



Restoration of the principal Marotere Islands



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ABSTRACT

A ten-year restoration plan is provided from 2003–2013 for those Marotere Islands from which kiore have been removed. The plan covers the three largest islands in the Marotere group: Mauimua (Lady Alice), Mauiroto (Whatupuke) and Mauipae (Coppermine). All three islands are Nature Reserves. The vision is for: *Restoration of the biological diversity of Mauimua, Mauiroto and Mauipae in order to form complex communities of indigenous plants, animals and micro-organisms; their numerous parts interacting within natural pathways as far as possible unmodified by the detrimental effects of introduced organisms.* The management philosophy in support of this vision is to enable the re-establishment of the complex seabird-dominated systems representative of the region, either by natural means or by cautious restoration using local elements of the fauna and flora. If successful, these activities would protect populations of at least 10 species of plants and animals currently regarded as threatened, and increase populations of at least 28 species of additional plants, invertebrates, lizards and birds now declining or lost from the mainland. The plan provides a conceptual model for restoration of the islands based on past direct links between the islands, but more recent human modification of the islands in different ways. For plants, natural dispersal should enable recolonisation by species lost through human effects. However, there are some invertebrates and reptiles now locally extinct or confined to small offshore islets and which cannot naturally recolonise the larger islands. These include some large land snails, flightless insects, geckos and skinks. No releases of birds on the islands are proposed at present.

Keywords: restoration, Nature Reserves, management philosophy, conceptual model, threats, plants, invertebrates, reptiles, tuatara, geckos, skinks, seabirds, avifauna, research

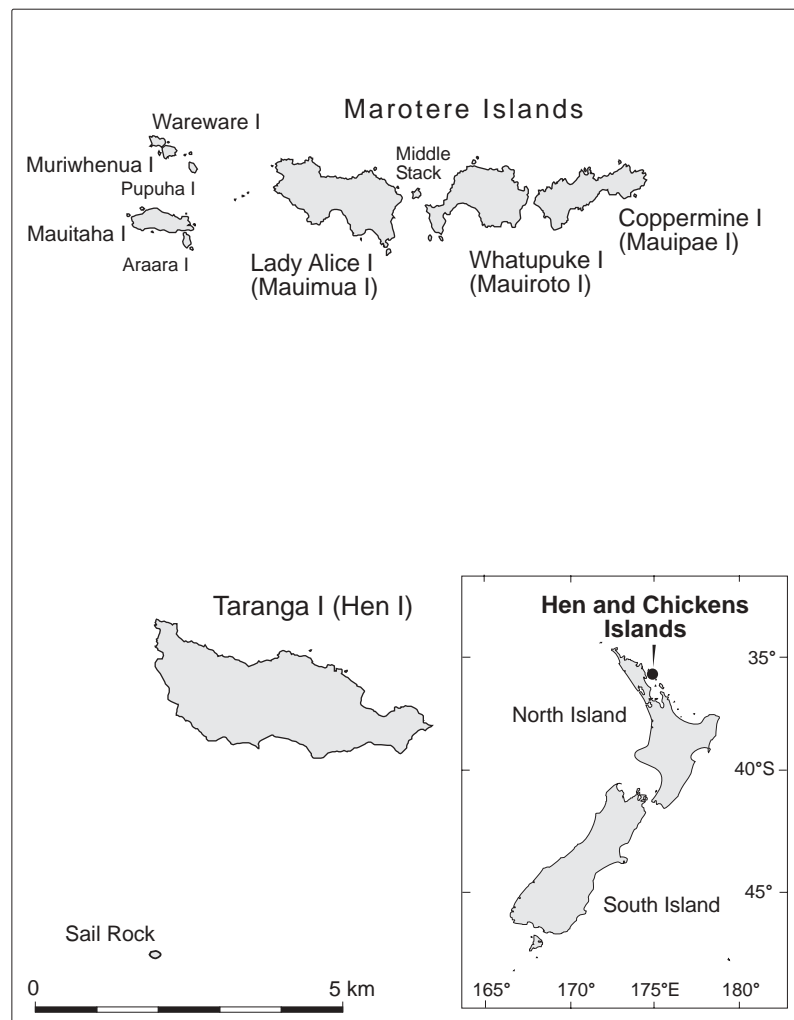
1. Introduction

The following plan is one of a series compiled under the umbrella of the Action Plan for island Nature Reserves in Bream Bay (in prep.). The series includes fire plans, weed plans and pest invasion contingencies, all of which are based around priority actions defined in the Northland Conservation Management Strategy (Anon. 1999). The restoration plan focuses on the future management of those Marotere Islands from which kiore were removed, and has been compiled jointly by Ngatiwai and the Department of Conservation (DOC).

The plan does not address the management of kiore on Mauitaha and Araara Islands. Any change to the present approach to kiore on these islands will need to be defined in the Action Plan for the Nature Reserves.

Ngatiwai view the Marotere Islands as the sons of Taranga cast adrift on her loincloth because of their disruptive behaviour. The largest of the sons are Mauimua (Lady Alice, 155 ha), Mauiroto (Whatupuke, 102 ha) and Mauipae (Coppermine, 80 ha) and these are surrounded by 12 smaller islands and islets (Fig. 1).

Figure 1. The Hen and Chickens Islands, off Northland, New Zealand, comprise Taranga I. and islands of the Marotere group. The map shows islands mentioned in the text with alternative names.



The geological history of the Marotere Islands coincides with the traditions of Ngatiwai. Waters around the group are about 50 m deep, but between Muriwhenua, Pupuha and the rest of the group, are less than 18 m. Mauimua, Mauiroto and Mauipae are separated by 150–500 m and joined by rocky reefs covered by only 2–3 m of water. As identified in legend, they therefore form a single unit ‘on the loincloth of Taranga’. The Marotere Islands were joined to Taranga during the last ice age, and with Taranga were part of the coastline c. 10 000–11 000 years ago. With subsequent rises in sea level, Taranga became separated from the Marotere Islands, but most of the Marotere Islands remained connected as a ‘super-island’ for another 5000 years until the Flandrian transgression of 5000 years ago (see Hayward 1986).

Although once connected, Mauimua, Mauiroto and Mauipae are each geologically unique. Mauimua and the western half of Mauiroto are formed from ancient (possibly Jurassic) sedimentary sandstone and mudstone, whereas the eastern half of Mauiroto and all of Mauipae are of much younger (probably Miocene) rocks of volcanic origin (Moore 1984). On Mauipae, mineralisation of the volcanic rocks is associated with the deposition of copper.

The natural resources of these islands are amongst the most diverse in northeastern New Zealand. In recognition of this diversity, the islands were designated as flora and fauna reserves when they were included in the Hauraki Gulf Maritime Park in 1973. Because of the important and fragile nature of their biological resources, the Marotere Islands were administered by the Hauraki Gulf Maritime Park as Class A ‘Inviolable Reserves’, with strict limits on access (Mossman & Miller 1986). The islands were reclassified as Nature Reserves with passing of the Reserves Act 1977.

2. Vision

2.1 MANDATE

Nature Reserves were established ‘for the purpose of protecting and preserving in perpetuity indigenous fauna and flora or natural features that are of such rarity, scientific interest or importance, or so unique that their protection and preservation are in the public interest.’

Nature Reserves are to be maintained such that:

- They are preserved as far as possible in their natural state.
- The indigenous flora, fauna, ecological associations and natural environment shall as far as possible be preserved and the exotic flora and fauna as far as possible be removed.

The present plan for the now kiore-free Marotere Islands aims to work within this framework by:

- Enabling the natural processes of interaction between the environment and communities of indigenous plants and animals. These processes include dispersal, pollination, predation, mutualism, parasitism, migration, regeneration,

nutrient cycling and energy flow; and will be allowed to respond to natural changes over time without intervention.

- Identifying and returning components of natural communities once present on the islands, affected by human-induced disturbance, and unable to recolonise unaided.
- Where possible, reducing detrimental impacts of introduced pests and weeds at present on the islands.
- Ensuring that the islands are kept free from additional introduced pests and weeds.

2.2 SHARED VISION

The vision/tirohanga shared by Ngatiwai and DOC is for: *Restoration of the biological diversity of Mauimua, Mauiroto and Mauipae in order to form complex communities of indigenous plants, animals and micro-organisms; their numerous parts interacting within natural pathways as far as possible unmodified by the detrimental effects of introduced organisms.*

3. Duration, principles, goals and outcomes

3.1 DURATION OF THE PLAN

The plan is for the 10 years from 2003 to 2013. However, it should be reviewed at five years (2008) and the goals, outcomes, and priorities reassessed. Other components of the plan, such as the priority order of key tasks, addition of new tasks and the range of information needs, can be revised at any time.

3.2 DEFINITIONS AND PRINCIPLES

This plan defines ecological restoration as 'active intervention to restore species or physical conditions lost due to human-induced disturbance in order to recreate a biological community that previously existed' (after Atkinson 1988). The plan uses the following guiding principles to achieve maximum benefit and cost-effectiveness:

- The short-term financial cost of restoration comprises removal of pest species; reintroduction of species once present; monitoring effectiveness of reintroductions and natural recovery of resident species; technical developments and research required to support these.
- Species reintroduced to the islands should eventually form self-sustaining populations that do not require further interventional management.

- Reintroduction should only be undertaken for those species that are clearly unable to recolonise by other means.
- The way members of restored biological communities interact would be determined through natural processes of change rather than through continued manipulation.
- The long-term financial cost of maintaining the restored island system eventually would be restricted to the cost of protection from reinvasion of plant and animal pests.

The plan is also based on the following assumptions:

- The restoration actions proposed here will follow predetermined ecological agendas.
- The Nature Reserve classification of each island will have primacy over all other uses. Consequently, all activities undertaken on the islands will minimise impacts on the biological communities. Most importantly, the landing and unloading of all stores on the islands will follow risk mitigation procedures established to maintain its present rodent-free status and to protect against the introduction of invertebrate pests. The necessary procedures are defined by DOC (Whangarei Area Office) and in a national Standard Operating Procedure at present under development.
- Implementation of the plan will be based on cooperative agreements with Ngatiwai as defined in a Memorandum of Understanding with DOC.

