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Feasibility study towards restoring missing fauna of Ōtamahua/Quail Island, with a focus on invertebrates

by

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Neoramia sp. ©Sarah Visser

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1. EXECUTIVE SUMMARY

Introduction:

1. Quail Island/Ōtamahua (85 ha.) located in the Lyttelton Harbour, Banks Peninsula, Canterbury is undergoing ecological restoration
2. Approximately 100,000 native trees have been planted and all mammalian pests (hedgehogs, rats, cats, rabbits, stoats) apart from mice have been eradicated
3. The Banks Peninsula tree weta (*Hemideina ricta*), Leaf vein slug (*Pseudaneitea* '*maculata*') and ground beetle *Megadromus guerinii* have been successfully translocated to the island and have established sustainable populations in the presence of mice.
4. Many flightless invertebrate species are absent from the island compared to similar habitat in the harbour basin and require human assistance to establish

Objective:

5. To determine the suitability of reptile, bird and invertebrate candidate species for reintroduction to Quail Island, with more detailed information on the sources and methodology for translocation and monitoring for the invertebrate species.

Methods:

6. Literature review of research on candidate invertebrate species likely to be found at local Banks Peninsula sites.
7. Field work - hand searching under logs and rocks for candidate species at local Banks Peninsula sites.
8. Weta motels were also placed on trees at likely source sites to observe which candidate invertebrate species occupy them over time.

Results:

9. The literature showed there is a wealth of information from previous studies on Port Hill populations.
10. Rock and log rolling provided an adequate technique for finding all but one of the main targeted species (*Nuisiana arboris*)
11. Weta motels, once set up and given enough time to be occupied, resulted in a presence of all the targeted spider species.

Conclusions:

12. No one obvious bird species stands out as being easy to reintroduce to the island.
13. Two species of local lizards could be reintroduced to the island, but it is unknown if the presence mice is an impediment to their success. A small predator exclusion fence may be an option.
14. Reasonable populations of all candidate carabids and spider species were found apart from *Nuisiana arboris.*
15. Five ground beetles (Carabidae), five spiders (Arachnida), four aphids (Aphididae), the reticulate stag beetle, a darkling beetle (Tenebrionidae) and a weevil (Curculionidae) species are considered best as candidate species for reintroduction.

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Ōtamahua / Quail Island ©Mike Bowie

2. INTRODUCTION

Global deforestation has had a profound effect on biodiversity (Munroe et al. 2011); Vivay et al. 2016). Aotearoa/New Zealand has unique biodiversity due to its previous connection to Gondwana, the long period of isolation from surrounding landmasses, and its unique geological history creating opportunity for many species to diverge and adapt to the variety of habitat (Gibbs 2016). Because of this isolation, New Zealand was only relatively recently settled by humans, Māori likely arriving in the 1200s, and Europeans in the 1700s. With humans came introduced exotic species that took advantage of native flora and fauna's evolutionary weaknesses, most species being flightless without defences against mammalian predators (Gibbs 2016; Holdaway 1998). Overtime the land was rapidly developed and fragmented through fires and deforestation to be used for farming and urbanisation, leading to a great loss of biodiversity (Walker et al. 2006; Bowie et al. 2016). Ecological restoration including pest eradication and the reintroduction of locally extinct species is now common practice to conserve threatened or vulnerable native wildlife. Offshore islands have been favoured as suitable refugia for threatened species due to presence of mature forests, ease of controlling mammalian and weed pests, and an ability to monitor protected populations. However, islands are still vulnerable to reinvasions, loss of genetic diversity, and if small enough, can lack sufficient space for larger species' populations to thrive (Atkinson 1990; Gibb 1990).

Before arrival of Māori, Ōtamahua/Quail Island is presumed to have been a coastal broadleaf-podocarp forest (Burrows et al. 1999; Burrows & Wilson 2011). During the first European occupation in 1842, there was an abundance of silver tussock (*Poa cita*) grassland, matagouri (*Discaria toumatua*) and cabbage trees (*Cordyline australis*), also with native quail (*Coturnix novaezelandiae*), which the island became named after, became extinct in 1875 (Jackson, 2006; NZ birds online 2019). Quail Island was farmed from 1851 and became an official recreation reserve in 1975 (Jackson, 2006). The long-term farming, predation and other human activity saw the demise of many remaining flora and native fauna which contribute significant ecological processes for a functioning and healthy ecosystem. Significant ecosystem processes include pollination, nutrient cycling, seed dispersal, and providing food for larger fauna.

Ecological restoration is widely used to mitigate or reverse habitat destruction (Barral et al. 2015; Benayas et al. 2009). The Quail Island Ecological Restoration Trust was formed by volunteers in 1997 (Burrows & Wilson 2011) to ecologically restore, historically preserve and protect the indigenous character of the island (Norton et al. 2004). With help from the DOC, the Trust has removed cats, rabbits, mustelids, hedgehogs and rats (Bowie et al. 2011). Restoration planting of 97,000 native trees and weed management has also been undertaken by the Trust on the island. Being close to the mainland, 450m away from Moepuku Point, the island is susceptible to pest re-invasions particularly at low tide (Bowie et al. 2018). Ōtamahua/Quail Island is kept free of high priority animal pests (e.g. rats, mustelids), while other animal pests (fallow deer and mice) are controlled to levels that do not threaten the restoration process or other values of the island (Bowie et al. 2018).

As a part of their efforts to restore Ōtamahua, the Quail Island Ecological Restoration Plan was written to provide guidance in restoring a functioning ecosystem (Norton et al. 2004). The plan included a list of potential candidate species for reintroduction, including invertebrates. To fit the requirements of the Trusts plan, the species should be: indigenous, locally extinct, rare, or endangered species in Banks Peninsula. Species will be prioritised by an inability to self-disperse (such as larger flightless species), being threatened and in currently in decline (species that would most benefit from a predator free island), having significant biological interactions with other species (e.g. decomposer, predator, scavenger, herbivore), and ease of collection, transportation and monitoring methods (e.g. using weta motels (Bowie et al. 2006; 2014) and wooden discs (Bowie & Frampton 2004)). Based on these preferences, a list of possible invertebrate candidates for Ōtamahua was made (see Appendix 1).

Translocating these suggested candidate species would contribute to assisting populations to successfully breed and become self-sustaining. Then potentially they become a source population for individuals to be translocated and establish more populations at other reserves throughout Banks Peninsula. There are many species to be considered and this report focuses on the invertebrate fauna to be translocated. Invertebrates

are important components of a healthy functioning ecosystem due to their many roles in pollination, breakdown of organic matter, biological control, seed dispersal and food sources (see Bowie & Frampton 2004). Once the native forests on Ōtamahua can support an abundance and diversity of native invertebrate populations, then it will provide the essentials for larger fauna, such as reptiles and birds, to be introduced as well.

Since the creation of this list of candidates for reintroduction, three species have been successfully translocated in 2004 to Ōtamahua being: *Megadromus guernii* (Carabidae) (Takada & Bowie 2018), *Hemideina ricta* (Anostostomatidae) (Bowie 2010a), and the leaf-veined slug *Pseudaneitea 'maculata'* (Athoracophoridae) (Bowie 2010b). These species were released in three separate locations where native habitat was considered suitable using refugia, such as weta motels and log discs (Bowie, 2014; Bowie & Frampton 2004) to help provide a safe microhabitat which could also be suitable for non-destructively monitoring their survival and success. All three invertebrate species have since established breeding populations and are dispersing in the presence of mice. These successes show that these translocation techniques could be replicated for future invertebrate translocations. The success also showed that some of the restored habitat was suitable for these native invertebrate species and may well be suitable for other similar species to be translocated.

The aim of this report was to assess candidate faunal species for reintroduction on Quail Island. Given the ten week duration of the Lincoln University summer scholarship efforts would be focussed on invertebrate species, including locating source populations and methodology for translocations.

Figure 1. Map of Port Hills and Lyttelton Harbour showing key locations mentioned in report (Source Google Maps). Relevant sites mentioned in report shown on map AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OB = Orton Bradley Park; OR=Orongamai; OT=Otahuna; SL=Sugarloaf).

3. METHODS

3.1 Reptiles

Literature including Lukis (1999) and Norton et al. (2004) provide the historical views on which species are suitable for translocations.

3.2 Birds

Quail Island workshop (Bowie et al. 2006), restoration plan (Norton et al. 2004) documents and discussions with several experienced ornithologists were used to identify a basis for candidate species selection.

3.3 Invertebrates

Previous preliminary invertebrate lists have been published in Bowie et al. (2003), restoration plans (Norton et al. 2004) and subsequent research on the Port Hills (e.g. Bowie 2008) were used to determine if additional species are suitable for future translocations.

3.3.1 Researching method

Data from previous Port Hills wooden disc and weta motel monitoring was reanalysed to extract useful abundance and locality information from Lincoln University Wildlife Management Reports (Bowie & Sirvid 2004; Bowie & Sirvid 2005; Bowie & Vink 2006; Bowie 2007 & 2008; Bowie et al. 2019). Even though the information may not be correct currently, it is the most up-to-date data we have on these species in these locations. It provides a good starting point to determining the relative abundance of these species to assess the ease of collecting specimens of each candidate species.

3.3.2 Port Hills and Orton Bradley Surveying Methods

Log and rock rolling was used to test the target species collection methodology and see which species are still present in in the areas. A suitable site is one accessible and safe to walk and climb for surveying. To make the search more time efficient, and to increase the chances of finding an abundant population of the target species, a site was selected with 10-30^{+} rocks and/or logs.

3.3.3 Knowledge of an ideal habitat

To search efficiently we set a rule to survey rocks and logs larger than a hand-palm size, as it would be a realistic place for adult spiders and beetles to use as refugia. The larger unsubmerged rocks resting on the soil surface tended to be the most suitable place to find beetles. The larger rocks were less likely to be dislodged and provided a safe refuge from predators during the day. However, some larger rocks that were often too difficult to move safely.

