Mamaku Point Conservation Reserve

Restoration Plan

June 2019

Prepared by Kathleen Lalor
kathleen.lalor@gmail.com

This report has been submitted in partial fulfilment of
WILM501 *Wildlife Management Research Placement*

Table of Contents

Summary assessment

Mamaku Point Conservation Reserve is a biosecure nature reserve on Stewart Island, 4km north-west of the central township of Oban. It is an undisturbed, largely predator-free, forest sanctuary, fit for native birds, lizards, and invertebrates. The objectives of the Mamaku Point Conservation Trust are to: maintain and enhance biodiversity; offer an opportunity for education, learning, and research, and to create a financially and environmentally sustainable Reserve. It is my opinion that the Trust is achieving these objectives. The Reserve's predator control programme is working well and is continuing to improve. The Reserve hosts a variety of school groups throughout the year and is open to visitors that pre-book. From what I observed, the Reserve is currently environmentally sustainable in its operations. I was able to spend a total of 2.5 months on the Reserve, conducting habitat, bird, and skink surveys. I conclude that the Reserve offers a diverse and rich flora and fauna population. Future translocations should be considered for this Reserve, as it is a safe place for species at risk. Restorative planting to limit erosion, as well as stream restoration should be done in the near future in order to maintain the quality of habitat that the Reserve is protecting. Based on my observations, it is my opinion Mamaku Point Conservation Reserve will continue to be a success in its protection of this site, given the mandate of the current management.

Introduction

Mamaku Point Conservation Reserve

Mamaku Point Conservation Reserve is located at the end of Horseshoe Bay Road, 4km north-west of Oban township on Stewart Island (Figure 1). The Reserve includes 172 hectares of hilly terrain, grasslands, sandy beaches, and some of the oldest podocarp forests on Stewart Island (Mamaku Point Website). The Dancing Star Foundation described four floral zones within the reserve: "Podocarp-broadleaf forest; coastal vegetation with an array of Coprosma, tree ferns and tree fuchsia; a small sphagnum-and-sedge wetland; and pasture with sedges, bracken and various grasses." The native forest consists of kamahi (*Weimannia racemosa*), rata (*Metrosideros umbellate*), rimu (*Dacrydium cupressinum*) and miro (*Prumnopitys ferruginea*) trees (Dancing Star Foundation Website).

Figure 1. Stewart Island/Rakiura with Mamaku Point Conservation Reserve within the red circle. (Google Earth 2019).

The reserve is enclosed by a 2.1km predator-free fence. In addition to the fence, there is an extensive grid of bait stations and traps on both sides of the fence, which are monitored remotely using VHF, cellular, and satellite communications to ensure that any mammal breach is detected immediately (Mamaku Point Website).

Presumably due largely to the extensive and long-term predator control, there are at least 25 native species of birds occupying and thriving within the Reserve. In addition to native birds, the Reserve hosts a variety of invertebrates and a healthy population of common skinks (*Oligosoma polychroma)*. The coastline offers habitat for NZ fur seals, NZ sea lions, and the occasional leopard seal (Mamaku Point Website).

Biological History of Stewart Island

Around 12,000 years ago, Stewart Island was dominated by tree ferns with a few *Metrosideros* species (Mcglone and Wilson 1996). It is likely that the lack of solar insulation in the early Holocene limited the expansion of hardwood species and left ferns to dominate (Mcglone and Wilson 1996). By 5000-3000 years before present (BP) rimu and miro began to spread over Stewart Island to form the podocarp/hardwood forests we see today (Mcglone and Wilson 1996). This shift to a hardwood forest is likely attributed to a cool south-westerly air flow that increased solar insulation on Stewart Island (Mcglone and Wilson 1996). In the late Holocene, climate conditions favoured hardwood species (Mcglone and Wilson 1996).

Stewart Island's relatively untouched forest has always housed a wide diversity of life. Cockayne 1909 published a report on the botanical and faunal diversity of Stewart Island. He reported seeing "common birds" such as the Bittern *(Botaurus poiciloptilus)*, Yellow-crowned parakeet *(Cyanoramphus auriceps),* South Island kokako (*Callaeas cinereal)*, Yellowhead *(Mohua ochrocephala)*, the Godwit/Snipe *(Limosa)*, many of which are in low densities, are no longer found on the island, or have gone extinct entirely. The reason that these bird species are no longer present in high densities, or at all, is because of the introduction of predators such as possums, rats, and feral cats (Table 1, King 2005). Competitors such as red deer (*Cervus elaphus*) and white-tailed deer (*Odocoileus virginianus borealis*) were also introduced, and likely reduced the niche availability for native species (King 2005).

Table 1. The approximate timing of introduction of pests to Stewart Island, summarized from King 2005.

Pest	Year of approximate introduction to Stewart Island
Kiore/Polynesian rat (*Rattus exulans*)	AD 1300
Norway rat (*Rattus norvegicus*)	1790s-Early 1800s
Feral cat (*Felis catus*)	Early 1800s
Ship rat (*Rattus rattus*)	1830s-50s
Mice (*Mus musculus*)	1850s
Bushtail possum (*Trichosurus vulpecul)*	1890
Red deer (*Cervus elaphus scoticus)*	1901
White tailed deer (*Odocoileus virginianus)*	1905
European hedgehog (*Erinaceus europaeus)*	1930

History of the Reserve

The Mamaku Point Conservation Reserve has always been private land. Prior to November 2000, the property was privately owned by the Turnbull family and used as a farm with the seaward faces used for sheep/cattle grazing, while the inland areas were kept as native bush (Mamaku Point Website). According to trustee Phillip Smith, the forest would have been scarcely milled, if at all, however, deer and possum hunting was common on the property for 75+ years.

In November 2000, an American conservation group called Dancing Star Foundation bought the property to create a biosecure preserve for natural flora and fauna. The Dancing Star Foundation drove out all deer and stock. In 2005, a 2.1km fence (designed by the New Zealand company, 'Xcluder') was completed to keep out invasive mammal predators, and other inhibitory measures included "electronic and video surveillance, with instant telephonic and satellite communication to a national network and a response team that can counteract any and all breaches" (Dancing Star Foundation Website). In November 2015, the property was listed for sale and in 2017 it was bought by a family trust associated with Roy and Rachel Thompson, who upon purchase established the Mamaku Point Conservation Trust "in order to engage the wider community in their biodiversity, education and sustainability objectives for the Reserve" (Mamaku Point Website).

According to Phillip Smith, there is only a 5-acre portion of land that is Māori-owned on the Reserve, which is adjacent to Frenchman's Beach. Frenchman's Beach is owned by DOC. Nathan's Island, off the north face, is thought to have been used by Māori settlers for a short time, and there are two other sites of cultural significance to Māori on the Reserve.

The Restoration Vision (inspired by the Orokonui Restoration Plan 2011 and interpreted from Mamaku Point Conservation Reserve Operation Plan 2018)

Vision Statement

Mamaku Point Conservation Reserve (MPCR) is a predator-free sanctuary for native flora and fauna which is representative of historical New Zealand. The Reserve offers appropriate habitat to sustain, preserve, and enhance populations of native species, as well as offering a visitor-friendly nature experience and hands-on learning opportunities for locals, tourists, and students.

Trust Objectives *As interpreted from the Mamaku Point Conservation Reserve Operational Plan 2018	**Explanation**
Biodiversity	Conserve and enhance the health and diversity of the native flora and fauna within the Reserve. • Ensure that the biosecurity of the Reserve is maintained to the best of the Trust's ability

	• Seek opportunities to re-establish native species not currently found within the Reserve
Education	Facilitate education, research and public awareness of the importance of restoring and conserving our native flora and fauna. • Allow access to the Reserve, to school groups, to scientific and academic researchers, and to the public (via appointed guides) for general conservation education and experiences
Sustainability	Financial and environmental sustainability. • Charge an access fee to Reserve visitors to help fund the Trust's biodiversity and education objectives • Apply for grants and seek donations to help fund the Trust's biodiversity and education objectives • Minimize the use of non-renewable energy in its daily operations • Maximize the generation of renewable energy in its daily operations • Minimize the generation of non-recyclable waste

Conservation Outcomes	Explanation
A self-sustaining ecosystem representative of historical Stewart Island/Rakiura	The goal of restoration at MPCR is to recreate, if possible, the ecosystem and forest that would have existed pre-humans. This is currently being done through: continued eradication of pests, weed control, and replanting of native species. With restricted pest and non-native forager numbers, the Reserves forests are revitalising and native species are recuperating. Future translocations of native and endemic Stewart Island species will be undertaken.
Key ecological processes within the Reserve	Restoration outcomes for the Reserve include restoring the land to a fully functioning and healthy ecosystem. It is the Trusts goal to achieve natural processes such as regeneration,

	succession, nutrient cycling, breeding, and dispersal with minimal human intervention.
A refuge for threatened & taonga species	MPCR strives to supply a pest free mainland-island sanctuary for New Zealand's threatened and taonga species. It furthermore hopes to contribute and collaborate with New Zealand's Biodiversity Strategy and national recovery programmes. Surveys of habitat and biodiversity will continue to be done within the reserve to determine their condition.
Valued site for ecological and conservation research and education	Restoration outcomes for the Reserve include education and research programs. The Reserve aims to use informed and sound ecological research to make conservation decisions and monitor the existing and future biodiversity. MPCR also aims to offer a natural learning experience for school groups and ecotourism groups.
Contribute and collaborate to New Zealand conservation programs	Information and knowledge acquired throughout the restoration of MPCR will be shared with nationwide conservation programs and initiatives.

Restoring Mamaku Point's Birdlife

Current birdlife

Approximately 130 bird species are found on and about Stewart Island (Stewart Island/Rakiura website 2018). At least 25 native species occupy the Mamaku Point Conservation Reserve, and while all are considered in relation to restoration plans and management, there is relatively high consideration and focus on the 11 species that have conservation status of At Risk or Threatened (NZ Birds Online 2019). A total of 29 bird species have been observed within the reserve listed below. Dancing Star Foundation translocated rifleman (*Acanthisitta chloris)* and brown creepers (*Mohoua novaeseelandiae)* into the Reserve in 2008, and Stewart Island robin (*Petroica australis Rakiura)* in 2012 and 2013.

