

Nga mokomoko o Mamaku Point Conservation Reserve: survey and conservation opportunities assessment

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Introduction

Rakiura/ Stewart Island has several rare (and nearly all island-endemic) lizard species, including the harlequin gecko (*Tukutuku rakiurae*; Threatened - Nationally Vulnerable), jewelled gecko (*Naultinus* sp. (a potential new taxon; extremely rare; no threat classification yet), cloudy gecko (*Mokopirirakau nebulosus*; At Risk), Rakiura green skink (*Oligosoma* aff. *chloronoton* “Stewart Island”; At Risk), small eared skink (*Oligosoma stenotis*; At Risk), southern grass skink (*O.* aff. *polychroma* clade 5; At Risk), southern skink (*O. notosaurus*; Not Threatened). For most of these species, the majority of their range on Stewart Island do not include predator-free sites, apart from Codfish Island (cloudy gecko, Rakiura green skink). The Threatened harlequin gecko and small-eared skink ranges are not known within any predator-free sites.

Mamaku Point Conservation Reserve (MPCR) is the only predator-exclusion fenced sanctuary on Rakiura/ Stewart Island, holds significant conservation potential for lizards and could potentially harbour rare and threatened species (eg. cloudy gecko, jewelled gecko), or be a viable receptor site for species translocations (eg. Rakiura green skink).

Discovery of any of these species in MPCR would be significant, as the reserve would be the only Predator-Free Stewart Island mainland site for these species. Further, consideration can then be given to potential species translocations into MPCR from non-managed sites, expanding species range and establishing new insurance populations. Their presence would enable researchers, citizen scientists and community volunteers to undertake scientifically-based research studies on lizards (all other sites are very remote, inaccessible and very expensive to visit). A translocation event involves significant community & iwi involvement.

In 2021, MPCR received funding from WWF – New Zealand to undertake a lizard survey and conservation opportunities assessment project in the reserve. The purpose of the work is to improve knowledge of the lizard species present and their abundances within MPCR, and to determine the opportunities that MPCR may offer for the conservation management of Rakiura/ Stewart Island’s lizards.

The survey results contribute to the broader knowledge of Stewart Island lizard species to guide management, and the potential translocation opportunities for Threatened and At-Risk lizard species into the Reserve are investigated. Management recommendations are provided.

Background

Mamaku Point Conservation Reserve is a large (172-hectare), privately owned biodiversity sanctuary in north-eastern Rakiura/ Stewart Island. The reserve consists of a peninsula comprising of rugged hilly terrain, native podocarp forest, rewilding grasslands and sandy beaches. The ecological characteristics and values are well described in Stowe (2019) and Newell & Stowe (2020) (see Ecological Context and Values section below).

Prior to 2000, Mamaku Point was a privately owned block with the seaward faces farmed and grazed by sheep and cattle. In late 2000, the Dancing Star Foundation purchased the property, with the intention of establishing a biodiversity reserve.

In 2005, the property was enclosed the Dancing Star Foundation in a 2.1km long Xcluder™ pest-exclusion fence extending from Horseshoe Bay to Lee Bay, preventing incursions of non-native mammals into the sanctuary. An extensive biosecurity grid is maintained both inside and outside the fence and both the fence and the biosecurity grid are remotely monitored using very high frequency (VHF), cellular and satellite communications to ensure that any biosecurity breaches are detected immediately (Ritchie 2018, Stowe 2019).

In 2017, the Reserve was purchased by a family trust associated with Roy and Rachel Thompson, who subsequently established the Mamaku Point Conservation Trust. The trust is an incorporated charitable trust and registered charity. The primary objectives of the Trust are:

- Maintaining and enhancing biodiversity within the reserve.
- Making the reserve accessible by the public for conservation education and eco-tourism activities
- Working toward the financial and environmental sustainability of the Reserve's operations.

In 2020, a 10- year Restoration Plan (2021- 2030) funded by WWF, was prepared to enhance the conservation potential and the biodiversity of the reserve (Newell & Stowe 2020).

Objectives and scope

Objectives of this project include:

- Review all current knowledge and management planning relevant to lizards of MPCR.
- Implement a comprehensive lizard survey of MPCR, utilizing:
 - Funnel traps for terrestrial species.
 - Foam covers for arboreal species.
 - Day searching for both arboreal and terrestrial species.
 - Spotlighting for nocturnal and cryptic species.
- Baseline data and knowledge collected on the presence/absence, distribution and abundance for all lizard species within MPCR, including morphological data on all individuals captured, and demographic data on populations.

- Reporting survey results, long-term monitoring design and future recommendations for lizard conservation within MPCR.
- Investigation of potential translocation opportunities for Threatened and At Risk lizard species into MPCR.
- Develop a Lizard Management Plan for the reserve, including long-term monitoring design and future management for lizard conservation within the Reserve. The LMP will include survey results, long term monitoring design, and management measures for lizard conservation, including potential species translocations. The LMP will provide reference material for use as training resources.
- Training of Trust members, mana whenua, and community group members in lizard surveying, monitoring and species identification. This is so that the community and iwi can eventually sustainably undertake long-term lizard management at Mamaku Point, including surveys, monitoring and translocations.

Ecological context and values

MPCR is located in the Anglem Ecological District of Rakiura north of Freshwater Inlet and Paterson Inlet (McEwen 1987). The districts historic ecosystems remain largely unchanged in extent and degree of modification since human occupation; it is dominated by montane *Olearia lyallii* muttonbird scrub (70%) with lowland/montane rimu-kamahi forest accounting for a further 15% of its area (Stowe 2019). Coastal and sub-alpine ecosystems (shrubland, rushland and tussockland) collectively accounted for a relatively minor proportion (15%) of the total area.

MPCR includes a range of aspects, landforms and topography ranging from hill country of moderate relief to sandy beaches, rocky shorelines and steep coastal embankments and cliffs (Stowe 2019). Nathan Island, to the northwest of Mamaku Point, is also managed as part of the Reserve. The altitudinal range encompasses 0-120 metres. Climatically, much of the northern coastal area is exposed to frequent, strong, salt laden winds from the westerly quarter, as well as less frequent easterly gales.

In MPCR, the northern coastal faces were cleared of their former forest cover probably well before 1959 (Stowe 2019), based on the earliest easily available aerial imagery obtained for the site. Despite presumably still being grazed between 1959 and 1978, regenerating native forest and shrubland appears to have expanded, notably in the western coastal areas near Lee Bay and along the northern tall forest margin and down into the major gully between Bob's Point and Mamaku Point (Stowe 2019). Since 1978, regeneration of forest and scrub has continued over this time in similar areas.

Stowe 2019 identified at least eight distinct plant communities which can be classified into seven ecosystem types according to Singers & Rogers' (2014) nationally recognised terrestrial ecosystems classification system. Additionally, further vegetation types (or "habitat units") are present within these ecosystems (Figure 1). At least 130 native species of plant have been recorded within MPCR,

considered to be a high diversity. These ecosystems and habitat units are reproduced below from Stowe (2019):

Ecosystem: SA9 *Olearia*, *Brachyglottis* and *Dracophyllum* scrub/herbfield/loamfield [muttonbird scrub]

Unit 1: muttonbird scrub-manuka-hardwood scrub (6.8 ha). Indigenous scrub with a characteristic composition and c. 2-5 m in height found intermittently around the immediate coastal zone. It consists mainly of one or a mix of muttonbird scrub (*Brachyglottis rotundifolia*), manuka, shore hebe (*Veronica elliptica*), inaka (*Dracophyllum longifolium*), common tree daisy (*Olearia arborescens*) and various other woody species such as shining karamu (*Coprosma lucida*), *Coprosma areolata*, broadleaf (*Griselinia littoralis*) and red mapou (*Myrsine australis*). The understorey is variable. In the more exposed coastal locations, a number of distinctive, specialist ferns are locally abundant. These include spleenworts (*Asplenium* spp. with numerous hybrid forms) and *Blechnum* spp.. Other associates may include a range of herbs, coastal sedge (*Carex appressa*), bracken (*Pteridium esculentum*) and bush flax (*Astelia fragrans*). On some of the steep coastal faces, a low scrub/shrubland dominated by shore hebe is present. This community is more akin to the CLF5 ecosystem (Harakeke, *Hebe elliptica* flaxland/rockland) but was included within SA9 and/or VS6 as it couldn't be readily differentiated for mapping purposes with the aerial imagery available.

Ecosystem: VS5 Broadleaved species scrub/forest

Unit 2: mixed hardwood-manuka scrub (53.7 ha). This community represents the younger, regenerating forest at the site. It merges somewhat with the coastal scrub of unit 1 and with the more intact podocarp-hardwood forest of unit 4. It consists of a range of hardwood species include manuka (*Leptospermum scoparium*; which can be locally dominant), red mapou, kamahi (*Weinmannia racemosa*), shining karamu, *Coprosma areolata*, broadleaf, tree fern (*Dicksonia squarrosa*) and others. Occasional emergent rimu (*Dacrydium cupressinum*) punctuate the canopy in places. Where this community extends down the main gully between Bob's Point and Mamaku Point, half a dozen mamaku tree ferns (*Cyathea medullaris*) can be found.

Ecosystem: VS6 Matagouri, *Coprosma propinqua*, kowhai scrub [Grey scrub]

Unit 3: mingimingi-hardwood scrub (0.7 ha). There are two small areas of this vegetation. Both are dominated by mingimingi (*Coprosma propinqua*) with scattered *Coprosma areolata*, tree fern (*Dicksonia squarrosa*), broadleaf, shining karamu, wineberry (*Aristotelia serrata*) and other hardwoods. Regeneration of hardwoods within this community is likely to be relatively rapid.

Unit 6: [mingimingi-manuka-hardwood]/bidibid-exotic grassland (24.2 ha). This unit generally represents the previously farmed and grazed portions of the reserve. It occurs all along the northern coast and patchily in the west within regenerating forest towards Lee Bay. Overall, it is dominated by exotic grasses and herbs with some large patches of bidibid (*Acaena anserinifolia*) as well as water fern (*Histiopteris incisa*), shield fern (*Polystichum vestitum*) and bracken. Scattered to locally common regenerating natives are also present (e.g. mingimingi, manuka, broadleaf, *Coprosma areolata*). These represent the future trajectory of vegetation

change towards native scrub/forest given time and the continued absence of browsing animals. The open grassland areas are the locations in which 'assisted' regeneration of native plant communities could be instigated. A slightly different community occurs within this unit on some of the exposed, steep coastal faces. These areas may support scattered to abundant shore hebe, knobby clubrush (*Ficinia nodosa*), blue shore tussock (*Poa astonii*), pohuehue (*Muehlenbeckia complexa*), New Zealand spinach (*Tetragonia implexicoma*), shore spleenwort (*Asplenium obtusatum*) and Stewart Island forget-me-not (*Myosotis rakiura*).

Ecosystem: CLF6 Kamahi, southern rata, podocarp forest

Unit 4: (rimu)/kamahi-hardwood forest (90.0 ha). This is the dominant vegetation at Mamaku Point. The canopy is dominated by kamahi (*Weinmannia racemosa*) with much emergent rimu, along with occasional miro (*Prumnopitys ferruginea*) and southern rata (*Metrosideros umbellata*). The canopy is c. 15 m tall though the emergent rimu reach 20 m height. The understory is also dominated by kamahi, along with occasional broadleaf (*Griselinia littoralis*) and haumakoroa (*Raukaua simplex*). The shrub layer includes much hard tree fern (*Dicksonia squarrosa*) and stinkwood (*Coprosma foetidissima*), along with some *Coprosma rhamnoides*, soft tree fern (*Cyathea smithii*) and occasional other species. The forest floor contains much crown fern (*Blechnum discolor*) and the filmy fern *Hymenophyllum demissum*, with *Lastreopsis hispida* being locally common.

