5)
- ❍ Improving ecosystem representation (eg. reference system identified; introduction/re-establishment of plant and animal taxa unnecessary or completed). (6)
- ❍ Others … (7) _____

Display This Question:
If Are ecological restoration projects monitored for success by you or anyone else? No Is Selected

Q2.9 How does your agency know that the goals of the New Zealand Biodiversity Strategy are being met?)
_____

Supplement S.2 *– continued*

Q3.1 A LITTLE ABOUT YOU

This section asks questions about you. This information is necessary to provide an insight into the participants in restoration projects. The data you share with us will not be used to personally identify you, and will not be passed on to anyone else. If you prefer not to answer these questions, please indicate below or leave the question blank:

- ❍ Continue with questions (1)
- ❍ Prefer not to say (2)

Condition: Prefer not to say Is Selected. Skip To: End of Survey.

Q3.2 What is your gender?

- ❍ Female (1)
- ❍ Male (2)

Q3.3 What is your age?

- ❍ Less than 18 years old (1)
- ❍ 18-29 years old (2)
- ❍ 30-49 years old (3)
- ❍ 50-64 years old (4)
- ❍ 65 years or over (5)

Q3.4 Which of these qualifications, if any, do you have?

- ❍ No formal qualification (1)
- ❍ School qualification (2)
- ❍ National/trade certificate or equivalent (3)
- ❍ Partially completed degree or diploma (4)
- ❍ Undergraduate degree or diploma (5)
- ❍ Postgraduate qualification (6)
- ❍ Other (please specify): (7) _____

Display This Question:	
If Which of these qualifications, if any, do you have?	National/trade certificate or equivalent Is Selected
Or Which of these qualifications, if any, do you have?	Partially completed degree or diploma Is Selected
Or Which of these qualifications, if any, do you have?	Undergraduate degree or diploma Is Selected
Or Which of these qualifications, if any, do you have?	Postgraduate qualification Is Selected

Q3.5 Does your qualification have a background in ecology?

- ❍ Yes (1)
- ❍ No (2)

Q3.6 Which ethnic group do you belong to? Select the space, or spaces, that apply to you.

- ❍ New Zealand European (1)
- ❍ Māori (2)
- ❍ Samoan (3)
- ❍ Cook Islands Maori (4)
- ❍ Tongan (5)
- ❍ Niuean (6)
- ❍ Chinese (7)
- ❍ Indian (8)
- ❍ Other (eg Dutch, Japanese, Tokelauan (9) _____

Supplement S.3 – Indicative questions for interviews as a follow-up to online survey.

AUT
TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Indicative Questions for Interviews

*(** Follow-up to web-based surveys undertaken August-September 2017)*

Project title: ***Assessing the 'success' of ecological restoration projects***

Project Supervisor: ***Prof. David Towns***

Researcher: ***Mel Galbraith***

The interview will explore a number of key elements and patterns emerging from the on-line surveys to augment understanding of the participants' perspectives. The indicative questions to be presented in the interview that relate to restoration success are:

To community group participants:

1. The on-line survey indicated that community groups appear to place higher value on broader ecological concepts (i.e. management of invasive species, prevention of extinction/declines, improving ecosystem condition and links to other ecosystems) than agencies? Have you experienced this? Can you offer any explanations for this difference?
2. The on-line survey indicated that links to the larger ecological matrix were not considered important as a gauge of success? Since Tiritiri Matangi is an island, why are links to the larger ecological matrix of the Hauraki Gulf not considered important to gauge success?
3. Do you feel that you have access to, sufficient information about restoration theory and progress?
4. The on-line survey indicated that communicating science outcomes and linking participants with scientists are less important than the social interactions and benefits associated with community participation in ecological science. Is this consistent with your experience of participation? Credibility from advocacy & communication gained a high indicator of success for Tiritiri Matangi. Can you explain this?
5. The on-line survey suggested that access to funding is the major barrier to community participation in ecological science. How could more funding change this situation?
6. The on-line survey suggested that the perception of unreliable data is a significant barrier to community participation in ecological science. Is this consistent with your experience of participation?
7. The on-line survey indicated that training and access to training resources is of high importance for future development of community participation in New Zealand, but is considered a minor barrier to community participation in ecological science. What areas of training are needed to make a difference for the future?

