Baseline lizard survey and lizard habitat identification on Mamaku Point Conservation Reserve

By Daron Titus

Bachelor of Environmental Management (2022)

2019008222

Mamaku Point
CONSERVATION RESERVE

Wildlands

Contents

Acknowledgement

I would like to express my sincerest gratitude to Roy and Rachel Thompson for giving me this opportunity to do my research on Mamaku Point Conservation Reserve. I would like to thank Trent Bell from Wildlands Consultants for guiding me throughout field work. His expert opinions and his knowledge on New Zealand reptiles helped me throughout my study. The collaboration with Wildlands Consultants removed certain limitations so I was able to work with Nationally protected reptiles. I appreciate Ernie Mason and Antony Simpson for their hospitality and their support throughout fieldwork.

I would like to express my sincere gratitude to the Environmental Management faculty especially Anna Palliser, Jordon Traill, Christine Liang and Claudia Gonnelli for guiding me throughout my study. Special mention to my supervisors Anna and Jordon for their support and their constructive feedback. I really appreciate Anna for joining me to scope out MPCR before my field work and Jordon for sharing relevant literature with me.

I would like to thank my family for their continuous moral support and encouragement throughout my tertiary education.

And finally, I would like to thank Kathleen Lalor for her work on Mamaku Point, from which my research question was developed.

Abstract

Mamaku Point Conservation Reserve (MPCR) is nationally recognized for its intrinsic values and outstanding biodiversity. Recent studies identified the conservation potential of the reserve and opened a range of opportunities for scientific knowledge. The 2019 Restoration Plan confirmed the presence of skinks in the reserve; however, their diversity remained a question. This study aimed to answer this question by conducting a baseline lizard survey. The survey encompassed systematic approaches where different techniques were used for lizards belonging to different genera. Hand and visual survey, artificial retreats and spotlighting techniques were adopted. A brief habitat identification was conducted prior to practicing the selected methods. Forty-nine gee minnow traps were installed across northern MPCR targeting terrestrial and saxicoline lizards. Spotlighting was practiced on selected areas targeting arboreal and semi-arboreal geckos. The survey identified a healthy population of Tussock skinks (*Oligosoma chionochloescens*), of which twenty-one specimens were captured from the installed traps and seven individuals were visually observed. Spotlighting yielded zero observations. The survey identified Tussock skinks as sole lizard fauna of MPCR. However, more species were likely present in the area before human colonization. Referring to previous studies on the ecology of New Zealand lizards, potential habitats were identified for lizard translocation programs. The presence of Polynesian rat (*Rattus exulans*) threatens the welfare of the existing skinks and the activities involved in the Restoration Plan 2021- 2030 put forward by the Mamaku Trust. To enhance biodiversity, MPCR aims to be predator free within 2030. With the possible future predator free status, MPCR can be a sanctuary for native lizards at risk.

Chapter 1. Proposal

1.1 Introduction

The Mamaku Point Conservation Reserve (MPCR) is located 4km north-west of Oban township on the north-eastern coastline of Stewart Island (Stowe, 2019, p. 1). The reserve is nationally recognized for its aesthetic values and biodiversity (Stowe, 2019, p. 1). MPCR is managed by the Mamaku Trust established in 2017 (Stowe, 2019, p. 1). Their main objective is to preserve and enhance the biodiversity of the reserve while making it accessible for the public to promote conservation values, environmental education, and ecotourism (Stowe, 2019, p. 1).

The vegetation of MPCR comprises of eight district plant communities, and their distribution was influence by the past anthropogenic disturbances, climatic conditions, and the coastal influences (Stowe, 2019, p. 37). Stowe (2019) classified the reserve into seven distinguished habitats, which contains a range of nationally protected native flora and fauna.

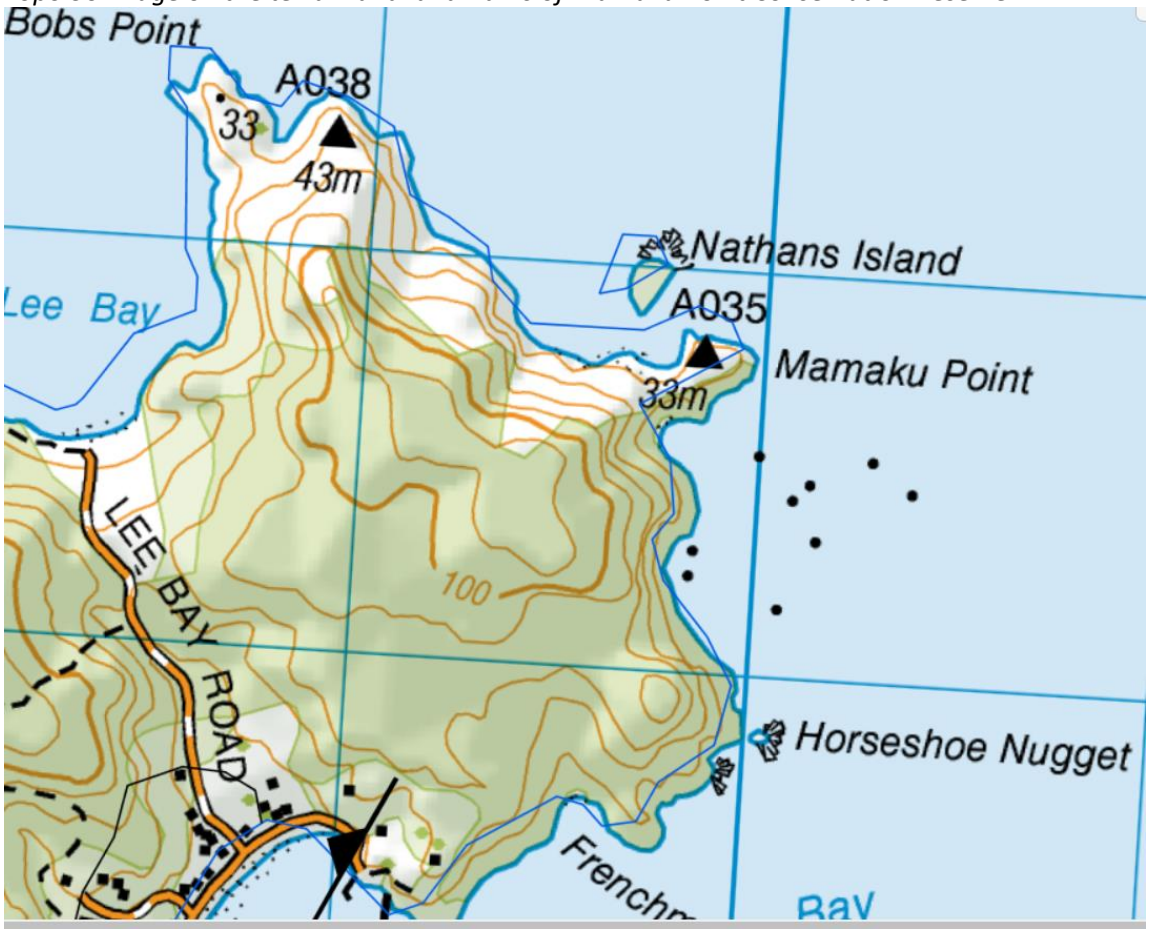
The reserve is enclosed by a predator proof fence which extends up to 2.1 km (Ritchie, 2018, p. 14). The fence was installed by the Dancing star foundation (previous owners) in 2005 and predator control has been conducted since (Stowe, 2019, p. 1). An extensive biosecurity grid maintained both inside and outside the predator-proof fence are remotely monitored using VHF (Very High Frequency), cellular and satellite communications to detect any biosecurity breaches (Ritchie, 2018, p. 14). Active predator control measures are practiced inside the reserve in case of a biosecurity breach (Ritchie, 2018, p. 14).

Mamaku Trust has released a 10- year Restoration Plan (2021- 2030) to enhance the conservation potential and the biodiversity of the reserve (Newell & Stowe, 2020). This was made possible through funds attained by the trust from the One Billion Tree programme and the World Wild Fund (WWF) (Newell & Stowe, 2020), which opened a wide range of opportunities for scientific knowledge in the reserve.

A 2019 skink survey confirmed the presence of lizards in the reserve, where 22 healthy Tussock skinks (*Oligosoma chionochloescens*) were caught, confirming the presence of lizards in MPCR. Lalor's (2019) skink survey raised the question on the possible existence of other lizards in the reserve. Thus, this research aimed to survey the lizard diversity of the reserve to identify the possible existence of lizard species.

Figure 1.

Topo 50 image on the terrain and landmarks of Mamaku Point Conservation Reserve.



Note. Topo map of MPCR. From *NZ topo maps*, by LINZ, 2022. (https://www.topomap.co.nz/NZTopoMap?v=2&ll=-46.868914,168.119874&z=14).

1.2 Rationale

Since the conformation of skinks, there have been an increased interest to find the different lizards that occupy MPCR. This study was focused to identify diversity and habitat preferences of Stewart Island lizards that are likely present in the reserve, which was made possible by conducting a baseline lizard survey across MPCR. This study filled the three-year gap in scientific knowledge on lizards in MPCR, by providing scientific data on the resident lizard population and demography and the potential habitats, creating new opportunities for conservation, restoration, and translocation.

1.3 Aim

The study aims to conduct a baseline lizard survey to identify the species that occupy Mamaku Point Conservation Reserve.

1.4 Objectives

- To conduct a survey on lizard biodiversity on MPCR.
- To identify the habitats of the targeted species.
- To briefly identify the potential areas where lizards could be translocated in the future.
- To briefly identify the potential risks factors that threaten the survival of the existing skinks and future lizard translocations.

1.5 Methodology

The site was visited over the summer of 2022. Former studies on MPCR were used to attain an overview of the reserve's dynamics. New Zealand lizards are cryptic, so an integrated systematic approach was used to actively survey them.

1. Systematic approach involved the following methods:

a) **Funnel trapping**: Gee minnow traps was installed on potential lizard habitats after scouting the terrain.

- The trapped individuals were be handled, identified, measured.
- Specimens were photographed using a Digital SLR.

b) **Spotlighting**: Spotlighting was conducted along the selected traplines in search of nocturnal geckos.

- The practice was conducted between hours 23:00 and 2:00.
- The spotlighted geckos would be captured, identified, measured and photographed.

c) **Hand and visual survey**: Hand and visual survey were conducted across MPCR.

- Wild lizard encounters were marked using a GPS for further documentation

2. **Habitat and microhabitat identification**: The potential habitats and microhabitats were identified before implementing the integrated systematic search.

- The habitats of the eight Stewart Island lizards were recognised in the reserve.
- This practice aided in getting better chances of lizard encounters.

- Vegetations were grouped based on the dominant species.
- Service providing flora were identified.

3. **Management practices**: Management practices were suggested to promote the welfare of the existing Tussock skinks and future translocation candidates.