Bird species that regularly visit the Mamaku Point Conservation Reserve	Native	Introduced	At Risk?		Native	Introduced	At Risk?
Sooty Shearwater/tītī (*Ardenna grisea*)	✔		✔	Grey Warbler/riroriro (*Gerygone igata)*	✔		
Bellbird/makomako (*Anthornis melanura*)	✔			Kaka (*Nestor meridionalis*)	✔		✔
Tui (*Prosthemadera novaeseelandiae*)	✔			Rifleman/titipounamu (*Acanthisitta chloris)*	✔		
Red Crowned Parakeet/kakariki (*Cyanoramphus novaezelandiae)*	✔		✔	Skylark (*Alauda arvensis)*		✔	
Tomtit/piropiro (*Petroica macrocephala)*	✔			Fantail/pīwakawaka (*Rhipidura fuliginosa*)	✔		
Starling (*Sturnus vulgaris*)		✔		Silvereye/tauhou (*Zosterops lateralis)*	✔		
Brown Creeper/pīpipi (*Mohoua novaeseelandiae)*	✔			NZ Wood Pigeon/kereru (*Hemiphaga novaeseelandiae)*	✔		
Long Tailed Cuckoo/koekoeā (*Eudynamys taitensis*)	✔		✔	Blackbird (*Turdus merula*)		✔	
Gulls	✔			South Island Pied Oyster Catcher/tōrea (*Haematopus finschi)*	✔		✔
Shining Cuckoo/pipiwharauroa (*Chrysococcyx lucidus)*	✔			Song Thrush (*Turdus philomelos*)		✔	
White Fronted Tern/tara (*Sterna striata*)	✔		✔	Swamp Harrier/kāhu (*Circus approximans*)	✔		
Sacred Kingfischer/kotare (*Todiramphus sanctus*)	✔			Welcome Swallow/warou (*Hirundo neoxena*)	✔		
Stewart Island Robin/kakaruwai (*Petroica australis Rakiura)*	✔		✔	Little Blue Penguin/korora (*Eudyptula minor*)	✔		✔
Fernbird/mātātā (*Bowdleria punctata*)	✔		✔	Fiordland Crested Penguin/tawaki (*Eudyptes pachyrhynchus*)	✔		✔
Morepork/ruru (*Ninox novaeseelandiae)*	✔			Southern Brown Kiwi/tokoeka (*Apteryx a. lawryi*) *Nationally Endangered	✔		✔

Feasibility assessment for future translocations of bird species

There are six species of native New Zealand birds that would make excellent candidates for translocation to Mamaku Point Conservation Reserve, they are described in the following table. Due to the Reserve not being 100% free of predators, not all species are suitable for translocation at this time. Rats might be able to swim from outside of the Reserve to the areas where the fence stop at the cliffs, while cats may occasionally breach the fence. Many of the translocatable species have high-level threat classifications. For this reason, the Reserve may be unsuitable for them at this time due to the risk of predation from animals that breach the fence. Translocations of these species may be possible in the future, should predator control be improved, or the situation of an individual species becomes dire and Mamaku Point Conservation Reserve is required as a refuge. Information in the explanations column in the following table was extracted from NZ Birds Online (2019).

Species	Was the species found on Stewart Island in the past?	Is the species likely to find its way back to the Reserve/stay in the Reserve after translocation?	Is it feasible to translocate it?	Explanation
Yellow crowned parakeet/kakariki (*Cyanoramphus auriceps*)	Yes	Yes	Yes	Coexists well with Red crowned parakeet on Ulva Island.
Takahē (*Porphyrio hochstetteri)*	No	N/a, would not be able to leave the Reserve.	Yes	Grassland habitat available, attractive to visitors. Could translocate retired breeders as ambassadors.
Yellowhead/mohua (*Mohoua ochrocephala)*	Yes	Yes	Yes	Doing well on Ulva island, used to be found in all forest on Stewart Island.
South Island Saddleback/ tīeke (*Philesturnus carunculatus*)	Yes	Yes	Yes	Doing well on Ulva island, used to be found in all forest on Stewart Island.
Stewart Island Robin/kakaruwai (*Petroica australis Rakiura)*	Yes	Yes	Yes	Top-up translocation would be beneficial as numbers are low.
Fernbird/mātātā (*Bowdleria punctata*)	Yes	Yes	Yes	Top-up translocation would be beneficial as numbers are low.
Orange-fronted parakeet/kakariki (*Cyanoramphus malherbi)*	No	Likely, able to fly in and out at will.	No	Nationally Critical, need intensely managed site. Not feasible at the current state of MPCR.
Sooty Shearwater/tītī (*Ardenna grisea*)	Yes	Yes	No	Top up translocation seems like a good idea, as muttonbird usually breed in colonies. It is unclear if there is enough space for another breeding pair. It is recommended to use speakers with bird calls to attract birds during

				Sept/Oct/Nov when they are prospecting pre-breeding.
Orange-wattled crow/South Island kokako (*Callaeas cinereal)*	Yes (Cockayne 1909)	No	No	Data deficient, presumed extinct. Even if not extinct, MPCR is not viable at the current state.
New Zealand dottrel/ tūturiwhatu (*Charadrius obscurus)*	Yes	No	No	Not appropriate breeding habitat for them (need exposed subalpine herb fields and rocky areas above the tree-line)
Australasian Bittern/ matuku hūrepo (*Botaurus poiciloptilus)*	Yes (Cockrayne 1909)	No (15km radius range)	No	Need wetlands. Reserve is not large enough or attractive enough habitat for them.
Pukeko (*Porphyrio melanotus)*	Yes (Cockrayne 1909)	Yes	No	Not threatened. Cause damage to tree planting programs and occasionally eat other birds' chicks.
Pipit/ pīhoihoi (*Anthus novaeseelandiae)*	Yes (Cockrayne 1909)	Yes	Maybe	Thrive in coastal margins and high elevations on Stewart Island. Declining, so maybe not appropriate to introduce at MPCR's present state.

Seabirds

Stewart Island is host to a wide diversity of seabirds because of its surrounding rich food supply. Albatross, mollymawk, prion, petrel, cormorants, and little blue penguins, are just some of the seabirds that attract visitors to the island. (Stewart Island Website 2018). Mamaku Point Conservation Reserve is already hosting at least one breeding pair of sooty shearwater, many pairs of little blue penguin, and several breeding pairs of Fiordland Crested penguins (Mamaku Point Conservation Reserve website 2018, Field observations 2018/2019). Seabirds are likely to recolonise on their own, thus they tend not to be a high priority for translocation to coastal sites (Orokonui Restoration Plan 2011). However, as there is only one pair of Sooty shearwater in the Reserve, it is recommended to look to attracting more breeding pairs using speakers around time of breeding. Continued management of seabird habitat is essential to try and lure them back to the Reserve. It is currently unclear if the Reserve is big enough to host any more breeding pairs of flying seabirds, and future seabird

niche assessment surveys would be useful. The grassland area (or black habitat zone in Appendix I and II) could be used as a location for artificial seabird burrows in the future, as seabirds represent an opportunity for ecotourism.

Habitat suitability for reintroducing missing birds

Mamaku Point Conservation Reserve offers a variety of quality habitats, similar to those on the rest of Stewart Island, supporting a high diversity of native birds (Appendix II bird survey results). The Reserve has old growth podocarp forest, coastal forest, wetland, freshwater sources, and rewilding grassland. Leaf litter deposition is varied across the reserve (See Appendix II), making it suitable for ground-nesting birds and/or birds that feed on a variety of invertebrates. In addition, the adjacent Rakiura National Park, and the vegetation of many close islands, is an advantage for flighted birds as they provide added habitat and food sources. This neighbouring park also allows for the possibility of outward migration, survival of surplus progeny, and intermingling with other individuals.

Unlike the rest of Stewart Island, the near absolute removal of mammalian predators within the Reserve has increased bird productivity, evident from the anecdotal increase in bird life experienced by birders who visit the Reserve. The absence of grazing herbivores such as white-tailed deer has reduced bird, invertebrate, and other native grazers competition for resources. In addition, the reduced risk of rat predation results in less competition for food for insectivorous birds. To ensure these conditions continue, the Reserve should continue to advocate for predator control outside of the fence, to reinforce a healthy and safe neighbouring habitat for the birds.

Blue gum (*Eucalyptus globulus*) is found within the Reserve. Blue gum offers a nectar source for kaka, bellbird, and tui, however, it is an invasive tree species and considered a pest due to its ability to spread quickly via seeds and displace native plants (Harper 2009). Flax/harakeke (*Phormium tenax*) is a native source of nectar, and is found outside of the Reserve. It is recommended that the Reserve move towards planting more flax and controlling existing *Eucalyptus*.

The Reserve is lacking in appropriate nest sites for some birds, specifically for kaka and mohua which require dead broadleaf trees with holes to nest in (Orokonui Restoration Plan 2011). It is recommended that the Reserve supply artificial nest boxes, and artificial burrows should seabirds be a focus for translocation.

It is essential for MPCR consult with DOC and Stewart Island/Rakiura Community and Environment Trust (SIRCET) when deciding on translocation steps.

Restoring Mamaku Point's Other Fauna

Reptiles

The reptile survey conducted (Appendix I & II) showed that a healthy population of Southern Grass Skink (*Oligosoma aff. polychrome*) is present at Bob's Point. More surveys need to be done across the other grassland habitats within the Reserve, along with further surveys investigating the possible presence of forest dwelling geckos.

Tuatara

The tuatara (*Sphenodon punctatus*) is an interesting candidate for translocation. Along with the threats of introduced predators and genetic vulnerability, tuatara is at risk from the effects of climate change. Tuatara are very long lived and are not sexually mature until they are 10-20 years of age. In addition, they only reproduce every four years, which reduces their ability to adapt to a changing environment (Mitchell et al. 2008). Changes in New Zealand's climate may result in more droughts, potentially reducing the success rate of egg hatching and reducing food availability (Thompson et al. 1996). Tuatara are an egg-laying species with temperature-dependent sex determination (TSD), meaning that the sex of offspring is determined by the temperature at which eggs were incubated (Cree et al. 1995). When incubation conditions are above 22°C, males are almost exclusively produced, and below this temperature females are almost exclusively produced (Cree et al. 1995; Mitchell et al. 2006). The difference in temperature for the production of completely male or completely female offspring is predicted to be only 1.1°C (Mitchell et al. 2006), which is coincidentally almost identical to the predicted country-wide temperature increase by the year 2040 (Ministry of Env. 2016). As tuatara have TSD, moving them to more southern locales in the face of a warming climate is a potential strategy. This has worked with previous translocations to Orokonui Ecosanctuary and Zealandia. Stewart Island offers a similar seasonal temperature variation to these sanctuaries (Figure 2), however, temperature surveys will need to be done prior to a translocation.

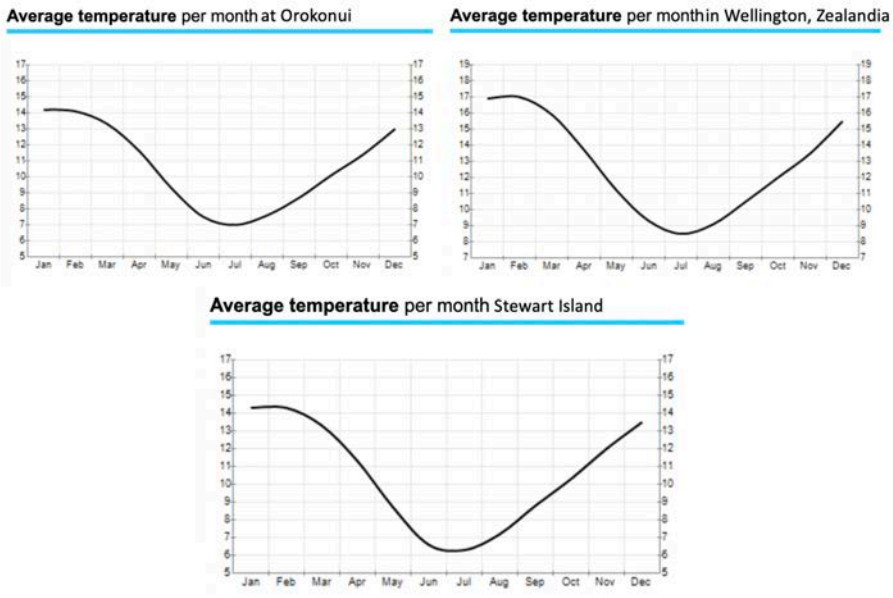


Figure 2. The yearly trends in temperature exhibited at Orokonui Ecosanctuary, Zealandia, and Stewart Island (YR-Weather Statistics).

Translocation of tuatara to many offshore and mainland island refuges has been successful. 70 individual tuataras from Takapourewa (Stephens Island) were translocated into Zealandia in 2005 (Zealandia website 2019). They have been breeding successfully in Zealandia since 2007 and are regularly seen by visitors. One issue to note from the Zealandia translocation is the overlap of tuatara and kiwi burrows. An aggressive interaction between a tuatara and kiwi occurred at Zealandia over a burrow space, but neither individual was harmed (Taylor et al. 2019). Mamaku Point Conservation Reserve is host to a healthy population of Southern Brown Kiwi/tokoeka (*Apteryx a. lawryi*) and they must be considered when thinking of translocating tuatara. Coexistence happened historically and could potentially occur again (Taylor et al. 2019). The overlap of tuatara with seabird burrows will also need to be considered, as tuatara are known to occasionally eat sea bird eggs.