Ecosystem: SA7 Iceplant, glasswort herbfield/loamfield

Unit 5: glasswort-iceplant-knobby clubrush herbfield (0.03 ha). This herbfield community occupies areas close to, or within, the splash zone of waves on the shoreline. In these locations, glasswort (*Salicornia quinqueflora*), native ice plant (*Disphyma australe* subsp. *australe*), shore stone crop (*Crassula moschata*), knobby clubrush (*Ficinia nodosa*), shore gentian (*Gentiana saxosa*), native celery (*Apium prostratum* var. *filliforme*), sea primrose (*Samolus repens* var. *repens*), slender clubrush (*Isolepis cernua* var. *cernua*) and shore pimpernel (*Selliera radicans*) are common.

Ecosystem: CL10 Kiokio fernland/rockland

Unit 7: kiokio-[mingimingi-hardwood] fernland (0.33 ha). This unit occupies a poorly drained slump or slip. Kiokio fern (*Blechnum novaezealandiae*) is dominant but is interspersed with mingimingi (*Coprosma propinqua*), broadleaf, *Coprosma areolata* and shining karamu.

Ecosystem: WL22 *Carex*, *Schoenus* sedgeland

Unit 8: *Carex* sedgeland (seepage) (0.4 ha). At least two seepages are present on the northern hillslopes. These are dominated by sedges and exotic grasses with cutty grass (*Carex coriacea*) and *C. appressa* common. Though supporting plants more typical of wetlands, and classified as such, these areas are likely to have supported forest originally.

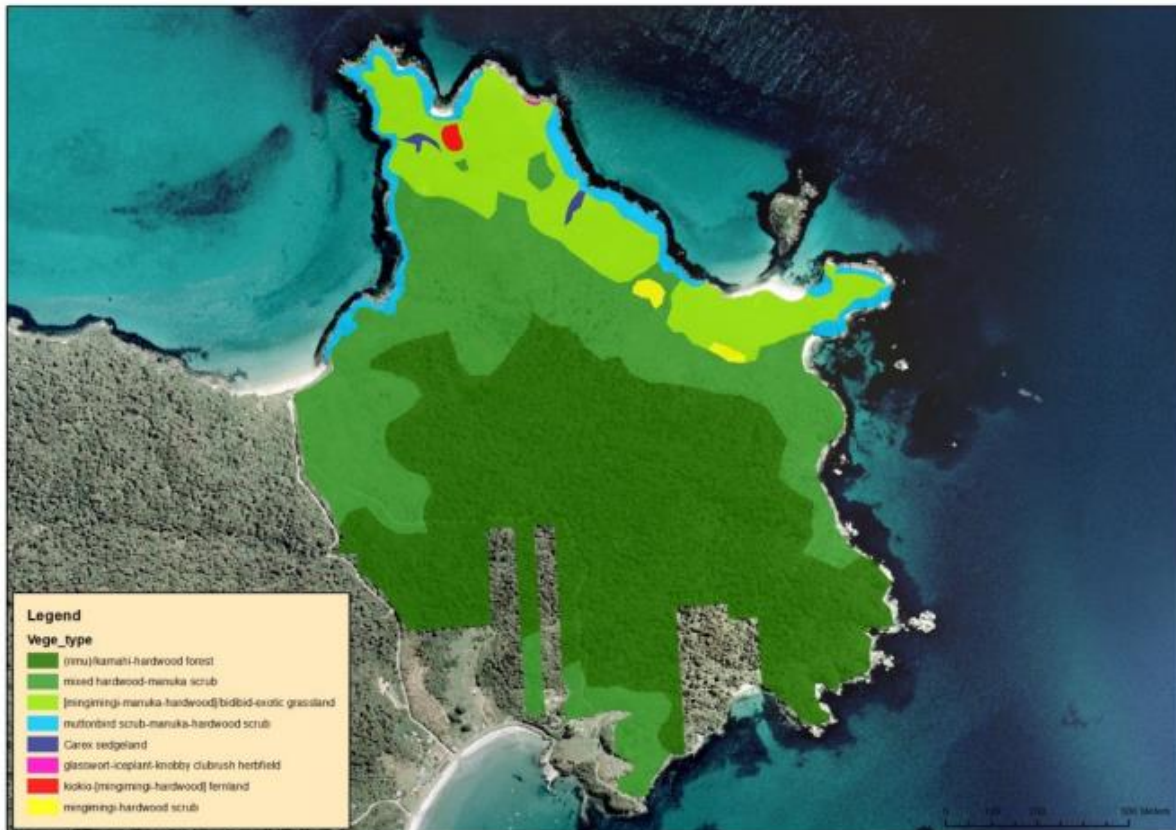


Figure 1: Aerial imagery showing the broad habitat units at Mamaku Point Conservation Reserve (sourced from Stowe 2019).

Restoration planting took place in September 2020, which was funded by MPI One Billion Trees. 18 hectares at a stocking rate of 1000 stems per hectare on coastal or previously grazed land. The planting is intended to facilitate the reversion of land to native forest, with select areas remaining as open grassland habitat for lizards.

MPCR supports at least 26 species of indigenous birds, including kākā (*Nestor meridionalis*), southern brown kiwi (*Apteryx australis lawryi*), tomtit (ngiru-ngiru, *Petroica macrocephala*), fernbird (mātātā, *Bowdleria punctata*), morepork (ruru, *Ninox novaeseelandiae*), and Fiordland crested penguin (tawaki, *Eudyptes pachyrhynchus*). However, the Stewart Island weka (*Gallirallus australis scotti*), although native to Rakiura/Stewart Island, is not present inside the Reserve. Weka are a well-known predator of lizards, and their continued exclusion is likely to be highly beneficial for the lizard populations within the Reserve. There may also be native bat and marine mammal values.

MPCR is considered ecologically significant regionally, with an outstanding and diverse range of habitats and ecosystems, many of which are in excellent condition and have few threats; supporting nationally threatened flora and fauna; with considerable translocation potential (Stowe 2019, Newell & Stowe 2020). Under regional guidelines, almost all of the natural habitats would meet or exceed one or more of the criteria for significance (i.e. representativeness; rarity and distinctiveness; diversity and pattern; and ecological context) under the Southland Regional Policy Statement.

MPCR is the only predator-proof fenced reserve on Rakiura/ Stewart Island giving it significant conservation potential for vulnerable species, including lizards (Newell & Stowe 2020).

Lizard values

Rakiura/ Stewart Island, and its surrounding offshore islands, are known to support at least seven lizard species (Department of Conservation BioWeb *Herpetofauna* database, Bell & Wiles 2015): harlequin gecko (*Tukutuku rakiurae*), jewelled gecko (*Naultinus gemmeus* Foveaux Strait/ Codfish Island form), cloudy gecko (*Mokopirirakau nebulosus*), southern skink (*Oligosoma notosaurus*), small-eared skink (*O. stenotis*), Rakiura green skink (*O. aff. chloronoton* “Stewart Island”), and southern grass skink (*O. aff. polychroma* Clade 5¹) (Table 1, Appendix 1). All of these species are endemic to Rakiura/ Stewart Island and adjacent islands apart from southern grass skink, which is also widespread in the southern part of the South Island, and jewelled gecko, although the Foveaux Strait/ Codfish Island form is potentially a unique endemic species.

Of these species, only one has been confirmed present at MPCR. This is the southern grass skink, which has been recorded through pitfall trap surveys around Bob’s Point (Lalor 2019). This species is likely the one seen frequently by MPCR operations staff. Brief species descriptions, ecology and habitat preferences of the lizards of Rakiura are provided in a Powerpoint presentation.

Kathleen Lalor undertook a skink survey at MPCR involving pitfall trapping between 25 January-10 February 2018 (Lalor 2019). Lalor’s methodology involved the use of three transects of three pitfall traps (made from yogurt or icecream containers and lids and baited with canned fruit or honey), with these traps separated by 20 m intervals at Bob’s Point. Interestingly, Lalor also used a 600 x 200 m glass rectangle over each trap to attract skinks during periods of cold weather. Twenty-two southern grass skinks were captured by Lalor over the 15-d period, with captures occurring during sunny or partly cloudy days with light breezes and daytime temperatures ranging from 14-27°C.

Mamaku Point Restoration Plan

Newell & Stowe (2020) prepared a MPCR Restoration Plan that spans a 10 year period (2021-2030) Within this Restoration Plan, there are a number of goals, objectives and actions. Those relevant to lizard management are summarised in Table 2:

¹ The southern grass skink was described by Jewell (2022) as tussock skink (*O. chionocholescens*), although the description is yet to be accepted widely by New Zealand taxonomists.

Table 1: Lizards of Rakiura/ Stewart Island, threat classification, likelihood of presence and suitability for translocation into MPCR.

Species	Threat status ²	Known locations on Rakiura/ Stewart Is	Likelihood of presence at MPCR	Suitability for translocation into MPCR + comments	Comments
Cloudy gecko <i>Mokopirirakau nebulosus</i>	At Risk - Relict	North-eastern muttonbird islands (Zero Rock, Womens, Paukeokaoka/ Jacky Lee and Te Marama/ Herekopare), Deceit Peaks, south-western muttonbird islands (Kundy, Big, Kaimohu), Whenua Hou/ Codfish Island. Cloudy geckos may have once been present on Taukihepa/ Big South Cape and Rerewhakaupoko/ Solomon Islands.	Low-moderate	Yes	Likely historically present within the Reserve's forests. The most likely viable source population would be one of the north-eastern muttonbird islands where dense, presumably stable populations occur (Hitchmough <i>et al.</i> 2021); however, a remnant population may yet survive within MPCR at undetectable densities.
Jewelled gecko <i>Naultinus gemmeus</i>	At Risk – Declining	Whenua Hou/ Codfish Island, Green Island.	Low-moderate	Yes	Likely historically present within the Reserve's forests. Extremely rare in Rakiura. A source is unlikely to be found; however, a remnant population may yet survive within MPCR at undetectable densities.
Harlequin gecko <i>Tukutuku rakiurae</i>	Threatened – Nationally Endangered	South of Rakeahua River both in lowland and high-altitude sites throughout the Mt Allen Ecological District.	Low	Possible	Surveys of both lowland and highland Anglem Ecological District would be required before confirming the species has a wider natural distribution on Rakiura.
Rakiura green skink <i>O. aff. chloronoton</i> "Stewart Island"	Threatened – Nationally Vulnerable	The Neck, Little Mt Anglem, Mason Bay, Tin Range, Pikihatiti/ Port Pegasus, Big and Betsy Islands (Boat Group).	Low-moderate	Yes	Likely historically present in open, sunny and coastal habitats within the Reserve. Rakiura green skinks were once widespread on the

² Threat classifications are from Hitchmough R., Barr B., Knox C., Lettink M., Monks J. M., Patterson G. B., Reardon J. T., van Winkel D., Rolfe J. & Michel P. (2021). *Conservation status of New Zealand reptiles, 2021*. New Zealand threat classification series 35. Wellington: New Zealand Department of Conservation.

					mainland, however, populations are unmanaged and likely in significant decline.
Southern skink <i>Oligosoma notosaurus</i>	At Risk – Declining	Throughout Rakiura, including Whenua Hou/ Codfish, Herekopare, Kundy, Betsy, Putauhina, and Taukihepa/ Big South Cape Islands.	Moderate-high	Yes	Likely historically present within the Reserve in open, sunny sites. It is somewhat surprising that this species has not (yet) been discovered within MPCR.
Southern grass skink <i>O. aff. polychroma</i> Clade 5	At Risk – Declining	Lee Bay, Mason Bay, East Ruggedy, Little Hellfire, Big Hellfire, Tin Range, Whenua Hou/ Codfish Island; translocated to Ulva Island (source: Old Sand Neck). Also Ruapuke and Green Islands.	Present	N/A	The species is already present.
Small-eared skink <i>O. stenotis</i>	Threatened – Nationally Vulnerable	Mount Anglem, Mount Rakeahua, Table Hill, Blaikies Hill, east of Mount Allen.	Nil	No	This species is limited to high-altitude herbfields and fractured rock slab habitat, and therefore not appropriate for translocation into MPCR

Table 2: Relevant Objectives and Actions from the MPCR Restoration Plan (Newell & Stowe 2020) and our comments.

