

Kupe's Sail environmental assessment

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March 2021



'Te Rā e Kupe', Cape Palliser. William Mein Smith c1849. Alexander Turnbull Library, Ref E-011-f-004.

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March 2021

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The report may be cited as:

Uys R and Michalak F. 2021. *Kupe's Sail environmental assessment*. Greater Wellington Regional Council, Publication No. GW/ESCI-G-21/5, Wellington.

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1. Introduction

The area around Kupe's Sail has been identified as a conservation priority by the Department of Conservation / Te Papa Atawhai (DOC). Wanting to prioritise conservation action in the area, staff from the DOC Whakaoriori / Masterton Office approached the Greater Wellington Regional Council (GWRC) Environmental Science Department to provide an environmental assessment of the area.

The area selected for survey encompassed the southern-most extent of the North Island. It included the coastal zone from Kupe's Sail Rock Recreation Reserve in the west up to, but not including the Stonewall Scenic Reserve in the east (Figure 1.1).

Surveys were conducted by specialists from GWRC and Wellington City Council (WCC), along with two private expert botanists, over three days in December 2020. The aim of this field work was to survey the health of conservation priority species and ecosystems, and to quantify the pressures of pest species that may be threatening them.

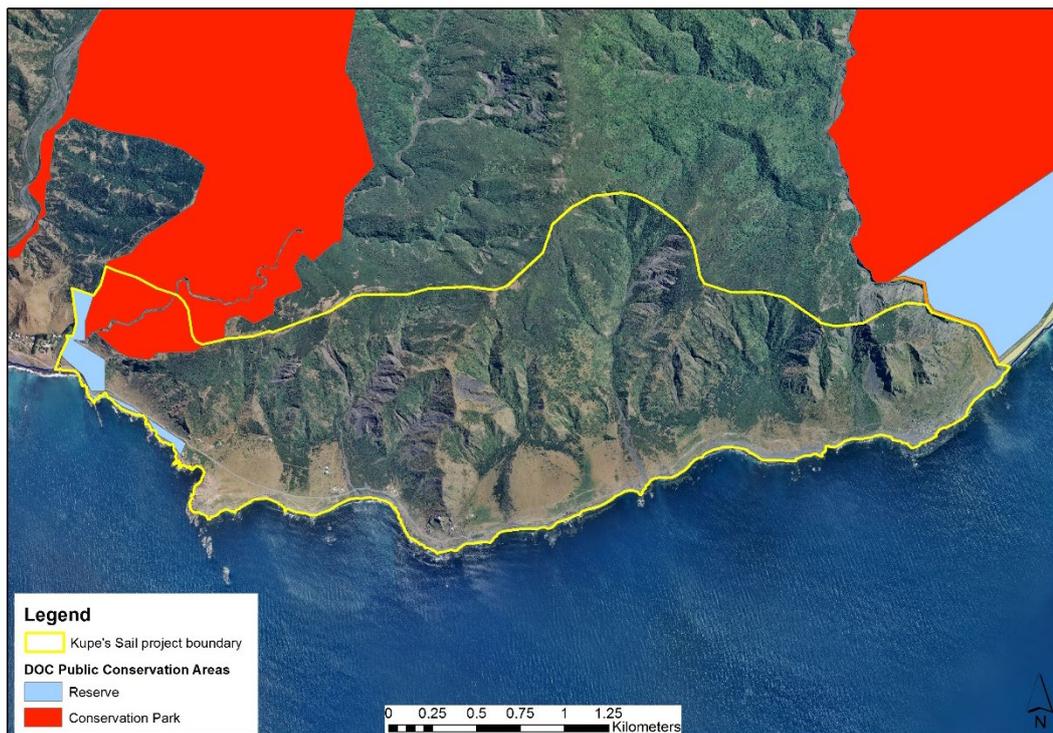


Figure 1.1: Extent of the project area, showing Kupe's Sail Recreation Reserve in the west and Stonewall Scenic Reserve in the east, bounded by the Aorangi Forest Park

2. Methods

2.1 Priority species

Mr Patrick Enright had previously surveyed the flora of the area which included a number of plant species of conservation concern. Mr Enright's species lists were added to during the field surveys as additional species were encountered during the survey (Appendix 1).

Of primary conservation concern was the Threatened: nationally Endangered, regionally Critical plant, shrubby tororaro (*Muehlenbeckia astonii*) (de Lange et al 2018, Crisp 2020a). The area was known to support the largest known wild population of shrubby tororaro in the lower North Island, including naturally established and planted individuals. To establish the status of the population, plants were tagged, their average length, breadth and height recorded to the nearest 100mm and their sex determined. Aluminium tags with unique codes were attached to the base of adult plants using aluminium wire. One tag, code K2016, was misplaced resulting in a break in the numerical series. Plants in Kupe's Sail Recreation Reserve were not tagged as the canopy had not closed. Given the poor condition and exposure of the plants, there was a concern that frequent movement of the tags by the wind may ring-bark the plants. Material for cultivation was collected by WCC staff from shrubby tororaro plants that were determined to have established naturally and for which the sex could be determined.

Little is known of the reptile fauna in the survey area. A detailed survey was not possible in the time available, but two staff from GWRC spent a day searching likely habitats. They worked their way along the road from Cape Palliser lighthouse west up to Kupe's Sail Recreation Reserve, recording all the lizards encountered through active searches. These records are to be submitted as Amphibian and Reptile Distribution Scheme (ARDS) cards to DOC.

A once-off survey, like the survey of the indigenous bird values of the Wellington region coastline (McArthur et al 2019), will only capture some of the birds in an area, particularly in coastal zones where a number of the species might be migrants. The website eBird.org offers a repository for ornithologists to record their sightings and is widely used by competent birdwatchers across New Zealand. The list for the Cape Palliser birding hot spot was checked against individual sightings lists from the project area. This was completed as the hotspot list was pinned to the Cape Palliser lighthouse and may not have captured species from all the habitats in the project area. The lists were extracted by searching for a species map for a commonly observed species in the area, south black-backed gull (*Larus dominicanus*). This resulted in the mapping of all the records in the project area with species lists that included this common species, allowing the individual lists to be compared to the combined list for the hot spot. Only records from 2015 or later were accepted to ensure that the list reflected the current species composition. Birds were sorted into indigenous coastal species, indigenous terrestrial species typical of

inland areas, indigenous pelagic species that are typically migrants or vagrants in the area, and exotic species.

2.2 Priority ecosystems

Priority ecosystems were assessed from recent surveys commissioned by GWRC and during the field visit. The work included assessments of rare and naturally uncommon ecosystems, the natural character of the coastal marine area and significant habitats identified for the regional Natural Resources Plan (GWRC 2019a).

Rare and naturally uncommon ecosystems are of high conservation concern (Wiser et al 2013). These were mapped during the field surveys and included: active dunelands, coastal turfs, marine mammal haulouts, and wetlands (Holdaway et al 2012).

The natural character assessment of the survey area was completed for the terrestrial, coastal reef and continental shelf around Cape Palliser (Boffa Miskell Limited and NIWA 2020). This work combines the biotic, abiotic and experiential condition to describe the overall condition of the coastal marine area and highlights conservation priorities that could be addressed to improve the natural character.

A coastal bird survey of the Wellington region has also been completed for GWRC. This identified areas of high coastal bird diversity and priority coastal bird breeding sites, including the area around Cape Palliser (McArthur et al 2019). This survey, along with other new information, has been used to review the distribution of significant bird areas around the Wellington region (McArthur in press) with a view to updating Schedule F2: "Significant Habitats for Indigenous Birds" in the regional Natural Resources Plan (GWRC 2019a).

The distribution of significant New Zealand fur seal (*Arctocephalus forsteri*) colonies has been identified in Schedule F5: "Habitats with Significant Indigenous Biodiversity Values in the Coastal Marine Area" in the regional Natural Resources Plan (GWRC 2019a). These colonies represent marine mammal haulouts (Wiser et al 2013) that are nationally Threatened: Critically Endangered ecosystems (Holdaway et al 2012). The coastal bird survey also mapped the location of New Zealand fur seal colonies around the Wellington region. However, the extent of these haulouts was not mapped in detail, so this was completed during the field survey.

Coastal turfs are nationally Threatened: Critically Endangered ecosystems (Holdaway et al 2012). Their location was mapped as part of this survey, along with the extent of wetlands that are regionally Threatened: Critically Endangered with less than three percent of their historical extent remaining in the Wellington region (StatsNZ and MfE).

2.3 Pest species

Pest species were selected for survey based on the regional pest management plan (GWRC 2019b). These included the plant, boneseed (*Chrysanthemoides monilifera* subsp. *monilifera*) and animal pests: cats, hedgehogs, mustelids and rodents (mice and rats). Pest plants were surveyed as part of the work to expand the plant list for the area. Plants were GPSed, photographed and the GWRC Pest Plants Team alerted to prioritise their control.

Rodents were surveyed across five transect lines (Figure 2), each with ten peanut butter filled chew cards spaced at 50m intervals. Chew cards were folded into a "V" and placed horizontally, ~20mm off the ground, on aluminium pegs. Lines were laid from the eastern extent of the survey area, with their ends space at least 200m apart along the coast road. The cards were deployed for two fine nights and collected on the third day. Hedgehogs and mustelids were surveyed using two lines (Figure 2), each with ten tracking tunnels spaced at ≥ 100 m intervals and baited with an approximately 20mm x 20mm chunk of rabbit meat. One line was placed on either side of Cape Palliser lighthouse >1km apart along the coast road. Tracking cards were deployed for two fine night at the same time as the chew cards.