Supplement S.3 *– continued*

Additional questions to participants in the Tiritiri Matangi project

1. Is reducing exotic species less important as an indicator to Tiritiri Matangi because such species are already controlled/low (or pest mammals eradicated)?
2. Is the difference in preventing extinctions/declines due to large number of successful translocations to the island?
3. Is credibility from advocacy & communication a high indicator for Tiritiri Matangi because of regular newsletters and/or a high profile through media?
4. Since Tiritiri Matangi is an island, why are links to the larger ecological matrix of the Hauraki Gulf not considered important to gauge success?

To agency employees:

1. The on-line survey indicated that community groups appear to place higher value on broader ecological concepts (i.e. management of invasive species, prevention of extinction/declines, improving ecosystem condition and links to other ecosystems) than agencies? Have you experienced this? Can you offer any explanations for this difference?
2. The on-line survey indicated that communicating science outcomes and linking participants with scientists are less important for participants than the social interactions and benefits associated with community participation in ecological science. Is this consistent with your experience of participation? Credibility from advocacy & communication a high indicator of success for Tiritiri Matangi. Can you explain this?
3. The on-line survey indicated that retaining volunteers is a significant barrier to community participation in ecological science. What needs to be changed to improve volunteer retention?
4. The on-line survey suggested that data management is a major barrier to community participation in ecological science. Is this consistent with your experience of community involvement with your agency?
5. The on-line survey suggested that communicating science outcomes through meetings and conferences is relatively low importance for community participation in ecological science to develop further in New Zealand. Would a higher priority of communicating science help with recruiting and retaining volunteers?

Supplement S.4 – Sample information sheet provided to potential survey and interview respondents.

AUT
TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Participant Information Sheet

Online survey – community groups

Date Information Sheet Produced:

05 July 2017

Project Title

Assessing the success of ecological restoration projects

An Invitation

Kia ora. My name is Mel Galbraith. My life-long interest in natural history, especially ornithology and herpetology, has lead to my involvement in a number ecological restoration projects over the past 37 years. Over this time, community-based voluntary participation in ecological restoration has become an integral part of conservation efforts in New Zealand, indeed worldwide. Through my involvement in projects, I have gained an extensive and valuable insight into the activities of restoration, and am now in a position to extend my interest through formal research. I am a Doctor of Philosophy candidate at Auckland University of Technology (AUT), studying measures for assessing the 'success' of ecological restoration projects.

I invite you to contribute to this research through sharing your experience in ecological restoration by taking part in an on-line survey.

What is the purpose of this research?

The purpose of this research is to identify measures appropriate to determining the progress (and hence 'success') of ecological restoration actions, and is expected to provide information that can improve the effectiveness of restoration projects. This knowledge has application to restoration projects worldwide, and is expected to be of particular value in New Zealand given current aspirations of environmental stakeholders to integrate the collective visions into a common, shared ecological future. The research will contribute to the requirements of a Doctor of Philosophy qualification at Auckland University of Technology (AUT), and the findings are intended to be published in peer-reviewed journals and presented at conferences.

How was I identified and why am I being invited to participate in this research?

You were identified as a potential participant in this survey because of you are associated with a community-based ecological restoration project in the North Island. If you are under 16 year of age, you are ineligible to take part in the survey.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice), and whether or not you choose to participate will neither advantage nor disadvantage you. Since the survey is web-based, there is no consent form to complete. However, at the start of the web-based survey, you will be asked to enter or leave the survey. Entering the survey will be interpreted as your consent to participate. The web-based survey will ask you for some demographic details, but it will not record any personal contact data. You will have the option to not respond to any questions that you choose, and you are able to withdraw from the study at any time. If you choose to withdraw from the survey, your survey answers will not be recorded and thus excluded from any the findings that will be produced.