- Risk involved in the translocation was discussed.
- Pest management practices was suggested,

4. **Health and safety**: Health and safety will be prioritised during field work.

- The health and safety guidelines of Southern Institute of Technology and Mamaku Point Conservation Reserve was followed.
- Climatic hazards will be considered and appreciate gears were carried during fieldwork.
- GPS, compass and a map of MPCR was carried during field work.
- The areas of the reserve that poses potential risks were avoided.
- The lizards were handled under the supervision of an expert herpetologist.
- Environmental impacts were kept to a minimum.

1.6 Data analysis

The data collected from the field were analysed using Microsoft Excel, Google Earth Pro, and Garmin base camp applications to illustrate lizard diversity, range, habitat, size and demography.

The following data were collected to interlink the above-mentioned aspects:

- Lizard taxa.
- Measurements in millimetres (SVL, tail break, and tail length).
- Sex.
- Demographic ratios.
- Vegetative groupings.
- Co- ordinates of the encountered lizard.
- Photographs.

1.7 Timeframe and budget

The collaborative survey was centred on the funding allocated to Mamaku Trust by World Wildlife Fund (WWF). The scientific data was collected from 16th to the 22nd of January 2022. The travel expenses and accommodation of the was funded by the Mamaku Trust.

1.8 Health and safety

The dangers involved in outdoor data collection were recognised prior to visiting the study site. Health and safety measure were prioritised throughout field work. Appropriate gears (both personal and research) were carried to the field, anticipating the unpredictable weather of Stewart Island. The guidelines mentioned in the health and safety documents of Southern Institute of Technology (SIT) and MPCR were read, acknowledged, and followed throughout fieldwork.

1.8 Ethics

Ethical consideration is critical for scientific research. This study involved both archival and field aspects, so ethical factors surrounding both criterium were considered. The archival section of the study gathered information from various peer reviewed literatures, which have been cited and referenced throughout this thesis. The data collection included the interaction with protected wildlife in a nationally recognized environment, so all the ethical factors that surrounds criterion was addressed. The collaborative research involved an experienced herpetologist who holds a Wildlife Permit, which made the interaction with protected lizards were ethically acceptable.

Mamaku Trust notified the presence of native saplings prior to field data collection, so caution was taken to avoid any harm to the native regenerating flora. Environmental impacts were kept to a minimum as caution were taken not to harm any native flora and fauna. After data collection all the study materials used were removed from the site.

Ethical guideline issued by Southern Institute of Technology were recognized and followed throughout data collection.

1.9 Limitations and delimitations

Identifying the limitations and delimitations of a study can yield in a focused approach on data collection. Potential limitations for this study include undesirable weather, which could halt the data collection or can lead to undesirable outcomes. Other limitations were the lack of time and the

unpredictable weather of Stewart Island which affected the extent to which the adopted methods were scheduled to be practiced. Since the research was conducted in collaboration with Wildlands consultants, majority of the limitations involved with animal welfare were removed. The delimitation of the study included the exclusion of detailed descriptions on the geology, geography, and the vegetation of MPCR, as they have been explained in previous literatures.

Chapter 2. Literature review

2.1 Introduction

New Zealand reptile are extraordinary compared to their tropical counterparts. They were subjected to evolve under isolation as the landmass was separated from Gondwana around 80 million years before present (Nielsen et al, 2011, p. 1). New Zealand harbours both Diplodactylid geckos and Lygosomine skinks, which represents high levels of endemism (Pickard & Towns, 1988, p. 3). Both native skinks and geckos have radiated into all available habitat type offered by the land (Nielsen et al, 2011, p. 1). Due to their crypticity the diversity of both these reptile families are underestimated with the current New Zealand reptile taxonomic classifications (especially geckos) (Nielsen et al, 2011, p. 1).

2.2 Brief history of endemic skink taxonomy

Endemic *Oligosoma* skinks share common ancestry with the New Caledonian species as they are believed to be colonized from New Caledonia (Chapple et al, 2009, p. 472). There was no land connection between New Caledonia and New Zealand till the Oligocene Epoch but during the early-late Miocene Epoch (10–20 million years ago) the two land masses were connected by a chain of islands- Lord Howe Rise and Norfolk Ridge (Chapple et al, 2009, p. 472). It is hypothesized that they were successfully dispersed through water over the contemporary timescales (Chapple et al, 2009, p. 472).

McCann (1995) prepared the modern taxonomic revision of the New Zealand skinks which resolved decades of confusion on their taxonomy and synonymy (Chapple et al, 2009, p. 473). In the modern revision of endemic skinks thirty- five species are described belonging to the two genera, *Cyclodina* and *Oligosoma* (Chapple et al, 2009, p. 473). Recent studies have discarded the genus *Cyclodina*, and all the endemic skinks were collectively integrated into the genus *Oligosoma* (56 species) (Bell, 2014, p. 8- 9). In addition, undescribed *Oligosoma* skinks are being discovered in remote areas of the country and it is believed that their numbers are likely to increase in the future (Chapple et al, 2009, p. 473).

2.3 Brief history of endemic gecko taxonomy

Kluge (1967) proposed the idea that 'Asian geckos dispersed overwater to Australia, then island-hopped to New Caledonia before eventually reaching New Zealand in the Miocene Epoch' (Nielsen et al, 2011, p. 2). Fossil evidence from Otago region confirmed the Diplodactylids geckos were present in New Zealand by Miocene (Nielsen et al, 2011, p. 2). The origin of New Zealand geckos is

unclear, it has been hypnotized that endemic gecko might be of Gondwana origin or a result of the recent dispersal event (Nielsen et al, 2011, p. 2).

McCann (1955) divided the endemic geckos into two genera, the *Hoplodactylus* and *Naultinus* (Nielsen et al, 2011, p. 2). Recent studies on the cryptic gecko diversity using allozyme, and preliminary mitochondrial DNA sequence data have classified geckos into seven genera- *Dactylocnemis* (6 species), *Hoplodactylus* (2 species), *Mokopirirakau* (10 species), *Naultinus* (9 species), *Toropuku* (2 species), *Tukutuku* (1 specie) and *Woodworthia* (11 species) (Bell, 2014, p. 8-9).

2.4 Stewart Island Lizard taxa

Eight lizards are known to occupy the diverse habitats of Stewart Island. It is believed that these species were present in the area encompassing MPCR before human colonisation. The eight recognised Stewart Islands are:

- Harlequin Gecko (*Tukutuku rakiurae*).
- Cloudy Gecko (*Mokopirirakau nebulosus*).
- Kōrero Gecko (*Woodworthia* sp.).
- Jewelled Gecko (Foveaux form) (*Naultinus* sp.).
- Tussock Skink (*Oligosoma chionochloescens*).
- Green Skink (Stewart Island form) (*Oligosoma chloronoton*).
- Small- eared Skink (*Oligosoma stenotis*).
- Southern Skink (*Oligosoma notosaurus*).

This chapter will provide a brief species descriptions and ecology and habitat preferences of the above-mentioned lizards.

2.4.1 Harlequin Gecko (*Tukutuku rakiurae*)

Figure 2
An image of Harlequin Gecko.

Note. Harlequin gecko resting on a mossy bed. From *New Zealand Herpetological Society*, by T. Jewell, n.d. (https://www.reptiles.org.nz/herpetofauna/native/tukutuku-rakiurae).

Harlequin Gecko are renowned for their striking colour patterns (Jewell, 2011, p. 20). These geckos have herringbone patterns with networks off white and grey lines with brown, olive or bright green coloration on their dorsal surface (Jewell, 2011, p. 20). These geckos have a Snout-vent length (SVL) of 55 to 71 mm and their tail length are equal or smaller than their SVL (Jewell, 2011, p. 20). They are commonly found in the mainland south of Peterson Inlet (Jewell, 2011, p. 20). Harlequin geckos occupy wetlands, shrublands and herb lands ranging from the coastal to the subalpine conditions (Jewell, 2011, p. 20). They live on the ground along sedges and dense foliage particularly on Tangle Ferns (*Gleichenia microphylla*) and Manuka (*Leptospermum scoparium*) (Jewell, 2011, p. 20). They breed once in two or three years often producing off springs between late summer and autumn (Jewell, 2011, p. 20).

2.4.2 Cloudy Gecko (*Mokopirirakau nebulosus*)

Figure 3.
An image of a Cloudy Gecko.

Note. An image of a Cloudy Gecko on mossy rock. From. *New Zealand Herpetological Society*, by J. Reardon, n.d. (https://www.reptiles.org.nz/herpetofauna/native/mokopirirakau-nebulosus).

Cloudy Gecko was first described in the 1955 and they first taught to be a type of forest gecko (Jewell, 2011, p. 41). Very little is known about their ecology and natural history (Jewell, 2011, p. 41). These geckos have 'W' shaped dorsal pattern with olive- grey to dark pinkish or olive-green colorations (Jewell, 2011, p. 41). They have a SVL of 75 to 80mm and tail lengths are equal or shorter than the SVL (Jewell, 2011, p. 41). These geckos occupy forests and shrub lands with cold wet climate (Jewell, 2011, p. 41). They are largely nocturnal can have been observed from the coast up to 500m above sea level (Jewell, 2011, p. 41).

2.4.3 Kōrero Gecko (*Woodworthia sp.*)

Figure 4.
An image of Kōrero gecko gecko.

Note. An image of a Kōrero Gecko on a rock. From *New Zealand Herpetological Society*, by, S. Purdie, n.d., (https://www.reptiles.org.nz/herpetofauna/native/woodworthia-otagosouthland-large#:~:text=K%C5%8Drero%20geckos%20are%20terrestrial%2Farboreal,(hence%20their%20colloquial%20name)).

Kōrero Gecko are one of the most widespread species found in Southern New Zealand (Jewell, 2011, p. 62). These geckos occurring in three geographical races (Jewell, 2011, p. 62). Kōrero geckos are found in hardwood forest and rocky grass lands and can occupy areas 1300m above sea level (Jewell, 2011, p. 62). They are primarily nocturnal with both terrestrial and arboreal characteristics (Jewell, 2011, p. 62). They breed once a year at low altitude and biennially at high altitude (Jewell, 2011, p. 62). The southern form of Kōrero gecko is dark brown or grey- brown in colour with a drab paler or blotch dorsal patterns (Jewell, 2011, p. 64). The southern form is described to have a SVL of 75 to 80mm (Jewell, 2011, p. 64).

2.4.4 Jewelled Gecko (foveaux form) (*Naultinus gemmeus*)

Figure 5.
An image of a Jewelled Gecko.

Note. Jewelled Gecko on a native flora. From *New Zealand Herpetological Society*, by C. Knox, n.d. (https://www.reptiles.org.nz/herpetofauna/native/naultinus-gemmeus).

Very little is known about the Foveaux form of this species. This variant is described to have uniform green coloration on their dorsal surface (Jewell, 2011, p. 30). They have a SVL of 70 to 80mm and tail equal to its SVL (Jewell, 2011, p. 30). A very old museum specimen is labelled to be from Stewart Island (Jewell, 2011, p. 30).