Five Bushnell HD Trophy Cam (Model 119877) camera traps were deployed along the length of the survey area (Figure 2.1). These were baited with a tablespoon of peanut butter on a stick and an approximately 20mm x 20mm chunk of rabbit meat to attract cats, hedgehogs, mustelids and rodents. Where camera traps were placed in the open, the bait was placed under a length of driftwood so that it wouldn't be obvious to the resident southern black-backed gulls (*Larus dominicanus*). Camera traps were programmed to operate throughout the day and night (using an infrared flash), taking photographs upon detection of movement, with a 30 second interval between photographs. Camera traps were placed 300-400mm above the ground on wooden stakes and inclined slightly to focus on the bait that was placed ~1.5m in front of the camera. Camera traps were deployed for two nights at the same time as the chew cards.

The abundance of rabbits was noted through casual observation during the field surveys.

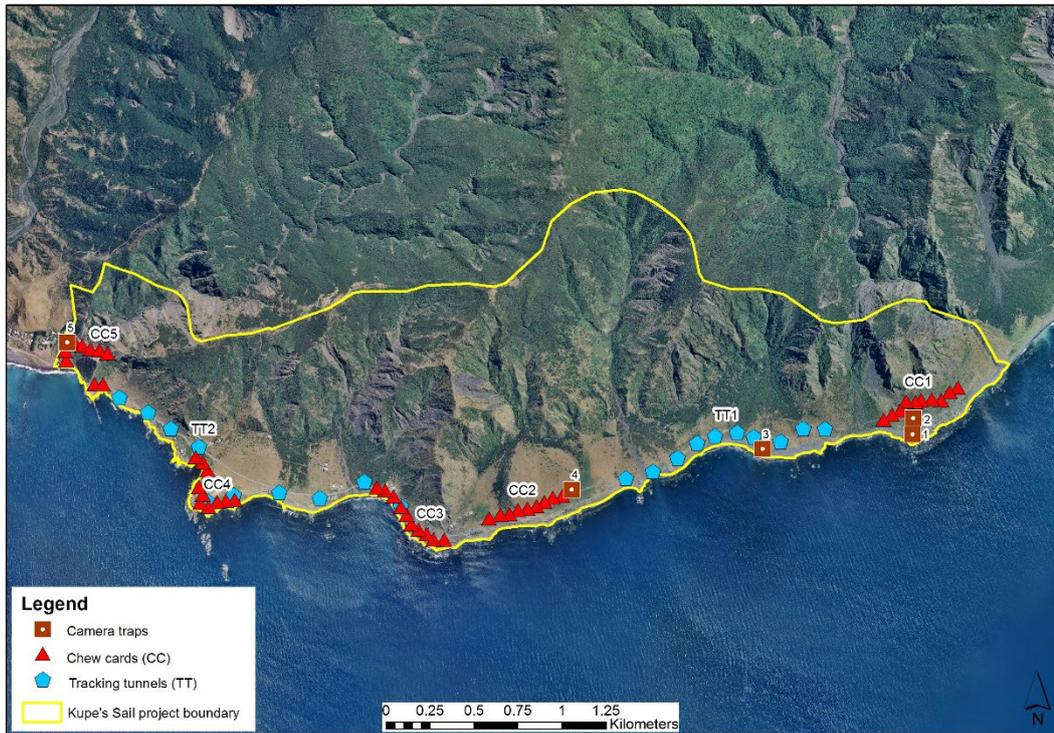


Figure 2.1: Location of animal pest monitoring devices in the project area

3. Results

3.1 Priority species

Mr Patrick Enright has recorded 386 vascular plant species in the project area. Of these 222 (58 percent) were indigenous and 164 (42 percent) were exotic. Twelve indigenous species were regionally Threatened, including: seven Critical (*Convolvulus waitaha*, *Crassula peduncularis*, *Eryngium vesiculosum*, *Leptinella pusilla*, *Muehlenbeckia astonii*, *Rytidosperma petrosum*, *Sophora molloyi*), three Endangered (*Anogramma leptophylla*, *Anthosachne solandri*, *Brachyglottis greyi*) and two Vulnerable species (*Aciphylla squarrosa*, *Daucus glochidiatus*) (Crisp 2020a).

Ten clumps of shrubby tororaro were surveyed (Figure 3.1), including 193 adult plants, 183 of which were tagged (Appendix 2). Three seedlings were recorded near the middle of Clump 7. Of the 133 adult plants where sex could be determined, 62 (47 percent) were female and 71 (53 percent) were male. None of the fences around the two eastern clumps (1 and 2) or the two clumps in the middle (3 and 4) of the study area were intact. Cattle dung was found within the fenced area in the east, while a dead goat was located in the middle of another fenced area.

Vegetative cuttings were prepared from 15 shrubby tororaro plants, sampled from clumps 1-4. Plants were selected from what were thought to be naturally established individuals that could be sexed. Cuttings were taken from four female and three male plants in clump 1, one female and three male plants in clump 2, two female plants in clump 3, and two male plants in clump 4. If cutting material is successfully propagated then the plan is to cultivate these plants at a site where they are isolated from other *Muehlenbeckia* species. Any seed produced will contribute to our understanding of viability, seed storage requirements and potentially contribute to future in situ recovery plans.

No material was taken from clumps 7-10, as these were planted populations of unknown provenance. Material from these clumps should not be used as part of a recovery plan until their origin can be confirmed. The plants are likely to have been grown from seed as at least 6 plants showed a likely hybridism with *Muehlenbeckia complexa*, a coastal plant that regularly grows in association with *Muehlenbeckia astonii*. No material was taken from clumps 9 and 10 as the plants were very small and in very poor health. Material from these planted clumps should not be used as part of a recovery plan until their origin can be confirmed.

Seed was not mature or suitable for collection during the field survey. A revisit to the site in March/April would be advised to collect ripened seed. This would allow germination tests to confirm seed viability and the storage requirements for long-term seed-banking to be investigated.



Figure 3.1: Location of shrubby tororaro (*Muehlenbeckia astonii*) clumps in the project area

Around five-and-a-half hours was spent searching for lizards around the Cape Palliser lighthouse and the seal haulout at the Matakītaki-a-Kupe Reserve (Figure 3.2). Twenty-three lizards were observed, including: 22 Raukawa geckos (*Woodworthia maculata*) and one unidentified skink (*Oligosoma* sp.), (Appendix 3). Raukawa geckos and Northern grass skinks (*Oligosoma polychroma*) have previously been recorded from the site (ARDS cards). This survey has however shown that Raukawa geckos are widespread and in reasonable abundance across the site. Raukawa geckos and Northern grass skinks are both nationally and regionally Not Threatened (Hitchmough et al 2013, Crisp 2020b).

The area to the east of the Cape Palliser lighthouse was not searched for lizards, but the “rock garden” at the eastern most end, beyond the shrubby tororaro clumps 1 and 2 holds lots of promise. The habitat was in equal or better condition than the similar landscape at the Turakirae Head Scientific Reserve that is known for its lizard abundance (ARDS cards).



Figure 3.2: Location of lizard encounters in the project area

Of the 58 bird species recorded from the project area in eBird 45 species (78 percent) were indigenous and 13 species (22 percent) were exotic (Appendix 4). There were 17 indigenous coastal species (29 percent) recorded from the project area, thirteen of which were regionally Threatened, including: four regionally Critical, two regionally Endangered, and seven regionally Vulnerable, plus one species considered a Migrant to the region that was nationally Endangered (Crisp 2020c).

3.2 Priority ecosystems

Two areas of coastal turf were identified in the project area. The largest at the Matakītaki-a-Kupe Reserve was severely damaged by trampling by visitors. The other turf was on the seaward side of the road approximately half way between Kupe’s Sail and Matakītaki-a-Kupe Reserve. This was fed by a seepage and is part of the marine mammal haulout, being frequented by seals at the time of the survey.

Dunelands were identified east of the Mangatoetoe Stream around the mouth of the Little Mangatoetoe Stream by Kupe’s Sail, labelled “West of Cape Palliser” by Partridge (1992) and by Cod Rocks (Figure 3.3).

Seals were observed in four areas along the coast: between Kupe’s Sail and Matakītaki-a-Kupe Reserve, around the Matakītaki-a-Kupe Reserve, below the Cape Palliser lighthouse and east of Cod Rocks (Figure 3.3). The three western areas were subject to regular disturbance by people.

The coastal bird survey of the Wellington region (McArthur et al 2019) identified a priority coastal bird breeding site at the Matakītiki-a-Kupe Reserve (Figure 5). This site supported a significant breeding colony of the nationally At Risk: Declining, regionally Threatened: Vulnerable red-billed gull (*Larus novaehollandiae*) on the Wairarapa coast (Robertson et al 2017, Crisp 2020c). The survey also recognised the diversity of coastal bird species in the study area. Subsequently a review of significant habitats for indigenous birds has confirmed that the study area meets the 'Diversity' and 'Rarity' thresholds for being identified as a "habitat of significance for indigenous birds" under the regional Natural Resources Plan (GWRC 2019a, McArthur in press).

Eleven wetlands were determined in the project area, ten of which were east of the Cape Palliser lighthouse. The wetland immediately north of the marine mammal haulout east of Cod Rocks had an invasion of yellow flag iris (*Iris pseudacorus*). Although not identified in the Greater Wellington Regional pest management plan (GWRC 2019b), this species has the potential to become a serious threat to the wetlands (NIWA 2020). Sheep were grazing around the wetland at the Matakītiki-a-Kupe Reserve and likely had access, along with cattle, to the other wetlands in the project area, none of which were fenced. A number of wet areas throughout the coastal plain were not mapped as natural wetlands due to the abundance of pasture species. Exclusion of grazing from these areas could result in an increase in aerial cover that that would likely increase the water retention, leading to rewetting of the areas, which would favour wetland plant recovery. Exclusion of livestock from the wetlands could align with a coastal restoration program.