Feasibility assessment for future translocation of reptile species

Stewart Island is home to the rare Harlequin gecko (*Hoplodactylus rakiurae*), Cloudy gecko (*Mokopirirakau nebulosus*), and the endemic Small-eared skink (*Oligosoma stenotis*). These reptile species most likely were found at MPCR in pre-human times, but were probably extirpated due to mammalian pests. They are all worthwhile candidates for translocation. It is unclear if mice are able to breach the biosecurity fence, and a mouse survey would be important before translocating gecko or skink species. Alternatively, a mouse-proof fence could be used around the area that the reptiles would be using. Additionally, a niche availability survey is needed to determine if Mamaku Point has enough habitat to introduce competing species of reptiles. Explanations in the following table were sourced using the DOC 2019 website.

Species	**Was the species found on Stewart Island in the past?**	**Is it feasible to translocate it?**	**Explanation**
Harlequin gecko/tukutuku (*Hoplodactylus rakiurae*)	Yes	Yes	Likely historically present within the Reserve's forests; would thrive in predator-free sanctuary.
Cloudy gecko (*Mokopirirakau nebulosus*)	Yes	Yes	Likely historically present within the Reserve's forests; would thrive in predator-free sanctuary.
Small-eared skink (*Oligosoma stenotis*)	Yes	Yes	Likely historically present within the Reserve's grasslands; would thrive in predator-free sanctuary.
Tuatara (*Sphenodon punctatus*)	No	Maybe	MPCR could be a useful, southern, refuge for tuatara. Need to do temperature survey to ensure the proper temperature conditions are present for successful breeding. Need

			to ensure overlap with kiwi and seabirds will be safe for all species.
Jewelled gecko (*Naultinus gemmeus*)	No	No	On Codfish Island but not in high densities; need to understand why they are not doing well there before translocating to MPCR.
Green skink (*Oligosoma chloronoton*)	Yes	Maybe	At risk-declining, MPCR is not suitable currently. It is unclear if there is enough suitable habitat to support another *Oligosoma* species
Cryptic skink (*Oligosoma inconspicuum*)	Unknown	Maybe	At risk-declining, MPCR is not suitable currently. It is unclear if there is enough suitable habitat to support another *Oligosoma* species

Bats

The only known population of long-tailed bats (*Chalinolobus tuberculatus*) on Stewart Island is found in the Halfmoon Bay area, in the center of the township (SIRCET 2019). The greater short-tailed bat (*Mystacina robusta*) was previously found on offshore islands off Stewart Island, but was last seen in 1967 and is presumed extinct (Sedgeley et al. 2012). South Island lesser short tailed bats (*Mystacina tuberculata tuberculata*) are found on Whenua Hou/Codfish Island, but not on Stewart Island (Sedgeley et al. 2012). Short-tailed bats are at risk-recovering and long-tailed bats are Nationally Critical (O'Donnell et al. 2017). There have been some anecdotal sightings of long-tailed bats flying over Mamaku Point Conservation Reserve near the fence.

Translocations are not a viable option for bats. Bats can fly long distances, and 3/5 translocations have failed because the bats disperse away from the release site (Ruffell et al. 2009). Furthermore, bats colonise with hundreds of other individuals, which is far too many for a single translocation, not to mention they are highly selective about the type of roost they use (Ruffell et al. 2009). Translocating bats into the Reserve is not feasible, however, it would be beneficial for Mamaku Point to implement bat boxes as artificial roosts in certain areas to attract bats for the sake of ecotourism.

Fish

Several freshwater creeks run through Mamaku Point Conservation Reserve (Figure 3). The freshwater system is disrupted by an old dam that is represented by the red dot (3A) and the photos (3B). It is recommended that this dam be removed and that creek restoration become a management goal so that the Reserve can better protect and offer habitats for freshwater species. Once creek restoration is complete, a thorough habitat assessment should be done to determine the quality of the creeks for freshwater species. A freshwater

invertebrate and fish survey should be conducted inside and outside of the Reserve, to determine the difference between native and non-native species on both sides of the fence.

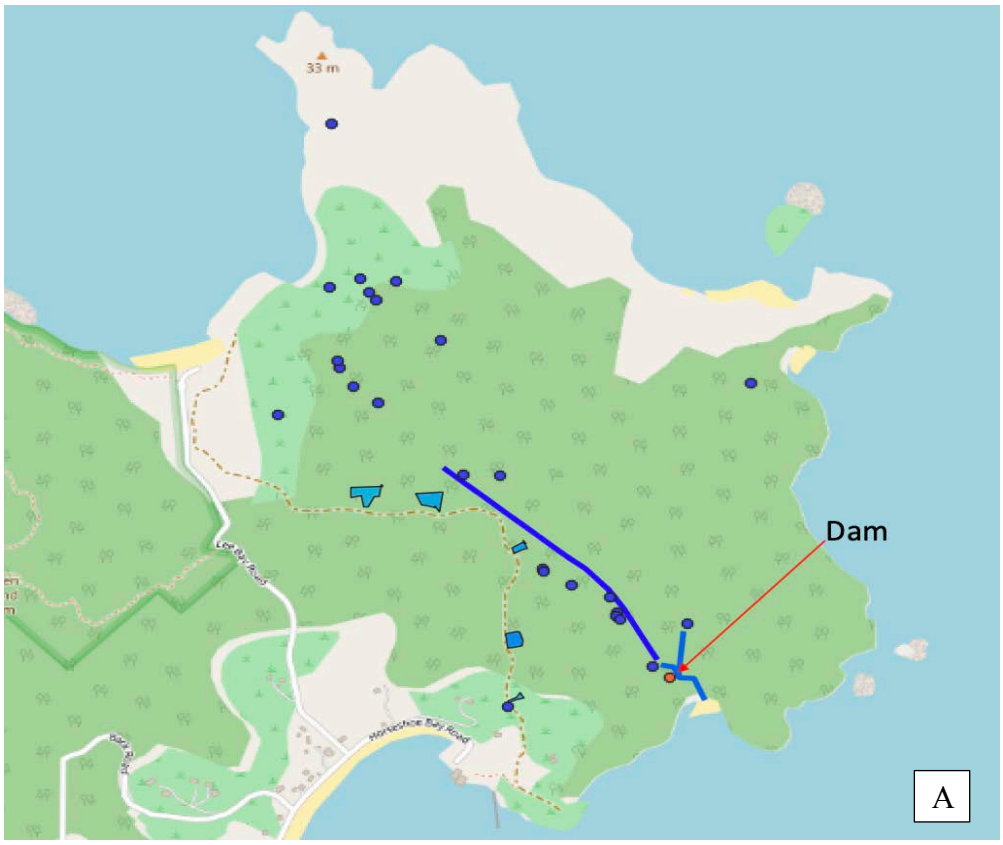


Figure 3. A. The freshwater sources in Mamaku Point Conservation Reserve. The light blue polygons are ponds, the blue points are river/creek intercepting with a bait line, the blue lines are the approximate trajectory of the streams that were followed, and the red dot is a dam. B. Pictures of the dam.

Freshwater species present in MPCR

Common name	***Scientific name***
White Bait/inanga	*Galaxia maculatus*
Green Crayfish/koura	*Paranephrops zealandicus*
Damselfly species	*Xanthocnemis zealandica*

Speculated/Possible species in the MPCR (Southland Conservancy 2011)

Common name	***Scientific name***
Redfinned bully	*Gobiomorphus huttoni*
Giant bully	*Galaxias gobioides*
Upland bully	*Gobio morphus huttoni*
Lamprey	*Geotria australis*
Banded kōkopu	*Gal**l**axias fasciatus*
Gollum galaxias	*Galaxias gollumoides*
Southern flathead galaxias	*Galaxias 'southern'*
Giant kōkopu	*Galaxias argenteus*
Longfin eels	*Anguilla dieffenbachii*
Stoneflies	*Rakiuraperla nudipes*

Amphibians

There are no native frogs within Mamaku Point Conservation Reserve. The only frog observed is the Australian whistling tree frog (*Litoria ewingii*) which is the smallest of the three introduced species of frogs in New Zealand. The whistling frog is thought to transmit disease to native frogs when they are in contact (Orokonui Restoration Plan 2011). Their tadpoles, however, could provide a seasonal food source for some native birds (Orokonui Restoration Plan 2011).

Translocation of frogs requires careful planning to ensure adequate food, shelter, and climate protection (Orokonui Restoration Plan 2011). All three of New Zealand's native frog species are found in the North Island, thus Mamaku Point Conservation Reserve does not seem like an appropriate locale for such a translocation because of climate as well as potential predators.

Invertebrates

It is unclear what the state of invertebrate diversity is within the Reserve, however, it is presumed to be recovering/increasing as other nature sanctuaries have observed increased invertebrate numbers after eradication of pests (Rufaut and Clearwater 1998, Watts and Gibbs 2000). A thorough invertebrate survey is recommended, especially if considering introducing tuatara in the future. It would be beneficial to do a survey inside and outside of the fence to compare diversity in relation to predator exclusion.

One species of invertebrate that could be considered for translocation in the future is the Herekopare weta (*Deinacrida carinata*)**.** Herekopare weta are found on Herekopare Island, which is situated in Halfmoon Bay, Stewart Island (Sherley 1998). Their historical distribution is unknown, but they thrive in shrub habitat where predators and weka have been excluded, both conditions which are satisfied by Mamaku Point Conservation Reserve (Sherley 1998). Weta would add an aspect of public appeal to the Reserve as they are the more

charismatic of the invertebrates in New Zealand. As Herekopare island is a mutton-bird island only accessible to Rakiura Māori, there are several unknowns as to the feasibility of such a translocation.

A non-exhaustive list of invertebrates present in MPCR

N – native/endemic * – introduced ? – unknown

Common name	***Scientific name***
Harvestmen[N]	*Megalopsalis*[N]
Knobbled Orbweaver[N]	*Eriphora pustulosa*[N]
Spittlebug[?]	*Philaenus*[?]
Moss-eating Crambid snout moths[N]	*Scoparia minusculalis*[N]
Sheetweb spider[?]	*Cambridgea*[?]
Stick insect[N]	*Acanthoxyla*[N]
Ground beetle[N]	*Mecodema infimate*[N]
Nurseryweb spider[N]	*Dolomedes minor*[N]
Striped Lax beetle[N]	*Thelyphassa lineata*[N]
Helm's Stag beetle[N]	*Geodorcus helmsi*[N]
Flat-faced long horn beetle[?]	*Xylotoles* sub family *Lamiinae*[?]
Chorus cicada[N]	*Amphipsalta zelandica*[N]
Spider-hunting wasps[N]	*Pompilidae*[N]
Damselflies[?]	*Zygoptera*[?]
South Island lichen moth[N]	*Declana egregia*[N]
Spiny Longhorn[N]	*Blosyropus spinosus*[N]
Chafers[?]	*Odontria* sub family *Melolonthinae*[?]
Gastripods[?]	*Gastropoda*[?]
Blossom fly[N]	*Dilophus nigrostigma*[N]
New Zealand Looper[N]	*Epyaxa rosearia*[N]
Cooper butterflies[N]	*Lycaena*[N]
Ruddy Streak*	*Tachystola acroxantha**

Erosion

The erosion at Lee Bay is critical and needs to be remedied. Finding a solution is vital as erosion leads to reduction in habitat size, more competition for resources between and within species, and in general more stress on the plant, invertebrate, and vertebrate species that reside there. Often erosion destroys habitat that is essential, and species are forced to move somewhere else or are lost along with the habitat. In addition, the erosion at Lee Bay could potentially extend to the adjacent stream and cause sedimentation and clogging of this waterway, changing the stream environment and possibly having serious effects for the fish and

invertebrates hosted around and within the Reserve. Furthermore, erosion will inevitably affect the integrity of the predator-proof fence as it continues.