2.4.5 Tussock Skink (*Oligosoma chionochloescens*)

Figure 6.
An image of a Tussock Skink.

Note. Tussock Skink on plant debris, from *Flickr*, by T. Jewell, n.d. (https://www.flickr.com/photos/rocknvole/12986651694/in/photostream/).

Previously calssified as *Oligosoma aff. polychroma Clade* 5, Tussock skinks are moderately small skink with SVL of 65-72 mm (Jewell, 2022, p. 12). Their dorsal surface is golden brown with dark longitudinal streaks running from head to tail (Jewell, 2022, p. 12). Tussock skinks are usually found in both native and exotic grasslands (Jewell, 2022, p. 12). Tussock skinks occupy a range of habitats like rocky or woody covers, wetlands, herb land, shrubland, and stony shorelines (Jewell, 2022, p. 12). They have been observed in areas 1800 m above sea level (Jewell, 2022, p. 12). These skinks reproduce annually resulting in three to six off springs (Jewell, 2022, p. 12).

2.4.6 Rakiura Green Skink (*Oligosoma chloronoton*)

Figure 7.
An image of a Green Skink.

Note. *Green Skink on a on dry herbs*. From *New Zealand Herpetological society*, by C. Wedding, n.d. (https://www.reptiles.org.nz/herpetofauna/native/oligosoma-chloronoton#:~:text=Ecology%20and%20habitat&text=Southland%20green%20skinks%20rarely%20climb,skink%20are%20surprisingly%20quick%20(pers.)).

Green skinks have three geographical variants. Rakiura form is described have darker features compared to the other forms (Jewell, 2011, p. 77). They have larger scale with a crescent shaped green or brown patch giving it a unique appearance compared to the other variants (Jewell, 2011, p. 77). They often have SVL of 125mm with a robust build (Jewell, 2011, p. 77). Green skins inhabit dance vegetations and rock piles (Jewell, 2011, p. 77). These species occupy Tussock grass lands, shrubs, herb fields, and wetlands (Jewell, 2011, p. 76). One to four young ones are produced in a litter between February and March (Jewell, 2011, p. 76).

2.4.7 Small- eared Skink (*Oligosoma stenotis*)

Figure 8
An image of a Small- eared Skink.

Note. An image of Small eared Skink in mossy substrate. From *New Zealand Herpetological Society*, by C. Stonyer, n.d. (https://www.reptiles.org.nz/herpetofauna/native/oligosoma-stenotis#:~:text=Description,its%20relatively%20small%20ear%20openings.).

An alpine skink found in the southernmost part of New Zealand (Jewell, 2011, p. 86). Dorsal surface of these skinks are brown to green in colour with a black mid dorsal stripe which break abruptly on their tail (Jewell, 2011, p. 86). Black stripes run along the dorsal edges of these skinks (Jewell, 2011, p. 86). The Small eared skinks have a SVL of 52 to 75mm (Jewell, 2011, p. 86). Like the name suggests these skinks have very small ear openings (Jewell, 2011, p. 86). They are typically found in alpine grasslands, and herb fields, found typically among granite slabs and shrubby vegetation (Jewell, 2011, p. 86). In Rakiura, they are found above the tree line at 480 to 960m (Jewell, 2011, p. 86). They breed annually producing two to four young ones in a litter between November to January (Jewell, 2011, p. 86).

2.4.8 Southern Skink (*Oligosoma notosaurus*)

Figure 9.
An image of a Southern Skink.

Note. Southern Skink on woody shrubs. From *New Zealand Herpetological Society*, by C. Middleton, n.d. (https://www.reptiles.org.nz/herpetofauna/native/oligosoma-notosaurus#:~:text=The%20Southern%20skink%20is%20endemic,species%20observed%20in%20the%20area.).

Southern skinks are commonly observed in Stewart Island (Jewell, 2011, p. 87). Their dorsal surface is chestnut brown to blackish brown in colour with a dark brown mid dorsal stripe that breaks on the tail (Jewell, 2011, p. 87). These skinks have a SVL of 76mm (Jewell, 2011, p. 87). Southern skinks are only found in Rakiura and its outliers (Jewell, 2011, p. 87). They occupy sand dunes, grasslands, herb fields, wetlands, rocky areas, shrubs, and clearings within forest (Jewell, 2011, p. 87). Females breed annually producing one to four in each litter between January and March (Jewell, 2011, p. 87).

2.5 Review on systematic search

Systematic searches are commonly used to survey New Zealand's herpetofauna (Hare, 2012, p. 2). The methods involved in this approach are used to produce scientific data on distribution, inventory, relative abundance, density estimates, population trends, site occupancy and territory mapping for a herpetofauna in general (Hare, 2012, p. 2).

2.5.1 Hand and visual survey

Hand and visual survey often result in the sightings of the lizard or evidence of their presence in areas (like faeces, slough, and vocalization) (Hare, 2012, p. 2). These methods are species dependent are often practiced in open habitats (e.g., shrub lands) (Hare, 2012, p. 2).

2.5.1.1 Case studies example of Hand and visual survey.

A 1991 study used systematic searches to assess the distribution of Small-scaled Skink (*Oligosoma microlepis*) near Springvale Bridge (Hare, 2012, p. 10). Scientific data on the species were non-existent prior to the study (Hare, 2012, p. 10). The survey method encompassed the familiarisation with the species, determining preferred habitat and assessing distribution and status of small-scaled skinks within the 150 000-ha study area (Hare, 2012, p. 10). A full suite of systematic search techniques was used, including hand and visual searches (Hare, 2012, p. 10). To identify the habitat preferences of Small-scaled Skink, Whitaker (1991) assessed all the potential habitats around the study site (Hare, 2012, p. 10). Whitaker's (1991) accounted scat samples based on their amount (none, few and lots) (Hare, 2012, p. 11). Features like altitude, lithology, vegetation cover, and flora were recorded to identify the skinks' habitat preferences. Potential habitats were slowly approached and visually examined (Hare, 2012, p. 11). If no observations were made visually, hand searches were made in these areas for lizard sign (faeces and slough) (Hare, 2012, p. 11). The study identified Small-scaled Skink as saxicolous as they were only found on rocky sites like boulders, talus slopes, scree and rock falls (Hare, 2012, p. 11).

2.5.2 Artificial retreats- Funnel traps

All funnel traps consist of a cylinder with an inverted funnel in either one (Hare, 2012, p. 2). The methods work when the targeted lizards climb through a narrow opening of the trap and not being able to find their way out (Hare, 2012, p. 2). These artificial retreats are commonly used for trapping terrestrial lizards especially *Oligosoma* skinks (Hare, 2012, p. 2).

2.5.2.1 Case studies example of Funnel traps

To find the population estimate of Small-scaled Skink (*Oligosoma microlepis*) near the Springvale Bridge in the Rangitikei River region, Gebauer (2009) conducted trapping sessions using funnel traps

on the selected study areas. Funnel traps were installed on two sites based on their skink densities (Gebauer, 2009, p. 10). The sessions conducted on two Quarry sites (area with high skink density) resulted with thirteen trapped specimens, and the sessions on the Hut sites (area with low skink density) resulted with three specimens (Gebauer, 2009, p. 15). These successful trapping sessions helped to estimate the population of Small-scaled skinks in the Gebauer's study sites which provided new scientific data on their local population and distribution.

2.5.3 Spotlighting

Spotlighting is a standard technique used for surveying reptiles and amphibians (Corban & Fellers, 2001, p. 89). In New Zealand, this technique is largely used for surveying nocturnal geckos and are often coupled with radio tracking (Schlesselmann, 2014, p. 4). The principle of this method is when geckos are spotlighted, their immediate response is to remain stationary. Other factors that influence this method are the eye reflections produced by the geckos' retina when the source light hits them at an angle of incidence (Sherley, 1989., p. 2). Furthermore, the dorsal surface and pale stomach of geckos are easily distinguished from the surrounding vegetation when they are spotlighted (Corban & Fellers, 2001, p. 89). Hare (2012) states that the technique is helpful especially for locating nocturnal geckos as they produce a bigger reflection with a pink to white eye shine than diurnal geckos (Hare, 2012, p. 21).

Figure 10
Spotlighted image of Ngahere Gecko.

Note. A spotlighted image of Ngahere Gecko. From *Wildlands consultants Ltd,* by T. Bell. 2020.

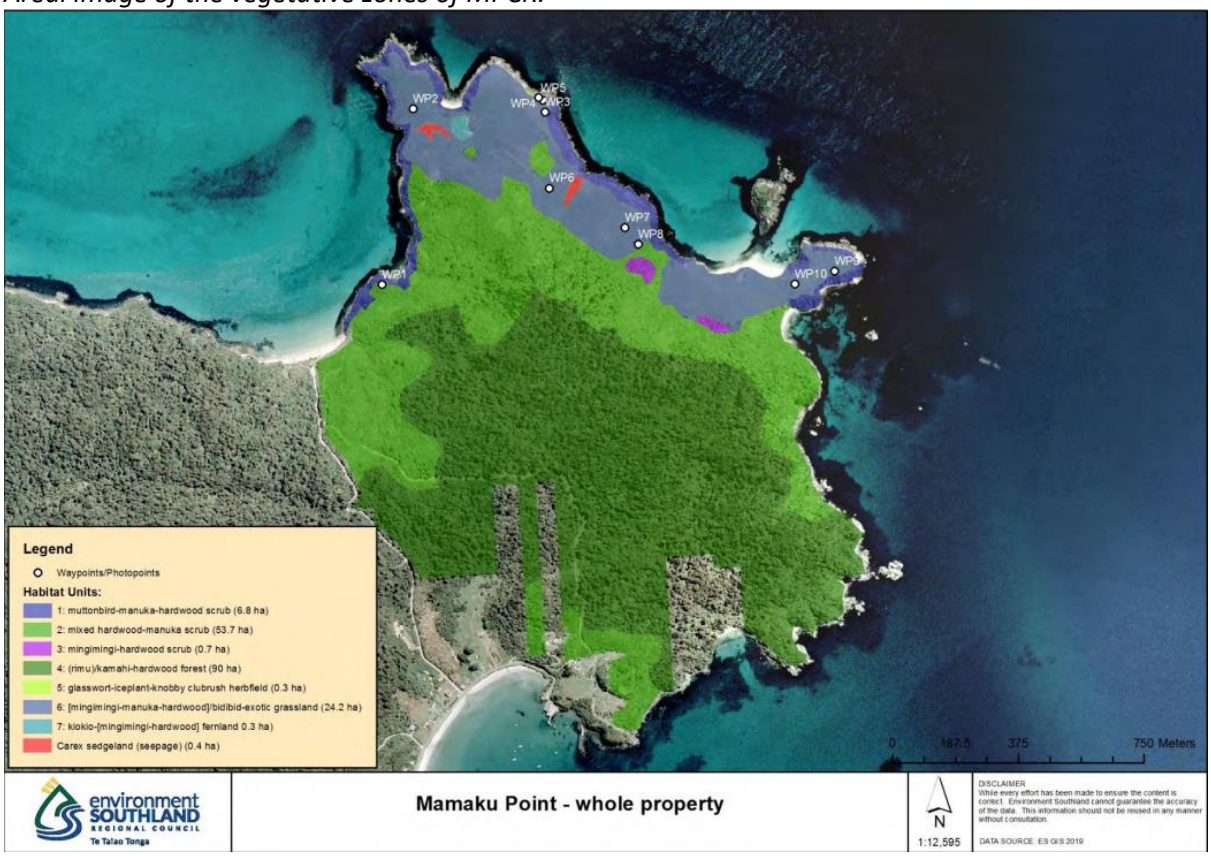
Note: 'Often the most common methods (spotlighting) are not included within recent published journal articles as word- and page-counts are limited by publishers and funding' (Hare, 2012, p. 16).