Objective	Action	Comment
Objective 1 Undertake a review of MPCR’s biosecurity and implement any recommendations.	Continue to maintain existing bait lines and trap stations for animal pests throughout MPCR, including the fenced cells and immediately outside the fence.	Critical, ongoing task.
	Continue to test & adopt new innovations & approaches to biosecurity, run a feasibility study to find better tools (e.g. thermal imaging) to improve detection of incursions.	Innovation is essential to improve effectiveness and efficacy of pest control.
	Ongoing, regular pest monitoring inside MPCR - Fast response to incursions or spikes in pest numbers - Better understanding of the types of incursions and the impact on native flora and fauna.	Fence breaches and rimu masting are significant issues for pest management at MPCR.
	Investigate methods to prevent low tide access for cats and other pests at Lee Bay.	Effective management of cats and rodents are essential for protection of current and future faunal values.
Objective 5 Quantify the current diversity of biota at MPCR through research, surveys and monitoring to understand what biota are present now and provide key information to assess future changes over time in a predator-free environment.	Seek advice from appropriate experts on setting up monitoring for specific fauna groups to assess changes over time resulting from management, ecosystem health, or to enable comparisons between taxa inside (predator-free) and outside of the Reserve - Robust but affordable methods for gathering information on fauna in the Reserve to be used to measure changes over time; the progress/success of management practises; and identify priorities for future management and research.	Comparative population monitoring of resident lizard populations within and external to MPCR is difficult, but a well-designed post-translocation study using soft-release pens improves the likelihood of securing sufficient data to determine outcomes over time through the four stages of translocation success (Miller <i>et al.</i> 2014).
	Undertake lizard monitoring survey - Quantify current lizard species distribution on which to base management and track future change.	The results of the lizard survey are in this report.
	Lizard monitoring training for community - Affordable monitoring undertaken by the community to inform management.	This project contributes towards lizard monitoring training, although further training is required.
Objective 6 Establish & improve ongoing monitoring and reporting systems to capture and communicate long-term	Remeasure monitoring plots and surveys for key flora and fauna at the appropriate intervals, with key species and remeasurement intervals determined by the expert group (see Objective 5) - quantify changes in key biota over time to determine the impact of management practises, pest incursions and stochastic events - Report on the data/results to the public, sponsors and funders.	It is recommended that monitoring lizards is on the basis of post-translocation population monitoring only.

management performance and ecosystem health.	Add all new data to the GIS, including initial flora & fauna datasets and remeasurements, pest plant survey and control results, photo points for restoration planting sites, biosecurity incursions.	Lizard sightings should be recorded and added to GIS.
Objective 8 Restore or re-establish appropriate flora and fauna to MPCR.	Undertake a desktop study to identify which birds and reptiles could have been historically present but are no longer present. - List of birds and reptiles known to be historically present in MPCR.	This report provides a desktop study on the lizard fauna potentially present historically.
	Obtain advice from DOC and relevant conservation specialists on the suite of bird and reptile species that could be suitable for reintroduction to MPCR and can contribute to broader Predator-Free Rakiura goals (e.g. as a soft-release staging post for wider reintroductions). - Establish or use existing national protocols for determining the suitability of species for translocation. - Create a prioritised list of birds & reptiles suitable for translocation.	This report provides advice for lizards, but not tuatara.
	Monitor populations of bird species (rifleman, brown creepers, Stewart Island robin) translocated to MPCR between 2008 & 2013 to measure population trends as part of planning for future translocations. - Quantify the populations and spatial extent of species previously translocated to MPCR.	Determining the success of previous faunal translocations assist in determining whether additional translocations should occur.
	Undertake a site-habitat assessment for the most suitable species using local knowledge, the vegetation community map and GIS to identify suitable habitat. - Identify the current size and location of specific habitat for potential translocation species. - Determine if current habitat needs to be enhanced/modified to suit target translocation species. - Identify all steps required to ensure suitable habitat, appropriate habitat size and protection & identify potential hazards, issues. If appropriate, develop and submit a proposal to DOC to translocate identified species to MPCR – 2021-28.	This report makes recommendations on potential sites for lizard translocations.
	Provide predator-free habitat for rare and threatened species	Most of Rakiura’s lizards are highly vulnerable to predators, due to their late maturity, low fecundity and long-life spans.
	Undertake any habitat and biosecurity requirements in preparation of translocation. 2023-26	Additional exclusion fencing and a rodent trapping or bait station halo around lizard translocation sites is likely to be required.
	Appropriate habitat requirements for target species. Translocate individuals of nominated species.	This report makes recommendations on potential lizard species and sites for translocations.

	- Provide predator-free habitat for rare and threatened species. Translocate 2025/26 + 2027/28 + 2029/30	
	Undertake monitoring of translocated species. - Determine establishment and any habitat adjustments required ongoing	Post-release population monitoring of translocated lizard species is an essential part of translocation activity and could require a 20+ yr time period to determine outcomes for some species.
	Consider 'population reinforcements' for translocated species. - Improve the genetic diversity and long-term sustainability of species.	Supplementary animals could be released into MPCR, such as lizards captured elsewhere in Rakiura by cats.
Objective 9 Restore degraded indigenous vegetation to create resilient, sustainable and regionally appropriate ecosystems in MPCR.	Use the vegetation map and other ecological information to identify the additional areas for vegetation restoration for 2022 to 2030.	It is recommended that consideration be made to identify vegetation types and locations to retain for lizard translocations.
	Spray rank grass and bidibid as part of site pre-planting preparation to improve survivorship and establishment of restoration plantings.	Spot-spraying herbicides needs to be taken with care as not to result in lethal or sublethal effects on lizards. It is recommended that spraying is undertaken during cool, overcast days when lizards are inactive.
	Initiate and complete the One Billion Trees planting project. - 17ha of planted land along the coastal slopes of MPCR.	There is a need to maintain some areas of open grassland/shrubland as suitable habitat for translocated lizard species in the future.
Objective 10 Formalise protection of MPCR to ensure the conservation achievements will continue in perpetuity	Progress legal protection of the Reserve through QEII Covenant protection.	Legal protection of release sites are a critical consideration when approving faunal translocations.

The 10-year MPCR Restoration Plan (Newell & Stowe 2020) includes development of a MPCR Lizard Management Plan, detailing survey results, long-term monitoring design, and future recommendations for lizard conservation, including potential special translocations and involvement of the local community. Further, the Trust has identified high level objectives for lizards as follows:

- Ensuring the preservation of the existing lizard population as best as we can;
- Enhancing the lizard biodiversity via translocations where practical;
- Making lizard biodiversity accessible by the public to improve awareness and appreciation of this important aspect of our native fauna;
- Generating income for the charitable trust via eco-tourism that can be channelled back into ongoing biosecurity.

Pest animal management

The ongoing control of non-native mammals is critical to the health of both flora and fauna within the reserve, and to the potential of the site for future species translocations (Stowe 2019). Intensive pest control has been in place since about 2000. The Xcluder predator proof fence is the first and arguably the most important aspect for maintaining pest numbers to low or non-existent levels (Ritchie 2018). A second line of defence is provided by fenced cells on the MPCR side of each end of the fence. The third line of defence is provided by trapping and baiting throughout the property and immediately outside the biosecurity fence.

Pest animal management is targeted at feral cats (*Felix catus*), all three species of rat (*Rattus* sp.), and possums (*Trichosurus vulpecula*). It is not known if hedgehogs (*Erinaceus europaeus*), a serious lizard predator, are targeted.

There are a total of 598 bait stations, and 278 rat traps on a 100 × 50 m distance interval throughout the entire MPCR, including the northern grassland. Brodifacoum has been the main toxin used in bait stations (with Selontra capsules coated in peanut lure). Previously, DoubleTap toxin was trialled with little success. Selontra with the active ingredient cholecalciferol has been used since September 2022, and appears to have been very effective based on bait take in the remaining months of 2022. Bait stations are serviced monthly during times of higher rodent numbers, but reduced to every 3 months when numbers are low. Figure 2 indicates the number of empty bait stations for 2022. Rodent monitoring is through bait uptake and kills, and rodent numbers in 2022 have been high due to a rimu mast.

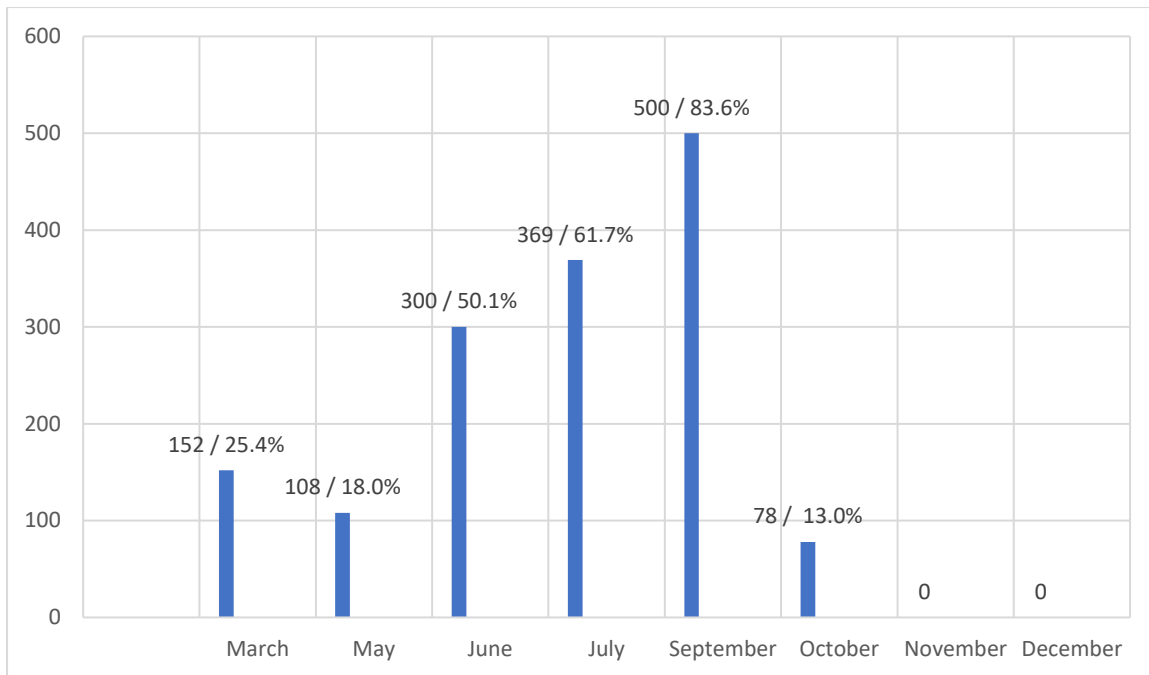


Figure 2: Rodent bait take from 598 bait stations across Mamaku Point Conservation Reserve.