Restorative Planting

In an area with extensive erosion, it is common to see invasive plants that are able to flourish and outcompete native plants. In the case of Lee Bay, gorse (*Ulex europaeus*) is taking over and becoming the prominent species. This is due to the fact that gorse is more successful in establishing in erosion zones because of its strong root system (SIRCET 2019). It prevents the growth of native species by releasing toxins into the soil (SRICET 2019). The negative effects of gorse on the ecosystem include reduction in plant biodiversity and forage for wildlife; furthermore, it reduces the recreational potential of the beach front area.

At Lee Bay, manuka and *Coprosma* scrub are being outcompeted by gorse, especially as the erosion continues to reduce the habitat for these native species. It is essential that the erosion is slowed and remedied so that native species can re-establish here. Restorative planting of native species such as manuka (*Leptospermum scoparium*), *Coprosma* species, and New Zealand broadleaf/Kapuka (*Griselinia littoralis*) should be implemented to combat gorse invasion and erosion. Getting rid of gorse and limiting the erosion at Lee Bay would be beneficial for every level of the ecosystem. Moreover, it would protect the integrity of the Reserve's biosecurity fence, and would make the Lee Bay area more attractive for visitors and tourists.

Measuring Conservation Outcomes – Initial Ideas (adapted from Orokonui Restoration Plan 2011)

Conservation Outcomes for Mamaku Point Conservation Reserve	Goals	Measure	Example Methods
A self-sustaining ecosystem representative of historical Stewart Island/Rakiura	Phase 1 – A general upwards trend (despite natural fluctuations) of: • Flowering and fruiting native plants • Seedling density • Plant diversity • Terrestrial and aquatic diversity • Breeding success of terrestrial and aquatic fauna • Invertebrate abundance	Improvement in population and breeding rates of native indicator species that are already present in the Reserve such as: • Stewart Island Robin • Rifleman • Southern grass skink • Kamahi • Rimu	• Annual flora and fauna surveys/monitoring • Mark-recapture study of birds and lizards • Nest counts • Artificial burrows/nests and survey to see occupancy rate
	Phase 2 – Sustained populations numbers of key species Return any species that would have been on the property prior to human arrival	Comparison of species abundance pre-human arrival, pre-biosecurity fence, after biosecurity fence, after translocations	As above
Key ecological processes within the Reserve	Functioning systems within Mamaku Point Conservation Reserve	• Comparison of stream habitat quality before and after restoration. • Comparison of aquatic species use before and after stream restoration.	• Flora and fauna surveys* • Mark-recapture study* • Stream quality assessment survey*

		• Percentage of indicator species maintaining or improving status • Regeneration of once absent species occurring naturally. • Vegetation success	*occurring at least three times every year
A refuge for threatened & taonga species	Phase 1 – General upwards trend of taonga species populations	Number of taonga species that are in the Reserve, and may have established beyond the biosecurity fence ie Kiwi, Yellow-eyed penguin, kaka, kakariki, fernbird, Fiordland crested penguin, and others (DOC 2006).	• Surveys inside and out of the Reserve • Bird Banding
	Phase 2 – Sustained population numbers of translocated and present taonga species	Number of taonga species still present within the Reserve each year after translocations.	Faunal and floral surveys
Valued site for ecological and conservation research and education	Increase public visitation and engagement with the Reserve "12,500 visitors annually by 2023" – Roy Thompson	• Annual visitor estimates. • Number of research projects completed/planned yearly	• Maintain database • Advertise research projects to Universities • Advertise school group opportunities
Contribute and collaborate with New Zealand conservation programs	• Increase reputation across New Zealand as a contributor to conservation. • Contribute to conservation	• Number of reports published/contributed • Number of talks/conferences attended/contributed	Database/library

	outcomes in New Zealand	• List of collaborating conservation organizations	

Restoration Policies (adapted from Orokonui Restoration Plan 2011)

Policy Area	**Policy**
Translocation	Translocations will be undertaken in accordance with DOC translocation guidelines. It will be in collaboration with SIRCET and DOC, and contingent on the presence of suitable habitat and food sources (including appropriate supplementary feeding).
Sourcing	Individuals for translocation will be sourced from the nearest geographical and/or genetic populations. This source population is able to support the loss of individuals, and from which sourcing is culturally appropriate. Sourcing from captive populations will be considered.
Cultural Issues	Māori will be considered with relation to management of the Māori land near Frenchman's Beach and Nathan's Island.
Protection	There will be no exploitative use of native species from the ecosanctuary for purposes other than restoration, such as using individuals for translocations around the country.
Analogues	To ensure ecological processes are maintained and functioning, analogue species may be considered where a formerly representative species has gone extinct.
Self-introductions	Native species that are confirmed from self-introduction will be will be managed appropriately.
Management techniques	Wildlife management will be done when considered appropriate and if funding allows, including: • Supplementary feeding • Captive rearing and breeding (in an aviary)

	• Soft release • Enclosures within the Reserve • Rehabilitation of injured fauna • Artificial nests/burrows/roosts • Restorative planting of native species • Planting of exotic species as food sources • Continued pest trapping
Faunal health and welfare	Surveillance, prevention, and treatment programmes will be used to maintain the health of native animals, according to best practice. All work with fauna will be conducted in accordance with the Animal Welfare Act. The Mamaku Point Conservation Trust should seek to involve Rakiura/Southland ethics committees.
Flagship species	To engage public, "flagship" floral or faunal species may be given priority for translocation, provided it does not impede the achievement of the restoration outcomes.
Public feeding of birds	Birds will not be fed by the public due to health risk and potential over-socialisation of species. Bird feeders may be set up for supplementary feeding programs.
Habitat manipulation	Manipulation of existing habitats or the development of new habitats will be permitted for purposes of: • Fire safety • Fence security • Managing forest succession • Providing stable habitat for translocatable species • Providing appropriate food sources for translocatable species • Creating opportunities for visitors to see rare/charismatic species
Research	Encourage research within and around Mamaku Point Conservation Reserve. Ensure appropriate

	coordination and documentation of research done for the Reserve.

Ecotourism, School groups, and Volunteer Access Plan

Mamaku Point Conservation Reserve offers a unique site for outdoor learning and nature appreciation. In the future, it could be useful to develop the education center with science communication activities and visual aids, as well as have an on-site science communicator to run programmes with school groups and visitors. Until then, I suggest creating a resource package for school groups and visitors so that they can get the most out of their time at Mamaku Point Conservation Reserve. This resource package could include games for different age groups, a map of the Reserve with key Reserve aspects of note (i.e. the tallest tree in the Reserve), etc. Some of the activities that could be considered for the resource package are explained in the following table. Furthermore, I suggest the Trust creates a brochure or a newsletter for schools to spread the word of the conservation education that can be experienced at Mamaku Point. In addition, the Trust could look to creating an online resource where groups could log different experiences they had on the Reserve, for example Esri Story Maps.

Environmental Education	Education for Sustainability
• Marine Beach Study - learn about the beach life at Lee Bay or Frenchman's Beach • Bird Call ID Activity - teach groups about the diverse range of bird calls in Mamaku Point's forests • Bird, insect, lizard, marine life, plant scavenger hunts (see following section) • Geocache/Orienteering scavenger hunt - Geocache activity where kids go to find containers/caches with unique hole punches. - learn about the Reserve and what flora and fauna it hosts • Spinning nature wheel with corresponding multiple choice questions for rainy day indoor activity	• Planting native plants - learn about rewilding and restoration of native forest • Possum Picnic Activity (DOC)* - game to show the impact of possums on NZ forests • Native vs Invasive Species game - pompoms are spread out around the game area - children are given spoons to pick up as many pompoms as they can (pretending this is food), at this stage they are all native species - the next round: a couple of kids are now invasive species and can use their hands to pick up pompoms while the rest are still native species that can only use spoons - each round, add more and more invasive species (changing kids from native to invasive strategies) - final round only one child is a native species and the rest are all invasive - ask the kids was it harder or easier for the native species to eat when there are more and more invasive ones? - teaches kids about invasive species and how this leads to competition and stress for native species *https://www.doc.govt.nz/get-involved/conservation-education/resources/possum-picnic/

Bird Scavenger Hunt

Activities where young visitors can search and find species have already been used by several other sanctuaries in New Zealand. For example, Zealandia has a trading card system in place for a nature card game based on what visitors see during their time at the sanctuary. For Mamaku Point Conservation Reserve, I suggest a "Bird Scavenger Hunt" (see Appendix IV). Children and teachers/parents can spend some of their time at the Reserve looking for and noting which bird species that they see. They can then log into an online forum on the Mamaku Point website, or send an email to a Mamaku Point email, to let the Trust know what species were observed. This information could be useful for future monitoring and research purposes. Other "scavenger hunts" could be made for invertebrates, lizards, and possibly plants in the future.

Toyota Kiwi Guardians

Kiwi Guardians is a programme run by DOC in partnership with Toyota for kids to explore, discover, and experience nature. It gives kids an opportunity to learn how wonderful New Zealand's unique biodiversity is and how they can help to protect it. Each site associated with Kiwi Guardians supplies an adventure map which notes fun facts around the site and things to look out for. There is also a Kiwi Guardian post on each site with a unique code so that kids/parents can register their adventure online and get a medal to commemorate their experience. Mamaku Point Conservation Reserve would be an excellent candidate for the Kiwi Guardian programme. Collaborating with the Kiwi Guardians programme would bring many future visitors, offer another fun aspect for school groups who are already visiting the reserve, and give Mamaku Point Conservation Reserve a reputation for conservation education through word-of-mouth, social media, and collaboration with DOC.

Volunteers – Access Plan

Mamaku Point Conservation Reserve offers potential for volunteers of all ages with many different interests. The Reserve should implement a volunteer-interest form for people to fill out and send in to determine if there is work for their particular interests. Volunteer duties could be divided into the categories Reserve Maintenance/Biosecurity and Restoration/Research. The following table outlines tasks that the Trust might consider opening up to volunteers within these two categories. Long term volunteers could be useful to Mamaku Point Conservation Reserve, as they would be able to see a job through from start to finish. If long term volunteers are considered, the Reserve could offer accommodation and food. A contract system and health & safety process should be used when taking on volunteers, establishing intent and responsibilities, number of days and hours/day working, number of days off, length of stay, etc.

Maintenance/Biosecurity	Restoration/Research
• Checking/re-baiting traps • Maintenance of biosecurity fence • Lawn care • Chopping firewood • Education Center maintenance • Track clearing	• Stream restoration, removing dam, limiting erosion • Restorative planting at Lee Bay • Weeding in grassland, restorative planting of native species • Invertebrate surveys

• Any other duties needing assistance by Antony Simpson, General Manager	• Lizard surveys • Species Monitoring pre and post translocation

Volunteering – WWOOF

WWOOF is an international organisation that connects volunteers with organic properties where they volunteer 4-6 hours a day helping the organic farmers in exchange for food and accommodation. Should Mamaku Point Conservation Reserve make the greenhouse an organic nursery for native plants, it could attract many conservationist/environmentalist volunteers to the reserve through WWOOF. These volunteers could help with pest management, fence repair, and care/planting of native plants in the greenhouse and around the Reserve. MPCR would be a rewarding and exciting place for volunteers to come and stay, as it offers a natural and practical hands-on experience for young environmentalists, and already has comfortable accommodation. MPCR can apply to be a host at https://wwoof.nz/.