3.3.4 Surveying search

Co-ordinates were recorded using GPS and each site surveyed under rocks &/or logs for 30 min. Rocks were tilted back on an angle and held while searching for movement, signs of spider/beetle habitat, then slowly placing it back down in to its original position to reduce habitat disturbance and/or squashing individuals. Surveying movement included sweeping the area in a zig-zag motion across from the initial starting point.

3.3.5 Identification

To help with identification for more effective observations, photos of the relevant/target species were examined beforehand with differences between similar species noted. A reference box with pinned beetle specimens were taken to the field to help with identification. Many of the *Neoramia* species have variable patterns and can look very similar to other spider species so it was necessary to record the colour, shape and patterning of the spiders. Photos helped to accurately identify species later as the spiders and beetles can be difficult to distinguish in limited time and without magnification. To help confirm the species identification, clear close-up photos, using a flash, of the specimen's distinguishing features were captured. Photos were uploaded to *iNaturalist* where a wider community of amateur and expert entomologists could contribute to the identification. Upon gaining an accurate identification the data was added to the spreadsheet recording

all the results of species found. The survey for spiders and carabid beetles was repeated four times at four different areas within Orton Bradley Park, Ahuriri Scenic Reserve, Coopers Knob, Cass Peak and Kennedy's Bush.

3.3.6 Weta motel surveying

Weta motels were used to test the target species collection methodology as they have been useful in previous studies (Bowie & Vink 2006; Bowie 2007; Hodge et al. 2007). Ten to 21 weta motels were positioned at each site on the dates listed below (Table 1). A weta motel is an untreated, partly hollowed out wood block, having a swinging 'door' on the face, with an entrance hole (14mm dia.) at bottom and plastic roof on top (Bowie et al. 2014). Site selection included places with higher density trees, leaf litter, accessible terrain, and native tree species that invertebrates have previously exhibited a preference for.

Table 1: Weta motel monitoring sites and key dates

	Sites				
	Ahuriri Reserve	**Coopers Knob**	**Cass Peak**	**Kennedys Bush**	**Orton Bradley Park**
No. of motels	15	15	10	10	21
Setup date	21/12/18	21/12/18	03/01/19	03/01/19	13/12/18
1st observation	28/01/19	28/01/19	28/01/19	28/01/19	16/01/19
2nd observation	26/04/19	26/04/19	26/04/19	26/04/19	26/04/19

3.3.7 Permission

Christchurch City Council (CCC) research permit to undertake research in Port Hills was obtained in 15/11/18. To collect and translocate the candidate species an additional permit from CCC would be required as well as approval by Department of Conservation (DOC) and local hapu Ngāti Wheke must be obtained.

4. RESULTS

Summary of past research and literature
Due to time constraints, the main focus of this report is on the invertebrates.

4.1 Reptile candidate species

Lukis (1999), Bowie et al. (2006) and the Quail Island Ecological Restoration Plan (Norton et al. 2015) document the potential candidate reptile species for the island.

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Jewelled gecko (*Naultinus gemmeus*)

There are four possible species that could potentially be translocated to Quail Island (Table 2). These are: jewelled gecko (*Naultinus gemmeus*); spotted skink (*Oligosoma lineoocellatum*); Duvaucel's gecko *Hoplodactylus duvaucelii*; and the tuatara (Sphenodon sp.). Protocols for two of the locally extinct species have been produced (Lukis 1999). Although only mice are remaining on the island these still may pose a threat to these species. There are examples on the mainland where mice cohabit with reptile species translocated (e.g. Tuatara at Zealandia, Wellington) and mice are managed through an annual use of rodenticide for a short period. Examples of reptiles successfully reintroduced in New Zealand include shore skinks to Auckland offshore islands (Baling et al. 2010), tuatara to Titi and Matiu-Somes Islands (Miller et al. 2010), and Duvaucel's geckos to Tiritiri Matangi and Motuora Islands (van Winkel et al. 2010).

Table 2: Potential candidate reptile species for reintroduction to Quail Island

Reptile species	Suitability for translocation to Quail Island
Jewelled gecko (*Naultinus gemmeus*)	Habitat suitable now as found in Lyttelton Basin. Mouse predation and security from smuggling are main issues. A lower (~ 1.5m) predator- proof fence (such as in Orokonui Sanctuary) with surveillance cameras could be an option.
Spotted skink (*Oligosoma lineoocellatum*)	Habitat suitable now as found in Banks Peninsula. Mouse predation and security from smuggling are main issues. A lower (~ 1.5m) predator- proof fence (as in Orokonui Sanctuary) with surveillance cameras could be an option.
Duvaucel's gecko *Hoplodactylus duvaucelii*	Successfully translocation elsewhere (Bell & Herbert 2017). A lower (~ 1.5m) predator proof fence (such as in Orokonui Sanctuary) with surveillance cameras could be an option.

Tuatara (*Sphenodon* sp.)	Great advocacy species. Habitat suitable now as found on Matiu-Somes Island in similar habitat. Lower temperatures would be advantage in terms of breeding issues. Mouse predation and security from smuggling are main issues. A lower (~ 1.5m) predator proof fence (such as in Orokonui Sanctuary) with surveillance cameras could be an option.

4.2 Bird candidate species

Bowie et al. (2006) and the Quail Island Ecological Restoration Plan (Norton et al. 2015) discuss the merits of the bird candidate species.

There are numerous translocations of birds to off shore islands in New Zealand that have been successful and there are possibilities for Quail Island (Table 3). There are lots of considerations before such an operation could proceed and each candidate species should go through a rigorous process in consultations with DOC and local iwi. However, there are many success stories and with any candidate species the conservation and educational gains must be weighed up with potential threats to populations. Translocations of the red-fronted parakeet to Matiu-Somes Island and Motuihe Island (Ortez-Catedral et al. 2010) is one example. A local example is tui that were translocated from Maud Island to Hinewai Reserve on Banks Peninsula successfully (Molles 2010).

Table 3: Potential bird candidates for translocation to Quail Island

Bird species	Comments on suitability for translocation to Quail Island
Australasian Gannet	Failed on Mana Island so not good prospect.
Banded Rail	Good species for reintroduction, but lack of close source populations.
Brown Creeper	Being considered for Port Hills by CCC – may disperse if they breed sufficiently.
Brown Teal	Little water other than stock dam.
Buff Weka	Would be possible, but likely hard for all other ground fauna (birds, invertebrates & lizards) and may swim from island as has happened elsewhere. Dogs an issue although not officially permitted on Quail Island. Would prey on mice.
Fairy Prion	Lyttelton Port lights may cause problems with their navigation
Fluttering Shearwater	Lyttelton lights may cause problems with their navigation
Hutton's Shearwater	Lyttelton lights may cause problems with their navigation
Kaka	Mobile so likely to leave island and can have issues with suburbia
Kakapo	Certain it would work but security/biosecurity an issue
Little Spotted Kiwi	Only on predator-free islands, dogs main threat. Low genetic diversity.
Mohua	Easy to translocate (easy to catch, pretty good track record). Habitat maybe too small for self-sustaining population.
Morepork	Probably will not recolonise themselves across water. Will prey on lizards, birds and insects. Little owl present on Quail Island, unsure how these may interact.
New Zealand Falcon	Seen in nearby Orton Bradley Park and other parts of Banks Peninsula.
North Island Brown Kiwi	The Eastern Kiwi now extinct was a close relative. Need island ranger to enforce 'no dogs' policy.
Northern Diving Petrel	Lyttelton lights likely to be problem.
Okarito Brown Kiwi	The Eastern Kiwi (now extinct) was a close relative, security and dogs are issues.
Red-fronted Kakariki	Habitat not sufficiently mature. Source populations currently limited. Would likely fly off island.
Rifleman	Small populations only on Banks Peninsula. Poor fliers, probably unlikely to fly to island. Habitat still too young?
Shore Plover	Translocated to predator-free Motutapu Island in 2019 as precedent.
Sooty Shearwater	Lyttelton lights likely to be problem for birds' navigation.
South Island Fernbird	More suited to wetter habitat?
South Island Robin	Have a good track record of translocating well and very charismatic. Translocation to Hinewai failed possibly due to insufficient numbers translocated.
South Island Saddleback	Good possibility given predator-free (stoat, rat and weka main threats) islands needed.
Spotless Crake	Good potential but very secretive so not so good for advocacy purposes.
Stubble Quail	Closest Australian relative of New Zealand quail that the island was named after but has been recently been reclassified from subspecies to separate species.
Takahe	Would easily work but a need for ranger on island. Uncontrolled dogs also an issue.
Tomtit	Present in Port Hills in low numbers so may naturally disperse if numbers increase sufficiently.
Tui	Already introduced to Hinewai Reserve and a pair have visited Quail island briefly. Likely to self-introduce in time, so not worth considering.
Yellow-crowned Kakariki	Habitat not sufficiently mature/more of a beech habitat species. Source populations limited.

Tomtit

Robin

Kaka

Rifleman

4.3 Invertebrate candidate species

The majority of this report includes information on potential invertebrate candidate species for reintroduction to Quail Island (Table 4). The report focusses on Banks Peninsula research and literature on the biology of species such as the spider and beetle candidate species where invertebrate sources close to Quail Island exist. All beetle and spider candidate species are nocturnal, flightless natives and found in Banks Peninsula sites apart from a Motunau Island Tenebriondae (*Omedes* sp.) and the Canterbury knobbled weevil *Hadramphus tuberculatus*. Native aphids present in Canterbury are also listed but can fly and some species are present on Quail Island at certain time of the year. Little is known about native aphids but some information is documented in Teulon and Stufkins (1998). Suggested number of individuals to be translocated is 50, with a higher preference for gravid females where possible, but including males when able to identify them.