The plan refers to many species of plants and animals for which scientific names are given in Appendix 2.

3.3 MANAGEMENT PHILOSOPHY AND OUTCOMES

The northeastern islands of New Zealand which are free of introduced predatory mammals are usually inhabited by complex plant-invertebrate-reptile-seabird systems in which the seabirds play a dominant role by fertilising and modifying soils (Daugherty et al. 1990). The long-term aim for Mauimua, Mauiroto and Mauipae Islands is to enable the re-establishment of the complex seabird-dominated systems representative of the region, and also to allow the systems to reflect the unique topography and geology of each island. This can be achieved by cautious restoration using local elements of the fauna and flora and by maintaining and enhancing the indigenous species and communities already present on the islands. Other goals include:

- Colonisation by all native plant and animal species known to have previously existed on the Marotere Islands.
- Eradication or control of plant and animal pests that have the potential to compromise other restoration goals.

Expansion of resident species (Table 1) and restoration of those historically present (Appendix Table 1.1) would:

- Reconstitute a seabird-reptile-invertebrate-plant system depleted and degraded through fire, forest clearance, grazing, introduced plants, and predators.

TABLE 1. SPECIES RESIDENT ON THE LARGE MAROTERE ISLANDS AND DECLINING ON THE MAINLAND THAT COULD BENEFIT FROM THIS PLAN
Suffix [†] indicates nationally threatened.

COMMON NAME	COMMENTS	REFERENCE
Coastal maire	Present on all three islands; recruitment suppressed by kiore	Cameron (1984); Campbell & Atkinson (1999)
Coastal cress [†]	Present on all three large islands	Cameron (1984); Norton & de Lange (1999)
Karo	Present on all three islands; recruitment suppressed by kiore; host for honeydew scale insect	Cameron (1984); Campbell & Atkinson (1999)
Mawhai, native cucumber [†]	Present on all three islands, often particularly abundant around bird burrows	Cameron (1984)
Milktree	Now rare on the mainland; present on all three islands; recruitment suppressed by kiore	Cameron (1984); Campbell & Atkinson (1999)
Parapara	Now rare on the mainland; present on all three islands; recruitment suppressed by kiore	Cameron (1984); Campbell & Atkinson (1999)
Shore spurge [†]	So far recorded only from Mauiroto	Ritchie & Ritchie (1970)
Tawapou	Present on all three islands; recruitment suppressed by kiore	Cameron (1984); Campbell & Atkinson (1999)
Flax snail, pupuharakeke [†]	Only known live population on Mauipae; frequent subfossil shells among sand dunes on Mauimua, with evidence of predation by kiore	Parrish et al. (1995); Brook (1999)
Giant centipede	Large predator of invertebrates, lizards and perhaps young tuatara; widespread on islands free of rodents; may be present (surveys needed)	Towns et al. (1997)
Ground weta	Suppressed by kiore on islands	Towns et al. (1997)
' <i>Coprosma</i> weevil'	Found on <i>Coprosma macrocarpa</i>	
Small darkling beetle	Present on Mauimua; often suppressed by kiore	Towns et al. (1997)
Tuatara	Present on all three islands; juvenile recruitment suppressed by kiore	Cree et al. (1995); Tyrrell et al. (2000); Ussher (1999b)
Duvaucel's gecko	Present on all three islands; juvenile recruitment apparently suppressed by kiore	Towns (1996)
Pacific gecko	Apparently suppressed by kiore on offshore islands; present on Mauimua and Mauiroto	Whitaker & Parrish unpubl. data; Parrish unpubl. data
Moko skink	Rare on mainland, on some islands appears suppressed by kiore	Towns et al. unpubl. data
Ornate skink	Declining on the mainland and apparently suppressed by kiore	Porter (1987)
Shore skink	Declining on the mainland and on some islands appears suppressed by kiore	Towns (1996)
Suter's skink	Rare on mainland, vulnerable to predation by rodents including kiore	Towns et al. (in press)
Diving petrel	Appears to suffer recruitment failure on many islands with kiore; reported on Mauipae	McCallum et al. (1984)
Fluttering shearwater	Appears suppressed by kiore; rare reports of breeding from all three islands	McCallum et al. (1984)
Little shearwater	Present on Mauimua and Mauipae; recruitment suppressed by kiore	McCallum et al. (1984); Booth et al. (1996); Pierce (2002)
Pycroft's petrel	Breeding on all three islands but recruitment suppressed by kiore	McCallum et al. (1984); Pierce (2002)
Bellbird	Abundant on all three islands; should benefit as forest matures to more flowering species; honeydew feeder	McCallum et al. (1984)
Flesh-footed shearwater	Absent from the mainland, but abundant on the larger islands in the group	McCallum et al. (1984)
Kaka [†]	Breeding on all three islands; should benefit as forest matures to more fruit-producing species; honeydew feeder	McCallum et al (1984)
Kukupu or kereru	Common on all three islands; should benefit as forest matures to more fruit-producing species	Campbell & Atkinson (1999)
Red-crowned kakariki	Rare on the mainland but common throughout the group; should benefit as forest matures to more fruit-producing species	McCallum et al. (1984)
Tieke or saddleback	Common on all three islands; should benefit as forest matures to produce more fruit and insects; some recruitment suppressed by kiore; reintroduced from Taranga	McCallum et al. (1984); Robertson et al. (1993)

- Enable natural regeneration of unique coastal broadleaf and hardwood forest containing species such as pukānui.
- Protect and enhance unusual or unique assemblages and communities including a sandy beach and dune system on Mauimua and a unique forest-soil-bird system on Mauipae (Atkinson 1968).
- Protect and enhance populations of invertebrates including pupuharakeke or flax snails, *Amborhytida* snails, darkling beetles, karo weevil and giant centipedes.
- Protect and enhance unique reptile assemblages, including tuatara, rare McGregor's skink, Mokohinau skink and the large Duvaucel's gecko that no longer exist on the mainland.
- Protect populations of forest birds now rare or absent on the Northland mainland, including bellbird, red-crowned kakariki, kaka and tieke.
- Protect and enhance rare burrowing seabirds such as Pycroft's petrel; protect the largest New Zealand populations of flesh-footed shearwaters.

Overall, these activities would (Table 1, Appendix Table 1.1):

- Protect populations of at least 10 species of plants and animals currently regarded as threatened.
- Increase populations of at least 28 additional plants, invertebrates, lizards, and birds now lost from, or declining on, the mainland.

4. Restoration to date

4.1 ECOLOGICAL PROTECTION THROUGH PLANT AND ANIMAL PEST CONTROL

The history of human modification of the Marotere Islands is summarised in the Action Plan for these Nature Reserves (in prep.). With implementation of the plan, there has been intensive and extensive weed control and surveillance. The main species targeted are those that may affect forest structure or impede regeneration. These include pampas grass, Mexican devil weed, mist flower and moth plant (see Table 2 for current management).

Each of the largest Marotere Islands has in the past been at least partly burned (Cameron 1984). In addition on Mauimua, flax was harvested and barged to Whangarei during the late 19th century and cattle were present until 1924–25. On Mauipae, forest was also cleared for several attempts at mining and mineral exploration (Cameron 1984).

The animal threat most recently identified and removed was kiore. The Northland Conservation Management Strategy (Anon. 1999) proposed the removal of kiore from the three largest of the Marotere Islands as a means of protecting natural resources and studying the effects of kiore on other wildlife. Following consultation with and agreement from Ngatiwai, kiore were removed from Mauiroto in 1993, from Mauimua in 1994 and from Mauipae in 1997. Kiore

TABLE 2. INTRODUCED FLORA AND FAUNA THAT ARE RESIDENT AND MAY DETRIMENTALLY AFFECT MAROTERE ISLAND SYSTEMS.

COMMON NAME	DISTRIBUTION	COMMENTS
Forget-me-not	One area on Mauimua	Under control
Pampas grass	Scattered on most islands	Under control
Mexican devil weed	Widespread and dense in places on Mauimua	Being controlled, but intensive work still required to delete seed bank
Mist flower	Localised	Under control
Montbretia	One site on Mauimua	Under control
Moth plant	Localised on Mauimua and Mauiroto	Under control
Purple groundsel	On three largest islands	Under control
Asian paper wasp	Occasionally present on Marotere Is	Effects on native species need to be determined on islands but no effective control methods presently available?
Australian paper wasp	Extremely abundant on Marotere Is, especially in autumn	Effects on native species need to be determined on islands but no effective control methods presently available?
Cabbage white butterfly	Throughout Marotere Is	Cook's scurvy grass may be at risk from caterpillars
Daddy-long-legs spider	Present in hut on Mauimua	Usually confined to buildings and possibly could be removed
European wasp	Present throughout	Abundance/frequency worth noting. On some islands declined after removal of rodents. May be possible to eradicate from Marotere Is (see Dymock 2000 for recolonisation risks)
Passionvine hopper	Present on Mauimua, not confirmed elsewhere	Attributed with spreading the plasma virus causing sudden decline in cabbage trees. Effects on other species unknown
Blackbird	Throughout Marotere Is	Known to occasionally feed on small lizards. Abundance and effects in Marotere Is unclear
Eastern rosella	Abundant on the adjacent mainland	Not known to have established in the Marotere Is; could detrimentally affect native parakeets and other hole-nesting species
Indian myna	Occasionally seen on Mauimua, but so far does not appear to have established	An opportunistic omnivore that preys on eggs and chicks; should be eradicated if a breeding population establishes
Song thrush	Throughout Marotere Is	Abundance and effects in Marotere Is unclear; known predator of <i>Placostylus</i> snails

remain on Mauitaha and Araara (26 and 2.2 ha respectively). The remaining islands in the group have not been inhabited by introduced mammals.