Concluding Statement

Mamaku Point Conservation Reserve is an excellent site for restoration, protection, and conservation of New Zealand's unique and inspiring biodiversity. The Reserve has a sophisticated biosecurity fence, and a highly efficient trapping and alert system in place inside and outside the fence, making it a secure and safe place for native New Zealand species. It is recommended that the next steps at Mamaku Point be restorative planting to limit erosion as well as stream restoration to offer protected habitat for freshwater species. In addition, developing an education package/brochure for schools and other visitors could be beneficial. In the future, Mamaku Point could be used as a sanctuary for many translocatable species in need of pest-free native habitat, however, monitoring efforts would need to be in place following any translocation. Initial translocations to consider would be a reinforcement translocation of Stewart Island Robins, Fern Birds, and Brown Creepers. Next, the Reserve could look into translocating Stewart Island species such as the Harlequin gecko, Cloudy gecko, mohua, and saddleback. Finally, in the more distant future, the Reserve could look to translocate other New Zealand species that need a refuge site such as tuatara or takahe, however, a niche availability assessment should be done to determine if safe habitat is available for these translocations.

Acknowledgments

I would like to express my sincerest gratitude to Roy Thompson, Rachel Thompson, Antony Simpson, and Ernie Mason for their support in my research and their generosity in hosting me at Mamaku Point Conservation Reserve. I am incredibly grateful for the opportunity to do field work at the Reserve, and write up this restoration plan. I would also like to thank Philip Seddon, Yolanda van Heezik, and Joanne Monks for their encouragement and guidance in the writing and planning process of my research and report. I'd like to thank the iNaturalist community for their assistance with identification of plants and invertebrates. My thanks to Hannah Thomson from YMCA Camp Elphinstone for her help with outdoor education programmes. Special thanks to Aliyah Ali, Alicia Cortes, Emma Dias, Tim Howarth, Laura Jarry Tia Julien, Eoin Lalor, Jacqueline Lalor, Patricia Lalor, Aidan Mora-Teddy, and Claire Thorrold for their suggestions and reviews of the manuscript. I'd like to finally thank my family and friends (Alicia Cortes, Patricia, Eoin, Jacqueline, and Kieran Lalor, Tia Julien, Tui Turnwald, and the Wildlife Management students) for their emotional and advisory support over the three months I spent on the Reserve and during the write up of the Restoration Plan.

Appendix I – Survey Methods

Questions

The questions fueling my research at Mamaku Point Conservation Reserve were:

- What habitat types are found within the Reserve?
- What is the state of bird diversity within the Reserve?
- Is the Robin present within the Reserve?
- What species, and what condition, are the skinks found within the Reserve?
- What should be the future conservation efforts for the Reserve?
- What could be translocated into the Reserve?

Habitat Assessment

Inspired by the Recce Method for describing New Zealand vegetation (Hurst and Allen 2007), 14 habitat assessment sites were evaluated, in five habitat zones. The five zones used were selected by myself through direct observation after two months in the Reserve (Table 2). The reserve was divided into an 8x10 grid and sample sites were chosen randomly using Google's random number generator (Figure 4).

Table 2. The five habitat zones sampled in Mamaku Point Conservation Reserve.

Zone	Description	Number of Samples
Teal	Native podocarp forest, accounts of the majority of the reserve.	3
Pink	*Coprosma*/lancewood/rimu area, highest elevation of the reserve, low canopy.	2
Blue	Native forest higher elevation than teal zone. North Coast facing.	3
Red	Coastal forest on western side of the reserve, runs along line 20.	3
Black	Front facing re-wilding grassland.	3

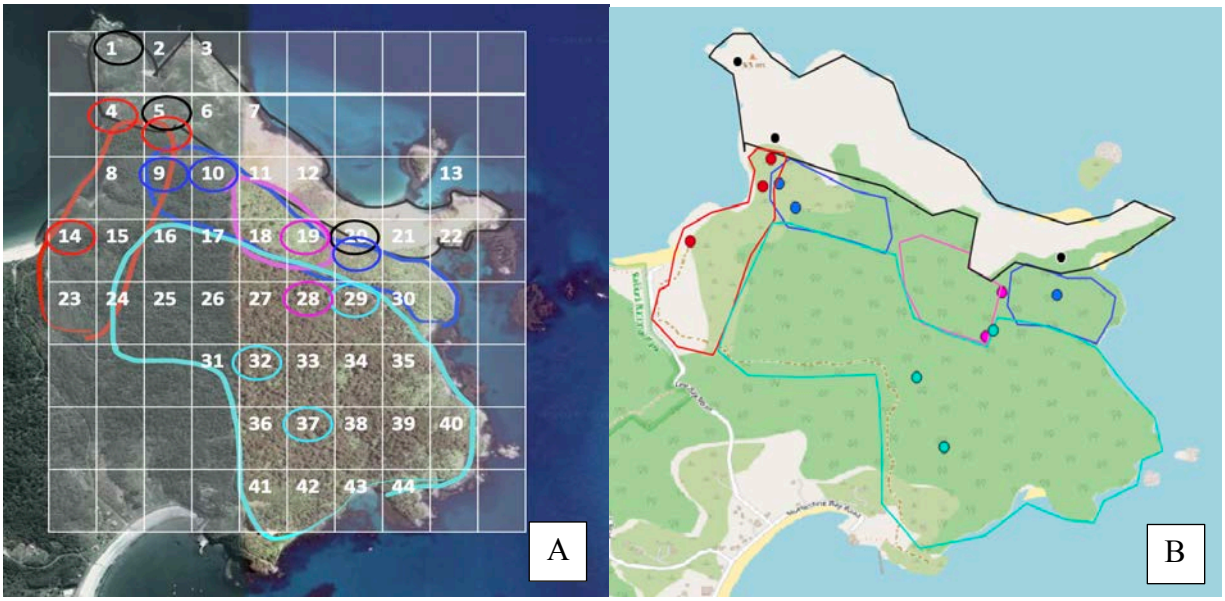


Figure 4. Sampling sites within the reserve. A. The grids chosen for sampling using a random number generator. B. The actual points sampled.

A 10x10m plot was sampled and forest characteristics were noted for each site. The characters of each site that were collected according to Hurst and Allen (2007) were: GPS coordinates at the center (see Appendix V), altitude at center, slope at center, physiography, % vegetation ground cover, % non-vascular ground cover, % litter ground cover, % bare ground, % rock ground cover, average top height, % canopy cover, and the plant species observed. Species of vascular plants were listed for each sample site.

Chao2 index of absolute species number was calculated for each habitat zone. Chao2 is used when presence and absence data are collected (Magurran 2005). The estimator gives an indication of absolute species number by using the number of singletons (species found in only one sample) and the number of doubletons (species found in more than one sample) (Magurran 2005). As more singletons are found, the estimation of absolute species number increases, as it is assumed there are likely still more rarities that have yet to be found (Magurran 2005). Chao2 index is calculated using the following formula:

$$S_{Chao2} = S_{obs} + \frac{{q_1}^2}{2q_2}$$

Where S_{obs} is the number of observed species, q_1 is the number of singletons (species found in only one sample), and q_2 is the number of doubletons (species found in more than one sample) (Magurran 2005).

Bird Survey

Five-minute bird counts (5MBC), with methods following those of Dawson and Bull (1975), were used to determine the state of bird diversity within the Reserve. Seventeen previously established bait lines (Lines 1-16, 20) were used for the transects (Figure 5, see Appendix V). 5MBCs were done every 100m along each transect, resulting in 3-15 counts per line. Surveys started at the end of October and finished mid December. 360° coverage of the area was attempted, and all birds heard and seen were noted.

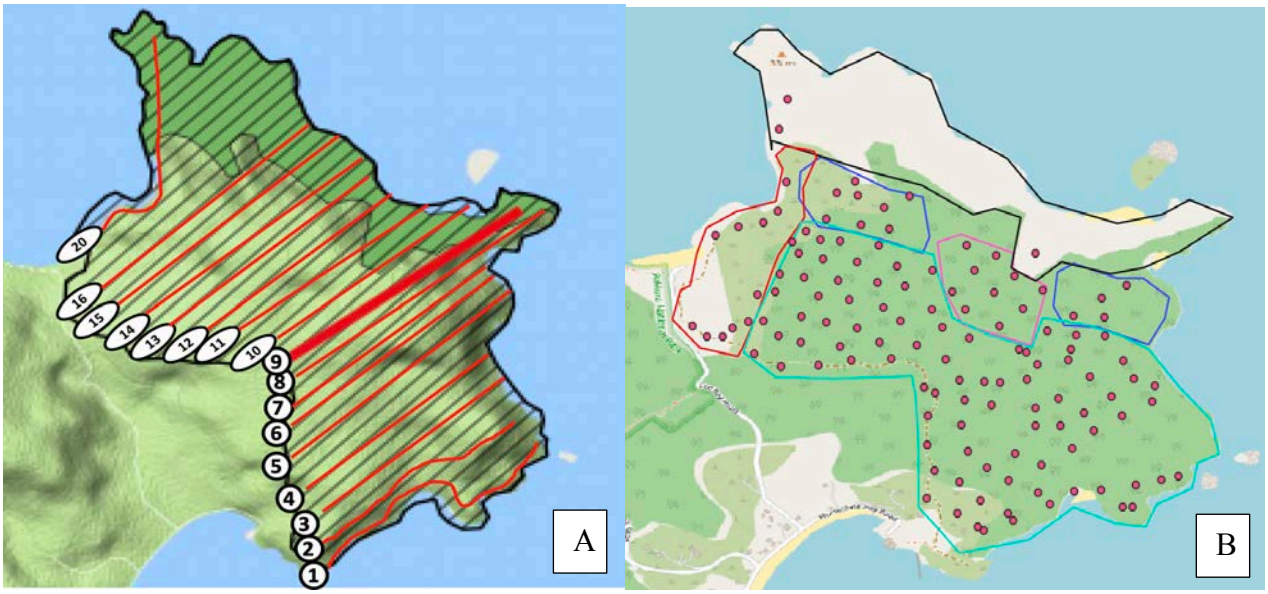


Figure 5. A. The approximate transects walked for bird surveys 1-16, and 20. Bait stations were 50m apart which allowed for accurate 100m measurements between bird counts. B. The 5MBC's done within the five habitat zones.

Rank abundance plots were made for the bird species in each habitat zone, and a total rank abundance plot was made including all transects in the study. Rank abundance plots give a visual representation of the abundance of species in samples, from most to least abundant (Magurran 2005).

Species diversity indexes were used to compare bird diversity between habitats. Simpson's index of diversity, the probability of any two individuals drawn at random from a finite community to be the same species (Magurran 2005), was calculated using the following formula:

$$\mathrm{D}simpson = \sum \frac{n_i(n_i - 1)}{N(N-1)}$$

Where n_i is the number of individuals of the i^{th} species, and N is the total number of individuals (Magurran 2005). As D increased, there is less diversity in the sample. For this reason, the inverse of Simpson's index ($1/D$) is taken to represent increasing diversity (Magurran 2005). Simpson's index is highly influenced by abundance of individual species, thus two other indices were used to quantify bird diversity within the Reserve (Magurran 2005).

The second index of diversity used was Margalefs index, calculated using the following formula:

$$D_{mg} = \frac{S-1}{lnN}$$

Where S is the number of species, and N is the total number of individuals (Magurran 2005). Margalefs index is heavily weighted towards richness, which is useful when comparing with Simpsons index (Magurran 2005).

A final index, Simpson's Index of Evenness was calculated using the following formula:

$$E_{1/D} = \frac{1/D}{S}$$

Where $1/D$ is the inverse of Simpson's diversity index, and S is the number of species. This index is able to give an indication of evenness while the other two indexes focus on richness and diversity. All three are important for understanding the big picture of bird diversity within the Reserve.