Figure 3.3: Rare and naturally uncommon ecosystems of the project area

The natural character of the terrestrial area of the coast around Cape Palliser has been assessed as High, with High abiotic and experiential values, and a Moderate to High biotic value. The Cape Palliser Coastal Reefs was also assessed as having High natural character, with High abiotic, biotic and experiential values. Offshore the Cape Palliser Continental Shelf was assessed as having a High natural character, with High abiotic and biotic values, and a Very High experiential value (Boffa Miskell Limited and NIWA 2020).

The current regional Natural Resources Plan (GWRC 2019a) does not identify the Cape Palliser (Matakitakiakupe) area as having significant values for indigenous coastal birds. The subsequent analysis of recent data has shown that this area would qualify as having significant values for indigenous coastal birds on both the 'Diversity' and 'Rarity' criteria (McArthur in press).

3.3 Pest species

Only one clump of four boneseed plants was encountered at the base of a services pole atop a rock below the Cape Palliser lighthouse. The location was passed on to the GWRC Pest Plant Team to address as part of their boneseed control programme. Although not listed in the Regional Pest Management Plan, box thorn (*Lycium ferocissimum*), buddleia (*Buddleja davii*), gorse (*Ulex europaeus*) and tree lupin (*Lupinus arboreus*) shrubs were widespread throughout the project area and have the potential to shade out herbaceous coastal plant communities.

No rats were recorded on the chew cards and mice chews were recorded on only one card on line 3. Cats chewed on two cards on line 2 and hedgehog chewed one card each on lines 2 and 4.

In the tracking tunnels, hedgehog were recorded in three tunnels on line 1. While a gecko (presumably a Raukawa gecko) and mouse were recorded on separate tunnels on line 2.

The camera traps recorded cats on camera 4 east of the Cape Palliser lighthouse. Hedgehog were recorded on cameras 3 and 4. Possum were recorded on cameras 1 and 5 with possibly two possum in one photograph on Camera 1 (fur close to lens and second animal in back left of photograph - Figure 3.4). Rabbits were recorded on cameras 2 and 4, but casual observations suggest that the greatest rabbit density was on the grassy plain east of the lighthouse where camera 4 was placed. In this area rabbits had burrowed under a penguin box (there was a rabbit skull in the box), rendering it unsuitable for penguins that prefer to place their egg on a flat surface.



Figure 3.4: Camera trap images clockwise from top left: cat (Camera 4), possum (Camera 1), rabbit (Camera 2 dislodged by seals), and hedgehog (Camera 3)

4. Discussion

While more surveys could be completed to record the location of threatened plant taxa and the abundance of the lizard fauna, the conservation needs for species of concern are well enough understood to prioritise conservation action. Ungulate and possum control is essential to protect Threatened and At Risk plant taxa in the hills, while rabbit control is important for recovering the habitat on the coastal plains. Fences need to be repaired to control cattle and sheep movements. Cattle dung was recorded around the eastern most shrubby tororaro clumps (1 and 2) and sheep were encountered around the wetland at the Matakaitaki-a-Kupe Reserve where fences have collapsed. No live goats were seen during the survey. However, a dead goat was found inside a shrubby tororaro enclosure fence, so culling should continue as required.

The pest plants of greatest regional concern (GWRC 2019b) were under control in the project area. There were however a number of other pest plant taxa, including exotic shrubs, which were affecting the composition and function of coastal plant communities. Box thorn was widespread along the coastal margin, with tree lupin throughout disturbed areas, along with buddleia and gorse. These shrubs were excluding shorter indigenous taxa that should characterise these communities. Their removal is key to the rehabilitation of the coastal plant communities. There were also a number of exotic forbs that dominated parts of the coastline, including: *Agapanthus* (*Agapanthus praecox* subsp. *orientalis*), *Carpobrotus* sp., *Gazania* sp., and pig's ear (*Cotyledon orbiculata* var. *orbiculata*). These garden escapees, although colourful, detract from the natural character of the coastline. Yellow flag iris, was found to be an emerging weed in the wetlands and along with arum lilies (*Zantedeschia aethiopica*) should be controlled before they spread.

Shrubby tororaro remains a priority for conservation intervention. The healthy clumps on the western side of Kupe's Sail (Clumps 5-8, Figure 3.1) and in the east of the project area (Clumps 1 and 2, Figure 3.1), indicate that *in situ* conservation can be successful in this area. The existing plants, however need continued protection and, given its threat status and the success of the *in situ* conservation efforts, the population should be supplemented with further plantings of material grown from locally sourced wild stock. We recommend that the survival of the existing tagged plants be monitored at least every five years, efforts be made to determine the origin of planted material, and vegetative and reproductive material continue to be collected and cultivated with a view to establishing additional populations in suitably wet areas along this coast.

Lizards and coastal birds would benefit from predator control, in particular cats, hedgehogs and possums. The cat population is most likely being supported by abundant rabbit numbers. Cat control is therefore unlikely to be effective if rabbit numbers are not reduced first. Controlling rabbits will have the added advantage of releasing native vegetation from seedling browsing, which may facilitate its recovery on the coastal plains. These efforts should focus on the

area east of the Cape Palliser lighthouse where the highest density of rabbits and highest frequency of cat detections were recorded.

Hedgehog were also encountered east of the Cape Palliser lighthouse. While there is some trapping in this area, this could be supplemented with additional traps, particularly towards the eastern end around the rock garden that supports ground nesting coastal birds around the seal haulout and is likely to support an abundance of lizards. Any additional trapping for hedgehogs will also help control any mustelids, which although not recorded in these surveys, are likely to be present in the project area.

Possum were recorded at either end of the project area, which may suggest that they were coming out of the Aorangi Forest Park. Experience from GWRC parks suggests that control operations every five years can maintain possum at low densities. This is best completed as part of a broader landscape control programme to reduce reinvasion from neighbouring areas.

The rare and naturally uncommon ecosystems that were recorded in the project area were under pressure from uncontrolled herbivory and human disturbance. Livestock, although at low density, need to be controlled through the project area through improved fencing, particularly around the wetlands. Access control is also required to manage the impact of people across the project area. Pedestrians and vehicles are damaging coastal vegetation, including the coastal turf communities and disturbing the marine mammals. These impacts were the greatest in the Matakītiki-a-Kupe Reserve. The reserve would benefit from demarcated parking to prevent vehicles driving over the coastal turf community and pedestrian control to reduce trampling and disturbance of the seals. This could take the form of rope-fenced walkways that would still allow seals to move freely around the area. The reserve is a popular visitor destination and with the coastal bird breeding colony, coastal turf community, seal haulout and wetland all in close proximity provides a great opportunity for environmental education and tourism.

Based on the environmental values of the project area, priorities for conservation action should include: continued management of the shrubby tororaro population, pest animal control (particularly rabbits), access control of people and vehicles and restoration of coastal plant communities (particularly the control of box thorn).

Acknowledgements

This work was commissioned and facilitated by James Harbord and Jamie Fitzgerald of the Department of Conservation / Te Papap Atawhai. Surveys were undertaken by Anita Benbrook (Wellington City Council – WCC), Finn Michalak (WCC), Helen White (Greater Wellington Regional Council – GWRC), Matthew Ward (Restore), Owen Spearpoint (GWRC), Patrick Enright (Private), Richard Romijn (GWRC), Rob Masters (GWRC) and Roger Uys (GWRC). Advice on the shrubby tororaro management was provided by Anita Benbrook, Finn Michalak and Karin Van der Walt (WCC).

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Appendices

Appendix 1: Vascular plant species list recorded for the project area by Patrick Enright with the regional and national conservation status listed for regionally Threatened indigenous species (Crisp 2020a).

CR = Critical, EN = Endangered, VU = Vulnerable, Dec = Declining, Nat Unc = Naturally Uncommon, NT = Not Threatened, DD = Data Deficient

Species	Māori name	Pakēhā name	Regional status	National status
Indigenous species				
Monocotyledonous trees and shrubs				
<i>Cordyline australis</i>	tī kōuka	cabbage tree		
Dicotyledonous trees and shrubs				
<i>Brachyglottis greyi</i>			EN	Nat Unc
<i>Brachyglottis repanda</i>	rangiora	rangiora		
<i>Carmichaelia australis</i>	tainoka	native broom		
<i>Coprosma crassifolia</i>				
<i>Coprosma propinqua</i> var. <i>propinqua</i>				
<i>Coprosma propinqua</i> x <i>C. robusta</i>				
<i>Coprosma repens</i>	taupata	taupata		
<i>Coprosma rhamnoides</i>				
<i>Coprosma rhamnoides</i> x <i>C. repens</i>				
<i>Coprosma robusta</i>	karamu			
<i>Coriaria arborea</i>	tutu	tree tutu		
<i>Coriaria</i> sp. (unnamed aff. <i>C. plumosa</i> and <i>C. pteridoides</i>)	tutu			
<i>Corynocarpus laevigatus</i>	karaka	karaka		
<i>Helichrysum lanceolatum</i>	niniao			
<i>Knightia excelsa</i>	rewarewa	rewarewa		
<i>Kunzea robusta</i>	kānuka	kānuka		
<i>Leptospermum scoparium</i> agg.	mānuka	manuka		
<i>Leucopogon fasciculatus</i>	pātōtara			
<i>Macropiper excelsum</i> subsp. <i>excelsum</i>	kawakawa	kawakawa		
<i>Melicytus crassifolius</i>		thick leaved māhoe	Dec	Dec
<i>Melicytus ramiflorus</i> subsp. <i>ramiflorus</i>	māhoe	whitey wood		
<i>Metrosideros excelsa</i>	pohutakawa	pohutakawa		
<i>Muehlenbeckia astonii</i>		shrubby tororaro	CR	EN
<i>Myoporum laetum</i>	ngaio	ngaio		
<i>Myrsine australis</i>	mapou	red matipo		
<i>Olearia paniculata</i>	akiraho			
<i>Olearia solandri</i>		coastal daisy		
<i>Ozothamnus leptophyllus</i>	tauhinu	tauhinu		
<i>Pennantia corymbosa</i>	kaikōmako	kaikōmako		
<i>Piper excelsum</i> subsp. <i>excelsum</i>	kawakawa	kawakawa		
<i>Pittosporum crassifolium</i>	karo	karo		
<i>Plagianthus divaricatus</i>	mākaka	saltmarsh ribbonwood		
<i>Sophora molloyi</i>	kowhai	Cook Straight kowhai	CR	Nat Unc