4.2 NATURAL RESTORATION

The most developed forest is on Mauiroto, the island with the least evidence of recent human disturbance (Ritchie & Ritchie 1970). Natural changes to the forest systems have largely been recorded on Mauimua and have included (see also Table 1):

- Declining manuka and kanuka and increasing spread of kohekohe and karaka (Bellingham 1984).
- Increase in the extent of pukaniu (R. Beever 1984).
- Increases in the abundance and distribution of large-bodied petrels and shearwaters, especially flesh-footed shearwaters. The Marotere Islands now support the largest populations of the species in New Zealand (McCallum et al. 1984).

Even without further restorative actions, the existing biological communities of the Marotere Islands will trend toward a distinctive coastal mixed forest with pohutukawa and pukaniu. Eventually the pohutukawa component will become confined to cliffs (Bellingham 1984). Without further intervention, the vegetation is likely to show:

- Succession of existing pohutukawa-coastal broadleaf forest to include a larger component of species such as kohekohe, nikau, tawapou, kowhai, parapara and milktree, all of which are suppressed by kiore (Campbell 1978; Campbell & Atkinson 1999, 2002).
- Increasing spread of fruit-producing trees such as tawa and taraire by kukupa (Campbell & Atkinson 1999).
- Increased contribution to the coastal vegetation by karo, a species often heavily suppressed by kiore (Atkinson 1986; Campbell & Atkinson 1999).

Some distinctive features of resident vegetation will continue to include:

- Abundance of pukaniu and parapara.
- Understorey that includes abundant taurepo.
- Expanding areas of mawhai, scurvy grass and small herbaceous species on disturbed, open or fertile sites around seabird colonies.

Elements of the fauna likely to change over time include:

- Large insects such as cicadas and tree weta should increase in abundance.
- Tuatara increasing in abundance and with a higher rate of juvenile recruitment; likely to be most abundant around dense seabird colonies (Towns et al. unpubl. data)
- Suter's skinks abundant in a range of habitats in coastal areas (Towns et al. in press).
- Duvaucel's gecko abundant throughout forests and around shorelines.
- Pacific gecko common in forest areas.
- Moko skink abundant in more open sites, especially around areas of flax such as on Mauiroto.
- Seabirds continuing to spread and reaching high local densities in areas where there are deep soils, but a growing proportion comprised of small-bodied species (e.g. Pycroft's petrel and little shearwater).
- Kukupa, kaka, tui, bellbird and tieke populations expanding with increasing fruit production and invertebrate abundance.
- Kingfishers and moreporks increasingly abundant, supported by expanding food supplies of large insects and lizards.

4.3 ECOLOGICAL RESTORATION

Ecological restoration in the Marotere Islands has involved the reintroduction of one species of bird and three species of lizards, all of which were probably once present.

- McGregor's skinks transferred from Sail Rock to Mauimua in 1997-98 and to Mauiroto in 2000.

- Mokohinau skinks transferred from Muriwhenua to Mauimua in 1997–98, from Middle Stack to Mauiroto in 2000, and from Middle Stack to Mauipae in 2002.
- Pacific geckos transferred from Pupuha Island to Mauimua in 1997.

The skink releases were recommended in the *Cyclodina* skink recovery plan (Towns 1999). So far, breeding has been confirmed only for the Pacific geckos; juvenile McGregor's skinks were confirmed on Mauimua in January 2003 (R. Parrish unpubl. data).

- Tieke successfully released on Mauiroto in 1964 after several previous failures; transferred from Mauiroto to Mauimua in 1971 (Merton 1973) and self colonised from Mauiroto to Mauipae (Newman 1980).

4.4 REMAINING THREATS

Introduced plants on the Marotere Islands are mostly annuals and herbaceous plants that have minor impacts on the ecological systems (Cameron 1984). The exceptions are four species of wind-dispersed weeds, all of which are currently being controlled (Table 2). In addition, four species of bird are resident or likely vagrant to the islands (Table 2):

- Myna may cause damage through predation or exclusion of native species but do not appear to have established a permanent resident population.
- Eastern rosellas have the potential to establish because they are very abundant on the adjacent mainland. They could compete for nest holes with tieke and kakariki (T.C. Greene pers. comm.).
- Thrushes and blackbirds are known predators of invertebrates; blackbirds also eat some small reptiles (Bell 1996). However, it is unclear whether these birds are present in sufficient numbers to be of concern.

The remaining pests are invertebrates, with the most significant effects probably from introduced wasps (Table 2). The effect of wasps on resident invertebrates is yet to be determined, as is the feasibility of remedial action.

5. Conceptual model for the restoration of Marotere Islands

Restoring components of the communities of plants and animals can be based on one or a combination of the following (Atkinson 1997):

- Historical accounts of the distribution and abundance of plants and animals before and after disturbance.
- Subfossil remains of organisms previously present.
- Nearby reference sites that have not been modified by human-induced disturbance.

There is considerable recent information about elements of the Marotere Islands flora and fauna spanning almost 50 years. However:

- There are only brief and scattered accounts from late in the 19th century.
- Known subfossil remains have only been identified on Mauimua and only for selected land snails.
- There are no reference sites of equivalent size for the Marotere Islands. The nearest similar islands are the Poor Knights, but these have a different geological history, have been isolated from other islands for up to two million years (Hayward 1991), are inhabited by endemic species of plants and reptiles, and for some groups such as birds and reptiles, are less diverse than the Marotere Islands.

Despite the above impediments, additional fragments of the likely original flora and fauna have survived on some larger islands, on small islands and islets within the Marotere Group or within the broader Ecological District (Appendix Table 1.1). Examples include:

- A population of large-flowered broom that has survived on Araara (Atkinson 1972).
- A population of pupuharakeke that survived on Mauipae.
- Common and Pacific geckos on small islands and stacks.
- Mokohinau skinks on Muriwhenua and Wareware, Pupuha and Middle Stack.
- McGregor's skinks on Sail Rock and Mauitaha in the Bream Islands.
- Honeydew scale, karo weevil and large darkling beetles on Muriwhenua.

Furthermore, the subfossil remains of pupuharakeke on Mauimua indicate that these large snails were once more widely distributed. Analyses of these deposits by Brook (1999) raised two points relevant to this plan:

- Damage to snail shells was consistent with predation by kiore.
- The sequence of damaged and undamaged shells is consistent with arrival of kiore on Mauimua at about the time of first European occupation in the early 19th century.

Other evidence that supports a recent arrival of kiore in these islands includes:

- Large numbers of little shearwaters breeding on Mauimua when the island was visited in 1880 (Reischek 1885) compared with subsequent visits in the 1960s, suggesting recent declines in abundance (McCallum et al. 1984 and references therein). Booth et al. (1996) and Pierce (2002) have subsequently demonstrated the species' sensitivity to predation by kiore.
- Relatively large populations of tuatara compared with other islands inhabited by kiore (e.g. Cree et al. 1995); discovery of tuatara on smaller islands (Mauitaha) than those occupied by kiore elsewhere.
- Parasites on kiore from Mauimua consistent with contact between kiore and European rodent species (Roberts 1991). The Marotere kiore may therefore have been derived from the mainland after the spread of Norway rats in the 18th century (Atkinson & Towns 2001).

Given the geological and human history of the islands, restoration is based on the following model:

- The large Marotere Islands were previously a single island now divided into three by narrow water gaps. For most species of birds and plants these gaps are irrelevant. However, for flightless species of invertebrates and all reptiles, the gaps are effective barriers to dispersal between the islands.

- The flora and fauna of these islands has been modified by human-induced disturbances. Some of these, such as harvesting of seabirds and flax, probably only had local effects. Forest clearance by burning, the arrival of kiore and some recent invertebrate pests apparently had more lasting effects. Some of these effects may have been interactive, but their result has been the loss of some species from the larger islands.
- The most accurate evidence of species lost from the larger Marotere Islands is provided by species that persist on small islands in the Marotere Group (Appendix Table 1.1).
- A less accurate, but wider pool of likely previous inhabitants of the Marotere Islands can be derived from neighbouring islands in the Ecological District (Taranga, Sail and Bream Islands) (Appendix Table 1.2).
- The least accurate pool of species is from regional flora and fauna (Appendix Table 1.3).

Because accuracy of the assumptions about species distribution varies, we propose that reintroductions should follow the same protocols across groups of organisms so that future options are not foreclosed. These protocols are:

- Species present within the Marotere group can be translocated to any or all of the larger Marotere Islands. This is being followed, for example, with translocations of Mokohinau skinks to all three islands (Towns 1999).
- Species present within the Ecological District should be translocated to no more than two islands. This was followed with the translocations of tieke from Taranga to Mauiroto and Mauimua (see above). However unlike tieke, any species released in future should be unlikely to spread to other islands.
- Species present in the region, but not recorded in the Ecological District should only be released onto one island. We suggest that this island should be Mauimua because of its size and greater distance from Mauiroto compared with Mauipae. As above, the species should not be able to spread to other islands.

These priorities could change if new evidence is obtained that the species listed (Appendix Tables 1.2, 1.3), or additional species, were previously more widespread through the group.

The aims of this approach are to:

- Reconstruct ecological systems that represent the unique features of the island group.
- Reconstruct interactive pathways once present in the region but since lost and not easily reconstructed elsewhere.
- Undertake restoration in such a way that results can be measured over the long term. These may include unforeseen negative interactions between species.

6. Restoration of flora

6.1 CURRENT SITUATION

Botanical lists for the Marotere Islands were first compiled in the early 1930s (Cranwell & Moore 1935), with more intensive studies since the early 1950s. Early vegetation maps were published for Mauimua by Percy (1956), for Mauiroto by Ritchie & Ritchie (1970) and for Mauipae by Atkinson (1968). These have been supplemented by lists of the mosses and lichens (J. Beever 1984; Hayward & Hayward 1984) higher plants (Jane & Beever 1965; Cameron 1984), accounts of the distribution and abundance of pukauui (Atkinson 1956; R. Beever 1984), and a model of forest succession on Mauimua (Bellingham 1984).