When higher numbers of rodents are detected through increased bait uptake or trap kills, biosecurity efforts are increased or decreased in conjunction with what is happening. Trapping and baiting efforts are increased pre-emptively by MPCR prior to and during rimu masting years.

Of the three rodent species present within MPCR, kiore (*Rattus exulans*) is the more abundant species, usually found in the northern grasslands, with very low numbers of ship rat (*R. rattus*) and Norway rats (*R. exulans*) throughout the forest.

Pest detection dogs are used to tracking any cats, possums or rats that have been detected entering MPCR around fence ends by trail cameras, and shot with the assistance of thermal cameras. In the past tracking tunnels were used to detect incursions, but were not found effective. MPCR is currently undertaking improvements of fence ends to reduce the number of pest animal incursions.

Cat incursions are always recorded using trail cameras, with cats usually entering at Lee Bay during low tide and then they carry on along the coast to Bob's Point. In 2022, 15 cats were detected coming around the fence, and caught or trapped, and 8 caught on the outside of the fence.

A Biosecurity Plan (Ritchie 2018) identifies the likely sources and pathways for invasive species to access Mamaku Point and measures that need to be undertaken at source points for the likely pathways. Currently, the biosecurity system is being overhauled by the Trust, with re-labelling all kill traps and bait stations, clearing bait lines, installing thermal imaging cameras, upgrading fence ends, and using apps to record trap and bait station checks. This effort will improve both record keeping and understanding of pest animals numbers within MPCR at any point in time.

Lizard Survey Methods

Systematic searches were conducted throughout MPCR using visual survey, hand search, funnel traps (Gee's minnow traps) and spotlighting. Closed-cell foam covers were installed throughout the MPCR forest for later survey effort. The different methods target different lizard species, such as arboreal (cloudy gecko, jewelled gecko) or terrestrial species (harlequin gecko, southern skink, small-eared skink, southern grass skink, Rakiura green skink). Survey methodologies are described in more detail below.

Survey periods. The first survey was undertaken between the 17-21 January 2022, using day searching, gee's minnow traps, and spotlighting. A second survey was undertaken between the 17-23 Oct 2022, further survey work was undertaken at MPCR at sites with potential for jewelled gecko, cloudy gecko, and Rakiura green skink, along with addition of closed-cell foam covers for future survey effort.

Survey site selection. In southern New Zealand, most terrestrial lizard species require open habitat types (indigenous or exotic grasslands, scrubland and shrubland; and rocklands such as scree, boulderfields, tors or cliffs) receiving high solar radiation (sunlight). Some lizards can survive under closed canopy forest cover, however, these are typically arboreal geckos. Therefore, the majority of survey effort was undertaken in the northern part of MPCR, which consisted of open, sunny habitat types (habitat subtypes flaxland, tussock grassland, manuka-*Coprosma* shrubland, native and exotic herbland within manuka-mingimingi shrublands, muttonbird-manuka shrublands and hardwood-kamahahi habitat types; Stowe 2019). Day searching and spotlight effort was expended in the forest interior for arboreal gecko species, with a closed-cell foam cover network installed on rimu trees.

Day searching. During trapping operations, visual day and hand searches were undertaken concurrently for both active or inactive lizards (Figure 3), which were identified (if possible) and the location of lizard sightings recorded on a Garmin GPS unit. Lizards, although cryptic and hard to detect in the wild, often give away their presence through sudden movement and sound in response to disturbance. Hand searching in shrubs, tree ferns, under loose bark, creviced granite or gabbro rock outcrops, and fallen wood was also undertaken for inactive lizards.



Figure 3: Day search tracks undertaken throughout Mamaku Point Conservation Reserve during January and October 2022.

Spotlighting. Spotlighting is a suitable survey method for arboreal diurnal and nocturnal gecko species in shrubland and forested habitats. 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. Nocturnal geckos produce bigger reflections with a pink to white eye shine than diurnal geckos. Furthermore, the body, and particularly the pale ventral of geckos can be easily distinguished from the surrounding vegetation when they are spotlighted. During the night of 16 January 2022, spotlighting using LedLenser H14 2000 lumen headlamps with binoculars was undertaken along the fence line from the MPCR base to Lee's Bay and on the 17 January 2022, a much larger area was spotlighted, from the fence line to trapline 14 and back to Lee's Bay (typically between 2100 – 0200 hours; 12 person hours). Temperatures during the spotlight evenings were between 15-20° Celsius on dry evenings without precipitation or dew, in the absence of wind, and 1/8 to 6/8 cloud cover. Spotlighting was not conducted between 18 to 20 January 2022 due to rain. Spotlighting was repeated on 17 October 2022 from the fence line to the north-western end of MPCR for jewelled geckos and cloudy geckos (six person hours); although there was a light drizzle towards the end of the spotlight survey, this was unlikely to affect results as this targeted the coastal shrubland. Large trees, most sub-canopy trees and shrubs, and the predator-exclusion fence were spotlighted (Figure 4).



Figure 4: Spotlight tracks undertaken throughout Mamaku Point Conservation Reserve during January and October 2022.

Gee's minnow traps. Gee's minnow traps are a type of inverted funnel trap made of wire mesh and have an inverted funnel at each end (Figure 5). Lizards are trapped when they climb through the narrow funnel entrance and are unable to find their way out. These were baited with sliced pears. A sponge soaked in water was kept in each trap to prevent dehydration by the trapped individuals. Grasses and other vegetation were added to the traps, to blend the trap with the surrounding vegetation, and provide protective cover for trapped lizards. These traps are checked at least once every 24 hrs. Once data has been collected, lizards are released outside of the trap.

Forty-nine (49) gee's minnow traps were installed across the northern MPCR and operated for four days (169 trap nights), with 40 traps relocated daily to maximise trapping area coverage in January 2022. Twenty-one (21) gee's minnow traps were run for four days (84 trap nights) in October 2022. Traps were marked with flagging tape and location recorded using a GPS unit (Figure 6). A total of 253 trap days were achieved.

In January 2022, twenty-five traps were placed in manuka-mingimingi shrubland. Thirteen traps were placed in exotic grasslands mainly in areas of higher elevation near the northern coastline. Eight traps were placed two areas of flaxland. Four traps were placed in herbland containing bidibid (*Acaena novae zelandiae*) and birds-foot trefoil (*Lotus corniculatus*) along the western coastline of Mamaku Point. In October 2022, all 21 traps were placed in exotic grasslands surrounding a wetland near Lee Bay, specifically targeting Rakiura green skinks.



Figure 5: Gee's minnow trap.

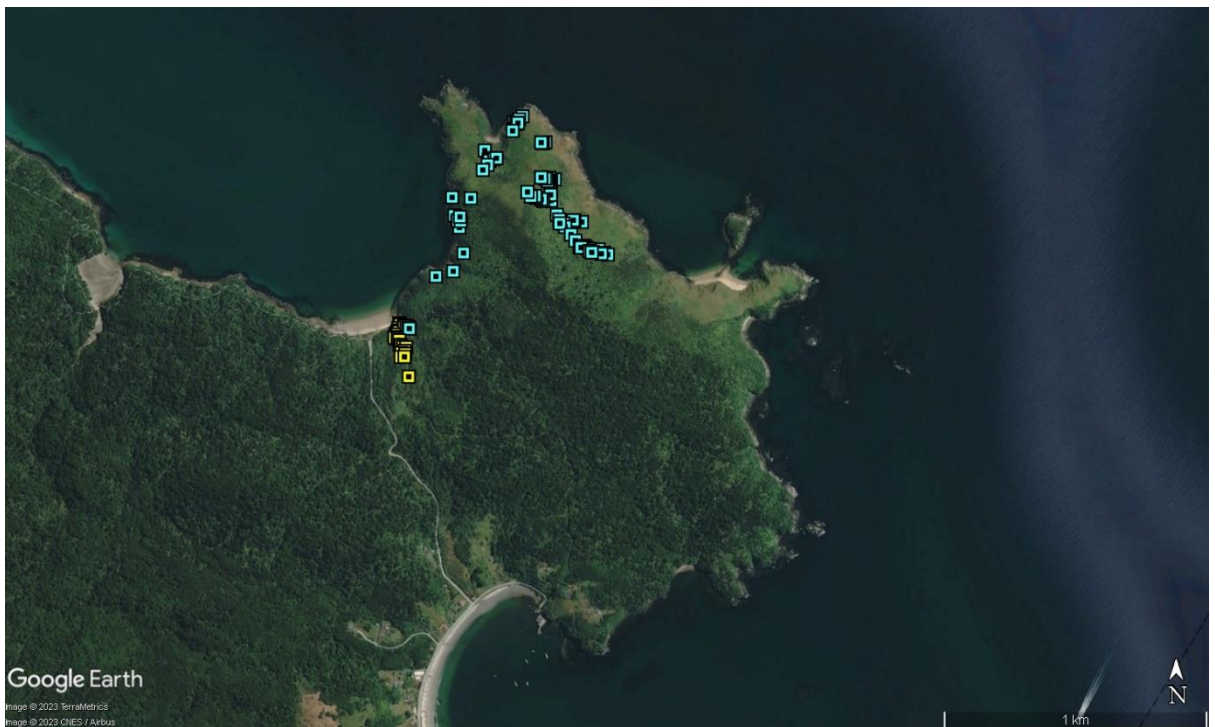


Figure 6: Locations of gee's minnow traps installed throughout Mamaku Point Conservation Reserve in January and October 2022. Blue squares represent the locations of the January 2022 traps while yellow squares represent the October 2022 trap locations.

Closed-cell foam covers. Sixty-four black polyethylene closed-cell foam covers, measuring 60 mm long and 30 mm wide and 5 mm thick (Figure 7, Bell 2009), were placed throughout MPCR along pest control lines at chest height on tree trunks, typically in a sunny, north-facing orientation in October 2022. These covers are designed to mimic split bark and hollows in trees in which fauna often colonise and were installed specifically for cloudy gecko, which are a highly cryptic arboreal gecko species. The covers were nailed to the trees using six 60 mm flat-head nails, fitted flush on each side to prevent wind and rain entry, but finger sized gaps are created along the centre of the cover to create refuges for geckos to occupy. They are to be checked in the future by wildlife-permitted sanctuary staff and visiting experts for cloudy gecko, during mainly during cool but dry weather conditions (typically overcast days), with low to moderate wind. The locations of the closed-cell foam covers were fixed using a Garmin GPS unit and are shown in Figure 8.



Figure 7: Closed-cell foam cover from another study.



Figure 8: Locations of closed-cell foam covers installed at Mamaku Point Conservation Reserve. White circles represent the locations of each cover and blue lines represent the pest control lines.