Species	Māori name	Pakēhā name	Regional status	National status
<i>Sophora microphylla</i>	kowhai	kowhai		
<i>Urtica ferox</i>	ongaonga	tree nettle		
<i>Veronica stricta</i> var. <i>stricta</i>	koromiko	hebe		
Dicotyledonous lianas and related trailing plants				
<i>Calystegia sepium</i> subsp. <i>roseata</i>	pōhue	pink bindweed		
<i>Calystegia soldanella</i>	panahi	shore convolvulus		
<i>Calystegia tuguriorum</i>	pōwhiwhi	native bindweed		
<i>Clematis afoliata</i>		leafless clematis	Nat Unc	NT
<i>Clematis forsteri</i>	pikiarero	small white clematis		
<i>Convolvulus waitaha</i>		grassland bindweed	CR	NT
<i>Muehlenbeckia australis</i>	pohuehue			
<i>Muehlenbeckia australis</i> x <i>M. complexa</i>				
<i>Muehlenbeckia complexa</i>	pohuehue	wire vine		
<i>Parsonsia capsularis</i>	aka kiore	NZ jasmine	DD	DD
<i>Scandia geniculata</i>			Nat Unc	NT
Ferns				
<i>Adiantum cunninghamii</i>	huruhuru tapairu	maidenhair fern		
<i>Anogramma leptophylla</i>		Jersey fern	EN	VU
<i>Asplenium appendiculatum</i> subsp. <i>appendiculatum</i>			Nat Unc	NT
<i>Asplenium appendiculatum</i> subsp. <i>maritimum</i>				
<i>Asplenium appendiculatum</i> x <i>A. flaccidum</i>				
<i>Asplenium flabellifolium</i>		necklace fern		
<i>Asplenium flaccidum</i>	makawe	hanging spleenwort		
<i>Asplenium hookerianum</i>				
<i>Asplenium oblongifolium</i>	huruhuruwhenua	shining spleenwort		
<i>Asplenium polyodon</i>	petako	sickle spleenwort		
<i>Blechnum blechnoides</i>			Nat Unc	NT
<i>Blechnum chambersii</i>				
<i>Blechnum minus</i> (of NZ authors)	kiokio	swamp kiokio		
<i>Blechnum novae-zelandiae</i>	kiokio	kiokio		
<i>Cheilanthes distans</i>		woolly rock fern	Nat Unc	NT
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>		rock fern	Nat Unc	NT
<i>Cyathea medullaris</i>	mamaku	black tree fern		
<i>Hypolepis ambigua</i>				
<i>Microsorium pustulatum</i> subsp. <i>pustulatum</i>	kowaowao	hound's tongue fern		
<i>Ophioglossum coriaceum</i>		adders tongue fern		
<i>Paesia scaberula</i>		ring fern		
<i>Pellaea calidirupium</i>			Nat Unc	NT
<i>Pellaea rotundifolia</i>	tarawera	button fern		
<i>Polystichum neozelandicum</i> subsp. <i>zerophyllum</i>	pikopiko	shield fern		
<i>Polystichum oculatum</i>	pikopiko	shield fern		

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<i>Polystichum vestitum</i>	pūnui	prickly shield fern		
<i>Pteridium esculentum</i>	rauaruhe	bracken		
<i>Pteris macilenta</i>	titipo	sweet brake		
<i>Pteris tremula</i>	turawera	trembling brake		
<i>Pyrrosia eleagnifolia</i>	ota	leather-leaf fern		
Orchids				
<i>Acianthus sinclairii</i>				
<i>Caladenia chlorostyla</i>				
<i>Caladenia variegata</i>			Nat Unc	Nat Unc
<i>Corybas macranthus</i>		spider orchid		
<i>Earina autumnalis</i>	raupeka	Easter orchid		
<i>Earina mucronata</i>	peka-a-waka	bamboo orchid		
<i>Microtis unifolia</i>	maikaika	onion leaved orchid		
<i>Prasophyllum colensoi</i>		leek orchid		
<i>Pterostylis alobula</i>				
<i>Pterostylis banksii</i>	tutukiwi	greenhood		
<i>Pterostylis foliata</i>		greenhood	Nat Unc	Nat Unc
<i>Pterostylis montana</i> agg.				
<i>Thelymitra longifolia</i> agg.	māikuku	sun orchid		
Grasses				
<i>Anthosachne solandri</i>		wheat grass	EN	NT
<i>Austroderia fulvida</i>	toetoe	toetoe		
<i>Austroderia toetoe</i>	toetoe	toetoe		
<i>Chionochloa beddiei</i>				
<i>Dichelachne crinita</i>		plume grass		
<i>Echinopogon ovatus</i>		hedgehog grass		
<i>Festuca multinodis</i>				
<i>Lachnagrostis billardierei</i> subsp. <i>billardierei</i>		sand wind grass		
<i>Lachnagrostis pilosa</i> subsp. <i>pilosa</i>		wind grass		
<i>Microlaena stipoides</i>	pātiti	meadow rice grass		
<i>Poa anceps</i> agg.				
<i>Poa cita</i>		silver tussock		
<i>Poa imbecilla</i>		weak poa		
<i>Puccinellia stricta</i>		salt grass		
<i>Rytidosperma biannulare</i>				
<i>Rytidosperma gracile</i>				
<i>Rytidosperma petrosum</i>			CR	Nat Unc
<i>Spinifex sericeus</i>	kōwhangatara	spinifex		
<i>Trisetum arduanum</i>				
Sedges				
<i>Carex breviculmis</i>				
<i>Carex dipsacea</i>		teasel sedge	Nat Unc	NT
<i>Carex flagellifera</i>	mānaia	Glen Murray tussock		
<i>Carex geminata</i>				
<i>Carex pumila</i>				
<i>Carex secta</i>	purei			
<i>Carex virgata</i>				
<i>Cyperus ustulatus</i>	upoko tangata	umbrella sedge		

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<i>Eleocharis acuta</i>		spike sedge		
<i>Eleocharis gracilis</i>		spike sedge		
<i>Ficinia nodosa</i>		club sedge		
<i>Isolepis cernua</i> var. <i>cernua</i>				
<i>Isolepis prolifera</i>				
<i>Machaerina rubiginosa</i>				
<i>Schoenoplectus tabernaemontani</i>	kāpūngāwhā	lake club rush		
Rushes and allied plants				
<i>Apodasmia similis</i>	oioi	tape measure rush		
<i>Juncus australis</i>	wiwi	leafless rush		
<i>Juncus caespiticus</i>				
<i>Juncus pallidus</i>	wiwi	leafless rush		
<i>Juncus planifolius</i>				
<i>Luzula banksiana</i> var. <i>banksiana</i>		woodrush		
<i>Luzula picta</i> var. <i>picta</i>		woodrush		
<i>Luzula subclavata</i>		woodrush		
Remaining monocotyledonous plants				
<i>Arthropodium cirratum</i>	rengarenga	renga lily		
<i>Lemna disperma</i>		duckweed		
<i>Libertia mooreae</i>	mikoikoi	NZ iris		
<i>Phormium cookianum</i> subsp. <i>hookeri</i>	wharariki	coastal flax		
<i>Triglochin striata</i>				
<i>Typha orientalis</i>	raupo	bulrush		
Daisy-like herbs				
<i>Centipeda aotearoana</i>		sneezeweed	Nat Unc	Nat Unc
<i>Centipeda cunninghamii</i>		sneezeweed		
<i>Cotula australis</i>		button daisy		
<i>Cotula coronopifolia</i>		bachelor's buttons		
<i>Craspedia uniflora</i> var. <i>grandis</i>	puatea	woollyhead	DD	DD
<i>Euchiton audax</i>		cudweed		
<i>Euchiton involucratus</i>		cudweed		
<i>Euchiton japonicus</i>		cudweed		
<i>Leptinella pusilla</i>		button daisy	CR	Dec
<i>Microseris scapigera</i>				
<i>Pseudognaphalium luteoalbum</i> agg.		Jersey cudweed		
<i>Raoulia australis</i>		mat daisy		
<i>Raoulia glabra</i>		mat daisy		
<i>Raoulia tenuicaulis</i>		mat daisy		
<i>Senecio glomeratus</i>				
<i>Senecio hispidulus</i>		fireweed		
<i>Senecio lautus</i>				
<i>Senecio minimus</i>				
<i>Senecio quadridentatus</i>		fireweed		
Dicotyledonous herbs other than Composites				
<i>Acaena anserinifolia</i>	piripiri	bidibid		
<i>Acaena juvenca</i>	piripiri	bidibid	Nat Unc	NT
<i>Acaena novae zelandiae</i>	piripiri	bidibid		
<i>Acaena pallida</i>	piripiri	bidibid		
<i>Aciphylla squarrosa</i>	taramea	speargrass	VU	Dec