These studies provide a rich source of information that pre-dates the removal of kiore. However, there have been no recent updates of these accounts. The various botanical surveys identified 130 species of lichens, 62 species of mosses and 245 species of native ferns and higher plants. In addition, there are at least 53 species of introduced flowering plants and 20 species of introduced grasses (Table 3), although few of these were regarded as problem weeds (Cameron 1984).

The lichen flora was regarded as the most diverse for any northern offshore islands (Hayward & Hayward 1984), and is similar to the diversity recorded from the larger Taranga (Hayward & Hayward 1978). This diversity appears to reflect the diversity of available habitats and many stages of forest regeneration.

The mosses of the Marotere Islands tend to lack luxuriant growths and few species are characteristic of the moist forests of Northland. Instead, many of the mosses are species tolerant of relatively dry conditions (J. Beever 1984), probably a reflection of the early stages of succession of some of the forest, but also the dry, porous or compacted soils (Percy 1956; Ritchie & Ritchie 1970).

The flora of ferns and higher plants is, like that of lichens, similar in size to that present on Taranga (Cameron 1984), although some species relatively common on Taranga are represented in the Marotere Islands by a few individuals. However, as with mosses, the understorey cover is typical of dry environments (Cameron 1984).

TABLE 3. SUMMARY OF THE FLORA OF THE LARGE MAROTERE ISLANDS (AFTER CAMERON 1984).

	MAUIMUA	MAUIROTO	MAUIPAE	ALL ISLANDS COMBINED
Native ferns and fern allies	42	37	36	51
Native gymnosperms	3		1	3
Native dicotyledons	121	90	100	134
Introduced dicotyledons	45	26	32	53
Native monocotyledons	51	38	42	57
Introduced monocotyledons	17	11	14	20
Totals	279	202	225	318

At least five species of plants from the Marotere Islands are on the threatened plant list of Cameron et al. (1995). Two, the cresses *Lepidium* spp. and *Rorippa divaricata*, are listed as endangered; mawhai and large-flowered broom are listed as vulnerable; and shore spurge is listed as rare.

6.2 WHAT WAS THE MAROTERE ISLANDS' ORIGINAL VEGETATION COVER?

The three largest Marotere Islands represent various stages of forest succession. The most mature forest is the puriri and pohutukawa forest on Mauiroto. This forest had a subcanopy comprised variously of karaka, kohekohe, mahoe, mapou, tawapou, taraire, five-finger, pigeonwood, pukanui, parapara, nikau and coastal maire when surveyed by Ritchie & Ritchie (1970). Much of the forest on Mauimua is at an intermediate stage, with smaller patches of mature forest in the damper valleys containing various combinations of pohutukawa, kohekohe, karaka, puriri and taraire (Bellingham 1984). The least mature forest was on Mauipae, where much of the island was covered with coastal scrub, pohutukawa-dominated forest and kanuka scrub and forest. However even here, a mixed forest stand was one of the most diverse on the Marotere Islands (Atkinson 1968). These descriptions suggest that succession is now heading towards communities that resemble the original forest: a diverse, mixed forest comprised largely of broad-leaved species, which in the more sheltered sites would have a canopy height of at least 15 m. However, this would be surrounded by a mosaic of other species, the combinations at particular sites depending on exposure to wind and the effects of burrowing seabirds.

In detail these changes could include (see also Bellingham 1984):

- Continued rapid decline of communities dominated by manuka and kanuka, although kanuka is likely to remain in some areas, such as exposed ridge tops (see section on invertebrates below).
- Gradual loss of pohutukawa, which will eventually become restricted to coastal and disturbed sites.
- Increased density of understorey vegetation, leading to reduced airflow and locally increased ground cover of mosses and ferns (J. Beever 1984).
- Locally increased soil friability due to expanded seabird colonies, with associated reductions in seedling density and litter cover (Mulder & Keall 2001).
- Further increases in the distribution and abundance of pukanui (R. Beever 1984), although this spread may stabilise as seabird populations increase if the species is sensitive to root disturbance.
- Recolonisation or increased rate of regeneration by species sensitive to kiore. These include nikau, parapara, tawapou, milktree, coastal maire and puriri (Campbell & Atkinson 1999), and also karo, which is likely to become one of the most widespread coastal species (Atkinson 1986).

6.3 IS ACTIVE RESTORATION OF PLANTS NEEDED?

The various studies of succession in the Marotere Islands indicate that the vegetation is trending towards more mature forest. The removal of kiore may speed up this process, and affect the composition of the mature forest by enabling more rapid spread of species that bear large fruit. This is likely to further encourage feeding by kukupa, which will add to the distribution and abundance of many species (Campbell & Atkinson 1999, 2002).

Given the high diversity of the flora of these islands, there is little need to actively restore plants with the exception of species such as large-flowered broom, which may not be able to spread from Araara to other Marotere Islands unassisted. However, since there is a chance that isolated plants have survived undiscovered, artificial spread of this species could be seen as a future option if natural recruitment fails.

7. Restoration of invertebrates

7.1 CURRENT SITUATION

Knowledge about the invertebrates of the Marotere Islands is variable. There do not appear to have been systematic surveys for insects. However, there were extensive surveys for spiders by Court (1984) and intensive surveys for land snails on Mauimua by Brook (1999) and throughout the group by Parrish (unpubl. data).

7.1.1 Land snails

The known mollusc (land snail and slug) fauna for Taranga and the Marotere Islands is 70 species. At least one, and possibly two species of freshwater snails live in the streams or coastal rock pools. The total fauna for each individual island is (Parrish unpubl. data): Taranga 64; Mauimua 27; Mauiroto 19; Mauipae 13; Mauitaha 6; Araara 6; Sail Rock 6; Muriwhenua 2; Pupuha 1.

The large fauna of Taranga reflects its size and diversity of habitats. Species present on Taranga but not in the Marotere Islands include two large carnivorous species: the kauri snail and the snail *Amborhytida tarangensis*. Both species are preyed on by kiore (Parrish et al. unpubl. data). Subfossil shells of *A. tarangensis* are present on Mauimua (Brook 1999).

The three main Marotere Islands have a similar land mollusc fauna but Mauipae has three small punctid snails not known anywhere else in the group. The reason for this is not known but may reflect the different geological origins and mineralisation of the volcanic rocks. Six species are currently only known from Mauimua, possibly because of more extensive collecting carried out there.

The large herbivorous pupuharakeke or flax snail survived on Mauipae, there are sub-fossil remains on Mauimua (Brook 1999) and there is a record of one shell from Mauiroto collected c. 1978 (C.R. Veitch pers. comm.).

The origin of the flax snail surviving on Mauipae and previously on Mauimua and perhaps Mauiroto is unknown. Brook & McArdle (1999) concluded that the Poor Knights populations of flax snails, and possibly the populations on the Mokohinau Islands, were endemic but that the Marotere Islands populations and others were introduced. The reason why flax snails survived in the presence of kiore on Mauipae but not on Mauimua and Mauiroto is not known.

7.1.2 Spiders

Court (1984) identified 65 species of spiders from the Marotere Islands. Of these, 58 were collected from Mauimua (where his collecting was based). Three species were found only on small islets. The fauna is mainly indigenous, with only four introduced species found (some of these are unclear as to whether introduced or indigenous). Court (1984) found apparent displacement of two related species of funnel web spiders through the Marotere Islands. *Hexathele kobua* was found on Mauimua, but not *Porrhothele* cf. *quadrigyna*, which was found on Mauiroto. Since Court's visit, an additional introduced species has arrived: the daddy-long-legs spider, which is now common inside the hut.

7.1.3 Insects

Several species of beetles of particular interest have been found in the Marotere Islands. Most collecting effort has been concentrated on Taranga, where Watt (1962, 1986) identified at least 45 species of beetles. Amongst these are interesting beetles that inhabit the nests of some native birds. Also, on the sand beach on Mauimua, are small carrion-feeding beetles (*Phycosecis limbata*) (R. Parrish unpubl. data). The rare karo (Turbott's) weevil was recorded on Muriwhenua Island (Watt 1986), and large darkling beetles are present (at least on Muriwhenua Island), but have not been seen on the islands previously inhabited by kiore (Towns & Parrish unpubl. data).

The only systematic collections on the Marotere Islands have been as part of diet studies of kiore and tuatara (Newman & McFadden 1990; Ussher 1999a). Identification of invertebrates in these studies was rarely below family level. Included in these collections were three species of weta widespread throughout the Marotere Islands: small cave weta, tree weta and ground weta.

7.2 WHAT WAS THE MAROTERE ISLANDS' ORIGINAL INVERTEBRATE FAUNA?

The invertebrate faunas of northern islands free of introduced mammals contain broadly similar components that include (Daugherty et al. 1990):

- Land snail assemblages comprising numerous small species and at least one large carnivorous species; and on the more northern islands the large, herbivorous pupuharakeke.
- Giant centipedes, which are the largest invertebrate predator in the system.
- Large weta, which may be either herbivorous or partly carnivorous.
- Flightless beetles, including large flightless weevils. Amongst these, large darkling beetles are important in the diet of tuatara (Walls 1981).

- At least one species of honeydew scale insect. These may infect coastal tree and shrub species and are highly attractive to geckos and honey-eating birds (Towns 2002).