What will happen in this research?

In this research, you are invited to complete a web-based questionnaire/survey (see link below) about your involvement in an ecological restoration project. The survey will ask you about your current practices and opinions in relation to ecological restoration - your views and experience are just what the project is interested in exploring. The survey is estimated to take no more than 10 minutes to complete.

Supplement S.4 *– continued*

As a follow-up to the online survey, a number of small focus-group discussions are intended to take place in late-2017. You may be invited to take part in one of these discussions, arranged at a time and place convenient to the group participants. Should you be invited to participate in a focus group, details about the event will be provided separately for you to consider.

What are the discomforts and risks?

Participating in the research is not anticipated to cause you any disadvantages or discomfort, but please let us know if you have any concerns. The potential physical and/or psychological harm or distress will be the same as any experienced in everyday life.

What are the benefits?

Whilst there are no immediate benefits for the individuals participating in the project, it is hoped that this work will have a beneficial impact on ecological restoration in New Zealand by informing best practice on the ground. The findings of the research will be shared with participants, and may also lead onto further studies practices. The survey data will also contribute to the requirements of a Doctor of Philosophy degree at Auckland University of Technology.

How will my privacy be protected?

All the information that is collected about you during the course of the research will be kept strictly confidential. You will not be able to be identified or identifiable in any reports or publications. Your organisation will also not be identified or identifiable. Survey data, demographic data collected about you, will be summarised descriptively using the analysis functions of the survey software (Qualtrics), and will be in an anonymised form. The data collected may be shared in an anonymised form to allow reuse by the research team, but will not allow any individuals or their organisations to be identified or identifiable.

What are the costs of participating in this research?

The cost of participating in this research is your time. Participation in the survey is expected to take about 10 minutes of your time.

What opportunity do I have to consider this invitation?

The online survey link will be available until 31 August 2017.

Will I receive feedback on the results of this research?

The study forms a part of the requirements for a Doctor of Philosophy degree and, as such, findings will be presented at a number of forums for ecological research. Formal publications of the findings of the research will be sent to the participating organisations. If you wish to receive a copy of any such publications, please ask to be included on our circulation list.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Prof. David Towns, *dtowns@aut.ac.nz* , 09-9219999 ext. 6574.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 09-9219999 ext. 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Mel Galbraith, PhD Candidate, NZ Institute of Applied Ecology, Auckland University of Technology

Email: mgalbraith@unitec.ac.nz

Project Supervisor Contact Details:

Prof. David Towns, NZ Institute of Applied Ecology, Auckland University of Technology

Email: dtowns@aut.ac.nz

I would like to thank you in advance for your time and consideration. If you are happy to participate in the research, simply click on the link below and complete the survey. If you would prefer not to be involved, thank you for your time. No further action is required.

The following link will lead you to the online survey: **SURVEY LINK CLICK HERE**

(or copy **https://aut.au1.qualtrics.com/jfe/form/SV_9KtZj71eXh5l35b** and paste into your browser address field)

By clicking on the link to the survey questions, you are acknowledging you have read the study information. You also understand that you may end your participation at end time, for any reason without penalty.

Approved by the Auckland University of Technology Ethics Committee on 28 June 2017, AUTEC Reference number 17/167.

Supplement S.5 – Vision Mātauranga Statement.

Ecological restoration study:

Vision Mātauranga outline

Toitū te marae a Tāne-mahuta Toitū te marae a Tangaroa Toitū te whenua	Care for the realms of Tāne-mahuta and Tangaroa, and the land will sustain you