Chapter 3. Methodologies for Baseline lizard survey

3. 1 Description of Mamaku Point Conservation Reserve

Stowe 2019 classified MPCR into seven ecosystems with eight distinct plant types (Stowe, 2019, p. 5). These ecosystems contain approximately 130 native florae (Stowe, 2019, p. 5). The 2019 High Value Area ecological assessment surveyed coastal section of the reserve (above high tide line) to identify the vegetation, these areas were dominant with herb fields, grasslands, sedgelands, and shrublands (Stowe, 2019, p. 5). Although a detailed vegetation survey was not conducted on the forest (away from the coastline), Stowe (2019) managed to identify the dominant species in that area and classified them as an individual ecosystem (Stowe, 2019, p. 5).

Figure 11
Areal image of the vegetative zones of MPCR.



Note. Vegetative classification of MPCR. From *Hight value areas Ecological assessment report Mamaku Point*, by C. Stowe, 2019. (https://static1.squarespace.com/static/598a394c46c3c4323c816d0b/t/5e48a2c73be8c0066dc60530/1581818641526/Chris+Stowe+HVA+Ecological+Assessment.pdf).

As shown in figure 10, the reserve is dominant with woody scrubs like Manuka (*Leptospermum scoparium*), Mutton-bird scrub (*Olearia lyallii*), Mingimingi (*Coprosma propinqua*), Kamahi (*Weinmannia racemose*), Rimu (*Dacrydium cupressinum*) and other hardwood trees (Stowe, 2019, p. 6). Vegetation and geological setting of MPCR provides favourable conditions for Stewart Island lizards, based on the species and ecological description provided in section 2.4.

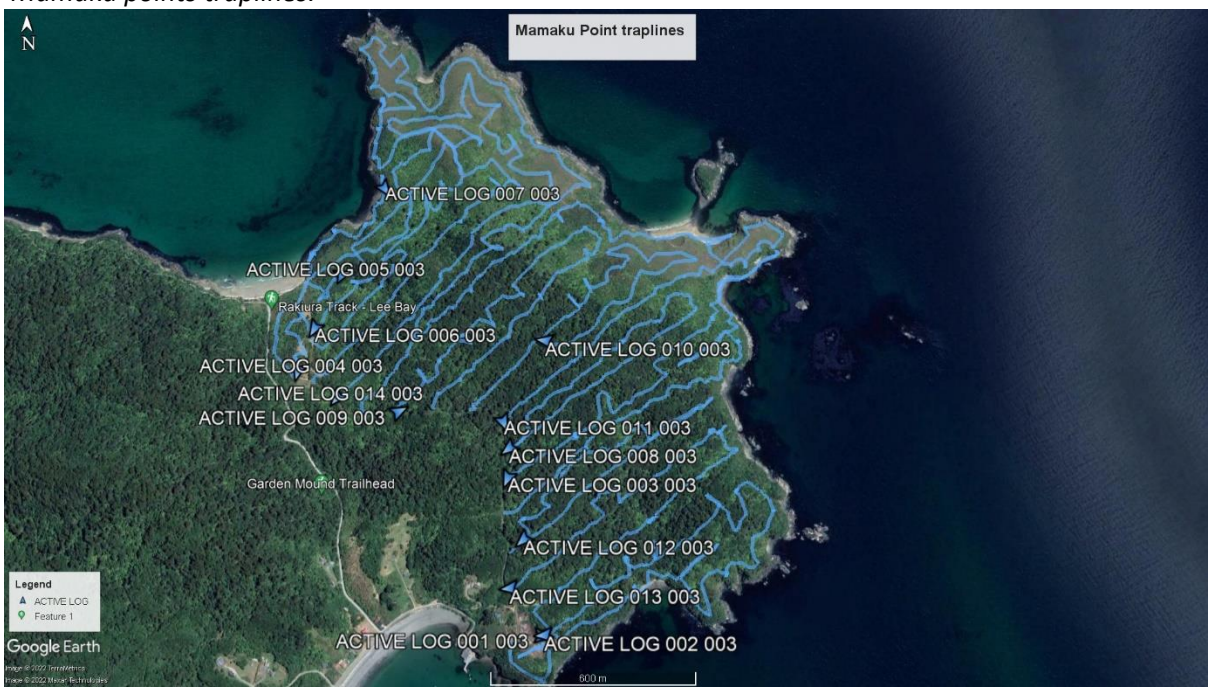
3.2 Habitat assessment

A brief habitat assessment was conducted on northern MPCR. The assessment was builds on the Stowe's (2019) HVA report and Lalor's (2019) Restoration Plan. The open habitats of Northern MPCR were subdivided into categories based on its dominant vegetations and lizard habitat potentials.

3.3 Systematic Search

Systematic searches were conducted using visual survey, hand search, funnel traps (Gee minnow) and spotlighting.

Figure 12
Mamaku points traplines.



The targeted species for the survey include:

- Cloudy Gecko (*Mokopirirakau nebulosus*).
- Kōrero Gecko (Southern Form) (*Woodworthia. Spp*).
- Jewelled Gecko (Foveaux form) (*Naultinus* sp.).

- Tussock Skink (*Oligosoma chionochloescens*)
- Green Skink (Rakiura form) (*Oligosoma chloronoton*).
- Small- eared Skink (*Oligosoma stenotis*).
- Southern Skink (*Oligosoma notosaurus*).

Note: Harlequin geckos were not targeted for the survey as they are only found on the southern parts of Paterson Inlet which is located outside the study range.

3.3.1 Visual survey and hand searching

Visual surveys and hand searching techniques were used throughout the survey. Potential habitats and microhabitats were identified and carefully searched to find lizards or signs of their presence. Hand searches were used on woody shrubs (e.g., Manuka and Mingimingi), tree barks, black tree ferns/Mamaku (*Cyathea medullaris*) and on plutonic outcrops. This approach was dependent on movements and sounds made by the species, which provided insight on their presence. Native lizards are incredibly cryptic and are hard to spot in the wild. In such cases artificial retreats are used to capture them (Lettink & Monks, 2016, p. 19).

3.3.2 Live capture trapping

Figure 13
Stacked gee minnow traps stacked.

49 Funnel Traps (gee minnow traps) were installed across northern MPCR, targeting terrestrial and saxicoline lizards. These funnel traps were baited with sliced pears. A sponge soaked in water was kept in each trap to prevent dehydration by the trapped individuals. Substrates were added to the traps, to blend it with the surrounding vegetation. The microhabitats were identified, and traps were kept accordingly. Traps were marked with flag taps and their placements (waypoints) were recorded using a GPS.

Figure 14
Image of an installed gee minnow tarp.

Tussock Skink, Southern Skink, Small- eared Skink, and Rakiura Green Skink were the species likely to be encountered in these funnel traps. The trapped specimens were handled to identify their species, sex, maturity, SVL, tail length and tail break.

3.3.3 Spotlighting

Spotlighting was adopted for surveying nocturnal geckos. A headlamp with approximately 2000 lumens and a binoculars were used for this method. The Rimu- Kamahi hardwood forest was identified as an ideal habitat for arboreal and semi arboreal geckos based on the ecological descriptions provided in Chapter 2 (section 2.4). Due to the limited timeframe, the method was restricted to some parts of the reserve.

The method was practiced by walking along a selected predetermined path with a head lamps and binoculars, searching of the nocturnal geckos. Hand searches were used in hardwood bushes, tree ferns, in between tree trunks and other spots where geckos were likely to be present. Encountered geckos would be captured and brought back to the main camp for identification. The specimen would be photographed and measured. After the required data was collection, the captured specimen will be released back to the place of encounter.

3.4 Data collection and organization

The following data will be recorded when lizards are found:

- Date.
- Location.
- Time starts.
- Time finish.
- Coordinates (waypoints).
- Species.
- Sex.
- Snout-vent length (mm).
- Tail break (mm).
- Tail length (mm).
- Pregnancy.
- Habitats and microhabitats.
- Surrounding vegetation.

3.5 Data Analysis

The habitat subdivisions of northern MPCR were plotted using Google Earth Pro. With the collected data, a size distribution graph and a demography chart were made using Microsoft Excel. The collected data were linked to discuss the intricate relations of lizards with their habitats in the coming chapters.

Chapter 4. Data analysis

4.1 Overview

The survey was conducted from the 16th to the 22nd of January 2022. A brief habitat assessment was conducted focusing on the structural flora that defined the sub habitats of Northern MPCR. During this period 21 Tussock skinks were trapped, and some were encountered in the wild. Trapline 14 and the path along the predator proof fence line were spotlighted on two separate occasions, but no were observed. Climatic conditions like rainfall and cold temperatures limited the extent to which spotlighting was practiced. The data collected was structured and analysed using Microsoft Excel, Garmin Base camp and Google Earth Pro.

4.2 Lizard habitat identification and assessment

To practice the adopted survey techniques, a brief habitat assessment and lizard habitat identification were conducted based on the species ecology by Jewell (2011) and the vegetative distribution provided by Stowe (2019) and Lalor (2019). After scouting the property on 16/01/2022, it was understood that the northern part of the reserve had the best probability of housing native terrestrial and saxicoline lizards. The dense native forest was identified to feasibly house arboreal geckos. Artificial retreats, spotlighting and visual and hand surveys were put to practice accordingly.

For this research three out of the seven habitat units described by Stove (2019) were selected mainly the Manuka Mingimingi shrub lands, Muttonbird Manuka shrublands and the hardwood Kamahi Forest (figure 11). The shrubland classified by Stowe (2019) were subdivided into smaller habitats zones according to the habitat descriptions of the targeted species (section 3.3) to aid in trap placements.

The following are the identified sub habitats of Norther MPCR:

1. Flax land
2. Tussock grassland
3. Manuka coprosma shrubland
4. Native and exotic herb lands

Some of these habitat subdivisions showed a patchy distribution (as they were confined in a certain space) while others were spread throughout the open habitats.