In the Marotere Islands, the presence of kiore has apparently resulted in local extinctions of some larger species of invertebrates. Brook (1999) described these effects for land snails. Evidence of similar effects on other invertebrates is provided by the fragmented distribution of darkling beetles, some large weevils and common honeydew scale on the rodent-free islets but not on the larger Marotere Islands. The evidence from subfossil deposits, and fragmented distributions within the group indicate that the fauna comprised the following:

- A distinctive living fauna of 34 species of land snails. The fauna also historically included the predatory *Amborhytida* snail.
- The large pupuharakeke, which still survives on Mauipae (possibly as a human introduction).
- Large darkling beetles and large flightless weevils.
- Common honeydew scale as well as kanuka honeydew scale. The latter species is still present (at least on Mauiroto). Since females are flightless, their kanuka hosts may have remained an element of the vegetation since the islands were isolated.

Other species that may have been present include additional species of weta (Appendix Table 1.3). For example, early records indicate that wetapunga were once widespread on the mainland (Sherley 1998). However, aside from the presence of two related species on the Poor Knights Islands and on Hauturu, there is no direct evidence for their previous presence in the Marotere Islands. A second species, the Northland tusked weta, has survived on the mainland in the presence of introduced predators, and might therefore be expected to survive on the Marotere Islands. So far, none have been found.

7.3 SPECIES REINTRODUCTIONS OF INVERTEBRATES

Species identified in Appendix Table 1.1 as having potential for reintroduction include large darkling beetle, karo weevil and common honeydew scale (all on Muriwhenua Island), and two species of land snail. If appropriate, it should also be possible to reintroduce pupuharakeke to Mauimua using snails from Mauiroto. In order of priority these could be:

- Large darkling beetle, since it is an important food chain species and is consistently absent from islands inhabited by kiore. Relict populations are unlikely.
- Pupuharakeke to Mauimua subject to a suitable source of snails being identified on Mauipae. This may require several years for the existing population to expand sufficiently to sustain removal to Mauimua.
- *Amborhytida* snail to Mauimua subject to further surveys of snails being undertaken there and on the other Marotere Islands.
- Common honeydew scale subject to further surveys on suitable hosts on all Marotere Islands.

- Karo weevil subject to studies on Muriwhenua Island, and perhaps on the Poor Knights Islands, to determine the species' host range and habits.

Whether wetapunga should be included in the reintroductions is a value judgement. However, based on our criteria, it is a low priority due to the absence of specific data on its previous range (Appendix Table 1.3). If included in reintroductions, these should be confined to Mauimua. Similarly, whether pupuharakeke should be released on Mauiroto may require reassessment of the evidence of the role of humans in their distribution. In the meantime, any reintroductions should be confined to Mauimua.

8. Restoration of reptiles

8.1 CURRENT SITUATION

Tuatara and nine species of lizards are known from the Marotere Islands (Whitaker & Parrish unpubl. data), but only 6 or 7 of the lizard species were present on the larger islands before kiore were removed (Table 4).

Tuatara in the Marotere Islands showed impaired recruitment while kiore were present (Whitaker 1978; Newman 1987; Cree et al. 1995), and at fewer than 20/ha, were also at lower densities than on islands without introduced predators (Cassey & Ussher 1999; Tyrrell et al. 2000). The most extreme example is on Mauitaha where only one or two adult tuatara remain. Surveys on Mauimua in March 2001 and Mauiroto and Mauipae in January 2002 demonstrated significant recruitment of immature tuatara following the removal of kiore (Towns et al. unpubl. data; Parrish & Ussher unpubl. data respectively).

TABLE 4. LIZARD FAUNA OF THE LARGE MAROTERE ISLANDS AS AT 17 SEPTEMBER 2001 (AFTER WHITAKER & PARRISH UNPUBL. DATA).
+ indicates presence, I for introduced species.

	MAUIMUA	MAUIROTO	MAUIPAE	KIORE-FREE ISLETS
Common gecko				+
Duvaucel's gecko	+	+	+	+
Pacific gecko	+, I ^a	+	+?	+
Copper skink	+	+	+	
McGregor's skink	I	I		
Mokohinau skink	I	I	I	+
Ornate skink	+	+	+	
Moko skink	+	+	+	+
Shore skink	+	+	+	+
Suter's skink	+	+	+	+
Totals ^b	7	7	7	7

^a Breeding confirmed.

^b Excludes reintroduced species.

Similarly, systematic trapping for lizards before and after removal of kiore showed increased capture frequencies for several species, the greatest being for Suter's skinks on Mauiroto (Towns et al. in press). There were also increased capture frequencies of Duvaucel's geckos soon after kiore were removed, but these relatively rapid changes appear to have been in response to a behavioural change as the animals became increasingly terrestrial (Towns et al. unpubl. Data; Whitaker & Parrish unpubl. data).

8.2 WHAT WAS THE MAROTERE ISLANDS' ORIGINAL REPTILE FAUNA?

In addition to the seven species on the larger islands, two species were confined to smaller islets free of introduced mammals. These include common geckos found on Muriwhenua (including Wareware) and Pupuha Islands, and Mokohinau skinks found only on Muriwhenua, Pupuha and Middle Stack. A third species, McGregor's skink, is present on the nearby Bream Islands and Sail Rock.

The fauna almost certainly comprised nine species, probably at least 10. This fauna is not unusually diverse, although it is larger than the eight species recorded from the Poor Knights Islands. The Marotere fauna is distinctive for its potentially unusual species combinations. For example, up to five species of *Cyclodina* skinks may have coexisted. This no longer happens anywhere, although there is subfossil evidence for such assemblages on the mainland (Worthy 1991).

The strongest present evidence is for the coexistence of four species of *Cyclodina*. The fifth, robust skink, has populations in the nearby Mokohinau Islands, and is represented by subfossil deposits on the adjacent mainland (Worthy 1991). The Marotere lizard fauna therefore likely comprised three species of geckos, three species of skinks in *Oligosoma* and four (perhaps five) species in *Cyclodina*.

8.3 SPECIES REINTRODUCTIONS OF REPTILES

Reintroductions of species of lizards have already commenced in the Marotere Islands (Table 4). So far, these have been confined to species with high probability of previous presence on the islands and little or no chance of surviving in the presence of kiore. These reintroductions were completed with the release of Mokohinau skinks onto Mauipae. Possible future releases include:

- Robust skinks, which may be released onto one island. Towns (1999) proposed that this should be Mauipae but, given priorities of the present plan, they might more appropriately go to Mauimua.
- Common geckos could be released onto all three islands. However, they may have survived in very low numbers in inaccessible habitats (Whitaker & Parrish unpubl. data). The need for releases of these species should await further surveys for lizards on each island.

9. Restoration of avifauna

9.1 CURRENT SITUATION

The Marotere Islands support particularly diverse and abundant forest bird assemblages, as well as a range of seabirds, some of which are locally numerous. McCallum et al. (1984) recorded 16 native species breeding on the islands. This should probably be increased to 17 by inclusion of shining cuckoo which visit in spring, but are rarely encountered during summer when McCallum et al. conducted their surveys. There are probably at least five introduced species breeding on the island and a sixth, myna, appears to be a vagrant.

For the more mobile forest birds, the Marotere Islands form one link in a chain of habitats from Bream Head through Taranga to Hauturu. Some species, such as kukupa, kaka and tui, appear to commute along this chain and at times are therefore particularly abundant in the Marotere Islands. The combined effects of their strategic location and the proximity of the Marotere Islands to each other, appear to have resulted in forest-bird species richness on the Marotere Islands which is higher than individual northeastern islands of equivalent size, including the Poor Knights and Mercury Islands (McCallum 1981; Robertson et al. 1993 respectively). All of the burrowing seabirds and many of the forest birds were once present on the adjacent mainland, from which they have now disappeared or are in decline. For example, bellbirds and red-crowned kakariki, although abundant in the Marotere Islands, are very rare or absent from the Northland mainland.

Seven species of burrowing seabirds were identified by McCallum et al. (1984), who found a predominance of large species. Small species, such as little shearwaters, appeared to be declining and others such as fluttering shearwaters and diving petrels were largely confined to the small rodent-free islets. Declines of little shearwaters and Pycroft's petrel were attributed to predation of eggs and chicks by kiore (Booth et al. 1996; Pierce 2002). However, flesh-footed shearwaters appear to have greatly increased in numbers since the first surveys of the late 19th century (McCallum et al. 1984).

9.2 WHAT WAS THE MAROTERE ISLANDS' ORIGINAL AVIFAUNA?

The seabird fauna of the Marotere Islands may not have included many more species than are now present. One species that may have been present is white-faced storm petrel, a species highly vulnerable to rodents (Imber 1975). However, it is likely that before the arrival of kiore, seabird assemblages included much larger numbers of smaller species such as diving petrels, fluttering shearwaters and little shearwaters, especially on steep ground near the coast.

The forest fauna may have included more species than at present. For example, it is possible that spotless crakes and banded rails were present. Whether additional species such as riflemen, robins, snipe, and whiteheads (Appendix

Table 1.3) were present is difficult to determine. These species were all present or recorded historically on Hauturu Island (Turbott 1961). Snipe appear sensitive to predation by rodents (Holdaway 1999), and had disappeared from Hauturu by the beginning of the 20th century. However, riflemen, robins and whiteheads can survive in the presence of an array of introduced predators. Their absence from the Marotere Islands and Taranga may therefore reflect problems with the availability of resource rather than the effects of predation, unless predation was combined with extensive reductions in forest cover (Appendix Table 1.3).

9.3 SPECIES REINTRODUCTIONS OF BIRDS

So far, the only species of bird released in the Marotere Islands are tieke derived from Taranga. Additional bird species that are possible candidates for release onto the Marotere Islands include snipe and shore plover, neither of which survives anywhere on the mainland (Appendix Table 1.3). The Marotere Islands were proposed as a possible release site in a draft recovery plan for shore plover. Two additional species, banded rail and spotless crane, may recolonise naturally; spotless crane have already been seen on Mauimua (R. Pierce pers. comm.). A further four species are probably unsuitable for release in the Marotere Islands because of the lack of sufficient habitat and potential effects on other organisms (Appendix Table 1.4).