Table 4: Candidate invertebrate species for reintroduction to Quail Island

Species name	Family	Common name	Banks Peninsula Endemic	Habitat required invertebrate species	Source population for reintroduction	Translocated or proposed date for reintroduction
Hemideina ricta	Stenopelmatidae	BP Tree weta	Yes	Canopy for dispersal, roosting sites / weta motels, leaf litter for oviposition	Eastern Banks Peninsula	2004 ✓
Pseudaneitea 'maculata'	Athoracophoridae	Native slug	No	Bush cover, logs / wooden discs	Orton Bradley Park	2004 ✓
Megadromus guerinii	Carabidae	Ground beetle	Yes	Some scrub cover, logs / wooden discs	Orton Bradley Park	2004 ✓
Holcaspis intermittans	Carabidae	Ground beetle	No	Bush cover, logs / wooden discs	Port Hills	2020
Holcaspis suteri	Carabidae	Ground beetle	Yes	Bush cover, logs / wooden discs	Ahuriri Reserve	2020
Paradoxaphid plagianthi	Aphididae	Aphid	No	Sufficient ribbon wood *Plagianthus regius*	Landcare Research Lincoln or Banks Pen.	2020
Paradoxaphis aristoteliae	Aphididae	Aphid	No	Sufficient wineberry *Aristotelia serrata*	Victoria Park?	2020
Aphis healyi	Aphididae	Aphid	No	Sufficient native broom *Carmichaelia australis*	Landcare Research Lincoln or Banks Peninsula	2020
Aphis coprosmae	Aphididae	Aphid	No	Sufficient *Coprosma rigida, C. crassifolia*	Simon Bulman contact	2020
Mecodema oregoides	Carabidae	Ground beetle	Yes	Bush cover, logs / wooden discs	Ahuriri Reserve	2021
Paralissotes reticulatus	Lucanidae	Stag beetle	No	Bush cover, logs / wooden discs	Ahuriri Reserve / Orton Bradley Park	2021
Periegops suterii	Periegopidae	6-eyed spider	No?	Bush cover, logs / wooden discs	Banks Peninsula remnants	2022

Neoramia setosa	Stiphidiidae	Sheetweb spider	Yes	Weta motels, rocks & logs	Ahuriri, Orton Bradley Park	2022
Neoramia janus	Stiphidiidae	Sheetweb spider	No	Weta motels, rocks & logs	Ahuriri, Orton Bradley Park	2022
Porrhothele antipodiana	Hexathelidae	NZ Funnel web	No	Under wooden discs, rocks & logs	Coopers Knob, Ahuriri	2024
Onawea pantomelas	Carabidae	Ground beetle	Yes	Bush cover, logs / wooden discs	Eastern Banks Peninsula remnants	2025
Mecodema howitti	Carabidae	Ground beetle	Yes	Bush cover, logs / wooden discs	Eastern BP reserves	2025
***Uliodon* sp.**	Zoropidae	Vagrant spider	No	Under wooden discs, rocks & logs	Sugarloaf, Kennedys Bush, Ahuriri Reserve	2026
***Omedes* sp.**	Tenebrionidae	Darkling beetle	No	Ice plant on cliff edges	Motunau Island	2026
Hadramphus tuberulatus	Curculionidae	Canterbury knobbled weevil	No	Area of spear grass *Aciphylla subflabellata* or *A. aurea*	Burkes Pass, Canterbury	2030

4.3.1 *Neoramia setosa & N. janus*

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New Zealand Agelenidae spiders are distinct from others found in the Northern Hemisphere (Paquin et. al. 2010). There are 22 *Neoramia* species found throughout New Zealand in restricted areas (Vink 2015). They build a messy, formless, sheet web extending out of their retreat under rocks, logs and in weta motels (Hodge et al. 2007). They are nocturnal and are preyed upon by larger invertebrates, and mammals.

Commonly found in habitats that range from forest, scrubland, scree slopes, and alpine where they find refuge under rocks and in woody plants. Found in South Island gardens and could easily be transported around. Egg sacs are rounded and loosely covered in silk and can be built lenticular (biconvex in shape like a lens) on substrate. *N. janus* and *N. setosa* differ by size, colouring and genitalia (Forster & Wilton 1973). *N. setosa* is a Banks Peninsula endemic, while *N. janus* is more widespread (Forster & Forster 1973). Historic monitoring data suggests that Ahuriri, Coopers Knob, Cass Peak and Otahuna (1) and Kennedys Bush (2) reserves were the best places to source *Neoramia* species (Table 4) and they are found in weta motels in good numbers (Table 5).

Table 5: Numbers of *Neoramia* species found in weta motels at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

	Location of motels										
Year	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**	**Identified as:**
2004	12	14	9	2	8	12	8	4	1	4	*Neoramia setosa*
2005	11	-	12	-	-	10	-	-	-	-	*Neoramia janus*
2006	10	14	10	10	10	4	10	6	5	4	*Neoramia* spp.
2007	7	10	9	7	11	8	11	2	8	3	*Neoramia* spp.
Mean	**10**	**9.5**	**10**	**6.3**	**9.7**	**8.5**	**9.7**	**4**	**4.7**	**3.7**	

4.3.2 *Nuisiana arboris*

Nuisiana (*Maniho*) *arboris*), is an arboreal hunter that is widespread in NZ where it lives in narrow burrows but has been found beneath bark of totara (Forster & Forster 1973). They are found in holes of large trees, under log discs and in weta motels on trees (Vink et al. 2011; Bowie & Frampton, 2004). To help distinguish the females from the males, besides the males' larger pedipalps, females have their third pair of legs turning backwards (Vink et al. 2011).

Research on the port Hills suggest the best locations for collecting this species in weta motels is Kennedys Bush (1) and the two Sugarloaf sites (Table 6).

Table 6: Numbers of *Nuisiana arboris* species found in weta motels at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

		Location of motels									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
34	2004	0	0	0	1	1	0	3	0	2	0
35	2004	1	0	4	5	1	0	2	2	2	2
40	2005	0	-	0	-	-	0	-	-	-	-
42	2006	0	0	0	0	0	3	0	0	1	0
44	2007	2	0	1	0	2	0	0	0	0	3
	Mean	1	0	1.7	2.4	1.6	1	2	0.8	2	2

4.3.3 Vagrant spider *Uliodon* spp.

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The genera is widespread throughout the country and badly in need of taxonomic attention (Paquin et al. 2010). Scientists believe there are about 20 endemic species in New Zealand but only three have been named. These spiders live in a variety of habitats, native forests, plantations, open habitat amongst logs and rocks, scree slopes and occasionally in houses and feed on ground-dwelling invertebrates. After mating the female prepares a chamber lined with silk beneath a log, stone or inside a rotten log where they construct a large round, white egg sac that will be guarded until the young hatch and disperse (Paquin et al. 2010). *Uliodon* are nocturnal but can dart away rapidly when disturbed, although their dark colour and ability to remain motionless can make them hard to see (Green & Lessiter 1987). Males have orange pedipalps and are

smaller in body length than females (~20mm) (Vink 2015). Although the vagrant spiders prefer native bush they can survive in modified areas as long as there is logs, stones or debris to hide under during the day (Early 2009). Despite their good camouflage, they are often captured by the large native spider-hunting wasps (e.g. *Sphictostehus nitidus*). These spiders are capable of delivering a painful bite because of their large fangs.

Wooden discs appear to be the better of the two refugia methods in terms of finding them, while Kennedy's Bush, Sugarloaf Reserves showed the highest numbers (Table 7 & 8).

Table 7: Numbers of *Uliodon* species found in weta motels at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

		Location of Motels									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
34	2004	0	0	0	0	0	0	0	0	0	0
35	2004	0	0	0	0	0	0	0	0	0	0
40	2005 Dec	0	-	0	-	-	0	-	-	-	-
42	2006	0	0	0	0	0	0	0	0	0	0
44	2007	0	0	0	0	0	0	0	3	0	1
	TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**1**

Table 8: Numbers of *Uliodon* species found under wooden discs at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

		Location of Discs									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
34	2003	1	0	0	0	0	0	0	0	2	0
35	2004	0	0	0	3	0	0	0	1	1	1
40	2005 Dec	0	-	0	-	-	0	-	-	-	-
40	2006 Jan	0	-	0	-	-	0	-	-	-	-
42	2006	0	0	0	0	3	0	0	0	2	0
44	2007	0	0	0	1	4	0	1	0	4	1
	TOTAL	**1**	**0**	**0**	**4**	**7**	**0**	**1**	**1**	**9**	**2**

4.3.4 NZ funnel-web spider *Porrhothele antipodiana*

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The NZ funnel-web spider is widespread and can be >3cm in body length. Being nocturnal, spiders typically live under logs, rocks, in tunnels in trees where it is moist as they are susceptible to desiccation. They are also found in weta motels in darker, well vegetated areas. Webs vary in size but can be as long as 20cm deep and 2cm-3cm across with a broad sheet web spanning out from the entrance to detect wandering prey. The species do move sites occasionally and males also wander in search of mates. Their diet is varied consists of almost anything that comes near its web e.g. beetles, spiders, millipedes, slaters, moths, snails, bumble bees and wasps. May also have the capability to eat mice. Can stab prey with chelicerae more than once to ensure deep penetration of venom. Maneuvering fangs to joints or soft spots on hard covered invertebrates. Usually carrying the prey back into their tunnel to be eaten. Although males do not live long past maturity, females may live three to six years. Number of eggs can range from 200-300 and develop in approximately 30 days (Paquin et al. 2010). Similar numbers were found in weta motels and wooden discs, with Ahuriri, Cass Peak and Coopers Knob reserves having largest numbers found (Table 9 & 10).