Statistical Analysis

A one-way ANOVA was done for each diversity index to determine any differences in mean indices across the five different habitat types. This was done using the statistical software R Studio (2015).

Stewart Island Robin

To determine the status of the MPCR SI robin population, I played robin calls at each 5MBC site for ~1min. This was completed after all bird surveys had been done for the day so as to not affect the bird count data.

Skink Survey

Pitfall skink traps were used in the grassland area of Mamaku Point to determine the species and the condition of individuals that are found in the reserve, using methods described by Hare (2012) and Lettink and Monks (2016). Three transects, 50m apart at Bob's Point, were used for pitfall traps, with three traps on each line, 20m apart (Figure 6, Appendix V). Traps were checked each day, and bait was replaced daily. Sampling occurred between January 25th, 2019 to February 10th, 2019 at approximately 4pm every day. Traps were created using empty yogurt/ice cream containers with open lids secured by rocks. In the traps were sponges, to ensure a moisture source for any trapped skinks, and bait (either canned fruit or honey) (Hare 2012). Balanced on vegetation over each trap was a 60cm x 20cm rectangle of glass to shelter traps and attract skinks in cold weather conditions.

Figure 6. The location of the skink transects and pitfall traps (Google Earth 2019).

Appendix II – Survey Results

Habitat Assessment

Out of the five habitat zones, the red (coastal) zone was the only one that had ground cover classified as rock and bare ground (Figure 7). The blue (front facing forest), pink (high elevation *Coprosma* forest), and the teal (main podocarp forest) had ground covers with litter, non-vascular and vascular plants, whereas the black (grass) zone was dominated by vegetation ground cover (Figure 7).

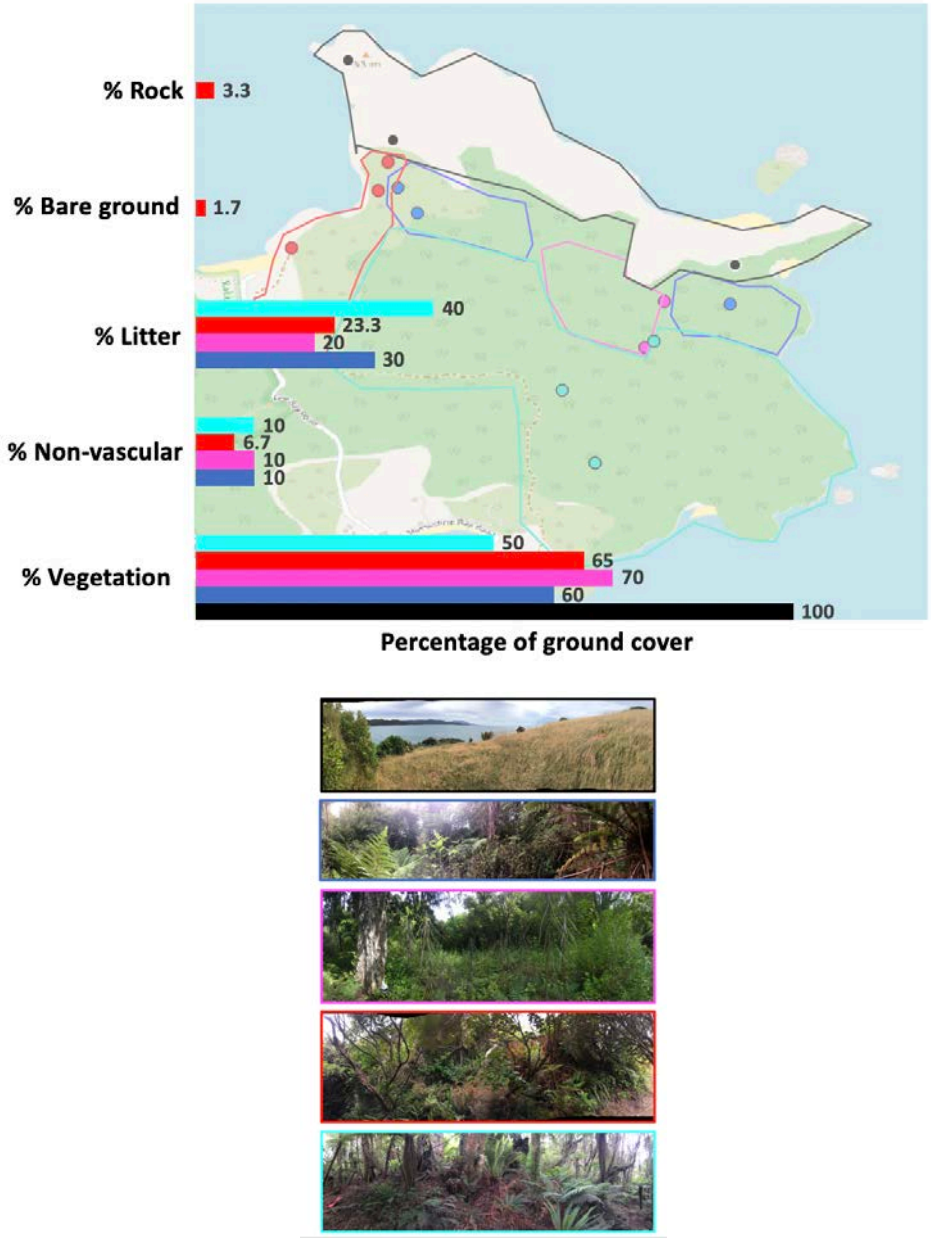


Figure 7. Allocation of ground cover for the five habitat zones within MPCR, accompanied by a photo of one sample from each zone.

The blue zone had the highest absolute/Chao2 species number based on the presence/absence data of plants found in the three samples (Table 3). Red had the lowest absolute/Chao2 species number, most likely because some of the ground cover was bare and rock. This would limit the availability of coastal habitat for a more diverse plant population. The remaining habitat characters are summarized in Table 3.

Table 3. The summarized Recce Method characters for the five habitat zones found within MPCR. Chao2 index is given, calculated using the Q1 (number of singletons) and Q2 (number of doubletons) values. The habitat zones used were: black (front-facing grassland), blue (high elevation native forest), Pink (*Coprosma*/lancewood forest at high elevation), Red (western coastal forest), Teal (native podocarp forest).

Habitat Zone	Average Altitude	Average Slope	Average Top height of the canopy	Average Canopy Cover	# of species	Chao2
Black	56m	20.8º	1.3m	0%	15	18
Blue	61m	20.8 º	5.8m	68%	19	33
Pink	141.5m	8º	4m	60%	12	20
Red	14m	30.1º	3.8m	80%	16	17
Teal	101m	9.35º	17m	77%	14	26.5

Bird Survey

There was no significant difference in any of the mean bird diversity indices calculated from bird counts in the five habitat zones ($p>0.05$) (Figure 8). A Levene's test for homogeneity of variance showed that the data did not violate the assumptions of ANOVA ($p>0.05$ for all three indexes). The trends indicate that the black zone (grassland) had the highest Simpson's diversity index and evenness index, while red (coastal forest) had the highest Margalefs index (Table 4). Black has the highest Simpson's diversity index, which is weighted by abundance, which can be explained by the higher evenness compared to the other four habitat zones (Figure 9). This means that the coastal forest had the highest species richness, or number of species, whereas the grassland had the highest species evenness; equal number of individuals of each species. This high evenness in the grassland zone explains the highest diversity, as diversity is highly swayed by the abundance of each species. Excluding the black zone, the habitats were highly dominated by tuis and bellbirds (Figure 9). The overall dominance of tuis and bellbirds can be seen in Figure 10.

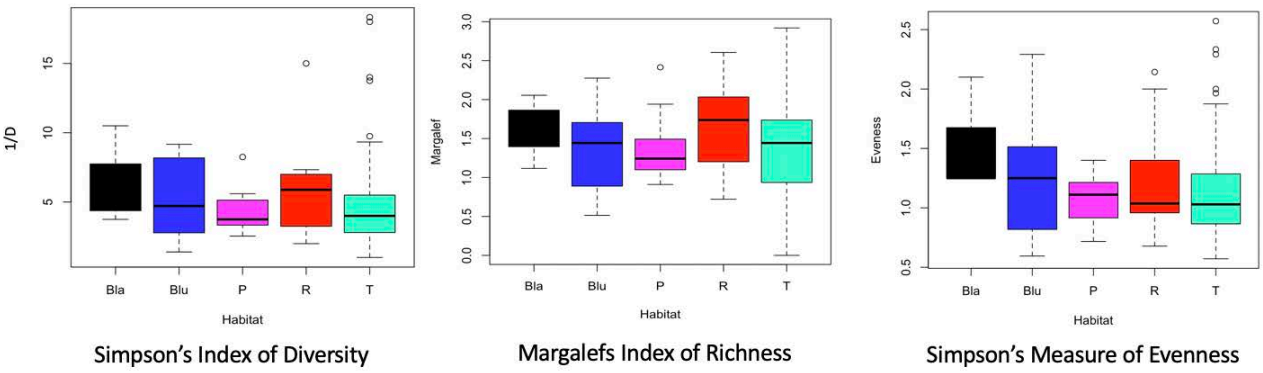


Figure 8. Boxplots demonstrating the overlapping of means for the bird community indexes across the five different habitat zones in Mamaku Point Conservation Reserve. The habitat zones used were: black (front-

facing grassland), blue (high elevation native forest), Pink (*Coprosma*/lancewood forest at high elevation), Red (western coastal forest), Teal (native podocarp forest).

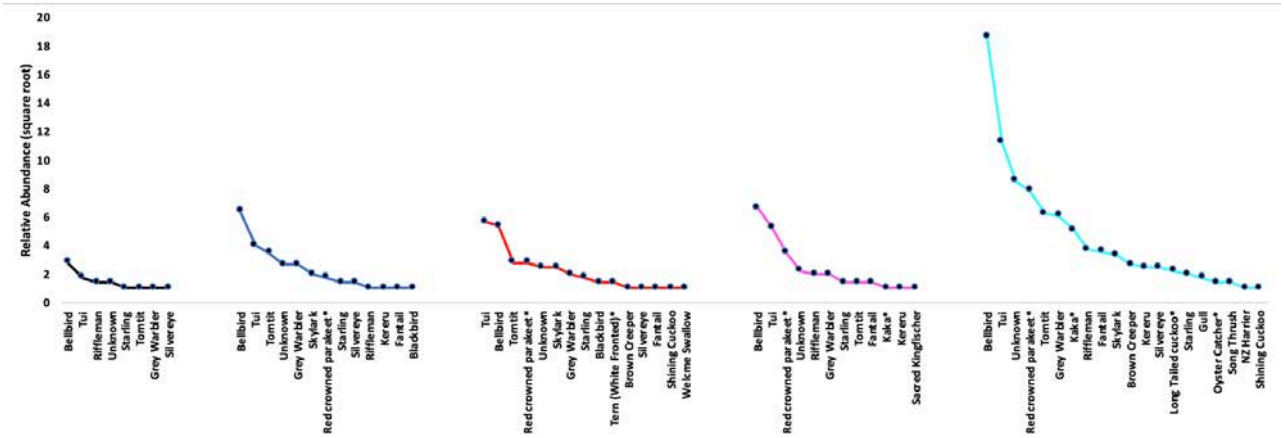


Figure 9. Rank abundance graphs showing the abundance of individual species in each habitat zone. A square root transformation was used due to the high abundance of tuis and bellbirds. The habitat zones used were: black (front-facing grassland), blue (high elevation native forest), Pink (*Coprosma*/lancewood forest at high elevation), Red (western coastal forest), Teal (native podocarp forest).