Species	Māori name	Pakēhā name	Regional status	National status
<i>Apium prostratum</i> subsp. <i>prostratum</i> var. <i>filiforme</i>	tūtae kōau	NZ celery		
<i>Cardamine forsteri</i>	panapana	bitter cress		
<i>Centella uniflora</i>				
<i>Chaerophyllum ramosum</i>				
<i>Chenopodium allanii</i>			Nat Unc	Nat Unc
<i>Chenopodium triandrum</i>		salt berry bush		
<i>Colobanthus apetalus</i>			DD	NT
<i>Colobanthus muelleri</i>				
<i>Colobanthus strictus</i>				
<i>Crassula colligata</i> subsp. <i>colligata</i>				
<i>Crassula mataikona</i>			Nat Unc	Nat Unc
<i>Crassula moschata</i>			Nat Unc	NT
<i>Crassula peduncularis</i>			CR	CR
<i>Crassula sieberiana</i>				
<i>Daucus glochidiatus</i>	native carrot		VU	Dec
<i>Dichondra brevifolia</i> agg.				
<i>Dichondra repens</i> agg.				
<i>Disphyma australe</i> subsp. <i>australe</i>	horokaka	NZ ice plant		
<i>Epilobium cinereum</i>				
<i>Epilobium microphyllum</i>	papakoura			
<i>Epilobium nerteroides</i>				
<i>Epilobium nummulariifolium</i>				
<i>Epilobium pubens</i>				
<i>Epilobium rotundifolium</i>				
<i>Eryngium vesiculosum</i>			CR	Dec
<i>Galium propinquum</i>	māwe	bedstraw		
<i>Geranium</i> aff. <i>microphyllum</i>				
<i>Geranium brevicaule</i>				
<i>Geranium solanderi</i>			DD	Dec
<i>Haloragis erecta</i> subsp. <i>erecta</i>	toatoa	shrubby haloragis		
<i>Hydrocotyle elongata</i>				
<i>Hydrocotyle heteromeria</i>		pennywort		
<i>Hydrocotyle moschata</i> var. <i>moschata</i>		hairy pennywort		
<i>Hydrocotyle novae-zelandiae</i> agg.				
<i>Lilaeopsis novae-zelandiae</i>				
<i>Limosella lineata</i>		mudwort		
<i>Linum monogynum</i>	rauhuia	NZ true flax		
<i>Lobelia anceps</i>		shore lobelia		
<i>Nertera depressa</i>				
<i>Oxalis exilis</i>				
<i>Oxalis rubens</i>			Nat Unc	NT
<i>Oxybasis glauca</i> subsp. <i>ambigua</i>				
<i>Parietaria debilis</i>				
<i>Pimelea prostrata</i>	pinatoro	NZ daphne		
<i>Plantago raoulii</i>				
<i>Plantago spathulata</i> subsp. <i>spathulata</i>			DD	NT
<i>Plantago triandra</i>				
<i>Ranunculus acaulis</i>				
<i>Ranunculus amphitrichus</i>	waoriki			

Species	Māori name	Pakēhā name	Regional status	National status
<i>Ranunculus glabrifolius</i>	waoriki			
<i>Ranunculus macropus</i>	waoriki		DD	DD
<i>Ranunculus reflexus</i>	mārūrū	hairy buttercup		
<i>Salicornia quinqueflora</i> subsp. <i>quinqueflora</i>		glasswort		
<i>Samolus repens</i> var. <i>repens</i>	māakoako	sea primrose		
<i>Selliera radicans</i>	remuremu	selliera		
<i>Spergularia tasmanica</i>				
<i>Stellaria parviflora</i>	kohuhu	native chickweed		
<i>Wahlenbergia racemosa</i>		coastal harebell		
<i>Wahlenbergia rupestris</i>		harebell		
Exotic species				
Dicotyledonous trees and shrubs				
<i>Buddleja davidii</i>		butterfly bush		
<i>Chrysanthemoides monilifera</i> subsp. <i>monilifera</i>		boneseed		
<i>Cytisus scoparius</i>		broom		
<i>Lupinus arboreus</i>		tree lupin		
<i>Lycium ferocissimum</i>		boxthorn		
<i>Malus domestica</i>		apple		
<i>Myoporum</i> aff. <i>insulare</i>		Australian ngaio		
<i>Paraserianthes lophanta</i>		brush wattle		
<i>Phytolacca octandra</i>		ink weed		
<i>Podalyria sericea</i>		satin bush		
<i>Rosa rubiginosa</i>		briar rose		
<i>Ulex europaeus</i>		gorse		
Dicotyledonous lianas and related trailing plants				
<i>Rubus fruticosus</i> agg.		blackberry		
<i>Senecio angulatus</i>		Cape ivy		
Ferns				
<i>Polypodium vulgare</i>				
Grasses				
<i>Agrostis capillaris</i>		browntop		
<i>Agrostis stolonifera</i>		creeping bent		
<i>Aira caryophylla</i> subsp. <i>caryophylla</i>		fairy grass		
<i>Aira praecox</i>		early hair grass		
<i>Ammophila arenaria</i>		marram		
<i>Anthosachne scaber</i>				
<i>Anthoxanthum odoratum</i>		sweet vernal		
<i>Arrhenatherum elatius</i> subsp. <i>elatius</i>		tall oat grass		
<i>Avena barbata</i>		slender oat grass		
<i>Briza maxima</i>		rattlesnake grass		
<i>Briza minor</i>		small rattlesnake grass		
<i>Bromus catharticus</i>		prairie grass		
<i>Bromus diandrus</i>		ripgut brome		
<i>Bromus hordeaceus</i>		soft brome		
<i>Bromus lithobius</i>		Chilean brome		
<i>Bromus sterilis</i>		barren brome		
<i>Bromus willdenowii</i>		prairie grass		
<i>Cortaderia selloana</i>		pampas grass		

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<i>Critesion murinum</i> subsp. <i>murinum</i>		barley grass		
<i>Cynosurus cristatus</i>		crested dogstail		
<i>Cynosurus echinatus</i>		rough dogstail		
<i>Dactylis glomerata</i>		cocksfoot		
<i>Ehrharta erecta</i>		veld grass		
<i>Glyceria declinata</i>		glaucous sweet grass		
<i>Holcus lanatus</i>		Yorkshire fog		
<i>Lagurus ovatus</i>		hares foot grass		
<i>Lolium arundinaceum</i> subsp. <i>arundinaceum</i>		tall fescue		
<i>Lolium perenne</i>		perennial rye grass		
<i>Paspalum dilatatum</i>		paspalum		
<i>Rytidosperma racemosum</i>		wallaby grass		
<i>Sporobolus africanus</i>		rat's tail dropseed		
<i>Vulpia bromoides</i>				
<i>Vulpia myuros</i>				
Sedges				
<i>Cyperus eragrostis</i>		umbrella sedge		
<i>Isolepis levynsiana</i>		tiny flat sedge		
Rushes and allied plants				
<i>Juncus amabilis</i>		gentle rush		
<i>Juncus articulatus</i>		jointed rush		
<i>Juncus bufonius</i> var. <i>bufonius</i>		toad rush		
<i>Juncus effusus</i>		soft rush		
<i>Juncus tenuis</i> subsp. <i>tenuis</i>		track rush		
Remaining monocotyledonous plants				
<i>Agapanthus praecox</i> subsp. <i>orientalis</i>		agapanthus		
<i>Iris pseudacorus</i>		yellow flag iris		
<i>Pauridia glabella</i> var. <i>glabella</i>				
<i>Sisyrinchium rosulatum</i>				
<i>Zantedeschia aethiopicum</i>		arum lily		
Daisy-like herbs				
<i>Achillea millefolium</i>		yarrow		
<i>Carduus nutans</i>		nodding thistle		
<i>Carduus pycnocephalus</i>		slender winged thistle		
<i>Cirsium arvense</i>		Californian thistle		
<i>Cirsium vulgare</i>		Scotch thistle		
<i>Dimorphotheca fruticosa</i>		dimorphotheca		
<i>Erigeron bilbaoana</i>		fleabane		
<i>Erigeron sumatrensis</i>		fleabane		
<i>Gamochaeta calviceps</i>		cudweed		
<i>Gamochaeta coarctata</i>		cudweed		
<i>Gazania linearis</i>		gazania		
<i>Gazania linearis</i> x <i>G. rigins</i>				
<i>Gazania rigins</i>		gazania		
<i>Helminthotheca echioides</i>		ox tongue		
<i>Hypochoeris radicata</i>		cat's ear		