Figure 15
Habitat subdivisions of northern MPCR.

4.2.1 Flax fields

The flax fields were observed on areas of relatively low elevation compared to the other vegetative complexes. They appeared to be growing in patchy clusters, restricted to some parts of the reserve. Two main flax fields were observed during the survey can be characterized as dense and compact. This habitat was identified and selected primarily to trap Rakiura green skinks. The observed flax fields mimicked some characteristics of a wetland system (like hydrated soil, lush hydrophilic plants and moisture content). These habitats were rich with invertebrates (spiders, flies, bees, etc.) and flax fruits.

The two flax lands observed in the survey were named as ‘Flax land 1’ and ‘Flax land 2’ to better illustrate the data. Traps 1140, 1141, 1142, 1143, and 1144 were placed in the flax land 1 and traps 1126, 1100, and 1125 were placed on Flax land 2. All the eight traps were placed mainly targeting Rakiura green skinks.

4.2.2 Tussock grasslands

Tussock grasslands were mainly observed on the areas of high elevation near the coastline. During the survey two dense Tussock grasslands were observed but small patches were spread on elevated areas of the reserve. These sub habitats bore exposed granite and gabbro outcrops. And lichens and moss that covered these plutonic rocks made it ideal habitat for saxicoline lizards.

The habitat was divided into three ‘Tussock grassland 1’, ‘Tussock grassland 2’ and ‘Tussock grassland 3’ and a total of thirteen traps were placed in these grass lands. Tussock grassland 1 had traps 1090, 1131, 1132, 1133, 1134 and 1135. Tussock grassland 2 had traps 1087, 1136 and 1137. Tussock grassland 3 had traps 1038, 1082, 1083, and 1139. These traps were placed targeting Tussock skinks, Small eared skinks, Southern skinks, Cloudy geckos and Kōrero geckos.

4.2.3 Manuka and Coprosma shrublands

Manuka and Mingimingi were the dominant shrubs found during the survey. They were seen all over northern MPCR. The shrubs were characterized as woody, entangled and compact. These fruit and flower bearing shrubs attracted various native faunas like birds, lizards and invertebrates. Their distribution was unique compared to the other plant complexes as they were scattered throughout the reserve.

Other native shrubs like leatherwood (*Olearia colensoi*), Inaka (*Dracophyllum longifolium*), Shining karamu (*Coprosma lucida*), Muttonbird scrub (*Brachyglottis rotundifolia var. ambigua*), Miki (*Coprosma propinqua*) were observed in small numbers in this habitat without any obvious growth patterns.

The habitat was divided into three ‘Manuka and Mingimingi shrubland 1’, ‘Manuka and Mingimingi shrubland 2’ and ‘Manuka and Mingimingi shrubland 3’. Twenty-five traps were place in this habitat where Manuka and Mingimingi shrubland 1 had traps 1095, 1127, 1128, 1129 and 1130. Manuka and Mingimingi shrubland 2 had traps 1097, 1106, 1121, 1122, 1123 and 1124, and Manuka and Mingimingi shrubland 3 had traps 1107, 1108, 1109, 1110, 1111, 1112, 1113, 1114, 1115, 1116, 1117, 1118, 1119 and 1120. The traps were place targeting Tussock skinks, Small eared skinks, Southern skinks, Kōrero geckos and Cloudy geckos.

4.2.4 Herb lands

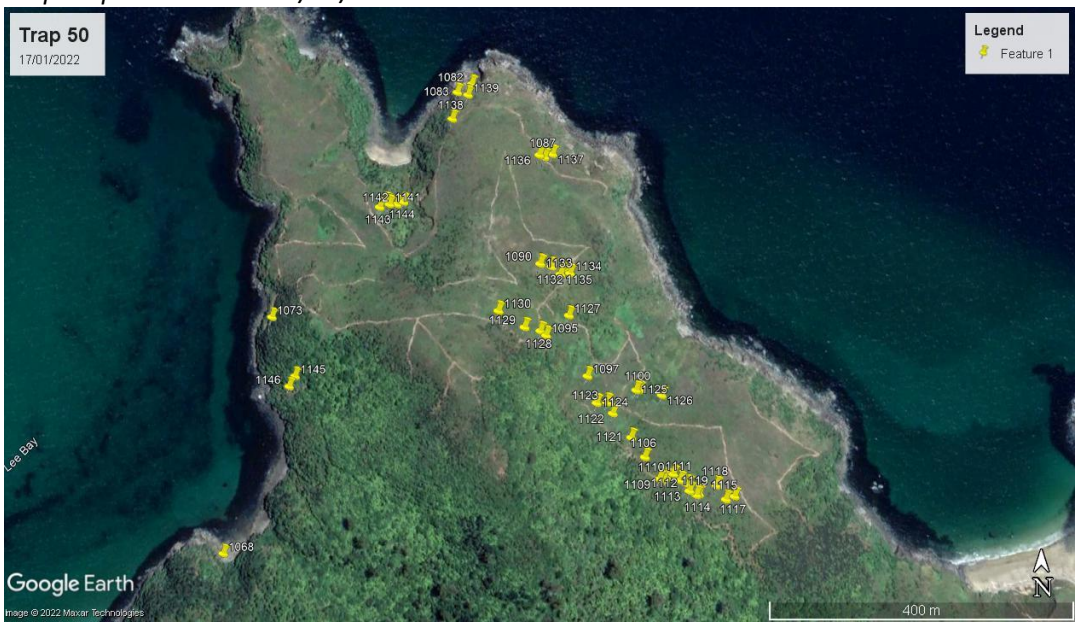
Biddy biddy (*Acaena novae zelandiae*) and Bird’s-foot Trefoil (*Lotus corniculatus*) were the dominant herbs observed. They were found throughout northern MPCR, and small fractions were observed in other identified reptile habitats (Section 4.2.3).

Note: Four traps (1068, 1073, 1145 and 1146) were place along the western coastline of Mamaku Point (Location: Lee’s Bay).

4.3 Artificial Retreats: Gee Minnow Traps

50 Gee Minnow traps were used for the survey. The traps were placed across the norther part of the reserve. The 49 of them were installed on 17/01/2022 and remained on the field for till 21/01/2022.

Figure 16
Trap 49 placement on 17/01/2022.



During the survey twenty-one Tussocks skinks were trapped. On the first day the of checking traps (18/01/2022) 20 Tussock skinks were captured from fourteen traps. Traps 1115, 1114, 1107, 1095, 1073 and 1068 had more than one specimen.

Figure 17
Traps where Tussock skinks were observed on 18/01/2022.

The trapped individuals were handled to measure their Snout- vent length, tail length, and tail break and to identify their sex and maturity. The specimen was measured using a ruler as showed in figure 18.

Figure 18
Image of the measuring the Snout vent length of a tussock skink.

The sex of the individuals was identified by gently moving their cloacal flap to reveal their reproductive organ. The male skinks had red colourations on their gonads while the female gonads were pale as showed in figure 19 and figure 20.

Figure 19
Image of a male specimen.

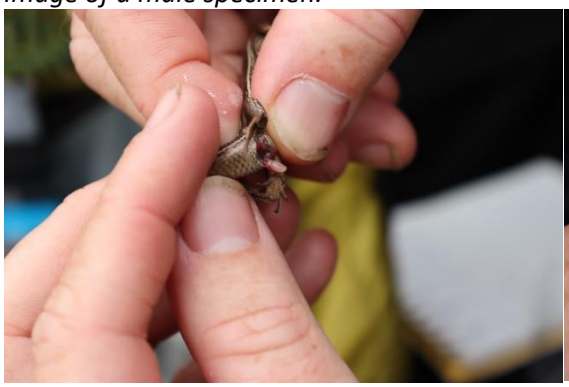
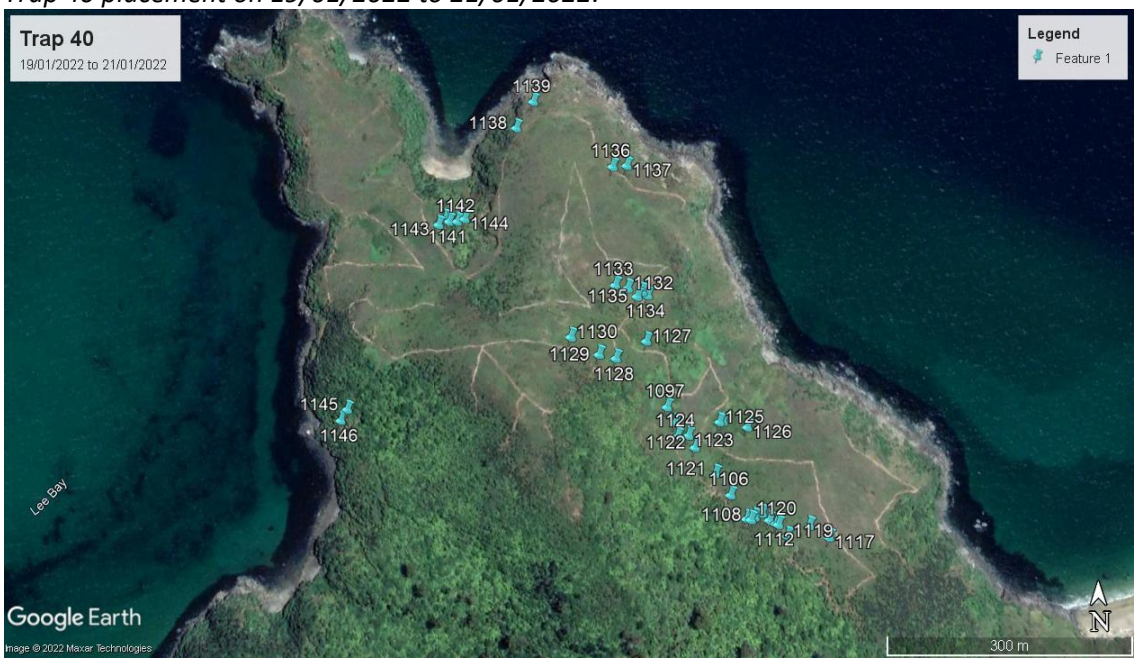


Figure 20
Image of a female specimen.

After the first day of observation, some of the traps were moved to different locations and nine of them were removed from the field. Leaving forty traps on the field. There was no observation made on the 19/01/2022 and 20/01/2022 and one tussock skink was observed in trap 1120 on the 21/01/2022.

Figure 21
Trap 40 placement on 19/01/2022 to 21/01/2022.



The below figure shows the trap number, species, sex, and measurements of the of the specimens that were caught from the field.

Figure 22

The collected data organised into a table for analysis.