Weather. The weather conditions during most of the January 2022 survey effort was warm ($15^{\circ}+$ Celsius), sunny and calm. Terrestrial microhabitats were warm, conducive to lizard activity such as sunbasking, and thus increasing the likelihood of detection or trapping of lizards. During the October 2022 survey, there were several periods of cool conditions with rain, which may have affected lizard capture rates. However, conditions for one day was suitably warm, sunny and calm for lizard surveys.

Data collection, organisation, and analysis. Search effort (date, location, time start and finish) and trapping effort (number of traps, trap days and trap location) were recorded. Lizard species were identified on capture. The following measurements were taken from each individual captured: body size as snout-vent length (SVL, in mm) as a proxy for the age class of the animal (neonate, juvenile or adult), total tail length (TL), and length of regenerated portions of tail if present. The sex of subadult and adult skins (SVL > 50 mm) was determined by examination of the internal and external features of the cloacal region. Locations of capture or sightings were recorded as waypoints using a hand-held Garmin GPS unit. Habitat and microhabitat data was also recorded.

Wildlife Authorisation. The survey field work was completed under an appropriate Wildlife Act Authority issued to Wildland Consultants by the Department of Conservation (DOC), and was carried out by Trent Bell, an experienced herpetologist, and Daron Titus, a Southern Institute of Technology student working under the herpetologist's supervision.

Results

In January 2022, 29 individual southern grass skink (*Oligosoma* aff. *polychroma* Clade 5) were trapped ($n=21$) or seen ($n=8$) (Figures 9, 10). During the day, lizards were seen running through rank grasslands, and were usually identified as southern grass skinks. Of the 21 captured, 14 were males, five were females and two were juveniles; indicating a trap bias towards adult males. Two of the five females were pregnant. Spotlighting effort did not result in detection of lizards. No other lizard species were detected. Lizard capture locations and data is shown in Figure 11 and Appendix 2, respectively.



Figure 9: Southern grass skink captured at Mamaku Point Conservation Reserve. PHOTO: DARON TITUS.

In October 2022, only 2 southern grass skinks were found, as unfortunately the weather at the time was mixed, affecting trap returns. however, 64 closed cell foam covers were put up within the forest along pest lines for future checking by sanctuary staff and volunteers as they undertake routine pest control operations.



Figure 10: Southern grass skink captured at Mamaku Point Conservation Reserve. PHOTO: TRENT BELL.

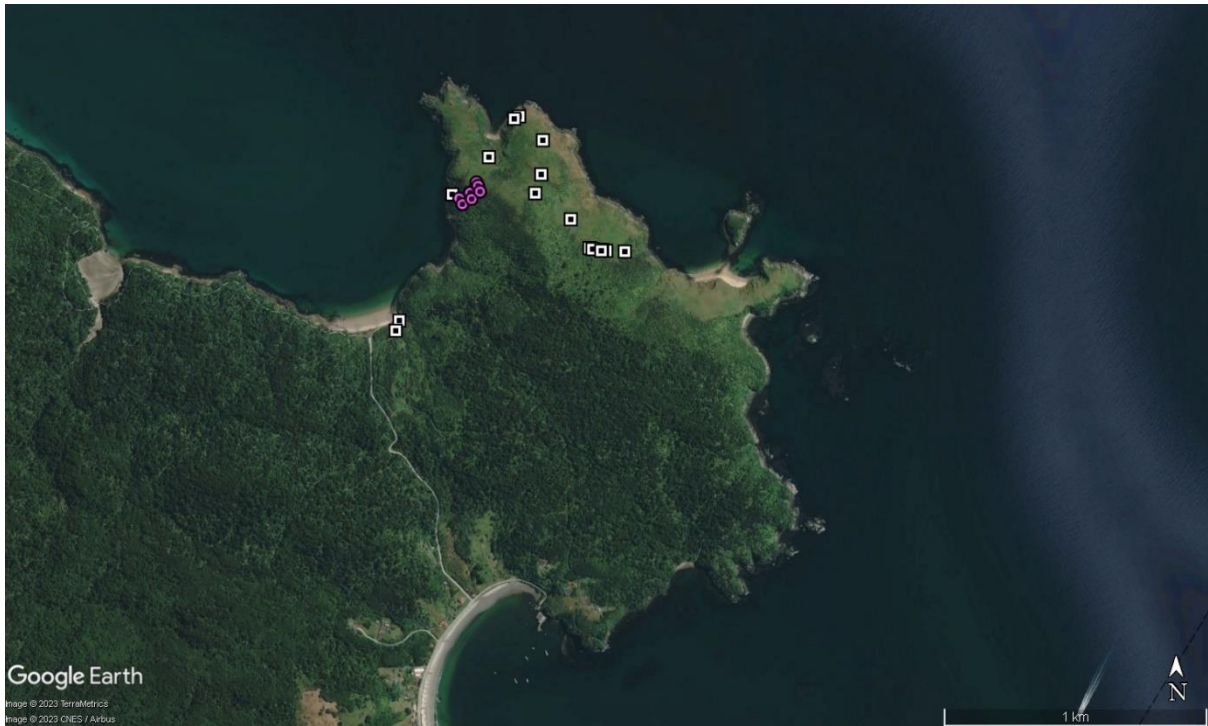


Figure 11: All known southern grass skink records to date for Mamaku Point Conservation Reserve. White squares are the records from this survey. Purple circles are records from Lalor (2019).

Brown tree frogs (*Litoria ewingii*), an exotic species, were found in small ponds near the exclusion fence.

The coronavirus outbreak and associated lockdowns created difficulties for community training opportunities during the surveys. In October 2022, Trent and Carey Knox co-delivered a community talk about Rakiura’s lizards and their conservation requirements (Appendix 1). Further community training will be provided in the future.

Discussion

Although currently only one species of lizard is known within MPCR, the reserve is likely to support as-yet non-detectable populations of other species. The widespread and abundant southern grass skink population confirm that Mamaku Point is suitable for a wide range of reptile species, some of which may be translocated there. Non-detected lizard species could include cloudy gecko, jewelled gecko, Rakiura green skink, and southern skink. The habitats present at MPCR is large, diverse and complex, and considered excellent for lizards.

Historically, MPCR would likely have supported a lizard fauna of at least five species: cloudy gecko, jewelled gecko, Rakiura green skink, and southern skink, as well as southern grass skink. It is uncertain whether harlequin geckos are or were once present. It is not likely that small-eared skink ever was present due to their ecological requirements.

Rakiura green skink and tuatara are currently considered by MPCR as high priority species for translocation. Other Rakiura lizard species that could potentially be considered for translocation are harlequin gecko, cloudy gecko, jewelled gecko and southern skink (Table 1), but significant thought needs to be given on their merits. It is possible that some of these lizard species are still surviving in Mamaku (particularly southern skink, cloudy gecko, and jewelled gecko) but these may still be at such low abundances that they remain undetectable. Passive surveillance by sanctuary staff and volunteers, and the occasional intensive day search or spotlighting effort by visiting herpetologists are the most likely opportunities for discovery of these species in MPCR. Rare and cryptic lizards are sometimes first discovered through incidental chance encounters by non-experts, despite prior expert survey efforts at the same sites.

Rodents are still present within MPCR, although we currently have relatively little time-series information on abundance, apart from bait take data from March – December 2022, in which take was as high as 83.6% in September, however, this was quickly brought down to 0% in November and December. Rodent numbers outside MPCR however likely remained very high without management and severely affected native species throughout Rakiura. Due to the slow-breeding abilities and significant vulnerability that most Rakiura lizards have to rodents, recovery in lizard populations is likely to be extremely slow if rodents remain in any abundance anywhere on Rakiura.

The continued presence of rats is an ongoing threat to the flora and fauna of both Rakiura and MPCR itself. Fortunately, Rakiura is not currently known to support a mouse population, so rodent management (for kiore, ship rats and Norway rats) in MPCR will not lead to elevated numbers of mice, which may have otherwise impacted on the lizard fauna. In addition, rodent numbers outside MPCR typically remain unmanaged for much of Rakiura.

Despite the continued presence of rodents, and probably hedgehogs, within MPCR, translocation of the threatened Rakiura green skink and harlequin gecko is strongly supported. This is because both species are highly vulnerable to cats, rodents and hedgehogs on the largely unmanaged Rakiura mainland. New populations within MPCR would provide respite from the stronger predatory pressures elsewhere on the mainland, and improve the species' potential resilience in the face of climate change. Considering existing opportunities both for Rakiura green skink and harlequin gecko in the immediate future, translocation into MPCR may be the most currently feasible and impactful action to take for species conservation.

Tuatara are currently being investigated as a potential species for translocation into MPCR, therefore there is a need to account for tuatara in lizard translocation planning. The two can co-exist as they do in significant abundances on New Zealand's offshore islands, but it is recommended that translocated tuatara and lizards are released at different locations within MPCR.

Although there are no known records of kiwi depredation events on lizards in New Zealand, this is a possibility that also needs to be considered. Low barrier fencing may be required to exclude foraging kiwi, and hedgehogs, from lizard release sites.

Recommendations

Below we provide our recommendations for management at MPCR, in relation to supporting lizard populations at the reserve.

- **Investigate strategies and techniques to enhance the suppression of cat and rodent numbers within Mamaku Point Conservation Reserve.** Trail cameras, thermal cameras and cat traps at the predator fence ends have now been set up by MPCR to reduce cat incursions, followed up by pest detection dogs and trail cameras to eradicate incursions. Rodents are the main threats to lizards within MPCR. For lizards to recover or establish as translocated populations, rodents will need to be eradicated or kept to <5% (i.e. recorded only as incursions, but not present as populations within the sanctuary). A network of bait stations containing appropriate toxin at fence ends and across MPCR may be an economical solution to manage rodent incursions. Bait station intervals will likely need to be at 50 × 50 m across the northern grasslands if kiore numbers are to be effectively suppressed especially during rimu and tussock masting events.
- **Addition of hedgehogs as a target pest animal.** Hedgehogs have no natural predators, reach very high local densities and are now known to have a severe impact on lizards and invertebrates. Nothing is currently known about hedgehog numbers within MPCR. DOC200 traps are suitable for hedgehog control, and are also effective for rats too; hedgehogs may also be excluded from sensitive areas (eg. translocation sites) through barrier fencing.
- **Rodent monitoring is undertaken at periodical times of the year using tracking tunnels, and a reference site is included in the monitoring.** During the rimu masting event of 2022, high rodent numbers were seen in MPCR, which the reserve has responded by bringing numbers from 83.6% to 0% within two months. However, without reference data, the Trust is unable to show context by comparing rodent numbers to those in unmanaged sites. Best practice rodent monitoring resources can be found here: <https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/animal-pests/> and particularly the resource for tracking tunnels: <https://www.doc.govt.nz/Documents/science-and-technical/inventory-monitoring/im-toolbox-animal-pests-using-tracking-tunnels-to-monitor-rodents-and-mustelids.pdf>. Tracking tunnels indices are a good monitoring method that is independent of bait take indexes or residual catch rates.
- **An application by MPCR for a Wildlife Act Authority is submitted to the Department of Conservation to undertake lizard surveys and monitoring programmes at Mamaku Point Conservation Reserve.** This is to ensure that sanctuary staff and volunteers are legally authorised to work with lizards, as protected wildlife. The Wildlife Act Authority (wildlife permit) application process is also a good way to consult tangata whenua. (Note this is not an application for a permit to translocate lizard species, but a permit to survey and monitor resident lizard species within MPCR.)
- **Periodical checks of closed-cell foam covers, and Onduline artificial cover objects (or similar) and spotlighting should be undertaken over time by MPCR staff and volunteers, and the occasional visiting ecologist with appropriate skills and experience.** Artificial retreats are far less weather dependent than live capture trapping, day searching or

spotlighting. If a suitable experimental design is developed, these can also be used as a monitoring tool to determine population trends over time. They are also methodologies that are more accessible for Trust members, iwi and community volunteers. The hope is that continued efforts may eventually find Rakiura green skink, jewelled gecko, or cloudy gecko.