Although snipe and shore plover may benefit most from release onto the Marotere Islands, neither species would remain confined to one island (see section 5), and the releases would also face practical problems:

- Snipe are now confined to outlying islands south and east of New Zealand. The North Island subspecies is extinct. It is unclear which of the existing subspecies would be most suitable.
- Releases of shore plover have so far met with mixed success; at least 40% of those released on Motuora Island dispersed (Aikman 1999), some to sandy beaches nearby where they were vulnerable to introduced predators (J. Dowding pers. comm). Other birds were killed by resident moreporks and harriers (Aikman 1999). It is unclear whether shore plover released in the Marotere Islands would remain, or whether they would survive the large resident populations of predatory birds.

10. Freshwater habitats

10.1 CURRENT SITUATION

Freshwater habitats other than temporary pools are rare on offshore islands. Within the Marotere Islands, the streams that permanently hold water are on Mauimua and Mauiroto. The streams with permanent water are inhabited by the freshwater snail *Potamopyrgus antipodarum* and, at least on Mauimua, by a few species of aquatic insects, and possibly also freshwater koura. Detailed surveys of these habitats have not been conducted.

The streams on Mauimua have direct access to the sea (at least periodically), whereas those on Mauiroto flow over bluffs inaccessible to most freshwater fish that have marine larval stages. Reports of fish on Mauimua include banded kokopu, short-jawed kokopu, shortfin eel and longfin eel.

10.2 FUTURE MANAGEMENT

The past presence of kiore on Mauimua and Mauiroto is unlikely to have had any effect on freshwater habitats. All of the streams are in tall forest and, at least on Mauimua, they harbour invertebrates and fish normally found in waters of high quality. In the very long term, water quality may change at some sites if seabird densities become so high that soil and droppings enter the waterways. This would be a natural change, so present conditions may serve as a useful baseline.

Flow rates and water quality probably fluctuate depending on the prevailing climate patterns, with dry conditions and little flow during the El Niño Southern Oscillation periods in contrast to the wetter La Niña pattern. Population densities and species composition of fish are also likely to reflect these changes.

No management of these habitats is proposed.

11. Control of plant pests

Priorities for the control of key weed species are outlined in the Taranga Ecological District Action Plan. At least three species of weeds appear to have been eradicated. They include boxthorn, smilax and kikuyu. However, weeds may arrive or reinvade, including boxthorn (often attributed to spread by starlings) and brush wattle. The latter species is being controlled on Muriwhenua Island. It will be necessary to continue to periodically monitor for introduced weeds and to take extreme care against the accidental spread of seeds as a result of other activities on the islands (see biosecurity below).

12. Control of other pests

Introduced species other than plants that may detrimentally affect the Marotere Island systems are listed in Table 2. As with weeds, the emphasis will need to be on precautions against the accidental spread of a wide range of introduced species now present on the mainland. One unusual problem is the phytoplasma responsible for cabbage tree disease. The vector for this disease is the Australian passionvine hopper, a species that at times infests pukunui on Mauimua and Taranga (I.A.E. Atkinson pers. comm.). There appears to be no practical method of control for the passionvine hopper, although they are eaten by lizards (D.R. Towns pers. obs.) and insectivorous birds such as silvereyes (A. Beauchamp pers. comm.).

13. Other threats

13.1 FIRE

Precautions against fire are provided in a separate fire contingency plan.

13.2 BIOSECURITY

A large number of introduced organisms present on the mainland could have serious effects on the fauna and flora of the Marotere Islands if they were to become established. They include eastern rosellas, Argentine ants, African praying mantis and Australian, North American and European cockroaches, a large fauna of introduced spiders and many species of weeds. Contingencies against invasions of rodents or the release of cats or possums are already in place. However, for many invertebrate pests and weeds, invasion prevention must rely on effective 'border controls'. These include careful cleaning of footwear and clothing to avoid importing unwanted seeds, and care with packing and transport of equipment. Simple precautions include:

- Cleaning of equipment **before use** on the islands. This should include checks for the presence of ants and the egg cases of spiders and preying mantis.
- Transport of equipment in sealable containers.
- On the mainland, storage of all equipment used on islands in a purpose-built facility impervious to most invertebrate pests.
- On the islands, unpacking of equipment in a confined area (preferably a sealed room).
- Restrictions on the use of those food items likely to provide indirect risks to resident species.

If these precautions fail, more expensive (but effective) methods include storage of all equipment in walk-in freezers for 24 hours immediately before their use on the islands.

14. Information needs

The following research and survey topics are those directly associated with this plan. Other more general topics, such as those associated with prevention of rodent invasions, are identified within the Northland Conservation Management Strategy (Anon. 1999). The topics are listed below in priority order.

14.1 METHODS FOR DETERMINING CRITERIA FOR SUCCESS OF RESTORATION

In order for progress with restoration to be assessed, criteria for success need to be defined and regularly measured. The criteria can be species-based as well as system-based. Species-based criteria include success with establishment after species translocations. System-based measures include shifts in dominance of key organisms and the effects these have on the ecological system. For example, they may include measurements of vegetation change due to forest succession, and changes in soil nutrient composition with expansion of burrowing seabird colonies. Other measures can include the use of food web analyses to predict changes in the relationships between categories of organisms (such as consumer and decomposer pathways). Some analyses will need more precise information on the distribution and abundance of seabirds, reptiles and invertebrates than is available at present.

14.2 DIVERSITY AND DISTRIBUTION OF INVERTEBRATES

There have been surveys for land molluscs and spiders, but no comprehensive surveys of the insect fauna of the Marotere Islands. It is therefore difficult to predict how the fauna will change over time, how these changes might affect other organisms, and what sources species are missing from the three largest islands. Some insects, such as honeydew scale, can have significant effects on the carrying capacity of forest habitats for birds and geckos. Other invertebrates, such as giant centipedes, have a significant role as predators whereas tree weta, cave weta and ground weta are important components of the food webs for larger vertebrates including tuatara. Furthermore, species such as large darkling beetles may be a major item in the diet of tuatara, but appear to be absent from the islands previously inhabited by kiore.

14.3 DISTRIBUTION AND ABUNDANCE OF BURROWING SEABIRDS

So far, useful studies have been conducted on the productivity of Pycroft's petrel and little shearwaters and their response to the removal of kiore from Marotere Islands. However, little is known about the distribution and abundance of other species, especially the small seabirds such as diving petrels and fluttering shearwaters, that may recolonise from neighbouring islands—or may still be present in small relict populations. These species may eventually have a significant role in soil structure and fertility because they can form extensive dense colonies.

14.4 VEGETATION CHANGE IN THE MAROTERE ISLANDS

Recent studies by Campbell & Atkinson (1999, 2002) indicate that kiore can have significant effects on the composition of coastal forest. If change within these forests is to be documented, it will be necessary to obtain data on vegetation composition that can be used for comparison with information obtained while kiore were present.

Perhaps concurrently with this, there is a need to identify the distribution and status of species such as shore spurge, coastal cresses and large-flowered broom.

14.5 COMPOSITION OF AQUATIC COMMUNITIES IN FRESHWATER STREAMS

So far there have only been occasional and anecdotal accounts of the flora and fauna of freshwater habitats of the Marotere Islands. Much of this work could be based on Mauimua Island, but there may also be interesting semi-aquatic organisms living in intermittent streams on other islands such as Mauiroto.

14.6 DISTRIBUTION AND BIOLOGY OF KARO WEEVIL

In the Marotere Islands, this species is thought to be confined to Muriwhenua Island where there are only a few potential host plants. Karo weevil may not in fact be confined to karo, so the distribution and abundance of the species on Muriwhenua needs to be assessed, and possible hosts on the larger islands determined for inclusion in reintroduction proposals.

14.7 DISTRIBUTION AND BIOLOGY OF *COPROSMA* WEEVIL

Unlike the karo weevil, this species appears less sensitive to the effects of kiore, since it survived on Mauiroto. Distribution and host use on this and other islands in the group still needs to be determined.

14.8 REINTRODUCTION OF LARGE DARKLING BEETLE

This species is abundant on parts of Muriwhenua Island. Translocation methods are being developed in the Mercury Islands. Once these methods are refined, a source of animals and appropriate habitats for their reintroduction to the three large Marotere Islands will need to be identified. This reintroduction strategy should be linked to wider insect surveys that determine the distribution of all populations of the species within the group.

14.9 DISTRIBUTION AND HOST AVAILABILITY FOR HONEYDEW SCALE INSECTS

The two species of honeydew scale insects appear to have different susceptibility to habitat modification. The scale on kanuka may be widespread on the larger islands, whereas the scale of ngaio and karo appears confined to the smaller islets. The distribution of both species should be determined, extent of potential hosts for the ngaio/karo species identified, and need for reintroductions from the smaller islets assessed.

14.10 EFFECTS AND POSSIBLE CONTROL OF WASPS

Two groups of wasps are present in the Marotere Islands. *Polistes* or paper wasps are at times extremely abundant. Their effects on native invertebrates are unknown. At present there is no known mechanism for control. The effects of these wasps should be determined and potential for control assessed.

Vespula wasps are usually less abundant. Their nests are often localised, so their eradication from the island may be feasible if the risk of reinvasion from the mainland is low. However, eradication would need to be undertaken simultaneously through the entire group to avoid reinvasion from neighbouring untreated islands.

14.11 DISTRIBUTION AND IMPACTS OF PASSIONVINE HOPPER

The distribution, effects and possible natural predation of passionvine hopper should be investigated. Islands with expanding gecko populations may be less prone to the effects of the insect and the phytoplasma it spreads, if the geckos prey on this species. The potential for damage by passionvine hopper on islands with and without kiore should be determined.