Trap	Species	Sex	SVL (mm)	Tail (mm)	Tail break (mm)
1115	*Oligosoma chionochloescens*	Juvenile	44	51	
1107	*Oligosoma chionochloescens*	Juvenile	44	46	
1113	*Oligosoma chionochloescens*	Female	49	62	
1108	*Oligosoma chionochloescens*	Female	50	55	
1083	*Oligosoma chionochloescens*	Female	62	63	2
1090	*Oligosoma chionochloescens*	Female (pregnant)	64	68	
1068	*Oligosoma chionochloescens*	Female (pregnant)	64	66	
1115	*Oligosoma chionochloescens*	Male	59	53	23
1068	*Oligosoma chionochloescens*	Male	53	65	
1114	*Oligosoma chionochloescens*	Male	58	68	
1120	*Oligosoma chionochloescens*	Male	58	62	39
1114	*Oligosoma chionochloescens*	Male	60	69	
1107	*Oligosoma chionochloescens*	Male	60	68	
1087	*Oligosoma chionochloescens*	Male	61	70	
1095	*Oligosoma chionochloescens*	Male	62	68	11
1082	*Oligosoma chionochloescens*	Male	62	73	
1109	*Oligosoma chionochloescens*	Male	63	47	31
1073	*Oligosoma chionochloescens*	Male	64	66	9
1095	*Oligosoma chionochloescens*	Male	65	74	
1114	*Oligosoma chionochloescens*	Male	66	67	27
1073	*Oligosoma chionochloescens*	Male	69	56	24

Note: Tail breaks were measured for individuals who kept their original tails (Jewell, 2011, p.16). Measurements of regenerated tails are not included in scientific literatures (Jewell, 2011, p.16).

Figure 23

Image of the size distribution of the trapped Tussock skinks.

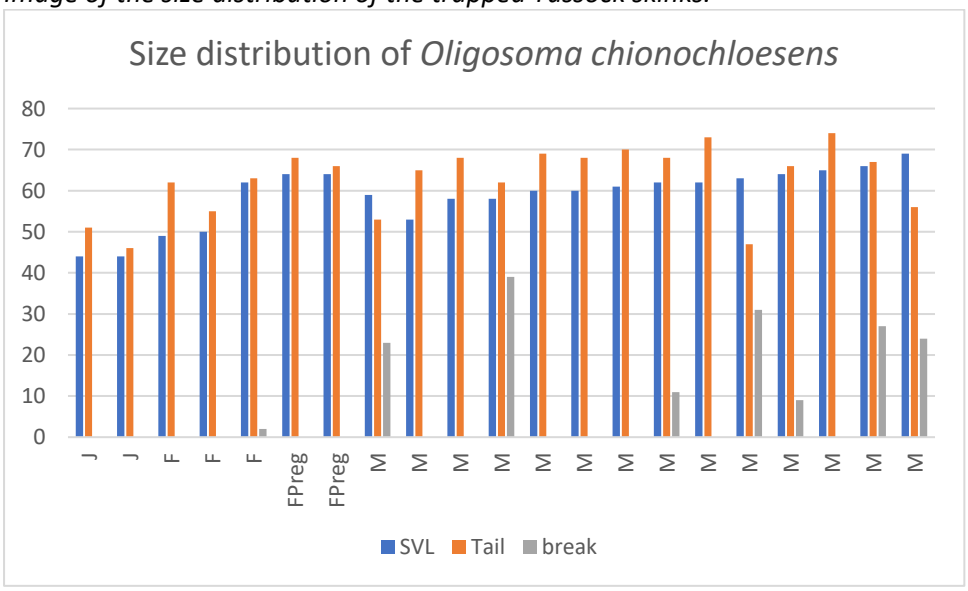
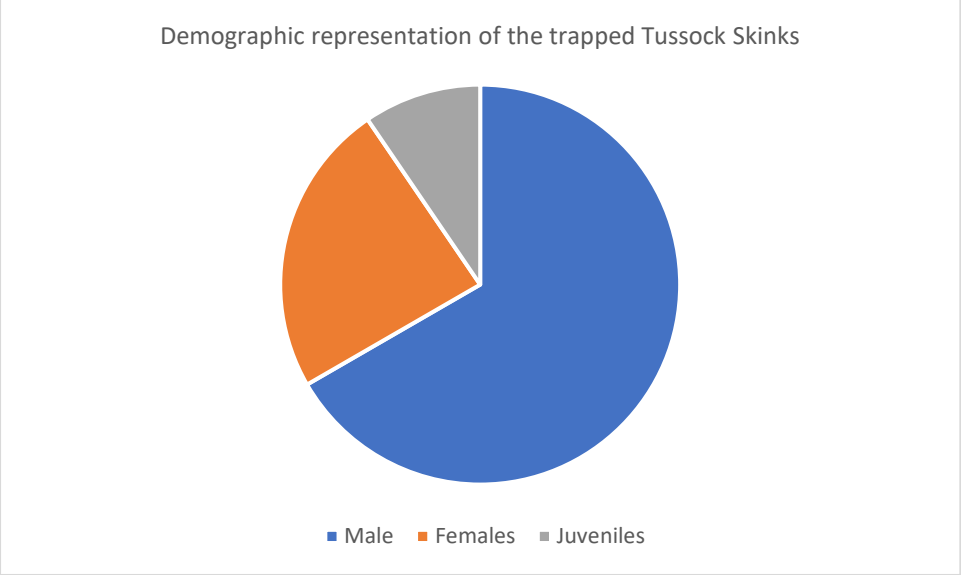


Figure 24

The demographic ratio Tussock skinks based on demography Male: Female: Juvenile.



The data in figure 22 was analysed using Microsoft excel to produce figures 23 and 24 to portray the size distribution and demography of the caught Tussock skinks. These figures show male individuals were slightly larger in size than females. There was a significant difference in the demography as males were caught in higher numbers than females and Juveniles (figure 24). Figure 22 indicates that out of 21 Tussock skinks caught, fourteen were males, five were females and two were juveniles. And, among the five females two were pregnant.

Note: Non targeted fauna like Kiore (*Rattus exulans*) and terrestrial insects were found in the installed traps.

4.4 Spotlighting

Spotlighting was conducted on the first and the second day of survey. On the first day (16/01/2022), the practice was conducted along the fence till Lee's Bay (figure 25) and on the second day (17/01/2022), a much larger area was spotlighted, mainly along the fence to trapline 14 and back to Lee's Bay (figure 26). Spotlighting was not conducted from the 18/01/2022 to 20/01/2022 due to rain, wet and boggy conditions.

Note: Non targeted observations of non-targeted exotic Brown tree frogs (*Litoria ewingii*) were made during spotlighting.

Figure 25
Spotlighting on 16/01/2022.

Figure 26
Spotlighting on 17/01/2022.

This method yielded zero observations as nocturnal geckos were not encountered.

4.5 Visual Encounter

Seven Tussock skinks were visually encountered. Their place of encounters was marked (using GPS) to illustrate their distribution.

Figure 27
Visual encounters.

4.6 Conclusion

In conclusion the survey identified that Mamaku point has a self-sustaining population of Tussock skinks. The results will be further discussed in the next chapter.

Chapter. 5 Discussion

5.1 Introduction

Baseline lizard survey conducted on Mamaku Point Conservation Reserve (MPCR) provided evidence on the presence of a self-sustaining population of native Tussock skinks. Though the reserve has ambient space and ecological capacity to hold the other target species mention in Chapter 3 (section 3.3) (except for Tussock skinks), none were observed during the survey. This study provided an in-depth understanding on lizards and their distribution in the reserve. The lizard habitat identifications provided by the study could aid in implementing future conservation practices. The identification of mammalian predators raised concerns on the welfare of the existing Tussock skinks. However, with advance pest management strategies, this issue could be mitigated in the future.

5.2 Herpetofauna and habitat identification and translocation

The identified lizard habitats on northern MPCR (section 4.2) could provide ecological services for all the lizards discussed in study. These habitats bore both flora and fauna resources that could meet their omnivorous dietary requirements. However, it is unclear on the manner that they might use these resources.

A 2003 scat analysis on Otago skinks (*Oligosoma otagense*) and Grand skinks (*Oligosoma grande*) in north Otago recorded a total of 23 food items from 245 scat samples from both species (Tocher, 2003, p. 247). The analysis indicated a notable difference in plant to animal ratio in their scat samples. 34% of the sample from Grand skinks accounted for dipterans and other bibionids (Tocher, 2003, p. 249). Fruit components were a major part of the skink's diet as they made up 32% of the scat composition (Tocher, 2003, p. 249). Whereas, for Otago skinks, 45% of the scat were composed of fruits (Tocher, 2003, p. 251). *Coprosma taylorae* and *Leucopogon fraseri*, made up 30% of the sample and small traces of Mingi mingi (*Coprosma propinqua*), porcupine shrub (*Melicytus alpinus*), carpet heath (*Pentachondra pumila*) and *Gaultheria spp* were recorded (Tocher, 2003, p. 249). On comparison Otago skinks consumed more plant matter, but the rest 55% of their diet comprised of invertebrates (Tocher, 2003, p. 249).

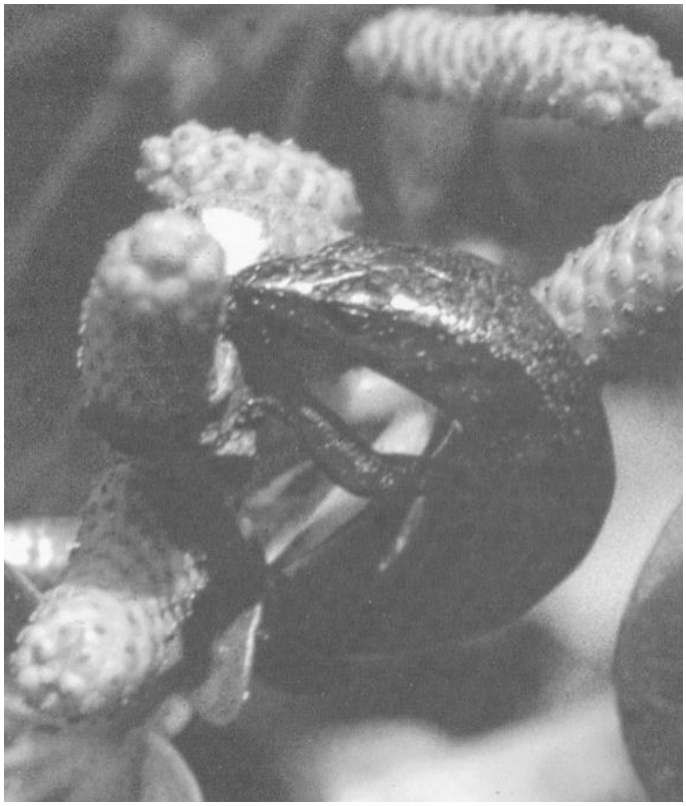
Evans et al (2015) assess the importance of sugar resources to endemic geckos of offshore islands. The study mainly encompasses species belonging to genera *Hoplodactylus* and *Woodworthia*, and their relationship with five native florae. The study indicated that Common Gecko (*Woodworthia maculatus*) exploited far more sugar resources and heavily relied on Falx (*Phormium tenax*) as a sugar source throughout the year (Evans et al, 2015, p. 266). Duvaucel's Gecko (*Hoplodactylus*

duvaucelii) preferred Ngaio trees infested with scale insects and honey dews (Evans et al, 2015, p. 266). Comparing these species of different genera, *Woodworthia* geckos are more likely to be attracted to floral plants and nectar than *Hoplodactylus* geckos.And, Whitaker (1987) study on the on the role of native lizards as seed dispersers, identified lizards of the genera *Hoplodactylus*, *Naultinus* and *Oligosoma* feeds on native fruits (Whitaker, 1987, p. 318).