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<i>Jacobaea vulgaris</i>		ragwort		
<i>Lactuca virosa</i>		acrid lettuce		
<i>Leontodon autumnalis</i> subsp. <i>autumnalis</i>		autumn hawkbit		
<i>Pilosella officinarum</i>		hawkweed		
<i>Senecio jacobaea</i>		ragwort		
<i>Senecio skirrhodon</i>		gravel groundsel		
<i>Silybum marianum</i>		variegated thistle		
<i>Sonchus asper</i>	pūhā	prickly sow thistle		
<i>Sonchus oleraceus</i>	pūhā	sow thistle		
Dicotyledonous herbs other than Composites				
<i>Acaena agnipila</i> var. <i>aequispina</i>		sheeps burr		
<i>Aeonium arboreum</i>		tree aeonium		
<i>Amaranthus retroflexus</i>		redroot		
<i>Anagallis arvensis</i> subsp. <i>arvensis</i> var. <i>arvensis</i>		scarlet pimpernel		
<i>Atriplex patula</i>		orache		
<i>Atriplex prostrata</i>		orache		
<i>Cakile edulenta</i> var. <i>edulenta</i>		sea rocket		
<i>Callitriche stagnalis</i>		starwort		
<i>Carpobrotus chilensis</i>		pig face		
<i>Carpobrotus chilensis</i> x <i>Disphyma australe</i>				
<i>Carpobrotus edulis</i>		pig face		
<i>Centaureum erythraea</i>		centaury		
<i>Cerastium fontanum</i>		mouse ear chickweed		
<i>Cerastium glomeratum</i>		mouse ear chickweed		
<i>Chenopodium album</i>		fathen		
<i>Cotyledon orbiculata</i>		pig's ear		
<i>Crassula decumbens</i>		Cape crassula		
<i>Digitalis purpurea</i>		foxglove		
<i>Erodium cicutarium</i>		storksbill		
<i>Erythranthe guttata</i>		monkey musk		
<i>Euphorbia peplus</i>		milkweed		
<i>Foeniculum vulgare</i>		fennel		
<i>Fumaria muralis</i>		scrambling fumitory		
<i>Galium aparine</i>		cleavers		
<i>Geranium dissectum</i>		cut leaved geranium		
<i>Geranium molle</i>		dove foot geranium		
<i>Geranium pusillum</i>		cut leaved geranium		
<i>Glaucium flavum</i>		horned poppy		
<i>Lepidium squamatum</i>		warty cress		
<i>Linum bienne</i>		pale flax		
<i>Lotus pedunculatus</i>		lotus		

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<i>Lysimachia arvensis</i> subsp. <i>arvensis</i> var. <i>arvensis</i>		scarlet pimpernel		
<i>Lythrum hyssopifolia</i>		hyssop loosestrife		
<i>Malva sylvestris</i>		large flowered malva		
<i>Matthiola incana</i> subsp. <i>incana</i>		hoary stock		
<i>Medicago lupulina</i>		black medick		
<i>Melilotus indicus</i>		King Island melilot		
<i>Mentha pulegium</i>		pennyroyal		
<i>Mentha spicata</i> subsp. <i>tomentosa</i>		spearmint		
<i>Modiola caroliniana</i>		creeping mallow		
<i>Montia fontana</i> subsp. <i>chondrosperma</i>		blinks		
<i>Myosotis laxa</i> subsp. <i>caespitosa</i>		water forget-me- not		
<i>Nasturtium officinale</i>		water cress		
<i>Orobanche minor</i>		broomrape		
<i>Paronychia brasiliiana</i>		nailwort		
<i>Plantago coronopus</i>		buck's horn plantain		
<i>Plantago lanceolata</i>		narrow leaved plantain		
<i>Plantago major</i>		broad leaved plantain		
<i>Polycarpon tetraphyllum</i>		allseed		
<i>Portulaca oleracea</i>		purslane		
<i>Ranunculus parviflorus</i>		small flowered buttercup		
<i>Ranunculus repens</i>		buttercup		
<i>Rumex acetosella</i>		sheep sorrel		
<i>Rumex brownii</i>		hooked dock		
<i>Rumex conglomeratus</i>		clustered dock		
<i>Rumex crispus</i>		curled dock		
<i>Rumex obtusifolius</i>		broad leaved dock		
<i>Sagina procumbens</i>		pearlwort		
<i>Sherardia arvensis</i>		field madder		
<i>Silene gallica</i>		catchfly		
<i>Sisymbrium officinale</i>		hedge mustard		
<i>Solanum chenopodioides</i>		velvety nightshade		
<i>Solanum nigrum</i>		black nightshade		
<i>Spergularia rubra</i>		sea spurrey		
<i>Stellaria media</i>		chickweed		
<i>Torilis nodosa</i>		hedgehog parsley		
<i>Trifolium angustifolium</i>		narrow leaf clover		
<i>Trifolium arvense</i>		haresfoot trefoil		
<i>Trifolium campestre</i>		hop trefoil		
<i>Trifolium dubium</i>		suckling clover		

Species	Māori name	Pakēhā name	Regional status	National status
<i>Trifolium fragiferum</i>		strawberry clover		
<i>Trifolium glomeratum</i>		clustered clover		
<i>Trifolium micranthum</i>		lesser suckling clover		
<i>Trifolium pratense</i>		red clover		
<i>Trifolium repens</i>		white clover		
<i>Trifolium subterraneum</i>		subterranean clover		
<i>Verbascum creticum</i>		Cretan mullein		
<i>Verbascum thapsus</i>		woolly mullein		
<i>Vicia hirsuta</i>		hairy vetch		
<i>Vicia sativa</i>		vetch		

Appendix 2: *Muehlenbeckia astonii* plants recorded in the study area

Clump	Easting	Northing	Tag	Sex	Height	Length	Width
1	1793391.763	5391396.616	k2001	m	1.6	2.4	1.1
1	1793391.763	5391396.616	k2002	f	1.6	2.1	1.4
1	1793391.763	5391396.616	k2003	f	1.4	2.1	1.5
1	1793391.763	5391396.616	k2004	m	1.6	1.8	1.7
1	1793391.763	5391396.616	k2005	f	1.5	1.4	0.9
1	1793391.763	5391396.616	k2006	f	1.4	1.5	1.6
1	1793391.763	5391396.616	k2007	f	1.3	1.3	1.5
1	1793391.763	5391396.616	k2008	f	1.4	1.4	1
1	1793391.763	5391396.616	k2009	?	1.5	1.3	1.3
1	1793391.763	5391396.616	k2010	m	1.7	1.7	1.3
1	1793391.763	5391396.616	k2011	m	1.8	1.3	1
1	1793391.763	5391396.616	k2012	f	1.4	1.4	1.2
1	1793391.763	5391396.616	k2013	f	1.8	1.3	1.1
1	1793391.763	5391396.616	k2014	f	1	0.7	0.6
1	1793391.763	5391396.616	k2015	f	1.3	1.5	0.9
1	1793391.763	5391396.616	k2017	?	0.9	1.1	0.4
1	1793391.763	5391396.616	k2018	?	0.7	0.4	0.6
1	1793391.763	5391396.616	k2019	m	1.2	1.4	1.1
1	1793391.763	5391396.616	k2020	m	1.3	0.7	0.8
1	1793391.763	5391396.616	k2021	m	1.3	1.4	1.5
1	1793391.763	5391396.616	k2022	m	0	1.5	1.2
1	1793391.763	5391396.616	k2023	m	1.3	1.1	1
1	1793391.763	5391396.616	k2024	m	1.6	1.6	1.5
1	1793391.763	5391396.616	k2025	m	1.2	0.6	0.6
2	1793391.763	5391396.616	k2026	m	0.9	1.1	0.9
2	1793391.763	5391396.616	k2027	?	0.5	0.4	0.4
2	1793391.763	5391396.616	k2028	m	0.9	1	1
2	1793391.763	5391396.616	k2029	m	1.1	1.1	1
2	1793391.763	5391396.616	k2030	m	1.2	1.2	1.1
2	1793391.763	5391396.616	k2031	m	1	1.1	1
2	1793391.763	5391396.616	k2032	m	0.9	0.9	0.9
2	1793391.763	5391396.616	k2033	?	0.5	0.4	0.4
2	1793391.763	5391396.616	k2034	m	1.4	1.6	1.7
2	1793391.763	5391396.616	k2035	m	1.6	1.8	1.5
2	1793391.763	5391396.616	k2036	m	1.2	1.2	1.2
2	1793391.763	5391396.616	k2037	m	1.1	1.3	1.6
2	1793391.763	5391396.616	k2038	?	0.7	0.5	0.4

Clump	Easting	Northing	Tag	Sex	Height	Length	Width
2	1793391.763	5391396.616	k2039	?	0.8	1.1	0.7
2	1793391.763	5391396.616	k2040	f	1	1.1	1
3	1789221.969	5391374.473	k2041	f	1	1.3	0.9
3	1789221.969	5391374.473	k2042	f	1.2	1.3	1.3
3	1789221.969	5391374.473	k2043	f	0.8	0.4	0.3
4	1789250.334	5391362.29	k2044	m	0.9	0.9	0.9
4	1789250.334	5391362.29	k2045	m	1	1.3	1.1
5	1788922.351	5391533.357	k2046	?	0.8	1.3	1.1
5	1788922.351	5391533.357	k2047	f	0.9	1.1	1
5	1788922.351	5391533.357	k2048	m	1	1.2	0.8
5	1788922.351	5391533.357	k2049	?	0.9	1.1	0.8
5	1788922.351	5391533.357	k2050	m	0.9	1	0.9
5	1788922.351	5391533.357	k2051	f	0.9	1.5	1
5	1788922.351	5391533.357	k2052	m	1.2	1.3	1.1
5	1788922.351	5391533.357	k2053	f	0.9	1.1	0.8
5	1788922.351	5391533.357	k2054	m	1.2	1.6	1.4
5	1788922.351	5391533.357	k2055	f	1.1	1.3	1
5	1788922.351	5391533.357	k2056	m	1.1	1.4	0.9
5	1788922.351	5391533.357	k2057	m	1.1	1.4	1.1
5	1788922.351	5391533.357	k2058	f	0.9	1.5	1.5
5	1788922.351	5391533.357	k2059	m	0.7	1.1	1
5	1788922.351	5391533.357	k2060	m	0.9	1.4	1.5
5	1788922.351	5391533.357	k2061	?	0.6	0.7	0.9
5	1788922.351	5391533.357	k2062	?	0.7	0.9	1.2
5	1788922.351	5391533.357	k2063	f	0.9	1	0.9
5	1788922.351	5391533.357	k2064	?	0.6	0.7	0.6
5	1788922.351	5391533.357	k2065	?	0.7	0.6	0.6
5	1788922.351	5391533.357	k2066	?	0.7	0.9	0.6
5	1788922.351	5391533.357	k2067	m	0.8	1.1	0.8
5	1788922.351	5391533.357	k2068	f	1.2	1.9	1.5
5	1788922.351	5391533.357	k2069	f	1.1	1.8	1.5
5	1788922.351	5391533.357	k2070	f	1	1	0.9
5	1788922.351	5391533.357	k2071	f	1.1	1.2	1.5
5	1788922.351	5391533.357	k2072	?	1.1	0.8	0.7
5	1788922.351	5391533.357	k2073	m	0.9	1.1	1
5	1788922.351	5391533.357	k2074	f	0.9	1	1.2
5	1788922.351	5391533.357	k2075	m	0.8	1.5	0.8
5	1788922.351	5391533.357	k2076	?	0.8	0.5	0.4