Table 9: Numbers of *Porrhothele antipodiana* found in weta motels at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

Report	Year	AH	CP	CK	KB1	KB2	OR	OT1	OT2	SL1	SL2
34	2004	1	1	3	0	0	1	2	0	0	0
35	2004	2	1	6	0	0	2	0	0	0	0
40	2005 Dec	2	-	0	-	-	1	-	-	-	-
40	2006 Jan	1	-	7	-	-	1	-	-	-	-
42	2006	4	1	1	0	1	0	0	0	0	0
44	2007	3	2	2	0	1	0	0	0	0	0
	Mean	**2.17**	**1.25**	**3.17**	**0**	**0.5**	**0.83**	**0.5**	**0**	**0**	**0**

Table 10: Numbers of *Porrhothele antipodiana* found under wooden discs at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

Report	Year	AH	CP	CK	KB1	KB2	OR	OT1	OT2	SL1	SL2
34	2003	2	2	0	1	0	0	0	0	0	0
35	2004	2	0	3	0	0	0	0	0	0	1
40	2005 Dec	3	-	1	-	-	1	-	-	-	-
40	2006 Jan	0	-	0	-	-	0	-	-	-	-
42	2006	5	2	3	0	2	1	1	0	0	0
44	2007	8	0	0	1	0	0	1	0	1	2
	Mean	**3.3**	**1**	**1.67**	**0.5**	**0.5**	**0.3**	**0.5**	**0**	**0.25**	**0.75**

4.3.5 *Holcaspis suterii*

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This is a medium sized ground beetle at 15.8mm long that live in native mixed podocarp forest on Banks Peninsula. Although large numbers were collected in Ahuriri Scenic reserve in pitfall traps over the last few decades (Bowie et al. 2019), much fewer were collected under wooden discs (Table 11). Pitfall trapping from 2006 suggest that Ahuriri, Coopers Knob, Orongamai and Sugarloaf reserves would be the best locations to search.

Table 11: Abundance of *Holcaspis suterii* found under wooden discs at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

Report	Year	AH	CP	CK	KB1	KB2	OR	OT1	OT2	SL1	SL2
34	2003	0	0	0	0	1	0	0	1	0	0
35	2004	1	2	1	0	0	0	3	1	1	1
40	2005 Dec	2	-	1	-	-	0	-	-	-	-
40	2006 Jan	1	-	0	-	-	0	-	-	-	-
42	2006	2	1	1	0	0	0	0	1	0	0
44	2007	1	1	0	0	0	1	0	2	0	0
	Mean	**1.17**	**1**	**0.5**	**0**	**0.25**	**0.17**	**0.75**	**1.25**	**0.25**	**0.25**

Table 12: Abundance of *Holcaspis suterii* in pitfall traps at 6 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; KB=Kennedys Bush; OR=Orongamai; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

Report	Year	AH	CP	CK	KB1	KB2	OR	OT1	OT2	SL1	SL2
40	2006	7	-	12	-	-	15	-	-	-	-
42	2006	-	-	-	1	0	-	-	-	15	-
	TOTAL	**7**	**-**	**12**	**1**	**0**	**15**	**-**	**-**	**15**	**-**

4.3.6 *Holcaspis intermittans*

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This is a medium sized ground beetle at 17.3mm long found in mid Canterbury. Kennedys Bush (2) was easily the best location for species based on wooden disc data (Table 13), while Coopers Knob, Kennedys Bush (2), and Ahuriri were good sites based on the pitfall data (Table 14).

Table 13: Numbers of *Holcaspis intermittans* under discs at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports

		Location of discs									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
34	2004	1	0	1	1	4	0	3	0	0	0
35	2004	1	1	0	0	2	0	1	0	0	0
40	2005 Dec	0	-	1	-	-	0	-	-	-	-
42	2006	0	1	0	1	2	0	2	0	0	0
44	2007	0	0	0	0	2	1	0	2	0	0
	Mean	**0.7**	**0.8**	**0.7**	**0.8**	**4**	**0.3**	**2.4**	**0.8**	**0**	**0**

Table 14: Numbers of *Holcaspis intermittans* in pitfall traps at 6 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; KB=Kennedys Bush; OR=Orongamai; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports

		Location of pitfalls									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
40	2006	3	-	8	-	-	0	-	-	-	-
42	2006	-	-	-	0	3	-	-	-	0	-
	TOTAL	**3**	**0**	**8**	**0**	**3**	**0**	**0**	**0**	**0**	**0**

4.3.7 *Mecodema oregoides*

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This is a medium sized Banks Peninsula endemic ground beetle that is 16.2mm in length. Ahuriri, Cass Peak and Coopers Knob were the locations with highest numbers under discs (Table 15), while pitfall traps at Coppers Knob and Sugarloaf Reserves (1) were the only sites which specimens were collected from of the six locations trapped (Table 16).

Table 15: Numbers of *Mecodema oregoides* under discs at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports

		Location of discs									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
34	2003	3	2	1	0	3	0	0	0	0	0
35	2004	7	4	8	0	2	1	1	0	1	4
40	2005 Dec	2	-	4	-	-	0	-	-	-	-
40	2006 Jan	3	-	3	-	-	0	-	-	-	-
42	2006	2	2	1	0	2	1	1	0	2	0
44	2007	4	2	3	0	0	0	0	0	0	3
	Mean	**3.5**	**2.5**	**3.3**	**0**	**1.8**	**0.3**	**0.5**	**0**	**0.8**	**1.8**

Table 16: Numbers of *Mecodema oregoides* in pitfall traps at 6 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; KB=Kennedys Bush; OR=Orongamai; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports

		Location of pitfalls									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
40	2006	0	-	5	-	-	0	-	-	-	-
42	2006	-	-	-	0	0	-	-	-	3	-
	TOTAL	**0**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**3**	**0**

4.3.8 Reticulate Stag beetle *Paralissotes reticulatus*

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This stag beetle species is the commonest and most widespread species of *Paralissotes* and is 13-22mm long including mandibles. Adult and larvae are found in and under soft rotting/decaying logs, branches, bark of native trees, and under rocks (Holloway, 2007; Manson, 1963). Stag beetles often require several years for lifecycle from larva to adult. Larva feeds on wood in contact with the soil, apparently preferring roots or buried tree stumps, especially when in the soft, red stage of decay (Hudson, 1934). Active at night throughout the year and sometimes during the day (Holloway, 2007). Pupae have been located in January while adults have been observed mating in October. Unlike their international relatives, NZ stag beetles many are flightless and slow moving. They are susceptible to deforestation and heavy predation, these unique species are at risk and need of protection, although more research is needed on their lifecycle and behaviour (Holloway 2007). Doubtful whether *P. reticulatus* occurs very far south of Christchurch. December appears to the best time to collect the beetles (Figure 2) and Sugarloaf (2) and Kennedys Bush (1) were sites with most found (Table 17).

Figure 2: *Paralissotes reticulatus* (Reticulate stag beetle) found at Ahuriri Scenic reserve in pitfalls (Butcher & Emberson unpublished data).

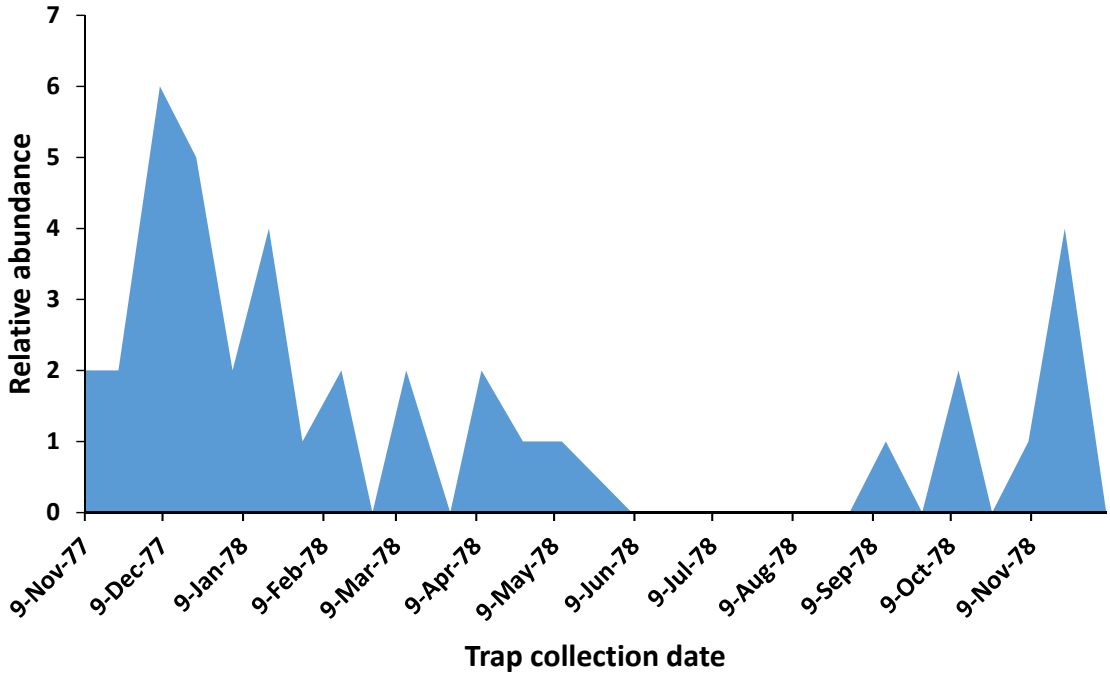

Table 17: Numbers of *Paralissotes reticulatus* under discs at 10 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush; OR=Orongamai; OT=Otahuna; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports

		Location of discs									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
35	2004	0	1	0	0	2	0	0	0	0	0
40	Dec 2005	1	-	0	-	-	0	-	-	-	-
40	Jan 2006	0	-	0	-	-	0	-	-	-	-
42	2006	0	3	0	8	3	0	0	5	0	13[L]
44	2007	0	1	0	1	0	0	0	0	2	2
	TOTAL	**1**	**5**	**0**	**9**	**5**	**0**	**0**	**5**	**2**	**15**

[L] = larvae

Table 18: Numbers of *Paralissotes* in pitfall traps at 6 Port Hills sites (AH= Ahuriri; CK=Coopers Knob; KB=Kennedys Bush; OR=Orongamai; SL=Sugarloaf). Extracted from Lincoln University Wildlife Management Reports.