- **Develop a suitable reporting system for lizard records at MPCR, whether lizards are found by incidental sightings or through systematic searches or monitoring effort.** These records should also be passed on to the Department of Conservation for submission into the BioWeb *Herpetofauna* Database.
- **If populations of Rakiura green skink or cloudy gecko are found present, develop a long-term lizard monitoring design for MPCR using artificial retreats.** Population monitoring conceptually could consist of 7 non-consecutive days of lizard monitoring (species-specific, depending on the species found present) conducted in summer every 5 years, using a sufficient number of artificial cover objects and closed-cell foam covers to determine abundance. This monitoring is to be undertaken to indicate lizard population abundance and trends over time for selected species, but not southern grass skink. Development of more intensive monitoring designs should be considered in the event that threatened lizard species are discovered within MPCR, or are translocated into the Reserve.
- **Formalise legal protection of MPCR to ensure conservation achievements will continue in perpetuity.** This can be achieved through placement of a QEII covenant on the property and would meet Objective 10 of the Restoration Plan (Newell & Stowe 2020). Legal protection of release sites are normally expected before faunal translocation projects are approved.
- **Conservation opportunities for lizards at Mamaku Point include translocation of threatened lizard species from unmanaged sites (non-predator controlled) elsewhere on Stewart Island into predator-managed MPCR.** Our recommendation are to reopen the historic application to translocate Rakiura green skink into Mamaku Point Conservation Reserve and include southern skink, cloudy gecko and harlequin gecko. In 2013/14, Kari Beaven of Solutionz acting for the Dancing Star Foundation applied for a permit from the Department of Conservation to translocate green skink (then known as *Oligosoma chloronoton*) from Whenua Hou and Mason Bay to MPCR. The application went through the permit process and the resultant permit was to be issued by the Department with the support of Kaitiaki Ropu ki Murihiku when the applicant withdrew it on the 7 April 2014 prior to the translocation going ahead later that month. This decision was likely due to failure of a funding application made by the Foundation for the transfer. In 2023, the Department has indicated that they are happy to further support the translocation proposal process, and would welcome a re-application. A potential release site at Lee Bay within Mamaku Point has been identified as suitable for these skinks. Mamaku Point Conservation Trust may need to apply for further funding to help with the harvesting of Rakiura skinks from a source location, undertake release site set up, and undertake post-release monitoring.

In parallel with the re-submission of a translocation application for Rakiura green skink, an application to relocate southern skink, cloudy gecko and harlequin gecko could be proposed. Southern skinks were likely present within MPCR, and they may remain undetected. However, experimenting with initial translocations of southern skink offers opportunities to develop hands-on translocation skills in the Trust for rarer species such as Rakiura green

skink, cloudy gecko and harlequin gecko. Translocating southern skinks also allows initial testing of translocation outcomes at MPCR. It is recommended that southern skink be sourced from Mason Bay.

It is recommended that a survey is undertaken for harlequin gecko in the Anglem Ecological District in by 2025, before consideration is made to (re)-introduce these geckos to MPCR between 2026-28. Although MPCR is currently outside the known range and habitat for harlequin geckos, this does not necessarily mean that they were never present. Currently, the harlequin gecko does not receive benefits of a predator-managed reserve within their range. These geckos remain at significant risk from feral cats, hedgehogs, and significant unmanaged rodent irruptions that may arise from rimu or tussock masting – a phenomenon that may become more frequent under climate change. Their likely slow-to-mature development, and very low fecundity make them inherently vulnerable to unmanaged threats. An accessible harlequin gecko population located at MPCR will enable significant research on the gecko's biology (such as reproductive rates, longevity), ecology, activity, and behaviour. In addition, the testing and refining the development of sampling and monitoring tools would be possible.

Similarly, conservation knowledge of cloudy geckos could potentially be improved significantly through a monitored translocation of these geckos into a core soft-release penned site at MPCR. Little is known about the biology and ecology of these geckos, but these geckos have apparently not yet recovered from (now eradicated) predators on Whenua Hou. Research into the gecko's biology and ecology would improve our understanding of the species' vulnerabilities and conservation requirements. Closed-cell foam covers have proven to be effective in monitoring *Mokopirirakau* geckos, including translocated species. These geckos could potentially be translocated from Te Marama/ Herekopare.

If kiore numbers could be suppressed to <5% year-round in the northern grasslands through a 50 × 50 m bait station grid by 2026, as evidenced by tracking tunnel monitoring, and lizards are released within a soft-release pen within a predator-fence within MPCR, then a translocation of any of these rarer species could be supported.

A recommended sequence of translocation events could be as follows: southern skink (2024) – Rakiura green skink and harlequin geckos (2026-28) – cloudy geckos (2030).

These translocation events should involve academic students undertaking intensive post-release monitoring studies.

- **Ensure Trust, community and mana whenua involvement in lizard projects at MPCR, under initial supervision and guidance of wildlife professionals before complete handover to Trust members.** Training during survey and monitoring programmes under the supervision of sufficiently experienced ecologists ensures that the Mamaku Point community can implement such work in the future without need for professionals (other than on an advisory basis). These lizard experts will be able to continue passing on their skills and knowledge regarding lizards of Stewart Island. Trust, community and iwi members should acquire skills with lizards (capturing, handling, identifying, processing and releasing) in time, which will enable them to work with lizards within Mamaku Point, such as via future

population monitoring programmes and lizard translocations. The role of the Department of Conservation and academia in supporting the community in lizard work should also be explored. This helps ensure long-term self-sufficiency and sustainability of lizard work at MPCR.

- **eDNA analyses of rodent gut or fecal samples may potentially identify the presence of undetectable lizard species within MPCR. Similarly, this technique may be able to identify other rodent prey.** This could be a potential student project, and Wilderlab (<https://www.wilderlab.co.nz/>) provides eDNA analyses services.

Acknowledgements

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References

- Bell, T.P., 2009. A novel technique for monitoring highly cryptic lizard species in forests. *Herpetological Conservation and Biology* 4(3), pp.415-425.
- Bell, T. & Wiles, A. 2015. Describing lizard and frog distribution and species assemblages using the Ecological Districts framework. *BioGecko* 3: 19-34.
- Hitchmough, R.A., Barr, B., Knox, C., Lettink, M., Monks, J.M., Patterson, G.B.; Reardon, J.T., van Winkel, D., Rolfe, J., Michel, P. 2021: Conservation status of New Zealand reptiles, 2021. New Zealand Threat Classification Series 35. Department of Conservation, Wellington. 15 p.
- Jewell, T. 2022. Discovery of an abrupt contact zone supports recognition of a new species of grass skink in southern New Zealand. Jewell Publications Occasional Publication #2022B.
- 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
- Newell, C & Stowe, C. (2020). Mamaku Point Conservation Reserve Restoration Plan 2021-2030. Mamaku Point Conservation Trust.
- Ritchie, J. (2018). Mamaku Point Biosecurity and Incursion Management Plan 2018. Mamaku Point Conservation Reserve.
- 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>

Appendix 1

Nga mokomoko o Rakiura

Brief species descriptions and ecology and habitat preferences of Rakiura's lizards



Nga mokomoko o Rakiura

The lizards of Stewart Island

Trent Bell & Carey Knox

Oban, Stewart Island, 22 October 2022



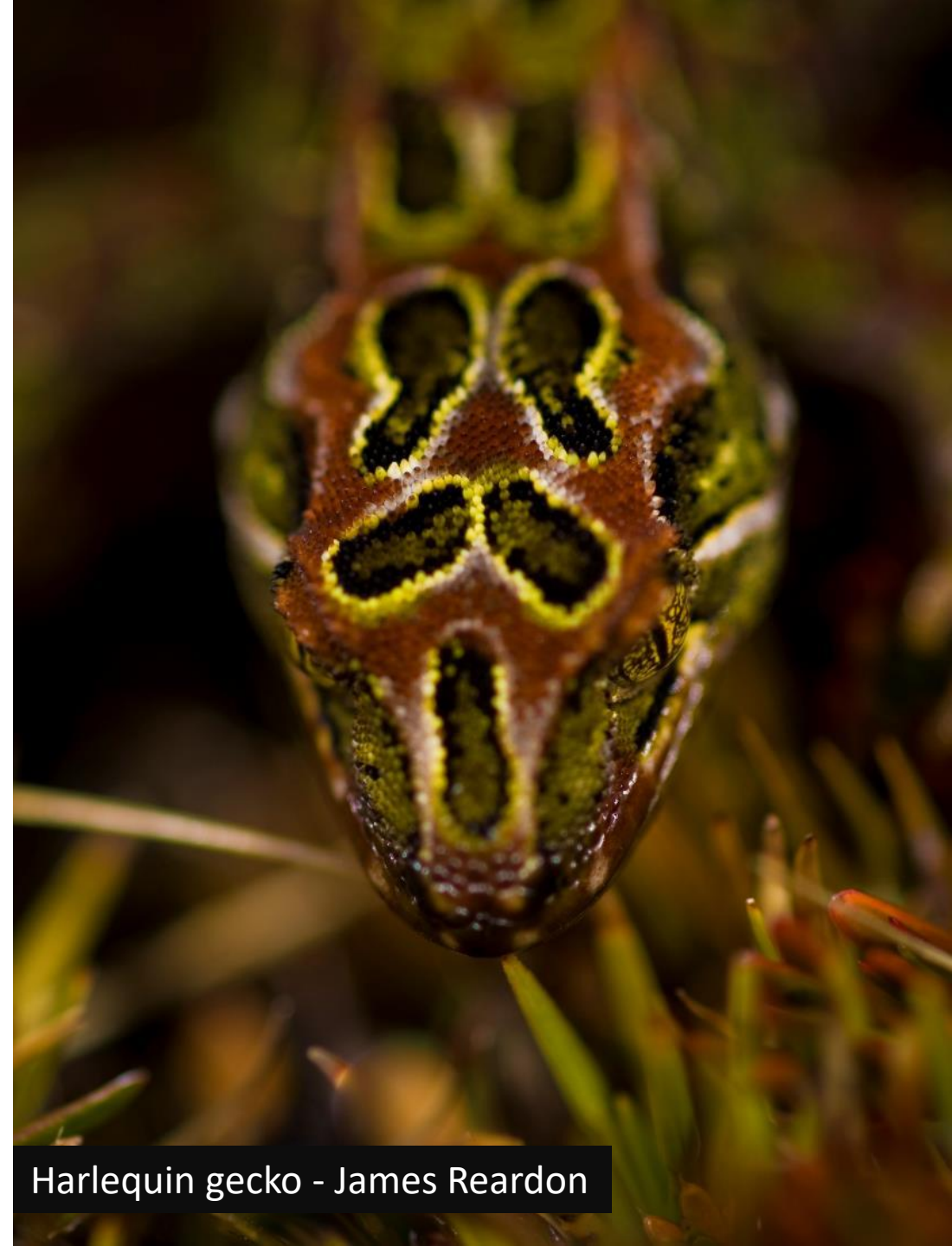
Introductions

Harlequin gecko – Carey Knox

- My name is Trent Bell. I am profoundly deaf, and have a 'Deaf accent', you might struggle to understand me when I speak.
- To help you follow my speaking, I generally read off the slides.
- I am a professional herpetologist currently doing lizard surveys at Mamaku Point Conservation Reserve.
- Carey Knox is a herpetologist and lepidopterist (moths and butterflies).
- Carey will help with any questions and answers.