14.12 POTENTIAL FOR DETRIMENTAL INTERACTIONS BETWEEN REINTRODUCED SPECIES, ESPECIALLY LIZARDS

The *Cyclodina* skink recovery plan (Towns 1999) identified the need to assess interactions between species of lizards that no longer coexist but are proposed for restoration projects. For example, in the Marotere Islands, McGregor's skinks and Mokohinau skinks have been released on Mauimua and Mauipae. The possibility of one species eventually excluding the other needs to be investigated.

15. Summary of tasks

Actions required within each group of organisms are summarised in Table 5 (overleaf). Some of these actions will remain broad in scope until detailed approaches are refined.

TABLE 5. SUMMARY OF PRIORITY ACTIONS OVER THE NEXT FIVE YEARS ON THE MAROTERE ISLANDS, WITH THE ACTIONS TIMED FROM DATE OF ACCEPTANCE OF THE PLAN. LOW-PRIORITY TASKS OR THOSE REQUIRED AFTER THE FIRST FIVE YEARS HAVE NOT BEEN INCLUDED.

PRIORITY	ACTION	EXPLANATION	PERFORMANCE MEASURE	TIMING
Plants				
High	Surveys on Mauiroto for shore spurge	Recorded in 1970, but not recently confirmed	Confirmation of presence or absence and assessments of the size of the population if still present	Within two years
High	Assessments of the distribution, abundance and identity of coastal cress species	The coastal cress recovery plan (Norton & de Lange 1999) defines objectives for management of two species present: <i>Rorippa divaricata</i> and <i>Lepidium oleraceum</i>	Confirmation of presence or absence and assessments of the size of the population if still present, recommendations for future management in the Marotere Is	Within two years
Moderate	Analysis of vegetation changes in the Marotere Is	The most recent assessments of vegetation succession were conducted on Mauimua in 1984. This and all other mapping assessments of the effects of kiore removal are to be obtained, this mapping needs to be repeated as soon as possible	Vegetation maps of the Marotere Is Analyses of successional change in the absence of kiore. Recommended monitoring protocols	Within five years
Invertebrates				
High	Surveys of aquatic and terrestrial invertebrates (other than spiders and land snails) in the Marotere Is	The species composition of most invertebrate communities is unknown for the Marotere Is. Some large invertebrates, such as large darkling beetles, can disappear from islands inhabited by rodents. Surveys are needed to confirm this	Report on distribution of terrestrial invertebrates of all islands in the group. Assessment of species requiring translocation within the group (e.g. darkling beetles) and definition of source populations	Within three years
Moderate	Distribution and abundance of karo weevil on Muriwhenua	So far, karo weevils in the Marotere Is are known only from Muriwhenua	Assessment of potential to use Muriwhenua weevils for translocation	Within five years
Moderate	Definition of the host range and habitats of karo weevil	Karo weevils are present in the Poor Knight Is which, like the larger Marotere Is, provide a wide range of host plants	Habitat profile for use in translocation plan of karo weevil	Within five years
Moderate	Surveys of distribution and abundance of pupuharakeke on Mauipae	This is the only living population of pupuharakeke in the Marotere	Assessment of the distribution, density and rate of range expansion of pupuharakeke	Within five years
Moderate	Translocation of <i>Amborhytida</i> snails from Taranga	The Taranga population is the only potential source of these snails for the Marotere Is (subject to additional surveys and criteria for concluding absence of the snails from the Marotere Is)	Location of suitable populations for translocation to Marotere Translocation plan for <i>Amborhytida</i> snails	Within five years
Reptiles				
High	Surveys of the lizards of Mauimua	Specific searches are needed for translocated species and for those likely to be candidates for translocation (e.g. common gecko)	Assessment of success of translocations of skinks and geckos; recommendations for future translocations	Within two years
Moderate	Surveys of the lizards of Mauipae	Specific searches are needed for translocated Mokohinau skinks five years after the release; and searches are needed for those likely to be candidates for translocation (e.g. Pacific gecko, common gecko)	Assessment of success of skink translocation; assessment of need for future translocations	Within five years
Birds				
High	Surveys of the distribution of seabirds in the Marotere Is	Considerable data are available for Pycroft's petrel and little shearwaters on Mauimua and Mauipae. Few data for Mauiroto. Specific need to identify whether species apparently confined to smaller islets are established elsewhere	Assessment of seabird distribution and composition early in recovery following kiore removal, especially fluttering shearwaters and diving petrels	Within two years
Pests				
High	Impacts of <i>Vespula</i> wasps on the island system	<i>Vespula</i> wasps have disappeared from or never colonised some islands	Assessment of the potential for permanent removal of <i>Vespula</i> wasps and their likely capacity for recolonisation	Within two years
Moderate	Ecology and effects of <i>Polistes</i> wasps	<i>Polistes</i> wasps are extremely abundant on some parts of the Marotere Is, but their effect on local species is unknown	Assessment of potential or need for control	Within five years
Measures of success				
High	Measures of ecosystem change	Ecosystems on islands without introduced mammals are strongly influenced by the activities of seabirds. Their recovery and spread in the Marotere Is may therefore influence many other components of the system, including plant succession	Measurements of the effects of seabirds and succession on ecosystem function. Development of performance measures for restoration	Within one year

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Appendix 1

BIOLOGICAL RESOURCES THAT MAY BE INCLUDED IN THE RESTORATION OF MAROTERE ISLANDS

TABLE A1.1. INDIGENOUS SPECIES CERTAINLY ONCE PRESENT ON MAROTERE ISLANDS, MOSTLY NOW CONFINED TO SMALL ISLETS IN THE GROUP. Suffix ^t indicates nationally threatened.

COMMON NAME	ECOLOGICAL ROLE	DISTRIBUTION	COMMENTS
Cook's scurvey grass ^t	Appears to prefer fertile soils near bird colonies	Only known from five plants on Mauitaha	Could be encouraged to replace the introduced? <i>L. pseudotasmaticum</i> around bird burrows on the larger islands (see Cameron 1984; Norton & de Lange 1999)
Large-flowered broom ^t	Nectar source	On Araara and Sail Rock	Does not appear to produce viable seedlings in the presence of kiore
Common gecko	Coastal and forest dwelling, feeds on invertebrates, fruit, nectar and honeydew	Muriwhenua and Wareware, Middle Stack	Seems to be absent from the three largest islands; surveys needed
Mokohinau skink ^t	Appears to be coastal scrub inhabitant, probably feeds on invertebrates and fruit	Muriwhenua and Wareware, Pupuha and Middle Stack	Re-introduced to Mauimua, Mauiroto and Mauipae
Honeydew scale	Infests ngaio and karo; important energy source for honey-eating birds and geckos	Appears confined to naturally rat-free small stacks	Capacity to recover depends on presence of ngaio and regenerating karo. Surveys needed, may have survived on cliffs
Karo weevil ^t	Large flightless, live-wood borer of ngaio and karaka	Muriwhenua	Habits and hosts on Muriwhenua unknown other than present on karaka (see Watt 1986)
Large darkling beetle	Large flightless beetle that feeds on algae on tree trunks; prominent in the diet of tuatara on rat-free islands	Muriwhenua and probably other small rat-free stacks	Not known to have survived on any islands previously inhabited by kiore
<i>Amborhytida</i> snail ^t	Predatory land snail	Taranga	Subfossil remains on Mauimua pre-date the arrival of kiore c. 200 years ago
Small land snail, <i>Phrixganthus paralaomiformis</i>	Probably a detritus feeder of fungi and algae	Confined to eastern Northland, nearest living populations on Poor Knights Is	Apparently a recent extinction on Mauimua, possibly following fires and cattle browsing; surveys needed on other Marotere Is

TABLE A1.2. INDIGENOUS SPECIES VERY LIKELY TO HAVE BEEN PRESENT ON MAROTERE ISLANDS—PRESENT ELSEWHERE IN THE ECOLOGICAL DISTRICT. Suffix ^t indicates nationally threatened.

COMMON NAME	ECOLOGICAL ROLE	DISTRIBUTION	COMMENTS
McGregor's skink ^t	Large nocturnal ground-dwelling skink, feeds on invertebrates	Sail Rock and Bream Is	Released on Mauimua in 1997-98 and Mauiroto in 2000. No further releases are planned for the Marotere Is
Tieke	Invertebrate feeder with poor powers of flight	Last natural population on Taranga	Already translocated to Mauimua and Mauiroto, self-introduced to Mauipae

TABLE A1.3. INDIGENOUS SPECIES PRESENT IN THE REGION AND POSSIBLY PRESENT IN THE MAROTERE ISLANDS IN THE PAST.
Suffix [†] indicates nationally threatened.