		Location of pitfalls									
Report	**Year**	**AH**	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**
40	2006	0	-	0	-	-	0	-	-	-	-
42	2006	-	-	-	0	1	-	-	-	2	-
	TOTAL	**0**	**-**	**0**	**0**	**1**	**0**	**-**	**-**	**2**	**-**

4.3.9 Additional candidate species for translocation

Some additional invertebrate species should be seriously considered even though they were not monitored over the 2019-20 period.

Aphids

Reintroduction of aphids would seem a simple process so long as sufficient healthy populations were located. Lincoln Landcare Research campus was a historical record for both but there may be better or alternative sites to collect these from (Simon Bulman pers. comm. 11 Nov. 2019)

Carabidae

There are many other species of ground beetle not mentioned here as candidates, but may well be deserve consideration. One species which was once on the Port Hills and considered under threat is the large (23-32mm) Banks Peninsula endemic *Mecodema howitti* (Johns 2005). A survey in 17 eastern Banks Peninsula remnants found them in nine of these sites, with larger numbers in Otepatotu reserve and Panama Rock remnant (Bowie et al. 2011).

Megadromus antarticus is a large carabid commonly found in disturbed urban areas so would do quite well on Quail Island. One reason we have held off is that it has been recorded to have bitten the Banks Peninsula endemic *Megadromus guerinii* (Rowan Emberson pers. Comm.) so may be a threat to the establishment of smaller ground beetles.

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Onawea pantomelas is another option and because of its relative rarity and taxonomic interest but may require denser, more mature bush before reintroduction. It has been found in Panama Rock and Armstrong Reserve (Bowie et al. 2011).

Spiders

The six-eyed spider *Periegops suterii* is a good option in the spiders given its relative rarity and is the only genus in its family (Periegopidae). Bowie et al. (2011) found this species in six of the 17 remnants surveyed on eastern Banks Peninsula, so there may be sufficient populations to support a translocation.


© Sarah Visser

Six-eyed spider *Periegops suterii*

4.4 Results from 2018-19 survey work

Weta motels

The main species found in the weta motels were Theridiidae (cob-web spiders); however, all three of the candidate spider species (*Neoramia* spp., *Porrhothele antipodiana* and *Nuisiana arboris*) were also found (Table 19). Coopers Knob and Cass Peak motels were the best place for *Neoramia* spp., Ahuriri and Coopers Knob motels were best for *Porrhothele antipodiana*, and only single specimens of *Nuisiana arboris* were found at Orton Bradley Park and Ahuriri Scenic Reserve.

Table 19: Occupation of weta motels by candidate spider species from five sites in January & April 2019 (OB=Orton Bradley; AH= Ahuriri; CK=Coopers Knob; CP=Cass Peak; KB=Kennedys Bush (lower)).

Date/Sites	*Neoramia* spp.	*Porrhothele antipodiana*	*Nuisiana arboris*	No. of weta motels	% motel occu-pation	*Neoramia* egg sacs
16/01/19						
OB			1	21	8	0
AH		1		15	7	1
CK	3	2		15	33	2
CP	3			10	33	1
KB				10	0	0
26/04/19						
AH	1	2	1	15	27	0
CK	4	1		15	33	1
CP	1			10	10	1
KB				10	0	0

Hand searching

Rock and log rolling for candidate spiders was considerably more fruitful than motels, and had the advantage of finding beetles also. Ahuriri was the best site for collecting overall, and particularly good for *Porrhothele antipodiana* (Table 20).

Table 20: Rock and log survey showing relative abundance of target (candidate) species from five sites over the summer of 2018-2019.

	Orton Bradley	Orton Bradley	Ahuriri Reserve	Ahuriri Reserve	Coopers Knob	Kennedy's Bush	Cass Peak
Survey dates ►	12/12/2018	15/01/2019	14/12/2018	17/01/2019	18/12/2018	19/12/2018	20/12/2018
Species ▼							
***Neoramia* spp.**	3	10	2	1	2	2	4
Nuisiana arboris							
Porrhothele			19	38	27	8	11
***Uliodon* sp.**	3		9	5		4	
M. oregoides			1	3	2	1	
H. suteri	1	1					
H. intermittens	1			1			
P. reticulatus				1	1		
Total target species found	**8**	**11**	**31**	**49**	**32**	**15**	**15**
No. of rocks	80	124	58	182	103	106	97
No. of targets under rocks	7	10	19	37	29	14	14
% of targets under rocks	9	8	33	20	28	13	14
No. of logs	12	1	20	16	9	13	3
No. of targets under logs	1	1	12	12	3	1	0
% of target species under logs	8	100	60	75	33	8	0
Total No. of rocks & logs	92	125	78	198	112	119	100
Total % of target species found	9	54	46	24	31	11	7

5. DISCUSSION

5.1 Reptiles

More than 85 lizard translocations have been undertaken in the last three decades in New Zealand with varied results (Romijn & Hartley 2016). In terms of reptile translocations to Quail Island the main impediment is the current presence of mice. However mice presence has not stopped other sanctuaries undertaking translocations (e.g. Zealandia). Norbury et al. (2014) concluded that mice are a limiting factor for Otago skinks (*Oligosoma otagense*) translocations particularly in the initial phase. This could be mitigated by intensive mouse control (e.g. one month of rodenticide as undertaken at Zealandia) or some sort of predator fenced area to protect them (Reardon et al. 2012).

5.2 Birds

Numerous avian translocations have been undertaken in New Zealand including those on Tiritiri Matangi Island Parker (2013). There are too many issues to consider in terms of translocations of birds to discuss in this report but Bellingham et al. (2010) gives a good summary of them.

5.3 Invertebrates

Several beetle species and spider species were found in sufficient abundance to consider them as possible candidates for future translocation to Quail Island.

5.3.1 Sources of invertebrates

Banks Peninsula in the South Island has several mature forest remnant reserves. Across the Lyttelton Harbour from Ōtamahua are the Port Hills where there are many reserves, which have been surveyed and monitored (Johns 1986; Butcher & Emberson 1981; Ward et al. 2007; Bowie et al. 2019). These broadleaf-podocarp forests have been modified overtime by fire and milling (Johns, 2007) and continued predation, by rodents and hedgehogs in particular, appear to be taking their toll on smaller carabid species (Bowie et al. 2019).

Source populations of candidate invertebrates were chosen from sites based on close proximity to Ōtamahua to best ecosource based on environmental matching. As there are minimal mature forest reserves left on the peninsula there are limited options to locate source populations. More recent research on Port Hills reserves (Figure 1) give clear indications of which species which appear to be present in good numbers and those that are not (Bowie & Sirvid 2004; Bowie & Sirvid 2005; Bowie 2007 & 2008; Bowie et al. 2019). As these sites had the most up-to-date research of species present, it was logical to save time and resources by surveying where we knew there was already species present to assess their populations as a possible source for translocations to Ōtamahua.

Ahuriri is known to be the most ecologically significant reserve on the Port Hills from being the least modified and most diverse floral species, allowing many native fauna to gain refuge from surrounding farmland (Kelly 1972). This site had the most carabid beetle species collected by pitfall (Grove 2005). The trees consist mostly of mahoe and tree fuchsia with some young podocarp trees throughout.

Ground beetles (Carabidae)

Recent research (Bowie et al. 2019) has shown an apparent decline in abundance of most carabids at Ahuriri Scenic Reserve. Only *Holcaspis intermittans* and *H. suteri* increased in abundance since they were previously surveyed 30 years earlier by Butcher & Emberson (1981). Bowie et al. (2019) found a significant correlation with size of beetle and their abundance after 30 years. The six smallest carabids found by Butcher & Emberson (1981) at Ahuriri were not found three decades later (Bowie et al. 2019). Does this indicate we should concentrate on the smaller more vulnerable species or the select those that are increasing in abundance such as *Holcaspis intermittans* and *H. suteri*? One of the criteria for a DOC permit for translocation is focussed around the negative effects of taking individuals from a source population. Given this, and the ease of finding sufficient numbers (~ 50 individuals), the two *Holcaspis* species above would appear to be prime candidates, with *H. suteri* being a higher priority given its Banks Peninsula (BP) endemic

status. Another BP endemic carabid is *Mecodema oregoides*. We easily found these on the Port Hills in this survey however Bowie et al. (2019) found them in serious decline (-63%) over the 30 years. It would make considerable sense to translocate all three species at once given they are all found on the Port Hills and searching could uncover any of these. The release sites on Quail Island would probably need to be separated.

Stag beetle (*Paralissotes reticulatus*)
This flightless species of stag beetle was not found in great abundance but we did not search specifically for this species. Placing pine or native logs in Port Hills reserves as habitat to capture this species is worthwhile as has worked previously in several (Bowie & Sirvid 2005; Bowie & Vink 2006; Bowie 2008).