Purpose of this talk

- Increase awareness of Rakiura's lizards in the local community
- Highlight the threats to their survival
- Advocate for their conservation on the island
- Support the implementation of practical actions that may make a difference
i.e. what can we do?



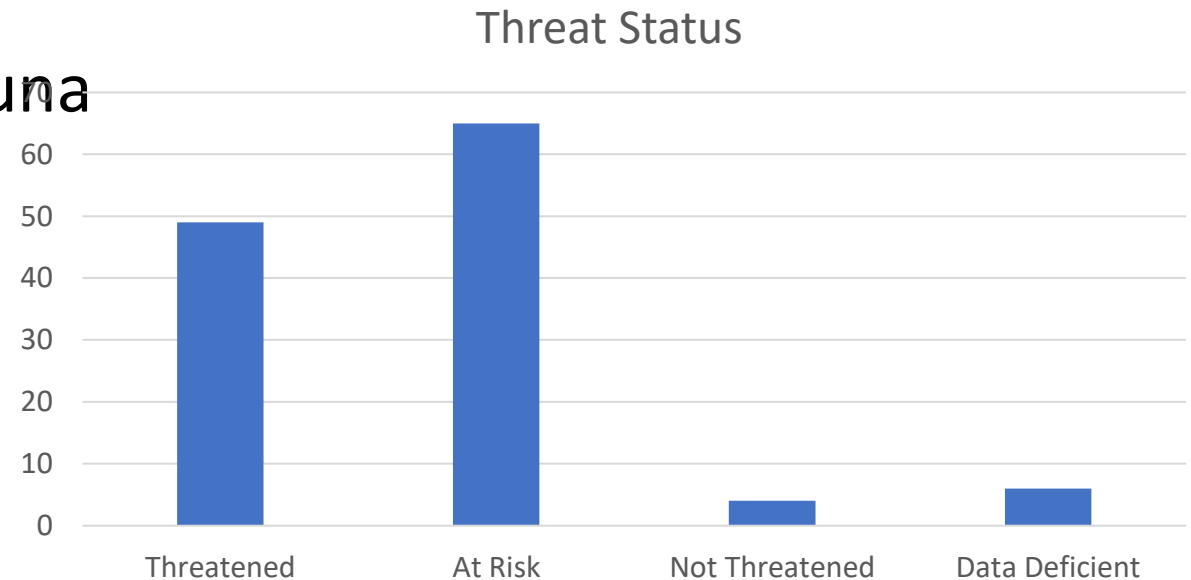
Harlequin gecko - James Reardon

New Zealand: a land of lizards

- New Zealand has 124 species of lizard, making our country one of the most diverse temperate assemblages for lizards on the earth
- New species of lizards continue to be discovered almost every year

- However, a highly threatened fauna

- 40% are Threatened species
- 52% are At Risk



- Most species of New Zealand's lizards are threatened by introduced predators in particular, because they are:
 - geared to live much longer (mainly 10-20+ yrs, some to ~60+ yrs)
 - slow breeding (low reproductive output) – biennial or more cycles in development of young in some species
 - are viviparous (retain young until birth)

When a pregnant female lizard is killed by a predator, the young also die. In contrast, many similar lizards overseas are shorter lived, have higher breeding outputs and lay eggs.

- NZ's lizards are also evolutionarily naive to predatory mammals, as New Zealand did not have such predators for 80 my
 - Poor self defence / escape abilities

Lizard diversity in New Zealand

A (really quick) overview of the lizard fauna across the country

- Seven gecko genera / 49 species
- Two skink genera / 76 species

Dactylocnemis

Pacific geckos: 6 spp – North Island only



Pacific gecko – Trent Bell

Hoplodactylus

Duvaucel's gecko: 2 spp – North & South Islands



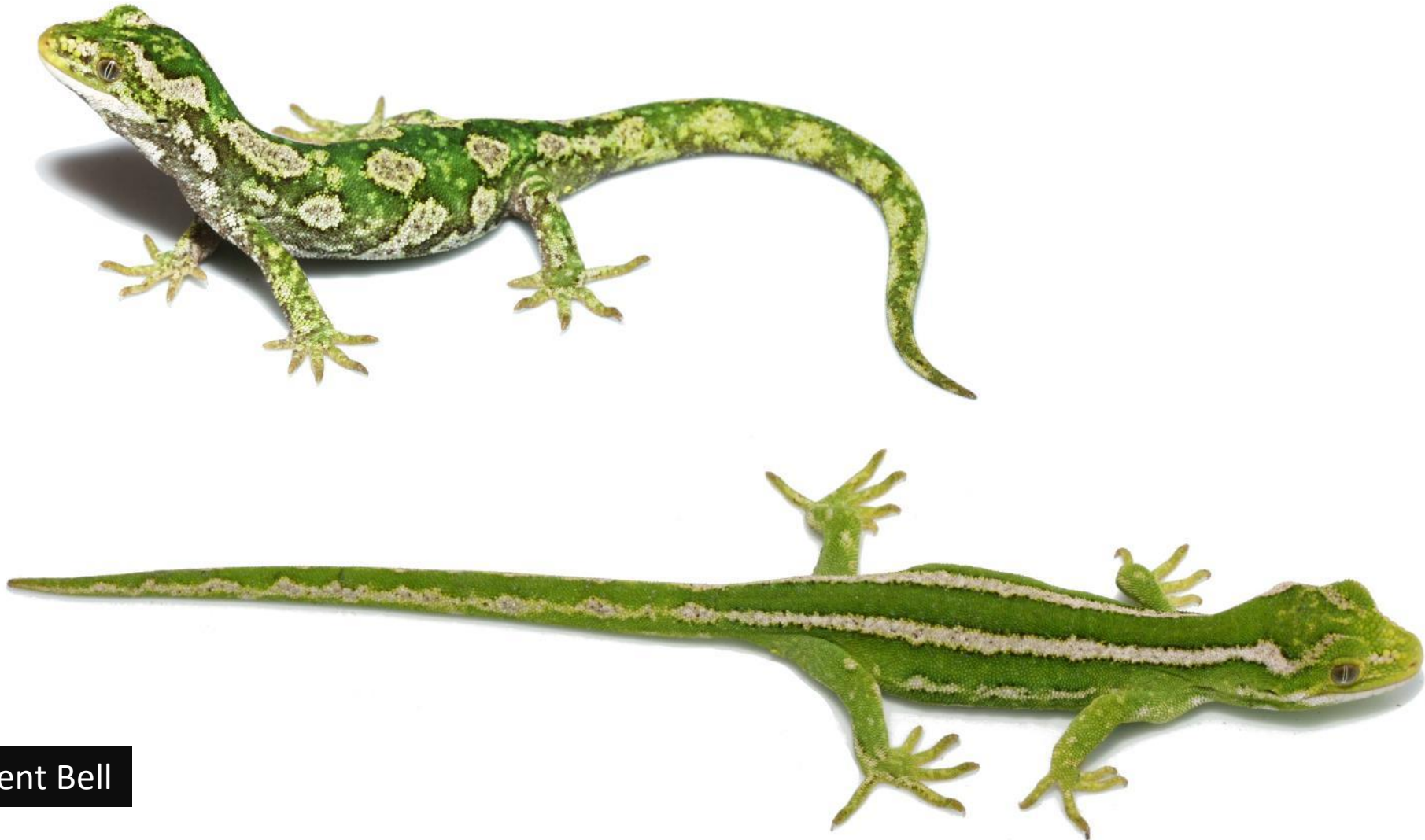
Mokopirirakau

Forest geckos: 11 spp – North, South & Stewart Iss



Naultinus

Green geckos: 9 spp – North, South & Stewart Iss



Jewelled gecko – Trent Bell

Toropuku

Striped geckos: 2 spp –
Coromandel & Marlborough



Tukutuku

Harlequin gecko: 1 sp – Stewart Is only



Harlequin gecko – Dylan van Winkel

Woodworthia

Brown geckos: 17 spp
– North & South Islands



Goldstripe gecko and Waitaha gecko – Trent Bell

Oligosoma

Native skinks: 75 spp
– North, South, Stewart
& Chatham Iss



Sinbad skink, Robust skink and cryptic skink – Trent Bell

Lampropholis

Introduced skink: 1 sp – North Is, establishing in South



Rakiura's lizards

- Rakiura has seven of these 124 species.
- Five (or six) species occur only on Rakiura or its outlying islands
- Rakiura is exceptional for its high level of endemism (live nowhere else – true 'locals')
- Lizards were/are an important component of Rakiura's ecosystem, as they are a predator, prey, pollinator and seed distributor.
- However, today Rakiura's lizards are now rare because of the introduced predator species that have made Rakiura their home.





The next slides will describe each of Rakiura's special lizards:

- Southern grass skink
- Southern skink
- Small-eared skink
- Rakiura green skink
- Cloudy gecko
- Green gecko
- Harlequin gecko

Southern grass skink

Oligosoma aff. *polychroma* Clade 5

At Risk - Declining

- A small, brown striped skink, to 80 mm SVL
- Found in open or semi-open habitats with thick ground cover, especially rank grassland from coast to alpine zone
- Often seen basking or running through grassland
- Omnivorous, eating invertebrates and fruits





- Annual breeder, with up to 6 young in mid to late summer
- It's small size and higher fecundity may explain why it is able to persist in some number where other species have been unable to

Southern skink

Oligosoma notosaurus

At Risk - Declining

- Island endemic (local)
- A small to moderate sized, brown skink, to 90 mm SVL
- Found in open or semi-open habitats from coast up to 700m ASL
- Often seen basking, including climbing into low vegetation
- Omnivorous, eating invertebrates and fruits
- Annual breeder, with up to 4 young in mid summer



Southern skink – James Reardon

Small-eared skink

Oligosoma stenotis

Threatened - Nationally Vulnerable



Small-eared skink – James Reardon

- Island endemic
- A small to moderate sized, brown skink, to 75 mm SVL, characterised by a very small (0.9mm) ear opening relative to other lizard species, and has a keeled tail
- Recorded at Hananui/Mt Anglem to southern Tin Range between 480-980 m ASL
- Found above the treeline in subalpine shrubland, tussockland or rocky herbfield habitats



- Often seen basking, including climbing into low vegetation
- Omnivorous, eating invertebrates and fruits
- Annual breeder, with two young in early spring

Rakiura green skink

Oligosoma aff. *chloronoton* "Stewart Island"

Threatened - Nationally Vulnerable

- Island endemic
- Large, robust green skink, to 128 mm SVL
- Rare on mainland Rakiura but doing well on Whenua Hou
- Found in duneland, coastal / lowland grassland, scrubland, fernland, forest and wetlands