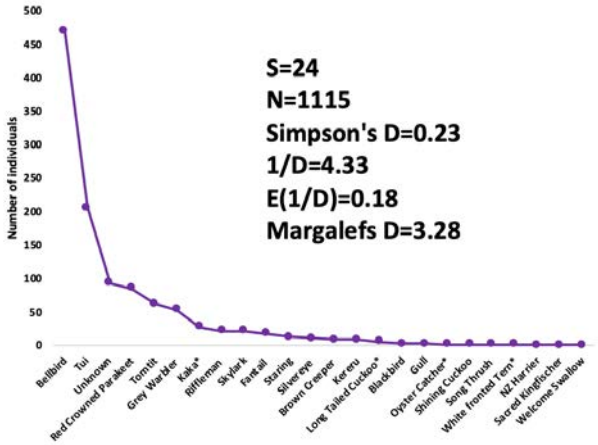


Figure 10. The rank abundance curve for the entire Reserve, demonstrating the dominance of bellbirds and tuis.

Table 4. Trends in bird diversity indices for the five different habitat zones within the Reserve. The red font shows the habitat zone with the highest value for the particular index. The habitat zones used were: black (front-facing grassland), blue (high elevation native forest), Pink (*Coprosma*/lancewood forest at high elevation), Red (western coastal forest), Teal (native podocarp forest).

Average	Black	Blue	Red	Pink	Teal
S	4	3.9	4.7	4.1	3.9
1/D	6.4	5.1	5.9	4.4	4.6
Margalefs	1.6	1.4	1.7	1.4	1.4
$E_{1/D}$	1.5	1.2	1.2	1.1	1.1

The Stewart Island robin (*Petroica australis rakiura*) was first translocated into the Reserve in 2012 by the Dancing Star Foundation. They released 28 juvenile robins in 2012, and an additional 29 robins in 2013 for reinforcement. It is unknown what the status of the SI robin is currently within MPCR. SI robins are highly territorial, and will aggressively defend their territory upon hearing another robins calls.

The Stewart Island Robin was only attracted at one bird count, line 15 trap 5. Tui and bellbirds would aggressively swarm to the robin call at the other 128 5MBC sites. It should be noted that the weather during bird counts was variable, and frequently wet. This could be a limitation to the bird count data and the ability to attract Stewart Island robins as weather conditions directly alter the detection rates of birds in census fieldwork, either by limiting sound detection or altering the behaviour of the birds (O'Connor and Hicks 1980).

Skink Survey

Twenty-two skinks were captured in the fifteen-day pitfall survey, all of which were Southern Grass Skink (*Oligosoma aff. polychrome*). Skinks were caught at daytime temperatures of 14-27°C, and nighttime temperatures of 5-18°C. Field conditions of capture days were sunny and partly cloudy with a light breeze, and the other conditions are summarized in Table 5. The average snout-to-vent length of the skink captured was 49.9mm, and the average vent-to-tail length was 57.5mm. One skink that was captured was evidently pregnant, and one newborn baby skink was caught on the last day of sampling. All twenty-two skinks were in good condition, with all of their fingers and toes.

Table 5. Average field conditions of successful skink captures.

Mode altitude of captures	15m (6 of 19 captures)
Average daily precipitation	26.32 mm
Average daily humidity	63.53%
Average wind speed with mode direction	24.05km/h N

Appendix III - Vascular plants of the Mamaku Point Conservation Reserve

*denotes exotic species

Trees and shrubs	***Climbers***	***Dicot herbs***
Southern rata (*Metrosideros umbellate*)	Climbing rata (*Metrosideros fulgens)*	New Zealand Groundsel *(Senecio minimus)*
Red pine/rimu (*Dacrydium cupressinum*)	Supplejack (*Ripogonum scandens*)	California Thistle (*Cirsium arvense*)*
Brown pine/miro (*Prumnopitys ferruginea*)	Bush Lawyer (*Rubus cissoids*)	Biddy-Biddy (*Acaena novae-zelandiae*)
Tea tree/manuka (*Leptospermum scoparium*)	Climbing clubmoss/ waewaekoukou (*Lycopodium volubile*)	Bird's-foot Trefoil (*Lotus corniculatus*)*
Broadleaf tree/kapuka (*Griselinia littoralis*)	Pohuehue (*Muehlenbeckia australis*)	Creeping Buttercup (*Ranunculus repens*)*
Tree nettle (*Urtica ferox*)		Bronze Piri-Piri Bur (*Acaena anserinifolia*)
Tree Fuschia/kotukutuku (*Fuchsia excorticata*)		Common liverwort (*Marchantia polymorpha*)
Lancewood/horoeka (*Pseudopanax crassifolius*)		
Muttonbird scrub (*Brachyglottis rotundifolia var. ambigua*)		
Coprosma spc.		
Pseudopanax anomalus x *simplex* hybrid/raukaua		
Shining karamu (*Coprosma lucida*)		
Wineberry/makomako (*Aristotelia serrata*)		
Seven finger/pate (*Schefflera digitata*)		
Aruhe (*Coprosma areolate*)		
Marblewood/putaputāwētā (*Carpodetus serratus*)		
Mingimingi (*Coprosma propinqua*)		
Kanono (*Coprosma grandifolia*)		
Mapou (*Myrsine australis*)		
Common tree daisy (*Olearia arbosrescens*)		
Miki (*Coprosma propinqua*)		
Inaka (*Dracophyllum longifolium*)		
Pigeonwood (*Hedycarya arborea*)		
Haymakaroa (*Raukaua simplex*)		
Gaultheria antipoda		
Blue gum (*Eucalyptus globulus*)*		

Grasses	***Other monocots***	***Ferns and fern allies***	***Bryophytes (moss and liverworts)***
Bush flax (*Astelia fragrans*) Lesser stitchwort (*Stellaria graminea*)* Cock's Foot (*Dactylis glomerata*)* Yorkshire Fog (*Holcus lanatus*)*	Greenhood orchid/tutukiwi (*Pterostylis*) Sun orchid (*Thelymitra*) Clover Spider orchids (*Corybas*)	Soft tree fern/katote (*Cyathea smithii*) Spleenwort (*Asplenium*) Gully fern (*Pneumatopteris pennigera*) Hard fern (*Blechnum discolor, Blechnum fluviatile, Blechnum vulcanicum*) Hen and chicken's fern/mauku (*Asplenium bulbiferum*) Leather-leaf fern (*Pyrrosia eleagnifolia*) Filmy fern/muku (*Hymenophyllum dilatatum*) Hound's tongue fern/kōwaowao (*Microsorum pustulatum*) Bracken/rarauhe (*Pteridium esculentum*) Kangaroo fern (*Microsorum pustulatum*) Palm-leaf fern/kiokio (*Blechnum novae-zelandiae*) Hanging spleenwort (*Asplenium flaccidum*) Common shield fern/pikopiko (*Polystichum richardii*) Water fern/mātā (*Histiopteris incisa*)	Sphagnum Moss (*Sphagnum*) Pipe cleaner moss (*Ptychomnion aciculare)* Thallose liverwort (*Marchantia foliacea*)

Appendix IV – Bird Scavenger Hunt

Mamaku Point
CONSERVATION RESERVE

BIRD SCAVENGER HUNT

See how many bird species you can see in the reserve! Let us know at https://www.mamakupoint.nz/contact-us

☐  Bellbird/ korimako

☐  Silvereye/ tauhou

☐  Tui

☐  Stewart Island Robin/ kakaruai

☐ Tomtit/piropiro  

☐  Southern Brown Kiwi/ tokoeka

☐  Brown Parrot/ kaka

☐  Little Blue Penguin/ kororā

☐  Wood Pigeon/ kereru

☐  Morepork ruru

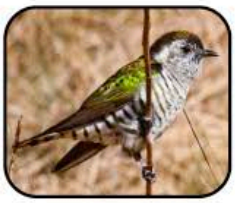
☐  Red Crowned Parakeet/ kākāriki

☐  Fantail/ pīwaka-waka

☐  Sacred Kingfisher/ kōtare

☐  Welcome Swallow/ warou

☐  Brown Creeper/ pīpipi

☐  Shining Cuckoo/ pipiwha-rauroa

☐  White Fronted Tern/tara

☐  South Island Pied Oyster-catcher/ tōrea

☐  Long Tailed Cuckoo/ koekoeā

☐  Swamp Harrier/ kāhu

☐  Rifleman/ tītipounamu

☐  Fernbird/ mātātā

☐  Sooty Shearwater/ tītī

☐  Pied Shag/ kāruhiruhi

☐  Grey Warbler/ riroriro

☐  Fiordland Crested Penguin/ tawaki

☐  Fantail/ pīwakawaka

Photos from Snapping Wild and NZ Birds Online

Appendix V – Coordinates from surveys

Habitat survey coordinates

Sample ID	Vegetation Zone	Sample Area	GPS Coordinate
Bla20	Black	10x10m	E 1229615 N 4798613 +/- 3m
Bla5	Black	10x10m	E 1228689 N 4799035 +/- 3m
Bla1	Black	10x10m	E 1228553 N 4799330 +/- 3m
Blu20	Blue	10x10m	E 1229610 N 4798465 +/- 7m
Blu9	Blue	10x5m	E 1228714 N 4798852 +/- 3m
Blu10	Blue	10x10m	E 1228770 N 4798760 +/- 4m
P28	Pink	10x10m	E 1229398 N 4798285 +/- 3m
P19	Pink	10x10m	E 1229438 N 4798465 +/- 3m
R14	Red	10x10m	E 1228450 N 4798605 +/- 3m
R4	Red	10x10m	E 1228663 N 4798840
R5	Red	10x10m	E 1228681 N 4798949 +/- 4m
T37	Teal	10x10m	E 1229257 N 4799833 +/- 9m
T32	Teal	10x10m	E 1229192 N 4798108 +/- 3m
T29	Teal	10x10m	E 1229420 N 4798311 +/- 3m

Bird survey coordinates

Line	Bait Station ID	Count #	GPS Coordinates
1	L1 B/S13	1	E 1229310 N4797520
1	L1 S15	2	E 1229393 N4797563
1	L1 S17	3	E 1229497 N4797634
1	L1 S19	4	E 1229564 N4797690
1	L1 S21	5	E 1229642 N4797700
1	L1 S23	6	E 1229710 N4797637
1	L1 S25	7	E 1229739 N4797640

Line	Bait Station ID	Count #	GPS Coordinates
1	L1 S27	8	E 1229742 N4797727
1	L1 S29	9	E 1229816 N4797749
1	L1 S31	10	E 1229866 N4797768
2	L2 S5	1	E 1229292 N4797533
2	L2 S7	2	E 1229377 N4797592
2	L2 S9	3	E 1229460 N4797678
3	L3 S2	1	E 1229229 N4797582