People are an integral part of ecosystems, and ecosystems are the life-support systems for people. For Māori, the relationship of people and ecosystems is one of inter-relatedness through genealogy (whakapapa) and iwi-identity. In the Māori worldview, humans are connected physically and spiritually (wairua) to the environment: Māori are an integral part of New Zealand ecosystems and ecosystems are an essential part of Māori geneology (whakapapa) and iwi-identity. Māori are obliged to act as kaitiaki (cultural guardians) towards taonga (treasured things) in the environment, such as significant places, waterways, and biodiversity. This kaitiakitanga is vital to the ongoing expression of Māori culture and identity. Such an intricate, holistic and interconnected relationship with the natural world can be at odds with reductionist science approaches. Hence, an important element of this research proposal is developing effective consultation and knowledge management frameworks that reconciles traditional and modern knowledge to support both cultural safety and sustainable resource management outcomes. AUT acknowledges and accepts the recommendations of the Wai262 report, which describes the cultural safety and consultation concerns when working with tangata whenua groups.

Given that this research will explore 'Kaitiaki Conservation' (Waitangi Tribunal 2011), encompassing biodiversity, ecological restoration and biosecurity, we have obligations (under the Treaty of Waitangi and AUT's Vision Mātauranga strategy) to engage with iwi in a culturally safe manner. Auckland University of Technology (AUT) recognises and respects the significance of the Treaty of Waitangi and mana whenua within its staff, students, and stakeholders. AUT's Vision Mātauranga provisions recognise the spiritual relationship Māori have with their ancestral lands, water, sites, waahi tapu (sacred areas) and other taonga (treasures). Vision Mātauranga outcomes will ensure that Māori have access to their own spiritual realm, their language and protocols throughout the consultation, implementation and reporting phases of this project. The consultation process is a minimum requirement.

As responsible scientists working with indigenous peoples, the consultation process will involve identifying indigenous values and concerns with regards to:

1. Identifying all individual iwi with mana whenua status in data collection areas.
2. Engaging iwi in developing a consultation process that recognises legislation and guiding policy requirements such as the Treaty of Waitangi, AUT's Vision Mātauranga policies, WAI262 Report, and the Privacy Act.
3. Developing a meaningful decision making process that recognises each iwi will practice their own style of collective decision-making at all levels of their society.
4. Recognition of the kaitiaki (Maori environmental caretakers) who are vested with the role of ensuring the environmental mauri (life force) is maintained and enhanced.
5. Providing an opportunity for feedback to ensure the research kaupapa (process) meets the expected tikanga of the stakeholders.

Vision Mātauranga provisions will include:

1. All tangata whenua groups will be given the choice of having karakia performed at the start and conclusion of all meetings.
2. Privacy will be sought for all iwi consultations and decision making during the consultation, data collection, analysis, and reporting phases of the project.
3. Tangata whenua will be made aware of the availability of Pou Kokiri (language interpreter and protocol advisor).
4. Culture and Identity (Māori measures of cultural recognition, cultural heritage, use of te reo Māori, tikanga) will be valued and protected at all times.
5. Participation and Equity (Building relationships, trust, respect; expression of kaitiakitanga, examples of co–management, tinorangatiratanga).
6. At a minimum, we plan to send copies of our interim and final reports to all iwi representatives as well as other stakeholders.
7. An invitation to tangata whenua to provide feedback on the research process.

It is essential that Māori are actively involved in developing the consultation process and key cultural performance indicators to ensure they are readily understood and a meaningful reflection of shared values and aspirations of all concerned. All Mana Whenua iwi will have their concerns met in a manner that respects and acknowledges their individual values and beliefs. These outcomes will ensure accessible and culturally safe services as guaranteed to Māori under AUT's Vision Mātauranga strategy.

Adopting these provisions and complementary approaches will lead to:

- opportunities for effective collaborative outcomes for Māori (e.g., iwi, hapū, kaitiaki groups) that benefit the whole community;
- shared learning, cultural appreciation and best practice within communities;
- greater integration of Māori values and knowledge in research and resource management;
- increased capacity (skills, resources, and empowerment) for collaborative environmental management;
- improved resource management decision-making based on mutual respect, trust and goodwill.

Additional contact with marae will be made throughout the project to keep Iwi updated with the research as its discoveries unfold. All data will be made freely available to Iwi after publication.

time for a wee dram