Rakiura green skink – Samuel Purdie

- Omnivorous, eating invertebrates and fruits
- Annual breeder, with young born in mid to late summer
- Aggressive to other skinks, may be territorial
- Shares burrows with the Whenua Hou Diving Petrel
- Excludes southern grass skinks from these burrows



Cloudy gecko

Mokopirirakau nebulosus

At Risk - Relict

- A moderate sized gecko, to 90 mm SVL
- Found mainly on Rakiura's predator-free islands (Whenua Hou and Titi/Muttonbird Islands) with sparse records on the mainland
- Found both in scrubland and forest or in rocky habitats
- Very cryptic (hidden) in the scrub and forest
- Nocturnal (active at night), but can sometimes be seen in the day, basking in the sunlight



Cloudy gecko – James Reardon



Cloudy gecko – Phil Melgren

- Little is known about its ecology/biology but is likely omnivorous, eating invertebrates and fruits and also likely at least a biennial breeder
- Due to its low fecundity, it is highly vulnerable to introduced predators
- Has not been seen on Rakiura mainland for many years
- Despite Whenua Hou being free of predatory mammals since 1998, it continues to be rarely seen, and may not have completely recovered
- However can be abundant on the other predator-free islands

Green gecko

Naultinus sp. / *Naultinus gemmeus*

At Risk – Declining (if *N. gemmeus*)

- ? Island endemic / otherwise Canterbury - Rakiura
- A moderate sized gecko, to 80 mm SVL
- Found in Coprosma and hebe bushes, and in shrubland/grassland
- Very cryptic (hidden) in the low vegetation in which it lives



James T. Reardon

Green gecko – James Reardon

- Likely to be omnivorous, eating invertebrates and fruits
- Little is known about the species' biology however, it is likely to have very low fecundity (slower reproduction), thus very vulnerable to introduced predators



Green gecko – James Reardon



Green gecko – James Reardon

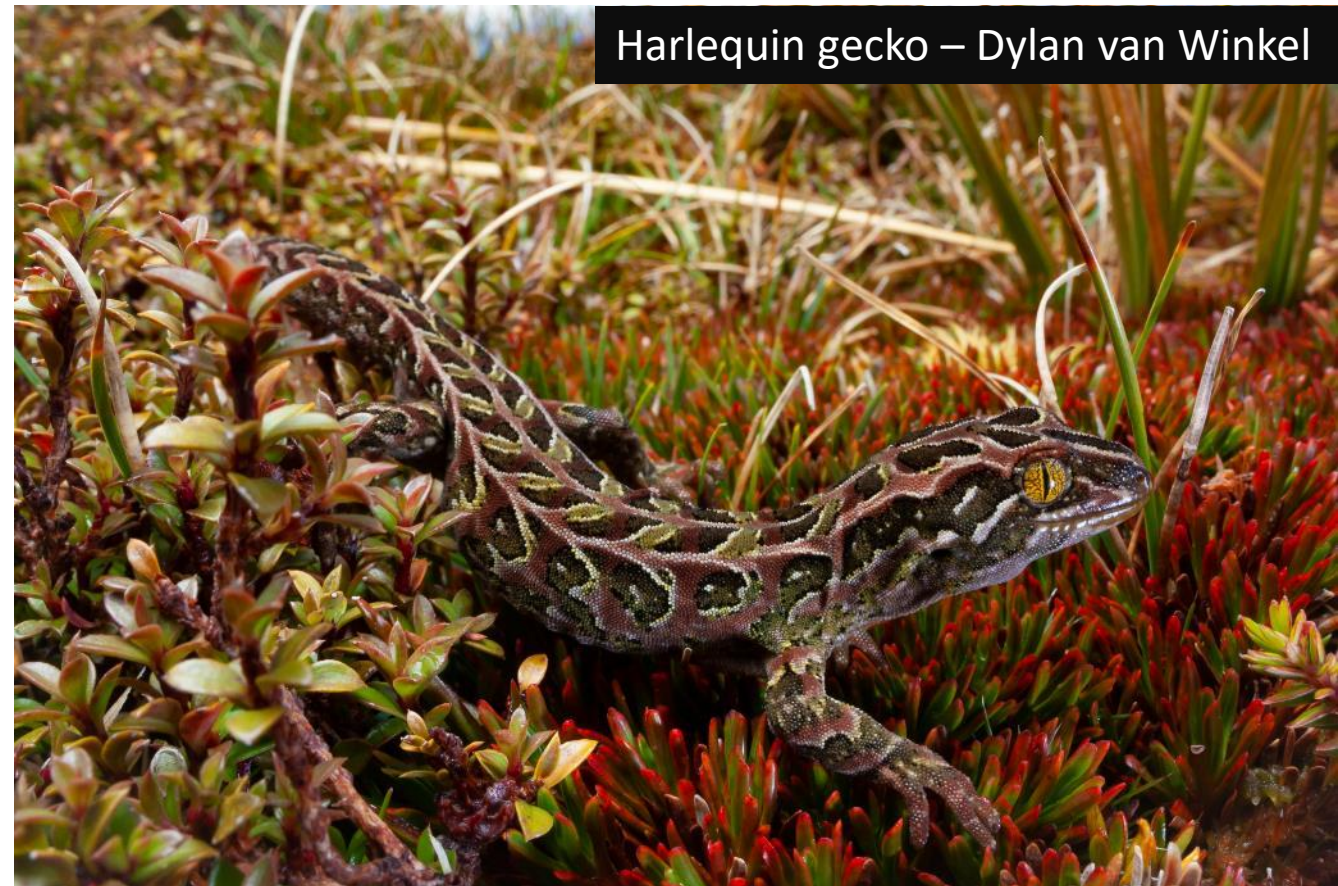
- Known only on Whenua Hou but very rare – numbers are still very low – still recovering
- It may have had a much wider distribution on Rakiura mainland

Harlequin gecko

Tukutuku rakiurae

Threatened - Nationally Endangered

- Island endemic
- A small to moderate sized gecko, to 71 mm SVL
- Found in southern parts of the Rakiura mainland
- Found in lowland and subalpine herbfield, tanglefern/manuka/*Olearia* shrubland, wire rush/sedge wetlands or rocky habitats



Harlequin gecko – Dylan van Winkel



Harlequin gecko – Dylan van Winkel

- Very cryptic (hidden) in the low vegetation in which it lives
- Omnivorous, eating invertebrates (weta, spiders, cockroaches, amphipods), fruits of little mountain heath, and nectar
- Biennial breeder, with 1-2 young born in late summer-early autumn; female gestates the embryos for more than a year
- Due to its very low fecundity, it is very vulnerable to introduced predators



Harlequin gecko – Carey Knox



Harlequin gecko – Carey Knox



Harlequin gecko – Dylan van Winkel

Threats

Introduced predatory animals

- feral cat
- ship rat
- Norway rat
- kiore
- hedgehog
- ? possum



Grand skink – Nathan Whitmore





Feral cat with 14 lizards – Tony Whitaker

- On NZ mainland, also threatened by mustelids (stoats, ferrets and weasels) and mice.
- Fortunately, Rakiura is currently free of these predators.



Weasel with Raukawa gecko – Trent Bell

Habitat loss and fragmentation

- Land development for housing, roading, mining, damming, farming, forestry, etc
- Not a significant issue on Rakiura, but is on mainland NZ



Stockton mine – Trent Bell

Climate change

- Emerging threat with uncertain/unpredictable outcomes
 - changed temperatures
 - increased frequency of rainfall, storms, flooding and/or droughts and wildfire
 - sea level rises inundating land, accelerated coastal erosion and amplifying tsunami impact
- changed ecology as a result of climate change:
 - shrinking alpine/subalpine habitats due to higher treeline
 - more frequent tussock masting (seeds) = more mice, rats, stoats
 - improved environmental conditions (warmer) in cooler parts of the country for introduced predators = more predators



Jewelled gecko – Carey Knox

Poaching

- Some New Zealand lizards are targeted by wildlife poachers
- Particularly the more attractive gecko species.



Wildlife Act 1953

- All native lizards protected by law from disturbance
- Require a Wildlife permit to search for, and capture lizards
- DOC is generally supportive of community conservation if the actions are appropriate (surveying, monitoring, translocating)
- Developers require wildlife permits if their projects affect lizards
- Iwi also need to be consulted on applications for permits

Conservation: what you can do

- Support Predator Free Rakiura - remove **ship rat**, **Norway rat**, **kiore**, **possums** and **hedgehog**. Climate change may increase the impact of these predators on our native wildlife
 - Also, increasing population size helps resilience against climate change
- Do as much as you possibly can to minimise and mitigate against climate change
- Maintain constant surveillance for **mustelids** and **mice** eg. at Oban wharf and township – island biosecurity
- Keep an eye out for suspicious visitors with an interest in lizards and tip off DOC
- Keep your eyes peeled for lizards, and report any sightings to DOC Halfmoon Bay with location, and photographs

Activities

- I have put up a large map of Rakiura, and a poster of Rakiura's lizards.
- Please let us know what you have seen, where, when, and we will pass on the details to DOC.
- Feel free to browse our two field guides on NZ's lizards on the table
- Feel free to come up to us to talk about lizards



Southern skink - James Reardon

Questions / Comments?

Contact us:

- Trent Bell: trent.ecogecko@gmail.com
- Carey Knox: southernscales@outlook.co.nz

This talk was supported by:



Thank you!

Appendix 2

Lizard capture data for the January and October 2022 surveys

Date	Trap	Species	Sex	SVL	Tail	Tail break
January 2022	1115	<i>Oligosoma polychroma</i> Clade 5	M	59	53	23
	1115	<i>Oligosoma polychroma</i> Clade 5	J	44	51	
	1114	<i>Oligosoma polychroma</i> Clade 5	M	60	69	
	1114	<i>Oligosoma polychroma</i> Clade 5	M	66	67	27
	1114	<i>Oligosoma polychroma</i> Clade 5	M	58	68	
	1113	<i>Oligosoma polychroma</i> Clade 5	F	49	62	
	1109	<i>Oligosoma polychroma</i> Clade 5	M	63	47	31
	1108	<i>Oligosoma polychroma</i> Clade 5	F	50	55	
	1107	<i>Oligosoma polychroma</i> Clade 5	J	44	46	
	1107	<i>Oligosoma polychroma</i> Clade 5	M	60	68	
	1095	<i>Oligosoma polychroma</i> Clade 5	M	62	68	11
	1095	<i>Oligosoma polychroma</i> Clade 5	M	65	74	
	1090	<i>Oligosoma polychroma</i> Clade 5	FPreg	64	68	
	1087	<i>Oligosoma polychroma</i> Clade 5	M	61	70	
	1082	<i>Oligosoma polychroma</i> Clade 5	M	62	73	
	1083	<i>Oligosoma polychroma</i> Clade 5	F	62	63	2
	1073	<i>Oligosoma polychroma</i> Clade 5	M	69	56	24
	1073	<i>Oligosoma polychroma</i> Clade 5	M	64	66	9
	1068	<i>Oligosoma polychroma</i> Clade 5	FPreg	64	66	
	1068	<i>Oligosoma polychroma</i> Clade 5	M	53	65	
October 2022	1366	<i>Oligosoma polychroma</i> Clade 5	N/A	N/A	N/A	
	1372	<i>Oligosoma polychroma</i> Clade 5	N/A	N/A	N/A	