Clump	Easting	Northing	Tag	Sex	Height	Length	Width
5	1788922.351	5391533.357	k2077	m	1	1.4	1.2
5	1788922.351	5391533.357	k2078	m	1	1.2	0.8
5	1788922.351	5391533.357	k2079	m	1	1.2	1.1
5	1788922.351	5391533.357	k2080	?	0.4	0.5	0.3
5	1788922.351	5391533.357	k2081	?	1.2	1.1	1.1
5	1788922.351	5391533.357	k2082	?	0.6	0.4	0.6
5	1788922.351	5391533.357	k2083	?	0.7	0.9	0.6
5	1788922.351	5391533.357	k2084	?	0.7	0.9	0.6
6	1788935.317	5391550.906	k2085	?	0.4	0.6	0.2
6	1788935.317	5391550.906	k2086	m	1	1.1	0.8
6	1788935.317	5391550.906	k2087	?	0.3	0.2	0.3
6	1788935.317	5391550.906	k2088	f	1	1.6	1.5
6	1788935.317	5391550.906	k2089	m	1.1	1.9	1.5
6	1788935.317	5391550.906	k2090	f	1.1	2	1.8
6	1788935.317	5391550.906	k2091	m	1	1.7	1.9
6	1788935.317	5391550.906	k2092	f	0.9	1.2	1.2
6	1788935.317	5391550.906	k2093	?	0.4	0.5	0.4
6	1788935.317	5391550.906	k2094	m	1	1.2	1.4
6	1788935.317	5391550.906	k2095	?	0.8	25	0.9
6	1788935.317	5391550.906	k2096	m	0.9	1.3	0.5
6	1788935.317	5391550.906	k2097	?	1	1.2	1.1
6	1788935.317	5391550.906	k2098	f	1.1	1.4	1.2
6	1788935.317	5391550.906	k2099	f	1.1	1.3	1.4
6	1788935.317	5391550.906	k2100	f	1.1	1.1	0.6
6	1788935.317	5391550.906	k2101	m	1.3	1.4	0.8
6	1788935.317	5391550.906	k2102	?	0.5	0.2	0.2
6	1788935.317	5391550.906	k2103	?	0.8	0.6	0.3
6	1788935.317	5391550.906	k2104	f	1.1	0.8	0.6
6	1788935.317	5391550.906	k2105	?	0.5	0.4	0.3
6	1788935.317	5391550.906	k2106	?	0.7	0.4	0.6
6	1788935.317	5391550.906	k2107	f	0.7	1	0.8
6	1788935.317	5391550.906	k2108	m	0.9	0.7	0.9
6	1788935.317	5391550.906	k2109	f	1.1	1.1	0.8
7	1788960.446	5391536.025	k2110	?	1	0.6	0.8
7	1788960.446	5391536.025	k2111	f	0.8	1	0.9
7	1788960.446	5391536.025	k2112	m	0.7	0.8	0.8
7	1788960.446	5391536.025	k2113	f	1.1	1	0.9
7	1788960.446	5391536.025	k2114	?	0.7	0.7	0.7

Clump	Easting	Northing	Tag	Sex	Height	Length	Width
7	1788960.446	5391536.025	k2115	f	1.5	1.1	0.9
7	1788960.446	5391536.025	k2116	f	1.3	1.3	1
7	1788960.446	5391536.025	k2117	?	0.4	0.3	0.4
7	1788960.446	5391536.025	k2118	f	1	0.6	0.9
7	1788960.446	5391536.025	k2119	m	1.4	1.3	1.1
7	1788960.446	5391536.025	k2120	m	1.2	0.9	1
7	1788960.446	5391536.025	k2121	m	1.3	1.2	0.9
7	1788960.446	5391536.025	k2122	f	2.1	1.6	1.2
7	1788960.446	5391536.025	k2123	f	1.9	1.3	0.8
7	1788960.446	5391536.025	k2124	f	1.4	1.6	0.8
7	1788960.446	5391536.025	k2125	f	1.7	1	1
7	1788960.446	5391536.025	k2126	f	1.5	1.3	1
7	1788960.446	5391536.025	k2127	f	1.4	1.1	0.9
7	1788960.446	5391536.025	k2128	f	1.4	1.2	1
7	1788960.446	5391536.025	k2129	m	0.9	1.1	0.9
7	1788960.446	5391536.025	k2130	f	0.7	1.3	0.8
7	1788960.446	5391536.025	k2131	m	0.8	1.1	0.9
7	1788960.446	5391536.025	k2132	f	1	1.3	1
7	1788960.446	5391536.025	k2133	f	0.7	0.9	0.8
7	1788960.446	5391536.025	k2134	f	1.5	0.6	1.1
7	1788960.446	5391536.025	k2135	m	1.8	1.9	1.1
7	1788960.446	5391536.025	k2136	m	1.7	3.1	1.1
7	1788960.446	5391536.025	k2137	m	1.5	1.8	1.1
7	1788960.446	5391536.025	k2138	f	1.8	1.1	1.2
7	1788960.446	5391536.025	k2139	m	1.6	1.1	1.2
7	1788960.446	5391536.025	k2140	f	1.4	1	1.1
7	1788960.446	5391536.025	k2141	f	1.2	1.2	1.1
7	1788960.446	5391536.025	k2142	m	1.4	1.5	1.1
7	1788960.446	5391536.025	k2143	m	1.1	1	0.9
7	1788960.446	5391536.025	k2144	?	0.6	0.7	0.8
7	1788960.446	5391536.025	k2145	?	0.6	0.6	0.9
7	1788960.446	5391536.025	k2146	?	0.9	0.6	0.8
7	1788960.446	5391536.025	k2147	m	1	0.8	0.6
8	1788947.825	5391515.905	k2148	m	1.9	1.4	1.1
8	1788947.825	5391515.905	k2149	?	1.1	0.7	0.6
8	1788947.825	5391515.905	k2150	m	1.2	1	0.9
8	1788947.825	5391515.905	k2151	?	1.2	0.9	0.7
8	1788947.825	5391515.905	k2152	m	1.1	1.1	0.6

Clump	Easting	Northing	Tag	Sex	Height	Length	Width
8	1788947.825	5391515.905	k2153	f	0.7	1.1	0.8
8	1788947.825	5391515.905	k2154	m	1.2	1.4	1.1
8	1788947.825	5391515.905	k2155	m	1.4	1.3	1.2
8	1788947.825	5391515.905	k2156	f	1.6	1.5	1.4
8	1788947.825	5391515.905	k2157	m	1	1.1	1.2
8	1788947.825	5391515.905	k2158	m	1	1.1	1
8	1788947.825	5391515.905	k2159	f	1.3	0.9	1.1
8	1788947.825	5391515.905	k2160	m	1.3	1.6	1.1
8	1788947.825	5391515.905	k2161	f	1.6	1.3	1
8	1788947.825	5391515.905	k2162	?	0.8	1.1	0.8
8	1788947.825	5391515.905	k2163	?	0.9	0.5	0.8
8	1788947.825	5391515.905	k2164	f	0.7	1	0.7
8	1788947.825	5391515.905	k2165	?	0.6	0.4	0.4
8	1788947.825	5391515.905	k2166	?	0.6	0.7	0.4
8	1788947.825	5391515.905	k2167	m	0.9	0.6	0.6
8	1788947.825	5391515.905	k2168	?	0.7	0.8	0.6
8	1788947.825	5391515.905	k2169	?	0.8	0.6	0.6
8	1788947.825	5391515.905	k2170	?	1.5	1.3	0.9
8	1788947.825	5391515.905	k2171	m	1	0.9	0.6
8	1788947.825	5391515.905	k2172	?	0.8	0.8	0.7
8	1788947.825	5391515.905	k2173	?	1.1	1.1	0.7
8	1788947.825	5391515.905	k2174	?	0.8	0.7	0.6
8	1788947.825	5391515.905	k2175	f	1.1	0.9	0.7
8	1788947.825	5391515.905	k2176	?	0.9	0.7	0.6
8	1788947.825	5391515.905	k2177	m	1.1	1	0.8
8	1788947.825	5391515.905	k2178	f	1	0.9	0.8
8	1788947.825	5391515.905	k2179	f	1.4	1.1	0.8
8	1788947.825	5391515.905	k2180	m	1.3	1.1	0.8
8	1788947.825	5391515.905	k2181	?	1	0.9	0.7
8	1788947.825	5391515.905	k2182	f	1	1	0.9
8	1788947.825	5391515.905	k2183	m	1	0.6	1.1
8	1788947.825	5391515.905	k2184	m	0.8	0.7	0.6
9	1788714.093	5391783.266	nd	nd	nd	nd	nd
9	1788714.093	5391783.266	nd	nd	nd	nd	nd
9	1788714.093	5391783.266	nd	nd	nd	nd	nd
10	1788675.117	5391680.515	nd	nd	nd	nd	nd
10	1788675.117	5391680.515	nd	nd	nd	nd	nd
10	1788675.117	5391680.515	nd	nd	nd	nd	nd