Figure 28
Pacific gecko (*Dactylocnemis pacificus*) *feeding on nectar.*

Note. *Hoplodactylus pacificus* feeding on the nectar from the flowers of Pohutukawa. From "The roles of lizards in New Zealand plant reproductive strategies," by A. H. Whitaker, 1987, *New Zealand Journal of Botany, 25*(2), p. 317 (https://doi.org/10.1080/0028825X.1987.10410078).

Figure 29
Shore skink (Oligosoma smithi) feeding on fruit.



Note. Oligosoma smithi feeding on ripe fruits of kawakawa. From "The roles of lizards in New Zealand plant reproductive strategies," by A. H. Whitaker, 1987*, New Zealand Journal of Botany, 25*(2), p. 320 (https://doi.org/10.1080/0028825X.1987.10410078).

These literatures provide insight on the dietary preferences of lizards in general. With the brief understanding of the dynamic relationship of the lizards with their food source, it is assumed that MPCR has the capability of housing a diverse lizard community. Floral and fruit bearing plants like *Coprosma* species, Manuka, Southern Rata (*Metrosideros umbellata*), Tree Fuchsia (*Fuchsia excorticata*), Wineberry (*Aristotelia serrata*), Common tree daisy (*Olearia arborescens*), etc, recorded by Lalor, 2019 can be a valuable food source for lizards. These florae often attract range of invertebrates (dipterans and other bibionids) which could be consumed by existing lizards, contributing to the complex food web inherent in MPCR. Arthropods, isopods and other terrestrial insects observed in the Gee minnow traps and the eye reflections observed from nocturnal moths, flies and spiders offered some insight on the insect population and these invertebrates are valuable sources of Calcium and Phosphorus (Gibson, n.d., p, 32).

These mentioned ecological services benefits the existing skinks and future lizard translocation candidates. Northern MPCR provide ideal conditions for the translocation of terrestrial and

saxicoline lizards. From Lalor's (2019) recommendations, Harlequin gecko, Green skink, Small-eared skink and Cryptic skink (*Oligosoma inconspicuum*) are ideal candidates for introducing into the identified habitats (Lalor, 2019, p. 14- 15). However, more studies are required to understand niche availability and how it might affect the existing Tussock Skink population.

Referencing to Lalor's (2019) vegetation survey, it is understood that fruit, flower and nectar producing florae are present in the Rimu- Kamahi hardwood forest, which has the capacity of providing ecological services to arboreal geckos and semi arboreal geckos. Though no geckos were observed during the survey, it is believed that the forest could be an ideal habitat for Cloudy geckos, Kōrero geckos and Jewelled geckos (Lalor, 2019, p. 14- 15), the translocation candidates that can possibly occupy niche available in the native forest. With the proposed translocation programmes, it is likely that these species would be released into reserve.

5.3 Interpretation of the results form artificial retreats and spotlighting

Tussock skinks were the only native lizard found during the survey, so it could be evident that these species are the sole lizard fauna of MPCR. Lalor's (2019) study obtained similar results by using pitfall traps with 22 trapped Tussock skinks. Historically all the lizards found Stewart Island were likely present in MPCR before human colonisation, these species might have been extirpated by intensive land use and mammalian pests (Lalor, 2019, p. 14). The survival of Tussock skinks in the reserve could be relation to their relatively higher breeding rates and their adaptability to wider range of habitats comparing to the other Stewart Island lizards. It is unclear that whether geckos are present on the reserve, as spotlighting was not conducted to the full extend as previously scheduled due to unfortunate weather.

5.4 Pest

Understanding the dynamic predator prey relations is critical for species conservation. Polynesian rat/ Kiore (*Rattus exulans*) trapped in the artificial retreat (non-targeted) indicated the presence of mammalian predators inside MPCR. The diverse habitats of the reserve provide ideal conditions for these rodents to thrive as they provide services in the form of food (plant matter and invertebrates) and shelter to meet their ecological demands (Whitaker, 1973, p. 131).

Studies have identified that, Kiore population are highly influenced by the presence of invertebrates, and they often occupy native lizards' niches (Thoresen, 2011, 47). With their presence in MPCR, it is likely that competition exists between Tussock skinks and Kiore for food and habitat. Studies on Lizard Island, Mokohinau Group (outer Hauraki Gulf) provide data on the population of birds and

lizards before and after Kiore eradication (McCallum, 1986, p. 83), where healthier of populations the mentioned native lizards and birds were recorded after the eradication process (McCallum, 1986, p. 83). Predation of gravid females by pests can influences the population density of the of lizards (Worth, 2011, p. 40). That might be the case in MPCR as a notable difference were observed in the demography of the Tussock Skinks (Chapter 4, figure 24). More studies are required to validate this statement.

Figure 30
Trapped non targeted Kiore.

Figure 31
Trapped Kiore killed as part of pest management.

The long-term peat management of MPCR has been carried out using three effective management tools- the predator proof fence, fenced cells on both ends of the fence and trapping and baiting practices (Newell & Stowe, 2020, p. 7). With the proposed Restoration Plan (2021- 2030), Mamaku Trust aims to meet the pest management objectives to reduce their numbers to low or at nil densities in the near future (Newell & Stowe, 2020, p. 12). Feral cats and Kiore are pests that threatens the biodiversity of the reserve. To obtain a pest free status more targeted management practices are required. And it is believed that the Trust will implement active pest management practices to meet their pest free objective by 2030.

5.5 Conclusion

In conclusion, the diverse habitats of MPCR can provide structural and dietary services for the for the existing skink population and for the potential candidates for translocation. However, extensive pest management and the eradication should be prioritized to promote the lizard welfare and conservation of the reserve.

Chapter 6. Conclusion

6.1 Overview

The increasing interest on lizard conservation over the past decades have led to a series of developments on management techniques, survey methods (Lettink & Monks, 2016, p. 16), translocation programmes and environmental education throughout the country. The baseline lizard survey conducted on Mamaku Point Conservation Reserve (MPCR) identified the resident lizard population and the lizard habitat potential of the reserve. The survey answered the long-term question on the lizard diversity of MPCR. The six-day survey used a systematic search approach to identify the lizard biota of the reserve. The study identified Tussock skinks as the only reptile found in the reserve and the habitats identification could aid in future translocation programmes.

6.2 Recommendations

6.2.1 Pest management

The study identified the presence of mammalian predators inside the reserve. Their presence poses a threat to the conservation of native species and can halt the restoration and translocation programmes put forward by Mamaku Trust. Installation of DOC 200 and trapping tunnels would be ideal for the reserve's rugged terrain. With the existing and the recemented trap installation it is believed that the pest number in the reserve would be significantly reduced in the future.

6.2.2 Translocation

With the presence of mammalian predators in MPCR, the candidate lizards cannot be translocated freely into the reserve. Critical thinking and strategic planning should be considered to get a desired post translocation outcome. The short-term translocation of Otago skinks to Orokonui Ecosanctuary is a prime example of a good translocation practice (Bogisch et al., 2016, p. 211). Orokonui is located outside geographical range of Otago skinks but with the construction of artificial structures that mimicked the specie's natural habitats, they were able to successfully translocate the skinks into the sanctuary (Bogisch et al., 2016, p. 212). A study conducted on Orokonui after translocation, observed breeding pairs and juveniles in the enclosure, these observations concluded that the translocation was successful (Bogisch et al., 2016, p. 213). The study outlined the feasibility of translocating native lizards into small artificial enclosures (Bogisch et al., 2016, p. 215). Similar translocation approach could be feasible in MPCR. As advised by Bell (2022), Cloudy geckos could be translocation into the reserve in a fenced enclosure. This process could be done by identifying the preferred habitat for the species and constructing a predator proof enclosure around it. This could act as an interim space where the species could breed and increase their population until the reserve becomes predator

free. Similar practice would be effective for the translocation of other skinks mentioned in the study. For example, Rakiura Green skinks could be translocated to the identified Flax lands and Small eared skinks to the identified Tussock grasslands. However, these conservation approaches are not infallible as uncertainties are inherent in the translocation processes. Pre translocation monitoring will be required on the candidate species preferred habitats, food sources, niche availability and more. Disease screening should be addressed before translocation, as herpetofauna are often associated with Salmonella transmission (Middleton, Minot & Gartrell, 2010, p. 247), which could affect the species themself and the other biota present in the reserve. Post translocation monitoring efforts would be ideal to identify whether the release was successful or not. Annual monitoring is recommended to identify the success rate of translocation (van Winkel et al., 2010, p. 115). As stated by Lalor (2019), MPCR has the potential to become a sanctuary for many translocatable species in need of a predator free habitat (Lalor, 2019, p. 27).

6.2.3 Further study recommendations

The studies conducted has open future possibilities for scientific data on the reserve. In general, the intricate biotic and abiotic components function synonymously in an ecosystem. Identifying these complex relationships could provide knowledge on the conservation potential and biodiversity of the reserve. Similarly, in MPCR, many factors should be considered to identify the interactions of lizards with the other complexes present in the reserve.

6.2.3.1 Future Study on lizard niche availability

With the proposed lizard translocations, it is critical to identify whether they would fit in the existing functional ecosystem of MPCR. This recemented study could control species selection for translocation. Translocating species that could occupy the same niche as the existing ones could cause competition between them (which may not be ideal) this could result in undesirable translocation outcomes. So, an in-depth study is recommended to identify available niches without compromising the ecology of the existing Tussock skinks of the reserve.

6.2.3.2 An entomology survey

Scientific knowledge on the reserve's invertebrate diversity is relatively low. Lalor (2019) presumed that there is a growing trend in invertebrate population in the reserve (Lalor, 2019, p. 17). Though many invertebrates were observed during this study, an in-depth assessment could identify their diversity, distribution and their ecological role in the reserve.

6.2.3.2 Baseline survey on frogs

Exotic Brown tree frogs (*Litoria ewingii*) were observed during spotlight. Their observation raised the question on the frog diversity of MPCR. A baseline frog survey is recommended to actively identify the species, distribution and habitat occupancy in the reserve.

6.2.3.3 Studies on Kiore diet

A diet assessment on Kiore is recommended to identify their interaction with the native biota. It is unclear whether these rodents' prey on the existing Tussock skinks. But, with a diet assessment involving dissections, their food preferences could be assessed and could identify whether they prey of the skinks of MPCR.