COMMON NAME	ECOLOGICAL ROLE	DISTRIBUTION	COMMENTS
Northland tusked weta	Unclear	Scattered through Northland with the nearest at Whananaki	Sufficient habitat may be present; translocations to islands not identified as a priority in weta recovery plan (Sherley 1998)
Wetapunga [†]	Very large herbivorous weta	Nearest natural population on Hauturu	Ideal habitat for this species; probably present on all Marotere Is
Robust skink [†]	Large forest-dwelling nocturnal skink that feeds on litter invertebrates	Nearest population in Mokohinau Is	Subfossil remains present on the adjacent mainland (Waipu Caves) indicate this species was once widespread through the region. Release onto Mauipae proposed in <i>Cyclodina</i> skink recovery plan
Banded rail	Feeds on ground-dwelling invertebrates	Nearest population in Poor Knights Is	Appear to be highly mobile and may recolonise naturally
Rifleman	Feeds on arboreal invertebrates, mostly in mature forest	Nearest natural population on Hauturu	Tolerant of kiore so reason for absence from Taranga and Marotere Is unclear. Would colonise all Marotere Is if released on one. Very long-term prospect if at all
Robin	Feeds on invertebrates, often on ground	Nearest natural population on Hauturu	Tolerant of kiore so reason for absence from Taranga and Marotere Is unclear. Would colonise all Marotere Is if released on one. Potential effects on reintroductions of invertebrates in Marotere Is would need assessment. Very long-term prospect if at all
Hihi/Stitchbird [†]	Nectar feeder that also feeds on insects and fruit	Last remaining natural population on Hauturu	Attempted release on Taranga failed. No island release self-sustaining for reasons unknown. Not clear if suitable habitat is present in Marotere Is
Shore plover [†]	Feeds on intertidal invertebrates	Nearest natural population in Chatham Is	Appears unable to survive with introduced predators
Snipe [†]	Insect feeder at ground level and in subsurface layers	Last specimens collected from Hauturu in 1890s	May once have been present in Marotere Is. Appears unable to survive with introduced predators, including kiore (Holdaway 1999)
Spotless crane	Insect feeder at ground level	Nearest resident population in Poor Knights Is	Highly mobile, already seen on Mauimua and may establish naturally
White-faced storm petrel	Nocturnal predators of Crustacea and plankton in open oceans	Nearest breeding population in Mokohinau Is	Appears confined to islands free of rodents. May not be able to recolonise naturally due to high site fidelity (Taylor 1990). Needs surveys to check for relict populations in Marotere Is
Whitehead	Feeds on invertebrates	Nearest natural population on Hauturu	Tolerant of kiore so reason for absence from Taranga and Marotere Is unclear. Would colonise all Marotere Is if released on one. Very long-term prospect if at all

TABLE A1.4. THREATENED INDIGENOUS SPECIES PRESENT IN THE REGION AND PROBABLY NOT SUITABLE FOR RELEASE.

COMMON NAME	ECOLOGICAL ROLE	DISTRIBUTION	COMMENTS
Brown teal	Feeds on vegetation and invertebrates	Wetlands in Northland	Unlikely to have formed self-sustaining populations due to lack of permanent fresh water; if ever present, probably a straggler
Kiwi	Litter-probing invertebrate feeder	Hauturu I. and Northland	Little-spotted kiwi already released on Taranga; unlikely to be sufficient area for self-sustaining populations on any Marotere Is; could detrimentally affect ground-dwelling invertebrates and reptiles
Kokako	Feeds on vegetation, fruit and invertebrates	Northland podocarp-kauri forest	May be sufficient habitat on Taranga, but probably not sufficient habitat and resources on Marotere Is; not identified as future translocation site in recovery plan (Innes & Flux 1999)
Weka	Omnivore. Feeds on invertebrates, reptiles, ground-living birds and their eggs	Northland but disappeared by the 1960s	Would establish on Taranga and Marotere Is, but likely to have devastating effects on ground-living invertebrates, reptiles and on some seabirds; not proposed in recovery plan for release onto these islands because of impacts on threatened or uncommon species (Beauchamp et al. 1999)

Appendix 2

SCIENTIFIC NAMES OF SPECIES MENTIONED IN THE TEXT

Suffix ^a indicates adventive species.

COMMON NAME	SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME
Plants			
Boxthorn ^a	<i>Lycium ferocissium</i>	Cabbage white butterfly ^a	<i>Pieris rapae</i>
Brush wattle ^a	<i>Paraserialthes lophantha</i>	'Coprosma' weevil	<i>Praolepra</i> sp.
Coastal cress	<i>Rorippa divaricata</i>	Daddy-long-legs spider ^a	<i>Pholcus phalangitoides</i>
Coastal maire	<i>Nestegis apetala</i>	Darkling beetle	<i>Mimopeus</i> spp.
Cook's scurvy grass	<i>Lepidium oleraceum</i> agg.	European wasp ^a	<i>Vesputula</i> spp.
Five-finger	<i>Pseudopanax arboreus</i>	Flax snail	<i>Placostylus bongii</i>
Flax	<i>Phormium</i> sp.	Giant centipede	<i>Cormocephalus rubriceps</i>
Forget-me-not ^a	<i>Myosotis sylvatica</i>	Ground weta	<i>Hemiandrus</i> sp.
Kanuka	<i>Kunzea ericoides</i>	Honeydew scale	<i>Coelostomidia zelandica</i>
Karaka	<i>Corynocarpus laevigatus</i>	Kanuka honeydew scale	<i>Coelostomidia wairoensis</i>
Karo	<i>Pittosporum crassifolium</i>	Karo weevil	<i>Anagotus turbotti</i>
Kikuyu ^a	<i>Pennisetum clandestinum</i>	Kauri snail	<i>Paryphanta busbyi busbyi</i>
Kohekohe	<i>Dysoxylum spectabile</i>	Koura	<i>Paranepbrops planifrons</i>
Kowhai	<i>Sopora chatbamica</i>	Large darkling beetle	<i>Mimopeus opaculus</i>
Large-flowered broom	<i>Carmichaelia williamsi</i>	Northland tusked weta	<i>Hemiandrus monstrosus</i>
Mahoe	<i>Meliccytus ramiflorus</i>	Passionfruit hopper ^a	<i>Scolypopa australis</i>
Manuka	<i>Leptospermum scoparium</i>	Small darkling beetle	<i>Mimopeus elongatus</i>
Mapou	<i>Myrsine australis</i>	Tree weta	<i>Hemideina thoracica</i>
Mawhai	<i>Sicyos angulata</i>	Wetapunga	<i>Deinacrida heteracantha</i>
Mexican devil ^a	<i>Ageratina adenophora</i>	Fish	
Milktree	<i>Stebulus banksii</i>	Banded kokopu	<i>Galaxias fasciatus</i>
Mist flower ^a	<i>Ageratina riparia</i>	Longfin eel	<i>Anguilla dieffenbachii</i>
Montbretia ^a	<i>Crococsmia x crocosmitiflora</i>	Shortfin eel	<i>Anguilla australis</i>
Moth plant ^a	<i>Araujia sericifera</i>	Short-jawed kokopu	<i>Galaxias postvectis</i>
Ngaio	<i>Myoporum laetum</i>	Reptiles	
Nikau	<i>Rhopalostylus sapida</i>	Common gecko	<i>Hoplodactylus maculatus</i>
Pampas grass ^a	<i>Cortaderia selloana, C. jubata</i>	Copper skink	<i>Cyclodina aenea</i>
Parapara	<i>Pisonia brunoniana</i>	Duvaucel's gecko	<i>Hoplodactylus duvaucelii</i>
Pigeonwood	<i>Hedycarya arborea</i>	McGregor's skink	<i>C. macgergori</i>
Pohutukawa	<i>Metrosideros excelsa</i>	Mokohinau skink	<i>Cyclodina</i> sp.
Pukanui	<i>Meryta sinclarit</i>	Moko skink	<i>Oligosoma moco</i>
Puriri	<i>Vitex lucens</i>	Ornate skink	<i>C. ornata</i>
Shore spurge	<i>Euphorbia glauca</i>	Pacific gecko	<i>Hoplodactylus pacificus</i>
Smilax ^a	<i>Asparagus asparagoides</i>	Robust skink	<i>C. alani</i>
Taraire	<i>Beilschmiedia taraire</i>	Shore skink	<i>O. smithi</i>
Taurepo	<i>Rhabdothermus solandri</i>	Suter's skink	<i>O. suteri</i>
Tawa	<i>Beilschmiedia tawa</i>	Tuatara	<i>Sphenodon punctatus</i>
Tawapou	<i>Pouteria costata</i>	Birds	
Invertebrates		Banded rail	<i>Rallus philippensis</i>
African praying mantis ^a	<i>Miomantis caffra</i>	Bellbird	<i>Anthornis melanura</i>
Argentine ant ^a	<i>Linepithema humile</i>	Blackbird ^a	<i>Turdus merula</i>
Asian paper wasp ^a	<i>Polistes chinensis</i>	Brown teal	<i>Anas chlorotis</i>
Australian paper wasp ^a	<i>Polistes humilis</i>	Diving petrel	<i>Pelecanoides urinatrix</i>
		Eastern rosella ^a	<i>Platycercus eximius</i>

COMMON NAME	SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME
Flesh-footed shearwater	<i>Puffinus carneipes</i>	Shining cuckoo	<i>Chalcites lucidus</i>
Fluttering shearwater	<i>P. gavia</i>	Shore plover	<i>Thinornis novaeseelandiae</i>
Grey-faced petrel	<i>Pterodroma macroptera</i>	Snipe	<i>Coenocorypha aucklandica</i>
Harrier	<i>Circus approximans</i>	Sooty shearwater	<i>Puffinus griseus</i>
Hihi or stitchbird	<i>Nottomystis cincta</i>	Spotless crane	<i>Porzana tabuensis</i>
Kingfisher	<i>Halcyon sancta</i>	Starling ^a	<i>Sturnus vulgaris</i>
Kiwi	<i>Apteryx</i> spp.	Thrush ^a	<i>Turdus philomelos</i>
Kokako	<i>Callaeas cinerea</i>	Tieke or saddleback	<i>Ptilesturnus carunculatus</i>
Kukupu or kereru	<i>Hemiphaga novaeseelandiae</i>	Tui	<i>Prosthemadera novaeseelandiae</i>
Little shearwater	<i>Puffinus assimilis</i>	Weka	<i>Gallirallus australis</i>
Long-tailed cuckoo	<i>Eudynamis taitensis</i>	White-faced storm petrel	<i>Pelagodroma marina</i>
Morepork	<i>Ninox novaeseelandiae</i>	Whitehead	<i>Mobua albicilla</i>
Myna ^a	<i>Acridotheres tristis</i>	Mammals	
Pycroft's petrel	<i>Pterodroma pycrofti</i>	Cat ^a	<i>Felis catus</i>
Red-crowned kakariki	<i>Cyanoramphus novaeseelandiae</i>	Kiore or Pacific rat ^a	<i>Rattus exulans</i>
Rifleman	<i>Acanthisitta chloris</i>	Norway rat ^a	<i>Rattus norvegicus</i>
Robin	<i>Petroica australis</i>	Possum ^a	<i>Trichosurus vulpecula</i>