Line	Bait Station ID	Count #	GPS Coordinates
3	L3 S4	2	E 1229293 N4797637
3	L3 S6	3	E 1229370 N4797719
3	L3 S8	4	E 1229462 N4797788
3	L3 S10	5	E 1229548 N4797858
3	L3 S12	6	E 1229607 N4797930
3	L3 S14	7	E 1229685 N4797993
3	L3 S16	8	E 1229771 N4798057
3	L3 S18	9	E 1229774 N4798119
4	L4 S1	1	E 1229134 N4797635
4	L4 S3	2	E 1229227 N4797705
4	L4 S5	3	E 1229303 N4797766
4	L4 S7	4	E 1229383 N4797826
4	L4 S9A	5	E 1229436 N4797940
4	L4 S10	6	E 1229509 N4797944
4	L4 S12	7	E 1229574 N4797999
4	L4 S14	8	E 1229651 N4798069
4	L4 S16	9	E 1229711 N4798143
5	L5 S1	1	E 1229152 N4797744
5	L5 S3	2	E 1229244 N4797827
5	L5 S6	3	E 1229430 N4798010
5	L5 S7	4	E 1229495 N4798049
5	L5 S9	5	E 1229583 N4798141
5	L5 S11	6	E 1229677 N4798211
6	L6 S1	1	E 1229123 N4797845
6	L6 S3	2	E 1229219 N4797928
6	L6 S5	3	E 1229301 N4798013
6	L6 S7	4	E 1229399 N4798120
6	L6 S9	5	E 1229515 N4798202
6	L6 S11	6	E 1229617 N4798303
7	L7 S1	1	E 1229118 N4797960
7	L7 S3	2	E 1229222 N4798028
7	L7 S5	3	E 1229322 N4798105
7	L7 S7 assumed	4	E 1229390 N4798226
7	L7 S7	5	E 1229426 N4798180
7	L7 S9	6	E 1229520 N4798246
7	L7 S10A	7	E 1229532 N4798303
7	Unknown	8	E 1229610 N4798377
8	L8 S1	1	E 1229134 N479805*
8	L8 S3	2	E 1229201 N4798104
8	L8 S5	3	E 1229275 N4798104
8	L8 S7	4	E 1229368 N4798235
8	L8 S9	5	E 1229447 N4798313
8	L8 S11	6	E 1229520 N4798377
8	L8 S13	7	E 1229597 N4798451
8	L8 S15	8	E 1229668 N4798507
9	L9 S1	1	E 1229100 N4798070
9	L9 S3	2	E 1229157 N4798182
9	L9 S5	3	E 1229221 N4798270

Line	Bait Station ID	Count #	GPS Coordinates
9	L9 S7	4	E 1229306 N4798323
9	L9 S9	5	E 1229370 N4798397
9	L9 S11	6	E 1229423 N4798471
20	L20 S1	1	E 1228453 N4798628
20	L20 S3	2	E 1228518 N4798664
20	L20 S5	3	E 1228591 N4798686
20	L20 S7	4	E 1228629 N4798735
20	L20 S9	5	E 1228648 N4798851
20	L20 S11	6	E 1228613 N4799056
20	L20 S13	7	E 1228632 N4799174
10	L10 S1	1	E 1228998 N4798175
10	L10 S3	2	E 1229068 N4798234
10	L10 S5	3	E 1229140 N4798307
10	L10 S7	4	E 1229201 N4798382
10	L10 S9	5	E 1229282 N4798454
10	L10 S11	6	E 1229338 N4798524
10	L10 S13	7	E 1229393 N4798617
11	L11 S1	1	E 1228881 N4798162
11	L11 S3	2	E 1228959 N4798239
11	L11 S5	3	E 1229015 N4798325
11	L11 S7	4	E 1229104 N4798376
11	L11 S9	5	E 1229160 N4798450
11	L11 S11	6	E 1229219 N4798539
11	L11 S13	7	E 1229279 N4798599

Line	Bait Station ID	Count #	GPS Coordinates
12	L12 S1	1	E 1228786 N4798139
12	L12 S3	2	E 1228845 N4798214
12	L12 S5	3	E 1228890 N4798289
12	L12 S7	4	E 1228961 N4798375
12	L12 S9	5	E 1229020 N4798465
12	L12 S11	6	E 1229097 N4798529
12	L12 S14	7	E 1229190 N4798635
13	L13 S1	1	E 1228678 N4798126
13	L13 S3	2	E 1228728 N4798224
13	L13 S5	3	E 1228799 N4798307
13	L13 S7	4	E 1228861 N4798400
13	L13 S9	5	E 1228939 N4798474
13	L13 S10 misslabled	6	E 1228992 N4798540
14	L14 S1	1	E 1228595 N4798172
14	L14 S3	2	E 1228662 N4798245
14	L14 S5	3	E 1228725 N4798326
14	L14 S7	4	E 1228770 N4798409
14	L14 S9	5	E 1228823 N4798473
14	L14 S11	6	E 1228874 N4798550
14	L14 S13	7	E 1228933 N4798618
14	L14 S15	8	E 1228960 N4798684
15	L15 S1	1	E 1228499 N4798231
15	L15 S2 (assumed 3)	2	E 1228570 N4798295
15	L15 S5	4	E 1228642 N4798419

Line	Bait Station ID	Count #	GPS Coordinates
15	L15 S7	5	E 1228723 N4798478
15	L15 S10 (should be 9)	6	E 1228774 N4798556
15	L15 S12 (assume)	7	E 1228820 N4798629
15	L15 S13	8	E 1228876 N4798696
15	L15 S15	9	E 1228940 N4798768
16	L16FENCE	1	E 1228454 N4798228
16	L16 S1	1	E 1228526 N4798268
16	L16 S3	2	E 1228591 N4798404
16	L16 S5	3	E 1228651 N4798487

Line	Bait Station ID	Count #	GPS Coordinates
16	L16 S7	4	E 1228701 N4798573
16	L16 S9	5	E 1228761 N4798630
16	L16 S11 (actually 10)	6	E 1228679 N4798615
16	L16 S11	7	E 1228717 N4798660
16	L16 S13	8	E 1228773 N4798711
16	L16 S15	9	E 1228797 N4798818
16	L16 S17 (assumed)	10	E 1228859 N4798810
16	L16 S17	11	E 1228849 N4798864
17	L17FENCE	1	E 1228409 N4798268
	InPen7	1	E 1228433 N4798443

Skink survey coordinates (occasions where skinks were observed)

Date	Time	Line	Trap	GPS Coordinates	Number of Skink observed
06-02-2019	4:06pm	3	A	E 1228718 N 4799204	1
06-02-2019	3:52pm	1	B	E 1228638 N 4799178	1
01-02-2019	4:15pm	3	B	E 1228709 N 4799225	1
01-02-2019	4:15pm	3	A	E 1228718 N 4799204	1
02-02-2019	4:00pm	2	B	E 1228680 N 4799199	1
02-02-2019	4:00pm	3	B	E 1228709 N 4799225	1
05-02-2019	4:45pm	1	B	E 1228638 N 4799178	1
03-02-2019	4:05pm	2	A	E 1228687 N 4799176	2
03-02-2019	3:40pm	1	A	E 1228651 N 4799157	1
07-02-2019	3:56pm	2	B	E 1228680 N 4799199	1
07-02-2019	4:04pm	3	C	E 1228702 N 4799238	1
04-02-2019	5:06pm	2	A	E 1228687 N 4799176	1
04-02-2019	4:50pm	1	A	E 1228651 N 4799157	1
08-02-2019	4:07pm	2	A	E 1228687 N 4799176	1
08-02-2019	3:52pm	1	A	E 1228651 N 4799157	1
30-01-2019	3:47pm	2	A	E 1228687 N 4799176	1
10-02-2019	3:40pm	1	A	E 1228651 N 4799157	2
09-02-2019	5:00pm	1	A	E 1228651 N 4799157	1
31-01-2019	4:15pm	3	A	E 1228718 N 4799204	2

References

Cockayne L 1909. Report on a botanical survey of Stewart Island. Department of Lands C-12: 1-88.

Cree A, Thompson MB, Daugherty CH 1995. Tuatara sex determination. Nature 375(6532): 543.

Dancing Star Foundation 2018 website. Biodiversity conservation New Zealand. http://www.dancingstarfoundation.org/new_zealand.php

Dawson DG, Bull PC 1975. Counting birds in New Zealand forests. Notornis 22: 101-109.

DOC 2006. Ngäi Tahu taonga animal species. RD&I Christchurch DOC: 1-2.

Google Earth 2019. earth.google.com/web/.

Hare KM 2012. Herpetofauna: pitfall trapping. DOC Inventory and Monitoring Toolbox: Herpetofauna. 1: 1-22.

Harper GA 2009. The native forest birds of Stewart Island/Rakiura: patterns of recent declines and extinctions. Notornis 56: 63-81.

Hurst JM, Allen RB 2007. The Recce method for describing New Zealand vegetation – expanded manual. Landcare Research Manaaki Whenua 4: 1-64.

King C 2005. The handbook of New Zealand mammals. Oxford University Press.

Lettink M, Monks JM 2016. Survey and monitoring methods for New Zealand lizards. Journal of the Royal Society of New Zealand 46(1): 16-28.

Magurran AE 2005. Measuring biological diversity. Blackwell Science Ltd.

Mamaku Point Conservation Reserve 2018. Biosecurity management plan October 2018. 1-13.

Mamaku Point Conservation Reserve 2018. Operational plan to 31 March 18. 1-15.

Mamaku Point Conservation Reserve 2019 Website. https://www.mamakupoint.nz/

Mcglone MS, Wilson HD 1996. Holocene vegetation and climate of Stewart Island, New Zealand. New Zealand Journal of Botany 34: 369-388.

Ministry for the Environment 2016. Climate projections snapshot June 2016. Wellington, New Zealand: Ministry for the Environment.

Mitchell NJ, Nelson NJ, Cree A, Pledger S, Keall SN, Daugherty CH 2006. Support for a rare pattern of temperature-dependent sex determination in archaic reptiles: evidence from two species of tuatara (*Sphenodon* spp.). Frontiers in Zoology 3(1): 9.

Mitchell NJ, Kearney MR, Nelson NJ, Porter WP 2008. Predicting the fate of a living fossil: how will global warming affect sex determination and hatching phenology in tuatara? Proceedings of the Royal Society of London B: Biological Sciences 275(1648): 2185-2193.

NZ Birds Online 2019 Website. http://nzbirdsonline.org.nz/

O'Connor RJ, Hicks RK 1980. The influence of weather conditions on the detection of birds during Common Birds Census fieldwork. Bird Study 27: 137-151.

O'Donnell CFJ, Borkin KM, Christie JE, Lloyd B, Parsons S, Hitchmough RA 2017. Conservation status of New Zealand bats. DOC 21: 1-8.

Orokonui Ecosanctuary 2011. Orokonui ecosanctuary restoration plan February 2011. 1-32.

RStudio Team 2015. RStudio: Integrated Development for R. RStudio, Inc., Boston, MA. http://www.rstudio.com/

Rufaut CG, Clearwater SG 1998. Chetwode Islands Recovery: The response of lizards and invertebrates following eradication of kiore and weka form Chetwode Islands. Department of Conservation Occasional Publication 41: 1-25.

Ruffell J, Guilbert J, Parsons S 2009. Translocation of bats as a conservation strategy: previous attempts and potential problems. Endangered Species Research 8:25-31.

Sedgeley J, O'Donnell C, Lyall J, Edmonds H, Simpson W, Carpenter J, Hoare J, McInnes K 2012. DOC best practice manual of conservation techniques for bats. DOC 1: 1-172.

Sherley GH 1998. Threatened weta recovery plan. Threatened Species Recovery Plan 25: 1-51.

SIRCET 2019 Website. https://www.sircet.org.nz/

Southland Conservancy 2011. Stewart Island/Rakiura conservation management strategy and Rakiura National Park management plan 2011-2021. DOC: 1-316.

Stewart Island/Rakiura 2019 Website. https://www.stewartisland.co.nz/

Taylor HR, Nelson NJ, Ramstad KM 2019. The first recorded interaction between two species separated for centuries suggests they were ecological competitors. New Zealand Journal of Ecology 43(1): 3361.

Thompson MB, Packard GC, Packard MJ, Rose B 1996. Analysis of the nest environment of tuatara *Sphenodon punctatus*. Journal of Zoology 238(2): 239-251.

QGIS Development Team (2019). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org

Watts CH, Gibbs GW 2000. Species richness of indigenous beetles in restored plant communities on Matiu-Somes Island, Wellington Harbour, New Zealand. New Zealand Journal of Ecology 24: 195-200.

Zealandia 2019 Website. https://www.visitzealandia.com/