Native Aphids
With proper time, experts, materials, and resources, it would be ideal to undertake some reintroductions as soon as possible. Further research needs to be done on native aphids to determine whether they are currently on Quail Island. A search for native aphids (*Aphis healyi* and *Paradoxyaphis*) was undertaken in early November 2019 on the island by Jason Butt and Mike Bowie on *Carmichaelia* and *Aciphylla* respectively to locate specimens, without luck. Aphids were found on the growing tips of Totara on the same day which were thought to be the native aphid (*Neophyllaphis totarae*) previously found there.

5.3.2 Evaluation of field methods
Some of the target species (*Neoramia* and *Holcaspis*) were difficult to distinguish, as characteristics are not always clearly visible to the naked eye, or the individuals moved out of reach. Other species however, even if only partially seen, were easily identified, such as *Porrhothele antipodiana,* which has few closely related species to misidentify as another similar species.

The *Holcaspis* beetles in particular were difficult to identify without magnification of a microscope or good magnifier, but specimens could be collected and brought back into laboratory for identification and sorting. The wet weather made it difficult to survey accurately and efficiently, impacting walking, vision, and possibly the abundance and diversity of invertebrates found, due to change in temperature and dampness.

At Orton Bradley Park fewer invertebrates were found compared to the other surveyed sites. It was observed that kanuka areas appeared to have fewer of the candidate species than the more florally diverse habitats. The time limit of 30 minutes gave a good amount of time to survey most areas selected; however, it would range from location, how many rocks and logs were available, and the time used to identify and photographing various species. If a site had greater abundance of rocks/logs, then in most areas, more individuals were observed than other sites with fewer amounts which could give an unfair representation of the populations present in the area. As most of the reserves are not the original forest but regrowth, it meant that there were limited coarse woody debris that could be surveyed. Most of the logs surveyed were a small size, with early degradation, unsuitable for many invertebrates to occupy. In Ahuriri Scenic reserve, there were more suitable sized and aged logs with increased surface area with more cavities for invertebrates to shelter under. At Ahuriri we also observed a greater abundance and diversity of species were located at the top of the reserve and along the edges.

The lack of knowledge at the time to distinguish between *N. janus* and *N. setosa* made it difficult to know the abundance of each species as photos were not taken of all individuals.
Whenever an interesting or hard to see individual was discovered, more time was used to observe, take photos and/or move surrounding soil of leaf litter to see the escaping invertebrate clearer. Location is key to finding species as beetles or spiders show greater abundance in certain areas rather than being evenly distributed across a reserve. It is hard to identify juveniles of spider and beetle species when their morphology simpler and similar to other species in their group. Therefore targeting gravid females is recommended as they are easier to identify and will be carrying progeny with them in a translocation. This makes timing of translocations crucial and possibly several episodes rather than all on the same day.

5.3.2.1 Rock and log rolling methods

If time, and weta motels were increased, it would allow for greater occupancy with more abundance and diversity of spiders to be recorded. However, the limited number of motels and time within the research provided limited data.

Motels were set at various heights on the trees to cater for the various spider species which might prefer to occupy cavities at certain distances from the ground. We observed that *P. antipodiana* were more often found in weta motels placed lower on trees. *Neoramia* species were more often observed to inhabit weta motels in rocky areas.

Selecting trees to place weta motels was based off tree species that were found to inhabit more of the target species from data collected in previous research (Bowie & Sirvid 2004; Bowie & Vink 2006; Grove 2005). Previous research suggests that motel occupancy increases with time (Bowie et. al 2014; Hodge et al. 2007; Smith et al. 2016) so motels need to be given sufficient time (preferably >6 months) to become fully occupied.

Most of the *Neoramia* species found were nesting females that preferred dry tight flat crevices in-between or under flat rocks to create a web and lay their eggs. Rocky banks were a common place to find them over flat leaf-littered ground where piled up rocks created a dark protected area to roam at night and hide during the day. When disturbed the nesting females would stay with their eggs to assumedly protect them from any immediate danger. Other individuals, without eggs, would run for a short distance away from their web, then stop and hide under cover. Those individuals would be further pursued for identification unless it would reach the point of possibly harming them.
The majority of *Porrhothele* were found in webs down the sides of rocks, in large worm holes or in holes in/under logs. Webs that resembled *Porrhothele* were occasionally observed in cavities or in-between the base trunks in mature trees. Many immature individuals were found rather than mature during our survey.
The *Uliodon* species were found resting under logs in burrows or cavities. Most identified were mature (and quite large!). If the rock or log was lifted slowly without sudden movements then the adults would stay resting.

Two of the stag beetles (*Paralissotes*) were found while turning over degrading logs that broke to reveal the beetle resting inside, one of which convincingly played dead. A third specimen was observed resting on a tree in during the day, in the shade, next to a weta motel.
No *Nuisiana* species were found using this surveying method/technique, assuming they were hiding in deeper cavities in living trees. Previously they have been found in weta motels and bird nesting boxes (Hodge et al. 2007); *iNaturalist*). Most *Holcaspis* species as well as *M. oregoides* were found under hand sized rocks surrounding leaf litter. Some individuals encountered were quite advanced at 'playing dead' by freezing in one position on their back, so it was uncertain as to whether to include them or not in the data. Also, some individuals escaped closer identification by darting into earthworm holes

5.3.2.2 Weta motels

Although many weta motels were occupied after a month or longer, it was by non-candidate species, often Theridiidae. Identification was difficult initially but with time and help from *iNaturalist* specimens became easier to identify. Although we were unable to distinguish between *N. setosa* and *N. janus*, some taxonomic advice would allow them to be determined.

5.3.3 Reproductive phenology

Knowing when ground beetle females are gravid to maximise your reintroduction potential is useful. Data from (Butcher & Emberson 1981) suggests late summer to autumn may be the optimum time for the two *Holcaspis* and one *Mecodema* species listed (Table 21).

Table 21: Percent of gravid carabid females (in reproductive condition) in Ahuriri Reserve 1978-79 (Butcher & Emberson 1981).

	Date						
Species	22/12/77	4/1/78	19/1/78	1/2/78	16/2/78	16/3/78	11/4/78
Holcaspis suteri	60	100	80	60	100	100	100
H. (*subaenea*) *intermittans*	75	80	100	80*	40*	-	100
Mecodema oregoides	0	40	-	0	11	0	100

*One individual rendered sterile due to nematode worms

5.3.4 Sex ratios of carabid beetles

The sex ratio of ground beetles is something to consider particularly with low numbers, but on the whole gravid females would be the ideal scenario. Butcher & Emberson (1981) found ratios differed greatly between the three species assessed (Table 22).

Table 22: Sex Ratios from 1978-79 study from Ahuriri Scenic Reserve (Butcher & Emberson 1981)

Carabid species	**Female: Male ratio**
Holcaspis suteri	1: 0.88
H. (*subaenea*) *intermittans*	1: 2
Mecodema oregoides	1: 0.8

5.3.5 Quail Island locations for translocations

There two good vegetated sites for releases; the oak grove and below rock outcrop (where the leaf-vein slugs were released). Wooden discs and/or weta motels would need to be placed out in these areas as refugia where appropriate for chosen species.

6. CONCLUSIONS

Two to four reptile species could be translocated to Quail Island with the jewelled gecko and spotted skink being the most obvious contenders.

Many bird translocations have been undertaken in New Zealand and Quail Island does offer opportunities for some species as outline in this document (Table 2), but further discussion with DOC needs to be undertaken before a case can be made. The main concerns are small habitat size, open access of island and associated pest/dog issues, and the influence of port lights on sea bird possibilities e.g. shearwater (*Puffinus*) species.

The invertebrates seem to be the best taxa to currently reintroduce as there are several source locations for them, proven methodology (wooden discs and weta motels) that help protect the invertebrates in the presence of mice and allow non-destructive monitoring to be used to document their colonisation. Invertebrates also provide additional prey items for the native vertebrate species (e.g. lizards and birds) which are insectivorous. The species listed in Table 3 provide a good starting point in terms of timing or priority but there are many species that have not been mentioned including several small carabid species on the Port Hills and Lyttelton Harbour basin. The predator situation may change on Quail Island with Predator Free Ltd 2050 initiatives which may pave the way for higher priority invertebrates, lizards or birds.

Populations of *Mecodema oregoides* have decreased by over 60% in 30 years at Ahuriri Scenic Reserve in Port Hills (Bowie et al. 2019). Given its apparent vulnerability and a Banks Peninsula endemic it would seem a species worth considering. The only two species increasing over the 30 years were the two largest *Holcaspis* species there were *H. suteri* and *H. intermittans,* the former also a Banks Peninsula endemic. These species seem to be candidates worth reintroducing as they will further test the methodology for other rarer species such as *Mecodema howitti* and *Onawea pantomelas.*

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8. REFERENCES

Atkinson IAE. 1990. Ecological restoration on islands: prerequisites for success. Pp73-90 in: Towns DR, Daugherty CH and Atkinson IAE (Eds). Ecological restoration of New Zealand islands. Conservation Sciences Publications No. 2. DOC, Wellington

Baling M, Wedding C, Barry M, Ji W, Brunton DH. 2010. Re-introduction of shore skinks to offshore islands in the Auckland region, New Zealand. Global re-introduction perspectives: Additional case-studies from around the globe. IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI.

Bartolozzi, L., Zilioli, M., & De Keyzer, R. (2017). The Stag Beetles of Australia New Zealand New Caledonia and Fiji. Czech Republic. Taita Publishers.

Bell TP, Herbert SM. 2017. Establishment of a Self-Sustaining Population of a Long-Lived, Slow-Breeding Gecko Species (Diplodactylidae: Hoplodactylus duvaucelii) Evident 15 Years after Translocation. Journal of Herpetology, 51(1):37-46.

Bellingham PJ, Towns DR, Cameron EK, Davis JJ, Wardle DA, Wilmshurst JM, Mulder, CPH. 2010. New Zealand island restoration: seabirds, predators, and the importance of history. New Zealand Journal of Ecology 34(1): 115-136.