Clump	Easting	Northing	Tag	Sex	Height	Length	Width
10	1788675.117	5391680.515	nd	nd	nd	nd	nd
10	1788675.117	5391680.515	nd	nd	nd	nd	nd
10	1788675.117	5391680.515	nd	nd	nd	nd	nd
10	1788675.117	5391680.515	nd	nd	nd	nd	nd

Appendix 3: Lizard capture summary with key to codes used below

Date	Time	Weather	Habitat	Easting	Northing	Number	Species	SVL	TL (Regen)	Sex / Status	Map location	Notes
23/12/2020	10:27	333	13D	1789370.963	5391224.889	1	Wm	66	74	m	G1	
23/12/2020	10:30	333	13D	1789370.963	5391224.889	4	Wm	-	-	?	G1	
23/12/2020	10:36	333	13D	1789370.963	5391224.889	1	Wm	66	51(39)	f	G1	
23/12/2020	10:40	333	13D	1789370.963	5391224.889	1	Wm	53	52	f	G1	
23/12/2020	10:49	333	13D	1789264.913	5391295.348	1	Wm	66	48(40)	m	G2	mites
23/12/2020	10:53	333	13D	1789264.913	5391295.348	1	Wm	-	-	j	G2	
23/12/2020	11:45	333	13J	1790708.742	5390760.939	1	Wm	-	-	?	A	
23/12/2020	12:01	333	13K	1790657.148	5390780.782	1	Wm	69	62(2)	m	B	Under plastic with mouse
23/12/2020	12:11	333	13D	1790655.561	5390710.932	1	Wm	61	58	f	C	
23/12/2020	12:11	333	13D	1790655.561	5390710.932	1	Wm	-	-	?	D	
23/12/2020	12:16	333	13D	1790699.217	5390672.038	1	Wm	47	48	j	D	
23/12/2020	12:19	333	13D	1790699.217	5390672.038	1	Wm	61	49	f	D	
23/12/2020	12:22	333	13D	1790699.217	5390672.038	1	Wm	54	58	f	D	
23/12/2020	12:30	333	13D	1790819.867	5390622.826	1	Wm	-	-	?	E	
23/12/2020	12:36	333	13D	1790874.636	5390626.001	1	Wm	62	60(42)	f	F	
23/12/2020	12:42	333	13D	1790874.636	5390626.001	3	Wm	-	-	?	F	
23/12/2020	12:51	333	13D	1790874.636	5390626.001	1	US	-	-	?	F	
23/12/2020	12:51	333	13D	1790917.499	5390641.876	1	Wm	66	71(37)	f	G	mites

Lizard capture summary – Key to codes used

Weather		Major Habitat Types		Micro habitats	Lizards
<i>Light</i>	<i>Temperature</i>	1 Beech Forest	12 Wet land	A Foliage	Oa <i>Oligosoma aeneum</i>
1 Fine/Sunny	1 Hot	2 Podocarp forest	13 Coastal	B Trunk	Ok <i>Oligosoma kokowai</i>
2 Part Cloudy	2 Warm	3 Broadleaf forest	14 Scree	C Branches	Oo <i>Oligosoma ornatum</i>
3 Overcast	3 Moderate	4 Exotic forest	15 Bare rocks	D Under stones	Op <i>Oligosoma polychroma</i>
4 Showers	4 Cool	5 Scrub	16 Beach	E Under wood	Oz <i>Oligosoma zelandicum</i>
5 Rain	5 Cold	6 Sub-alpine	17 Urban	F Open ground	M Mokopirirakau “southern NI forest gecko”
6 Night		7 Alpine		G Crevices	Wm <i>Woodworthia maculata</i>
7 0-½ Moonlit	<i>Wind</i>	8 Undeveloped tussock land		H Pitfall traps	Np <i>Naultinus punctatus</i>
8 ½-1 Moonlit	1 Calm	9 Developed farmland		I ACOs	US <i>Unidentified skink</i>
	2 Light breeze	10 River terrace		J Under vegetation	UG <i>Unidentified gecko</i>
	3 Mod breeze	11 Fresh water		K Under plastic	UL <i>Unidentified lizard</i>
	4 Gusty				
	5 Strong winds				

Appendix 4: Bird species list recorded for the project area in eBird with the regional and national conservation status listed for regionally Threatened indigenous coastal species (Crisp 2020c).

CR = Critical, EN = Endangered, VU = Vulnerable, Dec = Declining, Nat Unc = Naturally Uncommon, Rec = Recovering, Mig = Regional Migrant, NT = Not Threatened

Pakēhā name	Species	Regional status	National status
Indigenous coastal species			
Gull, Black-billed	<i>Chroicocephalus bulleri</i>	CR	CR
Gull, Red-billed	<i>Chroicocephalus novaehollandiae</i>	VU	Dec
Gull, South Black-Backed	<i>Larus dominicanus</i>		
Heron, Reef	<i>Egretta sacra</i>	CR	EN
Heron, White-faced	<i>Egretta novaehollandiae</i>		
Kingfisher, Sacred	<i>Todiramphus sanctus</i>		
Oystercatcher, Variable	<i>Haematopus unicolor</i>	VU	Rec
Pipit, New Zealand	<i>Anthus novaeseelandiae</i>	VU	Dec
Shag, Black	<i>Phalacrocorax carbo</i>	CR	Nat Unc
Shag, Little Black	<i>Phalacrocorax sulcirostris</i>	VU	Nat Unc
Shag, Little Pied	<i>Microcarbo melanoleucos</i>	VU	NT
Shag, Pied	<i>Phalacrocorax varius</i>	VU	Rec
Shag, Spotted	<i>Phalacrocorax punctatus</i>	EN	NT
Stilt, Pied	<i>Himantopus himantopus</i> subsp. <i>leucocephalus</i>	VU	NT
Tern, Black-fronted	<i>Chlidonias albostrigatus</i>	Mig	EN
Tern, Caspian	<i>Hydroprogne caspia</i>	CR	VU
Tern, White-fronted	<i>Sterna striata</i>	EN	Dec
Indigenous inland specie			
Falcon, New Zealand	<i>Falco novaeseelandiae</i>		
Fantail, New Zealand	<i>Rhipidura fuliginosa</i>		
Harrier, Australasian	<i>Circus approximans</i>		
Plover, Spur-winged	<i>Vanellus miles</i>		
Shelduck, Paradise	<i>Tadorna variegata</i>		
Silvereye	<i>Zosterops lateralis</i>		
Swallow, Welcome	<i>Hirundo neoxena</i>		
Tui	<i>Prosthemadera novaeseelandiae</i> subsp. <i>novaeseelandiae</i>		
Warbler, Grey	<i>Gerygone igata</i>		
Indigenous pelagic species			
Albatross, Light-mantled Sooty	<i>Phoebastria palpebrata</i>		
Albatross, Southern/Northern Royal	<i>Diomedea epomophora</i>		
Albatross, Wandering	<i>Diomedea exulans</i>		
Diving-Petrel, Common	<i>Pelecanoides urinatrix</i>		
Gannet, Australasian	<i>Morus serrator</i>		
Mollymawk, Black-browed/Campbell	<i>Thalassarche melanophris</i>		
Mollymawk, Buller's	<i>Thalassarche bulleri</i>		
Mollymawk, Salvin's	<i>Thalassarche salvini</i>		
Mollymawk, Shy	<i>Thalassarche cauta</i>		
Petrel, Cape	<i>Daption capense</i>		
Petrel, Grey-faced	<i>Pterodroma gouldi</i>		
Petrel, Northern Giant	<i>Macronectes halli</i>		
Petrel, Soft-plumaged	<i>Pterodroma mollis</i>		

Pakēhā name	Species	Regional status	National status
Petrel, Westland	<i>Procellaria westlandica</i>		
Petrel, White-headed	<i>Pterodroma lessonii</i>		
Prion, Fairy	<i>Pachyptila turtur</i>		
Shearwater, Buller's	<i>Ardenna bulleri</i>		
Shearwater, Fluttering	<i>Puffinus gavia</i>		
Shearwater, Sooty	<i>Ardenna grisea</i>		
Exotic species			
Blackbird, Eurasian	<i>Turdus merula</i>		
Chaffinch	<i>Fringilla coelebs</i>		
Dunnock	<i>Prunella modularis</i>		
Goldfinch, European	<i>Carduelis carduelis</i>		
Greenfinch, European	<i>Chloris chloris</i>		
Magpie, Australian	<i>Gymnorhina tibicen</i>		
Pigeon, Rock	<i>Columba livia</i>		
Quail, California	<i>Callipepla californica</i>		
Skylark	<i>Alauda arvensis</i>		
Sparrow, House	<i>Passer domesticus</i>		
Starling, European	<i>Sturnus vulgaris</i>		
Thrush, Song	<i>Turdus philomelos</i>		
Yellowhammer	<i>Emberiza citrinella</i>		