Bibliography

Bell, T. (2014). Standardized common names for New Zealand reptiles. *BioGecko*, 8-11.

Bell. T. (2020). *Wildlands consultants Ltd.*

Bogisch, M., Cree, A., & Monks, J. (2016). Short-term success of a translocation of Otago skinks (*Oligosoma otagense*) to Orokonui Ecosanctuary. *New Zealand Journal of Zoology*, *43*(2), 211–220. https://doi.org/10.1080/03014223.2015.1122638

Chapple, D. G., Ritchie, P. A., & Daugherty, C. H. (2009). Origin, diversification, and systematics of the New Zealand skink fauna (Reptilia: Scincidae). *Molecular Phylogenetics and Evolution 52*, 70–487.

Corban, C., & Fellers, G. M. (2001). A technique for detecting eyeshine of amphibians and reptiles. *Herpetological review, 32*(2), 89- 91.

Evans, A., Towns, D., & Beggs, J. (2015). Relative importance of sugar resources to endemic gecko populations in an isolated island ecosystem. *New Zealand Journal of Ecology*, *39*.

Fea, N. (2009). *Biodiversity monitoring in Rewanui Initial lizard survey for November 2008*. Greater Wellington Regional Council.

Gebauer, K. (n.d.). *Trapping and identification techniques for small-scaled skinks*. 24.

Gibson, R. (n.d.). *Guide to keeping New Zealand lizards in captivity*. Department of Conservation.

Hare, K. M. (2012). *Herpetofauna: systematic searches Version* 1.0. Department of Conservation.

Jewell, T. (2011). *A photographic guide to reptiles and amphibians of New Zealand*. New Holland (NZ) Ltd.

Jewell. T. (n.d.). *New Zealand Herpetological Society.* https://www.reptiles.org.nz/herpetofauna/native/tukutuku-rakiurae

Jewell. T. (n.d.). *Flickr.* https://www.flickr.com/photos/rocknvole/12986651694/in/photostream/

Lalor, K. (2019). *Mamaku Point Conservation Reserve Restoration Plan*. Mamaku Point Conservation Reserve.

Lettink, M., & Monks, J. M. (2016). Survey and monitoring methods for New Zealand lizards. *Journal of the Royal Society of New Zealand, 46*(1), 16-28. DOI: 10.1080/03036758.2015.1108343

Lettink, M. (2012). *Herpetofauna: artificial retreats Version 1.0*. Department of Conservation.

McCallum, J. (1986). Evidence odd predation by Kiore upon lizards form the Mokohinau Islands. *New Zealand Journal of Ecology 9*.

Knox. C. (n.d.). *New Zealand Herpetological Society.* https://www.reptiles.org.nz/herpetofauna/native/naultinus-gemmeus

LINZ. (2022). *NZ Topo maps*. https://www.topomap.co.nz/NZTopoMap?v=2&ll=-46.868914,168.119874&z=14

Middleton, D. M. R. L., Minot, E. O., & Gartrell, B. D. (2010). Salmonella enterica serovars in lizards of New Zealand's offshore islands. *New Zealand Journal of Ecology*, *34*(2), 247–252.

Middleton. C. (n.d.). *New Zealand Herpetological Society.* https://www.reptiles.org.nz/herpetofauna/native/oligosoma-notosaurus#:~:text=The%20Southern%20skink%20is%20endemic,species%20observed%20in%20the%20area

Newell, C & Stowe, C. (2020). *Mamaku Point Conservation Reserve Restoration Plan 2021-2030*. Mamaku Point Conservation Trust.

Nielsen, S. V., Bauer, A. M., Jackman. T. R., Hitchmough, R. A., & Daugherty, C. H. (2011). New Zealand geckos (Diplodactylidae): Cryptic diversity in a post-Gondwanan lineage with trans-Tasman affinities. *Molecular Phylogenetics and Evolution 59*, 1–22.

Purdie. S. (n.d.). *New Zealand Herpetological Society.* https://www.reptiles.org.nz/herpetofauna/native/woodworthia-otagosouthland-large#:~:text=K%C5%8Drero%20geckos%20are%20terrestrial%2Farboreal,(hence%20their%20colloquial%20name)

Reardon. J. (n.d.). *New Zealand Herpetological Society.* https://www.reptiles.org.nz/herpetofauna/native/mokopirirakau-nebulosus

Ritchie. J. (2018). *Mamaku Point Biosecurity and Incursion Management Plan 2018*. Mamaku Point Conservation Reserve. KAHUTARAE.

Schlesselmann, A.-K. (2014). *Habitat use and behaviour by forest geckos (Mokopirirakau granulatus) in relation to predator control on Waiheke Island, Hauraki Gulf, New Zealand*. 31.

Sherley, G. (1989). Initial surveys for the Black- eyed Geckos, *Hoplodactylus kahutarae*, *In the seaward Kaikoura range: November 1987, June 1988 AND Febuary 1989* (Science and research initial report No. 55). Department of Conservation. https://www.doc.govt.nz/globalassets/documents/science-and-technical/srir55.pdf

Stonyer. C. (n.d.). *New Zealand Herpetological Society.* https://www.reptiles.org.nz/herpetofauna/native/oligosoma-stenotis#:~:text=Description,its%20relatively%20small%20ear%20openings

Stowe, C. (2019). *High Value Areas Ecological Assessment Report Mamaku Point*, AGLM10. Environmental Southland. https://static1.squarespace.com/static/598a394c46c3c4323c816d0b/t/5e48a2c73be8c0066dc60530/1581818641526/Chris+Stowe+HVA+Ecological+Assessment.pdf

Stowe. C. (2019). *Hight value areas Ecological assessment report Mamaku Point.* https://static1.squarespace.com/static/598a394c46c3c4323c816d0b/t/5e48a2c73be8c0066dc60530/1581818641526/Chris+Stowe+HVA+Ecological+Assessment.pdf

Thoresen, J. J. (2012). *Monitoring the impacts of invasive mammals on arboreal geckos' habitat use, cell foam retreat use, and the effectiveness of different monitoring techniques: A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Conservation Biology, Massey University, Auckland, New Zealand* [Thesis, Massey University]. https://mro.massey.ac.nz/handle/10179/3898

Tocher, M. D. (2003). The diet of grand skinks *(Oligosoma grande)* and Otago skinks (O. *otagense)* in Otago seral tussock grasslands. *New Zealand Journal of Zoology*, *30*(3), 243–257. https://doi.org/10.1080/03014223.2003.9518342

van Winkel, D., Baling, M., Barry, M., Ji, W., & Brunton, D. (2010). *Translocation of Duvaucel's geckos to Tiritiri Matangi and Motuora Islands, Hauraki Gulf, as part of island ecological restoration initiatives* (pp. 113–115).

Wedding. C. (n.d.). *New Zealand Herpetological society.* https://www.reptiles.org.nz/herpetofauna/native/oligosoma-chloronoton#:~:text=Ecology%20and%20habitat&text=Southland%20green%20skinks%20rarely%20climb,skink%20are%20surprisingly%20quick%20(pers.)

Whitaker, A. H. (1973). Lizard Populations on Islands with and without Polynesian rats, Rattus exulans (PEALE). *Proceedings (New Zealand Ecological Society)*, *20*, 121–130.

Whitaker, A. H. (1987). The roles of lizards in New Zealand plant reproductive strategies. *New Zealand Journal of Botany*, *25*(2), 315–328. https://doi.org/10.1080/0028825X.1987.10410078

Whitaker. A. H. (1987). *The roles of lizards in New Zealand plant reproductive strategies*. https://doi.org/10.1080/0028825X.1987.10410078

Woolley, C. K., Knox, C., & Watson, M. (2021). Evaluating the risk of predation for lizards constrained in live traps. *New Zealand Journal of Zoology*. 10.1080/03014223.2021.1918730

Worth, Z. (2011). *Forest Lizard Research on Bluff Hill/Motupohue*. Southern Institute of Technology.

Appendix

Figure 32

An image of the field data sheet.

Figure 33

Image of Tussock Skinks.

Figure 34

An image of the open habitat of Norther MPCR.

Figure 35

Image of Trent Bell writing down field observations.

Figure 36

Image of me holding a Tussock Skink.

Risk Analysis and Safety Management System (RASMS)	No.	Form Four
	Issue	
	Date Issued	30/06/2011
	Review Date	01/07/2016

Activity: Third year research project at Mamaku point Conservation Reserve

SECTION A **"Significant refers to the potential for any harm that is not trivial and would warrant a response or intervention"**

RISK	HAZARD OR HARM	POSSIBLE OUTCOME (PERIL)	SIGNIFICANT	ACTION	DOES ACTION ELIMINATE, ISOLATE OR MINIMISE RISK

Physical	Getting lost in the bush, which could also result in injury Injury through trips falls or hazards such as cliffs, treefalls etc.	If lost might take hours to find a way back to the main camp, physical injuries could halt the study. Possible death or serious injury. Serious injury or death, being unable to return to house where staying	Yes Yes	Proper planning will be undertaken before the survey. Appropriate gear will be carried by the researcher to the site i.e.: ***a compass, phone, spare power bank for phone, GPS, emergency food supplies, first aid kit, water bottle, sunscreen, aluminum blanket and a hard copy of the map and a flashlight, waterproofs and change of clothing. An SIT emergency beacon will also be carried at all times.*** When tramping the researcher will record the tracks on GPS which will minimize the probability of getting lost. All of the above and also two messages will be sent each evening, one to a supervisor, one to the camp manager, to say the researcher is OK. If a message is not received by 7pm each evening the manager will	Minimize Minimize
Emotional	Loneliness	Depression and lack of motivation		The main camp will have Wi-Fi which will allow the research to make call to their loved ones.	

More physical	Extreme weather conditions such as sun, wind, rain, mist or cold. Injury from walking along the road	Sunstroke, exposure, treefall and other wind blown hazards, injury through low visibility, could cause serious illness, injury or death Once every few days a ten kilometer round trip along the roads	Yes	A weather check will be undertaken each morning with checks ins with met service for potential hazardous weather. Travel to study sites will only happen in safe weather. Sun is a good time for Lizards and skinks to be seen so if travel in sun proper precautions will be taken, sunscreen, hat, umbrella, and plenty of water. If the researcher feels at all dizzy in the sun he will move into shade. Windproof waterproofs and warm hat and gloves will be carried at all times. Only walk in daylight hours. Walk on right hand side of road facing oncoming traffic. Take care on bends.	Minimize
Cultural					
Financial					
Environmental	Rough tramping through the bush	Bight cause harm to some ground bearing plants		The researcher will take extra caution while tramping through the bush by carefully watching his steps.	
Other					

Should loss occur, what will you need to have in place to minimise the loss?	The researcher will carefully carry a day pack and
<u>IMPORTANT</u> This RASMS form is not complete unless attached to Section B and signed off by Manager	

Name: Daron Titus Date of Review: 21/12/21