Bowie MH, Marris JWM, Emberson RM, Andrew IG, Berry JA, Vink CJ, White EG, Stufkins MAW, Oliver EHA, Early JW, Klimaszewski J, Johns PM, Wratten SD, Mahlfeld K, Brown B, Eyles AC, Pawson SM, Macfarlane RP. 2003. A terrestrial invertebrate inventory of Quail Island (Otamahua): towards the restoration of the invertebrate community. New Zealand Natural Sciences 28: 81-109.

Bowie MH & Vink C. 2006. Measuring diversity and abundance of invertebrates in Ahuriri, Coopers Knob and Orongomai reserves in the Port Hills, Canterbury. Lincoln University Wildlife Management Report 40.

Bowie MH, Meurk C, Burrows C. 2006. Proceedings of the Quail Island Ecological Restoration Trust Workshop held at Lincoln University on 28 May 2006. Lincoln University Wildlife Management Report 39.

Bowie MH & Sirvid P. 2004. Measuring diversity and abundance of carabids and spiders of ten Port Hills Reserves in Canterbury. Lincoln University Wildlife Management Report 34.

Bowie MH & Sirvid P. 2005. Measuring ecosystem recovery: diversity and abundance of invertebrates in ten Port Hills reserves, Canterbury. Lincoln University Wildlife Management Report 35.

Bowie MH. 2008. Measuring diversity and abundance of carabids and spiders of ten Port Hills Reserves in Canterbury. Lincoln University Wildlife Management Report 44.

Bowie MH. 2010a. Re-introduction of the Banks Peninsula tree weta to Quail Island, Banks Peninsula, Canterbury, New Zealand. Global re-introduction perspectives: Additional case-studies from around the globe. IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI.

Bowie MH. 2010b. Re-introduction of the leaf-vein slug to Quail Island, Banks Peninsula, Canterbury, New Zealand. Global re-introduction perspectives: Additional case-studies from around the globe. IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI.

Bowie M, Mountier C, Fox B, Boyer S, Gamlin-Greene R, Brown S, Sullivan J, Hoare R. & Johns P. 2011. An Invertebrate survey of reserves, covenants and significant remnants of eastern Banks Peninsula in 2010-2011. Lincoln University Wildlife Management Report No. 25.

Bowie MH, Allen W, McCaw J, van Heugten RA. 2014. Factors influencing occupancy of modified artificial refuges for monitoring the range-restricted Banks Peninsula tree weta Hemideina ricta (Anostostomatidae). *New Zealand Journal of Ecology* 38(1): 132-138

Bowie MH, Corodji JM, Ford D, Ross JG, McLennan I, Fewster RM & Murphy EC. 2018. Mouse management on Ōtamahua/Quail Island—lessons learned, New Zealand Journal of Zoology 45 (3): 267-285.

Bowie MH, Shields MW, He S, Ross JG, Cruickshank RH, Hodge S. 2019. A survey of ground beetles (Coleoptera: Carabidae) in Ahuriri Scenic reserve, Banks Peninsula, and comparisons with a previous survey performed 30 years earlier. New Zealand Journal of Zoology 46 (4): 285-300.

Bowie MH. Black L. Boyer S. Dickenson NM and Hodge S. 2016. Persistence of biodiversity in a dryland remnant within an intensified dairy farm landscape. New Zealand Journal of Ecology 40(1)

Burrows CJ, Wilson HD, Meurk CD. 1999. The ecological restoration of Otamahua/Quail Island 2. The vascular land flora and vegetation. New Zealand Natural Sciences. 24:127–150

Burrows CJ, Wilson HD. 2011. The Island's plants: ecorestoration of Otamahua/Quail Island, 1997-2010. The Caxton Press, Christchurch, New Zealand. 130pp.

Butcher MR, Emberson RM. 1981. Aspects of the biology of carabid beetles of Ahuriri Bush Scenic Reserve, Banks Peninsula. Mauri Ora 9: 59-70.

Early J. 2009. Know your New Zealand Insects and Spiders. New Holland Publishers (NZ) Ltd. 176pp.

Fairweather B. 2008. Spiders in New Zealand. Penguin Group (NZ). 128pp.

Forster R. & Forster C. 1973. The Spiders of New Zealand: Part IV. Dunedin, New Zealand. Otago Museum Trust Board.

Forster R.R & Wilton CL. 1973. The spiders of New Zealand IV. Otago Museum Bulletin No. 4. Dunedin. 309pp.

Gibbs GW. 1990. Pp123-127 in: Towns DR, Daugherty CH and Atkinson IAE (Eds). Ecological restoration of New Zealand islands. Conservation Sciences Publications No. 2. DOC, Wellington.

Gibbs G. 2016. Ghosts of Gondwana. The history of life in New Zealand.416p.

Green O. & Lessiter M. 1987. Discover NZ: Fascinating Spiders. Auckland, New Zealand. The Bush Press.

Grove P. 2005. Monitoring the effects of biodiversity pest control in high value environmental areas. Technical Report No. U05/29. Investigations and Monitoring Group, Environment Canterbury. 46pp.

Hodge S, Vink C, Banks J, Bowie MH. 2007. The use of tree-mounted artificial shelters to investigate arboreal spider communities in New Zealand nature reserves. Journal of Arachnology 35:129–136.

Holdaway R. 1998. Grounded! Why do some birds walk? New Zealand Geographic 37(Jan-Mar):

Holloway, BA. (2007). Fauna of New Zealand 61: Lucanidae (Insecta: Coleoptera)

Hudson, G. V. (1934). New Zealand Beetles and Their Larvae. New Zealand. Ferguson & Osborn, Limited, Printers and Publishers, Wellington.

Jackson P. 2006. Otamahua/Quail Island – A link with the past. 2nd Edition. pp102

Johns PM. 1986. Arthropods of Banks Peninsula Reserves. Zoology Department, University of Canterbury. Report to the commissioner of Crown Lands, Christchurch August 1986.

Johns PM. 2005. Field guide to South Island carabid beetles of conservation interest. Coleoptera: Carabidae. Published by Department of Conservation, Christchurch. 74pp.

Johns PM. 2007. New genera and species of rare New Zealand endemic carabids. (Coleoptera: Carabidae). Privately published. Retrieved from http://www.nzbiodiversity.com/publications/carabidsnspp.pdf

Kelly GC. 1972. Scenic reserves of Canterbury. Biological survey of reserves. Report 2. Department of Lands and Survey.

Lukis K. 1999. Suggested protocol for the reintroduction of two locally extinct lizard species to Quail Island. Lincoln University Wildlife Management Report 24.

Manson, D. C. M. 1963. Nature in New Zealand: Native Beetles of New Zealand. 182 Wakefield Street Wellington. A. H. & A. W. REED publishers of New Zealand Books.

Miller KA, Gruber MAM, Keall SN, Blanchard B, Nelson NJ. 2010. Changing taxonomy and the need for supplementation in the management of re-introductions of Brothers Island tuatara in Cook Strait, New Zealand. Global re-introduction perspectives: Additional case-studies from around the globe. IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI.

Molles L. 2010. Tui transfer to Hinewai. Pp36-38, In: Bowie MH, Barker R, Troup T. proceedings of the Banks Peninsula Biodiversity Workshop Lincoln University Wildlife Management Report 30. 45pp.

Norbury G, van den Munckhof M, Neitzel S, Hutcheon A, Reardon J, Ludwig K. 2014. Impacts of invasive house mice on post-release survival of translocated lizards. New Zealand Journal of Ecology 38(2): 322-327.

Norton DA, Leighton A, Phipps H. (Compilers) 2004. Otamahua/Quail Island Restoration Plan. Otamahua/Quail Island Restoration Trust.

NZ birds online 2019. Retrieved from http://nzbirdsonline.org.nz/species/new-zealand-quail)

Paquin P, Vink C. & Duperre N. 2010. Spiders of New Zealand: Annotated Family Key & Species List. Lincoln, New Zealand. Manaaki Whenua Press.

Parker KA 2013. Avian translocations to and from Tiritiri Matangi 1974–2013. New Zealand Journal of Ecology (2013) 37(3): 282-287

Raven RJ. & Stumkat K. 2003. Problem solving in the spider families Miturgidae, Ctenidae and Psechridae (Araneae) in Australia and New Zealand. Journal of Arachnology 31: 105-121.

Reardon JT, Whitmore N, Holmes KM, Judd LM, Hutcheon AD, Norbury G, Mackenzie DI. 2012. Predator control allows critically endangered lizards to recover on mainland New Zealand. New Zealand Journal of Ecology (2012) 36(2): 151-156.

Romijn RL, Hartley S. 2016. Trends in lizard translocations in New Zealand between 1988 and 2013. New Zealand Journal of Zoology 43 (2): 191-210.

Smith CMS, Bowie MH, Hahner JL, Boyer S, Kim YN, Zhong HT, Abbott M, Rhodes S, Sharp D, Dickinson N. 2016. Punakaiki Coastal Restoration Project: A case study for a consultative and

multidisciplinary approach in selecting indicators of restoration success for a sand mining closure site, West Coast, New Zealand Catena 136: 91-103.

Takada A. & Bowie MH. 2018. How does ecological restoration influence invertebrate composition on Quail Island? Lincoln University Wildlife Management Report 69.

Teulon DAJ, Stufkens MAW 1998. Current status of New Zealand indigenous aphids. Conservation Advisory Science notes No. 216. Department in Conservation, Wellington. 23pp.

van Winkel D, Baling M, Barry M, Ji W, Brunton D. 2010. Translocation of Duvaucel's geckos to Tiritiri Matangi Islands, Hauraki Gulf, as part of island ecological restoration initiatives. Global re-introduction perspectives: Additional case-studies from around the globe. IUCN/SSC Re-introduction Specialist Group & Environment Agency-ABU DHABI.

Vink CJ, Fitzgerald BM, Sirvid PJ, Dupérré N, & Miller J. 2011. Reuniting males and females: redescriptions of *Nuisiana arboris* (Marples 1959) and *Cambridgea reinga* Forster & Wilton 1973 (Araneae: Desidae, Stiphidiidae). *Zootaxa 2739*: 41-50
Retrieved from https://www.gbif.org/species/100058446

Vink C. 2015. Spiders of New Zealand. New Zealand. New Holland Publishers.

Walker S. Price R, Rutledge D. Stephens T.R.T. Lee W.G. 2006. Recent loss of indigenous cover in New Zealand. New Zealand Journal of Ecology 30(2): 169-177.

Ward, J., R. MacFarlane, P. Quinn, S. Morris, T. Hitchings, E. Green, J. Early, R. Emberson, G. Fenwick, I. Henderson, R. Henderson, P. M. Johns, M.-C. Larivière, J. Marris, L. Matile, I. McLellan, B. Patrick, C. Smithers, M. Stufkens, C. Vink and H. Wilson. 1999. Insects and other arthropods of Hinewai Reserve, Banks Peninsula, New Zealand. Records of the Canterbury Museum 13: 97-121.

Ward, J. B., G. M. Ward, P. M. Johns, L. Jenner, P. Quinn, E. H. Green, J. M. Clark, T. R. Hitchings, R. Macfarlane and S. Pollard. 2007. A survey of the Arthropods of Kennedys Bush Reserve. Records of the Canterbury Museum 21: 57-68.

9. APPENDICES

Species profiles

***Neoramia* spp.**	
Family	Agelenidae/Stiphidiidae
Common Name	Sheetweb spider
Endemic status	*N. setosa* is a Banks Peninsula endemic. *N. janus* is restricted to certain areas
Refugia/Habitat required	Weta motels, logs/rocks
Common sites/conditions found	Inbetween/under rocks on rocky hills/banks
Diet	Generalist invertebrate
Nocturnal	Yes
Population locations	Ahuriri, CK, CP, OR, KB, Orton Bradley
Distinguishing features	Light X on abdomen, light brown, medium size
Ecological role	Predator
Parasites	Unknown
Predators	Rodents, hedgehogs, wasps, birds
Life span	-
# of offspring	60+
Egg season	October-January
Endangered/decline on mainland	-
Threat to human	-
Preferred flora	Mature native forest
Sex ratio?	-
Size	*N. janus* 8mm; *N. setosa* 10mm

Nuisiana arboris	
Family	Desidae
Common Name	Cobweb spider
Endemic status	Widespread NZ restricted area
Refugia/Habitat required	Weta motel, logs/rocks
Common sites/conditions found	Weta motels/nesting boxes, dry cavities or under bark in mature trees, wooden discs.
Diet	Generalist invertebrates
Nocturnal	Yes
Population locations	Orton Bradley Park and Sugarloaf 1
Distinguishing features	Dark X on abdomen, light and dark brown spotted patterning, stripey legs. Slightly bigger and more slim/pointed abdomen than *Neoramia*.
Ecological role	Predator
Parasites	-
Predators	Rodents, hedgehogs, wasps, birds
Life span	-
# of offspring	135-259 eggs (Vink et al. 2011)
Egg season	September
Endangered/decline on mainland	-
Threat to human	No
Preferred flora	Mature native trees
Sex ratio?	-
Size	12mm (Forster & Wilton 1973)

***Uliodon* sp.**	
Family	Zoropidae
Common Name	Vagrant spider, or prowling spider
Endemic status	Common, found throughout NZ
Refugia/Habitat required	Weta motel, logs/rocks
Common sites/conditions found	Under logs in burrows on ground
Diet	Inverts
Nocturnal	Yes
Population locations	Ahuriri, Orton Bradley, Kennedys Bush
Distinguishing features	Large size, dark brown, spots on abdomen
Ecological role	Predator
Parasites	Large parasitic worm
Predators	Mice, spider wasps, birds
Life span	1+years?
# of offspring	50-100??
Egg season	January
Endangered/decline on mainland	Still commonly found
Threat to human	Venomous bite if provoked, not deadly
Preferred flora?	Adaptable to native and exotic
Sex ratio	-
Size	20-30mm

Porrhothele antopodiana	
Family	Hexathelidae
Common Name	Tunnel web spider
Endemic status	Highly distributed in restricted areas NZ
Refugia/Habitat required	Weta motel, logs/rocks, wooden discs?
Common sites/conditions found	Rock sides, crevice's, holes, logs/trees
Diet	Invertebrates
Nocturnal	Yes
Source Population	Ahuriri, Orton Bradley, CK, CP
Distinguishing features	Tunnel-web, large size, thick black body
Ecological role	Predator
Parasites	Large parasitic worm
Predators	Rodents, hedgehogs, spider wasps: Pompilidae
Life span	♀6+ yr; ♂3+ yr after mating
# of offspring	200-300 hatching in 30 days
Egg season	
Endangered/decline on mainland	
Threat to human	Bite if provoked, not deadly
Preferred flora	Mature native, canopy closure
Sex ratio	
Size	~ 30mm long body, 50mm with legs

Holcaspis suteri	
Family	Carabidae
Common Name	Gound beetle
Endemic status	BP endemic
Refugia/Habitat required	Bush cover, logs/discs
Common sites/conditions found	Under rocks, solid logs in holes, cavities

Diet	Omnivore
Nocturnal	Yes
Source Population	Ahuriri, Orton Bradley
Distinguishing features	Black, dimples+hairs on elytra
Ecological role	Generalist predators
Parasites	Mites
Predators	Rodents, hedgehogs, birds
Life span	1-2 years
# of offspring	~12
Egg season	Unknown
Endangered/decline on mainland	Yes
Threat to human	Minimal pinch of skin by jaws
Preferred flora	Mature native
Sex ratio	1♀: 0.88♂
Size	16mm

Holcaspis intermittans	
Family	Carabidae (ground beetle)
Endemic status	Restricted areas of NZ
Refugia/Habitat required	Bush cover, logs/discs
Common sites/conditions found	Under rocks, solid logs in holes, cavities
Diet	Omnivore
Nocturnal	Yes
Source Population	Ahuriri, Orton Bradley
Distinguishing features	Black, lack of dimples+hairs on abdomen
Ecological role	Generalist predators
Parasites	Mites
Predators	Mice, birds?
Life span	1-2 years
# of offspring	Around a dozen?
Egg season	Unknown
Endangered/decline on mainland	Yes
Threat to human	No
Preferred flora?	Mature native
Sex ratio	1♀: 2♂
Size	17mm long

Mecodema oregoides	
Family	Carabidae
Common Name	Ground beetle
Endemic status	BP endemic
Refugia/Habitat required	Bush cover, logs/discs
Common sites/conditions found	Under rocks, solid logs in holes, cavities
Diet	Omnivore
Nocturnal	Yes
Source Population	Ahuriri, CK
Distinguishing features	Black, rounded thorax
Ecological role	Generalist predators
Parasites	Mites
Predators	Rodents, hedgehogs, birds
Life span	1-2 years
# of offspring	~12?

Egg season	Spring & autumn
Endangered/decline	Bowie et al 2019
Threat to human	Minimal pinch of skin by jaws
Preferred habitat	Mature native
Sex ratio	1♀: 0.8♂
Size	16mm

Paralissotes reticulatus	
Family	Lucanidae
Common Name	Reticulate Stag Beetle
Endemic status	Widespread in NZ, restricted to native forest
Refugia/Habitat required	Bush cover, logs/discs
Common sites/conditions found	In degrading logs on forest floor
Diet	Wood
Nocturnal	Yes
Source Population	Ahuriri, Orton Bradley, CK,
Distinguishing features	Black, jaws, patterning
Ecological role	Decomposer
Parasites	Unknown
Predators	Rodents, hedgehogs, birds
Life span	1-2?
# of offspring	-
Egg season	-
Endangered/decline	-
Threat to human	-
Preferred flora?	Mature native
Sex ratio?	-
Size	13-22mm

Comparison of Port Hill site descriptions (adapted from Grove 2005).

2005	Orton Bradley 1&2	Ahuriri Reserve 1&2	Coopers Knob	Cass Peak	Kennedy's Bush
Co-ordinates	S4338.782 E17227577 #1&2 S4340.277 E17242.819 #3&4 S4340.200 S17243.581		#1 S4340243 E17242.884 #2 S4338.201 E17237.462 #3 S4338.202 E17237.459 #4 S4338.207 E17237.482	#2 S43438.201 E17237.462 #3 S43438.202 E17237.459 #4 S43438.207 E17237.482	
Altitude		450m	480m	455m	280m
Description		Moderately Steep (15°)	Steep face (35°)	Moderately Steep (20°)	Steep Gully Face (30°)
Forest type		Podocarp/hard wood	Secondary growth mixed hardwood	Podocarp/hardwood	Podocarp/hard wood
Health ranking		1	3	4	2
Forest Age	Late 1800's?				
Trees/plants		Totara, Fuchsia, mahoe, broadleaf, ribbonwood, horopito	Fuchsia, Broadleaf, Horopito, Lemonwood,	Fuchsia Mahoe, lemonwood	Mahoe, Matai, Totara
Canopy (2005)		98%	90%	82%	70%
Vegetation		75%	70%	35%	60%
Litter		90%	90%	90%	75%
Moss		5%	5%	2%	1%
Bare ground		<5%	<5%	1%	2%
Exposed rock		<5%	<5%	2%	<1%
Ground cover browse level		Low	Low	Moderate	Moderate